Draft Environmental Impact Statement
Plan Formulation Appendix

Upper San Joaquin River Basin Storage Investigation

Prepared by:

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

U.S. Department of the Interior
Bureau of Reclamation

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Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

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

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Abbreviations and Acronyms

°F	degrees Fahrenheit
ADMA	Aquatic Diversity Management Area
Banks	Harvey O. Banks Pumping Plant
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BDCP	Bay Delta Conservation Plan
BLM	U.S. Department of the Interior, Bureau of Land Management
BMP	best management practices
BO	biological opinions
CALFED	CALFED Bay-Delta Program
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFRF	concrete face rockfill
cfs	cubic feet per second
CMS	comprehensive mitigation strategy
CNDDB	California Natural Diversity Database
Comprehensive Study	Comprehensive Study for the Sacramento and San Joaquin River Basins
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
CWC	California Water Code
CY	cubic yard
D-1641	State Water Resources Control Board Decision-1641
DBCP	dibromochloropropate
DDT	dichlorofiphenyl-trichloroethane
Delta	Sacramento-San Joaquin Delta
DMC	Delta-Mendota Canal
DMC/CA	Delta-Mendota Canal/California Aqueduct
DRMS	Delta Risk Management Strategy
DWR	California Department of Water Resources
EDT	Ecosystem Diagnosis and Treatment
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EQ	environmental quality

ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FR	Feasibility Report
FWUA	Friant Water Users Authority
GWh	gigawatt hours
IAIR	Initial Alternatives Information Report
IDC	interest during construction
Investigation	Upper San Joaquin River Basin Storage Investigation
JPOD	joint point of diversion
KRCD	Kings River Conservation District
LLIS	low-level intake structure
M&I	municipal and industrial
MAF	million acre-feet
msl	mean sea level
MW	megawatt
MWD	Metropolitan Water District of Southern California
NAHC	Native American Heritage Commission
NED	national economic development
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOD	north-of-Delta
NODOS	North-of-the-Delta Offstream Storage
O&M	operations and maintenance
OSE	other social effects
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PEIS/R	Programmatic Environmental Impact Statement/Report
PFR	Plan Formulation Report
PG&E	Pacific Gas and Electric Company
RCC	roller-compacted concrete
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RED	regional economic development
RM	River Mile
RMP	Resource Management Plan

ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
SAR	smolt-to-adult return rate
SCE	Southern California Edison
Settlement	San Joaquin River Stipulation of Settlement
SHPO	State Historic Preservation Office
SJRG	San Joaquin River Gorge
SRMA	Special Recreation Management Area
SJRRP	San Joaquin River Restoration Program
SJVAPCD	San Joaquin Valley Air Pollution Control District
SLIS	selective level intake structure
SMT	Study Management Team
SOD	south-of-Delta
SRA	State Recreation Area
State Water Board	State Water Resources Control Board
State	State of California
SWP	State Water Project
SWPPP	Stormwater Pollution Prevention Plan
TAF	thousand acre-feet
TCD	temperature control device
TDS	total dissolved solids
TMDL	total maximum daily load
Uniform Act	Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
WAM	Water Analysis Module

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Chapter 1
Introduction

This document is the Plan Formulation Appendix of the Draft Environmental Impact Statement (EIS) for the Upper San Joaquin River Basin Storage Investigation (Investigation). The Investigation is led by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), in cooperation with the California Department of Water Resources (DWR). The purpose of the Investigation is to determine the type and extent of Federal, State of California (State), and regional interest in a potential project to expand water storage capacity in the upper San Joaquin River watershed to (1) improve water supply reliability and flexibility of the water management system for agricultural, municipal and industrial (M&I), and environmental uses; and (2) enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish.

The Investigation is one of five surface water storage studies recommended in the CALFED Bay-Delta Program (CALFED) Final Programmatic Environmental Impact Statement/Report (PEIS/R) and Record of Decision (ROD) of August 2000. Preliminary studies in support of the CALFED PEIS/R considered more than 50 surface water storage sites throughout California and recommended more detailed study of the five sites identified in the ROD (CALFED 2000a, 2000b, 2000c). The Draft EIS, pursuant to the National Environmental Policy Act (NEPA), tiers from the CALFED PEIS/R and ROD (CALFED 2000a and 2000b) for specific purposes related to development of the project purpose and the range of reasonable alternatives.

Federal authorization for the Investigation was initially provided in Public Law 108-7, Division D, Title II, Section 215, the omnibus appropriations legislation for fiscal year 2003, enacted in February 2003. This act authorized the Secretary of the Interior to conduct feasibility studies for several storage projects identified in the CALFED ROD (2000a), including the Investigation:

> *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.*

Additional authorization was given in Public Law 108-361, Title I, Section 103, Subsection (d)(1)(A)(ii), the Water Supply, Reliability, and Environmental Improvement Act, signed October 25, 2004:

> *Planning and feasibility studies for the following projects requiring further consideration – ...(II) the Upper San Joaquin River storage in Fresno and Madera Counties.*

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

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

Progress and results of the Investigation have been documented in a series of interim reports that will culminate in a Final Feasibility Report and Final EIS, consistent with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (WRC 1983); Reclamation policies, and directives and standards; State policy and guidance; and applicable environmental laws, regulations, and policies.

This Plan Formulation Appendix incorporates previous planning documents prepared for the Investigation by reference, including the *Phase 1 Investigation Report* (Reclamation and DWR 2003), *Initial Alternatives Information Report* (IAIR) (Reclamation and DWR 2005), *Plan Formulation Report* (PFR) (Reclamation and DWR 2008), and *Draft Feasibility Report* (Reclamation 2014). The Draft Feasibility Report and Draft EIS address the results of the feasibility study process and build on the results and findings of previous Investigation planning documents, as well as the CALFED PEIS/R and ROD (CALFED 2000a and 2000b).

After a detailed plan formulation and site selection process that narrowed the reservoir sites through a phased set of evaluations, Temperance Flat River Mile (RM) 274 Reservoir was identified as the site to be carried forward for detailed feasibility design and evaluation. Evaluations were conducted in progressively greater levels of detail as the number of sites was reduced, and considered the ability to achieve project objectives, purpose and need, environmental impacts, constructability, and cost.

Appendix Purpose

This Plan Formulation Appendix describes the plan formulation process and its application in developing action alternatives for the Investigation. Water resources problems, needs and opportunities, and likely future water supply conditions are identified, followed by planning objectives and constraints for developing action alternatives to respond to the identified problems and opportunities. This appendix documents the iterative formulation and evaluation process, which includes the development of management measures considered, the process of refining the project site, features, operations, and the development of action alternatives for the purposes of the Federal feasibility study. Finally, the appendix describes the action alternatives that are evaluated and compared in the Draft EIS.

Appendix Organization

This Plan Formulation Appendix is organized as follows:

Chapter 1 describes the process for formulating and evaluating potential action alternatives consistent with the study authorizations, and defines planning objectives and planning constraints, considerations, and criteria.

Chapter 2 identifies management measures that could address the planning objectives and satisfy the other planning constraints, considerations, and criteria.

Chapter 3 describes the analysis conducted for and documented in the Plan Formulation and Draft Feasibility phases of the Investigation.

Chapter 4 provides a description of the features, operations, and accomplishments of action alternatives carried forward for analysis in the Draft EIS

Chapter 5 contains the sources used to prepare this appendix. Information presented in this appendix is used to support discussions in the Draft EIS.

Plan Formulation Process

The plan formulation process for the Investigation is consistent with Reclamation's directives and standards for *Water and Related Resources Feasibility Studies* (CMP 09-02) and the P&G (WRC 1983) and consists of the following steps:

1. **Identify Problems, Needs, and Opportunities**. Specific problems, needs, and opportunities within the study area will be identified, planning goals and objectives established, and significant constraints identified. This first step corresponds to the NEPA requirement to define the purpose and need. In addition to the requirements of the P&G, the planning goals and objectives will reflect the direction provided in the authorizing legislation, as well as the views of the study team, cooperating agencies, various stakeholders, and the public.

2. **Inventory Existing Resources and Forecast Future Conditions**. This step will quantify relevant water and related resource conditions as they currently exist within the study area and forecast future conditions over the period of analysis. This step confirms the problems, needs, and opportunities to be addressed in the subsequent steps. The inventory and forecast will provide information for understanding existing conditions and establishing a baseline for forecasting with- and without-project conditions. "Inventory Existing Resources" corresponds to the NEPA requirement to identify the affected environment. "Forecast Future Conditions" generally relates to the NEPA requirement to identify the No Action Alternative.

3. **Formulate Alternative Plans**. Alternative plan formulations will focus on solutions that are practicable, feasible, and meet the planning objectives. A reasonable range of potential plans are initially investigated, and as those plans are refined, some will be eliminated. The action alternatives developed at this stage will determine the range of reasonable action alternatives, as required for the NEPA analysis. The viability of an alternative will be determined through an evaluation of its acceptability, efficiency, effectiveness, and completeness as required in the P&G.

4. **Evaluate Potential Effects of Alternative Plans**. The beneficial and adverse effects of each alternative plan will be evaluated through comparison to the without-plan scenario in accordance with the P&G. The evaluation of alternatives is part of the NEPA alternatives analysis, in which the No Action Alternative and action alternatives are described, evaluated, and compared. The potential effects of action alternatives are displayed in terms of public costs and benefits.

5. **Compare Alternative Plans**. Plans will be compared in accordance with the P&G. The comparison of action alternatives is also part of the NEPA alternatives analysis. The plan that reasonably maximizes net public benefits will be identified.

6. **Select a Recommended Plan**. The study team will recommend a decision to take no Federal action or to select a recommended plan based on the comparison of action alternatives and rationale. The alternative plan with the greatest net economic benefits is to be selected as the recommended plan, in accordance with the P&G. Selection of another plan that does not provide the greatest net economic benefits requires a Secretarial Exception.

The planning process is led by a multiple-agency planning team of professional water resources planners, engineers, environmental scientists, and subject matter experts, and involves the input and participation of concerned stakeholders, advisory groups, regulatory agencies, and members of the general public. This Plan Formulation Appendix documents the plan formulation process as the basis for decision making by the Secretary of the Interior and Congress. Cooperating agencies and entities, including the State, will participate in this decision-making process.

Progress and results of the Investigation have been documented in a series of interim reports that will culminate in this EIS and the Feasibility Report. The Feasibility Report is the final planning report in the feasibility study process and builds on the results and findings of previous interim planning. The complete plan formulation approach and feasibility study process for the Investigation is shown in Figure 1-1 and described below.

- **Phase 1 –** During this phase, 17 possible reservoir sites in the upper San Joaquin Valley were identified and evaluated, and 6 were selected for continued study, including a raise of Friant Dam/enlargement of Millerton Lake. Formal initiation of NEPA and CEQA process also began in this phase, through the Notice of Intent/Notice of Preparation and public scoping activities.

- **Initial Alternatives Phase –** During this phase, 24 reservoir measures were evaluated (based on location and size), many with multiple alternative hydropower generation options. In addition, several initial water operations scenarios addressing various planning objectives were identified and evaluated. Enlargement of Millerton Lake and three new reservoir sites (Temperance Flat RM 274 Reservoir, Temperance Flat RM 279 Reservoir, and Fine Gold Reservoir) were selected for continued study.

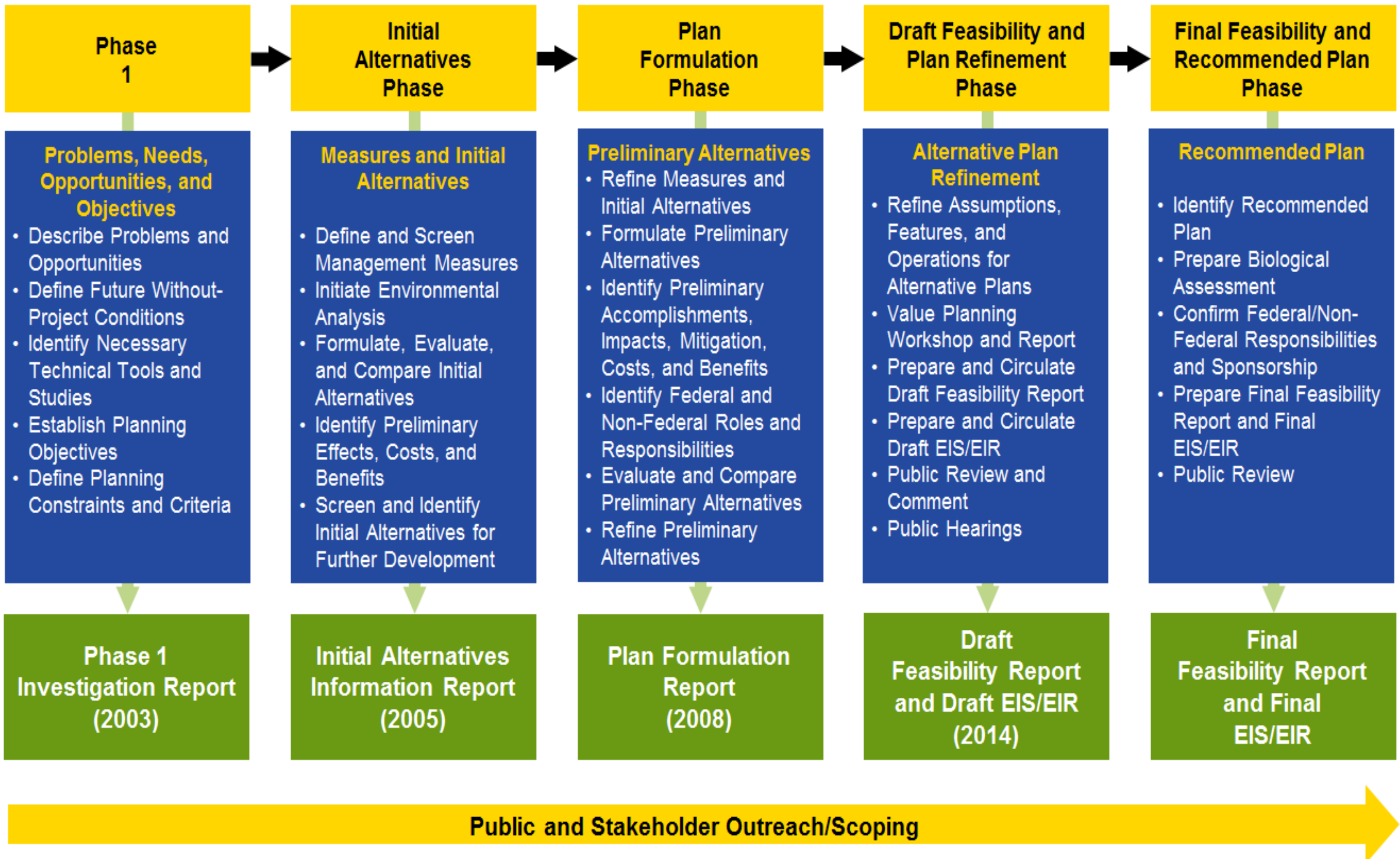

Figure 1-1. Plan Formulation Process

- **Plan Formulation Phase** –Analyses conducted during this phase refined initial alternatives to four groupings of alternatives, based on two dam site locations and inclusion/exclusion of a new Trans Valley Canal. The four groupings of alternatives were then evaluated based on P&G planning criteria, ability to address planning objectives, purpose and need, and meet planning constraints and considerations. The Temperance Flat RM 274 Reservoir grouping of alternatives (without the Trans Valley Canal) was retained for detailed feasibility design and evaluation.

- **Draft Feasibility and Plan Refinement Phase –** This phase focused on further physical features and operations refinement of the action alternatives to identify a plan suitable to be recommended for implementation. This phase includes preparing and circulating a Draft Feasibility Report and Draft EIS.

- **Final Feasibility and Recommended Plan Phase –** The next phase of the Investigation will focus on responding to comments, identifying a recommended plan, and confirming Federal and non-Federal responsibilities. This phase will conclude with responding to comments on the Draft EIS and preparing and publishing a Final EIS and a Final Feasibility Report to support a Federal recommendation and a Congressional decision.

Reclamation, DWR, and cooperating agencies carried out public and stakeholder outreach activities throughout the plan formulation process, as shown in Figure 1-1.

Study Area

The San Joaquin River is California’s second longest river and discharges to the Sacramento-San Joaquin Delta (Delta) and, ultimately, to the Pacific Ocean through San Francisco Bay. Originating high in the Sierra Nevada, the San Joaquin River carries snowmelt and rainfall runoff from mountain meadows south of Yosemite National Park to the valley floor near Fresno. Tributaries to the San Joaquin River from the east include the Merced, Tuolumne and the Stanislaus rivers; small streams, sloughs, wetlands, and agricultural drainage provide inflow from the west. The upper San Joaquin River Basin encompasses the San Joaquin River and tributary lands upstream from its source high in the Sierra Nevada to its confluence with the Merced River. Friant Dam and Millerton Lake are located on the upper San Joaquin River about 20 miles northeast of Fresno.

The Study Area evaluated in this Draft EIS includes both a primary and extended study area to reflect the localized effects of a potential new major dam and reservoir at upstream from Friant Dam in the upstream portion of Millerton Lake, and the effects of subsequent water deliveries over a larger geographic area. The primary study area was refined as the Investigation progressed and the number and location of feasible storage sites was narrowed. The primary study area includes the following (Figure 1-2):

- San Joaquin River upstream from Friant Dam to Kerckhoff Dam, including Millerton Lake and the area that would be inundated by the proposed Temperance Flat RM 274 Reservoir (Temperance Flat Reservoir area)
- Areas that could be directly affected by construction-related activities, including the footprint of proposed temporary and permanent facilities upstream from Friant Dam

The extended study area includes other locations of potential project features and areas potentially affected by action alternative implementation and/or operation. The extended study area encompasses the following (Figure 1-3):

- San Joaquin River downstream from Friant Dam, including the Delta
- Lands served by San Joaquin River water rights
- Friant Division of the Central Valley Project (CVP), including underlying groundwater basins in the eastern San Joaquin Valley
- South-of-Delta (SOD) water service areas of the CVP and State Water Project (SWP)

Detailed descriptions of the Study Area and existing conditions for physical, biological, cultural, and socioeconomic resources within the Study Area are included in the Draft EIS.

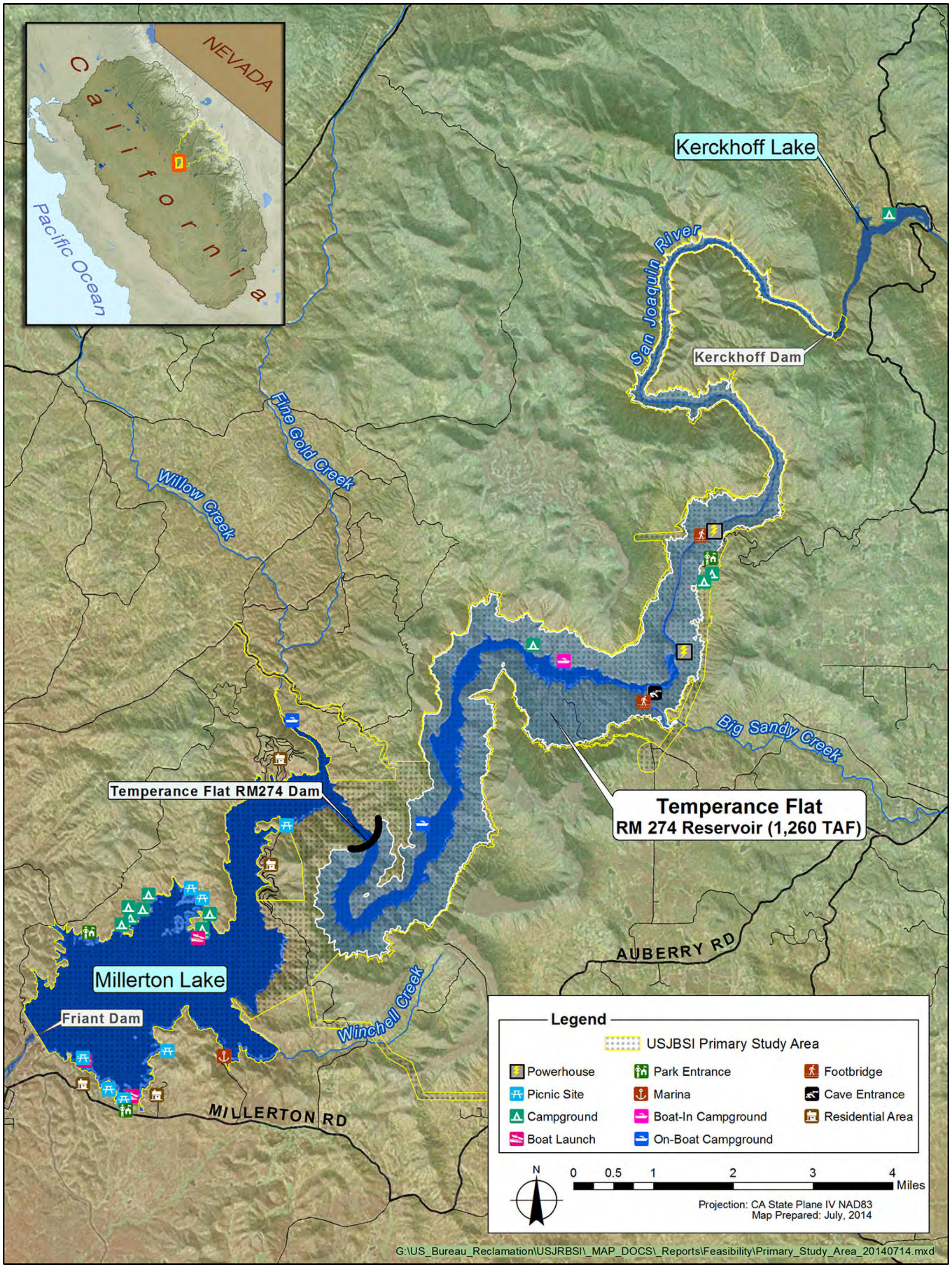

Figure 1-2. Primary Study Area Including Proposed Temperance Flat RM 274 Reservoir and Dam

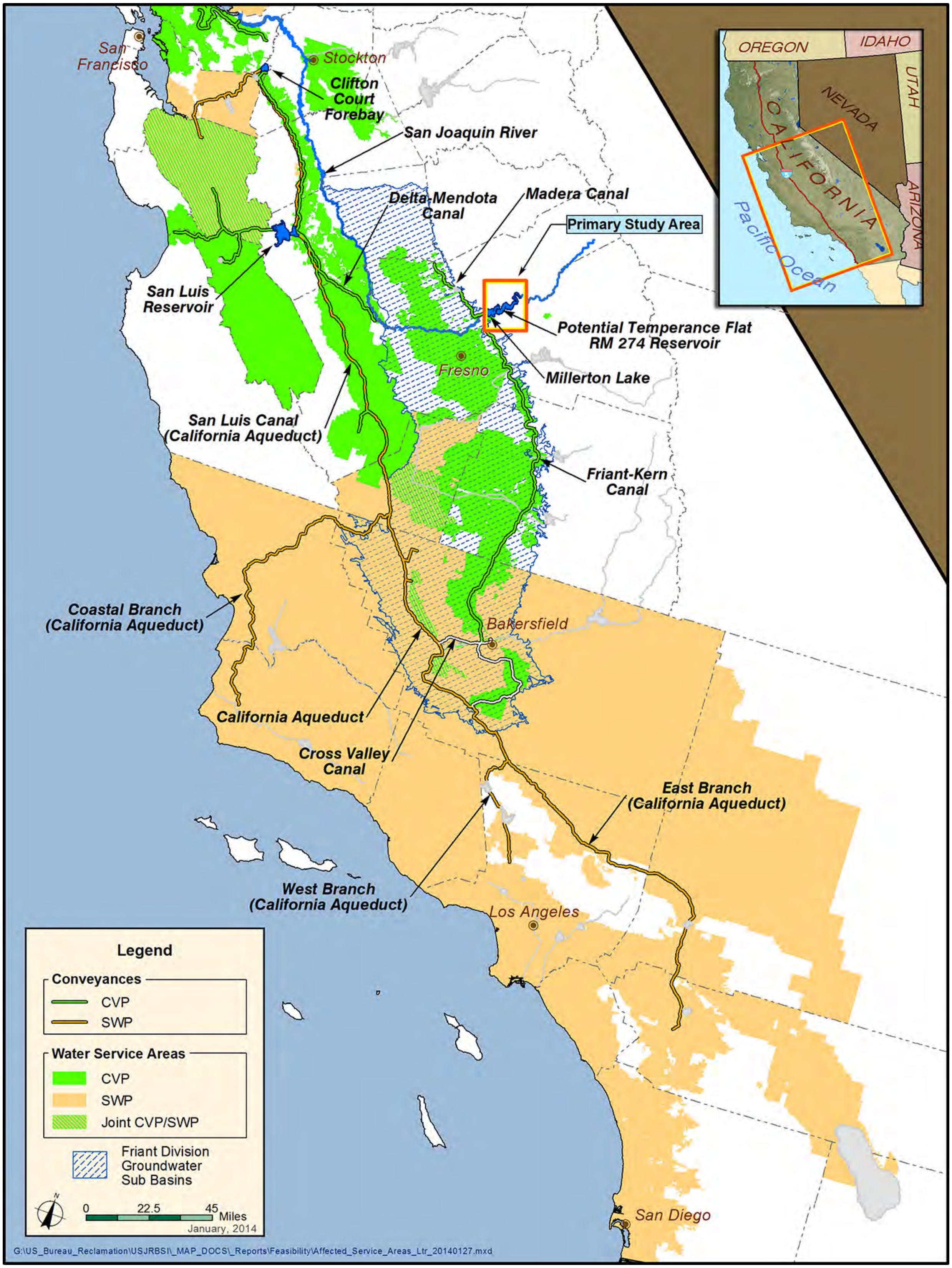

Figure 1-3. Extended Study Area

Water and Related Resources Problems, Needs, and Opportunities

Problems and needs to be addressed by the Investigation were identified in the CALFED ROD (2000a) and from stakeholder input. The primary purposes identified in the CALFED ROD for developing and managing additional water supplies from the upper San Joaquin River Basin include contributing to restoration of and improving water quality for the San Joaquin River, facilitating conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities.

These purposes were identified, in part, because of ongoing litigation and studies at the time. Over the past 14 years since the signing of the CALFED ROD in 2000, some of the without-project conditions have changed significantly, especially through the San Joaquin River Restoration Program (SJRRP), which implements the Stipulation of Settlement (Settlement) reached in *NRDC et al. v. Kirk Rodgers et al.*, as authorized in 2009 by the San Joaquin River Restoration Settlement Act (Settlement Act). The Settlement contains two primary goals:

- **Restoration Goal –** To restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence with the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.

- **Water Management Goal –** To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

Additional changes include acceleration of water supply reliability decline throughout the state of California, especially in the Central Valley.

Based on the overall authority of the Investigation, concerns expressed about existing and likely future water and related resources issues, and the Settlement, the following is a description of identified major water resources problems, needs, and opportunities that could be addressed in plan formulation for the feasibility study.

Water Supply Reliability and Operational Flexibility

California's water supply system faces critical challenges with demands exceeding supplies for urban, agricultural, and environmental (fisheries, wildlife refuges) water uses across the State. The *2009 California Water Plan Update* (DWR) concludes that California is facing one of the most significant water crises in its history, drought impacts are growing, ecosystems are declining, water quality is diminishing, and climate change is affecting statewide hydrology. Compounding these issues, Reclamation's *Water Supply and Yield Study* (2008b) describes dramatic increases in population, land-use changes, regulatory requirements, and limitations on storage and conveyance facilities further straining available water supplies and infrastructure to meet water demands. Resulting unmet water demands have increased competition for water supplies among urban, agricultural, and environmental uses.

Water supply reliability and operational flexibility problems and needs for the CVP Friant Division and SOD contractors, similar to those throughout the State, are associated with large annual hydrologic variations in water availability, regulatory constraints, and the limited capacity of current water storage and conveyance facilities. Projected demands exceed supply for agriculture, urban, and environmental purposes.

In the Friant Division of the CVP, the 520 thousand acre-foot (TAF) storage capacity of Millerton Lake is small relative to the average annual inflow of approximately 1.8 million acre-feet (MAF) and limits Reclamation's ability to capture additional water in wet years. Contracts in the Friant Division of the CVP differ from contracts elsewhere in the CVP, and are based on two classes due to the storage limitations. Class 1 contracts encompass the first 800 TAF per year of CVP contract water supply developed at Friant Dam, which at the time of their issuance generally corresponded to the estimated annual firm yield of the Friant Division of the CVP. Class 1 contracts are held by districts that have limited or no access to groundwater, or are underlain by impaired groundwater. Class 2 contracts total 1,400 TAF per year and apply to CVP contract water supplies that exceed 800 TAF in wetter years. Class 2 contracts are held by districts that have access to groundwater and can use groundwater during drier years. Class 2 water supplies are used either in lieu of groundwater pumping or for active groundwater recharge.

This two-class contract structure was designed and is operated to support conjunctive water management to reduce groundwater overdraft in the eastern San Joaquin Valley. Annual allocation of water to Friant Division long-term contractors varies widely in response to hydrologic conditions (Figure 1-4). The limited storage capacity has even resulted in less than full Class 2 allocations in years when significant flood releases are made.

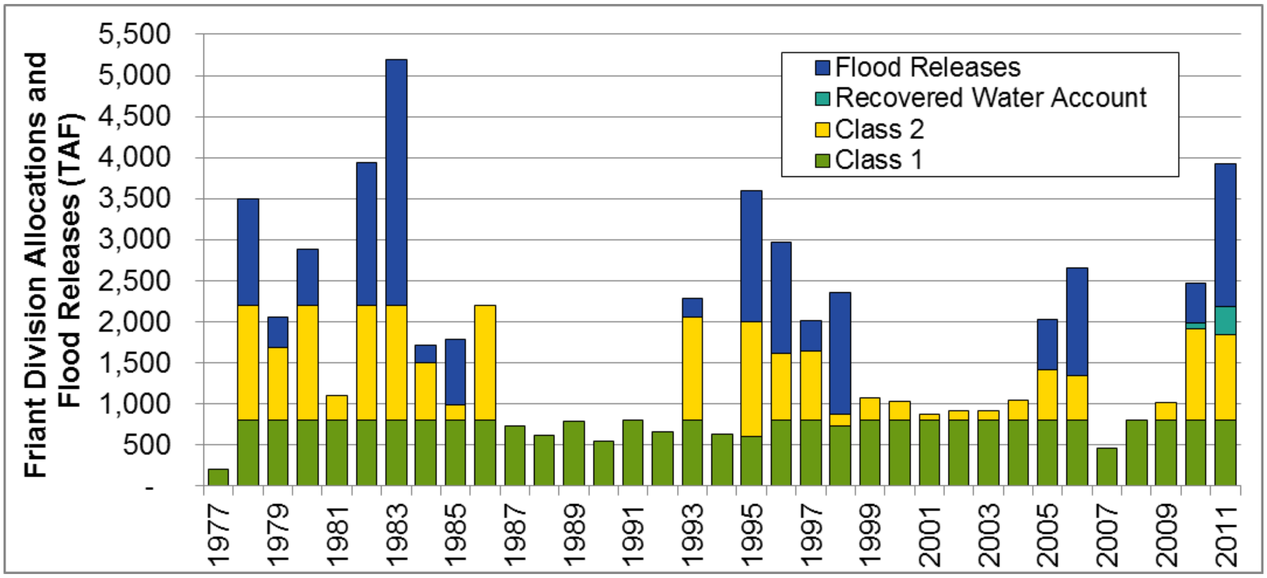

Figure 1-4. Friant Division Allocations and Flood Releases, 1977 – 2011

During dry periods when surface water deliveries are reduced, many water contractors rely heavily on groundwater to meet water demands. Although surface water deliveries from Friant Dam help reduce groundwater pumping and contribute to groundwater recharge, the groundwater basins in the eastern San Joaquin Valley remain in a state of overdraft in most years (i.e., more groundwater is pumped out than is replenished either naturally or artificially).

The continued general downward trend of groundwater levels reveals that considerable water supply reliability problems remain. Moreover, it is expected that the continued downward trend in groundwater levels may result in localized areas of impaired groundwater quality, and may ultimately reduce water use and irrigated acreage in the San Joaquin Valley.

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

Estimated Water Supply Shortages

Projecting accurate and quantified water supply and shortages in California is complex; there are numerous variables and, just as important, numerous opinions regarding these variables. Table 1-1 shows estimated water demands, available supplies, and shortages for the Central Valley and the State under existing conditions (Reclamation 2008). Current water supply shortages for the State are estimated at 2.3 MAF and 4.2 MAF for average and dry years, respectively. As shown in Table 1-2, without further investment in water management and infrastructure, future statewide shortages are expected to increase to approximately 4.9 MAF and 6.1 MAF in average and dry years, respectively, by 2030. Representative demands for dry and average years were based on water use data from the *2005 California Water Plan Update* (DWR 2005), adjusted for population growth, increasing urban water use, and reductions in irrigated acreage and environmental flow due to insufficient water supplies. Shortages were determined on a regional basis, assuming that limitations on conveyance and storage would prevent surpluses from one region or use category from filling shortages in another.

Full implementation of SJRRP Restoration Goal actions will reduce water deliveries to Friant Division long-term contractors by up to 180 TAF per year. Water Management Goal actions in the Settlement will reduce this amount, but are not expected to eliminate water supply reductions. As a result, groundwater overdraft conditions are expected to increase and the rate of long-term groundwater level decline is expected to accelerate compared to conditions without the SJRRP (SJRRP 2012).

Table 1-1. Estimated Water Demands, Supplies, and Shortages under Existing Conditions

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

Notes:

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

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

[3] Population estimates are from the California Department of Finance (2010)

[4] Total shortages are calculated as the sum of shortages for each category by region and, therefore, may not equal the difference between total demands and supplies. For categories where supply is greater than demand, the shortage is equal to zero.

Key:
MAF = million acre feet

Table 1-2. Estimated Water Demands, Supplies, and Shortages for 2030

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

Notes:
[1] Water demands, supplies, and shortages are from the *Water Supply and Yield Study* (Reclamation 2008).
[2] Representative dry and average year supplies and demands were based on water use and supply data from the *2005 California Water Plan Update* (DWR 2005) adjusted for population growth, increasing urban water use, and reductions in irrigated acreage and environmental flow due to insufficient water supplies.
[3] Population estimates are from the California Department of Finance (2010)
[4] Total shortages are calculated as the sum of shortages for each category by region and, therefore, may not equal the difference between demands and supplies. For categories where supply is greater than demand, the shortage is equal to zero.
Key:
MAF = million acre feet

Potential Effects of Population Growth on Water Demands

A major factor in California's future water picture is population growth. California's population is expected to increase by 36.9 percent from 2010 to 2050 (California Department of Finance 2012a, 2012b) and could force some of the existing water supplies currently identified for agricultural uses to be redirected to urban uses. Some portion of increased population in the Central Valley would occur on lands currently used for irrigated agriculture. Water that would have been needed for these lands for irrigation would instead be used to serve replaced urban demands. However, this would only partially offset the required agricultural-to-urban water conversion needed to sustain projected urban water demands, since much of the growth would occur on nonirrigated agricultural lands.

The *2009 California Water Plan Update* (DWR) estimates changes in future water demands by 2050 considering three different population growth scenarios as well as climate change. Table 1-3 shows results of this study for an average water year (DWR 2009). The first scenario (Current Trends) assumes that recent population growth trends will continue until 2050. The second scenario (Slow and Strategic Growth) assumes that population growth will be slower than currently projected. The third scenario (Expansive Growth) assumes that population growth will be faster than currently projected, with nearly 70 million people living in California in 2050. Estimated reductions in agricultural water demands in Table 1-3 represent decreases in future agricultural water demands due to conversion from agricultural to urban land uses. Under the Current Trends and Expansive Growth scenarios, as much as 3 MAF and 8 MAF, respectively, of increased demand is projected, adding to the current water shortages estimated in Table 1-1.

Table 1-3. Estimated Annual Change in Water Demand in California for 2050 Considering Different Population Growth Scenarios

Item	Current Trends	Slow and Strategic Growth	Expansive Growth
Population (million)	59.5	44.2	69.8
Irrigated Crop Acreage (million)	8.6	9	8.3
Water Demand Change[1] (MAF)			
Urban	7	2	11
Agricultural	-4.5	-5.5	-4
Environmental	1	2	1
Total	3	-1.5	8

Source: DWR 2009a

Note:

[1] Water demand change is the difference between the average demands for 2043—2050 and 1998—2005.

Key:

MAF = million acre-feet

Potential Effects of Climate Change on Water Supply and Demand

Another potentially significant factor affecting water supply reliability is climate change. Potential impacts due to climate change are many and complex (DWR 2006a), varying through time and geographic location across the State (Reclamation 2011a). Changes in geographic distribution, timing, and intensity of precipitation are projected for the Central Valley

(Reclamation 2011a), which could broadly impact rainfall-runoff relationships important for flood management as well as water supply. Additionally, when climate change is considered in projections of future water demand, annual water demand is higher than under a repeat of historical climate (DWR 2009). Other possible impacts range from potential sea-level rise, which could impact coastal areas and water quality, to impacts to overall system storage for water supply.

A reduction in total system storage is widely predicted to occur with climate change. Precipitation held in snowpack makes up a significant quantity of total annual supplies needed for urban, agricultural, and many environmental uses. It is expected that in the future, climate change may significantly reduce water held in snowpack in the Sierra Nevada (Reclamation 2011a, DWR 2009). Further potential for reductions in water conservation space in existing reservoirs in the Central Valley is anticipated because of increasing needs for additional space for flood management purposes. These potential reductions could significantly impact available water supplies. During drought periods, supplies could be further reduced, and expected shortages would be significantly greater. Possible effects of climate change on water supply in California are discussed in greater detail in the Modeling Appendix.

System Flexibility

In addition to concerns about current and future water supplies and demands, California's Federal and State water systems lack flexibility in timing, location, and storage capacity to fully meet their multiple purposes. The flexibility of the CVP and SWP has diminished over time as population continues to grow and environmental and ecosystem commitments and requirements continue to increase (Reclamation 2008).

Complicating this issue is the variability associated with water resources in California, coupled with anticipated changes in future supply and demand. Variability and uncertainty are the dominant characteristics of water resources in the State (Delta Stewardship Council 2012). Precipitation in California is seasonably, temporally, and spatially variable. In addition, urban, agricultural, and environmental water users have variable needs for quantity, quality, timing, and place of use. Challenges will be greater during drought years, when available surface water for agricultural and environmental purposes is in short supply, resulting in user turning to pumping from an overdrafted groundwater system, and exacerbating overdraft (DWR 2009).

Additionally, Delta vulnerabilities introduce opportunities related to system flexibility. More than half of Californians rely on water conveyed through the Delta for at least part of their water. The Delta faces extraordinary risks in both the near term and the long term, including earthquakes, river floods, sunny day levee failures, and continuing subsidence and sea-level rise (DWR 2009). Previous analyses suggest that a catastrophic levee failure would result in cessation of pumping capacity for as much as 18 months, causing $30 billion to $40 billion in economic damage to the State (DWR 2009).

Urban and required environmental water uses have each increased, resulting in increased competition and conflicting demands for limited water supplies. Increasing CVP and SWP operational constraints have reduced the timing and volume of available water supply for agricultural and urban uses, leading to growing competition for limited water resources. For example, the Central Valley Improvement Act (CVPIA), implemented in 1993, dedicated 800 TAF of CVP water supplies to the environment as well as additional water supplies for the Trinity River and wildlife refuges. Table 1-4 illustrates the impacts of the CVPIA, modeled using CalSim II, on urban and agricultural water deliveries to the north and south of the Delta. Dry year agricultural water deliveries were particularly impacted with deliveries to agricultural users, both NOD and SOD, reduced by about 50 percent.

Current CVP and SWP operational conditions are described in the 2008 *Formal ESA Consultation on the Proposed Coordinated Operations of the CVP and SWP* (USFWS 2008b) and the 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (NMFS 2009), collectively known as the 2008/2009 BOs. The 2008/2009 BOs have resulted in increased Delta pumping constraints and other operational restrictions, coupled with drought conditions, and have even further decreased CVP deliveries. As competition for limited resources grows, water management flexibility and adaptability will be even more necessary in the future.

Table 1-4. Impact of CVPIA on CVP Deliveries

CVP Contract Deliveries	All Years			Driest Years		
	Pre-CVPIA (TAF)	Post-CVPIA (TAF)	Percent Change	Pre-CVPIA (TAF)	Post-CVPIA (TAF)	Percent Change
NOD Urban	176	167	-5%	166	145	-13%
NOD Agriculture	279	234	-16%	169	84	-50%
SOD Urban	134	122	-9%	114	96	-16%
SOD Agriculture	1,588	1,137	-28%	931	471	-49%
Total	2,176	1,660	-24%	1,381	796	-42%

Source: Reclamation 2008
Note:
[1] Deliveries were modeled using CalSim II.

Key:
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
NOD = north of Delta
SOD = south of Delta
TAF= thousand acre-feet

San Joaquin Valley Refuge Water Supply

Securing a reliable water supply of sufficient quality has long been recognized as an important component for sustaining wetland habitats in the Central Valley and waterfowl of the Pacific Flyway, and supporting other wildlife species that depend on wetland habitat (Reclamation, et al. 2001). Of the 19 Central Valley refuges and managed wetlands, 10 SOD refuges and managed wetlands are served via Mendota Pool along the San Joaquin River. These refuges and managed wetlands include Grassland Resource Conservation District (GRCD), Los Banos Wildlife Area (WA), Mendota WA, Volta WA, the North Grasslands WA Complex's Salt Slough and China Island units, and the San Luis National Wildlife Refuge Complex's San Luis, West Bear Creek, Freitas, and Kesterson units (Reclamation).

The CVPIA Refuge Water Supply Program (Section 3406(b)), Reclamation is required to provide firm and reliable water supplies of suitable quality to maintain and improve wetlands and wildlife habitat on 19 specific Central Valley wildlife refuges. Numerous biological benefits have resulted from a reliable year-round water supply that adequately meets the delivery schedule for wetland management on CVPIA refuges (Reclamation 2012). Water supplies developed through the Refuge Water Supply Program also allow refuge managers to "flush" excess salts from wetlands while improving soil quality (Reclamation 2012).

Reclamation is currently implementing activities, such as shifted demand scheduling, reallocation of Level 2 supplies to other refuges, and supply flexibility options that are strategically prioritized, to improve coordinated management of refuge water supplies and lessen impacts to other water users (Reclamation 2012). Additionally, Level 2 diversification opportunities, which could provide mutual benefits to refuges and agricultural water service contractors, are being pursued.

Strategies to Address Water Supply Needs

As noted by Reclamation's *Water Supply and Yield Study* (2008b), the *California Water Plan Update 2009* (DWR 2009), *A CVP Yield Feasibility Investigation Report: The Delivery Impact of the CVPIA* (Reclamation 2005a), CALFED (2000a), and the *Least-Cost Yield CVP Increase Plan* (Reclamation et al. 1995), an integrated portfolio of solutions, regional and statewide, is needed to meet future water supply needs. The *Water Supply and Yield Study* stated that a "variety of storage and conveyance projects and water management actions have the potential to help fill [the] gap" between water supply and demand in California.

The *California Water Plan Update 2009* (DWR 2009) concluded that California must invest in reliable, high-quality, and affordable water conservation; efficient water management; and development of water supplies to protect public health, and improve California's economy, environment, and standard of living. However, even with major efforts by multiple agencies to address the complex water resources issues in the State, demands are expected to continue to exceed supplies in the future.

To avoid major impacts to the economy, overall environment, and standard of living in California, future water resource plans must consider additional water sources to increase supply reliability for expanding M&I uses and to maintain adequate supplies for agricultural and environmental purposes. Water management flexibility and adaptability will become even more necessary in the future to meet the challenges associated with increasing population, environmental needs, and climate change. Additionally, future water planning for the State should increase urban water use efficiency, recycling municipal supplies, and improving Delta conveyance through programs, such as the Bay Delta Conservation Plan (BDCP).

San Joaquin River Ecosystem

The San Joaquin River is undergoing extensive change. Large portions of the section of the river from Friant Dam to the Merced River (see Figure 1-5) have been historically dry because of water diversions at Friant Dam, which resulted in generally unhealthy ecosystem conditions for the native cold water fishery. Ongoing actions by the SJRRP are restoring this portion of the river to establish naturally-producing and self-sustaining Chinook salmon (*Oncorhynchus tshawytscha*). The actions included in the Selected Alternative described in the SJRRP ROD (Reclamation 2012) are included in the future conditions evaluated in this Draft EIS. Achievement of the Settlement goals is independent of any alternatives evaluated in this Draft EIS.

Restoration Flows began January 1, 2014, and will be increased gradually over the next several years up to the full flows specified in the Settlement, as channel capacity allows. The stipulated releases to the San Joaquin River vary by water year type and range from about 556 TAF during wet years to 71 TAF during critical-high years. These flows represent the quantity of flows released from Friant Dam in addition to the volume of flows required to satisfy riparian diversions between Friant Dam and Gravelly Ford and maintain 5 cfs of flow at the Gravelly Ford gage station. There are also provisions for an additional buffer flow of up to 10 percent for release to the river; releases to address unexpected seepage losses; flushing flows to enhance gravel conditions for spawning during wet and normal-wet years; and riparian recruitment flows during wet years.

The Settlement includes the reintroduction of spring-run and fall-run Chinook salmon. The Settlement implementing agencies have been conducting various fisheries studies on Chinook salmon requirements and habitat conditions in the San Joaquin River between Friant Dam and the Merced River and are performing initial reintroduction activities.

Chinook salmon populations are known to be affected by many factors, including water temperature and flow conditions. Implementing the flow and restoration provisions of the Settlement is expected to achieve the Restoration Goal; no additional commitment of water supply for Restoration Flows is required, but opportunities exist to enhance temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish.

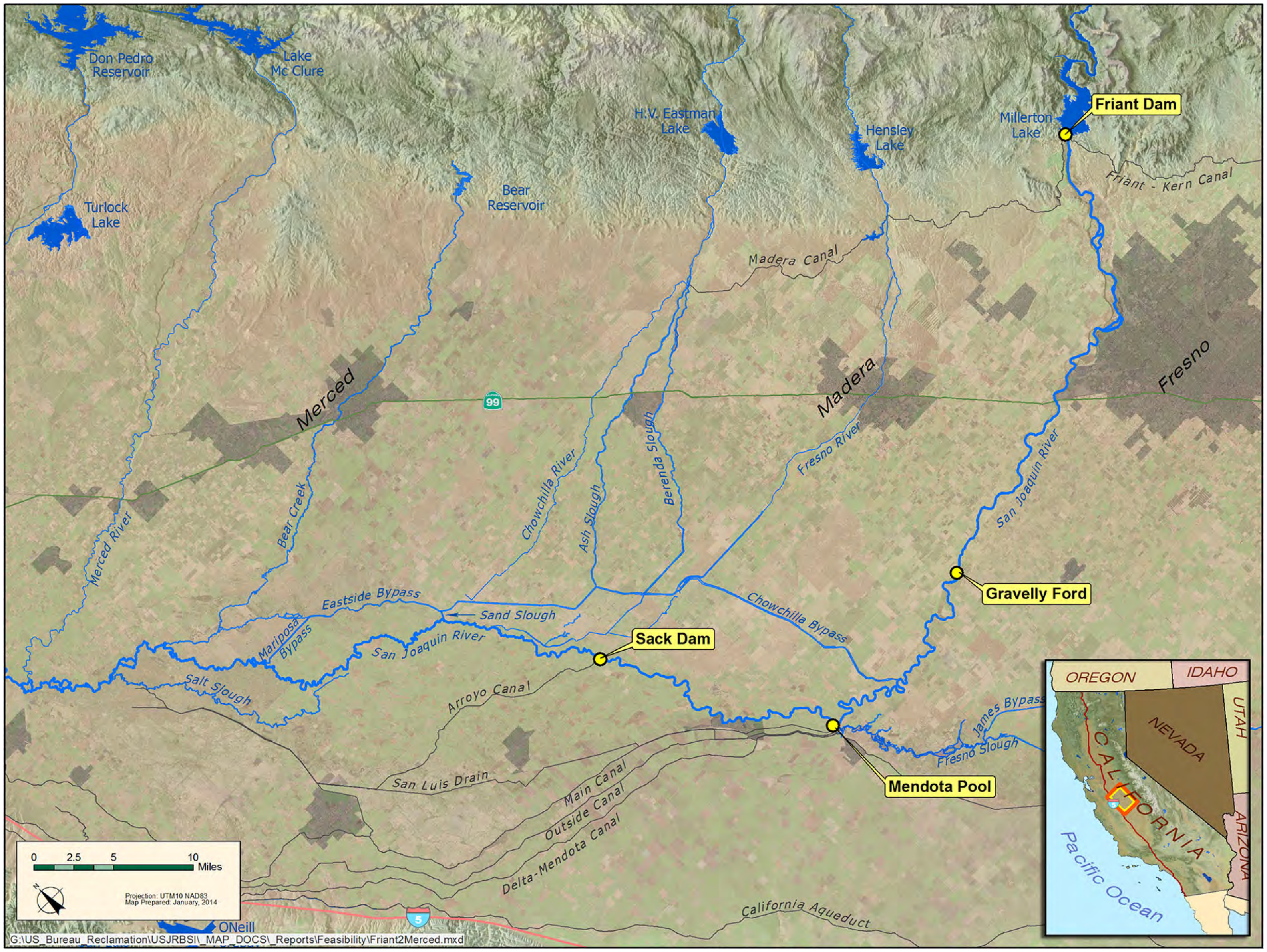

Figure 1-5. San Joaquin River from Friant Dam to Merced River

Flood Damage Reduction

Annual unimpaired runoff at Friant Dam from the upper San Joaquin River basin ranges from about 360 TAF to 4,600 TAF, with an average of 1,800 TAF (water years 1901-2007). Millerton Lake, at approximately 520 TAF in volume, is often undersized to adequately manage annual inflows, underscoring the need for additional storage. Flood operations at Friant Dam are based on anticipated precipitation and snowmelt runoff and the operations of upstream reservoirs. Flood releases from Friant Dam are maintained, when possible, at levels that could be safely conveyed through the San Joaquin River and Eastside Bypass. Generally, flood operations target releases at or below 8,000 cfs downstream from Friant Dam.

Major storms during the past 3 decades have demonstrated that Friant Dam has little capacity to store water from large runoff events. For example, between 1977 and 2011 flood control releases from Friant Dam totaled almost 17 MAF, and flood releases were made in about 50 percent of the years. January 1997 flood flows of nearly 60,000 cfs from Friant Dam resulted in levee failures and extensive downstream flooding.

As part of the Comprehensive Study, the USACE assessed system performance during major floods in the last 2 decades. The study found that Friant Dam was effective in reducing damages during floods, but that substantial damages were still experienced during recent flood events (USACE and The Reclamation Board 2002). The Comprehensive Study also developed a set of systemwide tools to simulate flood system performance for the entire San Joaquin River Basin. Under existing conditions, expected annual damages from flooding were estimated as $29 million in the San Joaquin River Basin.

Energy Generation and Management

Hydropower long has been an important element of power supply in California both from in-state and out-of-state sources. Hydropower currently supplies between 14 and 19 percent of California's annual electrical energy generation, depending on hydrologic conditions (CEC 2014). About 7.5 percent of electrical generation supplying the United States on a capacity basis comes from hydropower (U.S. Energy Information Administration 2014). Because of its ability to rapidly increase and decrease power generation rates, hydropower is often used to provide load-following generation both during on- peak and off-peak periods. Hydropower is also able to smooth and firm renewable generation such as wind and solar generation.

Demands for power are expected to increase as population, industry, and associated infrastructure growth occurs in the future. Over the next 10 years, California's peak demand for electricity is expected to increase up to 18 percent from about 278,000 gigawatt-hours (GWh) to 328,000 GWh (CEC 2013). There are, and will continue to be, increasing demands for new electrical energy supplies, including clean energy sources, such as hydropower.

Renewable energy generation from solar and wind facilities is also expected to increase in response to Executive Orders S-14-08 and S-21-09, issued in 2008 and 2009, respectively, which established a goal of using renewable energy sources for 33 percent of the State's energy consumption by 2020 (California Public Utilities Commission 2011). Increased power demand and renewable energy production will increase needs for energy management and storage facilities, like hydroelectric powerplants with water storage, that could provide energy and ancillary services to the grid as needed.

Recreation

As the population of the State of California continues to grow, demands would increase for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. Demands for water-based and land-based recreational opportunities in the San Joaquin River Basin are high. Some of these demands are served by reservoirs on the western slope of the Sierra Nevada. In the primary study area, regional population growth is expected to result in increased demand for recreation at Millerton Lake and increased visitation (Reclamation 2008a).

San Joaquin River Water Quality

Water quality in various segments of the San Joaquin River downstream from Mendota Pool has been a problem for several decades due to low flow and poor quality discharges from agricultural areas, wildlife refuges, and M&I treatment plants. Over time, regulatory requirements for water quality in the river have become more stringent and the number of locations along the river at which specific water quality objectives are identified and monitored has increased. Water quality conditions in the San Joaquin River would likely improve through implementation of the San Luis Drainage Feature Reevaluation selected alternative for lands draining to the San Joaquin River, SJRRP actions, and various total maximum daily loads (TMDL), including the San Joaquin River at Vernalis Salt and Boron TMDL and Basin Plan Amendment for the Control of Salt and Boron Discharges into the San Joaquin River upstream from Vernalis. However, the extent of water quality improvements is difficult to anticipate until water quality monitoring and analyses are completed for these actions.

Urban Water Quality

Water pumped from the Delta is the source of drinking water for approximately 25 million people in California. Delta water supplies generally contain elevated concentrations of bromide and organic carbon during late summer and early fall months. This increases drinking water treatment costs in urban areas and limits the use of Delta supplies for blending with other sources. In addition to conflicts among management of Delta water supplies for environmental, agricultural, and urban uses that reduce the reliability of water deliveries from the Delta, an increasing emphasis on facilitating exchanges and operational flexibility would place additional demands on water supplies and conveyance systems. A complementary action recommended for continued study in the CALFED ROD under the Conveyance and Water Quality programs was to facilitate water quality exchanges and similar programs to make available high-quality Sierra Nevada water in the eastern San Joaquin Valley to urban interests receiving water from the Delta (CALFED 2000a).

Several environmental flow goals and objectives in the Central Valley, including the Delta, have been established through legal mandates to address the impacts of water operations and water quality deterioration on the San Joaquin River Basin and Delta ecosystems and on endangered and threatened fish populations. Planning efforts, such as the BDCP, are intended allow implementation of projects that restore and protect water supply and reliability, water quality, and ecosystem health in the Delta to proceed within a stable regulatory framework. Additional operational flexibility is needed to provide further opportunities to improve San Joaquin River and Delta water quality conditions.

Likely Future Conditions

Identification of the magnitude of potential water resources and related problems, needs, and opportunities in the study area is based not only on the existing conditions, but also on an estimate of how these conditions may change in the future. Predicting future changes to the physical, biological, cultural, and socioeconomic environments in the primary and extended study areas is complicated by ongoing programs and projects and potential changes in regulatory requirements. Several ecosystem restoration, water quality, water supply, and levee improvement projects are likely to be implemented in the future. Collectively, these efforts may improve temperature and flow conditions in the San Joaquin River, and water supply reliability and system operational flexibility. Much of this improvement would be based on separate opportunities that are not integrated in a single plan or part of an approved and funded program.

The following sections summarize likely future conditions for physical, biological, cultural, and socioeconomic resources within the study area.

Physical Resources Environment

Physical conditions in the primary study area are expected to remain relatively unchanged in the future. No changes to area topography, geology, or soils are foreseen. Without major physical changes to the river systems upstream from Friant Dam (which are unlikely), hydrologic conditions would probably remain unchanged. Over time, projected climate change could impact regional hydrology in the form of changes in snowpack, rainfall, and runoff. Scientific work in this field of study is continuing, as summarized in Chapter 8, "Climate Change."

Physical changes to the San Joaquin River from Friant Dam to the Merced River will occur through implementation of the Settlement. These changes include levee modifications associated with improving habitat conditions in the San Joaquin River, and channel capacity changes to accommodate Restoration Flows.

Settlement implementation will result in changes in hydrologic conditions in the San Joaquin River below Friant Dam. Average annual flood releases from Friant Dam are also anticipated to decrease through Settlement implementation.

A serious consequence of long-term groundwater overdraft in the San Joaquin and Tulare Lake hydrologic regions is land subsidence, or a drop in the natural land surface. Land subsidence results in a loss of aquifer storage space and may cause damage to public facilities such as canals, utilities, pipelines, and roads. Continued groundwater overdraft and land subsidence is expected to continue in the future, as the availability of surface water supplies remains uncertain and deliveries consistently fall below requests (USGS 2013). For example, flows to the San Joaquin River from Friant Dam pursuant to the Settlement have reduced surface water supplies available for irrigation.

Much effort has been expended to control the levels and types of herbicides, fungicides, and pesticides that can be used in the environment. Further, efforts are underway to better manage the quality of runoff from urban environments to major stream systems. Water quality conditions in the future without-project conditions upstream from Friant Dam are expected to generally remain unchanged and similar to existing conditions. However, with implementation of the San Luis Drainage Feature Reevaluation selected alternative, the Settlement, and various TMDLs, water quality conditions downstream from Friant Dam in the future are expected to improve over existing conditions.

Most of the air pollutants in the primary and extended study areas would continue to be influenced by both urban and agricultural land uses. As the population continues to grow, with about 4 million additional people expected in the Central Valley by 2030 and agricultural lands converted to urban centers, a general degradation of air quality conditions could occur.

As the population continues to grow and agricultural lands are converted to urban and industrial uses, a general degradation of air quality conditions could occur. However, because of technological innovation and stringent regulations, air quality could improve over time. While similar types and sources of hazardous materials and waste are likely to be present in the future, increasing population will likely increase the potential for hazardous waste issues. Similarly, an increasing population will likely affect increases in environmental noise and vibration.

Biological Resources Environment

As described earlier, Settlement implementation will include the restoration and maintenance of fish populations in “good condition” in the main stem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish. Additional efforts are underway by numerous agencies and groups to restore various biological conditions throughout the study area. Accordingly, major areas of wildlife habitat, including wetlands and riparian vegetation areas, are expected to be protected and restored below Friant Dam. However, as population and urban growth continues and land uses are converted to urban centers, wildlife and plants dependent on native habitat types may be adversely affected.

Through the efforts of Federal and State wildlife agencies, populations of special-status species in the riverine and nearby areas are estimated to generally remain as under existing conditions, with the exception of increases in anadromous and other fish populations in the San Joaquin River through implementation of projects the SJRRP.

Cultural Resources Environment

In the vicinity of Millerton Lake any paleontological, archaeological, historic, or ethnographic resources currently affected by erosion due to reservoir fluctuations would continue to be impacted. These archaeological sites, and others situated around the perimeter of the existing reservoir, and other accessible locations within the primary study area (both documented and undocumented), would continue to be subject to collection and occasional inadvertent effects from recreation. The Native American community members would continue their ceremonies within the primary study area and would be able to maintain their traditional spiritual connection to the primary study area. They would also continue to gather plant and animal species from historically important areas. Fossils and artifacts located around the perimeter of the existing reservoir will continue to be subject to collection by recreationalists. Similarly, conditions related to the cultural environment downstream from Friant Dam are unlikely to change significantly.

Socioeconomic Resources Environment

The State's population is estimated to increase from approximately 37 million in 2010 to about 40 million by 2020, and to approximately 51 million by 2050. Between 2010 and 2050, Fresno and Madera counties are expected to continue their historic growth trends. According to the California Department of Finance (2012a, 2012b), Fresno County's population is expected to increase by 65.1 percent from 2010 to 2050 to a total of approximately 1,535,761 residents. This represents almost twice the expected percent increase in population of the State as a whole. Growth in Madera County during this period is expected to be even faster than in Fresno County. Madera County's population is expected to increase by

108.5 percent from 2010 to 2050 to a total of approximately 314,546 residents.

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

Increases in population would increase demands for electric, natural gas, and wastewater utilities; public services such as fire, police protection, and emergency services; and water-related and communication infrastructure. The increase in population, and the aging "baby boomer" generation would increase the need for health services. Regional population growth in the vicinity of Millerton Lake is expected to result in increased demand for recreation and increased visitation at Millerton Lake (Reclamation and State Parks 2010). An increasing population would produce employment gains, particularly in retail sales, personal services, finance, insurance, real estate, and health care. Recreation is expected to remain an important element of the community and regional economy.

Anticipated increases in population growth in the Central Valley will also significantly increase demands on water resources systems for additional and reliable water supplies, energy supplies, water-related facilities, recreational facilities, and flood management facilities, as summarized in Table 1-5. As shown in the table, estimated future shortages of water supplies in drought years are expected to be substantial. Increases in population and water demand are expected to continue well beyond the planning horizon of the Investigation.

Table 1-5. Estimated Water Demands, Supplies, and Shortages for 2020

Item	Sacramento and San Joaquin Hydrologic Basins Two-Basin Total		State of California	
	Average Year	**Drought Year**	**Average Year**	**Drought Year**
Population (million)	6.8		47.5	
Urban Use Rate (GPCPD)	274	288	226	233
Acres In Production (million)	4.1		9.2	
Agricultural Use (AFPA)	3.6	3.9	3.4	3.5
Applied Water (MAF)				
Urban	2.1	2.2	12.0	12.4
Agricultural	14.4	15.5	31.5	32.3
Environmental	9.3	6.1	37.0	21.3
Total	***25.8***	***23.9***	***80.5***	***66.0***
Water Supply (MAF)				
Surface Water	20.7	16.0	65.0	43.3
Groundwater	4.9	6.2	12.7	16.0
Recycled/Desalted	0	0	0.4	0.4
Total	**25.6**	**22.2**	**78.1**	**59.7**
Shortage (MAF)	**0.2**	**1.7**	**2.4**	**6.3**

Source: DWR 1998. California Water Plan Update, DWR Bulletin 160-98. November.
Key:
AFPA = acre-feet per acre
GPCPD = gallons per capita per day
MAF = million acre-feet

Purpose and Need for Action

NEPA regulations require a statement of “the underlying purpose and need to which the agency is responding in proposing the alternatives, including the Proposed Action” (40 CFR 1502.13). The California Environmental Quality Act (CEQA) Guidelines require a clearly written statement of objectives, including the underlying purpose of a project (Section 15124(b)). The purpose and need, and objectives provided below are consistent with CALFED objectives, as described in this chapter.

Project Purpose and Need

The purpose of the proposed action is to increase storage of water from the upper San Joaquin River watershed to improve water supply reliability and operational flexibility in CVP San Joaquin Valley areas and other regions of California; and to enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish.

Planning Objectives

This section documents the Federal and State planning objectives, and Investigation-specific objectives, constraints, considerations, and criteria.

The CALFED ROD (2000a) provides a programmatic framework for participating Federal and State agencies to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. Findings in the CALFED ROD established the initial basis for potential Federal interest in the Investigation; hence, the initial objectives identified in the CALFED ROD represent important context for the Investigation-specific planning objectives (2000a). Interpretation of the CALFED ROD objectives for the Investigation has been refined over time to reflect current and projected future conditions, as described in the "Planning Constraints and Other Considerations" section of this chapter.

Federal and State Objectives

The Federal objectives are guided by both the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (WRC 1983), which focuses on national economic development, and encourages projects that maximize public benefits, both monetary and non-monetary.

The Federal objective for water resources planning is defined in the P&G:

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

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

The federal objective to be implemented through the P&R is:

> *The Federal objective, as set forth in the Water Resources Development Act of 2007 (Public Law 110-114, Section 2031), 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 minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and*
> - *protecting and restoring the functions of natural systems and mitigate unavoidable damage to natural systems.*
>
> *In consideration of the many complex water management challenges and competing demands for limited Federal resources, Federal agencies investing in water resources should strive to maximize public benefits, particularly compared to costs. Public benefits encompass environmental, economic, and social goals, including monetary and non-monetary benefits, and allow for the inclusion of quantified and unquantified benefits. Stakeholders and decision makers expect the formulation and evaluation of a diverse range of alternative solutions. Such solutions may produce varying degrees of benefits and/or impacts relative to the three goals specified above. As a result, trade-offs among potential solutions will need to be assessed and properly communicated during the decision-making process.*

DWR requires that economic analyses conducted for programs and projects be conducted fundamentally in accordance with the Federal planning principles defined in the P&G (WRC 1983); however, innovative methods and tools can also be incorporated when appropriate, such as California's comprehensive water legislation, Senate Bill 1, enacted in 2009.

Investigation-Specific Planning Objectives

As a result of changing conditions, and using the CALFED ROD as a general framework, primary and secondary planning objectives were developed based on the problems, needs, and opportunities identified during Phase 1 of the plan formulation process, study authorities, and other pertinent direction, including information contained in the August 2000 CALFED ROD (2000a) and supporting documents. Primary objectives are those for which specific alternatives are formulated to address. The primary planning objectives are considered to have coequal priority, with each pursued to the maximum practicable extent without adversely affecting the other. Secondary planning objectives are actions, operations, or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary objectives.

- Primary Planning Objectives:
  - Increase water supply reliability and system operational flexibility for agricultural, M&I, and environmental purposes in the Friant Division of the CVP, other San Joaquin Valley areas, and other regions of California
  - Enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish
- Secondary Planning Objectives:
  - Reduce flood damages downstream from Friant Dam
  - Maintain the value of hydropower attributes in the study area
  - Maintain and increase recreational opportunities in the study area
  - Improve San Joaquin River water quality downstream from Friant Dam
  - Improve quality of water supplies delivered to urban areas

Planning Constraints and Other Considerations

The P&G provides fundamental guidance for the formulation of Federal water resources projects (WRC 1983). In addition, basic planning constraints and other considerations specific to the Investigation must be developed and identified. Following is a summary of constraints and considerations being used for the Investigation.

Planning Constraints

Planning constraints help guide the feasibility study. Some planning constraints are more rigid than others. Examples of more rigid constraints include congressional direction in study authorizations; other current applicable laws, regulations, and policies; and physical conditions (e.g., topography, hydrology). Other planning constraints may be less restrictive but are still influential in guiding the process. Several key constraints identified for the Investigation are as follows.

Study Authorizations

In 2003, Federal authorization was provided to prepare a Feasibility Report for storage in the upper San Joaquin River Basin (Public Law 108-7, Division D, Title II, Section 215). This act authorized the Secretary of the Interior to conduct feasibility studies for several storage projects identified in the CALFED ROD (2000a), including the Investigation. Additional authorization was given in the October 2004 Water Supply, Reliability, and Environmental Improvement Act (Public Law 108-361). Based on CWC Section 227, State authorization is in place to study reservoirs or reservoir systems for gathering and distributing flood or other water not under beneficial use in any stream, stream system, lake, or other body of water.

CALFED Record of Decision

CALFED was established to "develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system." The 2000 CALFED ROD (CALFED 2000a) includes program goals, objectives, and projects primarily to benefit the Bay-Delta system. The objectives for the Investigation are consistent with the CALFED ROD (CALFED 2000a), as follows:

> *…250-700 TAF of additional storage in the upper San Joaquin River watershed. It would be*

> *designed to contribute to restoration of and improve water quality for the San Joaquin River and facilitate conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities. Additional storage could come from enlargement of Millerton Lake at Friant Dam or a functionally equivalent storage program in the region.*

The ROD has been adopted by various Federal and State agencies as a framework for further consideration, including the Department of the Interior. In addition to objectives for potential additional storage in the upper San Joaquin River Basin, the Preferred Program Alternative in the ROD includes four other potential surface water and various groundwater storage projects to help reduce the gap between water supplies and projected demands. The CALFED ROD described a Storage Program that included five surface water storage projects in the Central Valley as follows:

> *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 will provide much needed flexibility in the system to improve water quality and support fish restoration efforts. Water supply reliability depends on capturing water during peak flows and during wet years.*

The CALFED ROD also includes numerous other projects to help improve the ecosystem functions of the Bay-Delta system. Action alternatives should address the goals, objectives, programs, and projects of the CALFED ROD (2000a).

CALFED conducted an initial screening of a list of 52 potential surface water storage sites to reduce the number of sites to 12, a more manageable number for more detailed evaluation during project-specific studies (CALFED 2000b). CALFED eliminated sites providing less than 200 TAF storage and those that conflicted with CALFED solution principles, objectives, or policies. Further, based on existing information, CALFED identified some potential surface water storage sites that were more promising in contributing to CALFED goals and objectives and more implementable due to relative costs and stakeholder support. The CALFED ROD recommended detailed evaluation of the five most highly rated sites and acknowledged that other sites in the list of 12 could serve as alternatives. Surface water storage sites recommended by CALFED for subsequent evaluation focused on those with the most potential for helping meet CALFED goals and objectives: Shasta Lake Enlargement, Los Vaqueros Reservoir Enlargement, Sites Reservoir, In-Delta Storage, and development of storage in the upper San Joaquin River Basin (CALFED 2000b) (Figure 1-6). Only the In-Delta Storage project was excluded from the Federal feasibility study authorization. Table 1-6 summarizes the CALFED surface water storage site evaluations leading up to the Investigation, as well as the subsequent site evaluations in the interim planning documents for the Investigation to date, which are described further in Chapter 2, "Management Measures," as well as Chapter 3, "Action Alternatives Development."

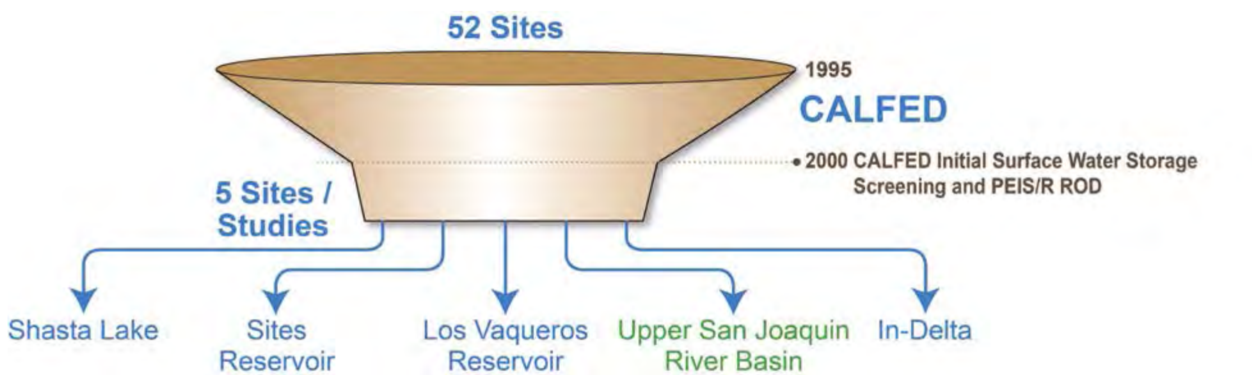

Figure 1-6. CALFED Surface Water Storage Investigations Screening

Table 1-6. CALFED and Upper San Joaquin River Basin Storage Investigation Surface Water Storage Site Evaluations

Year	Activity, Authorization, or Document	Number of Alternative Sites / Notes
1997	CALFED Bay-Delta Program Storage and Conveyance Component Inventories	52 sites identified through an initial inventory of surface storage sites with potential to contribute to improving water management for beneficial uses of the Bay-Delta system
2000	CALFED Initial Surface Water Storage Screening	12 of the 52 CALFED sites evaluated for consideration; 5 of the 12 sites retained for continued evaluation; The remaining 7of the 12 sites were deferred
2000	CALFED Final PEIS/R (CALFED 2000a) and ROD (CALFED 2000b)	3 of the 5 sites recommended for site-specific study; The remaining 2 sites, including the upper San Joaquin River Basin, recommended for additional consideration
2003	Public Law 108-7, Division D, Title II, Section 215	Authorized Federal feasibility studies for storage in the upper San Joaquin River Basin
2003	Phase 1 Upper San Joaquin River Basin Investigation Report (Reclamation 2003)	17 sites considered that could develop upper San Joaquin River water supplies; 6 were retained for further analysis
2004	Public Law 108-361: Water Supply, Reliability, and Environmental Improvement Act	Confirmed authorization of planning and feasibility studies for the Upper San Joaquin River storage in Fresno and Madera Counties
2004	Public Scoping for the Upper San Joaquin River Basin Storage Investigation	5 additional surface water storage sites recommended for consideration during scoping
2005	Initial Alternatives Information Report (Reclamation 2005)	11 surface water storage sites considered; 4 sites retained for further analysis (Raise Friant Dam 25 ft. retained as a measure that would have to be combined with other storage measures to develop alternatives.)
2008	Plan Formulation Report	1 of the 4 sites (Temperance Flat RM 274) identified as potentially feasible
2014	Draft Feasibility Report (Reclamation 2014) and Draft EIS	1 feasible reservoir site (Temperance Flat RM 274) and up to 5 operational and physical alternatives evaluated

Key:
CALFED = CALFED Bay-Delta Program
EIS = Environmental Impact Statement
PEIS/R = Programmatic Environmental Impact Statement/Environmental Impact Report
RM = river mile
ROD = Record of Decision

Table 1-7 provides a summary of the CALFED ROD guidance and the site specific objectives for the Investigation.

Table 1-7. Summary of CALFED ROD Guidance and Investigation Specific Objectives

CALFED ROD Storage Program Guidance	Investigation Specific Objectives
Expand storage to meet needs of a growing population[1]	Increase water supply reliability and system operational flexibility
Improve system flexibility[1]	
Capture water during peak flows and wet years[1]	
Facilitate conjunctive management[2]	
Support fish restoration[1]	Enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish
Contribute to restoration of the San Joaquin River[2]	
Improve San Joaquin River water quality[2]	Improve water quality in the San Joaquin River downstream from Friant Dam
Improve the quality of water deliveries to urban communities[2]	Improve quality of water supplies delivered to urban areas

Notes:
[1] From general CALFED ROD Storage Program guidance
[2] From CALFED ROD Storage Program guidance specific to additional storage in the upper San Joaquin watershed

Key:
CALFED ROD = CALFED Bay-Delta Program Record of Decision

Interpretation of the CALFED ROD objectives specific to additional storage in the upper San Joaquin River watershed has been refined for the Investigation over time to reflect current and projected future conditions, as summarized in the following:

- **Restoration and River Water Quality** – At the time the CALFED ROD was signed, litigation regarding restoration of the San Joaquin River was ongoing; however no commitment to restore the river had been made and the future outcome of the litigation was not known. The guidance in the CALFED ROD to "contribute to restoration of and improve water quality for the San Joaquin River" was interpreted in Phase 1 to mean that some or all of the water supply developed by additional storage would be used for restoration flows.

  The 2006 Settlement, and the 2009 Settlement Act, which authorizes its implementation, specifies physical modifications to the San Joaquin River and Restoration Flows to be released from Friant Dam in support of the Restoration Goal. The Settlement and the Act also specify a set of actions for the Water Management Goal of reducing or avoiding water supply impacts to Friant Division long-term contractors as a result of releasing Restoration Flows. Reclamation is implementing the Settlement through the SJRRP. In light of this change in without-project conditions, the CALFED ROD guidance for additional water storage to "contribute to restoration of …the San Joaquin River" is now interpreted in the Investigation-specific primary objective as enhancing water temperature and flow conditions in the San Joaquin River downstream from Friant Dam for salmon and other native fish. Under the Investigation, this objective would be addressed through the management of stored water and would not involve the commitment of additional water supplies for Restoration Flows.

Similarly, during Phase 1 and the Initial Alternatives phase of the Investigation and prior to the Settlement, the CALFED ROD guidance for additional water storage to "improve water quality for the San Joaquin River" was addressed through considering release of water from the additional storage to improve the quality of water in the San Joaquin River. Under the updated without-project conditions reflecting the Restoration Flows, some water quality improvement is already represented, but additional opportunities for water quality improvement incidental with water supply operations were also considered.

- **Conjunctive Management.** The Friant Division of the CVP was designed and is operated as a regional conjunctive management project. Class 2 water is used either in lieu of groundwater pumping or for active groundwater recharge. Section 215 supplies are also used conjunctively, but are less reliable short-term contracts. Increased Class 1 and Class 2 water deliveries to Friant Division long-term contractors from additional surface water storage would reduce groundwater overdraft and would increase reliable conjunctive management of surface and groundwater supplies in the region. The guidance in the CALFED ROD to "facilitate conjunctive water management" is addressed through delivering water developed through additional storage to Friant Water Division long-term contractors. Additional discussion of conjunctive management measures is included in Chapter 2, "Management Measures."

- **Urban Water Quality.** At the time the CALFED ROD was signed, the Friant Water Users Authority (FWUA) and Metropolitan Water District of Southern California (MWD) were undertaking studies of potential water quality exchanges that would deliver high quality water from the Friant Division of the CVP to MWD in exchange for water supply exported from the Delta through the coordinated operation of the Friant Division and south-of-Delta CVP and SWP facilities. The studies were terminated in 2007 and FWA and MWD did not pursue water quality exchanges for several reasons, including uncertainty regarding Delta operations, concerns about potential water quality impacts in the Friant Division, and Settlement implementation, among others. The guidance in the CALFED ROD to "improve the quality of water deliveries to urban communities" is addressed through delivering some portion of the high quality water from the upper San Joaquin River Basin developed through additional storage to urban areas.

Laws, Regulations, and Policies

Numerous laws, regulations, executive orders, and policies need to be considered by either the federal or state lead agencies, among them: the P&G, the NEPA, Fish and Wildlife Coordination Act, Clean Air Act, Clean Water Act (CWA), National Historic Preservation Act, California Public Resources Code, Federal Endangered Species Act (ESA), CEQA, California Endangered Species Act (CESA), CVPIA, and the San Joaquin River Restoration Settlement Act. Important laws and regulations are discussed in Chapter 28 of the Draft EIS.

CVPIA Section 3404(a)

In accordance with Section 3404(a) of the CVPIA, the Secretary of the Interior shall not enter into any new short-term, temporary, or long-term contracts or agreements for water supply from the CVP for any purpose other than fish and wildlife before the provisions of Subsections 3406(b)-(d) (fish, wildlife, and habitat restoration) are met.

Statewide Water Operation Considerations

Reclamation developed a version of the California Water Resources Simulation Model (CalSim) II model, the March 2012 CalSim II Benchmark, based on a set of assumptions for facilities and operation of the CVP and SWP systems. This version of the CalSim model, and the associated facilities and assumptions were adopted as the basis for evaluation of the No Action Alternative and action alternatives in this analysis. Federal planning guidance was used to make assumptions about which future projects and plans may or may not be implemented; and correspondingly which should be included or excluded from these models and evaluations. The most up-to-date information and assumptions are used for the operations modeling at each phase of the Investigation.

Other Planning Considerations

In addition to the planning constraints, a series of other planning considerations helps guide plan formulation, not only in formulating the initial set of concept plans, but also in determining which action alternatives best address the planning objectives. Planning considerations relate to economic justification, environmental compliance, technical standards, etc., and may result from local policies, practices, and conditions. Examples of these planning considerations, used in the Investigation for formulating, evaluating, and comparing initial plans, and later, detailed alternatives, include the following:

- A direct and significant geographical, operational, and/or physical dependency must exist between major components of action alternatives.
- Action alternatives should meet the project purpose and need.
- Action alternatives should address, at a minimum, all of the identified primary planning objectives, and, to the extent possible, the secondary planning objectives.
- Measures to address identified secondary planning objectives should be either directly or indirectly related to the primary planning objectives (i.e., plan features should not be independent increments).
- Action alternatives should account for offsetting affected hydropower generation value.
- Action alternatives should consider issues raised in coordination with other Federal and State agencies.
- Action alternatives should avoid any increases in flood damages or other substantial hydraulic effects to areas downstream on the San Joaquin River.

- Action alternatives should either avoid potential adverse effects to environmental, cultural, and historical resources or include features to mitigate significant effects, when feasible.

- Action alternatives should not result in a substantial adverse effect on existing and future water supplies, or related water resources conditions.

- Action alternatives should either avoid potential adverse effects on recreational resources or include features to mitigate unavoidable effects, when feasible.

- Action alternatives should be formulated and evaluated based on a 100-year period of analysis.

- Construction costs for action alternatives should reflect current prices and price levels, and annual costs should include the current Federal discount rate and an allowance for interest during construction (IDC).

- Action alternatives should have a high certainty for achieving intended benefits and not depend on long-term actions unrelated to the Investigation (past the initial construction period) for success.

Criteria

The Federal planning process also includes four specific criteria for consideration in formulating and evaluating alternatives: completeness, effectiveness, efficiency, and acceptability (WRC 1983).

- **Completeness** is a determination of whether a plan includes all elements necessary to realize planned effects, and the degree that intended benefits of the plan depend on the actions of others.

- **Effectiveness** is the extent to which an alternative alleviates problems and achieves objectives.

- **Efficiency** is the measure of how efficiently an alternative alleviates identified problems while realizing specified objectives consistent with protecting the Nation’s environment.

- **Acceptability** is the workability and viability of a plan with respect to its potential acceptance by other Federal agencies, State and local governments, and public interest groups and individuals.

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Chapter 2
Management Measures

Once water resources problems, needs, and opportunities have been identified, and planning objectives, constraints, considerations, and criteria have been developed, the next major plan formulation process element is identifying management measures. A management measure is any structural or nonstructural project action or feature that could address the planning objectives, project purpose and need, and satisfy the other applicable planning constraints, considerations, and criteria. Action alternatives are formulated by combining retained management measures that address primary planning objectives, and adding measures that address secondary planning objectives.

Numerous potential measures to address the planning objectives were identified based on information from previous studies, environmental scoping, and stakeholder outreach to address the planning objectives and satisfy the applicable planning constraints, considerations, and criteria. Measures were reviewed and refined through Investigation team meetings, field inspections, and coordination with stakeholders.

In the discussion of management measures, the term “enhancement” specifically refers to restoration actions that improve environmental conditions above the future without-project condition. Correspondingly, the term “mitigation” refers to restoration actions that compensate or offset project impacts, returning conditions back to a similar level as the future without-project condition. The relationship between enhancement and mitigation is illustrated in Figure 2-1.

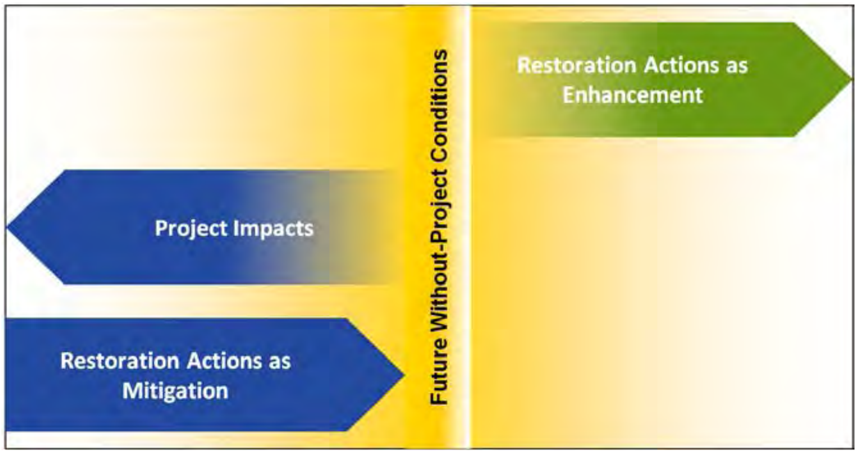

Figure 2-1. Conceptual Schematic of Restoration Actions as Enhancement versus Restoration Actions as Mitigation

Of the measures identified, several were selected for development into initial action alternatives investigated in the Draft Feasibility Report and Draft EIS. Other measures were deleted during Phase 1 (Reclamation 2003), the Initial Alternatives Phase (Reclamation 2005), the Plan Formulation Phase (Reclamation 2008a), and the Draft Feasibility and Plan Refinement Phase of the Investigation.

One important factor was the potential for a measure to directly address a planning objective without adversely impacting other objectives. Measures were rated on a scale of high to low, based on their relative ability to address the planning objectives. In most cases, measures that were rated as moderately addressing a planning objective, or less than moderately, were deleted from further consideration, while measures rating higher were retained. This is primarily because measures that could only marginally address an objective were generally found inconsistent with study constraints or other principles and criteria. Other major factors and rationale in retaining or deleting a measure through the end of the Plan Formulation Phase of the feasibility study are included in the following descriptions of the individual management measures. Following is a general description of the measures considered, reasons for retaining or deleting the measures from further development, and information on how retained measures could fit into potential action alternatives.

It should be noted that measures that did not directly address the planning objectives, or were otherwise dropped from consideration and further development as action alternative components under certain circumstances, may be incorporated into action alternatives as mitigation measures. This is primarily because some measures may be found potentially effective in mitigating adverse impacts.

Measures to Address Primary Planning Objectives

A number of potential measures to address both primary planning objectives, and project purpose and need were identified. Of 28 measures identified, 3 were retained for consideration in subsequent investigations.

The following is a brief discussion of the array of measures considered, which are separated into five broad categories: (1) perform reservoir operations and water management, (2) increase surface water storage in the upper San Joaquin River Basin, (3) increase surface water storage in other eastern Sierra Nevada watersheds, (4) increase surface water storage off the Friant-Kern Canal, and (5) increase groundwater storage. The management measures to address both primary planning objectives are summarized in Table 2-1. Table 2-2 and Table 2-3, respectively, summarize management measures to address each of the two primary planning objectives.

Table 2-1. Management Measures Addressing Both Primary Planning Objectives

Measure	Status	Rationale
Perform Reservoir Operations and Water Management		
Modify storage and release operations at Friant Dam	**Retained**	Potential to combine with other measures involving development of San Joaquin River supplies. Consistent with other planning objective. Consistent with CALFED goals. This measure was retained through Draft Feasibility and Plan Refinement Phase of the Investigation.
Increase conservation storage in Millerton Lake by encroaching on dam freeboard	Deleted	Operable gates on the spillway allow for storage in the portion of the top of active storage capacity above the spillway crest. The remaining height to the top of the parapet walls is about 7.5 feet, providing very limited potential to encroach on existing freeboard. This measure was deleted from consideration during the Plan Formulation Phase of the Investigation.
Increase conservation storage in Millerton Lake by reducing flood space	Deleted	The flood management capacity of Friant Dam is lower than originally anticipated. Evaluations suggest that additional flood space would be beneficial in reducing flood damage in downstream areas. Reducing flood space would increase flood damage. This measure was deleted from consideration during the Plan Formulation Phase of the Investigation.
Increase Surface Water Storage in the Upper San Joaquin River Basin		
Enlarge Millerton Lake by raising Friant Dam	Deleted	Raises of up to 140 feet (920 TAF additional storage) were considered. Evaluations during the initial alternatives phase concluded that this measure would not be carried forward as a stand-alone alternative because the new water supply that could be developed would not likely contribute to planning objectives and the project purpose and need. Friant Dam raise of more than 25 feet was deleted from consideration during the Initial Alternatives Phase because it would result in extensive residential relocation, power generation losses, and environmental effects along the San Joaquin River and in the Fine Gold Creek watershed, and was not considered cost effective, compared to other retained water storage measures. A Friant Dam raise of 25 feet combined with one of the other surface water storage measures would not be effective because very limited additional water supply would be provided and because of the impacts to private property and recreational facilities. A dam raise of 25 feet was deleted from consideration during the Plan Formulation Phase of the Investigation.
Enlarge Millerton Lake by dredging lake bottom	Deleted	Very high cost and substantial environmental effects for a small potential benefit. This measure was deleted from consideration during the Plan Formulation Phase.
Construct Temperance Flat RM 274 Reservoir	**Retained**	Reservoir sizes up to elevation 1,100 feet above mean sea level (msl) (2,110 TAF additional storage) at this site were considered. A maximum reservoir size at elevation 985 feet msl (1,260 TAF new storage capacity) was retained in the IAIR because larger, costlier reservoirs at the site were not justified due to substantial additional effects on environmental resources and hydropower generation. Temperance Flat RM 274 Reservoir also had greater benefits, greater net benefits, and a higher benefit-cost ratio than other reservoir sites considered. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.

Table 2-1. Management Measures Addressing Both Primary Planning Objectives (contd.)

Measure	Status	Rationale
Increase Surface Water Storage in the Upper San Joaquin River Basin (continued)		
Construct Temperance Flat RM 279 Reservoir	Deleted	Reservoir sizes up to elevation 1,300 feet msl (2,740 TAF additional storage) at this site were considered. Retained maximum size at about elevation 985 feet msl (690 TAF new storage capacity) in IAIR because the incremental new water supply did not appear justified because of substantial additional effects to environmental resources, additional effects to hydropower generation, and higher construction costs. Compared to Temperance Flat RM 274 Reservoir alternatives evaluated during the Plan Formulation Phase, Temperance Flat RM 279 Reservoir alternatives have lesser benefits, lesser net benefits, a lower benefit-cost ratio, and are less effective in meeting the project purpose and need. This measure was deleted during the Plan Formulation Phase of the Investigation.
Construct Temperance Flat RM 280 Reservoir	Deleted	Similar to Temperance Flat RM 279 Reservoir. Would result in similar effects on environmental resources, hydropower generation, and water supplies. Total storage capacity would be less and cost would be greater than at RM 279. This measure was deleted during Phase 1 of the Investigation.
Construct Temperance Flat RM 286 Reservoir	Deleted	Reservoir sizes up to elevation 1,400 feet msl (1,360 TAF additional storage) at this site were considered. Deleted because environmental effects and net effects to hydropower generation would be greater and construction costs would be similar to comparable storage capacities at other Temperance Flat locations. This measure was deleted during the Initial Alternatives Phase of the Investigation.
Construct Fine Gold Reservoir	Deleted	Reservoir sizes of up to 800 TAF of new storage capacity at this site were considered under configurations that included pumpback from Millerton Lake and/or upstream diversion from San Joaquin River and conveyance to Fine Gold Reservoir in combination with additional upstream storage. Water would be released from Fine Gold Creek Reservoir to Millerton Lake during periods of highest demand for releases from Friant Dam to the San Joaquin River and Friant-Kern and Madera canals. A configuration involving diversion from San Joaquin River in combination with additional upstream storage was deleted during the Initial Alternatives Phase because of substantial impacts to environmental resources and high cost of water supply. Based on relative ability to meet the four P&G criteria, Fine Gold Reservoir surface water storage measure was considered inferior to the Temperance Flat RM 274 and RM 279 surface water storage measures. This measure was deleted during the Plan Formulation Phase of the Investigation.
Enlarge Mammoth Pool Reservoir	Deleted	During the early phases of the Investigation, this measure was under study by the Friant Water Users Authority and Metropolitan Water District of Southern California in a study of water quality exchange opportunities. This measure would have similar costs to Temperance Flat RM 274 but could only provide about half the water supply; and therefore, proportionally less benefits. This measure was deleted during the Plan Formulation Phase of the Investigation.

Table 2-1. Management Measures Addressing Both Primary Planning Objectives (contd.)

Measure	Status	Rationale
Increase Surface Water Storage in the Upper San Joaquin River Basin (continued)		
Construct RM 315 Reservoir	Deleted	This reservoir, with a maximum storage capacity of about 200 TAF, would cause greater environmental effects and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as a water supply measure. This measure was deleted during the Initial Alternatives Phase of this Investigation.
Construct Granite Project reservoirs	Deleted	Total storage capacity of about 110 TAF from multiple dams and reservoirs would cause greater environmental effects and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as a water supply measure. This measure was deleted during the Initial Alternatives Phase of this Investigation.
Construct Jackass and Chiquito Creek reservoirs	Deleted	Total storage capacity of about 180 TAF from multiple dams and reservoirs would cause greater environmental effects and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as a water supply measure. This measure was deleted during the Initial Alternatives Phase of the Investigation.
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds		
Construct Montgomery Reservoir	Deleted	An off-stream reservoir with a storage capacity of up to about 240 TAF on Dry Creek would store water diverted from the Merced River and provide water in exchange for Friant Division deliveries. Potential exchange partners were not interested in a water supply with potential water quality problems, such as algae, associated with warm water. This measure was deleted during the Phase 1 phase of the Investigation.
Modify Big Dry Creek Reservoir for water storage	Deleted	Modifications to the Big Dry Creek Reservoir would allow for water storage. A zoned earthfill embankment dam could create a reservoir with approximately 30 TAF of storage; however, due to seepage concerns and insufficient inflow, the total storage capacity has not been tested. Consequently, uncertainty remains regarding the existing dam's ability to store more than a few TAF of water. Modifications to enable long-term storage may require extensive reconstruction. This measure was deleted during Phase 1 of the Investigation.
Enlarge Pine Flat Lake by raising Pine Flat Dam	Deleted	Water stored in about 120 TAF of additional storage space in Pine Flat Lake would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. This measure was deleted during Phase 1 of the Investigation.

Table 2-1. Management Measures Addressing Both Primary Planning Objectives (contd.)

Measure	Status	Rationale
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds (contd.)		
Construct reservoir on Mill Creek	Deleted	Water diverted from Pine Flat Reservoir and stored in this new off-stream reservoir with a storage capacity of up to 200 TAF would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure could cause immitigable environmental effects to sycamore alluvial woodland habitat. This measure was deleted during Phase 1 of the Investigation.
Construct Rogers Crossing Reservoir on the Kings River	Deleted	Water stored in Rogers Crossing Reservoir, with a storage capacity of up to 950 TAF, would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure would inundate a Federally designated Wild and Scenic River and a California-designated Wild Trout Fishery. This measure was deleted during Phase 1 of the Investigation.
Construct Dinkey Creek Reservoir on a tributary to the Kings River	Deleted	Water stored in Dinkey Creek Reservoir, with a storage capacity of up to 90 TAF, would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure would cause substantial adverse effects to regional transportation and adversely affect high value fishery areas in downstream areas. This measure was deleted during Phase 1 of the Investigation.
Construct Dry Creek Reservoir on a tributary to the Kaweah River	Deleted	Water diverted from Lake Kaweah and stored in a 70 TAF off-stream reservoir would be exchanged for Friant Division deliveries. This measure could cause immitigable environmental effects to sycamore alluvial woodland habitat. This measure was deleted during Phase 1 of the Investigation.
Raise Terminus Dam	Deleted	Previously authorized for construction by the U.S. Army Corps of Engineers; the dam raise was completed in 2004. This measure was deleted during Phase 1 of the Investigation.
Raise Success Dam	Deleted	Previously authorized for construction by the U.S. Army Corps of Engineers; the dam raise was cancelled in 2011 due to seismic concerns. This measure was deleted during Phase 1 of the Investigation.
Construct Tulare Lake Storage and Conveyance Facilities	Deleted	Development of reservoir storage in the Tulare Lake bed to store flood flows from eastside rivers and recirculated supplies for use as an integrated surface water and groundwater storage facility. Substantial institutional arrangements and limitations to the use of water supplies transferred and stored in Tulare Lake. This measure was deleted during the Plan Formulation Phase of the Investigation.

Table 2-1. Management Measures Addressing Both Primary Planning Objectives (contd.)

Measure	Status	Rationale
Increase Surface Water Storage off the Friant-Kern Canal		
Construct reservoir in Yokohl Valley	Deleted	A new reservoir with a capacity of up to about 800 TAF would store water conveyed from Millerton Lake via the Friant-Kern Canal. Deleted because of conveyance limitations in the Friant-Kern Canal, potential that water quality problems associated with warm water would preclude water transfers, potential environmental effects, and likely low willingness of local landowners to participate. This measure was deleted during the Initial Alternatives Phase of the Investigation.
Construct Hungry Hollow Reservoir on Deer Creek	Deleted	A new reservoir with a capacity of up to about 800 TAF would store water conveyed from Millerton Lake via the Friant-Kern Canal. Deleted because of potential high costs associated with poor foundation conditions, conveyance limitations in the Friant-Kern Canal, and the presence of a potentially immitigable sycamore alluvial woodland habitat. This measure was deleted in Phase 1 of the Investigation.
Increase Groundwater Storage		
Increase conjunctive management of water in the Friant Division	**Retained**	Conjunctive management in the Friant Division occurs by increasing incidental groundwater storage and/or recharge with additional Class 2 deliveries or the development of local surface water supplies, such as increasing surface water storage in the upper San Joaquin River Basin. Groundwater banks operated as allocable water supplies in the Friant Division could increase water supply reliability and provide water for river releases. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Construct and operate groundwater banks in the Friant Division	Deleted	Groundwater banks operated as allocable water supplies in the Friant Division could provide water for river releases. Because evaluations performed showed inability to meet study objectives and the project purpose and need, this measure was deleted during the Draft Feasibility and Plan Refinement Phase of the Investigation.

Key:
CALFED = CALFED Bay-Delta Program
IAIR = Initial Alternatives Information Report
P&G = *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC 1983)
msl = mean sea level
RM = river mile
TAF = thousand acre-feet

Table 2-2. Management Measures Addressing Primary Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility

Measure	Status	Rationale
All Measures Listed in Table 2-1	**Retained / Deleted**	All measures listed in Table 2-1 also address the planning objective of increasing water supply reliability and system operational flexibility
Perform Reservoir Operations and Water Management		
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division	Retained in Concept Only	Integrating operations of Friant Division facilities with SWP and/or CVP facilities through water exchanges could improve water supply reliability and urban water quality. Opportunities with existing facilities are limited. Potential to combine with other measures relating to increasing surface water storage in the upper San Joaquin River Basin. This measure was retained in concept only through the Draft Feasibility and Plan Refinement Phase because operating conditions under the 2008/2009 BOs make integration less feasible. Integration opportunities under alternate future conditions with more flexible CVP and SWP Delta export operations may be assessed in the Final Feasibility Report
Modify diversion to Madera and Friant-Kern canals	**Retained**	Modifying the timing and quantity of water diverted to Madera and Friant-Kern canals would increase water supply reliability to Friant Division contractors and may provide opportunities for groundwater banking. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Capture downstream San Joaquin River flow released from Friant Dam	Deleted	Downstream capture of regulated San Joaquin River flows could increase water supply reliability in the Friant Division of the CVP, other CVP service areas, and SWP. This measure was deleted because it is the subject of separate evaluation by the SJRRP.
Reduce Water Demand		
Implement water conservation and water use efficiency methods in excess of those in the Without-Project Condition	Deleted	Opportunities to apply large-scale water conservation measures in the Friant Division are limited because conveyance losses and excess water application returns to groundwater for use in subsequent years. This measure was deleted during the Plan Formulation Phase of the Investigation.
Retire agricultural lands	Deleted	Does not address planning objectives, consideration/criteria, and project purpose and need. On a large scale, could have substantial negative effects on agricultural industry. This measure was deleted during the Plan Formulation Phase of the Investigation.
Increase Transvalley Conveyance Capacity		
Construct Transvalley Canal	Deleted	Potential to combine with other measures, including integration of Friant Dam operations with CVP and SWP, and increasing surface water storage in the upper San Joaquin River Basin. This measure was deleted during the Plan Formulation Phase of the Investigation.
Perform Water Transfers and Purchases		
Transfer water between Friant Division water users	Deleted	Does not address planning objectives or considerations/criteria, and project purpose and need. An ongoing practice among Friant Division water users to maximize use of Friant Division water deliveries. This measure was deleted during the Plan Formulation Phase of the Investigation.

Table 2-2. Management Measures Addressing Primary Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility (contd.)

Measure	Status	Rationale
Enhance Delta Export and Conveyance		
Expand Banks Pumping Plant	Deleted	Does not address planning objectives or considerations/criteria, and project purpose and need. Would likely be accomplished with or without additional efforts to develop new sources. This measure was deleted during the Plan Formulation Phase of the Investigation.
Construct DMC/CA Intertie	Deleted	Currently under construction. This measure was deleted during the Plan Formulation Phase of the Investigation.
Improve Delta export and conveyance capability through coordinated CVP and SWP operations	Deleted	JPOD is being actively pursued in other programs. This measure was deleted during the Plan Formulation Phase of the Investigation.

Key:
CA = California Aqueduct
CVP = Central Valley Project
DMC = Delta-Mendota Canal
JPOD = joint point of diversion
RM = river mile
SJRRP = San Joaquin River Restoration Program
SWP = State Water Project

Table 2-3. Management Measures Addressing Primary Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River

Measure	Status	Rationale
All Measures Listed in Table 2-1	Retained / Deleted	All measures listed in Table 2-1 also address the planning objective of enhancing water temperature and flow conditions in the San Joaquin River
Perform Reservoir Operations and Water Management		
Balance water storage in Millerton Lake and new upstream reservoirs	**Retained**	Balancing water storage levels between multiple reservoirs could improve water temperature management and affect hydropower generation and recreation. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Construct Water Temperature Management Devices		
Construct temperature control devices on Friant Dam canal outlets	Deleted	Selective withdrawal of warm water for releases to the Madera and Friant-Kern canals from upper levels of Millerton Lake could conserve cold water in Millerton Lake, but does not manage cold water in reservoirs upstream from Millerton Lake. This measure was deleted during the Plan Formulation Phase of the Investigation.
Construct temperature control device on Friant Dam river outlet	Deleted	Selective withdrawal of warm water for releases to the San Joaquin River could improve the management of cold water in Millerton Lake, but does not manage cold water in reservoirs upstream from Millerton Lake. This measure was deleted during the Plan Formulation Phase of the Investigation.
Construct selective level intake structures on new upstream dams	**Retained**	Selective withdrawal of cold or warm water for releases to Millerton Lake from new upstream reservoirs could help manage cold water in Millerton Lake and provides flexibility in managing cold water in potential reservoirs upstream from Millerton Lake. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.

Perform Reservoir Operations and Water Management

Modify Storage and Release Operations at Friant Dam

This measure would include modifications to storage and release operations at Friant Dam. These operational modifications would be intended to optimize the existing system of reservoirs. In addition, this measure may be combined with other measures involving developing water supplies in the upper San Joaquin River Basin to enhance San Joaquin River water temperature and flow conditions and increase water supply reliability; therefore, this measure was retained for further investigation.

Increase Conservation Storage in Millerton Lake by Encroaching on Dam Freeboard

Freeboard is the distance between the active storage capacity of the reservoir and the top of the dam. For Millerton Lake, this distance is 3.25 feet. Operable gates on the spillway allow for storage in the portion of the top of the active storage capacity above the spillway crest. The remaining height to the top of the parapet walls is about 7.5 feet. This measure would include increasing the storage in Millerton Lake by encroaching on the existing freeboard. The available freeboard space is very limited, providing very limited potential for encroachment. This limited potential does not provide for fully meeting the planning objectives or purpose and need; therefore, this measure was deleted from consideration during the Plan Formulation Phase of the Investigation.

Increase Conservation Storage in Millerton Lake by Reducing Flood Space

Millerton Lake's 520 TAF capacity can be broken into several categories: 130 TAF of inactive storage (i.e., volume of water below the elevation of the canal outlets), 220 TAF of conservation storage, and 170 TAF of flood control space. This measure would include reducing the flood space in Millerton Lake to increase conservation storage.

Millerton Lake is operated to provide a maximum flow of 8,000 cfs downstream from Friant Dam. Despite an extensive network of flood control management infrastructure along the San Joaquin River, the area is still subject to annual flooding, and downstream property owners would prefer that releases be made at less than design flow rates to avoid damage to property as well as the river channel (USACE 1999). Reduction of flood damage has been evaluated in the area and suggested measures have included increasing the flood space with Millerton Lake because the flood management capacity of Friant Dam has proved to be lower than originally anticipated. Reducing the flood space within Millerton Lake would increase flood damage and the chance of flooding. Due to the limited flood space and the anticipated negative impacts on flood damage, this measure was deleted from consideration during the Plan Formulation Phase of the Investigation.

Increase Surface Water Storage in the Upper San Joaquin River Basin

The dams built in the upper San Joaquin River Basin were originally developed for power generation by Southern California Edison (SCE) and Pacific Gas and Electric Company (PG&E). Optimization of power generation does not equate to optimization of water storage, water supply reliability, and operational flexibility and, based on the average annual flows in the upper San Joaquin River, the existing dams are undersized for maximizing water supply reliability and operational flexibility. Additional storage along the upper San Joaquin River Basin would promote the planning objectives of increasing water supply reliability and operational flexibility, and enhancing water temperature and flow conditions in the San Joaquin River from Friant Dam to the Merced River. Surface water storage measures considered are shown in Figure 2-2.

Enlarge Millerton Lake by Raising Friant Dam

The existing capacity of Millerton Lake is 520 TAF while the average inflow is 1,800 TAF, more than three times the capacity of the lake. This measure would involve raising the height of Friant Dam and constructing the necessary saddle dams to enlarge Millerton Lake. Three different reservoir enlargement measures were considered, including a 25-foot, 60-foot, and 140-foot raise of Friant Dam. For each measure, Friant Dam would be raised by adding conventional mass concrete or overlays of roller-compacted concrete (RCC) to the dam crest and the dam’s downstream face, and constructing a saddle dam to contain the reservoir at a low point on the southwestern rim. These raises would increase the reservoir storage capacity by between 125 TAF and 920 TAF. The increased storage capacity would result in an increased cold-water pool that could be used to enhance conditions of the San Joaquin River after implementation of the Settlement. Additional storage capacity would provide opportunities to store larger flood volumes than with the current reservoir and could lead to the development of new water supplies, and would allow greater flexibility within the water supply system.

Raising Friant Dam and enlarging Millerton Lake would result in impacts to natural resources and infrastructure around the reservoir rim, potentially requiring mitigation and relocations. Any raise of Friant Dam would affect power generation at the Kerckhoff No. 2 Powerhouse and would impact vegetation, wildlife, and fisheries, recreational, land use, and cultural resources.

Evaluations during the Initial Alternatives Phase concluded that this measure would not be carried forward as a stand-alone alternative because the new water supply that could be developed would not likely contribute meaningfully to planning objectives or purpose and need. A Friant Dam raise of more than 25 feet was deleted from consideration during the Initial Alternatives Phase because it would result in extensive residential relocation, power generation losses, and environmental effects along the San Joaquin River and in the Fine Gold Creek watershed, and was not considered cost effective, compared to other retained water storage measures. A Friant Dam raise of 25 feet combined with one of the other surface water storage measures would not be effective because very limited additional water supply would be provided and because of the impacts to private property and recreational facilities. Thus, a dam raise of 25 feet was deleted from consideration during the Plan Formulation Phase.

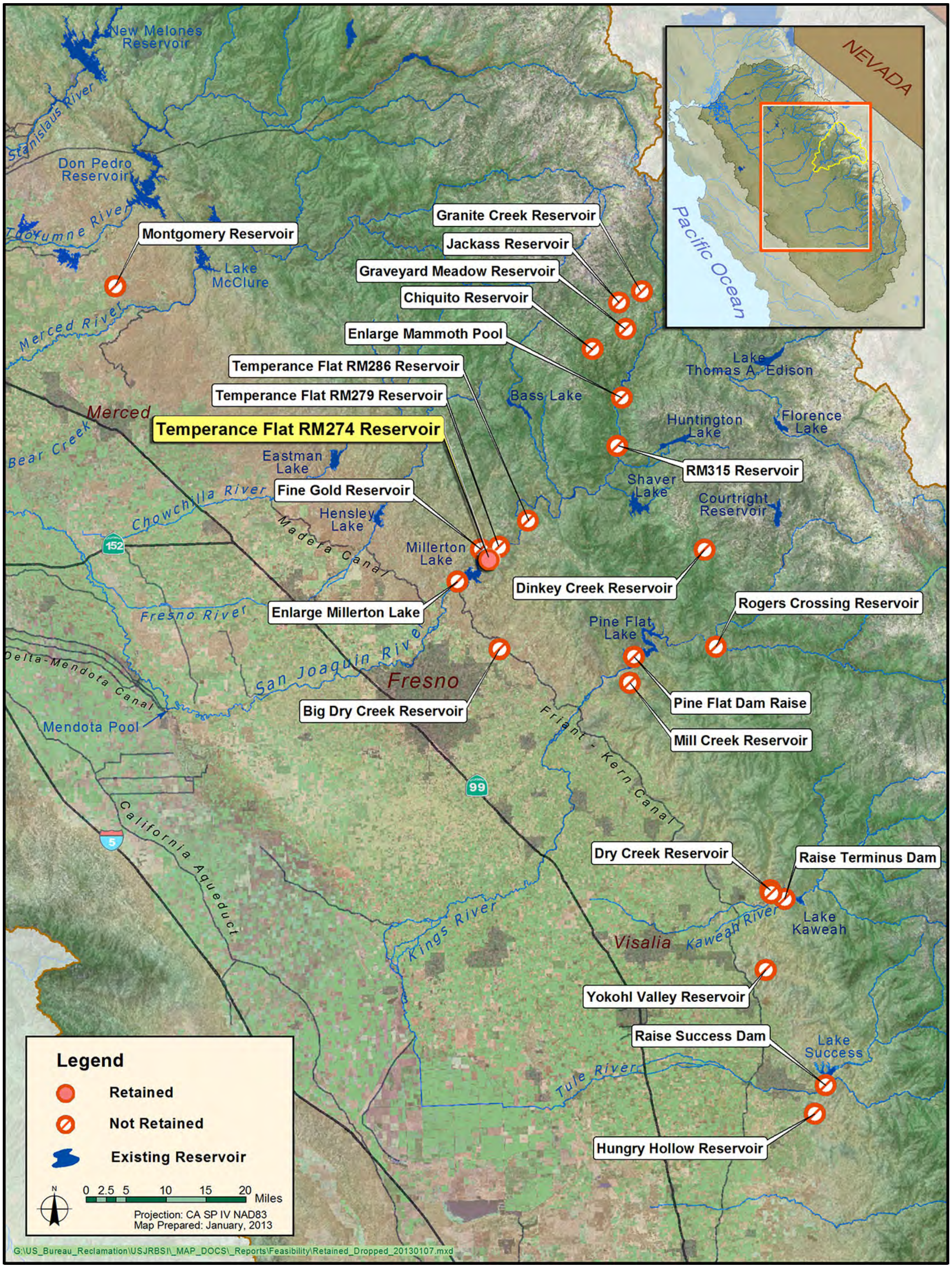

Figure 2-2. Surface Water Storage Measures Considered

Enlarge Millerton Lake by Dredging Lake Bottom

Friant Dam was constructed in 1942 and has been operated for the last 69 years. During its operation, sediments have accumulated and the operating capacity of the reservoir is smaller than the design capacity. Additional capacity could be regained through dredging the lake. This measure includes dredging Millerton Lake to increase storage capacity. The increase in capacity is expected to be small. In addition, the current active capacity is already smaller than the total operating capacity due to the height of the outlet structures, so the increase to active storage is expected to be small. Due to these factors, the expected benefits are expected to be small.

Dredging Millerton Lake would result in substantial impacts to the lake environment. In addition, this measure has significant costs in comparison to the small increase in expected benefits. This measure was deleted from consideration during the Plan Formulation Phase of the Investigation due to the high environmental and economic costs and the limited expected benefits.

Historical Dam Site Selection

Almost 84 years ago, Hyde Forbes, an engineering geologist, issued a geological report on three potential dam sites on the San Joaquin River for the State of California. The report evaluated geologic conditions at the Friant, Fort Miller, and Temperance Flat (RM 274) sites. The geologic study contributed to planning efforts that led to construction of Friant Dam (Forbes 1930).

From a water storage perspective, the RM 274 site was considered superior to the two other sites, but the Friant location was selected because constructing a dam at RM 274 would have required extending canals around or through the current Millerton Lake area, or constructing a second dam at Friant for diverting water to the canals (Reclamation 2003).

Construct Temperance Flat RM 274 Reservoir

Temperance Flat is a wide, bowl-shaped topographic feature in the upper portion of Millerton Lake, approximately 13 miles upstream from Friant Dam, at about RM 281. This measure would include the construction of a dam in the upstream portion of Millerton Lake at RM 274; water would be released from Temperance Flat RM 274 Reservoir to Millerton Lake for canal diversion and/or release to the San Joaquin River. The dam site would be located approximately 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. Reservoir sizes up to elevation 1,100 feet above mean sea level (msl) were considered with a corresponding increase in additional storage of 2,110 TAF.

Construction of any dam at Temperance Flat RM 274 would inundate both the Kerckhoff and Kerckhoff No. 2 powerhouses. Lost annual generation from these two facilities was estimated at 507 gigawatt hours (GWh) per year. A reservoir above elevation 985 feet msl would also affect generation of and potentially inundate the A.G. Wishon and Big Creek No. 4 powerhouses, with installed generation capacities of 20 MW and 100 MW, respectively.

While construction of any size dam at RM 274 would impact vegetation, wildlife and fisheries, recreational, land use, and cultural resources, a reservoir above elevation 985 feet msl corresponds to the elevation of Kerckhoff Lake and would potentially result in linking the existing Millerton Lake with Kerckhoff Lake. This would provide a transport path for several invasive species that are currently isolated to Millerton Lake and thereby substantially increasing the environmental impacts of a dam at RM 274.

With a top-of-active-storage capacity at elevation 985 feet msl, Temperance Flat RM 274 Reservoir would provide 1,260 TAF of new storage capacity and extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. At top-of-active-storage capacity, the reservoir level would reach about 12 feet below the crest of Kerckhoff Dam.

Sizes corresponding to elevations higher than 985 feet msl were not retained because the incremental new water supply provided did not appear justified in light of substantial additional effects to environmental resources and hydropower generation, and higher construction costs (Reclamation and DWR 2005). Temperance Flat RM 274 Reservoir with a top-of-active-storage capacity at elevation 985 feet msl was retained for further investigation.

Construct Temperance Flat RM 279 Reservoir

This measure would include the construction of a dam in the upstream portion of Millerton Lake at RM 279. The dam site would be located approximately 11.6 miles upstream from Friant Dam. Reservoir sizes up to elevation 1,300 feet msl were considered with a corresponding increase in additional storage of 2,740 TAF.

Construction of any dam at Temperance Flat RM 279 would inundate both the Kerckhoff and Kerckhoff No. 2 powerhouses. Lost annual generation from these two facilities was estimated at 507 GWh per year. A reservoir above elevation 985 feet msl would also affect generation of and potentially inundate the A.G. Wishon and Big Creek No. 4 powerhouses, with installed generation capacities of 20MW and 100 MW, respectively.

While construction of any size dam at RM 279 would impact vegetation, wildlife and fisheries, recreational, land use, and cultural resources, a reservoir above elevation 985 feet msl corresponds to the elevation of Kerckhoff Lake and would potentially result in linking the existing Millerton Lake with Kerckhoff Lake (Reclamation and DWR 2005). This would provide a transport path for several endangered species that are currently isolated to Millerton Lake and thereby substantially increasing the environmental impacts of a dam at RM 279. Therefore, sizes corresponding to elevations higher than 985 feet msl were not retained in the Plan Formulation Phase of the Investigation.

A dam at RM 279 and elevation 985 feet msl was evaluated in the Plan Formulation Phase of the Investigation along with a dam at RM 274. Based on the analysis conducted and documented in the PFR, a dam at RM 274 was considered to have greater benefits, have a higher benefit-cost ratio, and to better address Investigation planning objectives and purpose and need; therefore, constructing a reservoir at RM 279 was deleted during the Plan Formulation Phase of the Investigation. Additional details are included in Chapter 3,"Alternative Plan Development."

Construct Temperance Flat RM 280 Reservoir

This measure would include the construction of a dam at Temperance Flat RM 280. This location is similar in many respects to that of RM 279. A reservoir at either site with the same maximum surface elevation would result in similar environmental effects. Both of these sites also have similar geologic conditions, would be accessed in the same manner, would use the same construction lay-down area, and would obtain dam materials from the same general borrow area. However, a dam at RM 280 would require more material than a dam at RM 279 to create a reservoir of less storage capacity, and would therefore incur higher costs. Therefore, this measure was deleted during Phase 1 of the Investigation.

Construct Temperance Flat RM 286 Reservoir

This measure would include the construction of a dam at RM 286. Unlike the RM 274 and RM 279 sites, the RM 286 site is not located in Millerton Lake, but is approximately 6 miles downstream from Kerckhoff Dam, between the dam and Kerckhoff powerhouses. A dam crest up to elevation 1,400 feet msl was considered, which would result in a dam height of 660 feet and a reservoir capacity of 1,360 TAF of new storage.

Construction of a dam at RM 286 would adversely affect energy generation at existing hydropower facilities upstream from Millerton Lake. Big Creek No. 3 and 4 powerhouses, and the Wishon Powerhouse would be inundated. While the Kerckhoff and Kerckhoff No. 2 powerhouses would not be inundated, their operation would be affected by significantly raising the head at the tunnel diversions. Modifications to intakes, tunnels, surge capacity, penstocks, turbines, generating equipment, and likely substations would be required to continue operation of the Kerckhoff and Kerckhoff No. 2 powerhouses.

All storage capacities considered would completely inundate Kerckhoff Lake and a reservoir at RM 286 may impact vegetation, wildlife and fisheries, recreational, land use, and cultural resources. However, it will not affect most environmental resources in Millerton Lake. In addition, lands potentially affected by a dam at RM 286 contain no residences, and are managed by either the U.S. Department of the Interior, Bureau of Land Management (BLM) or the U.S. Forest Service (USFS).

This measure was deleted during the Initial Alternatives Phase of the Investigation because of the environmental effects and the effects on hydropower generation and construction costs would be greater for a comparable increase in storage capacity in comparison to other Temperance Flat locations.

Construct Fine Gold Reservoir

Additional storage capacity could also be constructed off stream from the San Joaquin River. Fine Gold Creek is a tributary to the San Joaquin River that enters Millerton Lake from the north at about RM 273 and drains a watershed area of approximately 91 square miles. This measure would include construction of a dam on Fine Gold Creek. The reservoir created by a dam on Fine Gold Creek could be filled by pumping water from Millerton Lake or from an upstream diversion from the San Joaquin River and conveyance to Fine Gold Reservoir in combination with additional upstream storage. Water would be released from Fine Gold Creek Reservoir to Millerton Lake during periods of highest demand for releases from Friant Dam to the San Joaquin River and Friant-Kern and Madera canals. This measure was suggested during the scoping process.

Dam sizes between elevations 900 and 1,110 feet msl were considered. A gross pool at elevation 900 feet msl would correspond to a dam 380 feet high with 120 TAF of storage capacity. A gross pool at elevation 1,110 feet msl would correspond to a dam 590 feet high with 800 TAF of storage capacity. Both concrete face rockfill (CFRF) and RCC gravity dams were considered. Additional supply would be created by evacuating space in Millerton Lake by pumping to accommodate additional capture of San Joaquin River inflow to Millerton Lake.

While this measure would not impact hydropower generation, it would require ongoing electricity costs to run the pump-back facility.

Creation of Fine Gold Creek Reservoir may result in adverse environmental impacts to physical and biological resources, and some social and cultural resources. The relatively pristine watershed of Fine Gold Creek supports many biological resources, and is considered an Aquatic Diversity Management Area (ADMA). Extensive areas of pine and oak woodland habitat would be affected, as would pockets of riparian and wetland habitats. Vernal pools and special-status species of plants and wildlife may be present in the inundation areas.

Water would be released from Fine Gold Creek Reservoir to Millerton Lake during periods of highest demand for releases from Friant Dam to the San Joaquin River and Friant-Kern and Madera canals. Based on its relative ability to meet the four P&G criteria, Fine Gold Reservoir surface water storage measure was considered inferior to the Temperance Flat RM 274 and RM 279 surface water storage measures. This measure was deleted during the Plan Formulation Phase of the Investigation.

Enlarge Mammoth Pool Reservoir

Mammoth Pool Reservoir is an existing reservoir in the upper San Joaquin River watershed. The dam crest height is 411 feet at elevation 3,361 feet msl and has a maximum capacity of approximately 120 TAF. Enlarging the Mammoth Pool Reservoir was studied in 1982 by SCE with the primary intent for power generation. This study looked at raising the dam by 25 feet for a total increase of storage of 30 TAF. Enlarging the Mammoth Pool Reservoir was again investigated in 2006 by the Water Management Partnership formed by FWUA and MWD. Their investigation also focused on enlarging the dam by 25 feet because this could be accomplished through the addition of radial gates and parapet walls.

This measure would include enlarging Mammoth Pool Reservoir through a raise of the existing dam or construction of a new dam at or near the existing Mammoth Pool Dam. The existing dam may be raised by installing eight 25-foot-high radial gates across the natural rock spillway to raise the maximum lake level, and constructing a 5-foot-high parapet on top of the existing dam to maintain freeboard under emergency storage conditions. Enlarging Mammoth Pool by 25 feet would create 30 TAF of additional water storage, and could contribute to the planning objectives of flood risk management and hydropower generation. Previous studies conducted by SCE and the FWUA and MWD partnership indicated that a 25-foot dam raise would be cost effective. This measure would have similar costs to Temperance Flat RM 274 but could only provide about half the water supply and therefore, proportionally less benefits. This measure was deleted during the Plan Formulation Phase of the Investigation.

Construct RM 315 Reservoir

This measure would include the construction of a dam on the San Joaquin River at RM 315, about 1 mile upstream from the Mammoth Pool Powerhouse. A dam at elevation 3,000 feet msl was considered. A dam of this size would be approximately 620 feet high and corresponds to a storage capacity of 200 TAF. The RM 315 Reservoir would capture spills from Mammoth Pool Reservoir. At this time, most spills from Mammoth Pool are captured in Millerton Lake downstream; therefore, this measure does not result in additional new water supply. The dam height and crest length are similar to the RM 286 dam site at elevation 1,400 feet msl; thus, costs may be roughly equivalent.

Unlike other surface water storage measures, this measure does not negatively impact hydropower generation. In addition to power that could be generated at a powerhouse at the RM 315 Dam, controlled releases from the reservoir would allow for additional generation at the Big Creek No. 3, Big Creek No.4, Kerckhoff, and Kerckhoff No. 2 powerhouses, and the Friant Power Project. The additional generation capacity that would be generated has not been quantified.

Construction of a dam at RM 315 would cost more, provide fewer water supply and cold water management benefits, and would result in more environmental impacts in comparison to other than other storage measures with equal or greater storage capacity. Thus, this measure was deleted in the Initial Alternatives Phase of this Investigation.

Construct Granite Project Reservoirs

This measure would include construction of a major dam and reservoir on Granite Creek, a forebay dam and reservoir at Graveyard Meadow, five diversion dams, two powerhouses, 18 miles of pipeline and tunnel, and a pumping plant. The dam would be located upstream from Mammoth Pool Reservoir on the west side of the basin. A dam at elevation 7,020 feet msl was considered. A dam of this size would be approximately 355 feet high and corresponds to a storage capacity of 105 TAF. The forebay dam at Graveyard Meadow would be at an elevation of 6,800 feet msl and corresponds to a dam height of 90 feet and a new storage capacity of 9 TAF. In contrast to an RM 315 Reservoir, the Granite Project would capture inflow to Mammoth Pool Reservoir and would reduce spills.

The Granite Project reservoirs were originally studied as a hydropower project. Early studies indicate that the project would generate an average annual energy of 489 GWh and would have a dependable capacity of 284 MW. This estimate does not include changes to power generation downstream from the proposed Granite Project reservoirs. Operation for water supply would differ from that of power generation. Power generation under water supply operation is expected to be much less, approximately 116 GWh per year.

Costs developed for the Granite Project reservoirs in the early 1980s and indexed to 2004 would be comparable to those for a dam at the Temperance Flat RM 286 site to elevation 1,400 feet msl (capacity 1,360 TAF). However, this measure would provide only 25 percent of the storage capacity. In addition, the environmental effects from multiple dams and reservoirs would be greater than other retained storage measures with greater storage capacity. Thus, this measure was deleted in the Initial Alternatives Phase of the Investigation.

Construct Jackass and Chiquito Creek Reservoirs

This measure would include the construction of a major dam and storage reservoir on Jackass Creek, a major dam and storage reservoir on Chiquito Creek, five diversion dams, two powerhouses, and 18 miles of pipeline and tunnel. This project would be located upstream from Mammoth Pool Reservoir on the west side of the basin and would use essentially the same sources of water as the Granite Project. The Chiquito Reservoir would be sized at elevation 5,013 feet msl, which corresponds to a dam height of 227 feet and a new storage capacity of 80 TAF. The Jackass Reservoir would be sized at elevation 7,070 feet msl, which corresponds to a dam height of 160 feet and a new storage capacity of 100 TAF.

The Jackass and Chiquito Creek reservoirs were originally studied as a hydropower project in the early 1980s as an alternative to the Granite Project. Initial studies indicate that the Jackass and Chiquito Creek Reservoirs would generation an average annual energy of 508 GWh and would cost approximately 10 percent more than the Granite Project.

Costs developed for the Jackass and Chiquito Project Reservoirs in the early 1980s and indexed to 2004 would be comparable to those for a dam at the Temperance Flat RM 286 site to elevation 1,400 feet msl (capacity 1,360 TAF). However, this measure would provide only 25 percent of the storage capacity. In addition, the environmental effects from multiple dams and reservoirs would be greater than other retained storage measures with greater storage capacity. Thus, this measure was deleted in the Initial Alternatives Phase of the Investigation.

Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds

Meeting the planning objectives of increasing water supply reliability and system operational flexibility, in addition to enhancing the water temperature and flow conditions in the San Joaquin River from Friant Dam to the Merced River might also be achieved through increasing storage in other eastern Sierra Nevada watersheds and executing water exchange with the Friant Division. Several surface water storage locations in other eastern Sierra Nevada watersheds were proposed during initial studies.

Construct Montgomery Reservoir

This measure would include an offstream reservoir on Dry Creek, a northern tributary to the Merced River. This reservoir would have a storage capacity of about 240 TAF and would store flood flows released or spilled from Lake McClure at New Exchequer Dam and diverted from the Merced River at Merced Falls. The diverted water would provide water to potential partners in exchange for Friant Division deliveries.

Initial review of this measure suggested that the stored water would likely be subject to algal growth and relatively high evaporative losses. This measure was deleted during Phase 1 of the Investigation because potential exchange partners were not interested in a water supply with potential water quality problems.

Modify Big Dry Creek Reservoir for Water Storage

This measure would include modifications to the existing Big Dry Creek Reservoir. Big Dry Creek Dam is an existing flood control structure in Fresno County, near Clovis, operated by the Fresno Metropolitan Flood Control District. The reservoir area spans Big Dry Creek and associated smaller drainages to the north. The zoned earthfill embankment dam could accommodate a reservoir with approximately 30 TAF of storage. The total storage capacity has not been exploited due to seepage concerns and insufficient inflow.

The measure would include a turnout from the Friant-Kern Canal, along with an energy dissipation structure, to divert water to Big Dry Creek Reservoir. DWR's Division of Safety of Dams has indicated that no more than 10 TAF can be stored in the existing reservoir, and only if the dam demonstrates satisfactory performance when the reservoir is 50 percent filled. Due to insufficient inflows, the reservoir has yet to be tested at this level of storage. Consequently, uncertainty remains regarding the existing dam's ability to store more than a few thousand acre-feet of water. In addition to these concerns, modifications to enable storage for longer than 90 days may require extensive reconstruction of the dam. Based on these concerns, enlarging the Big Dry Creek Reservoir for long-term water storage was deleted during Phase 1 of the Investigation.

Enlarge Pine Flat Lake by Raising Pine Flat Dam

This measure would include raising the gross pool elevation of Pine Flat Reservoir by 20 feet. This would provide an additional 124 TAF of storage. Additional water developed from an enlarged Pine Flat Reservoir would be exchanged for Friant Division Water. Early in the year, water from the Millerton Lake would be delivered to Pine Flat water users, thereby creating additional storage space in Millerton Lake to capture San Joaquin River flows. Kings River water that otherwise would have been delivered would be retained in the enlarged Pine Flat Reservoir. Later in the year, water from Pine Flat would be delivered to the Friant-Kern Canal in lieu of releases from Millerton Lake.

Implementation of this measure would require collaboration with the USACE and the Kings River Conservation District, which represents the users of water stored in Pine Flat Reservoir. This measure was deleted during Phase 1 of the Investigation because potential partners were not interested in exchanges that would affect Kings River water rights.

Construct Reservoir on Mill Creek

This measure includes construction of a 250-foot high dam on Mill Creek, which joins the Kings River approximately 1.7 miles downstream from Pine Flat Dam, to create a reservoir with a storage capacity of up to 200 TAF. Excess flows in the Kings River would be diverted by gravity into Mill Creek Reservoir by means of a 5,000-foot-long, 10-foot-diameter, unlined tunnel.

The Mill Creek environment includes extensive sycamore alluvial woodland in its lower reaches near its confluence with the Kings River (USACE 1990). This is a rare and sensitive habitat type that hosts a diverse assemblage of wildlife, particularly birds.

This measure would also require participation by Kings River Conservation District (KRCD) to facilitate water exchanges similar to the approach described for the raising Pine Flat Dam measure. KRCD is not interested in the measure.

Due to lack of interest from the required parties and the likely unmitigable negative impacts to the sycamore alluvial woodland habitat, this measure was deleted during Phase 1 of the Investigation.

Construct Roger Crossing Reservoir on the Kings River

This measure would include a dam at Rodgers Crossing on the main stem of the Kings River, above Pine Flat Reservoir, approximately 0.5 mile upstream from the confluence with the north fork of the Kings River. Reservoir sizes of 295 TAF and 950 TAF were considered. Stored water would be exchanged with Millerton Lake water, similar to the approach described for the raising Pine Flat Dam measure.

The Kings River is one of the least disturbed large rivers in California and its wild trout population is considered one of the best in the State. Upstream from Pine Flat Reservoir, the Kings River also supports whitewater recreation. Both reservoir sizes would inundate a portion of the Kings River Special Management Area, and the larger reservoir size would inundate a portion of the river that has been federally designated as a Wild and Scenic River, which would violate expressed congressional intent. A reservoir at Rodgers Crossing would also affect a Wild Trout Fishery, as designated by California Department of Fish and Wildlife (CDFW). This measure was deleted during Phase of the Investigation because of environmental concerns and because potential partners were not interested in exchanges that would affect Kings River water rights.

Construct Dinkey Creek Reservoir on a Tributary to the Kings River

This measure would include the construction of a dam on Dinkey Creek, located in the upper watershed of the north fork of the Kings River. A dam would be located within the Sierra National Forest at an elevation of over 5,400 feet msl. It would be a zoned rockfill dam, approximately 340 feet high and 1,600 feet long, creating a 90 TAF reservoir. Stored water would be exchanged with Millerton Lake water.

Developing a reservoir at Dinkey Creek would result in adverse environmental impacts in all categories that were assessed in Phase 1 of the Investigation–botany, wildlife, aquatic biology, recreation, and land use. In particular, a reservoir at Dinkey Creek would fundamentally alter the existing recreation-based community. Dinkey Creek is a popular recreational area and trout fishing destination. A flow reduction could reduce available habitat, particularly during spring and summer when rainbow trout are spawning and rearing. Changes in water temperature below the dam could adversely affect trout, and the dam would impede migration. The potentially inundated area includes two organizations' camps, vacation residences, and roads that provide access on both sides of the stream to numerous recreational resources in the Sierra National Forest. Creation of the reservoir would adversely impact an established community and may be unmitigable. In addition, this measure would cause substantial adverse effects to regional transportation, and potential partners were not interested in exchanges that would affect Kings River water rights; therefore, this measure was deleted during Phase 1 of the Investigation.

Construct Dry Creek Reservoir on a Tributary to the Kaweah River

This measure would include the construction of a dam on Dry Creek, which is a tributary to the Kaweah River, just downstream and northwest of Lake Kaweah at Terminus Dam. A dam would be sized for a reservoir storage capacity of 70 TAF. The reservoir would store local inflow and water diverted from Lake Kaweah through a 7,600-foot-long gravity tunnel. Because stored water would be exchanged with Millerton Lake water, this measure would require participation by Kaweah River water users.

The Dry Creek environment includes sycamore alluvial woodland near the confluence of Dry Creek and the Kaweah River. This is a rare and sensitive habitat type that hosts a diverse assemblage of wildlife. Due to likely unmitigable negative impacts to the sycamore alluvial woodland habitat, this measure was deleted during Phase 1 of the Investigation.

Raise Terminus Dam

This measure would include enlarging the existing Terminus Dam. However, during preliminary evaluation, construction of this project was authorized by the USACE; the dam raise was completed in 2004; therefore, this measure was deleted in Phase 1 of the Investigation.

Raise Success Dam

This measure would include enlarging the existing Success Dam. However, during preliminary evaluation, construction of this project was authorized by the USACE; the dam raise was cancelled in 2011 due to seismic concerns. Therefore, this measure was deleted in Phase 1 of the Investigation.

Construct Tulare Lake Storage and Conveyance Facilities

This measure would include development of reservoir storage in the Tulare Lake bed to store flood flows from eastside rivers and recirculated supplies for use as an integrated surface water and groundwater storage facility. This measure would assume that land in the Tulare Lake bed could continue to be used for agriculture during periods when the new reservoir is not needed to store water. Water stored in the Tulare Lake bed reservoir would be pumped to the California Aqueduct or delivered to adjacent lands for exchanges that reduce demands from the Friant-Kern Canal. Substantial institutional arrangements and limitation on the use of water supplies transferred and stored in Tulare Lake would be required.

As proposed by stakeholder groups and evaluated previously, the measure would include the capture and storage of flood flow releases from upstream reservoirs on the Tule, Kaweah, and Kings rivers; channel modifications to Fresno Slough/James Bypass to support bidirectional conveyance between the San Joaquin and Kings river basins; construction of a new water conveyance facility and intertie to the Friant-Kern Canal for transport of water from the Friant-Kern Canal to Tulare Lake; construction of a new water conveyance facility and pumping plant to transport water to and from the California Aqueduct to and from Tulare Lake; construction of a new pumping facility to pump water from the reservoir to existing canals; and consideration of existing water rights and place-of-use requirements, and necessary water rights applications for the transfer and use of water supplies from the San Joaquin, Tule, Kaweah, and Kings river watersheds. Additionally, this measure would likely require additional storage in the upper San Joaquin River Basin for storage of larger flood volumes than with the current reservoir.

The Tulare Lake watershed is essentially a closed basin since water that flows to Tulare Lake drains north into the San Joaquin River only in years of extreme precipitation. Vast quantities of salts have accumulated within this basin due to significant evaporation losses and the large amount of water supply imported to the region to maintain highly productive agricultural uses. The accumulation of salts has resulted in the degradation of groundwater quality. Due to potential water quality degradation through mixing of transferred supplies with highly saline shallow groundwater, substantial institutional arrangements and limitations on the use of water supplies transferred and stored in Tulare Lake would require consideration.

Several listed special-status species are known to be present in vicinity of the Tulare Lake bed, as well as large cultural resources sites and a high likelihood of additional significant sites in the area (FWUA and NRDC Coalition 2002). Also, Public Law 108-361 specifies planning and feasibility studies for the “upper San Joaquin River storage in Fresno and Madera Counties;” although it does not preclude areas outside of Fresno and Madera Counties to be considered under NEPA requirements.

Because Tulare Lake is the home of several-special status species as well as the location of several cultural resource sites, this measure was deleted during the Plan Formulation Phase of the Investigation.

Increase Surface Water Storage off the Friant-Kern Canal

In addition to additional surface water storage upstream from Friant Dam or within other eastern Sierra Nevada watersheds, meeting the planning objectives might also be achieved through capturing spills from Millerton Lake by increasing surface water storage off of the Friant-Kern Canal. Several surface water storage locations off the Friant-Kern Canal were proposed during initial studies.

Construct Reservoir in Yokohl Valley

This measure would include the construction of a reservoir in the Yokohl Valley approximately 15 miles east of Visalia and 8 miles south of Lake Kaweah. The Yokohl Valley Reservoir would be operated as a pump-back project served by the Friant-Kern Canal. Options for developing storage in Yokohl Valley Reservoir involve building a dam with a gross pool at up to elevation 860 feet msl. Two potential dam and reservoir sizes were considered. A gross pool at elevation 790 feet msl would correspond to a dam 260 feet high with a crest length of nearly 3,000 feet and 450 TAF of storage capacity. A gross pool at elevation 860 feet msl would correspond to a dam 330 feet high with 800 TAF of storage capacity. Conveyance to Yokohl Valley Reservoir would be limited by available space in the Friant-Kern Canal.

The Yokohl Valley Reservoir would be filled with water evacuated from Millerton Lake and conveyed through the Friant-Kern Canal. This creates the potential that water in Millerton Lake could fluctuate to a greater extent than under current conditions. This could decrease the cold water pool. Yokohl Valley Reservoir would also be shallower than any other comparably sized surface storage measure considered. It presents the highest potential for warming stored water and algae formation, which could adversely affect the ability for Friant Division contractors to beneficially irrigate or to exchange high-quality water with urban areas.

A reservoir in Yokohl Valley may result in impacts to vegetation, wildlife, and cultural resources. Yokohl Valley hosts a relatively well-developed mesic grassland habitat with several special-status plant and wildlife species potentially present. Numerous cultural resources are also known to be present in the area and may be affected by the Yokohl Valley Reservoir.

Public acceptance of the Yokohl Valley Reservoir measure is likely low with limited willingness of landowners in the valley to participate. Yokohl Valley is also outside of the area of study authorized by Public Law 108-61, which specifies planning and feasibility studies for the “upper San Joaquin River storage in Fresno and Madera Counties.”

Considering all of the factors described above, the Yokohl Valley Reservoir was deleted during Phase 1 of the Investigation.

Construct Hungry Hollow Reservoir on Deer Creek

This measure would include construction of a dam on Deer Creek, a tributary for the Tule River about 3 miles south and downstream from Lake Success and 6 miles east of Porterville. The reservoir would have a storage capacity of up to 800 TAF and could store water from the Friant-Kern Canal or water diverted from Lake Success. This would involve exchanging water with Millerton Lake and would require participation by Lake Success water users.

Preliminary studies found that construction of a dam at this site would be costly because extensive young alluvial deposits, over 300 feet thick, that lie beneath the potential dam axis could be subject to liquefaction during an earthquake. The reservoir also would inundate up to 8 miles of Deer Creek, which supports well-developed sycamore alluvial woodland, a rare and regionally important wildlife habitat for which mitigation may not be possible. Due to cost and environmental considerations, this measure was deleted during Phase I of the Investigation.

Increase Groundwater Storage

During Phase 1 of the Investigation, a theoretical evaluation was completed to assess if groundwater storage was a measure that should be further considered. The analysis focused on estimating the amount of water that could be made available at Friant Dam for groundwater recharge if adequate recharge facilities were in place. The analysis did not consider the subsequent withdrawal and use of water stored in groundwater basins. Several assumptions were applied to assess the reasonable amount of additional water from Millerton Lake that could be stored in San Joaquin Valley groundwater basins with no additional surface water storage. When canal conveyance limitations and exhibited historical preferences for delivery of water during wet conditions were represented, it was found that an upper limit of about 50 TAF/year of additional groundwater recharge could be possible. The outcome of the evaluation, as presented in the Phase 1 Investigation Report, demonstrated that additional groundwater storage could be possible if additional recharge capacity was developed to receive water when it is available (Reclamation and DWR 2003). It should be noted that local stakeholders have indicated a preference to use conjunctive management projects to meet local water needs first, a preference that is also stated in the CALFED ROD (2000a).

Following completion of the theoretical analysis, DWR initiated a review of potential projects and programs in the San Joaquin River and Tulare Lake hydrologic regions that could provide additional groundwater storage. Groundwater subbasins in the San Joaquin Valley that possess the greatest potential for groundwater recharge were identified and potential conjunctive management opportunities within these regions were assessed. Results from this assessment were provided in the IAIR (Reclamation and DWR 2005).

During plan formulation, DWR conducted a San Joaquin Valley Conjunctive Water Management Opportunities analysis and identified several potential conjunctive management or groundwater storage projects in the San Joaquin Valley that could be considered in any regional water resources study (DWR 2006b). Fifteen potential groundwater storage projects in the San Joaquin Valley were identified that appear to have high potential for implementation. As shown in Figure 2-3, recommended potential conjunctive management and groundwater storage projects are located in Madera, Kings, and Kern county groundwater basins (DWR 2006b).

Conjunctive management and proposed groundwater bank management measures were further evaluated in the Draft Feasibility and Plan Refinement Phase of the Investigation to determine their ability to contribute to Investigation objectives, as described below.

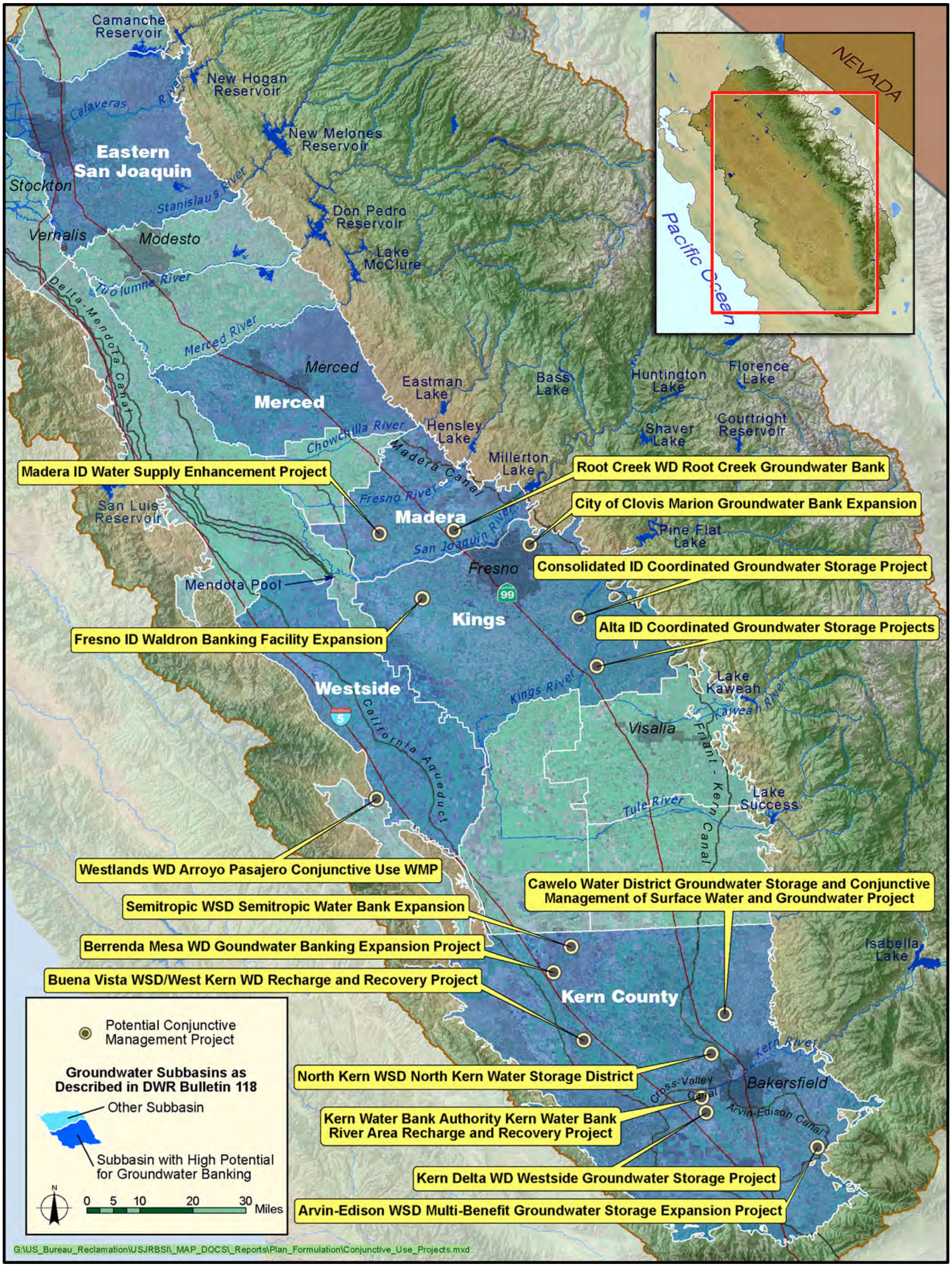

Figure 2-3. Potential Groundwater Storage Measures

Increase Conjunctive Management of Water in the Friant Division

Conjunctive management is the practice of coordinating the management of surface water supplies and groundwater supplies to increase groundwater storage during wet periods for use during dry periods. The Friant Division is already operated as a regional conjunctive management project. Currently, water deliveries under long-term Class 2 contracts are specifically intended for delivery to areas with access to groundwater. In wet years, Class 2 water and water delivered under Section 215 contracts are recharged to groundwater or delivered directly in lieu of groundwater pumping. Measures that increase the total delivery of Class 2 water and Section 215 supplies to Friant Division contractors, such as surface water storage measures, would increase conjunctive management and help reduce groundwater overdraft in the region.

Development of local surface water supplies for groundwater recharge, such as increasing surface water storage in the upper San Joaquin River Basin, or direct delivery in lieu of groundwater pumping, would also increase groundwater storage and help reduce regional overdraft. Increasing groundwater recharge through additional Class 2 deliveries or developing local surface water supplies could help facilitate exchange agreements between Friant Division water users and others. Several assumptions were applied to assess the reasonable amount of additional water from Millerton Lake that could be stored in San Joaquin Valley groundwater basins with no additional surface water storage. When canal conveyance limitations and exhibited historical preferences for delivery of water during wet conditions were represented, it was found that an upper limit of about 50 TAF per year of additional groundwater recharge could be possible. It should be noted that local stakeholders have indicated a preference to use conjunctive management projects to meet local water needs first, a preference that is also stated in the CALFED ROD (2000a).

This measure was retained for further investigation.

Construct and Operate Groundwater Banks in the Friant Division

Existing groundwater banks in the southern San Joaquin Valley have successfully helped manage water supplies for water users in California during the past few decades. A groundwater bank is characterized as an area in an aquifer where the volume of stored water is held under contract for future delivery to other areas. Banked groundwater may be stored through active recharge techniques, such as percolation or injection, or by delivering surface water in lieu of pumping. Generally, water is banked during wet periods and extracted during dry years. Extracted water is generally delivered to the contract holder directly or through exchange.

This measure would include the construction and operation of additional groundwater banks in the Friant Division. A generalized simulation of groundwater banking potential was completed to assess the potential magnitude of new supply that could be developed with groundwater banking and no additional surface water storage, as well as how the development of additional surface water storage would affect opportunities for groundwater banking. Surface water storage volumes were selected to correspond generally with retained surface water storage measures. The groundwater banking evaluations assumed varying recharge capacities up to 1,500 cfs and included releases from Friant Dam for Settlement Restoration Flows in the without-project condition. It was also assumed that water stored in groundwater banks would be available supplies for annual allocation, after deducting dissipation losses in the aquifer and use of 50 percent of new supply for local purposes.

Results indicated that an average annual new water supply of up to 17 TAF could be developed without additional surface water storage. Groundwater banking opportunities to support Investigation objectives would diminish as surface water storage capacity increases, and the additional water supply developed with conjunctive management above the supply developed with surface storage is quite small. The evaluation indicated that with new surface water storage of 690 TAF (capacity of the Temperance Flat RM 279 Reservoir) and 1,260 TAF (capacity of the Temperance Flat RM 274 Reservoir), the incremental amount of additional water supply developed with groundwater banking at a recharge capacity of up to 1,500 cfs would be up to 8 TAF and 3 TAF, respectively. Typically, reservoir storage capacity would be used before water would be recharged to avoid losses of surface water and the additional costs associated with groundwater extraction. Based on these evaluations, this measure was determined to not fully meet the objectives of the study and was deleted during the Draft Feasibility and Plan Refinement Phase of the Investigation.

Measures to Address Water Supply Reliability and System Operational Flexibility

A number of potential measures to address only water supply reliability and system operational flexibility were identified. Of 10 measures identified, 1 was retained, and 1 was retained in concept.

Following is a brief discussion of the array of measures considered, which are separated into five broad categories: (1) perform reservoir operations and water management, (2) reduce water demand, (3) increase transvalley conveyance capacity, (4) perform water transfers and purchases, and (5) enhance Delta export and conveyance. The measures to address water supply reliability and system operational flexibility are summarized in Table 2-2.

Perform Reservoir Operations and Water Management

Integrate Friant Dam Operations with State Water Project and/or Central Valley Project outside Friant Division

Integration of Friant Dam operations with the SWP and CVP outside the Friant Division and could provide opportunities for exchange of water supplies, allowing greater optimization of system operations for improved water supply reliability and operational flexibility. The extent to which water supply reliability and operational flexibility improvements can be realized may be limited by available conveyance capacity in existing transvalley conveyance facilities and available SOD storage capacity. Increasing surface water storage in the upper San Joaquin River Basin, along with expansion of existing conveyance facilities and/or construction of additional transvalley conveyance, would substantially increase potential water supply. This measure was retained in concept only because operating conditions under the 2008/2009 BOs make integration less feasible. Integration opportunities under alternate future conditions with more flexible CVP and SWP Delta export operations may be assessed in the Final Feasibility Report.

Modify Diversion to Madera and Friant-Kern Canals

This measure would involve modifying the timing and quantity of water diverted to Madera and Friant-Kern canals which would increase water supply reliability to Friant Division contractors and may provide opportunities for groundwater banking. This measure was retained was retained for further investigation.

Capture Downstream San Joaquin River Flow Released from Friant Dam

This measure would involve downstream capture of regulated San Joaquin River flows, which could increase water supply reliability in the Friant Division. This measure is currently under separate evaluation by the SJRRP for recapturing only Restoration Flows. This measure was deleted during the Plan Formulation Phase of the Investigation.

Reduce Water Demand

Implement Water Conservation and Water Use Efficiency Methods in Excess of those in the Without-Project Condition

This measure involves implementing water conservation and water use efficiency methods in excess of those in the without-project condition to reduce demand.

The primary land uses in the Friant District are open space and agriculture. Urban land uses (e.g., residential, commercial, industrial) account for only a small percentage of land use along the San Joaquin River. Opportunities to apply large-scale water conservation measures in this area are limited. Water conservation methods in agricultural areas focus on conveyance losses and excess water application. However, in the Friant District, water lost during conveyance or through excess water application percolates through the soil and ultimately returns to groundwater. Since the region is heavily reliant on groundwater (the San Joaquin Hydrologic Region receives 30 percent of its water supply from groundwater [DWR 2003]), this water is available for use in subsequent years and is not actually lost to the system. Because opportunities for water conservation that result in a reduction of water lost to the system are limited, this measure was deleted in the Plan Formulation Phase of the Investigation.

Retire Agricultural Lands

In an average year 34 MAF of water is used for agricultural irrigation within California (DWR). This measure would involve retiring agricultural lands for water conservation purposes. Millerton Lake sits near the Madera and Fresno County line and within these counties, agriculture is one of the predominate industries employing 12.5 percent of the population in Fresno County and almost 20.3 percent of the population in Madera County in 2008 (EDD 2010). On a large scale, retiring agricultural lands within the region could have substantial negative effects on the agricultural industry. In addition, while retiring agricultural lands could result in a reduction in water demand, this measure does not address the planning objectives of this study. For these reasons, this measure was deleted in the Plan Formulation Phase of the Investigation.

Increase Transvalley Conveyance Capacity

Construct Transvalley Canal

Within the current system, there is a limited ability to transfer water between the east and west sides of the San Joaquin Valley. This limits the ability to manage Delta water supplies in conjunction with SOD supplies, reducing system reliability and flexibility. This measure would involve constructing a new canal that would convey water across the southern San Joaquin Valley, from east to west or west to east, between the Friant-Kern Canal and the California Aqueduct. Increasing transvalley conveyance capacity through construction of a new major transvalley canal would enable potential integration between the Friant Division with the SWP and/or CVP system outside the Friant Division through water exchanges, and could increase water supply reliability and operational flexibility. The Transvalley Canal would have a conveyance capacity of 1,000 cfs. A conceptual alignment for the canal is more than 50 miles long, and includes a connection to the Friant-Kern Canal near Porterville and a connection to the California Aqueduct south of the Tulare Lake bed. This measure has the ability to combine with other measures retained in this study, including integration of Friant Dam operations with CVP and SWP, and increasing surface water storage in the upper San Joaquin River Basin. However, analysis conducted and documented in the PFR demonstrates that inclusion of the Transvalley Canal within an alternative does not significantly impact the benefit cost ratio of the alternative; therefore, this measure was deleted in the Plan Formulation Phase of the Investigation.

Perform Water Transfers and Purchases

Transfer Water Between Friant Division Water Users

This measure would involve additional water transfers between Friant Division water users. Water transfers to maximize the use of Friant Division water deliveries are currently an ongoing practice among Friant Division water users. It is unlikely that additional water transfers would significantly increase the net water deliveries to the region. In addition, this measure does not address the planning objectives, considerations, and criteria. Therefore, this measure was not deleted in the Plan Formulation Phase of the Investigation.

Enhance Delta Export and Conveyance

Expand Banks Pumping Plant

The current allowable pumping capacity at the SWP Harvey O. Banks (Banks) Pumping Plant is 6,680 cfs. Efforts are underway by Reclamation and DWR to construct fish protection features under the South Delta Improvements Program to allow increasing the allowable pumping capacity to 8,500 cfs during certain seasonal periods. The maximum installed pumping capacity at Banks is about 10,300 cfs. This measure includes implementing additional physical features and operational improvements aimed at benefiting the overall water quality of the Delta to further increase the allowable pumping capacity at Banks from 8,500 cfs to 10,300 cfs during certain seasonal periods, and splitting the increased pumping capacity equally between the CVP and SWP. This increased capacity would allow more water that otherwise would flow to the Pacific Ocean to be conveyed SOD. It is estimated that the average annual increase in supplies SOD allocated to the CVP could amount to over 100 TAF. The estimated unit cost for the increase in water supply reliability would be highly efficient when compared with other potential sources of new water supplies. However, because this measure would not contribute to the Investigation planning objectives, or identified plan formulation constraints, principles, and criteria, it was deleted in the Plan Formulation Phase of the Investigation.

Construct DMC/CA Intertie

This measure would include the conveyance and pumping facilities necessary to connect these two canals several miles south of the C. W. Bill Jones (Jones) Pumping Plant. However, the Delta-Mendota Canal/California Aqueduct (DMC/CA) intertie has been pursued under a different project. A contract for the construction of the intertie was awarded in July 2010 and completed in May 2012. Therefore, this measure was deleted in the Plan Formulation Phase of the Investigation.

Improve Delta Export and Conveyance Capability through Coordinated CVP and SWP Operations

This measure would involve improving Delta export and conveyance capability through coordinated CVP and SWP operations to allow for greater water supply to the region. This coordination is referred to as a joint point of diversion (JPOD), where CVP and SWP share pumping facilities for optimal use of the facilities and maximization of allowable exports. This measure is being actively pursued in other programs and thus was deleted in the Plan Formulation Phase of the Investigation.

Measures to Address Enhanced Water Temperature and Flow Conditions in the San Joaquin River

A number of potential measures to address only enhanced water temperature and flow conditions in the San Joaquin River were identified. Of four measures identified, two were retained for subsequent investigations.

Following is a brief discussion of the array of measures considered, which are separated into two broad categories: (1) perform reservoir operations and water management, and (2) construct water temperature management devices. The measures to address enhanced water temperature and flow conditions in the San Joaquin River are summarized in Table 2-3.

Perform Reservoir Operations and Water Management

Balance Water Storage in Millerton Lake and New Upstream Reservoirs

The management of water supplies between Millerton Lake and additional upstream surface water storage in the upper San Joaquin River Basin could affect water temperature management, hydropower generation, and recreation. Separate reservoir balancing scenarios were developed for surface water storage measures in the upper San Joaquin River Basin during the Plan Formulation Phase, and these reservoir balancing scenarios were refined in the Draft Feasibility and Plan Refinement Phase of the Investigation, as described below:

- **Millerton Lake Baseline Scenario –** This balancing scenario maintains storage levels in Millerton Lake similar to levels in the without-project condition. This scenario would likely cause minimum changes to recreational conditions at Millerton Lake.

- **Millerton Lake High Scenario** – This balancing scenario maintains high storage levels in Millerton Lake throughout the summer season. This scenario would provide the least hydropower generation at potential upstream reservoirs and enhance recreational opportunities at Millerton Lake.

These reservoir balancing scenarios were further refined through operational studies in the Investigation. This measure was retained for further investigation.

Construct Water Temperature Management Devices

The Settlement was enacted during the plan formulation for the Investigation. This resulted in a change in a change in alternatives formulation and without-project conditions to include Restoration Flows. Many of the new storage measures proposed as a part of the Investigation could enhance the implementation of the Settlement by creating a larger cold-water pool and installing temperature management features. Enlarging the cold-water pool and installing temperature management features would provide greater flexibility in meeting the Settlement goals thereby providing greater flexibility to water supply.

Construct Temperature Control Devices on Friant Dam Canal Outlets

Temperature control devices (TCD) could be constructed on each of the canal outlets to allow the diversion of water from upper levels of the reservoir to conserve colder water for release to the river.

This measure would not conflict with any other ecosystem restoration measures that were retained, nor would it conflict with other known programs or projects on the upper San Joaquin River. In fact, it would be beneficial to existing programs. However, this measure would not provide as much flexibility or cost effectiveness in managing water temperatures as a Selective Level Intake Structure, and thus was deleted in the Plan Formulation Phase of the Investigation.

Construct Temperature Control Device on Friant Dam River Outlet

A TCD could be constructed on the river outlet of Friant Dam to enable withdrawal of water that meets release objectives from the highest possible level in the reservoir, thereby preserving cold water for a longer period.

This measure would not conflict with any other ecosystem restoration measures that were retained, nor would it conflict with other known programs or projects on the Upper San Joaquin River. In fact, it would be beneficial to existing programs. However, this measure would not provide as much flexibility or cost-effectiveness in managing water temperatures as a selective level intake structure (SLIS), and thus was deleted in the Plan Formulation Phase of the Investigation.

Construct Selective Level Intake Structures on New Upstream Dams

An SLIS could be constructed on the intakes for dams associated with measures to increase surface water storage in the upper San Joaquin River Basin. The SLIS would allow selective withdrawal of water from these upper reservoirs for temperature management and discharged into Millerton Lake.

This measure was retained for further investigation because it would (1) directly contribute to one of the planning objectives of the Investigation, (2) combine favorably with other measures, and (3) have a high certainty of providing the intended benefits once implemented. This measure would not conflict with any other ecosystem restoration measures that were retained, nor would it conflict with other known programs or projects on the upper San Joaquin River. In fact, it would be beneficial to existing programs.

Measures to Address Secondary Planning Objectives

A number of potential measures to address secondary planning objectives were identified. Of 16 measures identified, 3 were retained for subsequent investigations, and 1 was retained in concept.

Following is a brief discussion of the array of measures considered, which are separated into five broad categories: (1) improve management of flood flows and Friant Dam, (2) maintain and increase energy generation and improve energy generation management, (3) maintain and increase recreational opportunities in the primary study area, (4) improve San Joaquin River water quality downstream from Friant Dam, and

(5) improve quality of water supplies delivered to urban areas. The measures to address secondary planning objectives are summarized in Table 2-4.

Table 2-4. Management Measures Addressing Secondary Planning Objectives

Measure	Status	Rationale
Reduce Flood Damages Downstream from Friant Dam		
Change objective flood release from Friant Dam	Deleted	Specific operations have not been defined, and in general, the potential flood risk management benefits resulting from a change in the objective flood release from Friant Dam are obtained incidentally through implementing the Temperance Flat Reservoir measures. This measure was deleted during the Plan Formulation Phase of the Investigation.
Increase flood storage space in or upstream from Millerton Lake	**Retained**	Available incidental flood storage space created through increasing surface water storage in the upper San Joaquin River Basin. Compatible with planning objectives and would not conflict with other opportunities or planning constraints/criteria. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Maintain the Value of Hydropower Attributes in the Study Area		
Modify existing or construct new generation facilities at Friant Dam canal outlets	Deleted	Measures addressing opportunities associated with the Enlarge Millerton Lake measure, such as modified or new generation facilities at Friant Dam canal outlets, are not being considered for further evaluation in the Investigation. This measure was deleted during the Plan Formulation Phase of the Investigation.
Modify existing or construct new generation facilities at Friant Dam river outlet	Deleted	Orange Cove Irrigation District filed on April 19, 2006, requesting Federal Energy Regulatory Commission approval of an amendment of license for the Fishwater Release Project to add a powerhouse with a single turbine generator with a capacity of 1.8 megawatts. This measure was deleted during the Plan Formulation Phase of the Investigation.
Construct new hydropower generation facilities on new surface water storage measures	**Retained**	Would increase the capability to recover lost generation capacity at each retained Temperance Flat Reservoir site. Would not conflict with other opportunities or planning constraints/criteria. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Extend Kerckhoff tunnels around new surface water storage measures	Deleted	Would involve extending the Kerckhoff No. 2 tunnel and constructing a new powerhouse downstream from either the Temperance Flat RM 279 or RM 274 dam sites. Would increase capability to recover lost generation. This measure was deleted during the Draft Feasibility and Plan Refinement Phase of the Investigation because the flow capacity and energy generation potential were considered too low to justify the expense.
Construct pumped-storage facilities	Deleted	Could be combined with hydropower generation facilities associated with Temperance Flat reservoirs. Would require participation by a non-Federal partner with an interest in power development and management. This measure is less cost effective than constructing conventional hydropower generation facilities alone, and was deleted during the Draft Feasibility and Plan Refinement Phase of the Investigation.

Table 2-4. Management Measures Addressing Secondary Planning Objectives (contd.)

Measure	Status	Rationale
Maintain and Increase Recreational Opportunities in the Study Area		
Replace or upgrade recreational facilities	**Retained**	Compatible with any potential modification of Millerton Lake. Would be consistent with established planning guidelines for Federal water storage projects and with existing recreational uses at Millerton Lake State Recreation Area. This measure was retained through the Draft Feasibility and Plan Refinement Phase of the Investigation.
Develop new management plan for Millerton Lake State Recreation Area	Deleted	Millerton Lake Resource Management Plan/General Plan was published by Reclamation in 2012 under a separate study. This measure was deleted during the Plan Formulation Phase of the Investigation.
Improve San Joaquin River Water Quality Downstream from Friant Dam		
Reduce salt discharge to San Joaquin River	Deleted	Currently being implemented under the San Joaquin Valley Drainage Management Program. This measure was deleted during the Plan Formulation Phase of the Investigation.
Recirculate Delta-Mendota Canal deliveries to the San Joaquin River	Deleted	Would increase flows and could improve water quality from Mendota Pool to the Delta. Would not provide flows in the reach from Friant Dam to Mendota Pool. Independent ongoing study authorized by Public Law 108-573. This measure was deleted during the Plan Formulation Phase of the Investigation.
Increase flows in tributaries to lower San Joaquin River	Deleted	Would increase flows and improve water quality from Mendota Pool to the Delta, but would not provide flows to the reach from Friant Dam to Mendota Pool. This measure was deleted during the Plan Formulation Phase of the Investigation.
Release water from Friant Dam during the late irrigation season to improve river water quality	Deleted	Conflicts with planning objective of increasing water supply reliability. This measure was deleted during the Plan Formulation Phase of the Investigation.
Improve Quality of Water Supplies Delivered to Urban Areas		
Treat poor quality groundwater	Deleted	High implementation costs, limited application and benefits. This measure was deleted during the Plan Formulation Phase of the Investigation.
Integrate Friant Dam operations with SWP and/or CVP outside the Friant Division	Retained in Concept Only	Same as described in Table 2-2.
Construct desalination facility	Deleted	Limited application as a dry-year supply, high unit cost, and potential environmental effects from treatment byproducts. This measure was deleted during the Plan Formulation Phase of the Investigation.

Key:
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
RM = river mile
SWP = State Water Project

Reduce Flood Damages Downstream from Friant Dam

Change Objective Flood Release from Friant Dam

Currently, the objective flood release from Friant Dam is 8,000 cfs. Altering this objective could improve the management of flood flows at Friant Dam. Evaluations completed in previous phases of the Investigation demonstrated without additional flood storage space, decreasing the objective flood release from Friant Dam actually increased flood damage. Increasing flood storage space in Friant Dam to 340 TAF resulted in a lower-than expected damage in flood events up to the 25-year flood, but greater damage for less frequent events because the flood storage fills faster for lager floods due to the lower-than expected objective release. Increasing flood storage space to 500 TAF resulted in lower expected damages up to the 100-year flood and was not significantly higher for the 200- and 500-year floods. In general, the potential flood risk management benefits resulting from a change in the objective flood release from Friant Dam are obtained incidentally through implementing the Temperance Flat Reservoir measures. This measure would not conflict with other planning objectives, constraints, criteria, or opportunities. Because specific operations have not been defined, this measure was retained in concept only through the Plan Formulation Phase of the Investigation.

Increase Flood Storage Space in or Upstream from Millerton Lake

Development of additional storage for water supply provides opportunities for additional dedicated or incidental flood storage space. Evaluations completed during the Initial Alternatives Phase considered the benefits associated with additional dedicated flood space in or upstream from Friant Dam (Reclamation and DWR 2005), but subsequent evaluations in the Plan Formulation and Draft Feasibility and Plan Refinement phases of the Investigation led to inclusion of incidental flood space with the additional storage. This measure could be compatible with the planning objectives and would not conflict with other opportunities or planning constraints/criteria. This measure was retained for further investigation.

Maintain the Value of Hydropower Attributes in the Study Area

Modify Existing or Construct New Generation Facilities at Friant Dam Canal Outlets

This measure would include modifying the existing generation facilities or constructing new generation facilities at Friant Dam. Since raising Friant Dam was not retained, measures addressing opportunities associated with the raising Friant Dam and enlarge Millerton Lake measure, such as modified or new generation facilities at Friant Dam canal outlets, were deleted in the Plan Formulation Phase of the Investigation.

Modify Existing or Construct New Generation Facilities at Friant Dam River Outlet

This measure would involve modifying existing or constructing new generation facilities at the Friant Dam river outlet. On April 19, 2006, the Orange Cove Irrigation District requested FERC approval of an amendment of license for the Fishwater Release Project to add a powerhouse with a single-turbine generator with a capacity of 1.8 MW. Since modifications to the generation facilities at Friant Dam are being pursued by another agency, this measure was deleted in the Plan Formulation Phase of the Investigation.

Construct New Hydropower Generation Facilities on New Surface Water Storage Measures

The construction of new surface water storage facilities would present an opportunity to add hydropower generation facilities and improve energy generation management in the study area. This measure was retained for further investigation.

Extend Kerckhoff Tunnels around New Surface Water Storage Measures

There are two powerhouses located between Kerckhoff Lake and Millerton Lake, the Kerckhoff Powerhouse and Kerckhoff No. 2 Powerhouse. Each powerhouse has a separate intake in Kerckhoff Lake and each intake is routed from the lake to the powerhouse via a tunnel. The Temperance Flat RM 274 or RM 279 reservoirs would inundate the Kerckhoff and Kerckhoff No. 2 powerhouses.

Evaluations conducted during plan formulation suggest that the Kerckhoff No. 2 tunnel could be extended to a location downstream from either the Temperance Flat RM 274 or Temperance Flat RM 279 dam sites, where a new powerhouse could be constructed. This measure would allow the continued operation of diversions for power generation through the Kerckhoff No. 2 tunnel. This and similar hydropower modifications considered for the Kerckhoff tunnel with the RM 274 or RM 279 reservoirs were not retained because the flow capacity and energy generation potential were considered too low to justify the expense.

Construct Pumped-Storage Facilities

Pumped storage facilities could be combined with hydropower generation facilities associated with Temperance Flat reservoirs. Construction of pumped storage facilities would not conflict with other opportunities or planning constraints/criteria. Hydroelectric pumped-storage facilities were considered during value planning but were found to be uneconomical given the variability in operations and head range; therefore, this measure was deleted during the Draft Feasibility and Plan Refinement Phase of the Investigation.

Maintain and Increase Recreational Opportunities in the Study Area

Potential measures retained in the Investigation that could maintain and increase recreational opportunities in the primary study area include replacing or upgrading recreational facilities, as described below. The measure to balance water storage in Millerton Lake and new upstream reservoirs could also benefit recreation, as previously described.

Replace or Upgrade Recreational Facilities

Implementation of surface water storage and reservoir operations measures would affect existing recreational facilities in the primary study area. This measure includes developing suitable replacement facilities, with necessary upgrades to meet current standards and codes, to provide similar or greater recreational opportunities. It is recognized that some recreational experiences, such as whitewater rafting and caving, may not be replaceable for some action alternatives. This measure is compatible with any potential modification of Millerton Lake and would be consistent with established planning guidelines for Federal water storage projects and with existing recreational uses at Millerton Lake State Recreation Area (SRA). This measure was retained for further investigation.

Develop New Management Plan for Millerton Lake State Recreation Area

Reclamation entered into a lease with the State through its State Park and Recreation Commission on November 1, 1957, for the purpose of developing, administering, and maintaining the public lands around Millerton Lake as part of the California Department of Parks and Recreation (State Parks) system (Reclamation and State Parks 2010). Under the agreement, the occupancy, control, and administration of the park are subject to use by Reclamation and other CVP purposes pursuant to the Federal reclamation laws, allowing for recreation consistent with the primary purpose of Friant Dam for water supply. This measure would include developing a new management plan for the Millerton Lake State Recreation Area.

A new Resource Management Plan/General Plan for the Millerton Lake area was released by Reclamation in April 2010 as a part of a separate study. Given the recent release of a new management plan, this measure was deleted in the Plan Formulation Phase of the Investigation.

Improve San Joaquin River Water Quality Downstream from Friant Dam

Between the Mendota Pool and the confluence with the Merced River, the San Joaquin River is characterized by degraded water quality due to low flow and discharges from agricultural areas and wastewater treatment plants. Reaches of the San Joaquin River exceed draft CWA Section 303(d) TMDLs for boron, chlorpyrifos, diazinon, dichlorofiphenyl-trichloroethane (DDT), group A pesticides, selenium, mercury, and arsenic.

Implementation of Restoration will alter the flows in the San Joaquin River and would help water quality; however, water quality may still be impaired.

Reduce Salt Discharge to San Joaquin River

Water naturally contains salt derived from natural processes, and water originating in the western side of the San Joaquin Valley contains naturally high levels of salt because the soil in the area originated as oceanic sediments. These salts are left behind in the soil during the evapotranspiration process. Irrigation brings additional water to a region altering the salt balance. To maintain agricultural productivity, salt must be flushed from the soil to a level that crops can grow in. This leads to high levels of salt discharge to the San Joaquin River. This measure would involve reducing the quantity of salt discharged to the San Joaquin River to improve river water quality. Reduction in salt discharge would be accomplished through implementing and improving subsurface agricultural drainage. Measures intended to reduce the salt discharged to the San Joaquin River are currently being implemented under the San Joaquin Valley Drainage Management Program, therefore this measure was deleted in the Plan Formulation Phase of the Investigation.

Recirculate Delta-Mendota Canal Deliveries to the San Joaquin River

Both Reclamation and DWR are required to meet water quality and flow standards as conditions of operating Jones Pumping Plant and the Banks Pumping Plant, respectively. Historically, Reclamation has met the standards in part by releasing water from New Melones Reservoir (Reclamation and DWR 2009). This measure would include using the Jones and Banks pumping plants, and wasteways that connect the Delta-Mendota Canal (DMC) to the San Joaquin River to recirculate water through the San Joaquin River, thereby improving water quality in the lower San Joaquin River. Recirculating DMC deliveries would not provide flows in the upper San Joaquin River, from Friant Dam to Mendota Pool.

A feasibility study investigating the potential for recirculation of water from the DMC was authorized separately from this study under Title 1, Section 103 of the CALFED Bay-Delta Authorization Act, Public Law 108-361. DMC Recirculation is also being studied pursuant to the State Water Resources Control Board (State Water Board) Decision-1641 (D-1641), and the CALFED ROD. Because this measure is authorized for study independently of this Investigation, it was deleted in the Plan Formulation Phase of the Investigation.

Increase flows in tributaries to lower San Joaquin River

This measure would include increasing flows in tributaries to the San Joaquin River to meet water quality goals. Increasing flows to the San Joaquin River would improve water quality from the Mendota Pool to the Delta, but would not provide flows to the reach of the San Joaquin River from Friant Dam to Mendota Pool. Therefore, this measure was deleted in the Plan Formulation Phase of the Investigation.

Release Water from Friant Dam to Improve River Water Quality

This measure would improve water quality in the San Joaquin River by releasing water from Friant Dam to the San Joaquin River. Releasing additional water from Friant Dam would provide a dilution factor, thereby raising overall water quality in the San Joaquin River downstream from Friant am. This measure would require a reduction in the water stored in Millerton Lake for conservation purposes. This conflicts with the planning objective of increasing water supply reliability and operational flexibility. Therefore, this measure was deleted in the Plan Formulation Phase of the Investigation.

Improve Quality of Water Supplies Delivered to Urban Areas

Treat Poor Quality Groundwater

Groundwater quality in the San Joaquin Valley Groundwater Basin varies considerably. In general, groundwater quality is suitable for most urban and agricultural uses. Primary constituents of concern include total dissolved solids (TDS), boron, chloride, nitrates, arsenic, selenium, dibromochloropropate (DBCP), and radon. Problems with groundwater quality are typically localized (DWR 2003). This measure would include treatment of poor quality groundwater to a level suitable for use in urban areas. Implementation of treatment for these constituents is expensive. Benefits would be limited because the application is limited to the localized problem areas. Therefore, this measure was deleted in the Plan Formulation Phase of the Investigation.

Integrate Friant Dam Operations with State Water Project and/or Central Valley Project Outside of the Friant Division

Integrating operations of Friant Dam with operations of SWP and CVP systems would allow for increased Delta exports during wet conditions, and the potential to reduce exports during dry periods, through exchange of water supplies. Water exported during wet periods would be of higher quality. Improvements in raw water quality can benefit urban water areas through a reduction in the treatment costs required to attain a given level of finished water quality. Therefore, this measure was retained in concept only because operating conditions under the 2008/2009 BOs make integration less feasible. Integration opportunities under alternate future conditions with more flexible CVP and SWP Delta export operations may be assessed in the Final Feasibility Report.

Construct Desalination Facility

This measure consists of constructing seawater or brackish surface or groundwater desalination plants to supplement existing water supplies and help offset future demands. There are 23 desalination facilities with a total capacity of about 80,000 acre-feet per year currently operating in California to provide water for municipal purposes. It is estimated that by 2030, 49 desalination facilities with a cumulative capacity of nearly 600 TAF per year will be in operation in California. Primary elements of any of the facilities include a water intake, pretreatment, desalination, brine disposal, and ancillary facilities for the desalination treatment plant. In addition, a conveyance system is needed to transport the desalinated water to the customer or to the water agency distribution systems. Although technological advances have substantially decreased treatment costs, desalination remains costly compared with most other water sources. Even with continual improvement in membrane technology, energy costs can account for as much as one-half the total cost of desalination. In addition, there are environmental concerns associated with intake facilities and treatment byproducts.

Desalination is most efficient when used as a base supply because the plants can be better and more cost effectively maintained if continuously operated, rather than if they are only operated during drought periods. Alternately, if desalination were operated as a base supply in all years, reserving contract water for use during drought periods, less expensive average and wet-year contract water would be forgone in most years. Consequently, desalination by itself would be a highly inefficient option for agencies that rely on multiple water sources or only intend to use desalination as a drought or emergency supply.

Depending greatly on the quality of the source water and the cost of power, desalination today can range from about $700 to several thousand dollars per acre-foot. As mentioned, desalination is energy intensive and, with rising power costs, it is expected to continue to be relatively expensive. Even if the unit cost for a base supply plant were measurably reduced, desalination by itself would likely not be superior to other potential water sources to address the primary planning objective of agricultural water supply reliability in the Investigation.

This measure was deleted in the Plan Formulation Phase of the Investigation because of its high unit cost, limited application as a dry-year supply, and potential environmental effects from treatment byproducts.

Measures Summary

Table 2-5 and Table 2-6 summarize the water management measures that were carried forward for potential inclusion in action alternatives in the Draft Feasibility Report and Draft EIS to address the planning objectives. The surface water storage measure retained for inclusion in action alternatives, Construct Temperance Flat RM 274 Reservoir, is shown in Figure 2-4. Those carried forward are believed to best address the objectives of the Investigation, with consideration of planning constraints and criteria. It should be noted that measures that have been dropped from consideration at this stage might be reconsidered in the future as mitigation measures or other plan features. Similarly, additional measures not considered herein may be added to action alternatives as they are formulated.

Table 2-5. Measures Retained in the Draft Feasibility Report and Draft Environmental Impact Statement to Address Primary Planning Objectives

Planning Objectives	Management Measure	
Increase water supply reliability and system operational flexibility AND Enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam	Perform reservoir operations and water management	Modify storage and release operations and Friant Dam
	Increase surface water storage in upper San Joaquin River Basin	Construct Temperance Flat RM 274 Reservoir
	Increase groundwater storage	Increase conjunctive management of water in the Friant Division
Increase water supply reliability and system operational flexibility	Perform reservoir operations and water management	Modify diversion to Madera and Friant-Kern canals
Enhance water temperature and flow conditions in the San Joaquin River downstream from Friant Dam	Perform reservoir operations and water management	Balance water storage in Millerton Lake and new upstream reservoirs
	Construct water temperature management devices	Construct selective level intake structures on new upstream dams

Key:
CVP = Central Valley Project
RM = river mile
SWP = State Water Project

Table 2-6. Measures Retained in the Draft Feasibility Report and Draft Environmental Impact Statement to Address Secondary Planning Objectives

Secondary Planning Objectives	Management Measure
Reduce flood damages downstream from Friant Dam	Change objective flood release from Friant Dam
	Increase flood storage space in or upstream from Millerton Lake
Maintain the value of hydropower attributes	Construct new hydropower generation facilities on new surface water storage measures
Maintain and increase recreational opportunities	Replace or upgrade recreational facilities
Improve quality of water supplies delivered to urban areas	Integrate Friant Dam operations with SWP/CVP outside the Friant Division

Key:
CVP = Central Valley Project
SWP = State Water Project

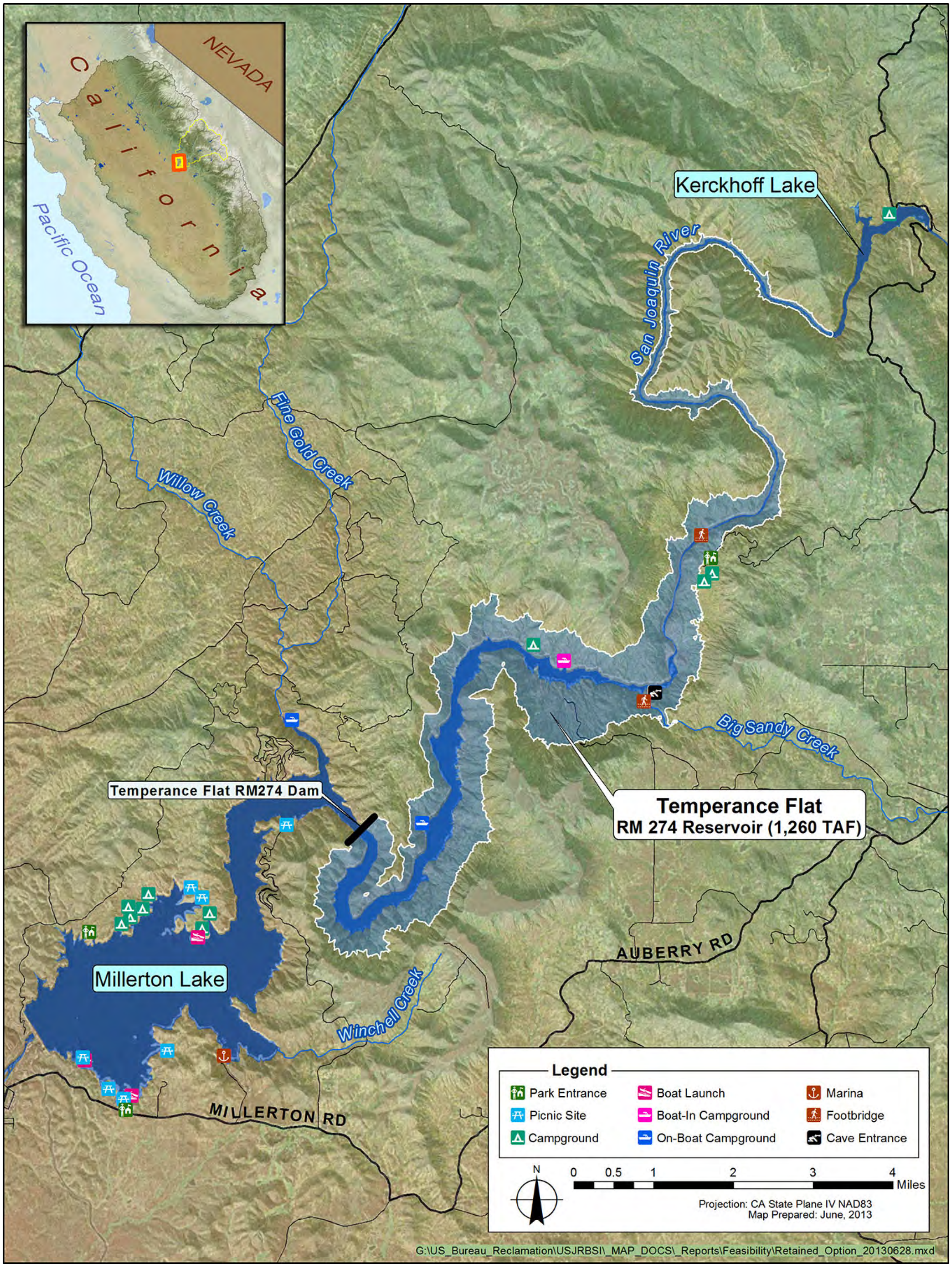

Figure 2-4. Retained Surface Water Storage Measure for Action Alternatives Formulation

Chapter 3
Action Alternatives Development

This chapter provides an overview of the storage sites, operations, and features considered for action alternatives development in the Plan Formulation Phase and Draft Feasibility and Plan Refinement Phase of the Investigation. This chapter summarizes preliminary alternatives and phases of feature design and operations development supporting action alternatives formulation.

Development of Alternative Plans in Plan Formulation Report

Evaluations conducted during previous phases of the Investigation and documented in the Phase 1 Investigation Report and IAIR primarily focused on surface water storage management measures (Reclamation and DWR 2003, 2005). After completion of the Phase 1 Investigation Report and the IAIR, the surface water storage management measures identified for further evaluation were enlarging Millerton Lake, Temperance Flat RM 274 Reservoir, Temperance Flat RM 279 Reservoir, and Fine Gold Reservoir. Preliminary comparison and screening during the Plan Formulation Phase of the Investigation resulted in the selection of the two Temperance Flat surface water storage management measures for further evaluation.

Initial plan formulation efforts concluded that combining a 25-foot raise of Friant Dam/enlargement of Millerton Lake with one of the other storage sites (Temperance Flat RM 274, Temperance Flat RM 279, or Fine Gold reservoirs) would not be effective because very limited additional water supply would be provided for the objectives and purpose and need, and because of the effects to private property and recreation facilities. Based on additional evaluation in the Plan Formulation Phase, Fine Gold Reservoir (with a storage capacity of 780 TAF) was considered inferior to Temperance Flat RM 274 and RM 279 reservoirs because it provides fewer water supply and cold water management benefits (the primary purposes), results in more reservoir area environmental consequences, and ranked lower based on the planning criteria (Reclamation and DWR 2008).

Along with surface water storage measures, additional management measures were retained after preliminary screening during the Plan Formulation Phase of the Investigation, shown in Table 3-1. These measures were combined to form alternative plans to address the planning objectives:

- Temperance Flat RM 274 Reservoir
- Temperance Flat RM 274 Reservoir and Transvalley Canal
- Temperance Flat RM 279 Reservoir
- Temperance Flat RM 279 Reservoir and Transvalley Canal

The PFR alternative plans fundamentally consisted of surface water storage measures and operating them primarily to address the planning objectives of increasing water supply reliability and operational flexibility, and enhancing water temperature and flow conditions in the San Joaquin River (Reclamation and DWR 2008). Measures to increase transvalley conveyance capacity were included in two of the four groupings of alternative plans. Other measures addressing planning objectives were included in all alternative plans described in this chapter.

Table 3-1. Management Measures Retained for Alternative Plans in the Plan Formulation Report

Management Measures Addressing Primary Planning Objectives
Perform Reservoir Operations and Water Management
Balance water storage in Millerton Lake and new upstream reservoirs
Modify storage and release operations at Friant Dam
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division
Increase Surface Water Storage in the Upper San Joaquin River Basin
Construct Temperance Flat RM 274 Reservoir
Construct Temperance Flat RM 279 Reservoir
Construct Water Temperature Management Devices
Construct temperature control devices on Friant Dam canal outlets
Construct temperature control device on Friant Dam river outlet
Construct selective level intake structures on new upstream dams

Table 3-1. Management Measures Retained for Alternative Plans in the Plan Formulation Report (contd.)

Management Measures Addressing Primary Planning Objectives
Increase Transvalley Conveyance Capacity
Construct Transvalley Canal
Management Measures Addressing Secondary Planning Objectives
Reduce Flood Damages Downstream from Friant Dam
Increase flood storage space in or upstream from Millerton Lake
Maintain the Value of Hydropower Attributes in the Study Area
Construct new hydropower generation facilities on retained new surface water storage measures
Extend Kerckhoff No. 2 Powerhouse tunnel around new surface water storage measures
Preserve and Increase Recreational Opportunities in the Study Area
Replace or upgrade recreational facilities
Improve Quality of Water Supplies Delivered to Urban Areas
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division

Key:
CVP = Central Valley Project
RM = river mile
SWP = State Water Project

Plan Formulation Report Alternative Plans

The effects of the four groupings of PFR alternative plans were determined in comparison to the No Action Alternative. For each alternative plan grouping, several operational scenarios were formulated and evaluated to assess the sensitivity of accomplishments for the alternatives to varying operational strategies and assumptions reflecting various management measures.

Temperance Flat RM 274 Reservoir Alternative Plans

This section describes the components of the Temperance Flat RM 274 Reservoir alternative plans considered in the PFR.

Surface Water Storage

The Temperance Flat RM 274 Dam site is located approximately 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. Permanent features would include a main dam with an uncontrolled spillway to pass floodflows, a powerhouse to generate electricity, and outlet works for other controlled releases. Upstream and downstream cofferdams would be required for river diversion, and to keep Millerton Lake out of the construction zone. Diversion tunnels to route river flows around the construction zone would be required during construction.

Figure 3-1 shows the extent of Temperance Flat RM 274 Reservoir and power features, and affected features in the reservoir area. At the top-of-active-storage elevation of 985 feet msl, Temperance Flat RM 274 Reservoir would provide about 1,260 TAF of additional storage (1,331 TAF of total storage, 75 TAF of which overlap with Millerton Lake), and would have a surface area of about 5,700 acres. The reservoir would extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. At-top-of-active-storage capacity, the reservoir would reach about 12 feet below the crest of Kerckhoff Dam. Temperance Flat RM 274 Reservoir would reduce Millerton Lake storage volume and acreage at top-of-active-storage capacity to 449 TAF and 3,890 acres, respectively.

Embankment dam types were assumed for the designs and cost estimates in the Plan Formulation Phase. The dam would be about 640 feet high, from about elevation 365 feet msl in the bottom of Millerton Lake (San Joaquin River channel) at the upstream face to the dam crest at elevation 1,005 feet msl. No saddle dams would be required.

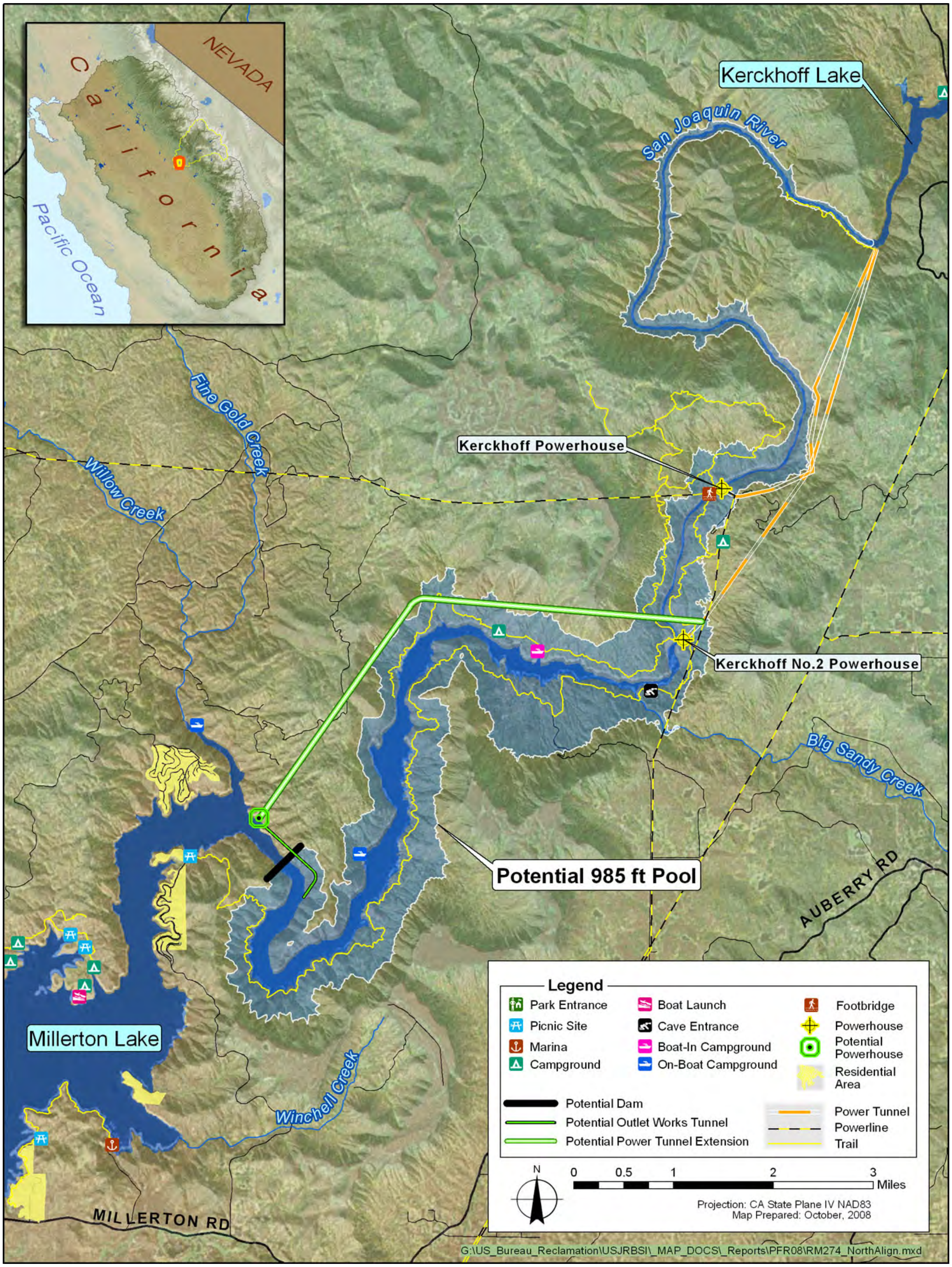

Figure 3-1. Potential Temperance Flat RM 274 Reservoir in the Plan Formulation Report

Water Temperature Management

Water temperature management components included an SLIS on Temperance Flat RM 274 Dam and TCDs on Friant Dam. The SLIS was assumed to have multiple ports to improve management of the cold water pool in the reservoir for releases to Millerton Lake. A steel TCD would be constructed for the Friant Dam river outlet and would be operated in a manner similar to the SLIS on Temperance Flat RM 274 Dam.

Energy Generation

Temperance Flat RM 274 Reservoir would inundate PG&E's Kerckhoff Hydroelectric Project, which consists of the Kerckhoff and Kerckhoff No. 2 powerhouses. Under these alternative plans, these facilities would be decommissioned and abandoned. To mitigate the loss of generation from the Kerckhoff Hydroelectric Project powerhouses, these alternative plans included extending the Kerckhoff No. 2 Powerhouse tunnel to route water from Kerckhoff Lake to a new powerhouse downstream from Temperance Flat RM 274 Dam that would discharge into Millerton Lake, as shown in Figure 3-1. Water not routed through the extended tunnel would flow into Temperance Flat RM 274 Reservoir. This configuration would make use of the relatively constant head in Kerckhoff Lake to maximize power generation. Another option without a Kerckhoff No. 2 Powerhouse tunnel extension was considered for mitigating hydropower impacts that was not included in the alternative plans presented in the PFR, but was evaluated further in the Draft Feasibility and Plan Refinement Phase of the Investigation.

Reservoir Operations and Water Management

Temperance Flat RM 274 Reservoir could be operated under a variety of scenarios, with each providing potential benefits to different purposes. For all operations scenarios, the primary focus was increasing water supply reliability and enhancing water temperature conditions in the San Joaquin River.

Operations scenarios vary, in part, on the degree to which Friant Dam would be operated in a coordinated manner with SWP facilities and other CVP facilities (operations integration). The level of integration, in combination with additional storage, has the potential to affect the geographic extent, type, and magnitude of potential water supply benefits that could be achieved with alternative plans for each reservoir site. Operations integration with the SWP and/or CVP would include coordinated management of water supplies in Millerton Lake and new storage with project operations of SOD facilities.

This would involve delivery of water supplies to the Friant Division in combination with water exchanges between the Friant Division and SWP and/or other CVP service areas. Some Delta water supplies diverted to San Luis Reservoir would be delivered to water users in the Friant Division, while San Joaquin River water would be stored in the new reservoir. Additional available storage space would accrue in San Luis Reservoir during wet periods, allowing export of additional Delta supplies. Accumulated San Joaquin River supplies would be provided to SWP and/or CVP SOD water users through exchange at a later time.

Two reservoir-balancing options were applied to represent a range of operations for balancing water storage levels between Millerton Lake and Temperance Flat RM 274 Reservoir. One balancing option maintained Millerton Lake storage levels at the average monthly storage level from simulation of without-project conditions with the Settlement (Millerton Baseline). A second balancing option set a priority for maintaining Millerton Lake levels higher during the recreational season (Millerton High).

To the greatest extent possible, without impacting the ability to meet the planning objectives, the alternative plans also would be managed to improve opportunities for hydropower generation and recreation. Potential flood damage reduction benefits would be achieved through the incidental effect of additional available storage space.

Temperance Flat RM 274 Reservoir with Transvalley Canal Alternative Plans

This Temperance Flat RM 274 Reservoir with Transvalley Canal grouping of alternative plans is the same as described for the Temperance Flat RM 274 Reservoir alternative plans, with an increased Transvalley conveyance capacity through construction of a Transvalley Canal.

The Transvalley Canal would have a conveyance capacity of 1,000 cfs, and could have several potential alternative configurations. The conceptual alignment for the canal was over 50 miles long, and included a connection to the Friant-Kern Canal near Porterville at the Tulare Check Structure and a connection to the California Aqueduct south of the Tulare Lake bed. It was assumed that the Transvalley Canal would be configured to flow both east-to-west and west-to-east, as needed, to facilitate exchanges. Primary components of this conveyance included the penstock from the California

Aqueduct to the valley floor, a canal across the valley floor, and a lift canal on the valley's eastern slope.

Temperance Flat RM 279 Reservoir Alternative Plans

This section describes the components of the Temperance Flat RM 279 Reservoir alternative plans considered in the PFR.

Surface Water Storage

The Temperance Flat RM 279 Dam site is located approximately 11.6 miles upstream from Friant Dam near the upstream extent of Millerton Lake. Permanent features would include a main dam with an uncontrolled spillway to pass flood flows, a powerhouse to generate electricity, and an outlet works for other controlled releases. Upstream and downstream cofferdams would be required for river diversion, and to keep Millerton Lake out of the construction zone. Diversion tunnels to route river flows around the construction zone would be required during construction. Figure 3-2 shows the extent of Temperance Flat RM 279 Reservoir and power features, and affected features in the reservoir area.

At the top-of-active-storage elevation of 985 feet msl, Temperance Flat RM 279 Reservoir would provide about 690 TAF additional storage (705 TAF total storage, 17 TAF of which would overlap with Millerton Lake), and would have a surface area of about 3,490 acres. The reservoir would extend about 13.6 miles upstream from RM 279 to Kerckhoff Dam. At the top-of-active-storage, the reservoir would reach to about 12 feet below the crest of Kerckhoff Dam. Temperance Flat RM 279 Reservoir would reduce Millerton Lake storage volume to 507 TAF and acreage to 4,540 acres.

Embankment dam types were assumed for the designs and cost estimates in the Plan Formulation Phase of the Investigation. Temperance Flat RM 279 Dam would be about 545 feet high, from about elevation 460 feet msl in the bottom of Millerton Lake (San Joaquin River channel) at the upstream face of the dam to the dam crest at elevation 1,005 feet msl.

Water Temperature Management

An SLIS could be constructed on the intake for Temperance Flat RM 279 Dam to manage the cold-water pool in the reservoir for releases to Millerton Lake. An SLIS would provide the ability to withdraw water from higher levels in the reservoir that may still meet temperature requirements, without releasing water from the elevation of the outlet works tunnel all of the time, and preserving cold water for a longer period.

TCDs could be constructed at Friant Dam canal and river outlets as described previously for the Temperance Flat RM 274 Reservoir alternative plans.

Energy Generation

Temperance Flat RM 279 Reservoir would also inundate the PG&E Kerckhoff and Kerckhoff No. 2 powerhouses; under these alternative plans, these facilities would be decommissioned and abandoned. To mitigate the loss of generation from the Kerckhoff Hydroelectric Project powerhouses, these alternative plans included extending the Kerckhoff No. 2 Powerhouse tunnel to route water from Kerckhoff Lake to a new powerhouse downstream from Temperance Flat RM 279 Dam that would discharge into Millerton Lake, as shown in Figure 3-2. The powerhouse configuration would be the same as described for Temperance Flat RM 274 Reservoir.

Reservoir Operations and Water Management

Reservoir operation scenarios for Temperance Flat RM 279 Reservoir would be similar to those described for the Temperance Flat RM 274 Reservoir.

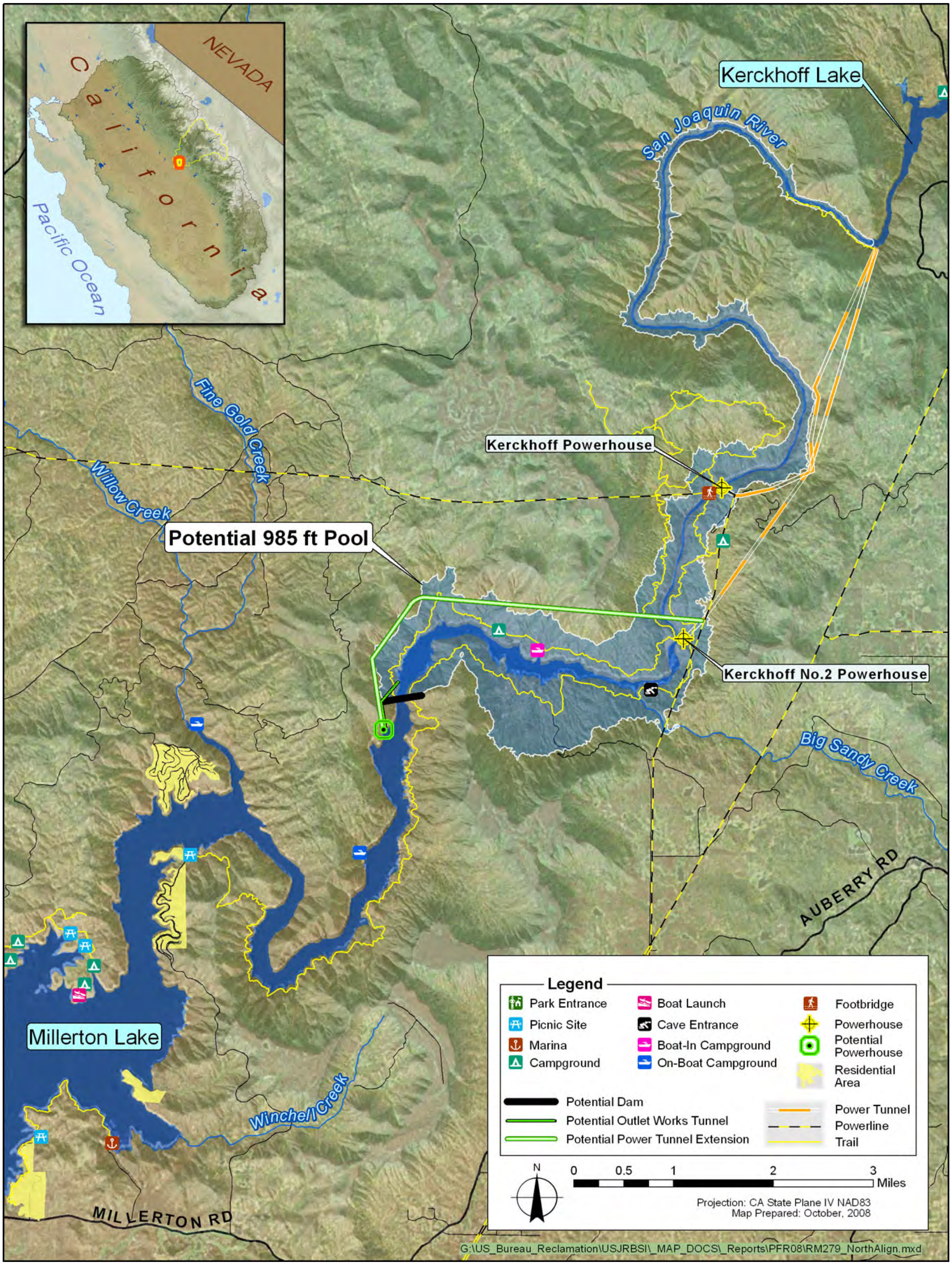

Figure 3-2. Potential Temperance Flat RM 279 Reservoir in Plan Formulation Report

Temperance Flat RM 279 Reservoir with Transvalley Canal Alternative Plans

Surface water storage measures, water temperature management measures, and energy-generation measures for this grouping of alternative plans are the same as described previously for the Temperance Flat RM 279 Reservoir alternative plans. In addition, this grouping of alternatives included the same transvalley conveyance measure described under the Temperance Flat RM 274 Reservoir with Transvalley Canal alternative plans.

Plan Formulation Report Alternative Plans Comparison

This section includes comparisons of the groupings of alternative plans described and evaluated in the plan formulation phase of the Investigation. These comparisons of alternative plans informed the selection of a grouping of alternative plans at a single surface water storage site, from which the final grouping of alternative plans were developed. The groupings of alternative plans were evaluated and compared according to: 1) accomplishments, benefits, and costs; 2) ability to address the stated planning objectives, opportunities, constraints, and considerations; 3) planning criteria of completeness, effectiveness, efficiency, and acceptability, as identified in the P&G; and 4) potential effects of the four P&G accounts, the NED, regional economic development (RED), environmental quality (EQ), and other social effects (OSE), at the plan formulation stage of the planning process.

Accomplishments

Table 3-2 summarizes accomplishments for the planning objectives/project purposes, and comparisons for addressing planning objectives/project purposes, meeting planning constraints and considerations for the alternative plans that had the highest potential monetary benefits within each grouping. Temperance Flat RM 274 Reservoir alternative plans had the highest preliminary benefit-cost ratio.

For the planning objective/project purpose of enhancing water temperature and flow conditions in the San Joaquin River, the Temperance Flat RM 274 Reservoir alternative plans (with and without the Transvalley Canal) provided the greatest improvement in the capability, reliability, and flexibility to store and release water at suitable temperatures for anadromous fish downstream from Friant Dam, specifically due to increases in cold water volume from September to December compared to future without-project conditions. The period of September to December corresponds to months that alternatives may provide the most benefits associated with enhancing water temperature conditions in the San Joaquin River, based on considerations in that phase of the Investigation. In other months of the year, the TCDs allow release of water at warmer temperatures than in the without-project conditions, but still at or below target temperatures, thus preserving additional cold water for later months. All of the alternative plans evaluated demonstrated improvements in the volume of cold water that would be available for management and release to the San Joaquin River to enhance temperatures throughout the year.

For the planning objective/project purpose of increasing water supply reliability and system operational flexibility, the Temperance Flat RM 274 Reservoir (with and without the Transvalley Canal) alternative plans provided the greatest ability to increase water supply reliability through developing the most change in water deliveries compared to future without-project conditions.

The smaller storage capacity associated with Temperance Flat RM 279 Reservoir alternative plans appeared to limit the amount of water that could be exchanged, thus reducing the additional water supply developed compared to Temperance Flat RM 274 Reservoir alternative plans. The Temperance Flat RM 274 Reservoir alternative plans would provide, on average, about 50 percent more water supply towards meeting the objectives/project purposes than the Temperance Flat RM 279 Reservoir alternative plans (without the Transvalley Canal). Temperance Flat RM 274 Reservoir (with and without the Transvalley Canal) alternative plans also ranked high in their ability to improve system operational flexibility, due to greater water storage and transvalley conveyance capacity for integrated operations of Friant Dam with SWP and/or CVP facilities outside the Friant Division.

All PFR alternative plans (except the No Action Alternative) were formulated to address opportunities for the Investigation, and provide benefits associated with the opportunities to varying degrees. Basic constraints and other considerations specific to the Investigation were developed and identified to guide the feasibility study and help formulate, evaluate, and compare the alternative plans. At this stage in the planning process, all alternative plans met planning constraints and considerations identified for the Investigation.

Table 3-2. Summary of Plan Formulation Report Alternative Plan Accomplishments and Comparison

Item	No Action Alternative	Temperance Flat RM 274 Reservoir		Temperance Flat RM 274 Reservoir with Transvalley Canal		Temperance Flat RM 279 Reservoir		Temperance Flat RM 279 Reservoir with Transvalley Canal	
		Operations Integration							
		SWP/CVP/ Friant	**SWP/ Friant**	**SWP/CVP/ Friant**	**SWP/ Friant**	**SWP/CVP/ Friant**	**SWP/ Friant**	**SWP/CVP/ Friant**	**SWP/ Friant**
Physical Characteristics									
Additional Storage Capacity (TAF)	0	1,260				690			
Additional Conveyance Capacity (cfs)	0	N/A		1,000		N/A		1,000	
Accomplishments for Planning Objectives									
Dry and Critical Year Increase in Delivery (TAF)[1]	0	168	171	254	230	120	103	137	126
Long-Term Avg. Increase in Delivery (TAF)[1]	0	180	158	240	177	132	107	158	120
Increase in Cold-Water Volume in All Year-Types	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Replacement of Impacted Hydropower Generation (%)	N/A	97%	98%	94%	NE	100%	100%	NE	NE
Available Flood Space at 90% Exceedance (TAF)	170	301	285	210	257	191	191	172	180
Addresses Planning Objectives	N/A	Yes		Yes		Yes		Yes	
Meets Planning Constraints	N/A	Yes		Yes		Yes		Yes	
Meets Planning Considerations	N/A	Yes		Yes		Yes		Yes	
Combined Ranking for Addressing Objectives, and Meeting Planning Constraints and Criteria	**VERY LOW**	**HIGH**		**HIGH**		**MEDIUM**		**MEDIUM**	

Notes:

This table was created from information presented in the Plan Formulation Report Table 6-1 and 6-2 (Reclamation and DWR 2008). Information from the Plan Formulation Report is a snapshot in time and the accomplishments of Temperance Flat RM 274 Reservoir have continued to be studied and refined in the Draft Feasibility and Plan Refinement Phase of the Investigation. All alternatives listed in this table assumed available transvalley conveyance capacity in the Shafter-Wasco Pipeline, Cross Valley Canal, and Arvin-Edison Canal. Potential benefits for alternatives listed in this table are based on the Millerton Baseline reservoir balancing option.

[1] Increase in water supply deliveries compared to the No Action Alternative. Dry and critical years as defined by the Sacramento River hydrologic index.

Key:
Avg. = average
cfs = cubic feet per second
CVP = Central Valley Project
M&I = municipal and industrial
N/A = not applicable
NE = not estimated
RM = river mile
SWP = State Water Project
TAF = thousand acre-feet

Storage Site Selection

This section summarizes the rationale for selection of the storage site that is considered in detail in the Draft Feasibility and Plan Refinement Phase which formed the basis of the alternatives evaluated in the Draft Feasibility Report and this Draft EIS.

Extensive alternatives analysis was performed as part of the plan formulation process for the Investigation since 2002, with 22 reservoir sites, in addition to those evaluated by CALFED previously (see Figure 3-3), evaluated for their ability to meet basic project purposes and objectives, and in consideration of environmental effects, cost-effectiveness, and overall feasibility. Alternative dam and reservoir sites included options suggested during the scoping process. The number of alternative reservoir sites was reduced through a phased evaluation process considering the ability to achieve site specific project objectives and/or the purpose and need.

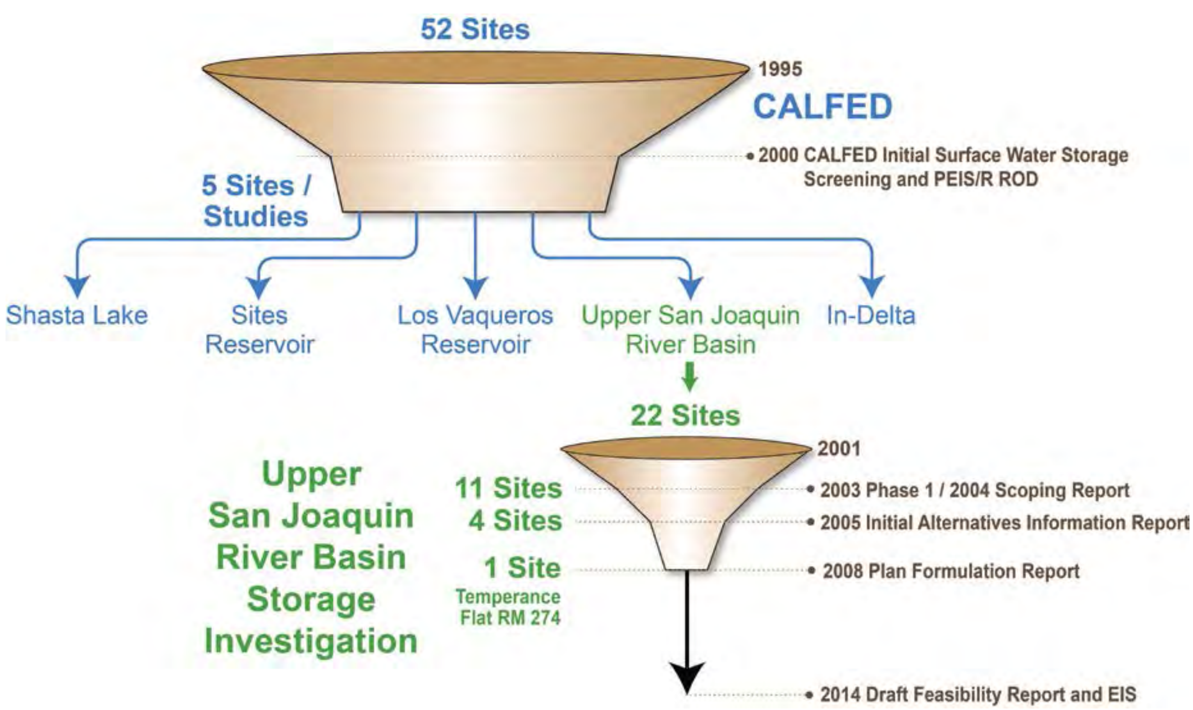

Figure 3-3. CALFED and Investigation Process Leading to Reservoir Site Selection

The Transvalley Canal component of PFR alternative plans was not retained for further evaluation in the Draft Feasibility and Plan Refinement Phase of the Investigation. The ranking of alternative plans and benefit-cost ratios were not substantially affected by including the Transvalley Canal with the Temperance Flat Reservoir alternative plans that would integrate operations with the CVP and SWP system. It is likely that such a facility would be jointly pursued by a variety of local, regional, State, and/or Federal water interests, and its justification would likely not be specifically attached to Investigation alternatives.

Temperance Flat RM 274 Reservoir Selection

Two dam and reservoir site locations between the upper end of Millerton Lake and Kerckhoff Dam, Temperance Flat RM 274 (1,260 TAF) and 279 (690 TAF), were considered in detail through the Plan Formulation Phase of the Investigation and were found to meet the objectives and purpose and need, but to different degrees. Other potential alternatives failed to meet the two primary objectives and basic project purpose and need, or were much less effective in meeting the objectives/purpose and need, and had substantial impacts on biological resources, hydropower, and other resources.

Evaluations conducted during Plan Formulation Phase of the Investigation illustrated that Temperance Flat RM 274 Reservoir best meets the objectives, purpose and need, planning criteria, and provides the greatest overall and net benefits. Limited additional analyses since the PFR also confirmed this finding. Selection of the Temperance Flat RM 274 Reservoir as the preferred storage site for further development in the Draft Feasibility and Plan Refinement Phase formed the basis of the alternatives evaluated in the Draft Feasibility Report and this Draft EIS.

Alternatives at Temperance Flat RM 279 would be less effective and efficient in meeting the primary objectives and purpose and need, as shown by evaluations in the PFR. Temperance Flat RM 274 Reservoir was selected, for the reasons summarized previously and highlighted below.

- Temperance Flat RM 274 Reservoir (1,260 TAF) alternative plans address the planning objectives and project purpose of enhancing water temperature and flow conditions in the San Joaquin River, and increasing water supply reliability and operational flexibility to a greater degree than Temperance Flat RM 279 Reservoir (690 TAF) alternative plans.

- Temperance Flat 274 Reservoir would have a larger ability to provide flow-related enhancements, and a larger ability to increase water supply reliability and operational flexibility. With a smaller storage capacity and, accordingly, a smaller volume of water supply that could be developed, Temperance Flat RM 279 Reservoir would have:
    - smaller volumes of cold water available and lesser ability to enhance water temperature conditions during critical periods for salmon;
    - a smaller ability to provide flow-related enhancements that accrue complementary with deliveries of new supply to CVP SOD contractors via the San Joaquin River to Mendota Pool; and
    - a smaller ability to increase water supply reliability and operational flexibility.
- Temperance Flat RM 279 Reservoir would reduce the frequency and magnitude of flood flows in the San Joaquin River to a smaller extent than Temperance Flat RM 274 Reservoir, but this would not likely compensate for the smaller temperature and summer and fall flow-related improvements.
- Temperance Flat RM 274 Reservoir best meets the objectives, purpose and need, and planning criteria.
- Temperance Flat RM 274 Reservoir alternative plans have greater benefits, greater net benefits, and a higher benefit-cost ratio compared to the Temperance Flat RM 279 Reservoir alternative plans.

Considerations for Range of Alternatives

While the plan formulation process following the P&G and documented in the 2008 PFR considers NEPA, it is not the direct vehicle for NEPA compliance. A NEPA document must provide specific information related to the process to develop, screen and evaluate alternatives. All reasonable alternatives should be screened, and those that meet the basic project purposes should be carried through the analysis of the NEPA document. The CEQ Section 1502.14 states that agencies shall "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." Agencies have discretion in determining the range of reasonable alternatives to include in the rigorous analysis of a NEPA document.

In *Northern Alaska Environmental Center v. Kempthorne*, U.S. 9th Circuit 457 F.3d 969, 978 (9th Cir. 2006), NEPA requirements for a range of reasonable alternatives are summarized succinctly:

> *…an agency's consideration of alternatives is sufficient if it considers an appropriate range of alternatives, even if it does not consider every available alternative. Headwaters, Inc. v. Bureau of Land Mgmt., 914 F.2d 1174, 1181 (9th Cir.1990). An agency need not, therefore, discuss alternatives similar to alternatives actually considered, or alternatives which are "infeasible, ineffective, or inconsistent with the basic policy objectives for the management of the area." Id. at 1180-81 (citing California v. Block, 690 F.2d 753, 767 (9th Cir.1982)).*

Reclamation has thoroughly explained its process for developing the range of alternatives carried forward in the EIS and explained why alternatives and management measures were rejected from detailed discussion in the EIS, consistent with the alternatives development processes upheld in recent case law (see *Protect Our Communities Foundation v. Salazar*, 2013 U.S. Dist. LEXIS 159281 [S.D. Cal. 2013]; and *La Cuna De Aztlan Sacred Sites Protection Circle Advisory Committee v. Interior*, 2013 U.S. Dist. LEXIS 123331 [E.D. Cal. 2013]).

Reclamation is required to examine a range of reasonable alternatives, and provide a detailed analysis of the action alternatives and No Action Alternative, but is not obligated to undertake a detailed examination of every conceivable measure that could benefit water supply reliability and operational flexibility or enhancements to water temperature and flow conditions in the San Joaquin River downstream from Friant Dam. For these reasons, Temperance Flat RM 274 was retained as the preferred dam and reservoir location in the Draft EIS.

Draft Feasibility and Plan Refinement Phase

Since selection of Temperance Flat RM 274 Reservoir for detailed feasibility and NEPA analysis, various planning activities have taken place to study a range of potential alternative variations at the site. Temperance Flat RM 274 Reservoir was evaluated under a range of operational priorities, beneficiaries, and feature configurations to illustrate trade-offs in the plan formulation process and test the sensitivity of alternative plan accomplishments, benefits, and costs to the various conditions. The following sections describe project feature refinements and iterations of potential operational scenarios that led to the development of the action alternatives described in Chapter 4.

Physical Features Development Process for Action Alternatives

Several engineering studies have been performed for the Draft Feasibility and Plan Refinement Phase of the Investigation to support development of Temperance Flat RM 274 Reservoir action alternatives. This section summarizes development of the main physical features of the action alternatives: Temperance Flat RM 274 Dam and appurtenant structures, diversion and outlet works, hydropower generation features, and temperature management features. Further details on site engineering and features are included in the Draft Feasibility Report Engineering Summary Appendix (Reclamation 2014).

Dam and Appurtenant Structures

The PFR included alternatives with an embankment dam type (Reclamation and DWR 2008); however, Reclamation reevaluated both embankment and RCC dam types and recommended the RCC dam type for development of feasibility-level designs at the Temperance Flat RM 274 Dam site (Reclamation 2009a). Initial feasibility-level designs for an RCC dam at the Temperance Flat RM 274 Reservoir site involved a 660-foot-tall, straight RCC gravity dam with a crest elevation of 1,005 feet msl, crest width of 20 feet, maximum base width of 490 feet, a downstream dam slope of 0.75:1, and a total RCC volume of 5,126,000 cubic yards (CY) (Reclamation 2010).

A value planning study was conducted in 2011 to identify potential means and methods to reduce costs on all engineering features while meeting the planning objectives (Reclamation

2011b). Proposals specific to the dam included assessment of a thinner straight RCC dam, a curved RCC dam, and a new spillway configuration. Three RCC gravity dam options and four RCC arch dam options were developed for consideration with varying point of intersection elevations and downstream face slopes. Considering the construction method for RCC, a single center arch dam layout with the point of intersection at elevation 1,005 feet msl and downstream face slope of 0.5:1 was determined to be most appropriate for the Temperance Flat RM 274 Dam site. The total volume of RCC was estimated to be 3,850,000 CY. The spillway flip elevation was also redesigned from elevation 550 to 900 feet msl (Reclamation 2013).

Diversion and Outlet Works

After the PFR (Reclamation and DWR 2008), updated flood routings prompted a refinement of the diversion-during-construction concept to use a 30-foot-diameter tunnel plus a diversion notch to pass floods during construction of Temperance Flat RM 274 Dam (Reclamation 2009b).

Initial feasibility-level designs for diversion at the Temperance Flat RM 274 Dam site included two rockfill cofferdams, two RCC cofferdams, the main RCC dam, a diversion notch in the left abutment of the RCC dam, and a 30-foot-diameter tunnel in the Big Bend area for diversion and river outlet works permanent releases (Reclamation 2010).

The value planning study had proposals specific to diversion, including assessments of diversion flow requirements, elimination of diversion notch, revisions to cofferdam layout, and new diversion and consolidation schemes. Diversion flows during construction were reduced from a 150-year to a 10-year return period. The 30-foot diversion tunnel and cofferdams built to elevation 580 feet msl would be sufficient for a 10-year return period flood. The cofferdams were also designed to withstand larger floods and overtopping in the event that becomes necessary during construction. The design team eliminated the diversion notch and rejected the proposal to relocate the river outlet works to the toe of the dam because both features would create congestion at the construction site and schedule limitations, and the notch has the potential to create weakness in the foundation. In addition, the river outlet works tunnel is shortest in the Big Bend area (Reclamation 2013).

In the PFR, upstream and downstream rockfill cofferdams were designed to elevations 550 and 520 feet msl, respectively. The design team had to redesign rockfill cofferdams to provide protection against flooding during the construction period until the main RCC dam is above elevation 580 feet msl. The stand-alone RCC cofferdams were eliminated because placement of the main RCC dam to elevation 580 feet msl was similar in construction time (Reclamation 2013).

Two diversion and consolidation schemes were assessed, including encased pipes through the dam construction site or diversion tunnels through left and right abutments; however, both proved to be more costly than the current Big Bend area diversion tunnel (Reclamation 2013).

Hydropower Generation

A powerhouse could be constructed downstream from Temperance Flat RM 274 Dam to enable power generation using releases from the reservoir. Initial appraisal-level designs for hydropower generation in the PFR included an extended Kerckhoff No. 2 Powerhouse tunnel to supply water from Kerckhoff Dam to the proposed powerhouse (Reclamation 2008a). Further assessment of the powerhouse design in the Draft Feasibility and Plan Refinement Phase incorporated additional appraisal-level design data, refining layouts and design concepts, and establishing a cost range for power mitigation planning purposes within constraints of water supply operations. In this assessment two power options were considered. Power Option 1 consisted of two 86 MW turbines for hydropower generation of water released from Temperance Flat RM 274 Reservoir. Power Option 2 consisted of one 122 MW turbine and an extended Kerckhoff No. 2 Powerhouse tunnel for hydropower generation using water released from Kerckhoff Lake, and one 44 MW turbine for hydropower generation using water released from Temperance Flat RM 274 Reservoir. Either powerhouse would be a vertical reinforced-concrete silo structure, excavated 120 feet into the ground (to accommodate variation in Millerton Lake levels), and located adjacent to and downstream from the diversion tunnel. The powerhouse would consist of a control room, electrical gallery, mechanical gallery, and housing for two turbine-generator units. External features would include a tailrace tunnel and open channel outlets to Millerton Lake, and an electrical distribution switchyard. The Draft Feasibility and Plan Refinement Phase assessment also included appraisal-level cost estimates for the Kerckhoff Hydroelectric Project decommissioning and a preliminary Kerckhoff Dam stability analysis (Reclamation 2011c).

The value planning study had proposals specific to hydropower generation, including evaluating viability of onsite power facilities, and consolidating the powerhouse to the downstream toe of the dam. Hydroelectric pumped-storage facilities were considered during the value planning study; however, were rejected because it was found to be uneconomical given the variability in operations and head range (Reclamation 2011b). The design team also rejected the proposal to relocate the powerhouse to the toe of the dam because it would create congestion and schedule limitations at the construction site (Reclamation 2013). Additional economic evaluations were performed in the Draft Feasibility and Plan Refinement Phase to reinforce the viability of onsite power facilities, which are also considered as necessary mitigation to meet the project objectives.

Reclamation selected Power Option 1 as the preferred onsite hydropower mitigation option for feasibility-level designs (see the Draft Feasibility Report (Reclamation 2014)). Power Option 2 was eliminated from further consideration in the Investigation because it was found to be less cost effective than Power Option 1 in meeting mitigation requirements. In addition to Power Option 1, some action alternatives will include additional power mitigation costs to fully mitigate the Kerckhoff Hydroelectric Project value. Significant changes were incorporated into Power Option 1 since initial appraisal-level designs, including raising the minimum tailwater elevation from 510 to 550 feet msl, changing the substructure from a silo to a traditional rectangular design excavated 85 feet into the ground, and changing the two turbine units from 86 to 80 MW each. Mechanical, structural, and construction phasing details were also prepared to bring the Power Option 1 design to feasibility-level. The hydropower features described in the action alternatives later in this appendix are for Power Option 1, but the option numbering has not be carried forward since a single option has been selected for the action alternatives.

Intake Structure and Temperature Management

The PFR included consideration of TCDs on Friant Dam and an SLIS at Temperance Flat RM 274 Reservoir. Additional study during the Draft Feasibility and Plan Refinement Phase showed that an SLIS at Temperance Flat Reservoir would be more effective for cold-water pool management than a TCD at

Friant Dam. Evaluations are summarized in the operations development section.

An SLIS could be constructed upstream from Temperance Flat RM 274 Dam to enable releases from a range of reservoir elevations and temperatures and thus manage the cold-water pool in the reservoir for releases to Millerton Lake. After the PFR, SLIS designs and cost estimates were updated with additional feasibility-level design data, refining layouts and design concepts, and coordinated layout and construction with the diversion tunnel feasibility design (Reclamation 2009c). This assessment included an inclined, 800-foot-long by 57-foot- to 82-foot-wide concrete structure, sloped at 35 degrees from horizontal, reinforced-concrete structure located adjacent to and upstream from the entrance to the diversion tunnel. The SLIS consisted of two low-level, fixed-wheel gates, sized to pass 20,000 cfs in combination, and three upper-level ports, each sized to pass 1,700 cfs.

The value planning study proposed assessing the need for temperature management, and potential temperature management devices on Millerton Lake and Temperance Flat RM 274 Reservoir (Reclamation 2011b). The incremental benefits and costs of an SLIS were evaluated using field costs and an economic benefit analysis for temperature improvements. Operations considered included a range of minimum carryover storage targets, and it was determined that the SLIS would be the most effective with higher Temperance Flat RM 274 Reservoir minimum carryover storage targets. For lower minimum carryover, the SLIS cost was not as cost effective, and a low-level intake structure (LLIS) was included in the design (Reclamation 2013).

Since the initial appraisal-level designs, the three upper level ports of the SLIS were increased in size to pass 6,000 cfs (in order for each to individually meet powerhouse flow requirements). This change also increased the overall footprint of the SLIS. Mechanical and structural details were also prepared to bring the SLIS design to feasibility-level.

Other Construction Areas and Affected Existing Infrastructure

This section summarizes Draft Feasibility and Plan Refinement Phase development of other construction areas, such as the access and haul roads, aggregate quarry, batch plant, and staging area, and affected existing infrastructure, such as recreational facilities and utilities.

Access and Haul Roads Initial feasibility-level designs for access and hauls roads at the Temperance Flat RM 274 Reservoir included five permanent access roads to provide accessibility to the main features of the project from Sky Harbor Road and Millerton Road to the south, and five haul and temporary construction access roads to provide access between structures under construction and the staging area, concrete batch plant, aggregate quarry, and County Road 210 to the north. The total length of the permanent access and hauls roads was approximately 5 and 9.6 miles, respectively (Reclamation 2010).

Since the initial feasibility-level designs, permanent access road alignments were updated to account for changes in locations of permanent facilities and construction phasing of diversion tunnel, outlet works, valve house, and powerhouse. With the selection of Power Option 1 for power mitigation, two permanent access roads were also removed from previous designs that included the Kerckhoff No. 2 Powerhouse tunnel extension. Designs were also refined to optimize earthwork activities; no significant changes were made to haul roads.

Aggregate Quarry, Batch Plant, and Staging Area Initial feasibility-level designs for Temperance Flat RM 274 Reservoir included construction of an aggregate quarry, batch plant, and staging area. These facilities would provide aggregate, concrete, and staging for the main dam, cofferdam, diversion tunnel, intake structure, and valve house/powerhouse construction (Reclamation 2010). Minimal changes to these facilities have been made since this assessment.

Recreational Facilities Temperance Flat RM 274 Reservoir would affect many recreational features found along the existing Millerton Lake shoreline. Reclamation would protect such facilities from inundation, modify existing facilities to replace affected areas (i.e., relocate facilities on site), or abandon existing facilities and replace them at other suitable sites (i.e., relocate facilities off site). Reclamation would seek to maintain the quality of visitor experiences by replacing affected recreational facility capacity with facilities providing equivalent visual resource quality, amenities, and access to the Millerton Lake SRA and BLM San Joaquin River Gorge (SJRG) Special Recreation Management Area (SRMA), as well as Temperance Flat RM 274 Reservoir. An appraisal-level assessment of these facilities was performed.

Reservoir Area Utilities A majority of the infrastructure adjacent to Millerton Lake upstream from RM 274 is located in the Temperance Flat area off Wellbarn Road, and PG&E and BLM facilities off Smalley Road. An assessment of impacts to potable water, power distribution, telecommunications, and wastewater facilities was performed during this phase of the Investigation.

Operations Development Process for Action Alternatives

Operations were refined after the Plan Formulation Phase during the Draft Feasibility and Plan Refinement Phase, which included evaluation of several potential operation assumptions. A range of values for each assumption was explored to assess how well they accomplished planning objectives and criteria. The major categories of operation assumptions included:

- Minimum carryover storage targets in Millerton Lake and Temperance Flat RM 274 Reservoir
- Hydropower generation options
- Temperature management options
- Water supply beneficiaries (Friant Division contractors, CVP SOD contractors, CVP wildlife refuges, SWP SOD M&I contractors)

Operations variables were refined from initial operations considered in the PFR, through several interim stages during the Draft Feasibility and Plan Refinement Phase, to the operations selected for the action alternatives. The refined features and operations were then developed into action alternatives, which, along with the No Action Alternative, are described in Chapter 4.

Stages of Operations Analyses

Multiple stages of operations refinement for Investigation action alternatives included the initial operations considered for multiple reservoir sites in the Phase 1 Investigation Report, IAIR, and PFR, an expanded range of operations simulated for the single Temperance Flat RM 274 Reservoir site, and a targeted refinement of operations for the single site to reach the range of operations included in the Temperance Flat RM 274 Reservoir action alternatives. Table 3-3 demonstrates the sites and operations variables investigated in each stage of analysis summarized in this section.

Table 3-3. Sites and Operations Variables Considered in Each Stage of Analysis

Stage of Operations Analyses		Phase 1 and IAIR	Plan Formulation Report	Single Site Expanded Range of Operations	Single Site Refinement of Operations	Action Alternatives Range of Operations
Reservoir Sites		22 sites	4 sites[1]	Temperance Flat RM 274		
Operations Scenarios		N/A	N/A	30+ scenarios	10+ scenarios	5 action alternatives + No Action
Operations Variables	**Active vs. carryover storage/ reservoir balancing between Millerton Lake and Temperance Flat**	Comparative General Estimate of New Water Supply	Various Sizing and Balancing Configurations	Temperance Flat minimum carryover storage target 100-700 TAF	Temperance Flat minimum carryover storage target 200-450 TAF	Temperance Flat minimum carryover storage target 100-325 TAF
				Millerton Lake minimum carryover storage target 220-445 TAF	Millerton Lake minimum carryover storage target 340 TAF	Millerton Lake minimum carryover storage target 130-340 TAF
	New water supply beneficiaries		Friant and SWP/CVP (through integration)[2]	Friant/SWP/ CVP Refuges	Friant/SWP/ CVP Refuges	Friant/SWP/CVP SOD/ CVP Refuges
	New water supply routing options		Included potential transvalley conveyance	Generalized analysis; not investigated	FKC (Friant and SWP) SJR (SWP and CVP)	FKC (Friant and SWP) SJR (SWP and CVP)
	Temperature management		Comparative Estimates of Cold Water Volume	TCD/SLIS	SLIS	SLIS
	Hydropower mitigation	Comparative Estimate of Hydropower Generation in IAIR	Comparative Estimates of Hydropower Generation	2 power options	Single power option	Single power option

Notes:
[1] Four surface water storage measures were considered in Plan Formulation Report; enlarge Millerton Lake by raising Friant Dam, construct Temperance Flat RM 274 Reservoir, construct Temperance Flat RM 279 Reservoir, and construct Fine Gold Reservoir.
[2] CVP and SWP water operations integration was only assessed in the Plan Formulation Report.

Key:
Ag = agriculture
CVP = Central Valley Project
FKC = Friant-Kern Canal
IAIR = Initial Alternatives Information Report
N/A = not applicable
RM = river mile
SJR = San Joaquin River
SJR = San Joaquin River
SLIS = selective level intake structure
SWP = State Water Project
TAF = thousand acre-feet
TCD = temperature control device

Initial Operations Considering Multiple Reservoir Sites in the Phase 1 Report, IAIR, and PFR As summarized in Chapter 2, 22 potential reservoir sites were evaluated in the Phase 1 Investigation Report and IAIR, and operations analyses were primarily focused on general estimates of new water supply for comparison between sites. As described in the alternative plans development in the PFR, four storage sites were considered; however, Fine Gold Creek Reservoir and enlarging Millerton Lake (in combination with other sites) were dropped early in the PFR phase. The two remaining storage sites, Temperance Flat RM 274 Reservoir and Temperance Flat RM 279 Reservoir, were analyzed in more detail for accomplishments in meeting the planning objectives. Operations considered both historical- and high-carryover storage for Millerton Lake operations, no dedicated carryover storage over 100 TAF in Temperance Flat Reservoir to exercise the full range of active storage, and two conveyance options (existing cross-valley conveyance and a potential new Transvalley canal). These operations also considered deliveries to the Friant Division of the CVP, other CVP SOD contractors, and the SWP.

Some key constraints and assumptions for the screening-level evaluations presented for Temperance Flat RM 274 Reservoir evaluations in the PFR included:

- Delta operations were based on the 2004 Biological Opinion on the Long-Term Operations of the Central Valley Project (CVP) and State Water Project (SWP) (NMFS) and 2005 Reinitiation of Formal and Early Section 7 ESA Consultation on the Coordinated Operations and Long-Term Operations of the CVP and SWP to Address Potential Critical Habitat Issues (USFWS).

- All alternatives allocated the new water supply generated by the storage of San Joaquin River flood flows to the Friant Division and allocated new water supply from integration of new storage with SOD exports and storage facilities to existing CVP and SWP contractors.

- Integrated operations with the CVP and SWP were based on using available capacity in existing conveyance facilities and increasing transvalley conveyance capacity to facilitate exchanges when San

Luis Reservoir storage is unable to store available Delta water supplies.

- Opportunities for hydropower mitigation were limited to potential onsite facilities that would generate power incidental to water supply management constraints.
- The No Action Alternative and all alternative plans included SJRRP Restoration Flows stipulated in the Settlement.

Through the analyses in the PFR, Temperance Flat RM 274 Reservoir and existing cross-valley conveyance were determined to be the most effective options, while Temperance Flat RM 279 Reservoir and the transvalley canal option were not retained. All potential water supply beneficiaries were retained.

The representative scenarios were appropriate for comparison and screening purposes for the storage sites in the PFR; however, they were not sufficient to evaluate the full range of potential operations and benefits for any site, including Temperance Flat RM 274 Reservoir. The range of potential operations at the single Temperance Flat RM 274 Reservoir site was expanded in the next stage of analyses.

Initial Evaluation of Operation Assumptions in the Draft Feasibility and Plan Refinement Phase Following the PFR, more than 30 operations scenarios were investigated to expand the range of operations analyses for the single Temperance Flat RM 274 Reservoir site. During this stage, future without-project conditions for the No Action Alternatives were updated in accordance with CVP and SWP operations. The future without-project conditions related to operations of the CVP and SWP have significant influence on the magnitude of water supply developed with new storage, the opportunity to integrate new storage with Delta supplies through exchange, and the corresponding economic benefits. The future without-project conditions scenario under which the feasibility of Temperance Flat RM 274 Reservoir is evaluated in the Draft Feasibility and Plan Refinement Phase to date represents operations of the existing CVP and SWP system under the 2008/2009 BOs.

Changing the future without-project conditions from CVP and SWP operations under the 2004/2005 BOs to the 2008/2009 BOs severely limits opportunities for integrating Temperance

Flat RM 274 Reservoir operations with CVP and SWP operations, and therefore reduces the volume of water supply that could be developed. Due to the constraints under the 2008/2009 BOs, integration of Temperance Flat RM 274 Reservoir operations with CVP and SWP system operations was not considered further in the development of Temperance Flat RM 274 Reservoir action alternatives in the Draft Feasibility and Plan Refinement Phase.

Operations variables in this stage of analyses included carryover storage, hydropower mitigation options, temperature management features, and water supply beneficiaries. Interim results informed decisions to limit carryover storage in Temperance Flat RM 274 Reservoir to less than 400 TAF to maintain a high level of water supply, and to operate Millerton Lake with a fixed carryover storage target rather than historical operations with a fluctuating surface level, to improve water temperature management. These analyses also demonstrated trade-offs between active storage and carryover storage, namely that water supply reliability and flood damage reduction improved with greater active storage capacity, while emergency water supply and recreational opportunities increased with greater dedicated carryover storage. Hydropower and temperature management opportunities increased or decreased, depending on the balance of carryover storage between the two reservoirs.

These analyses also included two hydropower options: a powerhouse operated with releases from Temperance Flat RM 274 Reservoir to Millerton Lake, and a powerhouse primarily operated with flows routed from Kerckhoff Reservoir to Millerton Lake through the Kerckhoff No. 2 Powerhouse tunnel extension. The hydropower options had minimal differences in new water supply but had different effects on storage balancing between Temperance Flat RM 274 Reservoir and Millerton Lake. The Kerckhoff No. 2 Powerhouse tunnel extension option was not retained for further evaluation because of its substantially higher cost (for more information, see the Draft Feasibility Report [Reclamation 2014]).

Multiple options for managing river release temperatures were tested: TCDs on Friant Dam outlets to the San Joaquin River, Madera Canal, and Friant-Kern Canal, an SLIS at Temperance Flat RM 274 Reservoir, and combinations of TCDs with an SLIS. Results showed that an SLIS could provide the greatest flexibility and most cost effectiveness in managing river release temperatures; TCDs were not retained.

The Friant Division, SWP SOD M&I contractors, and San Joaquin Valley wildlife refuges were considered as potential beneficiaries of new water supply from Temperance Flat RM 274 Reservoir in this stage of analyses. Results demonstrated that multiple water supply beneficiaries would likely be necessary for the project to be economically and financially feasible. Scenarios that were tested with a single agricultural beneficiary demonstrated that delivery of all the new water supply to agricultural would not be economically feasible. Further studies did not retain the concept of a single project beneficiary, but included the potential to partner agricultural and M&I beneficiaries for economic and financial feasibility.

Based on the results of this analysis, the potential range of operation assumptions was limited to the following:

- Maintain Temperance Flat RM 274 Reservoir minimum carryover storage targets to less than 400 TAF to balance project objectives (water supply and emergency water supply, water temperature, hydropower, recreation).
- Maintain a relatively constant Millerton Lake storage of 340 TAF to balance project objectives (hydropower, recreation, water supply and emergency water supply, water temperature).
- Maintain multiple project beneficiaries to meet project objectives (economic and financial feasibility).
- Include an SLIS to improve reservoir cold-water pool management and release temperatures to the San Joaquin River.

In this report, the term **carryover** refers to the minimum storage target maintained in Millerton Lake and/or Temperance Flat RM 274 Reservoir for multiple purposes.

Minimum carryover storage is assumed not to be delivered for water supply; it would be maintained for public benefits such as cold-water pool, recreation, and emergency water supply, as well as providing a minimum pool for hydropower.

Refinement of Operation Assumptions in the Draft Feasibility and Plan Refinement Phase Building on insights developed in the previous evaluation, reservoir operation assumptions were refined and grouped into 10 scenarios, with varying priorities placed on the primary planning objectives. Analyses included varying the volume of new water supplies delivered to beneficiaries, and routing new supplies via the Friant-Kern and Madera canals as well as the San Joaquin River and Mendota Pool (to be conveyed to CVP SOD contractors or wildlife refuges or exchanged for delivery to SWP SOD M&I via the California Aqueduct).

Consideration was given to Level 2 refuge diversification and providing Incremental Level 4 refuge supplies during this stage, but Incremental Level 4 deliveries were not included in the action alternatives formulated in subsequent stages of operations development. Annual acquisitions of Incremental Level 4 water will continue to vary from year to year, depending on annual hydrology, water availability, water market pricing, and funding. Each year, Reclamation strives to provide as much Incremental Level 4 water as possible. Section 3406 (d)(2) of the CVPIA specifies that Reclamation must acquire this Incremental Level 4 water "…through voluntary measures such as 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." Therefore, it would be speculative to predict or assume quantities and locations of annual Incremental Level 4 acquisitions from willing sellers. Without that information, it could not be incorporated into the CalSim II modeling assumptions or other analyses.

The scenarios in this evaluation also included three levels of Temperance Flat RM 274 Reservoir minimum carryover storage targets to better characterize potential water supply reliability and ecosystem benefits. An SLIS was incorporated in several scenarios to improve river temperatures, with varying operations and timing. During this evaluation, the ecosystem benefits assessment was expanded from inferring salmon habitat improvements from river temperature improvements to explicit modeling of spring-run Chinook salmon habitat improvements due to flow and temperature changes in the San Joaquin River, using the Ecosystem Diagnosis and Treatment (EDT) model.

The general strategy for these operations refinements was to test a range of beneficiaries, routing options, carryover storage, and water temperature management features. A wide range of potential beneficiaries was retained due to the strategic location and conveyance opportunities connected to Temperance Flat RM 274 Reservoir. Trade-offs related to the planning objectives were dependent on active storage as well as carryover storage targets, and were also due to water supply routing options.

Formulation of Action Alternatives From the operations scenarios in the previous evaluation, 3 operations at 3 carryover storage levels were carried forward. Additionally, several variations on those scenarios were developed to continue to refine operations variables and strategies in progress toward development of the action alternatives.

Remaining operations scenarios include both CVP and SWP deliveries, deliveries via the San Joaquin River, with 230 TAF to 665 TAF of carryover storage for every scenario (between Millerton Lake and Temperance Flat RM 274 Reservoir together). Scenarios with lower carryover storage demonstrated the highest water supply reliability improvements, while scenarios with water deliveries routed via the San Joaquin River and including an SLIS had the greatest ecosystem improvements. Because the primary planning objectives are water supply reliability and water temperature improvements for ecosystem, the revised operations scenarios were not specifically formulated for secondary planning objectives of emergency water supply, hydropower generation, recreation, flood damage reduction, or M&I water quality. However, within the variation of active storage and water supply routing in the scenarios, physical accomplishments for the secondary planning objectives improved to varying degrees.

The performance of different sets of operation assumptions determined in the Draft Feasibility and Plan Refinement Phase process were then used to develop five action alternatives or sets of assumptions that would meet planning objectives to varying degrees. Further details regarding formulation of the operations assumptions are included in the following section. The five action alternatives are described in detail along with their potential physical accomplishments in Chapter 4.

Range of Operations Variables in Action Alternatives

This section provides additional detail supporting refinement of the major operations variables considered in the Temperance Flat RM 274 Reservoir action alternatives. There are a number of operations assumptions and variations in implementing each assumption that affects the performance of the action alternatives in meeting planning objectives and criteria. The action alternatives formulated through the operations refinement process represent a range of (1) planning objective achievements and opportunities, (2) reservoir-balancing and water management actions between Millerton Lake and Temperance RM 274 Flat Reservoir, and (3) potential new water supply beneficiaries (multiple). Features, operations, and assumptions for Temperance Flat RM 274 Reservoir action alternatives and the No Action Alternative are described in Chapter 4.

Variables – The action alternatives vary based on operations (conveyance routing, potential beneficiaries, and carryover) and intake feature configurations.

This section contains details of operation assumptions in the action alternatives and how they could affect project accomplishments. These major operations variables relate to Millerton Lake/Friant Dam operations, Temperance Flat RM 274 Reservoir and Dam operations, new water supply beneficiaries, and new water supply routing. Operational rules for management of storage levels between Millerton Lake and Temperance Flat RM 274 Reservoir could significantly affect all project accomplishments. Water supply reliability and flood damage reduction would be influenced by total carryover storage in the two reservoirs; and river release temperature, hydropower management, and recreation would be strongly influenced not only by total carryover storage, but by the balancing of storage between the two reservoirs.

Variables to be considered in this context include dedicated carryover storage in each reservoir and how water levels fluctuate in each reservoir and between the two reservoirs. The operational scenarios considered a range of rules for managing storage in the two reservoirs to test the sensitivity of the accomplishments to changing operations.

Millerton Lake/Friant Dam Operations

Millerton Lake has historically been operated as an annual reservoir, with annual fluctuations of up to 110 feet between the Friant-Kern Canal outlet near elevation 470 feet msl (approximately 130 TAF) and the top of active storage at elevation 580 feet msl (approximately 520 TAF, or 450 TAF with Temperance Flat RM 274 Dam in place), depending on timing of inflow and demands. With Temperance Flat RM 274 Reservoir in place, Millerton Lake could either be operated similar to its historical fluctuations to capture and deliver water as available, or could be managed at a stable elevation (and allow the larger storage volume in Temperance Flat RM 274 Reservoir to fluctuate based on the timing and magnitude of inflows and release requirements). Evaluation of operations studies demonstrated that operations with stable Millerton Lake levels would result in multiple benefits, including cold water pool management, increased hydropower production at Friant Dam, and enhanced recreation opportunities, while only slightly decreasing water supply reliability. All further analyses considered one of three fixed carryover storage targets for Millerton Lake:

- The target at elevation 470 feet msl (130 TAF target storage) is the lowest elevation considered. This elevation could provide the greatest water supply benefit.

- The target at elevation 550 feet msl (340 TAF target storage) is a representative mid-point and also represents an elevation range that would maximize recreation by balancing shoreline and lake use, and would be below the Friant Dam spillway crest elevation (562.6 feet msl in North American Vertical Datum of 1988).

- The target at elevation 580 feet msl (445 TAF target storage) is the maximum elevation of Millerton Lake at the top of active storage, with the spillway gates raised, and could maintain a larger cold water pool for ecosystem benefits and inclusion in action alternatives.

Operating Millerton Lake at elevation 580 feet msl with the spillway gates raised full time would not be realistic, and was not retained. Operating Millerton Lake at elevation 470 feet msl would reduce cold-water pool and recreational opportunities on the reservoir; however, would maximize water supply reliability and was retained for further investigation. Operating Millerton Lake carryover target at elevation 550 feet msl to maximize recreation was also retained for further investigation.

Temperance Flat RM 274 Reservoir Operations

Constructing Temperance Flat RM 274 Dam and Reservoir would create a total storage capacity of 1,331 TAF, reduce the storage capacity of Millerton Lake by about 75 TAF, and create additional net storage capacity of about 1,260 TAF. The top of active storage in Temperance Flat RM 274 Reservoir would be at an elevation 985 feet msl. A range of minimum carryover storage volumes from 100 TAF to 700 TAF were assessed, with active storage fluctuating above the minimum carryover level. Carryover storage of 700 TAF would hold a minimum of just over 50 percent of Temperance Flat RM 274 Reservoir storage for cold-water pool, emergency water supply, and provide a higher minimum elevation for hydropower generation, but would decrease active storage for water supply development. Carryover storage of 100 TAF would provide greater active storage space for water supply and incidental flood storage. Operations scenarios were refined to a smaller range of carryover storage levels for Temperance Flat RM 274 Reservoir: 100 TAF to 325 TAF (elevation 606 to 731 feet msl), to increase the potential for water supply reliability and flow-related ecosystem benefits.

New Water Supply Beneficiaries

Temperance Flat RM 274 Reservoir could influence south-of-Delta water management by increasing water supply deliveries through various conveyance options. Potential beneficiaries of Temperance Flat RM 274 Reservoir new water supply include CVP Friant Division contractors, CVP SOD agricultural contractors, and SWP SOD M&I contractors. San Joaquin Valley CVP wildlife refuges could also benefit by diversifying or increasing the number of sources of Level 2 refuge water supplies, thereby delivering higher quality San Joaquin River water supplies. Interim analyses included single-beneficiary scenarios, but all action alternatives developed consider multiple beneficiaries to balance flexibility, economic and financial feasibility, and statewide and public benefits. Action alternatives considered water supply deliveries to a range of combinations of these beneficiaries. General options for routing water supply to different beneficiaries are shown in Figure 3-4.

Delivery of new supplies from Temperance Flat RM 274 Reservoir to the Friant Division considered CVP Friant Division long-term contract rules, conveyance capacities, delivery patterns, and changes due to the Settlement. Friant Division contractors would also see improved water supply reliability due to shifting Section 215 water to Class 2 supplies, which could be delivered on demand with greater storage capacity. The Friant Division was considered a beneficiary in all action alternatives.

Delivery of new supplies from Temperance Flat RM 274 Reservoir to CVP SOD contractors was limited to current CVP SOD contract allocation limits, and to contractors with access to Mendota Pool, the DMC, or the California Aqueduct. SWP SOD M&I contractors were considered as a beneficiary in most, but not all, action alternatives.

Delivery of new supplies from Temperance Flat RM 274 Reservoir to SWP SOD M&I contractors was based on the assumption that SWP SOD M&I contractors would have demand for any amount of water supply delivered from Temperance Flat RM 274 Reservoir, within conveyance constraints. Only SWP SOD M&I contractors in Southern California were considered. SWP SOD M&I contractors were considered as a beneficiary in most, but not all, action alternatives.

San Joaquin Valley CVP wildlife refuges could also benefit by diversifying or increasing the number of sources of Level 2 refuge water supplies, thereby delivering higher quality San Joaquin River water supplies. Delivery of new supplies from Temperance Flat RM 274 Reservoir to wildlife refuges was limited to CVPIA specifications for Level 2 water supply. San Joaquin Valley refuges with access to Mendota Pool were considered as a beneficiary; delivery to individual refuges was not modeled. Only refuges with access to Mendota Pool for water supply were considered. Water supplies from Temperance Flat RM 274 Reservoir could be delivered via the San Joaquin River to Mendota Pool, then to refuges in exchange for Level 2 supply that would be delivered from the Delta, providing Level 2 supply diversification and freeing up Delta supplies to be available to other SOD contractors.

New Water Supply Routing

Water supply could be routed from Friant Dam via several different conveyance routes depending on the beneficiary. Supply to the Friant Division would be delivered directly via the Friant-Kern and Madera canals. Supply to the CVP SOD could be delivered via the San Joaquin River to Mendota Pool (for direct delivery or exchange), to contractors with access to Mendota Pool, the DMC, or the California Aqueduct. SWP SOD M&I water supply could be directly delivered via the Friant-Kern Canal, cross-valley conveyance and the California Aqueduct. SWP SOD M&I supply could also be delivered via the San Joaquin River and Mendota Pool, through exchange with CVP SOD deliveries, and then via the California Aqueduct. All of these water supply routes were investigated and retained through the operations refinement.

It is recognized that institutional/regulatory changes may be required to implement potential water supply routing options. Direct delivery of Temperance Flat RM 274 Reservoir water supply to SWP SOD M&I contractors may require modifications to the CVP consolidated place of use. Alternatively, Temperance Flat RM 274 Reservoir could be developed jointly between the CVP and another partner.

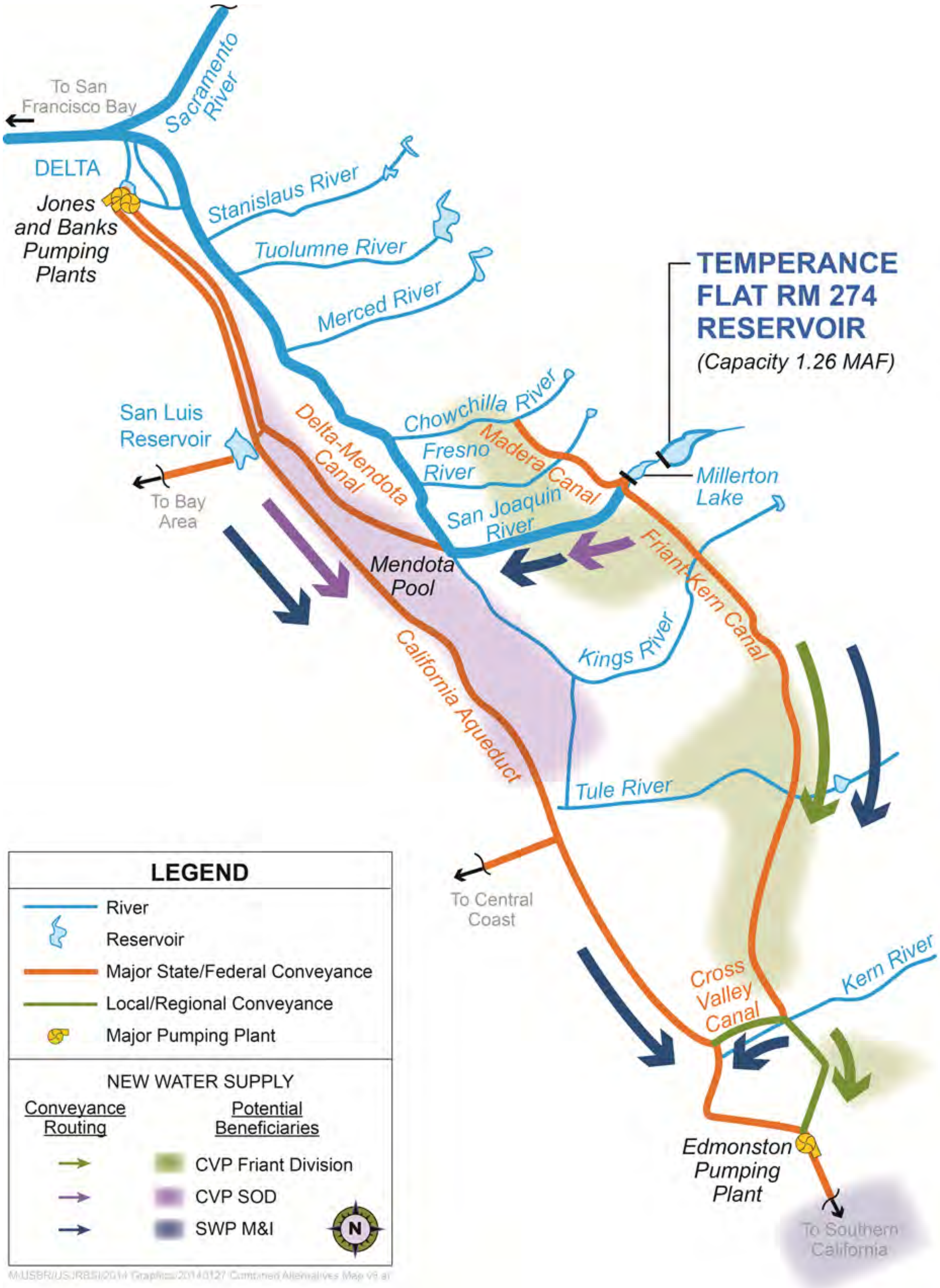

Figure 3-4. Potential Temperance Flat RM 274 Reservoir Water Supply Beneficiaries and Routing Options

Sensitivities for Operation Assumptions

The process of refining operations assumptions for action alternatives illustrates trade-offs between accomplishments tied to active storage capacity (long-term average water supply reliability and flood damage reduction) and those tied to a minimum carryover storage target (cold water pool, emergency water supply, hydropower generation, and recreation). In addition to the relative balancing of active and carryover storage, the water supply reliability accomplishments of Temperance Flat RM 274 Reservoir are also sensitive to CVP and SWP operating conditions in the Delta, and potential new conveyance in the Delta and between the east side and west side of the San Joaquin Valley.

This section summarizes the sensitivity of water supply reliability accomplishments of the action alternatives to carryover storage, CVP and SWP operating conditions and conveyance, and hydrological impacts of climate change on the No Action Alternative and a simplified representation of the action alternatives.

Carryover Storage

The action alternatives were formulated to balance traditional water supply reliability accomplishments (dependent on active storage capacity) with accomplishments tied to ecosystem and other public benefits (many of which are influenced by minimum carryover storage). This approach also is intended to maximize net benefits consistent with the P&G, maximize potential public benefits consistent with the Safe, Clean and Reliable Drinking Water Supply Act of 2010 (SBX7-2), and incorporate the various planning objectives for the Investigation.

Long-term average water supply reliability increases with greater active storage and smaller volumes of minimum carryover storage, which would capture more San Joaquin River flood flows for delivery. Table 3-4 summarizes analyses performed to illustrate the sensitivity of Temperance Flat RM 274 Reservoir new water supply to changes in minimum carryover storage.

Table 3-4. Long-Term Average Annual Change in Deliveries for Temperance Flat RM 274 Reservoir with Varying Minimum Carryover Storage Target

Minimum Carryover Storage in Millerton Lake and Temperance Flat RM 274 Reservoir (TAF)[1]	**230**	**320**	**440**	**540**	**665**
Active Storage Capacity in Millerton Lake and Temperance Flat RM 274 Reservoir (TAF)[2]	1,550	1,460	1,340	1,240	1,115
Average Annual Change in Deliveries (TAF)[3,4,5,6]	98	91	85	70 – 76[7]	61[8]

Notes:
[1] Combined total storage capacity = 520 TAF Millerton (existing) + 1,260 TAF Temperance Flat (net additional) = 1,780 TAF.
[2] Active storage capacity = total storage capacity minus minimum carryover storage.
[3] Does not include deliveries pursuant to Paragraph 16(b) of the Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al*.
[4] Alternatives compared to No Action Alternative.
[5] All estimates of new water supply/change in deliveries based on CVP and SWP operating conditions with the 2008 USFWS and 2009 NMFS BOs (USFWS 2008, NMFS 2009).
[6] The values represent the net change in CVP/SWP systemwide deliveries, accounting for new deliveries from Temperance Flat RM 274 Reservoir and decreases in Delta exports due to the decrease in San Joaquin River flood flows. These sensitivity scenarios are based on storage of San Joaquin River supplies only and do not include operations integration with the broader CVP and SWP.
[7] Values represent the range of new water supply for Alternative Plans 1, 2, and 3, which include the same minimum carryover.
[8] Value for new water supply represents Alternative Plan 4.
Key:
BO = Biological Opinion
CVP = Central Valley Project
RM = river mile
SWP = State Water Project
TAF = thousand acre-feet

For ecosystem enhancements, greater active storage would correlate to more new water supply and therefore more potential flow-related improvements, while greater carryover storage could support more temperature-related improvements. San Joaquin River ecosystem enhancement for anadromous fish would also be related to water supply routing when using the river as a conveyance route to Mendota Pool.

CVP and SWP Operating Conditions and Conveyance

The magnitude of new water supply that could be developed by Temperance Flat RM 274 Reservoir would be strongly influenced by CVP and SWP operating conditions and conveyance. Analysis of Temperance Flat RM 274 Reservoir in the draft feasibility phase with operating conditions under the 2008/2009 BOs focuses on developing new water supply by storing wet year water supplies from the San Joaquin River that would otherwise be released from Friant Dam as flood flows.

Operations of Temperance Flat RM 274 Reservoir could also be integrated with the broader CVP and SWP SOD export and storage system, as evaluated in the PFR, to provide additional water supply reliability by capturing additional Delta water supply in wet years through exchange. This operation was not included in the draft feasibility phase since operating conditions under the 2008/2009 BOs result in San Luis Reservoir filling less frequently, which makes integration less feasible. Assumptions regarding CVP and SWP operating conditions in the Delta do not affect the modeled new water supply generated from capturing San Joaquin River flood flows, but do affect changes in Delta exports the ability to develop additional wet year water supply from the Delta through exchange.

Evaluation of operations integration with the CVP and SWP system under future conditions with increased flexibility for CVP and SWP Delta export operations would likely result in significantly greater estimates of water supply reliability from Temperance Flat RM 274 Reservoir. Potential new Delta conveyance would increase the frequency of San Luis Reservoir filling and, correspondingly, increase the use of the available storage space in Temperance Flat RM 274 Reservoir for exchanges. This integrated operation of San Luis Reservoir with Temperance Flat RM 274 Reservoir could improve the ability to manage water supply for multiple purposes.

Increasing “transvalley” conveyance capacity (between the east side and west side of the San Joaquin Valley) through construction of a new major transvalley canal would further enable potential integration between Temperance Flat RM 274 Reservoir and the SWP and/or CVP system outside the Friant Division through water exchanges. A conceptual alignment for the canal could include up to a 1,000 cfs bi-directional connection between the Friant-Kern Canal near Porterville and the California Aqueduct south of the Tulare Lake bed (Reclamation and DWR 2008).

Some previous studies of potential Temperance Flat RM 274 Reservoir operations represented conditions with the 2004/2005 BOs, operations integration with the broader CVP and SWP system, and potential changes in transvalley and/or Delta conveyance. These studies, summarized in Table 3-5, illustrate the sensitivity of the new water supply that could be developed to changes in CVP and SWP operating conditions and conveyance.

Integration with CVP and SWP

Integrating operations with the CVP and SWP would include coordinated management of water supplies in Millerton Lake and Temperance Flat RM 274 Reservoir with operations of SWP and other CVP facilities.

- This could involve delivery of water supplies to the Friant Division in combination with water exchanges between the Friant Division and SWP and other CVP service areas. Some SWP or CVP water supplies from the Delta that are diverted to San Luis Reservoir could instead be delivered to water users in the Friant Division, while San Joaquin River water could be stored in the new Temperance Flat RM 274 Reservoir.
- This would provide additional available storage capacity in San Luis Reservoir during wet periods, which could allow capture of additional supplies from the Delta. Accumulated San Joaquin River water supplies would be provided through exchange to SWP and CVP SOD water users when available Delta supplies are less than demand.

With operations integration, Temperance Flat RM 274 Reservoir would not only be operated as an enlargement of Millerton Lake for managing flood or high flows on the San Joaquin River (functioning as a reservoir upstream from the Delta), but also operated as an expansion of SOD offstream storage (like a San Luis Reservoir on the east side of the San Joaquin Valley) to capture additional Delta supplies through exchange (functioning as a reservoir downstream from the Delta).

Source: DWR 2010b

Table 3-5. Long-Term Average Annual Change in Deliveries for Temperance Flat RM 274 Reservoir with Varying CVP/SWP Operations and Conveyance

Row ID	CVP and SWP Operations (BOs)	Total Minimum Storage in Millerton and Temperance Flat (TAF)[1]	Integration with CVP and SWP	New Delta Conveyance[2]	New Transvalley Conveyance[3]	Average Annual Change in Deliveries (TAF)[4]
A	2008/2009	230	--	--	--	98[5]
B[6]	2004/2005	230	--	--	--	113[5]
C[6]	2004/2005	230	☑	--	--	158 – 180[7]
D[6]	2004/2005	230	☑	--	☑	240
E[8]	2008/2009	230	☑	--	--	140
F[8]	2008/2009	230	☑	☑	--	230

Notes: General: Draft EIS action alternatives assume 2008/2009 BOs with No Integration, No New Delta Conveyance, and No New Transvalley Conveyance, with a total minimum carryover in Temperance Flat and Millerton of 540 to 665 TAF.

[1] Minimum storage in Millerton Lake is 130 TAF; minimum storage in Temperance Flat is 100 TAF.

[2] Assumed capacity and configuration of new Delta conveyance representation not specified in DWR 2010.

[3] Assumed new 1,000 cfs bi-directional Transvalley canal connecting Friant-Kern Canal and California Aqueduct. Water supply delivery estimate would be smaller with 2008/2009 BOs.

[4] Action alternatives compared to No Action Alternative. Values represent the net change in CVP/SWP system-wide deliveries, accounting for new deliveries from Temperance Flat RM 274 Reservoir and decreases in Delta exports due to the decrease in San Joaquin River flood flows. All scenarios presented assume implementation of the SJRRP.

[5] The 2 scenarios without integration would result in the same water supply developed from Temperance Flat and the same reduction in San Joaquin River flood flows, but the values with 2008/2009 BOs are smaller than with 2005/2005 BOs due to additional reductions in Delta exports.

[6] Source: Reclamation 2008a

[7] A range of values is presented since multiple scenarios were evaluated

[8] Source: DWR 2010

Key:
BO = Biological Opinion
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
DWR = California Department of Water Resources
EIS = Environmental Impact Statement
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
RM = river mile
SJRRP = San Joaquin River Restoration Program
SWP = State Water Project
TAF = thousand acre-feet

Compared to the 113 TAF long-term average new water supply that could be developed by Temperance Flat RM 274 Reservoir with minimal carryover storage and no integration with the 2004/2005 BOs (row B), Table 3-5 illustrates that water supply accomplishments would increase with additional flexibility for CVP and SWP Delta export operations (whether through regulatory changes or new Delta conveyance) and with increased transvalley conveyance capacity, as follows:

- Up to 59 percent (67 TAF) increase in water supply with integration under 2004/2005 BOs (row C).

- Up to 112 percent (127 TAF) increase in water supply with integration under 2004/2005 BOs and new transvalley conveyance (row D).
- Up to 24 percent (27 TAF) increase in water supply with integration under 2008/2009 BOs (row E).
- Up to 104 percent (117 TAF) increase in water supply with integration under 2008/2009 BOs and new Delta conveyance (row F).

Climate Change

All action alternatives, including the No Action Alternative, are projected to be impacted by climate change this century. Sea level rise would impact salinity in the Delta and operations of the CVP and SWP. Hydrological changes would impact the timing and availability of inflows into Temperance Flat RM 274 Reservoir and Millerton Lake, either increasing or decreasing inflow volume, and changing inflow timing. For the Investigation, hydrological impacts of climate change on the No Action Alternative and a simplified representation of the action alternatives (referred to as the Representative Alternative) were evaluated using temperature and precipitation developed using different projected socioeconomic-climate scenarios for water years 2012 through 2099. Details regarding the methodology used to evaluate the No Action alternative and the Representative Alternative under climate change forcings and the associated evaluation results can be found in Chapter 8 of the EIS, “Climate Change.”

For the No Action Alternative, water supply availability could either increase or decrease, as compared to current conditions, depending on the particular climate change forcing. Temperatures within the San Joaquin River are expected to rise, particularity in climate change scenarios with greater warming and less precipitation. Additionally, the peak inflow into Millerton Lake is expected to occur earlier in the year. Modeling performed for the Representative Alternative indicates the potential for Temperance Flat RM 274 Reservoir to increase water supply deliveries, relative to the No Action Alternative under climate change. Additionally, the Representative Alternative was simulated to reduce the temperature of deliveries from Friant Dam to the San Joaquin River under climate change.

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Chapter 4
Description of Alternatives

This chapter documents compliance with NEPA and CEQA requirements for the development, analysis, and documentation of alternatives, and describes the five action alternatives and the No Action Alternative evaluated in detail in this Draft EIS. This chapter includes the following sections:

- **Summary Description of Alternatives**
- **No Action Alternative**, describing the No Action Alternative, a scenario in which a project is not implemented
- **Action Alternatives**, describing each action alternative evaluated in this Draft EIS, including major components, potential benefits, operations and maintenance (O&M), and physical features/construction activities
- **Summary of Potential Accomplishments of Action Alternatives**, summarizing the major potential accomplishments of the action alternatives
- **Preferred Alternative and Rationale for Selection**, describing the basis for selecting a plan for recommendation, including the criteria and considerations used in selecting a recommended course of action by the Federal Government; the preferred alternative will be identified in the Final EIS

The purpose of including action alternatives in an EIS is to offer a clear basis for choice by decision makers and the public about whether to proceed with a proposed action or project. NEPA requires consideration of a range of alternatives. This range must include all reasonable alternatives, which must be rigorously explored and objectively evaluated, as well as other alternatives eliminated from detailed study. A brief discussion of the reasons for eliminating alternatives must be included (Section 1502.14). CEQA requires that an EIR describe a reasonable range of alternatives that could feasibly avoid or lessen any significant environmental impacts while substantially attaining the basic objectives of the proposed action or project. A No Action Alternative (which also constitutes the No Project alternative under CEQA) is also analyzed, as required by NEPA and CEQA.

Summary Description of Alternatives

This chapter summarizes the alternatives considered in detail in the Draft, which include a No Action Alternative and five action alternatives:

- **No Action Alternative –** Under the No Action Alternative, the project would not be implemented. The No Action Alternative reflects projected conditions under a 2030 level of development if the project is not implemented.

- **Alternative Plan 1 –** Alternative Plan 1 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern and Madera Canals, and to SWP SOD M&I contractors via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes a low-level intake structure LLIS and a 200 TAF minimum carryover storage target (water that is kept in the reservoir as a minimum storage reserve for cold water pool, hydropower generation, recreation, and emergency response, rather than delivered) in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 340 TAF minimum carryover storage target, with a preference to store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above the target.

- **Alternative Plan 2 –**Alternative Plan 2 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern Canal and Madera Canals, and to both SWP SOD M&I contractors and CVP SOD contractors, including refuges, via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes an LLIS and a 200 TAF minimum carryover storage target in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 340 TAF minimum carryover storage target, with a preference to store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above the target.

- **Alternative Plan 3 –** Alternative Plan 3 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern and Madera Canals, to SWP SOD M&I contractors via existing cross-valley conveyance and the California Aqueduct, and to CVP SOD contractors via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes an LLIS and a 200 TAF minimum carryover storage target in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 340 TAF minimum carryover storage target, with a preference to store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above the target.

- **Alternative Plan 4 –** Alternative Plan 4 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern and Madera Canals, and to SWP SOD M&I contractors and CVP SOD contractors via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes an SLIS and a 325 TAF minimum carryover storage target in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 340 TAF minimum carryover storage target, with a preference to store water in Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above the target.

- **Alternative Plan 5 –** Alternative Plan 5 would construct a dam in the upstream portion of Millerton Lake at RM 274 and provide new water supplies to the Friant Division of the CVP via the Friant-Kern and Madera Canals, and to CVP SOD contractors via the San Joaquin River through exchange at Mendota Pool and the California Aqueduct. This action alternative includes a LLIS and a 100 TAF minimum carryover storage target in Temperance Flat RM 274 Reservoir. Millerton Lake would maintain a 130 TAF minimum carryover storage target, with preferences to store water in Millerton Lake up to 340 TAF and store water in

Temperance Flat RM 274 Reservoir before increasing Millerton Lake storage above 340 TAF. Alternative Plan 5 also includes modification of the water supply allocation operational rules to increase drier year water supply reliability with minimal impact to long term average annual water supply reliability.

The action alternatives vary based on operations (conveyance routing of new water supply, potential water supply beneficiaries, and minimum carryover storage targets) and intake structure type for water temperature management (single low-level or selective-level). Variations in other physical features, such as dam design and construction approach, hydropower mitigation features, and location of outlet works/diversion tunnels, were considered during the development of feasibility designs and cost estimates, but the preferred approaches were identified during feasibility design and are reflected consistently in the action alternatives.

NEPA requires that agencies devote substantial treatment to each alternative such that reviewers may evaluate their comparative merits. In addition, the CEQ Regulations for implementing NEPA require a range of reasonable alternatives to be rigorously and objectively evaluated in an EIS (40 CFR 1502.14). Alternatives that cannot reasonably meet the project purpose and needs do not require detailed analysis and can, with explanation, be eliminated from further consideration.

CEQA requires that the lead agency consider alternatives that would avoid or reduce one or more of the significant impacts identified in an EIR. The State CEQA Guidelines state that an EIR needs to describe and evaluate only those alternatives necessary to permit a reasonable choice and to foster informed decision making and informed public participation (Section 15126.6(f)). Consideration of alternatives focuses on those that can either eliminate significant adverse environmental impacts or reduce them to less-than-significant levels; alternatives considered in this context may include those that are more costly, and those that could impede, to some degree, the attainment of all the project objectives (Section 15126.6(b)).

All action alternatives, including the No Action Alternative, are formulated and evaluated based on a 100-year project life or period of analysis, consistent with P&G, NEPA, and CEQA.

No Action Alternative

The No Action Alternative is the basis for comparison with the action alternatives, consistent with NEPA and CEQA guidelines and the Federal P&G (WRC 1983) and *Principles and Requirements for Federal Investments in Water Resources* (CEQ 2013). The No Action Alternative constitutes the No Project Alternative under CEQA, which represents “what would be reasonably expected to occur in the foreseeable future if the project were not approved, based on current plans and consistent with available infrastructure and community services” (State CEQA Guidelines Section 15126.6(e)(2)). The existing conditions are also a basis of comparison for determining potential effects of the action alternatives on the affected environment, consistent with State CEQA Guidelines (Section 15126.6(e)(2)). For Federal feasibility studies of potential water resources projects, the No Action Alternative is intended to account for existing facilities, conditions, land uses, and reasonably foreseeable actions in the study area. Reasonably foreseeable actions include actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete.

If the action alternatives are not determined to be feasible, the project would not be implemented. The No Action Alternative reflects projected conditions in 2030 if the project is not implemented (2030 is the future level of development for which water resources are simulated in Reclamation’s March 2012 CalSim II Benchmark). Plan formulation efforts and analysis of the action alternatives and the No Action Alternative described in this Draft EIS are based on CVP and SWP operational conditions described in the 2008 USFWS and 2009 NMFS BOs (USFWS 2008, NMFS 2009).

Examples of reasonably foreseeable actions included in the No Action Alternative that are reflected in water supply reliability simulations are shown in Table 4-1. The Modeling Appendix further describes the No Action Alternative, showing which actions and projects are assumed to be part of the future condition in the Reclamation’s March 2012 CalSim II Benchmark model for Investigation operations modeling efforts.

Table 4-1. Examples of Reasonably Foreseeable Actions Included in the No Action Alternative Related to Water Supply Reliability

Reasonably Foreseeable Action	Description of Action	Criteria for Inclusion in No Action Alternative
South Bay Aqueduct Improvement and Enlargement Project	Increases the capacity of the South Bay Aqueduct to 430 cfs to meet Zone 7 Water Agency's future needs and provide operational flexibility to reduce SWP peak power consumption.	Included in Future No Action Condition of Reclamation's March 2012 CalSim II Benchmark
Contra Costa Water District Alternative Intake Project	Seeks to reduce effects to Contra Costa WD customers from seasonal fluctuations and changing conditions in the Delta by altering diversion timing and location. The total amount of diversions will not change and no significant impacts to other Delta water users are anticipated.	Project was constructed in 2010; included in Future No Action Condition of Reclamation's March 2012 CalSim II Benchmark
San Joaquin River Agreement and Vernalis Adaptive Management Program 1999–2011	Implements the SWRCB 1995 *Water Quality Control Plan* for the lower San Joaquin River and the Delta. VAMP, officially initiated in 2000 as part of SWRCB Water Right Decision 1641, is a large-scale, long-term experimental/management program designed to protect juvenile Chinook salmon migrating from the San Joaquin River through the Delta. VAMP is also a scientific experiment to determine how salmon survival rates change in response to alterations in San Joaquin River flows and CVP and SWP exports with installation of the Head of Old River Barrier. Although VAMP expired in 2011, the No Action Alternative includes the continued operation of VAMP or a program with similar conditions.	Project is complete; a VAMP-like operating condition is included in Existing Condition and Future No Action Condition of Reclamation's March 2012 CalSim II Benchmark
Arvin-Edison Canal Expansion	Increases the capacity of Arvin-Edison WSD South Canal, giving MWD the ability to withdraw up to 75 TAF of water from Arvin-Edison WSD during dry years and to store up to a total of 350 TAF of SWP water.	Project is currently authorized, funded, and permitted for implementation

Key:
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
MWD = Metropolitan Water District of Southern California
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
SWP = State Water Project
SWRCB = State Water Resources Control Board
TAF = thousand acre-feet
VAMP = Vernalis Adaptive Management Program
WD = Water District
WSD = Water Storage District

The sections below describe reasonably foreseeable SJRRP actions included in the No Action Alternative, and the potential consequences of implementing the No Action Alternative, as they relate to the objectives of the Investigation. The Modeling Appendix further describes the No Action Alternative, showing which actions and projects are assumed to be part of the future condition in the Reclamation March 2012 CalSim II

Benchmark model for feasibility study operations modeling efforts.

San Joaquin River Restoration Program Reasonably Foreseeable Actions Included in No Action Alternative

SJRRP actions implemented as of January 2014 are considered part of the existing conditions evaluated in this Draft EIS, as shown in Table 4-2. These actions include the management and release of Restoration Flows pursuant to Paragraph 13 of the San Joaquin River Stipulation of Settlement (Settlement), recapture of Restoration Flows at existing facilities on the San Joaquin River, and recirculation of those flows to the Friant Division of the CVP, pursuant to Paragraph 16 of the Settlement (NRDC et al. 2006).

Actions from the SJRRP PEIS/R ROD Preferred Alternative are included in the future conditions evaluated in this Draft EIS. All actions included under the existing conditions are also included in the future conditions. Additional SJRRP actions anticipated to be implemented in the future are reasonably foreseeable under the No Action Alternative, and are included in the future conditions as shown in Table 4-2. These actions include physical modifications to the San Joaquin River pursuant to Paragraphs 11 and 12 of the Settlement; reintroduction of salmonids to the San Joaquin River, pursuant to Paragraph 14 of the Settlement; additional actions to recapture Restoration Flows at existing, modified, or new facilities on the San Joaquin River, pursuant to Paragraph 16; and improvements in the Friant Division of the CVP pursuant to Part III of Public Law 111-11.

Table 4-2. SJRRP Actions Included in Existing and Future Conditions

Settlement Paragraph	Action	Existing Conditions	Future Conditions
11a	Construct Mendota Pool Bypass and modify Reach 2B to convey at least 4,500 cfs	No	Yes
11a	Modify Reach 4B1 to convey at least 475 cfs	No	Yes[1]
11a	Modify San Joaquin River Headgate Structure to enable fish passage and flow routing	No	Yes
11a	Modify Sand Slough Control Structure to enable fish passage	No	Yes
11a	Screen Arroyo Canal and provide fish passage at Sack Dam	No	Yes
11a	Modify Eastside and Mariposa Bypasses for fish passage	No	Yes
11a	Enable deployment of seasonal barriers at Mud and Salt sloughs	No	Yes
11b	Modify Chowchilla Bypass Bifurcation Structure	No	Yes
11b	Fill or isolate gravel pits	No	Yes
11b	Modify Reach 4B1 to convey at least 4,500 cfs	No	No[1]
12	Enhance spawning gravel	No	Yes
12	Reduce potential for redd superimposition and/or hybridization	No	Yes
12	Supplement the salmon population	No	Yes
12	Modify floodplain and side-channel habitat	No	Yes
12	Enhance in-channel habitat	No	Yes
12	Reduce potential for aquatic predation of juvenile salmonids	No	Yes
12	Reduce potential for fish entrainment	No	Yes
12	Enable fish passage	No	Yes
12	Modify flood flow control structures	No	Yes
12	Apply various conservation measures to actions above	No	Yes
13a	Release of Restoration Flows (Base Flows, Buffer Flows, and application of provisions to flexibly manage releases for the best achievement of the Restoration Goal pursuant to Exhibit B)	Yes	Yes
13b	Riparian releases, downstream diversions, seepage losses	Yes	Yes

Table 4-2. SJRRP Actions Included in Existing and Future Conditions (contd.)

Settlement Paragraph	Action	Existing Conditions	Future Conditions
13c	Acquire and release additional water supplies to address seepage losses	Yes	Yes
13d	Minimize increases in flood risk in the Restoration Area as a result of Restoration flows	Yes	Yes
13e	Changes in releases for maintenance of CVP facilities	Yes	Yes
13f	Steps to prevent/address unexpected diversions or seepage	Yes	Yes
13g	Measurement of flows within Restoration Area	Yes	Yes
13h	Protection of water rights	Yes	Yes
13i	Manage unreleased Restoration Flows	Yes	No
13j	Establish Restoration Flow Guidelines	Yes	Yes
14	Reintroduce salmon	No	Yes
16a	Recapture Restoration Flows in Restoration Area at Mendota Pool and wildlife refuges	Yes	No[2]
16a	Recapture Restoration Flows in Delta at existing CVP/SWP facilities	No[2]	Yes
16a	Recapture Restoration Flows at existing facilities on San Joaquin River with potential in-district modifications to existing facilities	No[2]	Yes
16a	Recirculate recaptured Restoration Flows	Yes	Yes
16b	Establish a Recovered Water Account and manage Friant Dam to make water supplies available to Friant Division long-term contractors at a preestablished rate	Yes	Yes
20	Changes to the Restoration Flows after December 31, 2025	No	No
SA	Implement capacity restoration for the Friant-Kern and Madera canals	No	Yes[3]
SA	Construct permanent reverse flow pump-back facilities on the Friant-Kern Canal	No	Yes[3]
SA	Develop groundwater banking projects in the Friant Division	No	Yes[3]

Notes:
[1] As described in the Selected Alternative in the SJRRP PEIS/R ROD.
[2] Channel constraints temporarily limit conveyance of Restoration Flows
[3] Included in the Settlement Act: Part III – Friant Division Improvements(Public Law 111-11); addressed qualitatively in No Action and all action alternatives
Key:
cfs = cubic feet per second
CVP = Central Valley Project
Settlement = San Joaquin River Stipulation of Settlement
SJRRP = San Joaquin River Restoration Program
SWP = State Water Project

Where relevant and quantifiable, SJRRP actions shown in Table 4-2 are included in the existing condition and/or future condition of the Reclamation March 2012 CalSim II Benchmark model. The No Action Alternative does not include any changes to Restoration Flows pursuant to Paragraph 13 or Paragraph 20 of the Settlement.

The following discussions highlight the consequences of implementing the No Action Alternative, as they relate to the objectives of the Investigation.

Water Temperature and Flow Conditions

The No Action Alternative includes release of full Restoration Flows from Friant Dam to the San Joaquin River as provided in the Settlement. No actions other than SJRRP actions listed in Table 4-2 would be taken to enhance water temperature and flow conditions in the San Joaquin River under the No Action Alternative.

Water Supply Reliability and System Operational Flexibility

Delta-Mendota Canal and California Aqueduct

Demands for water in the Central Valley and throughout California exceed available supplies, and the need for additional supplies is expected to grow, as discussed in Chapter 2. The population of California and the Central Valley is expected to increase by approximately 19 percent and 35 percent, respectively, by 2030 (California Department of Finance 2013). As this occurs, along with the need to maintain a healthy and vibrant industrial and agricultural economy, the demand for adequate and reliable water supplies will become more acute. Competition for available water supplies will intensify as water demands increase to support M&I, and associated urban growth relative to agricultural uses. Delivering SOD water supplies for agricultural and M&I users has also become increasingly constrained and complex. Increases in population, land-use changes, regulatory requirements, and limitations on storage and conveyance facilities would further strain available water supplies and infrastructure capacity to meet water demands.

Water conservation and reuse efforts are increasing and mandatory conservation resulting from increasing shortages will continue. In the past, during drought years, many water conservation measures were implemented to reduce the effects of drought. In the future, as more water conservation measures become necessary to help meet even average year demands, the impacts of droughts will be more severe. Besides mandatory conservation, without developing cost-efficient new sources, more reliance will be placed on shifting uses from such areas as agricultural production to urban uses. It is likely that with continued and deepening shortages in available water supplies, increasing adverse economic impacts will occur over time in the Central Valley and elsewhere in California. One possible impact is an increase in water costs, resulting in a further shift in agricultural production to areas outside California and/or outside the U.S. or the conversion to higher value permanent crops.

Under the No Action Alternative, Friant Dam would continue operating similarly to existing conditions (with implementation of the Settlement, including Restoration Flows). The No Action Alternative would continue to meet water supply demands at levels similar to existing conditions.

Flood Management, Hydropower Generation, Recreation, San Joaquin River Water Quality, Urban Water Quality

Flood system improvements along the San Joaquin River downstream from Friant Dam are currently underway or will be initiated in the future by USACE, DWR, and local/regional flood management districts. Additionally, modifications to San Joaquin River flow conveyance features downstream from Friant Dam will be initiated in the future by Reclamation under the SJRRP.

California’s demand for electricity is expected to significantly increase in the future. Under the No Action Alternative, PG&E is assumed to relicense the existing Kerckhoff Hydroelectric Project under the FERC in 2022. PG&E will have decommissioned the No. 2 unit in the Kerckhoff Powerhouse (PG&E 2012), which would decrease the powerhouse capacity below the 30 MW Renewable Portfolio Standard limit.

As California’s population continues to grow, demands for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley would grow significantly. Regional population growth in the vicinity of Millerton Lake is expected to result in increased demand for recreation and increased visitation at Millerton Lake (Reclamation and State Parks 2010).

Several activities to improve San Joaquin River water quality conditions through reducing pollutant concentrations and/or reducing pollutant loading to the river are underway, including continued implementation of the Westside Regional Drainage Plan and the Grassland Bypass Project.

A complementary action recommended for continued study in the CALFED ROD under the Conveyance and Water Quality programs was to facilitate water quality exchanges and similar programs to make available high-quality Sierra Nevada water in the eastern San Joaquin Valley to urban interests receiving water from the Delta (CALFED 2000a). Under the No Action Alternative, there would be no actions to increase storage in the upper San Joaquin River watershed that could enhance operational flexibility to meet water quality goals in the Delta or facilitate water quality exchanges and similar programs to improve urban water quality.

Action Alternatives

The action alternatives are described in the following sections. Features common to all action alternatives are described in detail, including environmental commitments. Detailed discussions of potential effects and proposed mitigation measures for each action alternative are included in the Draft EIS. If any action alternative is authorized by Congress, Reclamation would implement the features, operations, environmental commitments, mitigation measures, and permit and approval conditions, as described throughout this Draft EIS, Final EIS, ROD, and in permits or approvals issued for implementation.

Features Common to All Action Alternatives

The following features are common to all action alternatives and are assumed for impact analyses in this Draft EIS. Physical features common to all action alternatives are shown in Figures 4-1 through 4-4. Variations in other physical features, such as dam design and construction approach, hydropower mitigation features, and location of outlet works/diversion tunnels, were considered during the development of feasibility designs and cost estimates, but the preferred approaches were identified during feasibility design and are reflected consistently in the action alternatives.

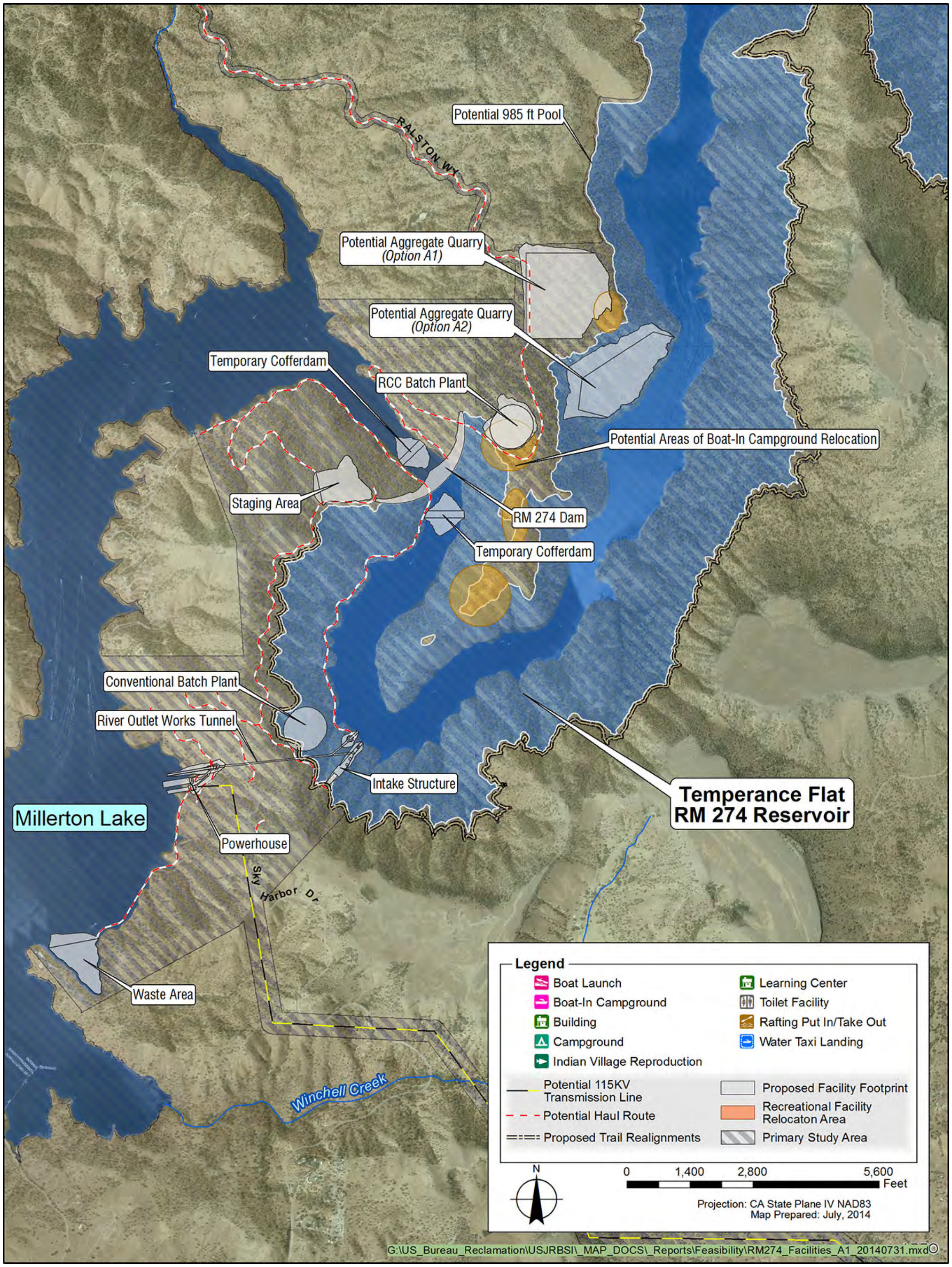


Figure 4-1. Proposed Temperance Flat RM 274 Reservoir Project Features for Quarry, Batch Plant, and Haul Road Option A

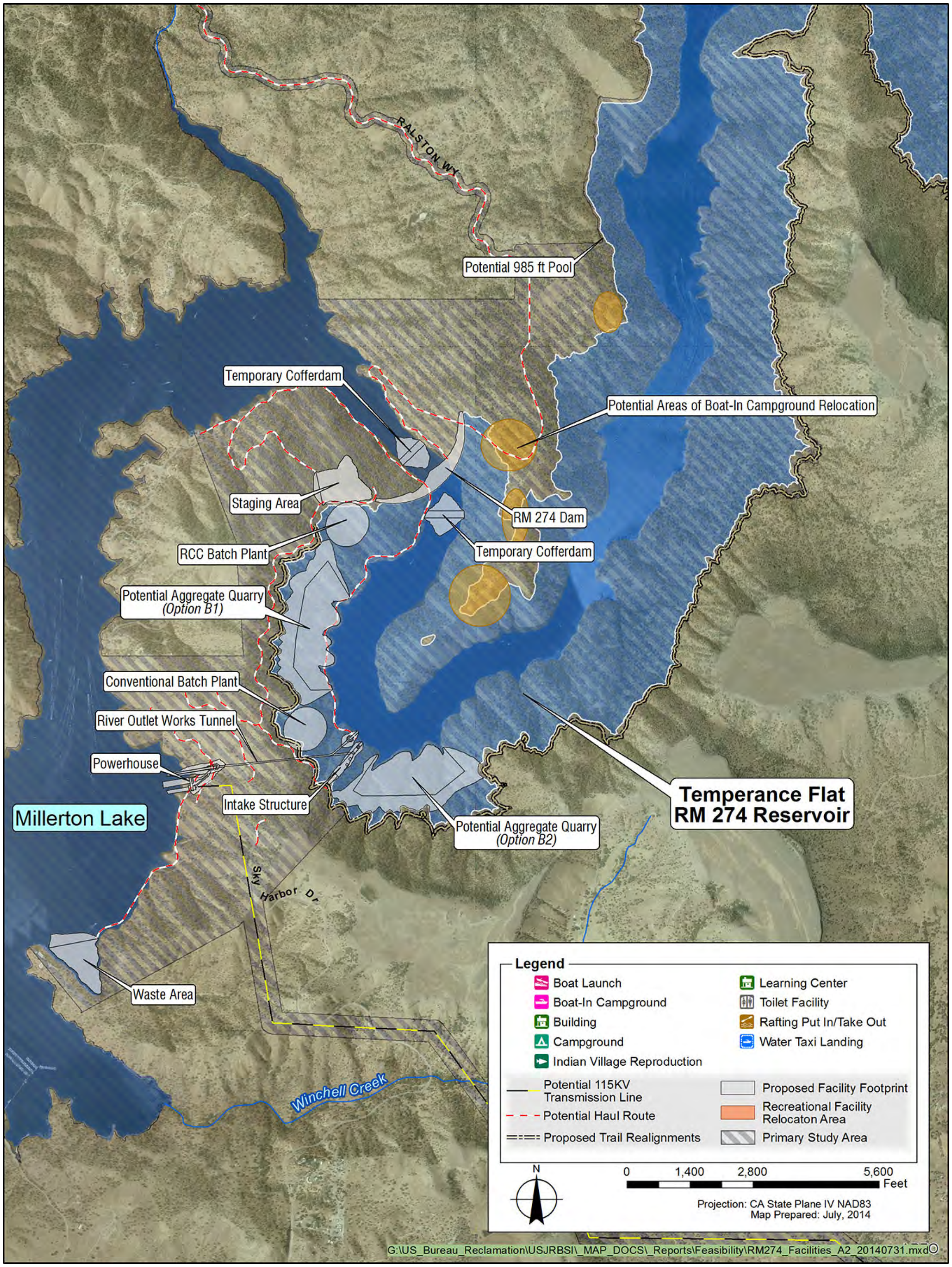


Figure 4-2. Proposed Temperance Flat RM 274 Reservoir Project Features for Quarry, Batch Plant, and Haul Road Option B

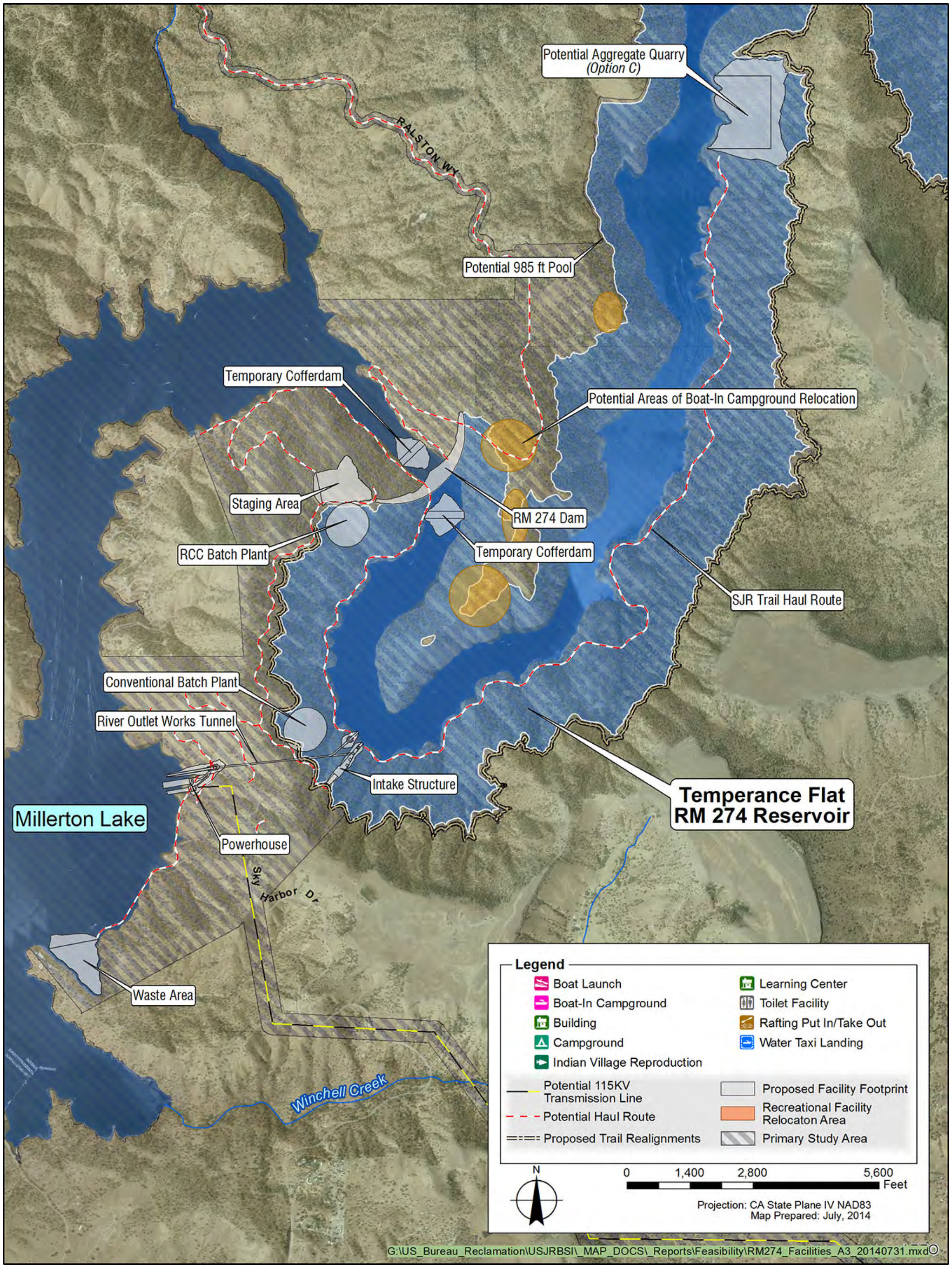


Figure 4-3. Proposed Temperance Flat RM 274 Reservoir Project Features for Quarry, Batch Plant, and Haul Road Option C

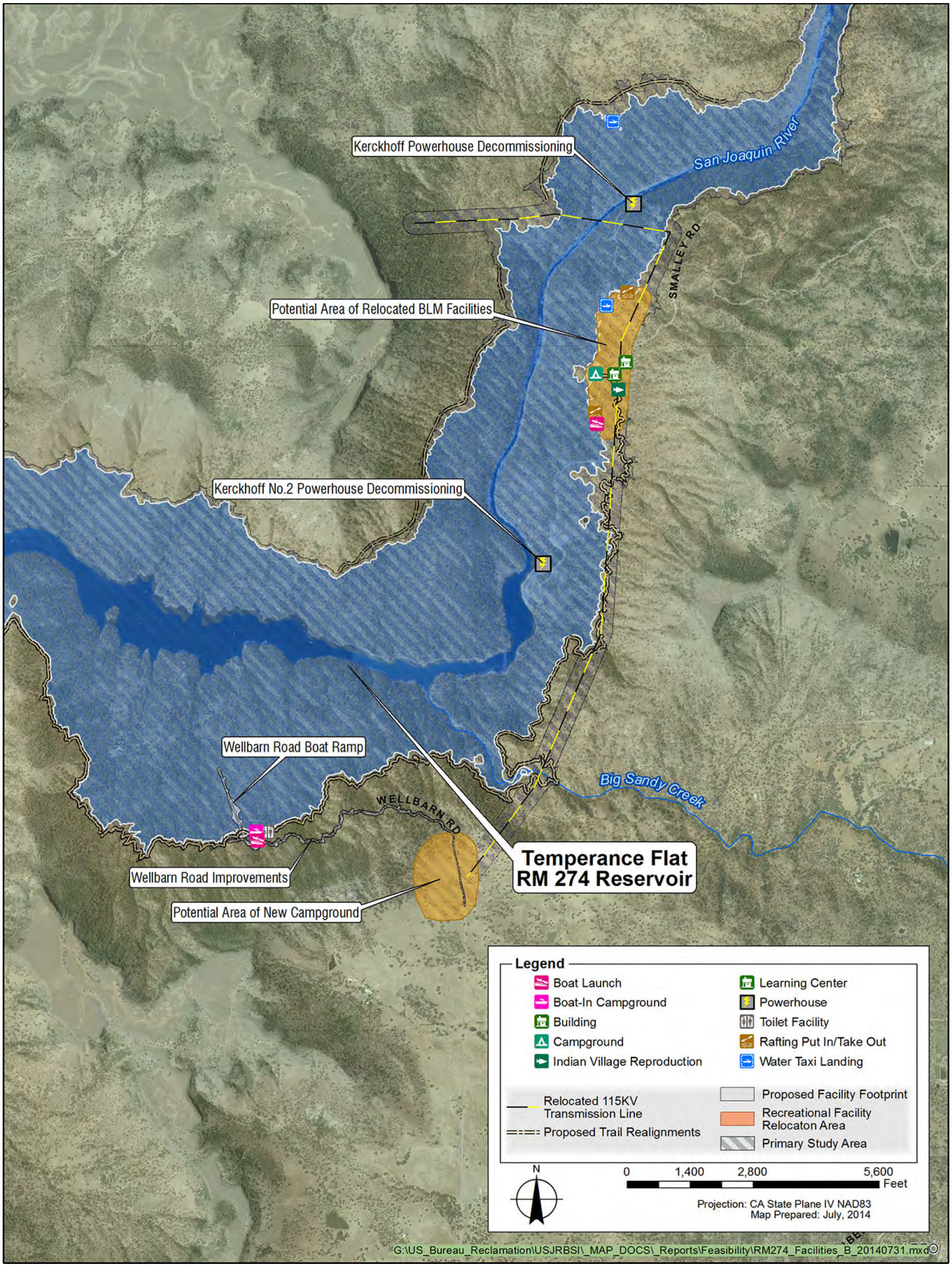
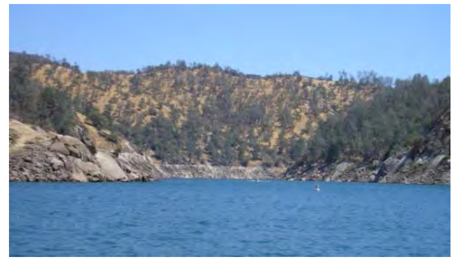


Figure 4-4. Proposed Temperance Flat RM 274 Reservoir Upstream Project Features

Dam and Reservoir

The proposed dam at Temperance Flat RM 274 would be an RCC arch gravity dam. The dam site would be located 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. Figures 4-1 through 4-4 show the extent of Temperance Flat RM 274 Reservoir and related project features in the reservoir area. The dam would be approximately 665 feet high, from a base elevation of 340 feet msl in the bottom of Millerton Lake (San Joaquin River channel) at the upstream face to the dam crest at elevation 1,005 feet msl. The width of the dam crest would be approximately 3,360 feet. The overflow section of Temperance Flat RM 274 Dam would consist of a 665-foot-wide uncontrolled ogee crest spillway at elevation 985 feet msl.



Potential Temperance Flat River Mile 274 Dam Site

At a top-of-active-storage elevation of 985 feet msl, Temperance Flat RM 274 Reservoir would provide about 1,260 TAF additional storage (1,331 TAF total storage, of which 75 TAF would overlap with the Millerton Lake), and would have a surface area of about 5,700 acres. Temperance Flat RM 274 Reservoir would reduce the Millerton Lake storage volume to 449 TAF and surface area to 3,890 acres. The reservoir would extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. At the top of active storage, the new reservoir would reach to about 12 feet below the crest of Kerckhoff Dam.

Cofferdams

Upstream and downstream cofferdams would be required to divert stream flows during construction and to prevent inundation of the site from Millerton Lake. Cofferdams would be sized for estimated diversion flows, and to allow normal operation of Millerton Lake during construction of Temperance Flat RM 274 Dam. Both cofferdams would require a minimum crest elevation of 580 feet msl and height of 240 feet to accommodate normal reservoir operation of Millerton Lake and to pass diversion flows. After completion of the RCC arch gravity dam, cofferdams would be removed to elevation 525 feet msl.

Diversion Tunnel

A 30-foot-diameter and approximately 2,900-foot-long, concrete-lined tunnel would be constructed through the left abutment, approximately 1.5 miles upstream from the main dam. The tunnel would later serve as the outlet works tunnel for the reservoir.

Relation of the Outlet Tunnel and Intake Structures

The diversion tunnel would be used to divert the San Joaquin River around the Temperance Flat RM 274 Dam site during dam construction. After the dam is completed, the diversion tunnel would serve as the outlet works tunnel for the reservoir. An intake structure on the outlet tunnel (either a Selective Level Intake Structure or Low Level Intake Structure, depending on the alternative) would direct water into the tunnel. Finally, water in the tunnel would be diverted through the powerhouse and/or valve house, depending on operations.

Intake Structure

All action alternatives would include an inclined reinforced-concrete intake structure, located approximately 7,200 feet upstream from the dam and adjacent to and upstream from the outlet works entrance. The length, width, and slope of the intake structure, along with number, location, and operability of inlet gates would vary among the action alternatives. Descriptions for the intake structure configurations specific to each alternative are included in the alternative-specific sections later in this chapter.

Powerhouse and Transmission Facilities

The Temperance Flat RM 274 Reservoir powerhouse would be located approximately 750 feet southwest from the diversion tunnel outlet portal and consist of an 85-foot-deep, reinforced-concrete substructure and 64-foot-high steel superstructure. The powerhouse would contain two 80 MW turbines, which in combination are sized to pass a design flow of 6,000 cfs. After passing through the turbine units, water would then flow through an approximately 490-foot-long tailrace tunnel into an open channel to Millerton Lake, regulated by a concrete weir to maintain a minimum tailwater elevation of 550 feet msl. An aboveground switchyard would connect to a new Temperance Flat transmission line, which would traverse approximately 5 miles southeast to the existing Kerckhoff–Sanger transmission line.

Valve House

The Temperance Flat RM 274 Reservoir valve house would be sized to pass up to 20,000 cfs. Water would be directed from the outlet works tunnel in a 30-foot-diameter penstock to be diverted through the valve house and/or powerhouse, depending on operations. The valve house would be an at-grade reinforced-concrete structure connected to the powerhouse superstructure, located approximately 650 feet southwest from the diversion tunnel portal. External features would include a river outlet works chute, approximately 600 feet long, which would release into Millerton Lake.

Quarry, Batch Plant, and Haul Road Options

The aggregate quarry would supply aggregate for the main dam and cofferdams. Because of uncertainties in the adequacy of rock for aggregate, three quarry options with varying locations are being considered within each action alterative. The main dam batch plant location and haul road connecting the potential quarry site to the main dam batch plant would also vary depending on quarry option. The specific locations of aggregate quarry sites, batch plants, and haul roads are subject to change based on further engineering and geotechnical analyses. Only one quarry site, batch plant, and haul road option, however, would be selected to support construction activities under any of the action alternatives.

Regardless of the quarry option selected, final quarry development would typically include benched or terraced rock faces in sound rock, with 40-foot vertical faces and 20-foot horizontal bench widths. The quarried area would be closed to the public and include access barriers. In addition, long-term slope inspection and maintenance would be required. Appropriate signage and restrictions for reservoir recreation would be required for quarry options within the reservoir. The three quarry, batch plant, and haul road options are described in the following sections.

Quarry, Batch Plant, and Haul Road Option A

Aggregate Quarry Quarry, batch plant, and haul road Option A includes two potential quarry sites. Potential quarry site A1 would be located approximately 2,500 feet northeast of the dam's right abutment on the Madera County side of Millerton Lake, outside the proposed inundation area. Potential quarry site A2 would be located directly southwest of quarry site A1 within the inundation area, also on the Madera County side of Millerton Lake. Both quarry sites would be approximately 92 acres in size. Only one quarry site would ultimately be constructed. An estimated 10 million cubic yards of material would be excavated from the proposed quarry site, and excavated to approximately elevation 600 feet msl. The specific location, size, and geometry of the site would be subject to change based on further engineering and geotechnical analyses.

Batch Plants The main dam potential batch plant site would be located approximately 800 feet east of the dam's right abutment. This batch plant site would about 19 acres in size and most of the site would be outside the proposed inundation area. This dam batch plant site is the same for both quarry sites (A1 and A2) under quarry, batch plant, and haul road Option A. The potential batch plant for the diversion tunnel, powerhouse, valve house, and intake structure would be located east of Sky Harbour Road between the powerhouse and intake structure sites (just east of the intersection of Access Road Nos. 1 and 2 within the inundation area). This second batch plant would be about 19 acres in size. Cement and pozzolan would likely be delivered by truck to both batch plants, most likely from railroad terminals near Fresno, California. The specific locations of the batch plants are subject to change based on further engineering and geotechnical analyses.

Haul Roads Five temporary haul roads would provide construction access to the aggregate quarry, batch plant, dam and cofferdams, staging area, intake structures, and diversion tunnel waste area. The total length of temporary haul roads would be approximately 10 miles with two lanes, with each lane width ranging from 12 to 20 feet. The specific locations of the haul roads are subject to change based on further engineering and geotechnical analyses.

Quarry, Batch Plant, and Haul Road Option B

Aggregate Quarry Quarry, batch plant, and haul road Option B includes two potential quarry sites, approximately 92 acres in size. Potential quarry site B1 would be located within the inundation area on the Fresno County side of Millerton Lake, between the main dam and intake structure. Potential quarry site B2 would be located southeast of potential quarry site B1, also within the inundation area, upstream from the intake structure. An estimated 10 million cubic yards of material would be excavated from either quarry site or a combination of both of the proposed quarry sites, and the quarry site(s) would be excavated to approximately elevation 600 feet msl. The specific location(s) of the aggregate quarry site(s) is/are subject to change based on further engineering and geotechnical analyses.

Batch Plants The main dam potential batch plant site would be located directly south of the staging area on the dam’s left abutment. This batch plant site would be about 19 acres in size and would be inside the proposed inundation area. The potential batch plant for the diversion tunnel, powerhouse, valve house, and intake structure would be located east of Sky Harbour Road between the powerhouse and intake structure sites (just east of the intersection of Access Road Nos. 1 and 2 within the inundation area). This second batch plant would be about 19 acres in size. Cement and pozzolan would likely be delivered by truck to both batch plants, most likely from railroad terminals near Fresno, California. The specific locations of the batch plants are subject to change based on further engineering and geotechnical analyses.

Haul Road Four temporary haul roads would provide construction access to the aggregate quarry/quarries, batch plant, dam and cofferdams, staging area, intake structures, and diversion tunnel waste area. The total length of temporary haul roads would be approximately 7 [revised this value] miles with two lanes, with each lane width ranging from 12 to 20 feet. The haul road from potential quarry site B2 would approximately follow the existing San Joaquin River Trail. The specific locations of the haul roads are subject to change based on further engineering and geotechnical analyses.

Quarry, Batch Plant, and Haul Road Option C

Aggregate Quarry The proposed quarry site under quarry, batch plant, and haul road Option C would be located within the inundation area on the Fresno County side of Millerton Lake at RM 279. The quarry site would be approximately 92 acres in size. An estimated 10 million cubic yards of material would be excavated from the proposed quarry site, and excavated to approximately elevation 600 feet msl.

Batch Plants Potential batch plants for quarry, batch plant, and haul road Option C would be the same as described under Option B. The specific locations of the batch plants are subject to change based on further engineering and geotechnical analyses.

Haul Road Five temporary haul roads would provide construction access to the aggregate quarry, batch plant, dam and cofferdams, staging area, intake structures, and diversion tunnel waste area. The total length of temporary haul roads would be approximately 14 miles with two lanes, with each lane width ranging from 12 to 20 feet. The haul road between Option C and the dam batch plant would approximately follow the existing San Joaquin River Trail. The specific locations of the haul roads are subject to change based on further engineering and geotechnical analyses.

Staging Area

The dam staging area would be located directly above the dam's left abutment, outside the proposed inundation area, and be approximately 21 acres in size. This area would be used for construction staging and aggregate stockpiling. Trucks would be used to transport stockpiled aggregate to the dam site.

A marine staging area for constructing the cofferdams would be located between the proposed haul roads and Millerton Lake shoreline downstream from the downstream cofferdam. Additional area, between the cofferdams and in the inundation area slightly upstream from the upstream cofferdam would also be used to stage and construct the cofferdams. Excavated material from the marine staging area would be used in the cofferdams.

Access Roads

Three permanent access roads would provide O&M staff with access to the dam, intake structures, and valve house/powerhouse. Permanent access roads would leave Sky Harbour Road near the valve house and have a total length of approximately 3.5 miles. These roads would consist of two 12-foot wide lanes.

Waste Area

The waste area would be located approximately 3,200 feet southwest of the powerhouse within the existing inundation area of Millerton Lake and be approximately 21.5 acres in size. This area would be used for permanent disposal of waste rock from diversion tunnel and powerhouse excavation.

Kerckhoff Hydroelectric Project Facilities

Temperance Flat RM 274 Reservoir, with a top-of-active storage at elevation 985 feet msl, would inundate the existing Kerckhoff Hydroelectric Project powerhouses, Kerckhoff Powerhouse and Kerckhoff No. 2 Powerhouse. Kerckhoff Powerhouse is an aboveground facility and its site would be restored to near-natural conditions. Kerckhoff No. 2 Powerhouse is an underground facility and would be abandoned in place. The majority of mechanical and electrical equipment for both powerhouses would be removed and salvaged.

Temperance Flat RM 274 Reservoir top-of-active storage would be just a few feet below the top of Kerckhoff Dam spillway gates. The top of Kerckhoff Dam would be modified to accommodate higher tailwater elevations, including modifications to mechanical operators and gates to the existing deck.

Inundated sections of the Kerckhoff–Le Grand and Kerckhoff–Sanger transmission lines (approximately 4 miles) would be reconstructed as the Le Grand–Sanger transmission line.

Recreational Facilities

Temperance Flat RM 274 Reservoir would affect several recreational features found along the existing Millerton Lake shoreline. Recreational facilities upstream from RM 274 include the Temperance Flat Boat-In Campground within the

Millerton Lake SRA, and the San Joaquin River Trail, which connects the SRA and the SJRG SRMA. Within the SJRG SRMA are hiking, biking, and equestrian trails, ; two footbridges; primitive campgrounds; and a cultural heritage learning center, which includes a reproduction of a Native American village, simulated archaeological dig, authentic bedrock mortars, and a nature trail. Reclamation would protect such facilities from inundation, modify existing facilities to replace affected areas (i.e., relocate facilities on site) or abandon existing facilities and replace them at other suitable sites to the extent feasible (i.e., relocate facilities off site and upslope). Reclamation would seek to maintain the quality of visitor experiences by replacing affected recreational facility capacity with facilities providing equivalent visual resource quality, amenities, and access to the Millerton Lake SRA and SJRG SRMA, as well as Temperance Flat RM 274 Reservoir (e.g., new Wellbarn Road and Smalley Road boat ramps and associated upgrades to access roads, and a San Joaquin River and Pa'san Ridge trails seasonal water taxi). Inundated recreational facilities and associated utilities would be relocated before demolition, with the exception of facilities identified for abandonment. Additional detail on recreational facilities can be found in the Draft Feasibility Report (Reclamation 2014).

Reservoir Area Utilities

A majority of the infrastructure adjacent to Millerton Lake above RM 274 is located in the Temperance Flat area off Wellbarn Road, and PG&E and BLM facilities off Smalley Road. Utilities in the area include potable water, power distribution, telecommunications, and wastewater facilities. If utilities are impacted by inundation, they would be demolished and relocated (if an associated facility is relocated or required to maintain distribution).

Coordination with San Joaquin River Restoration Program

Temperance Flat RM 274 Reservoir would capture San Joaquin River flood flows that would be released from Friant Dam under the No Action Alternative. Reclamation’s ability to meet Restoration Flow targets would not change; flood flows that meet Restoration Flow targets in the No Action Alternative would be replaced with managed releases from Friant Dam to meet Restoration Flow targets. Additional managed releases of Restoration Flows from Friant Dam would increase opportunities for downstream recapture pursuant to paragraph 16(a) and reduce the availability of water supply pursuant to paragraph 16(b). All action alternatives include operations of

Friant Dam for delivery of new water supplies via the San Joaquin River to Mendota Pool. Under all action alternatives, the following coordination actions with the SJRRP would be included:

- Revise Restoration Flow Guidelines, as necessary
- Revise the Recapture and Recirculation Plan, as necessary
- Revise accounting for Recovered Water Account (RWA) and delivery of water under Paragraph 16b, as necessary
- Coordinate scheduling of releases from Friant Dam for downstream delivery of additional water supply developed by Temperance Flat RM 274 Reservoir
- Coordinate with floodplain habitat planning efforts for Reach 2B and Reach 4B.

Reservoir Flood Storage Operations

The existing Flood Control Diagram at Friant Dam specifies that rain flood space increases from zero on October 1 to 170 TAF on November 1, and decreases from 170 TAF on February 1 to zero on April 1 (USACE 1980). From November 1 to February 1, rain flood space in excess of 85 TAF may be replaced by an equal amount of space in Mammoth Pool. The required total available rain flood control storage and operation rules at Millerton Lake were used for the combined Temperance Flat RM 274 Reservoir and Millerton Lake analysis to maintain the same level of regulatory rain flood control. The assumption was made that the available rain flood control storage could be in either reservoir, provided the required rain flood control storage space was always available between the two reservoirs. With Millerton Lake operated at elevation 550 feet msl (340 TAF) or lower in the action alternatives, the rain flood space requirement of 170 TAF would generally be maintained in Millerton Lake (operated in conjunction with Mammoth Pool). Temperance Flat RM 274 Reservoir could provide incidental additional rain flood storage space if space was available during a rain flood event.

CVP and SWP Operations Criteria

The operations modeling of the action alternatives was based on the Reclamation March 2012 CalSim II Benchmark, which represents operations of the CVP and SWP in accordance with the 2008 USFWS and 2009 NMFS BOs (USFWS 2008, NMFS 2009), and modified to include Temperance Flat RM 274 Reservoir and operations. The operations and requirements under the 2008 USFWS and 2009 NMFS BOs are described in further detail in the Modeling Appendix.

Conveyance Facilities Operations

The action alternatives include modifying the timing and quantity of water diverted to Madera and Friant-Kern canals, which would increase water supply reliability to Friant Division contractors and provide opportunities for groundwater banking. Additionally, the action alternatives would improve conjunctive management in the Friant Division by increasing incidental groundwater storage and/or recharge with additional Class 2 deliveries.

The action alternatives include existing and foreseeable available cross-valley conveyance capacity in the Cross Valley Canal, Shafter-Wasco–Semitropic Water Storage District Connection, and Arvin Edison Canal (the action alternatives do not include new or expanded transvalley conveyance). Total capacity is shown in the conveyance schematic in Figure 4-5. Further details on available conveyance capacity and modeling assumptions are described in the Modeling Appendix.

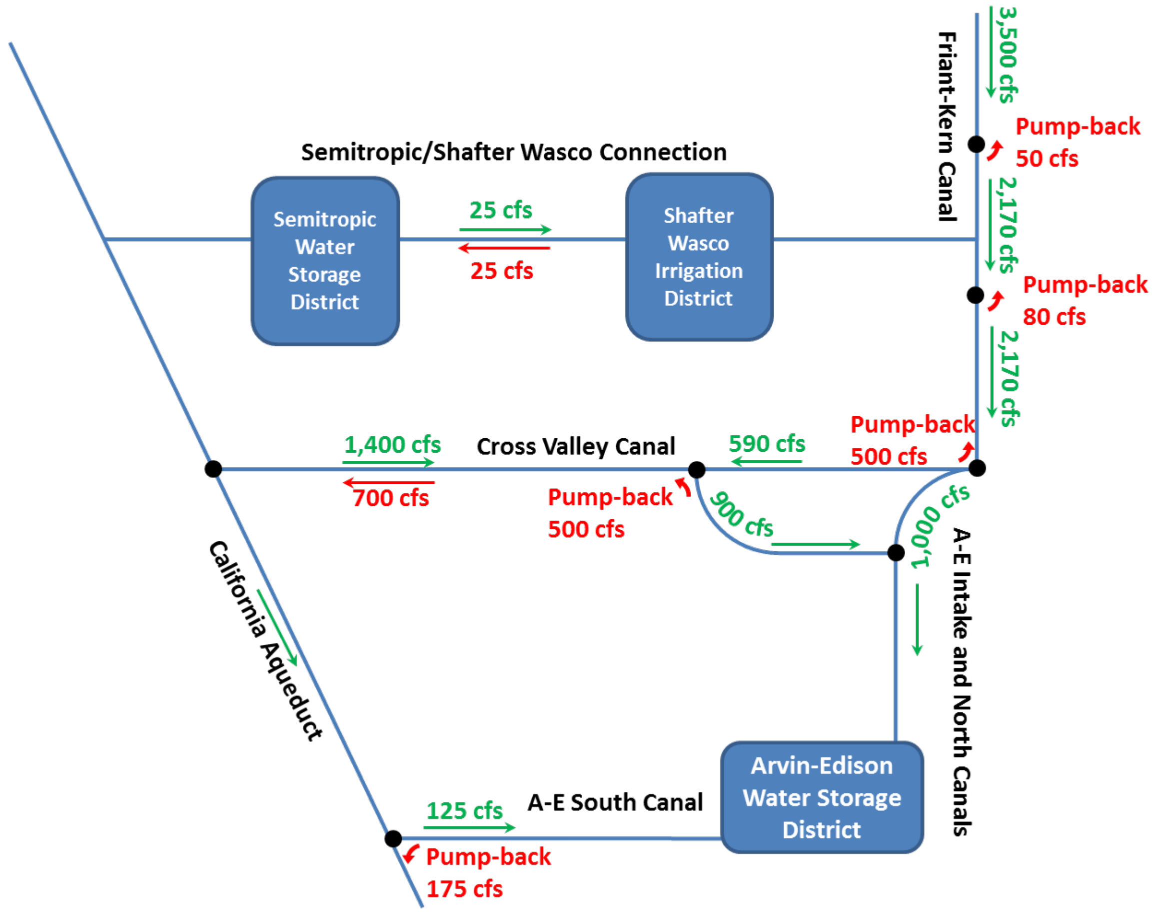


Figure 4-5. Schematic of Major Cross-Valley Conveyance Capacities

Features and Operations Varying Between Action Alternatives

The action alternatives mainly differ in five ways: carryover storage target for Millerton Lake, carryover storage target for Temperance Flat RM 274 Reservoir, beneficiaries of new water supply, routing of new water supply, and type of intake structure. Operations for the action alternatives are summarized in Figures 4-6 through 4-8, and Table 4-4.

Carryover Storage Target for Millerton Lake

The target water surface elevation for Millerton Lake for Alternative Plans 1, 2, 3, and 4 is elevation 550 feet msl (equating to a carryover storage target of 340 TAF). In Alternative Plan 5, Millerton Lake carryover storage is also maintained at 340 TAF, but could be drawn down to 130 TAF as needed for water supply. In all action alternatives, Millerton Lake could still fill all the way to the top of active storage capacity at elevation 580.6 feet msl (450 TAF) when needed in wet years and when Temperance Flat RM 274 Reservoir would also be full. Millerton Lake and Temperance Flat RM 274 Reservoir could be operated jointly and changes in Millerton Lake operations would not affect the ability to manage the joint Millerton Lake Temperance Flat RM 274 Reservoir system for water supply (including providing Restoration Flows) and flood damage reduction

Carryover Storage Target for Temperance Flat RM 274 Reservoir

The carryover storage target for Temperance Flat RM 274 Reservoir is 200 TAF for Alternative Plans 1, 2, and 3; 325 TAF for Alternative Plan 4; and 100 TAF for Alternative Plan 5.

Beneficiaries of New Water Supply

Temperance Flat RM 274 Reservoir could provide water supply to a range of beneficiaries. The action alternatives illustrate some representative combinations of anticipated beneficiaries based on the strategic location of Temperance Flat RM 274 Reservoir and the Investigation problems, needs, and objectives. The Friant Division, other CVP SOD contractors, and SWP SOD M&I contractors are considered beneficiaries in the action alternatives. All action alternatives would deliver some portion of the new water supply from Temperance Flat RM 274 Reservoir to the Friant Division. Alternative Plans 1, 2, 3, and 4 would also deliver some portion of the new water supply from Temperance Flat RM 274 Reservoir to SWP SOD M&I contractors. Alternative Plans 2, 3, 4, and 5 would also deliver new supply to CVP SOD contractors.

Routing of New Water Supply

New supplies to the Friant Division would be conveyed via the Friant-Kern and Madera canals in all action alternatives. New water supplies to CVP SOD contractors would be delivered via the San Joaquin River to Mendota Pool. At Mendota Pool, water would be exchanged with DMC deliveries of Delta supply to Mendota Pool, freeing Delta supplies for delivery to CVP SOD contractors. New water supplies would be delivered to CVP SOD contractors in Alternative Plans 2, 3, 4, and 5. In Alternative Plans 1, 2, and 4, new water supplies to SWP SOD M&I contractors would be routed via the San Joaquin River and exchanged for Delta supplies at Mendota Pool, allowing an equivalent amount of Delta water to be delivered to SWP SOD M&I contractors via the California Aqueduct through another exchange at the San Luis Reservoir Forebay. In Alternative

Plan 3, new water supplies to SWP SOD M&I contractors would be delivered through the Friant-Kern Canal and cross-valley conveyance to the California Aqueduct. Water delivered via the San Joaquin River for CVP SOD or SWP SOD M&I exchange with Delta supplies would create flexibility and source diversification for any contractors with access to Mendota Pool (wildlife refuges, CVP SOD contractors, Exchange Contractors).

Intake Structure Configuration

While Alternative Plans 1, 2, 3, and 5 include an LLIS, an SLIS is included in Alternative Plan 4 to provide additional flexibility for cold-water pool and Temperance Flat RM 274 Reservoir release temperature management.

Summary of Action Alternatives Features and Operations

Features, assumptions, and operations variables were combined and incorporated into the five action alternatives through the feasibility-phase plan refinement processes described in Chapter 3. The five action alternatives are intended to achieve the planning objectives by balancing water supply reliability and ecosystem enhancement, provide a wide range of potential physical accomplishments and economic benefits related to the planning objectives, and provide benefits to a wide range of potential beneficiaries. The following sections describe the specific feature and operations for each action alternative. Action alternative features are summarized in Table 4-3, and operations of the action alternatives are summarized in Figures 4-6 through 4-8 and Table 4-4.

Table 4-3. Summary of Physical Features of Action Alternatives

Facility	Feature	Alternative Plan 1	Alternative Plan 2	Alternative Plan 3	Alternative Plan 4	Alternative Plan 5
Dam and Reservoir	Temperance Flat RM 274 Dam	RCC gravity arch dam	Same as 1	Same as 1	Same as 1	Same as 1
Dam and Reservoir	Dam Height (feet)	665	Same as 1	Same as 1	Same as 1	Same as 1
Dam and Reservoir	Elevation of Dam Crest (feet msl)[1]	1,005	Same as 1	Same as 1	Same as 1	Same as 1
Dam and Reservoir	Elevation of Top of Active Storage (feet msl)[1]	985	Same as 1	Same as 1	Same as 1	Same as 1
Dam and Reservoir	Capacity (thousand acre-feet)	1,331	Same as 1	Same as 1	Same as 1	Same as 1
Dam and Reservoir	Capacity Increase (thousand acre-feet)	1,260	Same as 1	Same as 1	Same as 1	Same as 1
Dam and Reservoir	Spillway	665-foot-wide uncontrolled ogee crest spillway	Same as 1	Same as 1	Same as 1	Same as 1
Diversion Works	Diversion and Outlet Works Tunnel	30-foot-diameter, concrete-lined tunnel through left abutment	Same as 1	Same as 1	Same as 1	Same as 1
Diversion Works	Upstream and Downstream Cofferdams	Embankment cofferdams to divert stream flows around dam construction site	Same as 1	Same as 1	Same as 1	Same as 1
Diversion Works	Height (feet)	240	Same as 1	Same as 1	Same as 1	Same as 1
Diversion Works	Elevation of Cofferdam Crest (feet msl)[1]	580	Same as 1	Same as 1	Same as 1	Same as 1
Intake Structure	Low-Level Intake Structure	Inclined reinforced-concrete structure with two low-level fixed-wheel gates	Same as 1	Same as 1	None	Same as 1
Intake Structure	Selective-Level Intake Structure	None	None	None	Inclined reinforced-concrete structure with two low-level fixed-wheel gates and three upper-level fixed-wheel gates	None
Powerhouse, Valve House, and Transmission Facilities	Powerhouse	160 MW powerhouse and tailrace	Same as 1	Same as 1	Same as 1	Same as 1

Table 4-3. Summary of Physical Features of Action Alternatives (contd.)

Facility	Feature	Alternative Plan 1	Alternative Plan 2	Alternative Plan 3	Alternative Plan 4	Alternative Plan 5
Powerhouse, Valve House, and Transmission Facilities	Transmission	Transmission line approximately 5 miles southeast to the existing Kerckhoff–Sanger line	Same as 1	Same as 1	Same as 1	Same as 1
Powerhouse, Valve House, and Transmission Facilities	Valve House	At-grade reinforced-concrete structure connected to diversion tunnel and powerhouse.	Same as 1	Same as 1	Same as 1	Same as 1
Other Construction Areas	Access and Haul Roads	3 permanent access roads (approx. 3.5 miles) and 5 temporary haul roads (approx. 9.6 miles)	Same as 1	Same as 1	Same as 1	Same as 1
Other Construction Areas	Aggregate Quarry	92-acre quarry	Same as 1	Same as 1	Same as 1	Same as 1
Other Construction Areas	Batch Plants	19-acre plant and 15-acre plant	Same as 1	Same as 1	Same as 1	Same as 1
Other Construction Areas	Staging Area	21-acre staging area	Same as 1	Same as 1	Same as 1	Same as 1
Other Construction Areas	Waste Area	21.5-acre area for waste rock from diversion tunnel and powerhouse excavation	Same as 1	Same as 1	Same as 1	Same as 1
Affected Existing Facilities	Kerckhoff Project Powerhouses	Demolish Kerckhoff Powerhouse and Kerckhoff No. 2 Powerhouse and restore to near-natural conditions	Same as 1	Same as 1	Same as 1	Same as 1
Affected Existing Facilities	Kerckhoff Dam	Raise deck to elevation 1,005 feet msl and replace mechanical equipment for gate operations	Same as 1	Same as 1	Same as 1	Same as 1
Affected Existing Facilities	Existing Transmission	Relocate inundated portions of Kerckhoff–Le Grand and Kerckhoff–Sanger lines	Same as 1	Same as 1	Same as 1	Same as 1
Affected Existing Facilities	Recreational Facilities	Relocate inundated BLM and State Parks facilities. Construct new boat ramp	Same as 1	Same as 1	Same as 1	Same as 1

Table 4-3. Summary of Physical Features of Action Alternatives (contd.)

Facility	Feature	Alternative Plan 1	Alternative Plan 2	Alternative Plan 3	Alternative Plan 4	Alternative Plan 5
Affected Existing Facilities	Reservoir Area Utilities	Relocate inundated utilities if associated facilities are also relocated	Same as 1	Same as 1	Same as 1	Same as 1

Notes:
[1] Based on the North American Vertical Datum of 1988.
Key:
BLM = U.S. Department of the Interior, Bureau of Land Management
MW = megawatt
RCC = roller-compacted concrete
RM = river mile
State Parks = California Department of Parks and Recreation

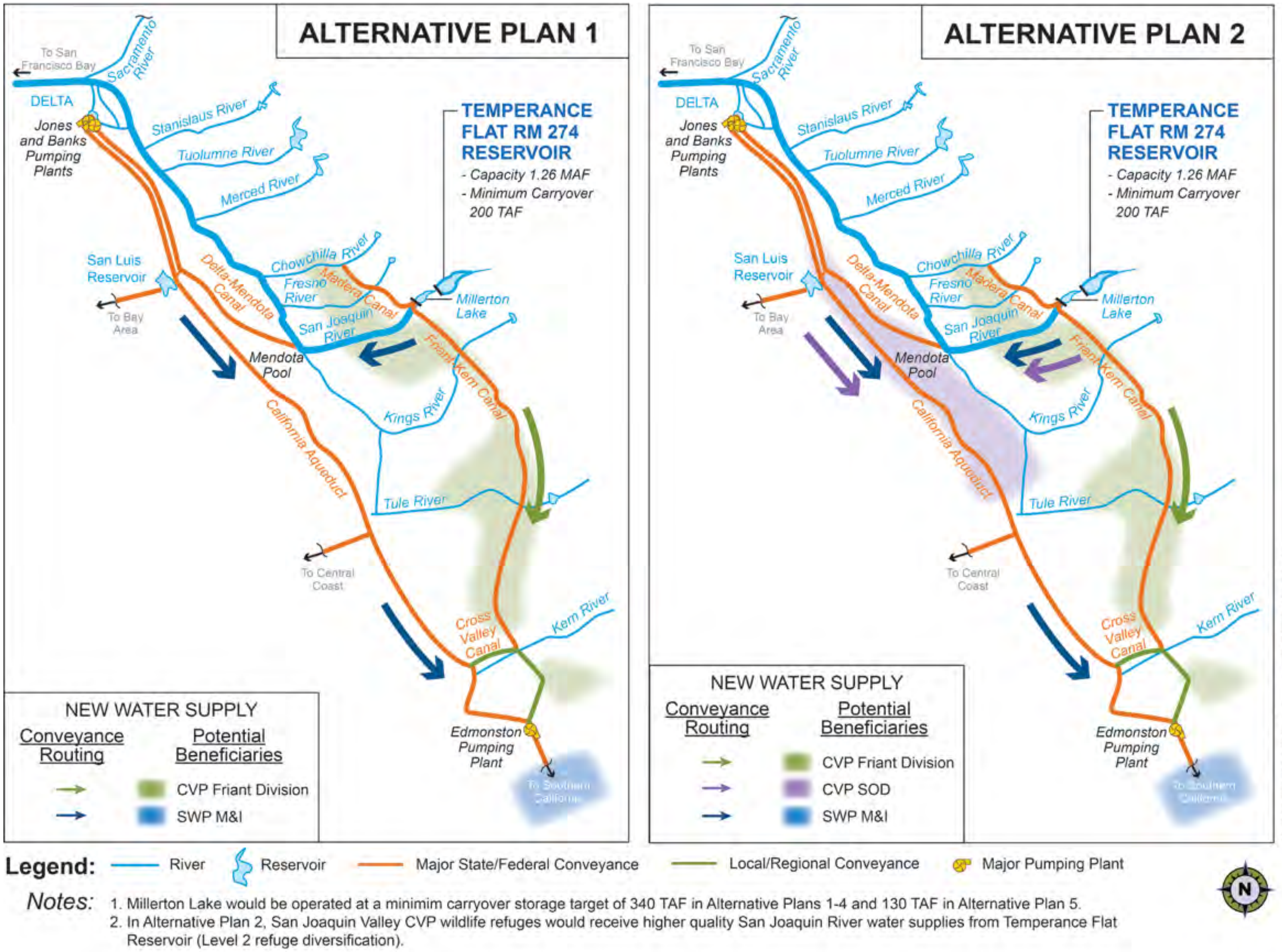


Figure 4-6. SOD Systemwide Operations of Alternative Plans 1 and 2

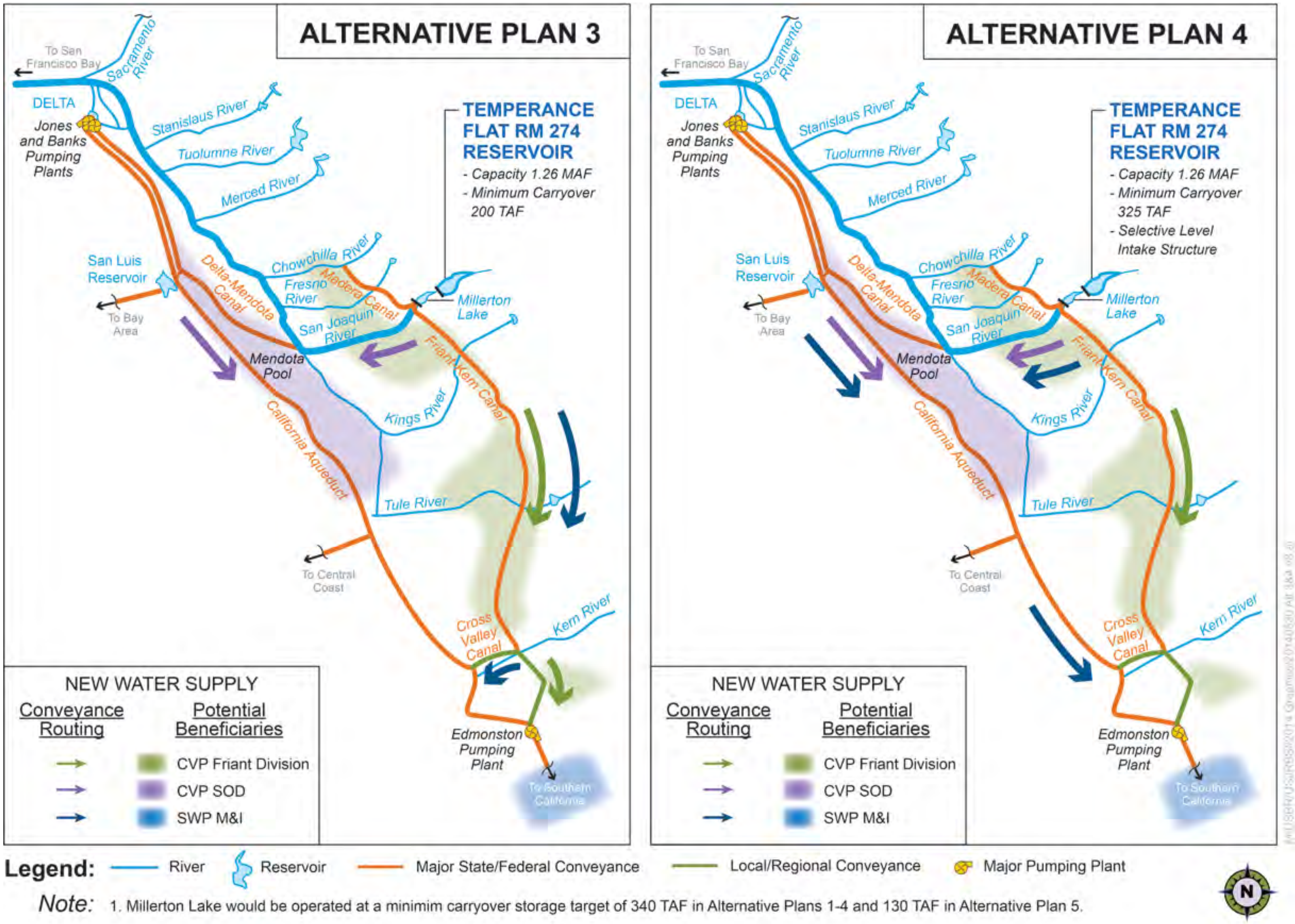


Figure 4-7. SOD Systemwide Operations of Alternative Plans 3 and 4

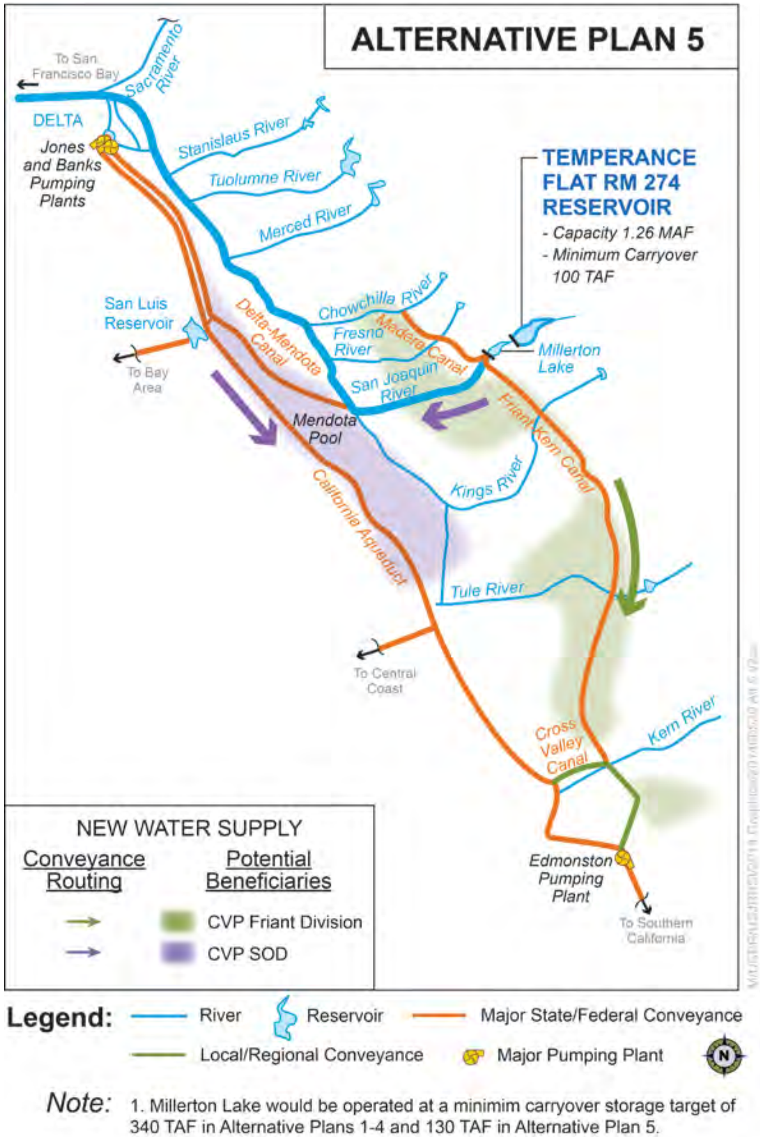


Figure 4-8. SOD Systemwide Operations of Alternative Plan 5

Table 4-4. Summary of Operations of Action Alternatives

Action Alternative	Conveyance Route to CVP Friant Division	Conveyance Route to CVP SOD Contractors	Conveyance Route to SWP SOD M&I Contractors	Millerton Lake Carryover Storage (TAF)	Temperance Flat Carryover Storage (TAF)	Intake Structure Type[1]
Alternative Plan 1	Friant-Kern/ Madera Canals	N/A	San Joaquin River[2]	340	200	LLIS
Alternative Plan 2	Friant-Kern/ Madera Canals	San Joaquin River[2, 3]	San Joaquin River[2]	340	200	LLIS
Alternative Plan 3	Friant-Kern/ Madera Canals	San Joaquin River[2, 3]	Friant-Kern Canal	340	200	LLIS
Alternative Plan 4	Friant-Kern/ Madera Canals	San Joaquin River[2, 3]	San Joaquin River[2]	340	325	SLIS
Alternative Plan 5	Friant-Kern/ Madera Canals	San Joaquin River[2, 3]	N/A	130[4]	100	LLIS

Notes:

1 Selective-level intake structure may be used for water temperature management.

2 Water supply delivered via the San Joaquin River to Mendota Pool could be available for exchange with CVP SOD contractors, CVPIA Level 2 refuge supplies, or San Joaquin River Exchange Contractor supplies.

3 Alternative Plans would exchange Temperance Flat RM 274 Reservoir water supply for Level 2 refuges supplies delivered from the Delta, diversifying the CVPIA Level 2 water supply, and freeing up Delta supplies to be delivered to CVP SOD contractors.

4 Millerton Lake would be operated with a preference for maintaining minimum storage at 340 TAF (when Temperance Flat is not full), but allows for Millerton Lake to be drawn down to 130 TAF when needed for water supply delivery.

Key:
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
Delta = Sacramento-San Joaquin Delta
LLIS = low-level intake structure
M&I = municipal and industrial
N/A = not applicable
RM = River Mile
SLIS = selective-level intake structure
SOD = South-of-Delta
SWP = State Water Project
TAF = thousand acre-feet

Alternative Plan 1

In addition to the features common to all of the action alternatives (dam and reservoir, diversion works, powerhouse, valve house, transmission facilities, other construction areas, and affected existing facilities), Alternative Plan 1 would include a fixed LLIS on Temperance Flat RM 274 Reservoir. The LLIS would be an inclined reinforced-concrete structure, located approximately 7,200 feet upstream from the dam and adjacent to and upstream from the outlet works entrance. The LLIS would consist of two, low-level fixed-wheel gates sized in combination to pass 20,000 cfs during high-flow conditions. Water through each gate would flow directly into the outlet works tunnel. Because the lower gates would also function to release higher flood flows, both would be necessary but only one gate would be opened, as needed, for normal releases.

Alternative Plan 1 would provide new water supplies to the Friant Division and SWP SOD M&I contractors. New supplies to SWP SOD M&I contractors would be delivered via the San Joaquin River, and exchanged for Delta supplies at Mendota Pool, where an equivalent amount of Delta water supply could be delivered to SWP SOD M&I contractors via the California Aqueduct. Alternative Plan 1 would include minimum carryover storage targets of 340 TAF in Millerton Lake and 200 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 540 TAF.

Alternative Plan 2

Alternative Plan 2 would include constructing the same physical features described in Alternative Plan 1. Alternative Plan 2 would provide new water supplies to the Friant Division, SWP SOD M&I contractors, and CVP SOD contractors. New supplies to SWP SOD M&I contractors would be delivered via the San Joaquin River and exchanged for Delta supplies at Mendota Pool, where an equivalent amount of Delta water could be delivered to SWP SOD M&I contractors via the California Aqueduct.

New water supplies to CVP SOD contractors would be developed by delivering CVPIA Level 2 refuge water from Temperance Flat RM 274 Reservoir. The water would be released to the San Joaquin River for refuge delivery from Mendota Pool, , which would make Delta supplies available at Mendota Pool for direct access or exchange with Delta supplies for delivery to CVP SOD contractors.

Similar to Alternative Plan 1, Alternative Plan 2 would have minimum carryover storage targets of 340 TAF in Millerton Lake and 200 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 540 TAF. Alternative Plan 2 would include a fixed LLIS on Temperance Flat RM 274 Reservoir, as described for Alternative Plan 1.

Alternative Plan 3

Similar to Alternative Plans 1 and 2, Alternative Plan 3 would include constructing the same physical features described in Alternative Plan 1. Alternative Plan 3 would provide new water supply to the Friant Division, SWP SOD M&I contractors, and CVP SOD contractors. New supplies to SWP SOD M&I contractors would be delivered via the Friant-Kern Canal, cross-valley conveyance, and the California Aqueduct. New water supplies to CVP SOD contractors would be delivered via the San Joaquin River to Mendota Pool for direct access or exchange with Delta supplies.

Alternative Plan 3 would have minimum carryover storage targets of 340 TAF in Millerton Lake and 200 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 540 TAF. Alternative Plan 3 would include a fixed LLIS on Temperance Flat RM 274 Reservoir, as described for Alternative Plan 1.

Alternative Plan 4

Alternative Plan 4 would include constructing the same physical features common to all of the action alternatives, and would also include an SLIS on Temperance Flat RM 274 Reservoir. The SLIS would be an inclined reinforced-concrete structure, located approximately 7,200 feet upstream from the dam and adjacent to and upstream from the outlet works entrance. The SLIS would consist of two low-level fixed-wheel gates sized in combination to pass 20,000 cfs during high-flow conditions and three 6,000 cfs upper-level fixed-wheel gates to allow selective withdrawal from different temperature zones in the reservoir. Water through each lower gate would flow directly into the outlet works tunnel. Because the lower gates would also function to release higher flood flows, both are necessary, but only one gate would be opened, when necessary, for low-elevation releases as driven by temperature objectives; the other would remain closed.

Alternative Plan 4 would provide new water supply to the Friant Division, SWP SOD M&I contractors, and CVP SOD contractors. New supply to SWP SOD M&I contractors and

CVP SOD contractors would be delivered via the San Joaquin River, and exchanged for Delta supplies at Mendota Pool, where an equivalent amount of Delta water would be delivered via the San Joaquin River to Mendota Pool for direct access or exchange with Delta supplies. Alternative Plan 4 would have minimum carryover storage targets of 340 TAF in Millerton Lake and 325 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 625 TAF.

Alternative Plan 5

Similar to Alternative Plans 1, 2, and 3, Alternative Plan 5 would include constructing the same physical features described in Alternative Plan 1. Alternative Plan 5 would provide new water supplies to the Friant Division and CVP SOD contractors. New water supplies to CVP SOD contractors would be delivered via the San Joaquin River to Mendota Pool for direct access or exchange with Delta supplies.

Alternative Plan 5 would have minimum carryover storage targets of 130 TAF in Millerton Lake and 100 TAF in Temperance Flat RM 274 Reservoir, for a total minimum carryover storage target of 230 TAF. Alternative Plan 5 considers an operational preference for keeping Millerton Lake storage at 340 TAF, but allows for Millerton Lake to be drawn down to 130 TAF when needed for water supply delivery, and to fill completely (to 450 TAF) after Temperance Flat RM 274 Reservoir fills. This action alternative also considers additional dry year carryover, where some new water supply that could be delivered in wetter years is held over for delivery in subsequent drier years. This operation slightly decreases the magnitude of long-term average new water supply, but increases deliveries in drier years. Alternative Plan 5 would include a fixed LLIS on Temperance Flat RM 274 Reservoir, as described for Alternative Plan 1.

Environmental Commitments Common to All Action Alternatives

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

The following environmental commitments are included in all of the action alternatives for project-related construction activities.

Develop and Implement Construction Management Plan

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

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

Comply with Permit Terms and Conditions

If any action alternative was approved and authorized for construction, Reclamation would require its contractors and suppliers, its general contractor, and all of the general contractor's subcontractors and suppliers to comply with all of the terms and conditions of all required project permits, approvals, and conditions attached thereto. If necessary, additional information (e.g., detailed designs and additional documentation) would be prepared and provided for review by decision makers and the public. Reclamation would ultimately be responsible for the actions of its contractors in complying with permit conditions. Compliance with applicable laws, policies, and plans for this project is discussed in Chapter 1, "Introduction," and Chapter 28, "Other NEPA and CEQA Conditions."

Provide Relocation Assistance through Federal Relocation Assistance Program

All Federal, State, and local government agencies, and others receiving Federal financial assistance for public programs and projects that require the acquisition of real property must comply with the policies and provisions set forth in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (Uniform Act) (49 CFR 24). All relocation and property acquisition activities, such as those associated with temporary easements during construction or condemnation for permanent changes in the Study Area, would be performed in compliance with the Uniform Act. Any individual, family, or business displaced by implementation of any action alternative would be offered relocation assistance services for the purpose of locating a suitable replacement property, to the extent consistent with the Uniform Act.

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

Develop and Implement Comprehensive Mitigation Strategy

Reclamation would develop and implement a comprehensive mitigation strategy (CMS) to minimize potential impacts to physical, biological, and socioeconomic resources described in this Draft EIS. The CMS described in this section is still under development at this stage in the planning process. The CMS is being developed consistent with the guidance provided in CEQ Regulations for Implementing Procedural Provisions of NEPA (40 CFR Parts 1500–1508). The CMS is intended to minimize the potential adverse impacts associated with action alternatives described in this chapter, as required under NEPA.

The CMS will be multi-faceted in terms of spatial and temporal scales. Based on the nature of some impacts described in this DEIS, the CMS may include one or more of the following types of mitigation as defined under CEQ Guidelines, Section 1508.20–Mitigation:

- Avoiding the impact altogether by not taking a certain action or parts of an action
- Minimizing the impact by limiting the degree or magnitude of the action and its implementation
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time through preservation and maintenance operations during the life of the action
- Compensating for the impact by replacing or providing substitute resources or environments

At this stage in the planning process, the following components are being considered for the CMS:

- Land acquisition
- Conservation easements
- Upland habitat improvements
- Wetland mitigation
- Riparian habitat improvements (riparian reserves)
- Aquatic habitat improvements (river and tributaries)
- Water quality actions (metals, temperature, sediment)
- Visuals and aesthetics actions

Reclamation will address CEQ's guidance on establishing, implementing, and monitoring mitigation, which specifies that when environmental analyses are premised on commitments to mitigate environmental impacts of action alternatives, agencies should adhere to those commitments during project implementation and monitor the implementation and effectiveness of mitigation (CEQ 2011). The CMS will incorporate elements intended to comply with these requirements, specifically those requirements directing agencies to also publicly report on these efforts. The CMS, including a framework for mitigation implementation and monitoring, will be included in the Final EIS.

Develop and Implement Resource Management Plan

Reclamation would lead development of a Resource Management Plan (RMP), in collaboration with BLM and State Parks, for the Temperance Flat RM 274 Reservoir area and lands potentially affected by implementation of action alternatives. The RMP would be prepared as a long-term plan to coordinate management of resources in the area and define the roles and responsibilities of each agency. The RMP would include establishment of management objectives, guidelines, and actions to achieve an integrated long-term vision for recreation and development, as well as resource protection and enhancement, within the reservoir area.

Example management objectives currently addressed by the Millerton Lake RMP/General Plan (Reclamation and State Parks 2010) that may be applicable for implementation of the action alternatives include:

- Enhancing natural resources and recreational opportunities without interruption of reservoir operations;
- Providing recreational opportunities to meet the demands of a growing, diverse population;
- Ensuring recreational diversity and quality;
- Protecting natural, cultural, and recreational resources, and providing resource education opportunities and good stewardship; and
- Providing management considerations for establishing management agreements.

Cultural Resources

If a project was authorized, Reclamation would implement regulations at 36 CFR Part 800 to identify historic properties (including traditional cultural properties, sacred sites, and sacred areas, as appropriate), assess effects, and resolve adverse effects through the consultation process. Consulting parties for the National Historic Preservation Act Section 106 process would include the State Historic Preservation Office (SHPO), the Advisory Council on Historic Preservation (if it chose to participate), other Federal agencies where applicable, tribal representatives, and other interested parties (including non-Federally recognized Native Americans, members of the public, and other State or local agencies) to develop methods to avoid, minimize, or mitigate adverse effects. Measures to avoid, minimize, or mitigate adverse effects would be funded through the project. Reclamation could enter into a Programmatic Agreement with the Advisory Council on Historic Preservation (if it chose to participate), the SHPO, and other consulting parties that would identify how the Section 106 process would be completed for the authorized project. The Programmatic Agreement could include alternative methods for compliance or phased identification efforts/phased finding of effects efforts, as agreed upon with the consulting parties. Any human remains, funerary objects, sacred objects, or objects of cultural patrimony that were removed from federally managed or tribal lands during any project activities would be treated consistent with the Native American Graves Protection and Repatriation Act. If human remains were removed from non-federally managed lands, they would be subject to the PRC regarding the treatment of human remains outside a dedicated cemetery.

To further avoid, minimize, or mitigate adverse effects to cultural resources, Reclamation would implement the following actions, as part of the Section 106 process or independently:

- Develop a Cultural Resources Data Recovery Plan
- Conduct subsurface archaeological investigations before ground disturbing activities
- Stop work for discovery of previously undiscovered cultural resources during project construction
- Stop potentially damaging work if human remains are uncovered during construction

These actions are further described below.

Develop a Cultural Resources Data Recovery Plan If feasible, Reclamation would protect cultural resources in place. If resources cannot be protected in place, Reclamation would implement data recovery consistent with 14 CCR Section 15126.4(b)(3)(c) and with the guidelines set forth in the Secretary of Interior’s standards and guidelines (Standards I through IV). CCR Section 15126.4(b)(3)(c) states that a data recovery plan shall be prepared and adopted before any excavation is undertaken. Because the historical significance of most archaeological sites lies in their potential to contribute to scientific research, the data recovery plan would make provision for adequately recovering the scientifically consequential data from and about the historical resource.

The Secretary of Interior's standards include following an explicit statement of objectives and employing methods that respond to needs identified in the planning process; using methods and techniques of archaeological documentation (data recovery) selected to obtain the information required by the statement of objectives; assessing the results of the archaeological documentation against the statement of objectives and integrating them into the planning process; and reporting and making public the results of the archaeological documentation. To this end, data recovery findings would be documented in a data recovery report, which would follow guidelines set forth by SHPO for such reports.

Conduct Subsurface Archaeological Investigations Before Ground Disturbing Activities Before ground disturbing activities, Reclamation would conduct subsurface investigations (i.e., archeological testing) for undiscovered cultural resources in the portions of the primary study area for the project elements that are identified as having moderate to high potential for undiscovered subsurface cultural resources.

Stop Work for Discovery of Previously Undiscovered Cultural Resources during Project Construction If previously undiscovered cultural resources (e.g., unusual amounts of shell, animal bone, bottle glass, ceramics, structure/building remains, etc.) are discovered during ground-disturbing activities, Reclamation would authorize the construction contractor to stop work in that area and within 100 feet of the find until a qualified archaeologist can assess the significance of the find according to National Register of Historical Places and, if applicable, CEQA (including CRHR) criteria. If necessary, Reclamation would develop appropriate treatment measures for significant and potentially significant resources which may include, but would not be limited to, no action (i.e., resources determined not to be significant), avoidance of the resource through changes in construction methods or project design, and implementing a program of testing and data recovery, in accordance with PRC Section 21083.2. This action would ensure proper identification and treatment of any significant cultural resources uncovered as a result of project-related ground disturbance and would reduce the potential impact resulting from inadvertent damage or destruction of unknown cultural resources during construction.

Stop Potentially Damaging Work if Human Remains are Uncovered During Construction California law recognizes the need to protect interred human remains, particularly Native American burials and associated items of patrimony, from vandalism and inadvertent destruction. The procedures for the treatment of discovered human remains are contained in California Health and Safety Code Section 7050.5 and Section 7052 and California PRC §5097.

In accordance with the California Health and Safety Code, if human remains are uncovered during ground-disturbing activities, including construction, and all such activities within a 100-foot radius of the find would be halted immediately and a designated representative would be notified. The representative would immediately notify the county coroner and a qualified professional archaeologist. The coroner is required to examine all discoveries of human remains within 48 hours of receiving notice of a discovery on private or state lands (Health and Safety Code Section 7050.5[b]).

If the coroner determines that the remains are those of a Native American, he or she must contact the Native American Heritage Commission (NAHC) by phone within 24 hours of making that determination (Health and Safety Code Section 7050[c]). The NAHC would contact the persons it believes to be most likely descended from the deceased Native American. The most likely descendant, in cooperation with the property owner and Reclamation, shall determine the ultimate disposition of the remains in accord with the provisions of California PRC Section 5097.98. If NAHC cannot identify any likely descendants, if the most likely descendant fails to make a recommendation, or Reclamation disagrees with the recommendation and mediation fails to resolve the issue, then Reclamation would reinter the human remains with appropriate dignity on a part of the property not subject to further subsurface disturbance, as is specified in Section 5097.98(b) and 14 CCR Section 1064.5(e)(2).

Develop and Implement Stormwater Pollution Prevention Plan

Any project authorized for construction would be subject to construction-related stormwater permit requirements of the Federal CWA National Pollutant Discharge Elimination System program. Reclamation would obtain any required permits through the Central Valley Water Board before any ground-disturbing construction activity. According to the requirements of Section 402 of the CWA, Reclamation, and/or its contractors would prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) before construction, identifying BMPs to prevent or minimize erosion and the discharge of sediments and other contaminants with the potential to affect beneficial uses or lead to violations of water quality objectives of surface waters.

The SWPPP would include development of site-specific structural and operational BMPs to prevent and control impacts on runoff quality, and measures to be implemented before, during, and after each storm event. BMPs would also control short-term and long-term erosion and sedimentation effects, and stabilize soils and vegetation in areas affected by construction activities (i.e., erosion and sediment control plan). The SWPPP would contain a site map that shows the construction site perimeter, existing and proposed buildings, lots, roadways, stormwater collection and discharge points, general topography both before and after construction, and drainage patterns across the project. Additionally, the SWPPP would need to contain a visual monitoring program, a chemical monitoring program for “nonvisible” pollutants to be implemented if a BMP fails, and a sediment monitoring plan if the site discharges directly to a water body listed on the CWA 303(d) list for sediment. BMPs for the project could include, but would not be limited to, earth dikes and drainage swales, stream bank stabilization, sediment basins, sandbag barriers, silt fencing, straw bale barriers, fiber rolls, storm drain inlet protection, hydraulic mulch, and stabilized construction entrances.

Develop and Implement Feasible Spill Prevention and Hazardous Materials Management Measures

As part of the SWPPP, Reclamation and/or its contractors would develop and implement a spill prevention and control plan to minimize effects from spills of hazardous, toxic, or petroleum substances for project-related construction activities occurring in or near waterways. The accidental release of chemicals, fuels, lubricants, and nonstorm drainage water into water bodies would be prevented to the extent feasible. Spill prevention kits would always be in close proximity when hazardous materials would be used (e.g., crew trucks and other logical locations). Feasible measures would be implemented so that hazardous materials would be properly handled and the quality of aquatic resources would be protected by all reasonable means during work in or near any waterway. No fueling would be done within the ordinary high-water mark, immediate floodplain, or full pool inundation area, unless equipment stationed in these locations could not be readily relocated. Any equipment that could be readily moved out of the water body would not be fueled in the water body or immediate floodplain. As for stationary equipment, for all fueling done at the construction site, containments would be installed so that any spill would not enter the water, contaminate sediments that may come in contact with the water, or damage wetland or riparian vegetation. Any equipment that could be readily moved out of the water body would not be serviced within the ordinary high-water mark or immediate floodplain.

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

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

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

Fisheries Conservation

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

Implement In-Water Construction Work Windows

Reclamation would identify and implement feasible in-water construction work windows in consultation with USFWS and DFW. In-water work windows would be timed to occur when sensitive fish species were not present or would be least susceptible to disturbance (e.g., July through September).

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

Perform Fish Rescue/Salvage If spawning activities for sensitive fish species were encountered during construction activities, the biologist would be authorized to stop construction activities until appropriate corrective measures were completed or it was determined that the fish would not be harmed.

A qualified biologist would identify any fish species that may be affected by the project. The biologist would facilitate rescue and salvage of fish and other aquatic organisms that become entrapped within construction structures and cofferdam enclosures in the construction area. Any rescue, salvage, and handling of listed species would be conducted under appropriate authorization (i.e., incidental take statement/permit for the project, Federal ESA Section 4(d) scientific collection take permit, or a Memorandum of Understanding). If fish were identified as threatened with entrapment in construction structures, construction would be stopped and efforts made to allow fish to leave the project area before resuming work. If fish were unable to leave the project area of their own volition, then fish would be collected and released outside the work area. Fish entrapped in cofferdam enclosures would be rescued and salvaged before the cofferdam area was completely dewatered. Appropriately sized fish screens would be installed on the suction side of any pumps used to dewater in-water enclosures.

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

Water Quality Protection

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

Implement In-Water Construction Work Windows All construction activities along the San Joaquin River would be conducted during months when instream flows were managed outside the flood season (e.g., June to September).

Comply with All Water Quality Permits and Regulations Project activities would be conducted to comply with all additional requirements specified in permits relating to water quality protection. Relevant permits anticipated to be obtained for the proposed action include a California Fish and Game Code 1602 Lake and Streambed Alteration Agreement, CWA Section 401 certification, and CWA Section 404 compliance through USACE.

Implement Water Quality Best Management Practices BMPs that would be implemented to avoid and/or minimize potential impacts associated with dam construction are described below.

Minimize Potential Impacts Associated with Equipment Contaminants For in-river work, all equipment would be steam-cleaned daily to remove hazardous materials before the equipment entered the water.

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

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

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

Revegetation Plan

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

Invasive Species Management

Reclamation would develop and implement a control plan to prevent the introduction of zebra/quagga mussels (*Dreissena rostriformis bugensis*), invasive plants, and other invasive species to project areas. The control plan would cover all workers, vehicles, watercraft, and equipment (both land and aquatic) that would come into contact with Millerton Reservoir, the shoreline of Millerton Reservoir, the San Joaquin River, and any riverbanks, floodplains, or riparian areas (Reclamation 2012). Plan activities could include, but would not be limited to, the following:

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

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

Approved cleaning methods would include a combination of the following:

- **Precleaning –** Draining, brushing, vacuuming, high-pressure water treatment, thermal treatment

- **Cleaning –** Freezing, desiccation, thermal treatment, high-pressure water treatment, chemical treatment

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

Construction Material Disposal

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

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

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

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

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

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

Asphalt Removal

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

Reduce Fugitive Dust Emissions

For reducing construction-related fugitive dust emissions, Reclamation would comply with Regulation VIII. If a nonresidential project is 5.0 or more acres in area, a dust control plan must be submitted as specified in Section 6.3.1 of Rule 8021. Therefore, Reclamation is required to submit a dust control plan, and construction activities would not commence until San Joaquin Valley Air Pollution Control District (SJVAPCD) has approved the plan. Reclamation would also implement the following SJVAPCD-recommended enhanced and additional control measures to further reduce fugitive dust emissions:

- Install sandbags or other erosion control measures to prevent silt runoff to public roadways from adjacent project areas with a slope greater than 1 percent

- Suspend excavation and grading activity when winds exceed 20 miles per hour

- Limit area subject to excavation, grading, and other construction activity at any one time

Fire Protection and Prevention Plan

Reclamation would prepare and implement a fire protection and prevention plan, addressing the following topics (found in 29 CFR 1926.150), to minimize the risk of wildfire or threat to workers, property, and the public:

- Dispensing of flammable/combustible liquids
- Welding and cutting
- Use, storage, and transport of compressed gas cylinders
- Management of open and enclosed storage yards or facilities
- Fire prevention measures
- Fire emergency response

Action Alternative Construction Activities and Schedule

Various technical assessments of activities, methods, and material production rates were conducted to support the construction schedule for project features. Construction activities and schedules were based on design drawings, quantities, and cost estimate information documented in the Draft Feasibility Report (Reclamation 2014). The activities and schedule described in this section give specific attention to high-risk activities and sequencing related to the diversion works needed to start and complete dam construction.

Construction activities under all action alternatives would include the following work breakdown phases:

- **Phase 1 –** Site work, tunnel, and marine phase. A subcategory of Phase 1, Phase 1b, would include a mitigation period, if needed, to address significant risk related to establishing stable and sufficiently tight cofferdams.
- **Phase 2 –** Powerhouse/valve house and intake phase
- **Phase 3 –** Dam/reservoir phase

Construction phases are based on construction timing and feature proximity. The detailed breakdown for each phase is shown in Figure 4-9. Additional details are in the Draft Feasibility Report (Reclamation 2014).

The schedule for phases and activities is preliminary and was developed to analyze the technical, economic, and financial feasibility in the separate Draft Feasibility Report, and for the analysis of impacts and development of mitigation measures for this Draft EIS. Revisions may occur through the planning, environmental, permitting, final design, and contracting processes.

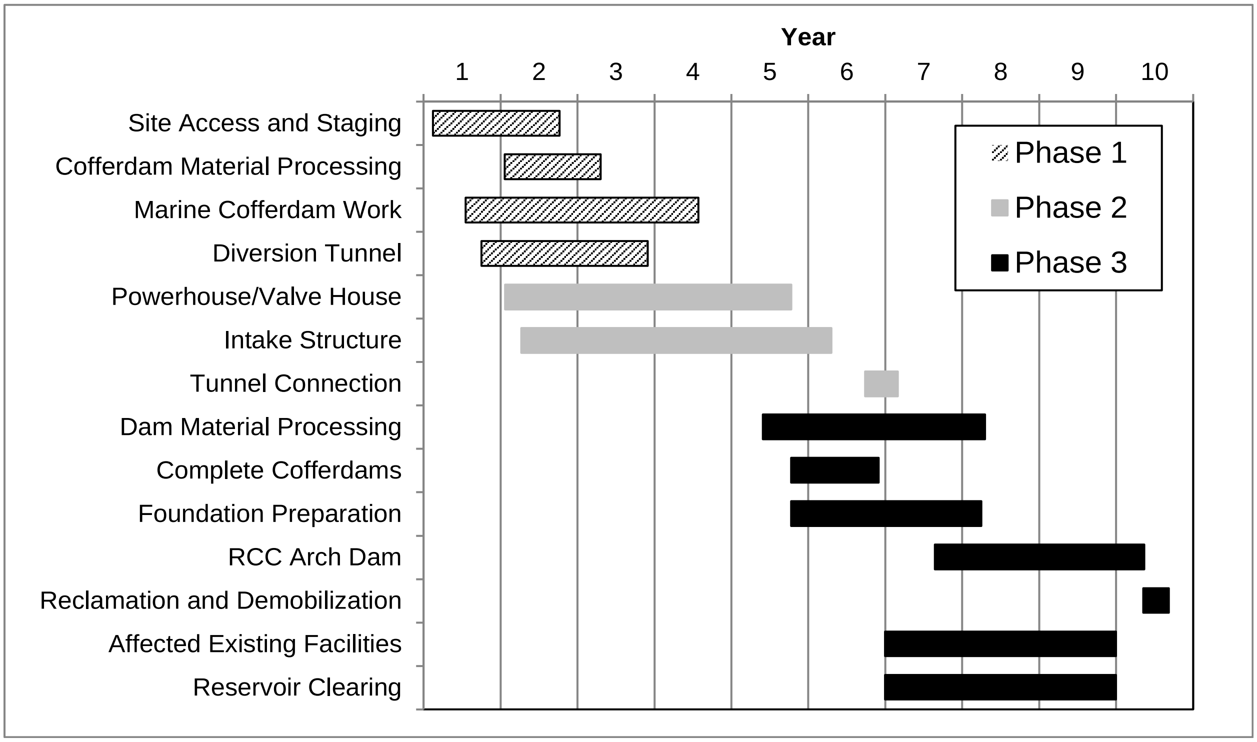


Figure 4-9. Preliminary Construction Activities and Schedule

Phase 1 – Sitework, Marine Phase, and Tunnel

Phase 1 would include activities preceding the main dam construction such as initial site access and contractor use area staging, material processing, and underwater cofferdam construction, and diversion tunnel construction. Estimates of fuel use, equipment use, and truck trips for Phase 1 activities are in the Draft Feasibility Report (Reclamation 2014).

Site Access and Staging This activity would include constructing haul and access roads, and developing the quarry, batch plant sites, and staging area. Embankment material would consist of excavation material, with the remaining waste excavation being stored at the quarry, staging area, or tunnel waste area. As scheduled, site access and staging construction activities would last 16 months.

The new Temperance Flat transmission line would be constructed along approximately 4.42 miles from the existing Kerckhoff-Sanger 115 kilovolt (kV) line to the proposed

Temperance Flat powerhouse switch yard. The line would be constructed using 31 predominately steel monopoles with steel-reinforced, drilled concrete piers. A temporary transmission line would be built from the powerhouse site east to the inundation area. Temporary lines would then run through the inundation area to provide power at the quarry, batch plant sites, and other construction areas.

Cofferdam Material Processing Quarry operations in Phase 1 would include processing 2,691 thousand cubic yards of material for the rockfill cofferdams. Processing would include crushing rock to obtain the fine rockfill, and quarrying to a maximum size, to obtain the larger rockfill. Material with impervious characteristics could be borrowed from the area or, alternatively, a clayey import may be blended with some quarried and crushed well-graded gravel. Cofferdam material processing would last 15 months.

Marine Cofferdam Work Phase 1 would include marine or underwater construction of both cofferdams. The cofferdam foundations and trenches would be constructed and prepared using clamshell barges and underwater drill-and-blast techniques. Waste material would be placed in the quarry via truck and potentially processed into construction material.

Below elevation 535 feet msl, materials would be placed using clamshell placement supplemented by higher production bottom-dump barges. Trucks would transport material from the quarry to the clamshells/barges. Central low zones 300 to 500 feet wide across the river and at elevation 528 feet msl, would allow river passage through Millerton Lake until a cofferdam closure was made and the river was diverted. Once the cofferdams were at elevation 535 feet msl and the diversion tunnel was complete, including the approach and discharge chute excavations, the cofferdam closures would be placed to above elevation 535 feet msl, thereby diverting the river through the diversion tunnel. The diversion would only be initiated at this point if the water surface was low enough in the September-through-January low-level period.

Upon successfully diverting the river through the diversion tunnel, the area between the partial cofferdams would be unwatered and observed for stability and seepage. Marine cofferdam excavation and material placement would last 13 months. Total marine cofferdam activities, including staging, construction, dewatering, observation, and cleanup, would last 37 months.

Diversion Tunnel The diversion tunnel and portals would be constructed using excavators and drill-and-blast techniques. Waste material would be placed in the tunnel waste area via truck. The tunnel would then be lined with concrete. Until the tunnel was completed and the project was prepared for diversion, the reservoir banks upstream from the intake portal and downstream from the tunnel discharge portal would be left in place to protect the diversion tunnel from flooding during construction. Other assumptions are detailed in the Draft Feasibility Report (Reclamation 2014). Diversion tunnel construction would last 26 months.

Phase 2 – Powerhouse/Valve House and Intake Construction

Phase 2 would include activities to construct the Temperance Flat Powerhouse/Valve House and intake structure (LLIS or SLIS). All structures would then be connected to the diversion tunnel to complete the river outlet works. Estimates of fuel use, equipment use, and truck trips for Phase 2 activities are in the Draft Feasibility Report (Reclamation 2014).

Powerhouse/Valve House A 200-square-foot work pad would be constructed next to the powerhouse excavation for staging. A small access road would be built to tie into proposed access/haul roads. Excavation construction of the powerhouse and valve house would occur simultaneously. A small cofferdam would be used for powerhouse tailrace and valve house chute construction. The bottom of the powerhouse would be constructed during low-water periods in Millerton Lake. The higher portion of the powerhouse (above elevation 580 feet msl) and most of the valve house are outside the influence of Millerton Lake levels and would be constructed during remaining periods of the year.

Construction would include extensive excavation for both structures and access road. Excavated material would be either disposed of in the diversion tunnel waste area or be used for infill or aggregate in powerhouse and valve house construction. Reinforced, cast-in-place concrete would be used for powerhouse and valve house structures. Cement, penstock steel, and other materials would be trucked from Fresno, California railyards via North Friant, Millerton, and Sky Harbor roads.

After construction was completed, riprap would be placed along the upstream and downstream sides of the structure to topographically tie existing ground contours to the structure, and to aid in erosion control. Temporary features that would be decommissioned once construction was complete include scaffolding and the construction staging pad. The area would be restored and revegetated. Powerhouse/valve house construction would last 45 months.

Intake Structure A 200-square-foot work pad would be constructed at the ridge above the intake (LLIS or SLIS) for staging. A small access road would be built to tie into proposed access/haul roads. The cofferdam used to construct the diversion tunnel was anticipated to be used for intake construction. The bottom of the intake would be constructed during low-water periods in Millerton Lake. The higher portion of the intake (above elevation 580 feet msl) would be outside the influence of Millerton Lake levels and would be constructed during remaining periods of the year.

Intake construction would include extensive excavation for both the structure and access road. Excavated material would be either disposed of in the inundation area or be used for construction aggregate. Cement, rebar, and other materials would be trucked from Fresno, California, rail yards via North Friant, Millerton, and Sky Harbour roads.

After intake construction was complete, riprap would be placed along the upstream and downstream sides of the structure to topographically tie the existing ground contours to the structure and to aid in erosion control. Temporary features that would require decommissioning once construction is complete would include scaffolding and the construction staging pad, which would be removed and the area restored and revegetated. Intake structure construction would last 49 months.

Tunnel Connection A crossover tunnel would be constructed once the dam was completed to connect the intake structure with the diversion tunnel. A concrete tunnel plug would be installed in the upstream end of the diversion tunnel, followed by controlled blasting techniques to excavate a tunnel from the base of the intake structure to the diversion/power tunnel downstream from the concrete plug. Excavation would be followed by concrete lining of the tunnel. The powerhouse/valve house penstock would also be connected to the diversion tunnel at this time. The tunnel connection work would last 5 months.

Phase 3 – Dam and Reservoir Construction

Phase 3 would include activities to process construction materials, such as aggregate from the quarry, complete the cofferdams to elevation 580 feet msl, prepare the dam foundation, construct the RCC dam, and reclaim and demobilize the construction site. Estimates of fuel use, equipment use, and truck trips for Phase 3 activities are in the Draft Feasibility Report (Reclamation 2014).

Dam Material Processing Quarry operations in Phase 3 would include processing 6.9 million tons of aggregate. Large primary, multiple secondary, and multiple tertiary crushing units would be needed both for production and for particle shaping and sizing. Aggregate would be transported to the batch plant via truck for all quarry, batch plant, and haul road options. Aggregate production would last 25 months, but total material processing, from mobilization to shutdown, would be 35 months.

Complete Cofferdams Dry cofferdam construction would complete the cofferdams to elevation 580 feet msl. Trucks would transport material from the quarry to the cofferdams. Final cofferdam construction would last 14 months.

Foundation Preparation The dam foundation would be prepared using excavators and drill-and-blast techniques. Waste material would be placed and potentially processed into construction material in the quarry area via trucks. Cement, pozzolan, and metal for the foundation and dam would be trucked from Fresno, California, rail yards via Highway 41, County Road 200/210, and the proposed haul road. Foundation preparation would last 30 months.

RCC Arch Dam A cement batch plant site would be located near the dam's right or left abutment depending on the quarry, batch plant, and haul road option. Multiple RCC plants, with multiple mixing units on each plant, would be likely at the batch plant site. Trucks would deliver aggregates, stockpiled high at the quarry, to the batch plant site. RCC delivery could be made with a custom conveyor or multiple conveyor system with a combined capacity meeting or exceeding the RCC plant capacity. The dam height could limit delivery to variable locations, as well as steady raising. Trucks could be used on the fill in lieu of conveyors to deliver materials to the spreading location. RCC placement would take 26 months presuming a 6-day/week placement. A total of 33 months would be needed to complete the RCC dam, including the dam crest and spillway.

Reclamation and Demobilization All disturbed sites, including contractor use areas and temporary roads outside of the reservoir area, would be reclaimed using the remaining excavated material stored at the quarry. Permanent access roads would be resurfaced. The downstream cofferdam would be demolished to elevation 500 feet msl, with waste material being placed at the toe of the cofferdam or at the quarry via truck. Reclamation and final demobilization would last 4 months.

Affected Existing Facilities – Kerckhoff Project Decommissioning All hydraulic, lubricating, and insulating oils would be drained and disposed. In addition, any refrigerants, storage batteries, or compressed gas would require disposal. Asbestos and equipment containing mercury, along with transformers and oil circuit breakers would be removed and disposed. Overhead conductors from the powerhouses to the switchyards would be removed. Transformers to be disposed of would be hauled to a licensed disposal facility in Los Angeles, 250 miles away. Construction waste would be disposed of in a Fresno, California, landfill or scrapyard. Several pieces of equipment would be salvaged and transported to the PG&E yard in Auberry, 9 miles from the Kerckhoff No. 2 site. Concrete plugs would be placed in the intake and draft tubes. The Kerckhoff penstock tunnel and surge chambers would also be plugged and backfilled. Kerckhoff Project decommissioning would last 36 months.

Inundated sections of the Kerckhoff-Le Grand and Kerckhoff-Sanger transmission lines (approximately 4 miles in length) would be reconstructed as the Le Grand–Sanger transmission line. The line would be constructed using 20 predominately steel monopoles with steel-reinforced, drilled concrete piers.

Affected Existing Facilities – Recreation Trail construction would use "full bench" construction whenever possible, locate trail switchbacks to reduce shortcutting, and protect environmentally sensitive areas and erodible slopes. Disturbed areas would be restored after construction. If buildings would be inundated, structures and foundations would be demolished. Asbestos material, if discovered, would be removed and taken to an approved landfill for disposal per permit requirements. General demolition waste would also be removed and trucked to an approved landfill. Pavement in parking areas would be removed, the underlying soil ripped to 6 inches depth, and then the area would be hydroseeded. Whenever possible, new recreational structures would use renewable, local, and/or recycled content materials; use natural lighting, renewable energy, and high-efficiency utilities; and protect sensitive areas and erodible slopes.

Roadway construction activities would involve, but not be limited to, demolition of existing roadways as required; clearing, grubbing, and site preparation of work areas, as required; grading road alignments to meet finished grades; placing road subgrade; paving operations; installing storm drain culverts; constructing retaining wall systems; installing road appurtenances such as guardrails; and performing construction-related traffic control. Boat ramp construction activities would involve, but not be limited to, clearing, grubbing and site preparation of work areas; and heavy earthwork operations. Recreations facility demolition and relocations would last 36 months.

Affected Existing Facilities – Utilities All utilities associated with demolished buildings would be disconnected (typically 6 inches deep), capped, and/or removed per permit requirements and governing utility standards. Potable water and wastewater lines that would be relocated would use trenching and backfilling. Water removed from the construction area would be treated to remove sediment and discharged to the closest drainage way.

Relocated potable water wells would require a rotary drill rig. A concrete pad would be constructed at the top of the well to keep contaminated water away from the well. The concrete pad would also typically accommodate a small pump and small bladder tank. Power would need to be routed to the new well to power the pump.

Relocating wastewater septic systems would include excavating a pit approximately 17 feet long, 11 feet wide, and 9 feet deep for the septic tank. The tank would be placed and backfilled to grade. A trench approximately 100 feet long, 3 feet wide, and 3 feet deep would be excavated for the leach field. The perforated leach pipe and approved backfill would be added to the trench and the trench backfilled to grade.

Power distribution poles and wires affected by inundation would be removed and disposed of at an approved landfill. Relocated wood-pole or steel-pole foundations could be directly embedded in the ground (typically 6 feet) with crushed rock or concrete backfill, or installed using reinforced-concrete caissons and anchor bolts. Utilities demolition and relocations would last 36 months.

Reservoir Clearing Three vegetation removal prescriptions would be applied to the inundation area. Complete removal (331 acres) would clear all existing vegetation and would generally be applied to areas adjacent to proposed recreation developments to reduce water recreation hazards. Overstory removal (3,249 acres) would remove all trees greater than 10 inches in diameter at breast height or greater than 15 feet in height, and would be applied to most areas outside of complete removal areas. No treatment (1,066 acres) would generally be applied to areas assumed to support little to no vegetation, and would also apply to special habitat areas to maximize habitat benefits of inundated and residual vegetation.

For complete removal and overstory removal areas, timber would be harvested by standard or specialized logging machinery and hand crews. Lumber would be removed via existing roads or proposed haul and access roads. Understory vegetation (for complete removal areas) and waste would be disposed of using self-contained incinerators.

Summary of Potential Accomplishments of Action Alternatives

This section summarizes the potential accomplishments of all action alternatives for the primary planning objectives of increased water supply reliability and system operational flexibility, and enhancement of water temperature and flow conditions in the San Joaquin River; and for the secondary planning objectives of improved flood management, hydropower generation, recreation, San Joaquin River water quality, and urban water quality. Model simulations completed to assess the physical accomplishments are described in detail in the Modeling Appendix. Project costs are further described in the Draft Feasibility Report Engineering Summary Appendix (Reclamation 2014), and economic analysis and benefits are further described in the Draft Feasibility Report Economic Analysis Appendix (Reclamation 2014).

Increase Water Supply Reliability and System Operational Flexibility

The primary planning objective to increase water supply reliability and system operational flexibility could address water supply and demand for agricultural and M&I CVP and

SWP water contractors. In addition to providing long-term average or dry-year water supply reliability, Temperance Flat RM 274 Reservoir could provide emergency water supply to SOD water users during prolonged Delta pumping outages. Both water supply reliability and emergency water supply are considered to meet this planning objective.

Water Supply Reliability

In the Draft Feasibility and Plan Refinement Phase, analyses of Temperance Flat RM 274 Reservoir conditions and operations under the 2008/2009 BOs focused on developing new water supplies by storing water from the San Joaquin River that would otherwise have been flood releases from Friant Dam. This operation would provide water supply reliability and operational flexibility to the CVP and SWP system. The action alternatives were analyzed for water supplies to the Friant Division contractors, SWP SOD M&I contractors, CVP SOD contractors, and CVP San Joaquin Valley wildlife refuges, based on CalSim II simulations. Table 4-5 summarizes the long-term average annual change in deliveries to the potential beneficiaries in each action alternative compared to the No Action Alternative. Table 4-6 lists the long-term average annual change in deliveries systemwide for all water year types for all action alternatives compared to the No Action Alternative. The long-term average annual change in systemwide deliveries accounted for reduced Delta pumping to SWP and CVP SOD contractors due to the reduction in Delta inflows during wet years (flood flows) from the San Joaquin River. On average, the action alternatives would provide between 61 to 87 TAF per year of additional CVP and SWP systemwide water deliveries, depending on operations.

The CalSim II modeling shows some infrequent, minor changes to CVP and SWP water operations north of the Delta. These changes are a result of the model response to reductions in San Joaquin River inflow to the Delta and implementation of the complex system of Delta inflows, exports, regulations, hydrodynamic and salinity interaction rules and their interactions with the Coordinated Operations Agreement on how water supply and regulatory responsibility are shared by the CVP and SWP north of the Delta in the model. The model follows the built in rules governing these interactions and cannot deviate from these rules when new or unexpected interactions occur.

These minor changes indicated in the modeling, and any potential impacts from these changes, are expected to be consistent between alternatives, and would not make any difference in the comparative analysis performed using the CalSim II simulation results. Because these small upstream changes are not expected to occur in real-time, would be small and infrequent, could have a positive or negative impact on SOD deliveries, and would be expected to be consistent between simulations, they are ignored for the purposes of this document. During project implementation corrective actions could be included in the project operating plan so that these potential impacts would be avoided in real-time operations.

In addition to carryover storage targets, the magnitude of long-term water supply reliability accomplishments was strongly influenced by CVP and SWP operating conditions. Evaluation of Temperance Flat RM 274 Reservoir, integrated with the broader CVP and SWP SOD exports and storage system under potential future conditions with increased flexibility for CVP and SWP Delta export operations, would likely result in significantly greater estimates of water supply reliability by capturing additional Delta water supply in wet years through exchange.

Table 4-5. Long-Term Average Annual Change in Deliveries for Temperance Flat RM 274 Reservoir (in TAF)

Average Annual Change in Delivery[1]	Alternative Plan 1	Alternative Plan 2	Alternative Plan 3	Alternative Plan 4	Alternative Plan 5
Friant Division of the CVP	43	36	38	27	48
CVP SOD Ag[2]	-10	16	16	16	48
SWP SOD M&I[2]	40	22	25	21	-7
Total CVP and SWP Change In Deliveries[3]	**70**	**71**	**76**	**61**	**87**

Notes:
[1] Action alternatives are compared to the No Action Alternative.
[2] Because Temperance Flat RM 274 Reservoir would increase the capacity to capture San Joaquin River flood flows, Delta inflows from the San Joaquin River would be reduced, therefore reducing CVP and SWP deliveries from the Delta in some years. In some action alternatives, the long-term annual average delivery to CVP SOD would be slightly less than the No Action Alternative.
[3] Total CVP and SWP delivery includes SWP Ag and CVP M&I, which are not included as water supply beneficiaries; consequently, line items may not sum to totals.

Key:
Ag = agricultural
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
M&I = municipal and industrial
RM = River Mile
SOD = South-of-Delta
SWP = State Water Project
TAF = thousand acre-feet

Table 4-6. Long-Term Average Annual Change in Deliveries for Action Alternatives[1]

Action Alternative	WY Type San Joaquin Index[2]	Change in System-wide Delivery[3]	Total Friant Ag	Class 1	Class 2	Section 215	Total SWP SOD	SWP SOD Ag	SWP SOD M&I	Total SOD CVP[2]	CVP SOD Ag	CVP SOD M&I
Alternative Plan 1	Wet	112	102	(1)	239	(137)	33	(10)	44	(23)	(22)	(1)
	Above Normal	152	82	2	133	(53)	79	(3)	82	(9)	(9)	0
	Below Normal	1	(49)	(3)	(14)	(32)	53	7	46	(3)	(3)	0
	Dry and Critical	19	12	4	23	(15)	13	0	13	(5)	(5)	(1)
	All Years	**70**	**43**	**1**	**103**	**(61)**	**38**	**(3)**	**40**	**(11)**	**(10)**	**0**
Alternative Plan 2	Wet	115	99	(1)	237	(137)	0	(10)	10	16	17	(1)
	Above Normal	145	65	1	117	(53)	43	(3)	46	36	37	0
	Below Normal	(4)	(65)	(3)	(30)	(32)	42	7	35	19	19	0
	Dry and Critical	24	8	6	18	(15)	15	1	13	1	1	(1)
	All Years	**71**	**36**	**1**	**95**	**(61)**	**20**	**(2)**	**22**	**16**	**16**	**0**
Alternative Plan 3	Wet	116	86	(1)	224	(138)	22	(10)	33	9	10	0
	Above Normal	152	62	1	113	(53)	48	(3)	51	42	43	0
	Below Normal	7	(38)	(3)	(2)	(32)	21	6	15	23	23	0
	Dry and Critical	30	18	7	27	(15)	8	1	7	3	3	(1)
	All Years	**76**	**38**	**2**	**98**	**(62)**	**22**	**(2)**	**25**	**15**	**16**	**0**
Alternative Plan 4	Wet	99	91	(1)	220	(128)	(2)	(10)	8	10	11	0
	Above Normal	122	39	2	90	(53)	40	(3)	43	42	42	0
	Below Normal	2	(62)	(3)	(27)	(32)	40	6	34	23	23	0
	Dry and Critical	21	6	6	15	(15)	14	1	12	2	3	0
	All Years	**61**	**27**	**2**	**85**	**(59)**	**18**	**(2)**	**21**	**16**	**16**	**0**
Alternative Plan 5	Wet	0	20	(1)	158	(137)	(45)	(11)	(35)	26	27	0
	Above Normal	152	84	(1)	138	(53)	(8)	(3)	(4)	76	76	0
	Below Normal	89	(6)	(29)	55	(32)	18	7	11	78	78	0
	Dry and Critical	121	75	25	66	(15)	8	1	6	39	39	(1)
	All Years	**87**	**48**	**4**	**106**	**(61)**	**(10)**	**(2)**	**(7)**	**48**	**48**	**0**

Notes:
[1] Changes in deliveries as simulated with CalSim II March 2012 Benchmark with future (2030) level of development and 82 year hydrologic period of record from October 1921 to September 2003.
[2] San Joaquin Year Type or 60-20-20 Year Type – This classification system is based on the historical and forecasted unimpaired inflows of the Stanislaus, Tuolumne, Merced, and San Joaquin rivers to the San Joaquin River Basin, as defined in State Water Board Decision D-1641. The classification consists of five year types: wet, above normal, below normal, dry, and critical. Average for all years is weighted average based on proportion of each year type out of 82-year period of record.
[3] Action alternatives are compared to the No Action Alternative.

Key:
Ag = agricultural
CVP = Central Valley Project
M&I = municipal and industrial
RM = river mile
SOD = South-of-Delta
SWP = State Water Project
WY = water year

Enhance Water Temperature and Flow Conditions

The primary planning objective to enhance water temperature and flow conditions in the San Joaquin River considers physical accomplishments for cold-water pool and Friant Dam river release temperatures to improve conditions for San Joaquin River anadromous fish in general, as well as potential to improve habitat for spring-run Chinook salmon in particular.

Ecosystem – Cold-Water Pool and River Release Temperature

The action alternatives could improve the capability, reliability, and flexibility to release water at suitable temperatures for anadromous fish downstream from Friant Dam. Reservoir and river water temperature simulations were performed for all action alternatives. Alternative Plan 4 also includes an SLIS to better manage reservoir cold-water pool and San Joaquin River release temperatures for anadromous fish.

All action alternatives would increase the total volume of cold water in Millerton Lake and Temperance Flat RM 274 Reservoir, with larger available cold-water pools in action alternatives with higher carryover storage. The SLIS included in Alternative Plan 4 would also allow for better management of the cold-water pool, resulting in improved water temperature conditions for anadromous fish in the San Joaquin River.

The action alternatives would improve San Joaquin River release temperatures from the critical September through December spawning period, as shown in Figure 4-10, at the cost of slightly warmer winter releases than in the No Action. However, in the winter months, release temperatures would still be cooler than required for successful anadromous fish survival (see Modeling Appendix for further detail on reservoir and river temperatures). Inclusion of an SLIS in Alternative Plan 4 would reduce release temperatures by up to 5 degrees Fahrenheit (°F) more than without the SLIS during falls months. The colder release temperatures would also slightly extend the distance downstream from Friant Dam where mean daily river temperatures stay below 55°F, a critical temperature for anadromous fish (Figure 4-11).

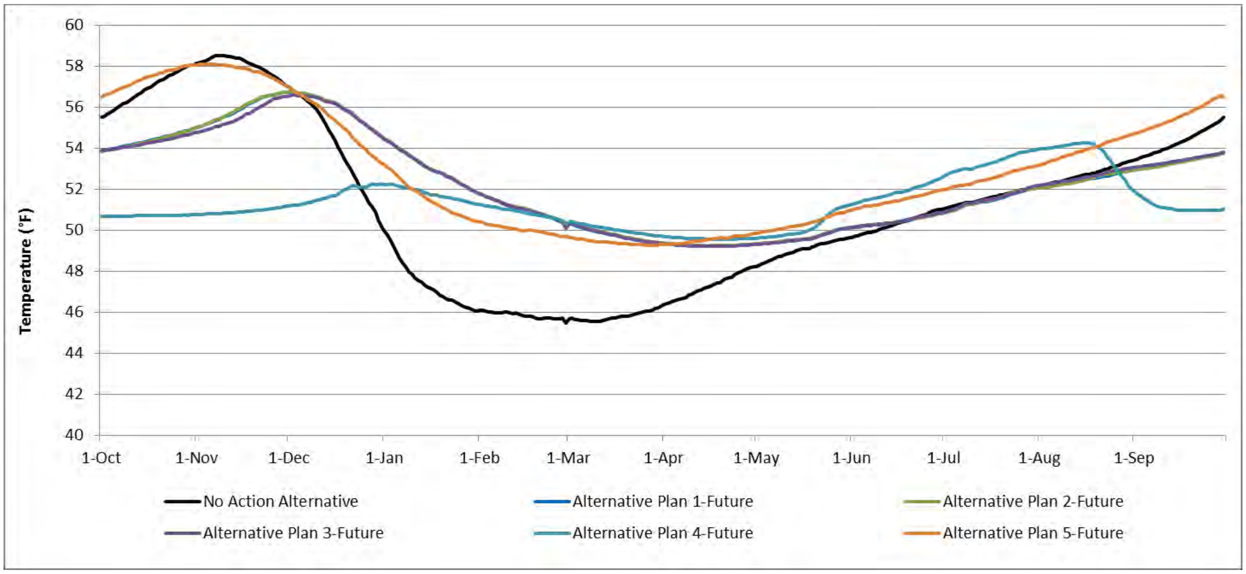


Figure 4-10. Mean Daily Temperature (°F) of Friant Dam Release to San Joaquin River – All Years

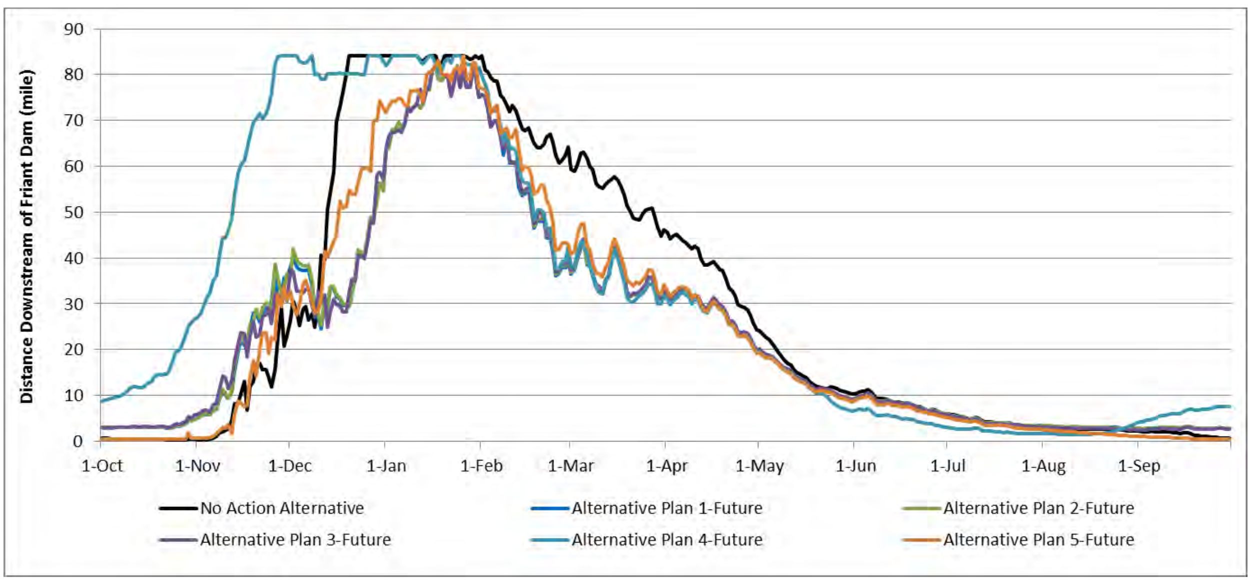


Figure 4-11. Distance Downstream Where Mean Daily River Temperature Less Than or Equal to 55° F – All Years

Ecosystem – Improvement in Spring-Run Chinook Salmon Abundance

The Ecosystem Diagnosis and Treatment (EDT) model (Mobrand et al. 1997, Blair et al. 2009) was used to estimate potential improvements to San Joaquin River spring-run Chinook salmon habitat that could be achieved by action alternatives. EDT output includes variables describing the productivity and capacity of fish habitat that could develop under flow and water temperature regimes for each action alternative. Productivity and capacity were both represented in the abundance metric estimated by the EDT model, representing the number of spawning fish the habitat could sustain. Due to uncertainty and limited data regarding the survival of salmon as they migrate below the Merced River to the ocean and then return to spawn, results were developed to demonstrate a range of potential results for a low and high potential smolt-to-adult return rate (SAR). EDT modeling is described in further detail in the Modeling Appendix.

Major EDT model outputs:

Productivity represents habitat quality and is based on the density-independent survival rate (i.e., survival without competition) and is a function of temperature, water quality, and food.

Capacity is the maximum abundance that could be supported by the quantity of suitable habitat and the density of fish in that habitat. It is a function of the quantity of habitat, productivity, and food.

Equilibrium Abundance is the best estimate for maximum number of returning/spawning adult fish that could be supported considering both habitat quantity and quality.

Potential improvements due to Temperance Flat RM 274 Reservoir operations for spring-run Chinook salmon habitat were measured by comparing the abundance for each alternative to that of the No Action Alternative as a percent improvement in equilibrium abundance. Equilibrium abundance was the best estimate for maximum number of returning/spawning adult fish that could be supported considering both habitat quantity and quality. Table 4-6 shows the increase in abundance of spring-run Chinook salmon habitat in the San Joaquin River due to improvements in flow and water temperature for weighted long-term average annual and dry year types. Alternative Plan 4, which includes an SLIS, would provide the highest long-term average annual improvement in equilibrium abundance. Improvements in abundance due to the action alternatives are related to a combination of water temperature improvements from additional flow or cold-water pool management through carryover storage and/or an SLIS, and additional flow in the San Joaquin River from Friant Dam to Mendota Pool (for water supply exchanges).

Table 4-7. Percent Improvement in Abundance of Spring-Run Chinook Salmon for Action Alternatives

Measured Timeframe	SAR	Alternative Plan 1	Alternative Plan 2	Alternative Plan 3	Alternative Plan 4	Alternative Plan 5
Long-Term Average Annual	High	2.8%	2.8%	0.6%	4.9%	-8.8%
Dry Year	High	15.9%	13.2%	14.7%	13.2%	18.3%
Long-Term Average Annual	Low	0.6%	0.4%	-0.6%	2.8%	-13.1%
Dry Year	Low	14.0%	9.2%	13.3%	11.1%	16.3%

Notes:
Further details are presented in the Modeling Appendix.
[1] Action alternatives are compared to the No Action Alternative, which varies depending on the smolt-to-adult return rate.
Key:
SAR = smolt-to-adult return rate

Flood Damage Reduction, Hydropower, Recreation, San Joaquin River Water Quality, Urban Water Quality

Physical accomplishments of the action alternatives regarding flood management, hydropower generation, recreation, and urban water quality are described below. San Joaquin River water quality improvements would be negligible and therefore are not discussed.

Increase in Incidental Flood Space

Incidental flood storage was evaluated as the total storage between Millerton Lake and Temperance Flat RM 274 Reservoir available 90 percent of the time on a monthly basis. Increased storage with Temperance Flat RM 274 Reservoir would allow greater ability to capture flood flows. Figure 4-12 shows the 90 percent exceedence flood storage availability for action alternatives compared to the No Action Alternative. Available storage in November through March also assumes that up to 85 TAF of flood storage would be available above Temperance Flat RM 274 Reservoir in Mammoth Pool. Action alternatives with lower carryover storage (1, 2, 3, and 5) would have more active storage available for flood damage reduction, but all action alternatives, including Alternative Plan 4, would have at least 200 TAF more flood storage availability in the rain flood season from October to March compared to the No Action Alternative.

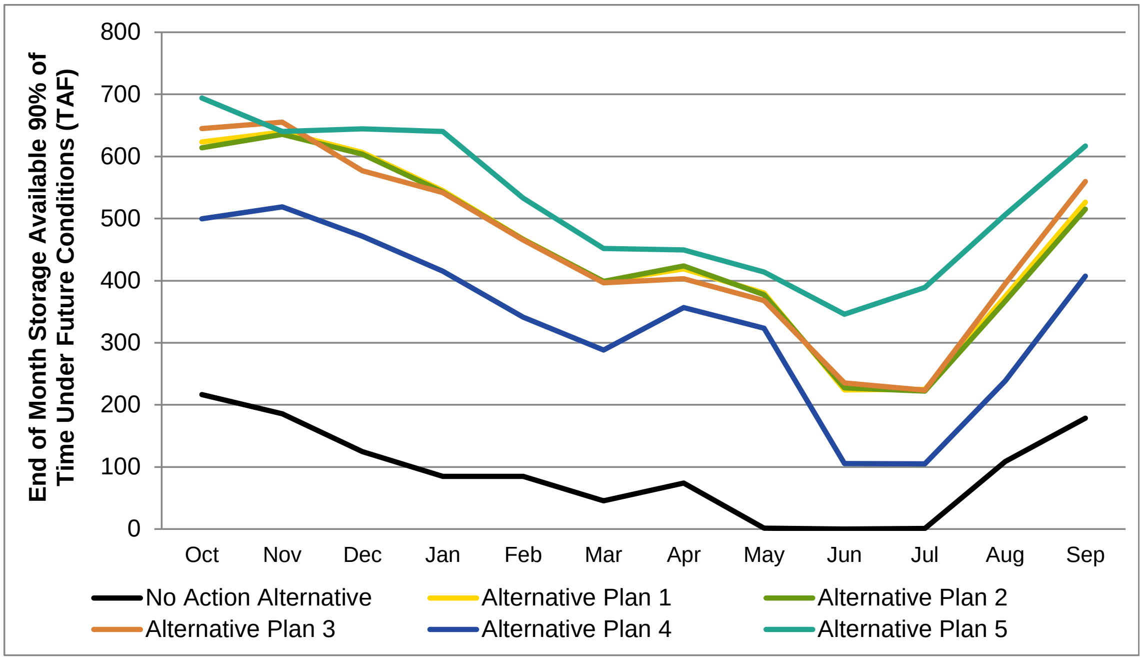


Figure 4-12. 90 Percent Exceedance Flood Storage Availability by Month for All Action Alternatives

Hydropower and Replacement of Impacted Hydropower Value

The ability of action alternatives to replace the value of the Kerckhoff Hydroelectric Project powerhouses would vary greatly, depending on how carryover storage was managed in Millerton Lake and Temperance Flat RM 274 Reservoir. Alternative Plans 1, 2, and 3 could replace all but 101 gigawatt-hours (GWh) per year (GWh/year) (83.8 percent) of impacted Kerckhoff Hydroelectric Project generation using onsite hydropower generation. Alternative Plan 4 could replace all but 54 GWh/year (91.2 percent) of impacted Kerckhoff Hydroelectric Project generation using onsite hydropower generation because of higher carryover storage in Alternative Plan 4 allowing for higher head for power generation. Alternative Plan 5 could replace all but 164 GWh/year (73.4 percent) of impacted Kerckhoff Hydroelectric Project generation using onsite hydropower generation. The Alternative Plan 5 carryover storage targets in both Millerton Lake and Temperance Flat RM 274 Reservoir would create a wider range of head and would inhibit hydropower generation more than other action alternatives. Alternative Plans 1 through 4 would operate Millerton Lake with a fixed water surface at elevation 550 feet msl (carryover storage target of 340 TAF). The fixed elevation would allow Friant Dam powerhouses to generate an additional 15.7 to 15.8 GWh/year, on average, compared to the No Action Alternative, as shown in Table 4-8. Alternative Plan 5 would operate Millerton Lake with a variable water surface elevation, resulting in smaller increases in generation at Friant Dam relative to other action alternatives.

Table 4-8. Friant Dam Hydropower Generation and Kerckhoff Hydroelectric Project Onsite Mitigation Opportunities

Hydropower Generation Parameter	Alternative Plan 1	Alternative Plan 2	Alternative Plan 3	Alternative Plan 4	Alternative Plan 5
Change in Hydropower Generation (GWh/year) (Kerckhoff Hydroelectric Project generation minus Temperance Flat RM 274 Powerhouse generation)[1]	-100.1	-100.1	-100.1	-54.3	-163.8
Percent Generation Replacement of Kerckhoff Hydroelectric Project[1]	83.8	83.8	83.8	91.2	73.4
Change in Hydropower Generation at Friant Dam from No Action Alternative (GWh/year)[1]	15.7	15.6	15.6	15.7	14.0

Note:
[1] Action alternatives are compared to No Action Alternative. Remaining requirements for Kerckhoff Hydroelectric Project are addressed in project costs.
Key:
GWh = Gigawatt-hour
RM = River Mile

Recreation Opportunities

Opportunities for recreational development would vary, depending on balancing of reservoir storage levels between Millerton Lake and Temperance Flat RM 274 Reservoir and water supply beneficiaries. Operating the reservoir balancing to generally keep Millerton Lake at a fixed elevation could improve early- and late-season boating opportunities in Millerton Lake, but at lower elevations, could allow vehicular access that would degrade shoreline use conditions. Operating Millerton Lake with a fixed elevation between elevations 540 to 560 feet msl would allow the best balance of shoreline and reservoir use. All action alternatives would be operated with a fixed Millerton Lake elevation of 550 feet msl. Boating and waterskiing activities would generate the highest economic value for Millerton Lake, followed by picnicking.

Temperance Flat RM 274 Reservoir could also support recreation, particularly boating activities. Recreational visitation at Temperance Flat RM 274 Reservoir is estimated as proportionate to Millerton Lake average historical visitation, considering the 50 percent exceedence reservoir surface areas. As a much larger reservoir, Temperance Flat RM 274 Reservoir could support 96,400 new visitor-days. Potential Temperance Flat RM 274 Reservoir recreational visitation may be understated because only peak recreation season boating activity participation was estimated, no land-based activity or camping participation was estimated, and no off-season participation was considered. Table 4-9 summarizes the increase in recreational visitor-days for action alternatives, considering recreation at Millerton Lake and Temperance Flat RM 274 Reservoir. Estimates in annual increase in recreational visitor-days range from 113,600 to 130,400.

Table 4-9. Estimated Increase in Recreational Visitor-Days Compared to No Action Alternative

Alternative Plans	1	2	3	4	5
Potential Annual Increase in Visitation at Millerton Lake[1] (1,000 visitor-days/year)	34	34	34	34	32
Potential Annual Visitation at Temperance Flat RM 274 Reservoir[1,2] (1,000 visitor-days/year)	74	75	72	86	37
Total Potential Annual Increase in Recreational Visitation (1,000 visitor-days/year)	**108**	**109**	**106**	**120**	**69**

Notes:
[1] Action alternatives are compared to No Action Alternative.
[2] Potential annual visitation at Temperance Flat RM 274 Reservoir is based solely on boating activities and peak recreational season Temperance Flat RM 274 Reservoir surface acres. Boating activities include waterskiing/wakeboarding, personal water craft, boat fishing, and general boating. This is considered a conservative estimate because with creation of Temperance Flat RM 274 Reservoir it is expected that new land-based recreational and camping facilities would be developed and support these recreational activities.
[2] Annual benefits are considered a conservative estimate because only peak recreational season boating activities economic value was estimated. Land-based recreational and camping activities are also expected at the new Temperance Flat RM 274 Reservoir and this has not been analyzed.
Key:
RM = River Mile

Summary of No Action Alternative and Action Alternatives Potential Accomplishments

Table 4-10 summarizes the physical accomplishments of action alternatives. Alternative Plan 5 would provide the greatest water supply improvement, both in dry and critical years, as well as over the long term. However, because of the proportion of supply to new beneficiaries, Alternative Plan 1 would provide the greatest long-term new water supply to SWP

SOD M&I, while Alternative Plan 5 would provide the greatest volume of new supply to agriculture. Alternative Plan 4 has the greatest potential to improve long-term average abundance of spring-run Chinook salmon, but Alternative Plan 1 has the greatest potential to improve abundance in dry and critical years.

The action alternatives would provide similar levels of increased hydropower energy generation at Friant Dam. Alternative Plan 4 could replace the most Kerckhoff Hydroelectric Project value (91 percent). Alternative Plan 4 has highest potential for increasing recreation, due to having higher carryover storage compared to other action alternatives. With lower carryover storage, Alternative Plan 5 would have a greater increase in flood space, up to 555 TAF.

Table 4-10. Physical Accomplishments for Temperance Flat RM 274 Reservoir[1]

Alternative Plan	1	2	3	4	5
Physical Characteristics					
Temperance Flat RM 274 Reservoir Net Additional Storage Capacity (TAF)[2]	1,260	1,260	1,260	1,260	1,260
Total Carryover Storage Capacity (Millerton and Temperance Flat RM 274) (TAF)	540	540	540	665	230
Temperance Flat Carryover Storage Capacity (TAF)	200	200	200	325	100
Millerton Lake Carryover Storage Capacity (TAF)	340	340	340	340	130
Powerhouse Tailrace Elevation and Millerton Lake Carryover Storage Elevation (feet)[3]	550	550	550	550	550
Potential Physical Accomplishments[4]					
Dry and Critical Year Increase in Total Delivery (TAF)	19	24	30	21	121
Long-Term Average Annual Increase in Agricultural Delivery (TAF)[5]	30	49	52	41	94
Long-Term Average Annual Increase in M&I Delivery (TAF)	40	22	24	20	-7
Long-Term Average Annual Increase in Total Delivery (TAF)	70	71	76	61	87
Long-Term Average Annual Spring-Run Chinook Abundance Increase–High SAR (percent)[6]	2.8%	2.8%	0.6%	4.9%	-8.8%
Dry and Critical Year Spring-Run Chinook Abundance Increase–High SAR (percent)[6]	15.9%	13.2%	14.6%	13.1%	18.3%
Long-Term Average Annual Spring-Run Chinook Abundance Increase–Low SAR (percent)[6]	0.6%	-0.7%	-0.1%	2.8%	-13.1%
Dry and Critical Year Spring-Run Chinook Abundance Increase–Low SAR (percent)[6]	14.0%	9.2%	13.3%	11.1%	16.3%
Net Increase in Friant Dam Hydropower Generation (GWh/year)	15.7	15.6	15.6	15.7	14.0
Replacement of Kerckhoff Hydroelectric Project Value (percent)[8]	83.8%	83.8%	83.8%	91.2%	73.4%
Increase in Recreation (thousands of visitor-days)[9]	108	109	106	120	69
Increase in Incidental Flood Space (TAF)[10]	354 – 481	353 – 479	351 – 470	243 – 347	406 – 555

Notes:
[1] Operations based on Reclamation March 2012 CalSim II Benchmark with 2008/2009 BOs.
[2] Total storage in Temperance Flat RM 274 Reservoir would be 1331 TAF, with 75 TAF overlapping with existing Millerton Lake.
[3] Elevation reported in NAVD 88.
[4] Accomplishments are reported as changes in comparison to No Action Alternative.
[5] Simulated water demands in the Friant Division of the CVP are based on existing Class 1 and Class 2 contracts.
[6] Action alternatives are compared to the No Action Alternative, which varies depending on the SAR.
[7] Emergency water supply represented by supply available for disruption due to 10-island levee breach.
[8] Impacts to Kerckhoff Hydroelectric Project will be mitigated. Costs include additional mitigation required after onsite replacement.
[9] Sum of potential annual visitor days at Millerton Lake and Temperance Flat RM 274 Reservoir.
[10] Incidental flood space is the flood space available during November through March at the 90 percent exceedance.

Key:
2008/2009 BOs = Formal ESA Consultation on the Proposed Coordinated Operations of the CVP and SWP (USFWS 2008a) and Biological Opinion and Conference Opinion on the Long-Term Operations of the CVP and SWP (NMFS 2009)
CVP = Central Valley Project
GWh/year = gigawatt hours per year
M&I = municipal and industrial
mg/L = milligrams per liter
NAVD = North American Vertical Datum
NE = not evaluated
SAR = smolt-to-adult return rate
RM = river mile
SWP = State Water Project
TAF = thousand acre feet
TDS = total dissolved solids

Preferred Alternative and Rationale for Selection

This Draft EIS does not identify a preferred alternative for implementation. Consistent with CEQ Regulations, 40 CFR Part 46.425, a preferred alternative (or alternatives, if there is more than one) will be identified in the Final EIS. The preferred alternative(s) will be identified in the Final EIS based on the information presented in this Draft EIS, in light of any potential revisions made in response to comments received on this Draft EIS. After the Final EIS is published, Reclamation may prepare and adopt a ROD. The ROD, which is the final step in the NEPA process, will document the Secretary of the Interior's determination of whether the requirements of NEPA have been met and which actions, if any, to recommend. It will also describe other alternative plans considered, identify any mitigation plans, and describe factors and comments taken into consideration when making its recommendation. Congress will make the final decision on authorizing a project for implementation, or not.

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