Upper San Joaquin River Basin
STORAGE INVESTIGATION

Initial Alternatives Information Report



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A Study By:

RECLAMATION
Managing Water in the West

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In Coordination With:

CALFED BAY-DELTA PROGRAM

UPPER SAN JOAQUIN RIVER BASIN STORAGE INVESTIGATION

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ABBREVIATIONS AND ACRONYMS

ºF	degrees Fahrenheit
ADMA	Aquatic Diversity Management Area
AFRP	Anadromous Fish Restoration Program
Basin	San Joaquin Valley groundwater basin
Basin Plan	Water Quality Control Plan for the Sacramento and San Joaquin river basins
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BDPAC	California Bay-Delta Public Advisory Committee
BLM	U.S. Department of the Interior, Bureau of Land Management
BMP	best management practice
BO	Biological Opinion
BRM	bedrock mortar
CALFED	CALFED Bay-Delta Program
CAR	Critical Aquatic Refuge
CBDA	California Bay-Delta Authority
CCSF	City and County of San Francisco
CCWD	Contra Costa Water District
CDEC	California Data Exchange Center
CDPR	California Department of Parks and Recreation
CEQA	California Environmental Quality Act
CFRF	concrete face rockfill
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO	carbon monoxide
COA	Coordinated Operations Agreement
Comprehensive Study	Comprehensive Study for the Sacramento and San Joaquin river basins
Corps	United States Army Corps of Engineers
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
Delta	Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DOI	United States Department of the Interior
DWR	California Department of Water Resources
D-xxxx	State Water Resources Control Board Decision-number
EAD	expected annual damages
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
elevation	elevation in feet above mean sea level

ERP	Ecosystem Restoration Program
ESA	Endangered Species Act
EWA	Environmental Water Account
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FR	Feasibility Report
FWA	Friant Water Authority
FWUA	Friant Water Users Authority
GWh	gigawatt-hour
IAIR	Initial Alternatives Information Report
IDSP	In-Delta Storage Project
Investigation	Upper San Joaquin River Basin Storage Investigation
ISI	Integrated Storage Investigation
JPOD	Joint Point of Diversion
KRCD	Kings River Conservation District
kV	kilovolt
kW	kilowatt
M&I	municipal and industrial
MAF	million acre-feet
MAWC	Millerton Area Watershed Coalition
mg/L	milligram per liter
MID	Merced Irrigation District
MW	megawatt
MWDSC	Metropolitan Water District of Southern California
MWh	megawatt-hour
NAWQA	National Water Quality Assessment
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOD	north-of-Delta
NODOS	North-of-the-Delta Offstream Storage
NOI	Notice of Intent
NOP	Notice of Preparation
NO_x	nitrous oxide
NRDC	Natural Resources Defense Council
NRHP	National Register of Historic Places
O_3	ozone
OCAP	Operations Criteria and Plan
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
PL	Public Law
PM_{10}	particulate matter 10 microns in aerometric diameter
RCC	roller-compacted concrete
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RM	river mile
RMP	Resource Management Plan
RNA	Research Natural Area
ROD	Record of Decision
ROG	reactive organic gas
RWQCB	Regional Water Quality Control Board
SCE	Southern California Edison Company
Secretary	Secretary of the United States Department of the Interior
SJRA	San Joaquin River Agreement
SJRECWA	San Joaquin River Exchange Contractors Water Authority
SJRGA	San Joaquin River Group Authority
SJRMP	San Joaquin River Management Program
SJVAB	San Joaquin Valley Air Basin
SJVUAPCD	San Joaquin Valley Unified Air Pollution Control District
SNF	Sierra National Forest
SO_2	sulfur dioxide
SOD	south-of-Delta
SO_x	sulfur oxide
SRA	State Recreation Area
State	State of California
SWP	State Water Project
SWRCB	State Water Resources Control Board
TA	technical appendix
TAF	thousand acre-feet
TDS	total dissolved solids
TM	technical memorandum
TMDL	total maximum daily load
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USJRWPA	Upper San Joaquin River Water and Power Authority
VAMP	Vernalis Adaptive Management Plan
WQCP	Water Quality Control Plan

EXECUTIVE SUMMARY

The Upper San Joaquin River Basin Storage Investigation (Investigation) is a feasibility study being performed by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR). The Investigation is evaluating alternatives to develop water supplies from the San Joaquin River that could contribute to restoration of, and improve water quality in, the San Joaquin River and enhance conjunctive management and exchanges to provide high-quality water to urban areas. The Investigation is one of five surface water storage studies recommended in the CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Report (PEIS/R) Record of Decision (ROD) of August 2000.

The Investigation is being prepared in two phases. Phase 1, which included preliminary screening of initial storage sites, was completed in October 2003. Initially, 17 surface water storage sites were considered, of which 6 were retained for further analysis. Phase 2 began in January 2004 with formal initiation of the environmental review processes consistent with Federal and State of California (State) regulations, and will continue through completion of all study requirements. The Investigation will culminate in a Feasibility Report (FR) and supporting environmental documents consistent with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (WRC, 1983), Reclamation directives, DWR guidance, and applicable environmental laws. Reclamation and DWR are coordinating the Investigation with the California Bay-Delta Public Advisory Committee (BDPAC), which provides advice to the Secretary of the United States Department of the Interior regarding implementation of the CALFED Program, and the California Bay-Delta Authority (CBDA), which provides general oversight and coordination of all CALFED activities.

To facilitate coordination with other agencies and related ongoing studies, preparation of the FR will include two interim planning documents: an Initial Alternatives Information Report (IAIR) and a subsequent Plan Formulation Report (PFR). The IAIR describes without-project conditions and water resources problems and needs; defines study objectives and constraints; screens surface water storage measures; describes groundwater storage measures development; and identifies preliminary water operations rules and scenarios. Retained storage measures and preliminary water operations scenarios will be included in initial alternatives.

This IAIR will be used as an initial component of the FR. Conclusions and recommendations regarding further technical evaluations are expected to evolve as the Investigation progresses.

Topics Addressed in the Initial Alternatives Information Report

- Without-project conditions
- Water resources problems and needs
- Study objectives and constraints
- Surface water storage measures screening
- Groundwater storage measures development
- Preliminary water operations rules and scenarios

BASIS OF INVESTIGATION

The San Joaquin River basin experiences several water resources problems that could be alleviated through development and management of additional water supply. These include ecosystem conditions in the San Joaquin River, water quality of the San Joaquin River, and groundwater overdraft in the eastern San Joaquin Valley. In addition, opportunities exist to address related water resources problems and needs, including additional flood protection, hydropower generation, and recreation, through the development of additional water supply.

The purpose of the Investigation is to formulate and evaluate alternatives that develop additional San Joaquin River water supply primarily involving the enlargement of Friant Dam and Millerton Lake, or a functionally equivalent storage program in the region. As described in the CALFED ROD, the developed water supply would be managed to contribute to the restoration of, and improve water quality in, the San Joaquin River, and enhance conjunctive management and exchanges to provide high-quality water to urban areas. To the extent possible through meeting these objectives, alternatives will include features to address other related water resources opportunities.

STUDY AREA EMPHASIS

The study area emphasis for the Investigation encompasses the San Joaquin River watershed upstream of Friant Dam, the San Joaquin River from Friant Dam to the Sacramento-San Joaquin Delta (Delta), and the portions of the San Joaquin and Tulare Lake hydrologic regions served by the Friant-Kern and Madera canals, as highlighted in **Figure ES-1**. The study area includes all potential storage sites under consideration, the region served by the Friant Division of the Central Valley Project (CVP), the eastern San Joaquin Valley groundwater basins, and the portion of the San Joaquin River most directly affected by the operation of Friant Dam.

STUDY AUTHORIZATION

Federal authorization for the Investigation was initially provided in Public Law (PL) 108-7, the omnibus appropriations legislation for fiscal year 2003. Subsequent authorization was provided in PL 108-361, the Water Supply, Reliability, and Environmental Improvement Act, of 2004. Reclamation is the responsible Federal agency for preparing the FR and the Environmental Impact Statement (EIS). Section 227 of the State of California Water Code authorizes DWR to participate in water resources investigations. DWR is the State lead agency for the Investigation and preparation of the Environmental Impact Report (EIR).

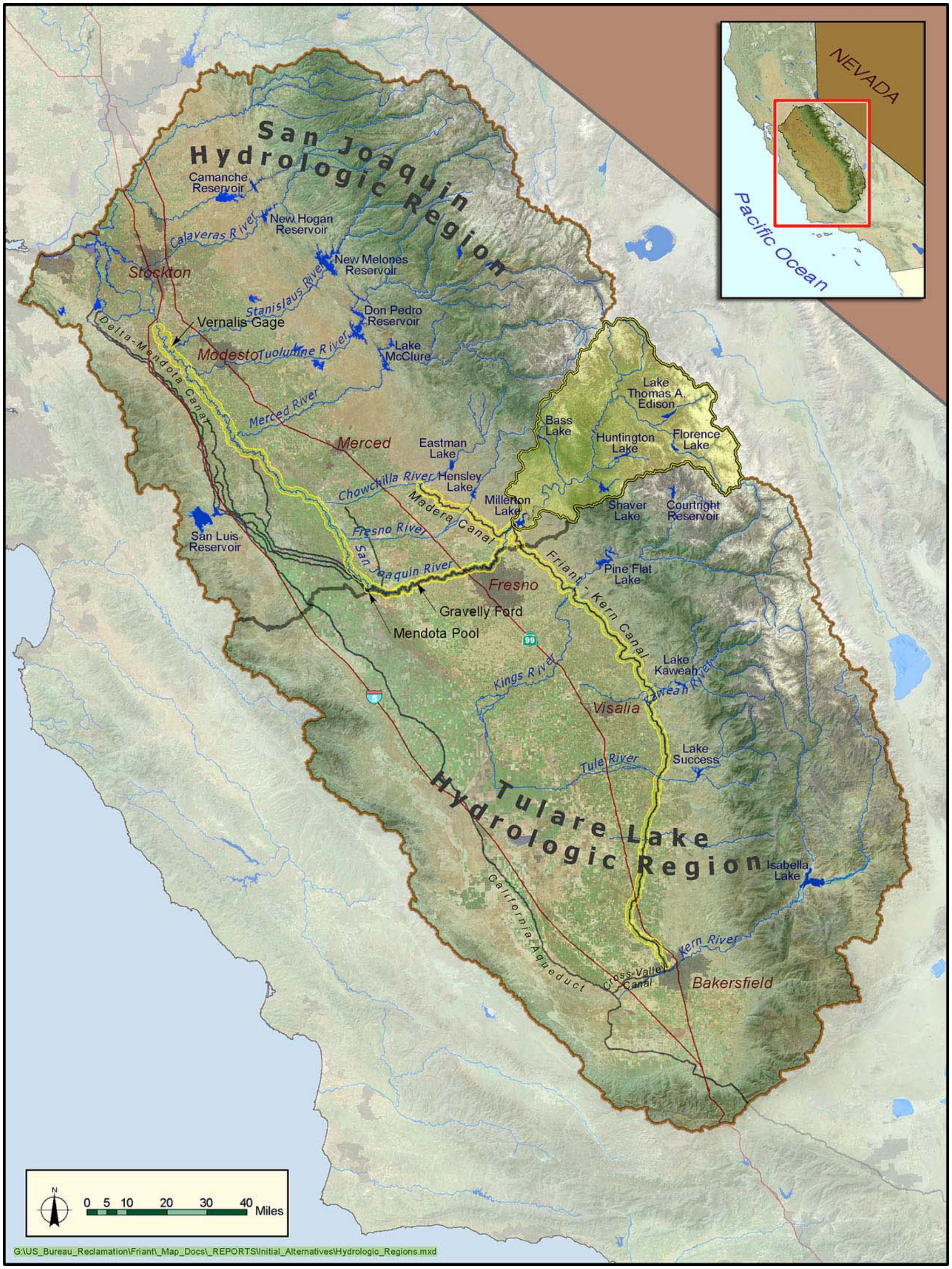

FIGURE ES-1.
UPPER SAN JOAQUIN RIVER BASIN STORAGE INVESTIGATION
STUDY AREA EMPHASIS

PROBLEMS, NEEDS, AND OPPORTUNITIES

Potential uses for additional water supply developed from the upper San Joaquin River basin were identified in the CALFED ROD. These include contributing to restoration of the San Joaquin River; improving water quality in the San Joaquin River; and facilitating conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities. The development and management of new water supply presents an opportunity to address other related water resources problems and needs in the region.

Problems and Needs

- San Joaquin River ecosystem
- San Joaquin River water quality
- Water supply reliability

Opportunities

- Flood control
- Long-term EWA water supply
- Hydropower generation
- Recreation

San Joaquin River Ecosystem – The reach of the San Joaquin River from Friant Dam to the Merced River confluence does not currently support a continuous natural riparian and aquatic ecosystem. Since completion of Friant Dam, most of the water in the river has been diverted for agricultural and urban uses, with the exception of releases to satisfy riparian water rights upstream of Gravelly Ford and flood releases. Consequently, some reaches of the San Joaquin River between Friant Dam and the Merced River are often dry.

San Joaquin River Water Quality – Water quality in portions of the San Joaquin River has been a problem for several decades due to low flow, and discharges from agricultural areas, wildlife refuges, and municipal and industrial treatment plants. From Mendota Pool to Vernalis, the river is listed as an impaired waterbody under the Federal Clean Water Act Section 303(d).

Water Supply Reliability – The Friant Division provides surface water supplies to areas that rely on groundwater and is operated to support conjunctive water management to reduce groundwater use in the eastern San Joaquin Valley. Although surface water deliveries from Friant Dam help reduce groundwater pumping and contribute to groundwater recharge, groundwater basins in the eastern San Joaquin Valley remain in a state of overdraft in most years. Surface water supply reliability problems are associated with large variations in water availability from year to year and the limited capacity of water storage and conveyance facilities.

Flood Protection – Major storms during the past two decades have demonstrated that Friant Dam, among many other dams in the Central Valley, may not provide the level of flood protection that was intended at the time the flood management system was designed. Increased water storage capacity in the upper San Joaquin River basin could provide an opportunity to reduce the frequency and magnitude of damaging flood releases from Friant Dam.

Water Supply for Long-Term EWA – The San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) is the largest estuary on the West Coast and provides essential habitat for a diverse array of fish and wildlife. Several water management programs have been established to assist in meeting numerous regulatory actions in the Delta region. The Environmental Water Account (EWA) was developed to provide water managers additional flexibility in meeting or exceeding Delta regulatory requirements without uncompensated losses to CVP and SWP water users. The management of additional water supply from the San Joaquin River presents an opportunity to provide less costly water for the EWA or a similar long-term program.

Hydropower – Hydropower long has been an important element of power supply in California, providing between 10 to 27 percent of California's annual energy supply. Due to its ability to rapidly increase and decrease power generation rates, hydropower often supports peak power loads in addition to base power loads. The Investigation is considering opportunities for additional hydropower generation capacity in association with the development and management of San Joaquin River water supplies.

Recreation – Demands for water-oriented 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 Mountains. As population increases in the San Joaquin Valley, demands for water-based and land-based recreation are expected to increase.

STUDY OBJECTIVES

Primary and secondary planning objectives were developed based on CALFED Program and Investigation-specific goals as described in the ROD. CALFED Program goals include increasing water supply reliability, improving water quality for all beneficial uses, improving ecosystem conditions for Delta-dependent species, and improving Delta levee stability. Investigation-specific considerations include identified problems and needs in the study area in relation to study authorities, study planning principles, and Federal planning requirements.

As described in the IAIR, and recognized in the CALFED ROD and supporting documents, increasing the reliability of managed water supplies from the San Joaquin River is integral in addressing ecosystem restoration, water quality, and water management problems in the study area. Therefore, alternatives will be formulated with a focus on developing and managing new water supplies from the San Joaquin River that address the following primary objectives:

- Contribute to San Joaquin River restoration
- Improve San Joaquin River water quality
- Facilitate additional conjunctive water management in the eastern San Joaquin Valley to reduce groundwater overdraft and support exchanges that improve the quality of water delivered to urban areas

To date, quantifiable restoration, water quality, and water management targets have not been established. Therefore, the Investigation will identify the extent to which alternatives can contribute to the primary objectives.

To the extent possible through pursuit of the primary planning objectives, alternatives will include features that address the following secondary objectives:

- Increase control of flood flows at Friant Dam
- Contribute to long-term EWA water supply
- Develop hydropower generation capacity in the upper San Joaquin River basin
- Develop additional recreational opportunities in the study area

DEVELOPMENT OF INITIAL ALTERNATIVES

Initial alternatives will combine one or more storage measures with operations scenarios for the management and use of new water supplies. Because targets for river restoration, river water quality, and exchange and conjunctive management actions have not been established, minimum accomplishments that each alternative must satisfy also have not yet been defined.

Surface Water Storage Measures Considered in the IAIR

Figure ES-2 shows the locations of surface water storage sites evaluated in the IAIR. These comprise six potential sites for developing a new surface reservoir or enlarging an existing reservoir retained from Phase 1 and five sites suggested during scoping. Each site could be configured at various storage sizes, with each configuration identified as a measure. The six surface storage sites retained from Phase 1 include the following:

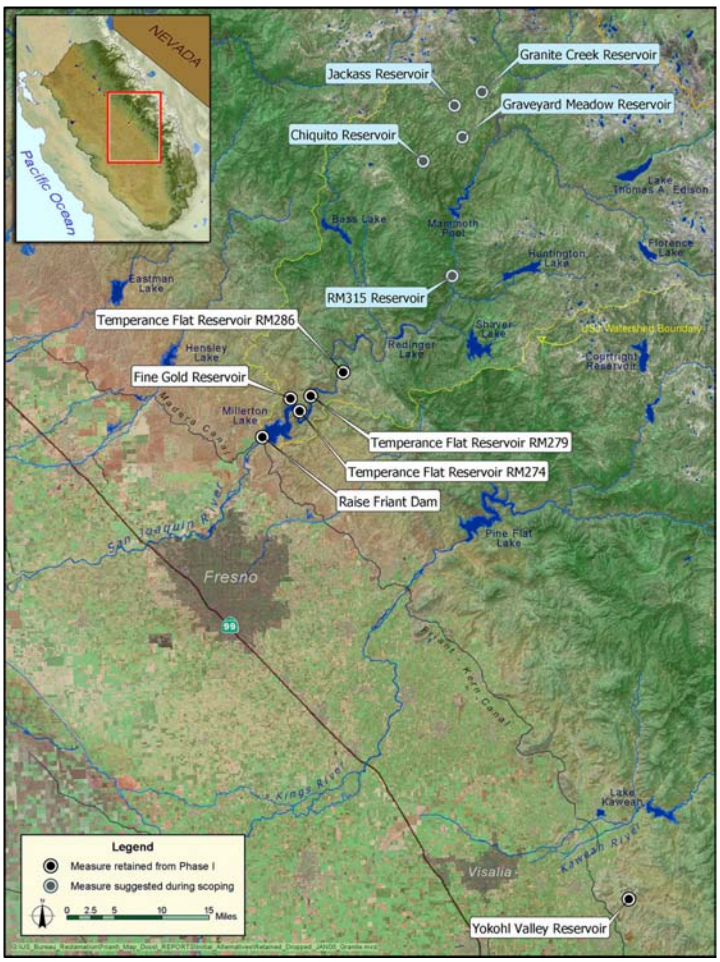

FIGURE ES-2.
SURFACE WATER STORAGE SITES RETAINED IN PHASE 1 AND SUGGESTED DURING SCOPING

- **Raise Friant Dam.** Raising Friant Dam up to 140 feet would increase Millerton Lake capacity by about 920 thousand acre-feet (TAF).
- **Temperance Flat Reservoir**. Constructing Temperance Flat dam and reservoir at one of three potential dam sites on the San Joaquin River between Friant and Kerckhoff dams, at River Mile (RM) 274, RM 279, or RM 286, could create a reservoir with storage capacity ranging from 450 TAF to over 2 million acre-feet.
- **Fine Gold Reservoir**. Constructing a dam on Fine Gold Creek could create a reservoir with storage capacity of up to 800 TAF that could store water diverted from the San Joaquin River or pumped from Millerton Lake.
- **Yokohl Valley Reservoir**. Constructing a dam in Yokohl Valley could create a reservoir with a capacity of up to 800 TAF to store water conveyed from Millerton Lake by the Friant-Kern Canal and pumped into the reservoir.

Most of the surface water storage measures retained from Phase 1 would result in a net loss in power generation. In March 2004, Reclamation and DWR held a series of scoping meetings to initiate development of the EIS and EIR. During scoping, power utilities that own and operate hydropower projects in the upper San Joaquin River basin raised concerns about impacts of lost power generation and the ability of retained measures to develop adequate replacement power. These hydropower stakeholders suggested additional potential reservoir sites that could store water supplies from the upper San Joaquin River without adversely affecting existing hydropower facility operations.

Suggested surface water storage measures include **RM 315 Reservoir** on the San Joaquin River between Redinger Lake and Mammoth Pool, and **Granite Project** (Granite Creek and Graveyard Meadow reservoirs) and **Jackass-Chiquito Project** (Jackass and Chiquito reservoirs) on tributaries to the San Joaquin River upstream of Mammoth Pool. The scoping comments also suggested combining these upstream storage measures with a diversion tunnel from Kerckhoff Lake to a Fine Gold Reservoir.

Surface Water Storage Measures Screening

A two-step approach was used to screen surface water storage measures for inclusion in initial alternatives. The first step focused on characteristics of individual reservoir sites. Construction cost, new water supply, environmental impacts, effects to existing hydropower generation, and potential to develop replacement power generation capacity were considered for various configurations of dam type, dam height, and reservoir size at each site. This resulted in the selection of specific storage sizes and replacement power options for raising Friant Dam, Fine Gold Creek Reservoir, and the three Temperance Flat reservoir sites. Based on these evaluations, Yokohl Valley Reservoir and all upstream storage measures suggested during scoping (RM 315 Reservoir, Granite Project, and Jackass-Chiquito Project, and Fine Gold Reservoir with diversion from Kerckhoff Lake) were dropped from further consideration. The upstream storage measures suggested during scoping were dropped because they would provide much less new water supply than the larger storage measures retained in Phase 1 at a similar cost. Further consideration of these measures would require participation by a non-Federal sponsor with an interest in power development. Results of the first screening step are summarized in **Table ES-1**.

The second step in screening measures for inclusion in initial alternatives involved comparing measures that provide similar amounts of new water supply based on construction cost, environmental impacts, hydropower facility impacts, and potential to develop replacement power generation capacity. These comparisons resulted in the selection of six surface water storage measures for inclusion in initial alternatives, as identified in **Table ES-2**.

Table ES-3 presents summary information about surface water storage measures retained for inclusion in initial alternatives. Retained surface storage measures range in size from 130 TAF (raise Friant Dam 25 feet) to about 1,310 TAF (Temperance Flat RM 274). These storage measures could provide average annual new water supply ranging from about 24 to 165 TAF/year and would have construction costs ranging from about $220 million to $1 billion. Construction costs are preliminary and do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation. As shown in **Table ES-3,** four retained surface water storage measures would affect the operation of existing hydropower facilities upstream of Millerton Lake.

TABLE ES-1. SUMMARY OF SURFACE WATER STORAGE MEASURES SCREENING – STEP 1

Surface Water Storage Measure	New Storage Capacity (TAF)	New Water Supply (TAF/year)	Status Following Site Evaluations[1]	Key Findings from Site Evaluations
Raise Friant Dam				
25-foot Raise	130	24	Retained	A raise greater than 60 feet would result in extensive residential relocation, significant power generation losses, and environmental impacts around Millerton Lake, along the San Joaquin River, and in the Fine Gold Creek watershed.
60-foot Raise	340	68	Retained	
140-foot Raise	920	146	Dropped	
Temperance Flat RM 274				
Elevation 800	460	88	Retained	Measures larger than 1,310 TAF storage capacity were dropped because the small incremental new water supply would be associated with significant additional impacts to power generation and environmental resources, and higher construction costs.
Elevation 865	725	122	Retained	
Elevation 985	1,310	165	Retained	
Elevation 1,100	2,110	197	Dropped	
Temperance Flat RM 279				
Elevation 900	450	86	Retained	Measures larger than 1,350 TAF storage capacity were dropped because the small incremental new water supply would be associated with significant additional impacts to environmental resources and higher construction costs.
Elevation 985	725	122	Retained	
Elevation 1,115	1,350	168	Retained	
Elevation 1,200	1,910	188	Dropped	
Elevation 1,300	2,740	215	Dropped	
Temperance Flat RM 286				
Elevation 1,200	460	88	Retained	No measures ranging from 460 to 1,360 TAF were dropped because large changes in incremental cost or impacts to hydropower and environmental resources were not evident in the evaluation.
Elevation 1,275	725	122	Retained	
Elevation 1,400	1,360	169	Retained	
Fine Gold Reservoir Measures				
Elevation 900	120	17	Dropped	The 120 TAF measure was dropped because it has a significantly higher unit cost than larger sizes of Fine Gold Reservoir.
Elevation 1,020	400	65	Retained	
Elevation 1,110	800	113	Retained	
Yokohl Valley Reservoir				
Elevation 790	450	60	Dropped	Yokohl Valley Reservoir is the least cost-effective surface storage measure retained from Phase 1 due to operational constraints and conveyance limitations along the Friant-Kern Canal.
Elevation 860	800	97	Dropped	
Storage Measures Suggested During Scoping				
Granite Project	114	23	Dropped	No storage measures suggested during scoping were found cost-effective as water supply measures. Further consideration would require participation by a non-Federal sponsor with an interest in power development.
Jackass-Chiquito Project	180	37	Dropped	
RM 315 Reservoir	200	40	Dropped	
Fine Gold Reservoir Elevation 960[2]	230	80	Dropped	

Key:
elevation – elevation in feet above mean sea level
RM – river mile
TAF – thousand acre-feet
Notes:
[1] Status following evaluation of surface water storage measures at a specific reservoir site.
[2] Fine Gold Reservoir at elevation 960 (230 TAF capacity) was evaluated in combination with RM 315 Reservoir at 200 TAF capacity and a gravity diversion tunnel from Kerckhoff Lake.

TABLE ES-2.
SUMMARY OF SURFACE WATER STORAGE MEASURES SCREENING – STEP 2

Surface Water Storage Measure	New Storage Capacity (TAF)	New Water Supply (TAF/year)	Status Following Measures Comparison[1]	Key Findings from Comparison of Measures that Provide Similar New Water Supply
New Water Supply Range of 0 to 50 TAF/year				
Raise Friant Dam 25 Feet Elevation 603	130	24	Retained	Appears to be cost-effective and would result in no loss of power generation.
New Water Supply Range of 50 to 100 TAF/year				
Raise Friant Dam 60 Feet Elevation 638	340	68	Dropped	Residential relocation and power impacts.
Temperance Flat RM 274 Elevation 800	460	88	Dropped	Highest cost of measures producing similar new water supply and similar environmental impacts.
Temperance Flat RM 279 Elevation 900	450	86	Retained	Greatest potential for replacement power.
Temperance Flat RM 286 Elevation 1,200	460	88	Dropped	Largest power and environmental impacts for measures providing similar new water supply.
Fine Gold Reservoir Elevation 1,020	400	65	Retained	No impacts to existing power facilities, pumping requirements similar to power losses for other retained measures, few residential relocations.
New Water Supply Range of 100 to 150 TAF/year				
Temperance Flat RM 274 Elevation 865	725	122	Dropped	Dropped because larger sizes would result in similar impacts to environmental resources and power generation and appear more cost-effective.
Temperance Flat RM 279 Elevation 985	725	122	Retained	Greatest potential to develop replacement power.
Temperance Flat RM 286 Elevation 1,275	725	122	Dropped	Largest power and environmental impacts for measures providing similar new water supply.
Fine Gold Reservoir Elevation 1,110	800	113	Retained	No impacts to existing power facilities, pumping requirements similar to power losses for other retained measures, few residential relocations.
New Water Supply Range Greater than 150 TAF/year				
Temperance Flat RM 274 Elevation 985	1,310	165	Retained	Less extensive impacts to environmental resources and lower cost than other measures providing similar new water supply.
Temperance Flat RM 279 Elevation 1,115	1,350	168	Dropped	Greatest impacts to environmental resources and more costly than other measures providing similar new water supply.
Temperance Flat RM 286 Elevation 1,400	1,360	169	Dropped	Greatest net power loss for measures providing similar new water supply.

Key:
Elevation – elevation in feet above mean sea level
RM – river mile
TAF – thousand acre-feet
Notes:
[1] Status following comparison of measures at different sites that provide similar water supply. Retained measures are included in initial alternatives.

TABLE ES-3. SURFACE WATER STORAGE MEASURES IN INTIAL ALTERNATIVES

		Raise Friant Dam 25 feet	Fine Gold Reservoir		Temperance Flat RM 274	Temperance Flat RM 279[1]			
Capacity and Water Supply	New Storage Capacity (TAF)	130	400	800	1,310	450		725	
	Gross Pool Elevation (feet above mean sea level)	603	1,020	1,110	985	900		985	
	Average New Water Supply (TAF/year)[2]	24	65	113	165	86		122	
Environmental	Number of Potentially Impacted Regulated Species	24	10	10	24	24		24	
	Inundation of Aquatic Diversity Management Area	Yes	Yes	Yes	No	No		No	
	Total Inundated Acres[3]	870	3,400	5,400	5,000	2,300		3,500	
Power	Affected Hydropower Facilities								
	Kerckhoff (38 MW)	No	No	No	Yes	Yes		Yes	
	Kerckhoff No. 2 (155 MW)	Yes[4]	No	No	Yes	Yes		Yes	
	Wishon (20 MW)	No	No	No	No	No		No	
	Big Creek No. 4 (100 MW)	No	No	No	No	No		No	
	Potential Replacement Facilities	Additional 5 MW capacity at Friant	N/A[8]	N/A[8]	100 MW PH at RM 274 Dam	Up to 120 MW PH at RM 279 Dam[5]	Up to 120 MW PH on ext. K2 tunnel, 15 MW PH at RM 279 Dam[5]	120 MW PH at RM 279 Dam	120 MW PH on ext. K2 tunnel, 15 MW PH at RM 279 Dam
	Lost Generation (GWh/year)[6]	-32	N/E[8]	-154[8]	-507	-507	-507	-507	-507
	New Generation (GWh/year)[7]	32	N/E[8]	114[8]	291	N/E	N/E	386	484
	Net Generation (GWh/year)	0	N/E[8]	-40[8]	-216	N/E	N/E	-121	-23
	Construction Cost ($ Million)[3,9]	220	470	640	1,000	670	800	870	1,000

Key:
GWh – gigawatt hour
K2 - Kerckhoff No. 2 PH
MW – megawatt
N/A – not applicable
N/E – not evaluated
PH – powerhouse
RM – river mile
TAF – thousand acre-feet

Notes:

[1] The two sets of replacement power facilities, power generation values, and cost values for the RM 279 measures represent different replacement power options. See Chapter 6 for more details.

[2] New water supply is defined as the average annual supply that could be developed in excess of historic water deliveries from Friant Dam.

[3] Cost and acreage values have been rounded to two significant figures.

[4] Kerckhoff No. 2 powerhouse would remain operational with a 25-foot raise of Friant Dam. A concrete wall to protect K2 access would be constructed.

[5] Replacement hydropower evaluations were not performed for RM 279 with a capacity of 450 TAF. Unit sizes estimated from 725 TAF reservoir size.

[6] Lost generation represents the estimated average future without-project generation at the affected power generation facilities. For Fine Gold Reservoir, it represents energy to pump water from Millerton Lake.

[7] New generation represents the average generation at the potential replacement power facilities.

[8] Fine Gold Reservoir would not impact any existing power facilities. More energy would be required for pump-back than would be generated by releases through a new powerhouse at the base of Fine Gold Dam.

[9] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design, and construction management, estimated at 25 percent of field costs. Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

Water Operations for Initial Alternatives

Implementing any of the storage measures and operating the new water supply for release to the San Joaquin River or diversion to the Friant-Kern and Madera canals could cause significant changes in water management in the San Joaquin Valley. Changes could occur in Friant Division canal water deliveries, San Joaquin River flow and water quality, project operations on tributaries to the San Joaquin River, New Melones Reservoir operations, south-of-Delta CVP and SWP deliveries, and Delta and upstream system operations. Water operations evaluations began during Phase 1 and continued through preparation of the IAIR. Two distinct evaluations were completed. These evaluations included single-purpose analyses to estimate available new water supplies, as presented in the Phase 1 Investigation Report, and development of preliminary water operations scenarios presented in the IAIR.

Preliminary operations scenarios developed during preparation of the IAIR focused on the use of water supply allocation and reservoir storage rules to manage new water supplies for a variety of uses. Six scenarios were evaluated for a hypothetical increase in storage of 1,400 TAF. This capacity was selected to generally correspond with the largest surface water storage measure retained for inclusion in initial alternatives. The evaluations were designed to identify how modifying water supply allocation and reservoir carryover storage rules would affect the development and management of new water supplies. All initial scenarios assume existing contracts, existing flood control operations, existing minimum downstream riparian and contractual requirements (116.7 TAF), and no reallocation of existing supplies. New water supply is defined as the average annual supply that could be developed in excess of historic water deliveries from Friant Dam. Initial water operations scenarios were grouped into two themes, as summarized in **Table ES-4**. Four scenarios were developed that would provide water supply for river uses (restoration or water quality) and two scenarios were developed that would provide water supply for canal uses. Preliminary results presented in **Table ES-5** were developed and evaluated using a screening tool based on the CALSIM model. As the investigation proceeds, the CALSIM model will be modified to include multiple-purpose operations rules and scenarios to support evaluation of the initial alternatives. Initial operations scenarios and preliminary results are informational only and are not intended to represent the final set of operations rules or project accomplishments.

TABLE ES-4.
INITIAL WATER OPERATIONS SCENARIOS

San Joaquin River Supply Scenarios	
Scenario 1	Allocate new supply for San Joaquin River restoration, with Mendota Pool diversions
Scenario 2	Allocate new supply for San Joaquin River restoration, with Mendota Pool bypass flow
Scenario 3	Allocate new supply for San Joaquin River restoration, constant annual allocation
Scenario 4	Allocate new supply to improve San Joaquin River water quality
Canal Supply Scenarios	
Scenario 5	Allocate new supply for canal delivery
Scenario 6	Allocate new supply for canal delivery, emphasizing multiyear reliability

TABLE ES-5.
PRELIMINARY RESULTS FROM INITIAL WATER OPERATIONS SCENARIOS

	Operations Scenario[1] Difference from Without-Project Results (TAF)[2]					
	1	2	3	4	5	6
Operations Scenario Criteria						
Operating Objective	San Joaquin River Restoration			SJR Water Quality	Canal Delivery	
	Diversions at Mendota Pool	Flow Past Mendota Pool	Diversions at Mendota Pool	Diversions at Mendota Pool	Increase Annual Delivery	Increase Multiyear Reliability
Annual Water Supply Allocation	Variable		Constant	Variable		
Reservoir Carryover Storage Rule	Existing[3]		Proportional to Supply[4]		Existing[3]	Prop. to Supply[4]
Change in Friant Operations						
Total Canal Diversion	-1	-1	-1	0	+165	+128
Friant Class 1 Delivery[5]	-3	-3	-16	-12	+11	+34
Friant Class 2 Delivery[6]	+116	+116	+127	+119	+261	+187
Section 215 Delivery[7]	-114	-114	-112	-107	-107	-92
Friant Dedicated Release to SJR	+194	+194	+175	+161	0	0
Friant Spills to SJR	-198	-198	-183	-172	-174	-148
Total Friant Release to SJR	-4	-4	-8	-11	-174	-148
Change in San Joaquin River Flow and Operations						
SJR Flow to Mendota Pool	-44	-44	-51	-19	-162	-137
DMC Flow to Mendota Pool	-72	+45	-61	-97	+43	+39
SJR Flow Upstream from Merced River	-116	+1	-112	-117	-119	-98
Groundwater Recharge from Gravelly Ford to Merced River	Increase				Minor decrease from reduction in flood flow	
SJR Flood Flow at Vernalis	Decrease in all scenarios					
SJR Flow at Vernalis (non-flood periods)	No change	Potential increase	No change			
Effect on April/May SJR Flow w/o VAMP	Potential decrease	Potential decrease or increase	Potential decrease			

Key:
DMC – Delta-Mendota Canal
MP – Mendota Pool
SJR – San Joaquin River
TAF – thousand acre-feet
TDS – total dissolved solids
VAMP – Vernalis Adaptive Management Plan
w/o – without

Notes:
1 All operations scenarios assume existing contracts, existing flood control operations, existing Friant minimum downstream riparian and contractual requirements (116.7 TAF), no reallocation of existing supplies, and 1,400 TAF additional storage.
2 Results and scenarios are preliminary and will change in the future.
3 The existing end-of-September carryover target is 130 TAF.
4 End-of-September carryover target increases above existing target in proportion to supply when supply exceeds 800 TAF.
5 Class 1 contracts are based on a firm water supply and represent the first 800 TAF of annual water supply delivered. These contracts are generally assigned to M&I and agricultural water users who have limited access to good-quality groundwater.
6 Class 2 water is a supplemental supply and is delivered directly for agricultural use or for groundwater recharge, generally in areas that experience groundwater overdraft. Class 2 contractors typically have access to good-quality groundwater supplies and can use groundwater during periods of surface water deficiency.
7 Section 215 water is defined under Section 215 of the Reclamation Reform Act of 1982 as unstorable irrigation water to be released because of flood control criteria or unmanaged flood flows.

Scenarios 1, 2, and 3 were developed to identify how new storage could be operated to contribute water to support restoration of the San Joaquin River. However, because restoration plans have not been identified, the scenarios did not include specific restoration flow targets. As indicated in **Table ES-5**, these scenarios included either diversions at Mendota Pool or flow past Mendota Pool, which allowed a preliminary assessment of potential effects on other water project operations in the San Joaquin Valley. No site-specific assumptions were made regarding the manner in which water would flow past Mendota Pool.

The annual allocation of new water supply for restoration releases in Scenarios 1 and 2 was based on total annual water supply available with no provision for carryover storage other than the current minimum operating level of 130 TAF in Millerton Lake. In Scenario 3, a constant annual amount of new water supply would be released to the San Joaquin River each year. In the case of the 1,400 TAF reservoir assumed in the operations scenarios, the long-term average new water supply would be about 175 TAF/year. To facilitate an annual supplemental water demand, a variable carryover storage target was used to assure that 175 TAF would be available for river release each year. In this scenario, supplemental releases made from Friant Dam to the San Joaquin River that reach Mendota Pool would be available for diversion at Mendota Pool. The use of carryover storage in Scenario 3 has the effect of reducing the average annual new water supply resulting from new storage, as compared to a scenario where all water supplies are allocated each year. The carried-over water would be available in dry years, thereby increasing dry year water supplies.

Scenario 4 was developed to assess how water supplies from new storage could be released from Friant Dam specifically to improve San Joaquin River water quality. Carryover and allocation rules were used to emphasize the availability of new water supply in dry and below-normal years, when water quality problems are prevalent.

Scenarios 5 and 6 were developed to identify how additional storage could affect water deliveries in the Friant Division. Scenario 5 assumes new water supply would be delivered based on contract demands to the maximum extent possible in any year, similar to the existing project operation. Scenario 6 introduced a carryover rule to reserve a portion of the available water supply for subsequent years. The application of this rule would reduce average annual deliveries by about 25 percent and increase dry year deliveries as compared to Scenario 5.

The six water operations scenarios will provide the basis for initial alternatives analysis as the Investigation proceeds. The scenarios will be applied to the retained storage measures, and modified as needed to evaluate the contribution of new storage to meeting specific restoration, water quality, or water supply reliability objectives, as plans developed through other studies become available.

Groundwater Storage and Conjunctive Management Measures

Many stakeholders have suggested that additional water supplies could be developed at Friant Dam through the implementation of groundwater storage and conjunctive management measures. In response, an approach to identifying potential groundwater storage and conjunctive management measures for the Investigation was developed in coordination with DWR's Conjunctive Water Management Program and with stakeholder input.

Potential Groundwater and Conjunctive Management Projects to be Considered for Inclusion as Measures in the Investigation

- Eastern San Joaquin County Groundwater Bank
- Gravelly Ford
- Madera Ranch
- Merced Irrigation District Groundwater Banking
- Westlands Water District Conjunctive Use Water Management Project
- Waldron Banking Facility Expansion
- Raisin City Recharge
- Arvin-Edison Water Storage District Expansion
- Kern Water Bank Expansion
- Semitropic Water Bank Expansion
- Poso Creek
- Deer Creek Expansion

The approach began with a theoretical analysis to evaluate the potential for groundwater recharge and determine if groundwater storage should be further considered as a measure. 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 outcome of this evaluation, as presented in the Phase 1 Investigation Report (October 2003), suggested groundwater storage may be possible to support Investigation purposes, but that specific facilities had not yet been identified.

Following the completion of the theoretical analysis, DWR initiated a regional Conjunctive Management Opportunities Study (Study), which is being conducted in parallel with the Investigation. The objective of the Study is to identify potential conjunctive management projects and programs in the San Joaquin River and Tulare Lake hydrologic regions that could contribute to the overall CALFED Program objectives of water supply reliability, water quality, and ecosystem restoration. The first phase of the Study identified groundwater sub-basins in the San Joaquin Valley that possess the greatest potential for groundwater recharge, and assessed potential conjunctive management opportunities within these regions. Preliminary results from the Study identified 12 potential projects in the San Joaquin Valley, at locations ranging from San Joaquin County in the north to Kern County in the south.

Upon completion of the Conjunctive Management Opportunities Study, the Investigation will review the recommended projects for their potential as conjunctive management and groundwater storage measures. The evaluation will consider the extent to which a project could contribute to Investigation objectives, either individually or in combination with surface water storage measures. A set of evaluation criteria will be applied to assess the applicability of each recommended conjunctive management or groundwater storage project for inclusion as a measure in the Investigation.

PUBLIC AND AGENCY PARTICIPATION

A public and agency participation program that is integrated with the progress of technical work supports the Investigation. The program, initiated during Phase 1, is designed to address issues of interest and concern to stakeholders engaged in local and regional water resource planning. To date, public and agency involvement has including the following:

- Structured series of interactive public meetings and workshops
- Briefings for governmental and nongovernmental agencies and coalitions
- Briefings for tribal representatives
- Coordination with local water resources planning and management groups
- Coordination with agencies
- Interviews with water management agency representatives
- Tours of Millerton Lake and portions of the upper San Joaquin River
- Distribution of informative brochures, fact sheets, and documents that provided background and updates on the Investigation's progress
- Distribution of Investigation documents via a Web site

The IAIR was initiated concurrent with a set of public scoping meetings in Sacramento, Modesto, Friant, and Visalia, California, to inform interested groups and individuals about the Investigation and to solicit ideas and comments. Two public meetings were held during preparation of the IAIR to provide updates on study progress and receive input on preliminary findings.

Cooperating agency teams are being formed to address several technical issues relevant to the Investigation. These include water operations, reservoir area environmental resources, river restoration, hydropower, flood damage reduction, engineering, economics, and conjunctive management. As the Investigation proceeds, involvement of cooperating agency teams will become increasingly important. Cooperating agencies will assist in data collection, provide guidance on incorporating restoration plan information from other sources, aid in developing impact analysis methodologies, and review findings from impact and benefit analyses.

INFORMATIONAL MATERIALS AND DOCUMENT ACCESS

An Investigation Web site, hosted by Reclamation at http://www.usbr.gov/mp/sccao/storage, contains technical documents prepared for the Investigation to date, presentations used at public workshops and meetings, the Phase 1 Investigation Report, the IAIR and technical appendices, contact information for the study team, and a gateway for contacting the study team. The Web site has been a key feature in outreach efforts and will continue to be expanded as the Investigation proceeds.

NEXT STEPS

During plan formulation, analytical methods and tools to support evaluations of monetary and non-monetary benefits and impacts will be developed, cost estimates will be refined, operations scenarios will be applied, and initial alternatives will be refined and screened. Plan formulation will culminate with a set of complete alternatives that appear feasible in meeting the planning objectives. Studies to support plan formulation will proceed in several key technical areas, as described below.

Water Operations – Water operations evaluations will focus on evaluating potential uses of new water supplies and identifying project benefits. The CALSIM model will be modified to incorporate operations criteria described in the IAIR and a water quality module for the San Joaquin River below Mendota Pool. The revised CALSIM model will be used to evaluate multiple purpose operations to address Investigation objectives.

Reservoir Area Environmental Resources – In coordination with cooperating agencies, the Investigation team will inventory aquatic, botanic, wildlife, cultural, historic, and archeological resources in and around areas that would be affected by the retained measures and develop impact assessment methodologies. Impacts of alternatives on species health and abundance, and cultural resources will be identified. Operations objectives for specific species and preliminary mitigation measures will be developed.

Downstream Environmental Resources – It is expected that restoration plans for the San Joaquin River under development by others will soon be available for consideration by the Investigation. Potential restoration strategies may range from targeting a resident fishery in a limited portion of the San Joaquin River to a naturally producing anadromous fishery from Friant Dam to the Delta. The Investigation will identify the extent to which an alternative can contribute to a given restoration plan, but will not identify specific additional actions that would be included for a comprehensive restoration plan and water supply alternative. This will require the development and use of additional models, such as reservoir and river temperature models.

Designs and Cost Estimates – Designs and cost estimates for retained storage measures will be developed and updated. Refinements will include enhancements of dam and associated infrastructure designs for specific elevations, establishing consistent levels of design for all features, and a common price level for all costs. Feasibility-level cost estimates will be prepared for the preferred alternative when it is identified.

Hydropower – Hydropower studies will address the affects of multiple-purpose water operations on hydropower generation, ancillary benefits of hydropower facilities, regional transmission, time-step refinement, and pumped storage opportunities for peak and off-peak conditions. These studies will be coordinated with operators of power facilities in the upper San Joaquin River basin. Project alternatives that include development of new hydroelectric generating facilities would likely require non-Federal partnership for the long-term operation of facilities.

Flood Control – Evaluations to be completed during plan formulation will address trade-offs between dedicated flood management space and new water supply. These evaluations will help refine the definition of flood management in the formulation of multiple-purpose alternatives. Issues to be addressed include incidental flood benefits that would accrue from enlarging storage with no change in dedicated storage space; future floodplain development; and effects of channel and levee modifications for river restoration on flood protection.

Economics – Economic analyses will focus on developing and applying methodologies to estimate benefits of a broad range of monetary and non-monetary outputs. These outputs include water supply reliability, river restoration, improved river water quality, improved urban water quality, lost and replacement hydropower generation, flood damage reduction, and recreation. Issues to be considered will include seasonal and multiyear effects resulting from changes in the availability of water for irrigation, municipal, and environmental uses.

Groundwater Storage and Conjunctive Management Measures – Additional work is needed to develop specific conjunctive management and groundwater storage measures for inclusion in Investigation alternatives. Specific projects recommended in the DWR Conjunctive Management Opportunities Study will be evaluated for inclusion in the Investigation. Retained groundwater storage and conjunctive management measures will be combined with surface water storage measures in project alternatives.

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CHAPTER 1. INTRODUCTION

In 2001, the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) initiated the Upper San Joaquin River Basin Storage Investigation (Investigation). The Investigation is a feasibility study evaluating alternatives to develop water supplies from the San Joaquin River that could contribute to restoration of, and improve water quality in, the San Joaquin River and enhance conjunctive management and exchanges to provide high-quality water to urban areas. The Investigation is one of five surface water storage studies recommended in the CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Report (PEIS/R) Record of Decision (ROD) of August 2000.

The Investigation is being prepared in two phases. Phase 1, which included preliminary screening of initial storage sites, was completed in October 2003. Initially, 17 surface water storage sites were considered, of which 6 were retained for further analysis. Phase 2 began in January 2004 with formal initiation of environmental review processes consistent with Federal and State of California (State) regulations, and will continue through completion of all study requirements. The Investigation will culminate in a Feasibility Report (FR) and supporting environmental documents consistent with the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (WRC, 1983), Reclamation directives, DWR guidance, and applicable environmental laws. Reclamation and DWR are coordinating the Investigation with the California Bay-Delta Public Advisory Committee (BDPAC), which provides advice to the Secretary of the United States Department of the Interior (Secretary) regarding the implementation of the CALFED Program, and the California Bay-Delta Authority (CBDA), which provides general oversight and coordination of all CALFED activities.

To facilitate coordination with other agencies and related ongoing studies, preparation of the FR will include two interim planning documents: an Initial Alternatives Information Report (IAIR) and a subsequent Plan Formulation Report (PFR). The IAIR describes without-project conditions and water resources problems and needs; defines study objectives and constraints; screens surface water storage measures; describes groundwater storage measures development; and identifies preliminary water operations rules and scenarios. Retained storage measures and preliminary water operations scenarios will be included in initial alternatives. This IAIR will be used as an initial component of the FR. The PFR will present the results of initial alternatives evaluation, identify refinements of the alternatives, and define a set of final alternatives. A Draft FR will evaluate and compare the final alternatives and identify a recommended plan. A Draft Environmental Impact Statement (EIS) and Environmental Impact Report (EIR) will be included with the Draft FR. Following public review and comment, a final FR/EIS/EIR will be prepared.

Topics Addressed in the Initial Alternatives Information Report

- Without-project conditions
- Water resources problems and needs
- Study objectives and constraints
- Surface water storage measures screening
- Groundwater storage measures development
- Preliminary water operations rules and scenarios

BASIS OF INVESTIGATION

The San Joaquin River basin experiences several water resources problems that could be alleviated through the development and management of additional water supplies. These problems include ecosystem conditions in the San Joaquin River, water quality of the San Joaquin River, and groundwater overdraft in the eastern San Joaquin Valley. In addition, opportunities exist to address related water resources needs, including flood protection, hydropower generation, and recreation, through the development of additional water supply.

The purpose of the Investigation is to formulate and evaluate alternatives that develop additional San Joaquin River water supply primarily involving enlarging Friant Dam and Millerton Lake, or a functionally equivalent storage program in the region. As described in the CALFED ROD, the developed water supply would be managed to contribute to the restoration of, and improve water quality in, the San Joaquin River and enhance conjunctive management and exchanges to provide high-quality water to urban areas. To the extent possible through meeting these primary objectives, alternatives will include features to address identified flood control, hydropower, recreation, and other related water resources opportunities.

STUDY AREA EMPHASIS

As described in CALFED documents, the upper San Joaquin River basin comprises the San Joaquin River and tributary lands upstream of its confluence with the Merced River. Changes in San Joaquin River flows could affect this reach and the San Joaquin River as it continues to the Sacramento-San Joaquin Delta (Delta). Friant Dam, on the San Joaquin River, currently serves water to the eastern San Joaquin Valley from Chowchilla in the north to Bakersfield in the south. Releases from Friant Dam that reach Mendota Pool via the San Joaquin River could provide a supply to Mendota Pool water user demands otherwise served from Delta exports, and thereby provide water supplies for other south-of-Delta (SOD) water users.

The study area emphasis for the Investigation therefore encompasses the San Joaquin River watershed upstream of Friant Dam, the San Joaquin River from Friant Dam to the Delta, and the portions of the San Joaquin and Tulare Lake hydrologic regions served by the Friant-Kern and Madera canals, as highlighted in **Figure 1-1**. The study area includes all potential storage sites under consideration, the region served by the Friant Division of the Central Valley Project (CVP), the eastern San Joaquin Valley groundwater basins, and the portion of the San Joaquin River most directly affected by the operation of Friant Dam. As described in **Chapter 3**, the study area includes a primary study area and an extended study area.

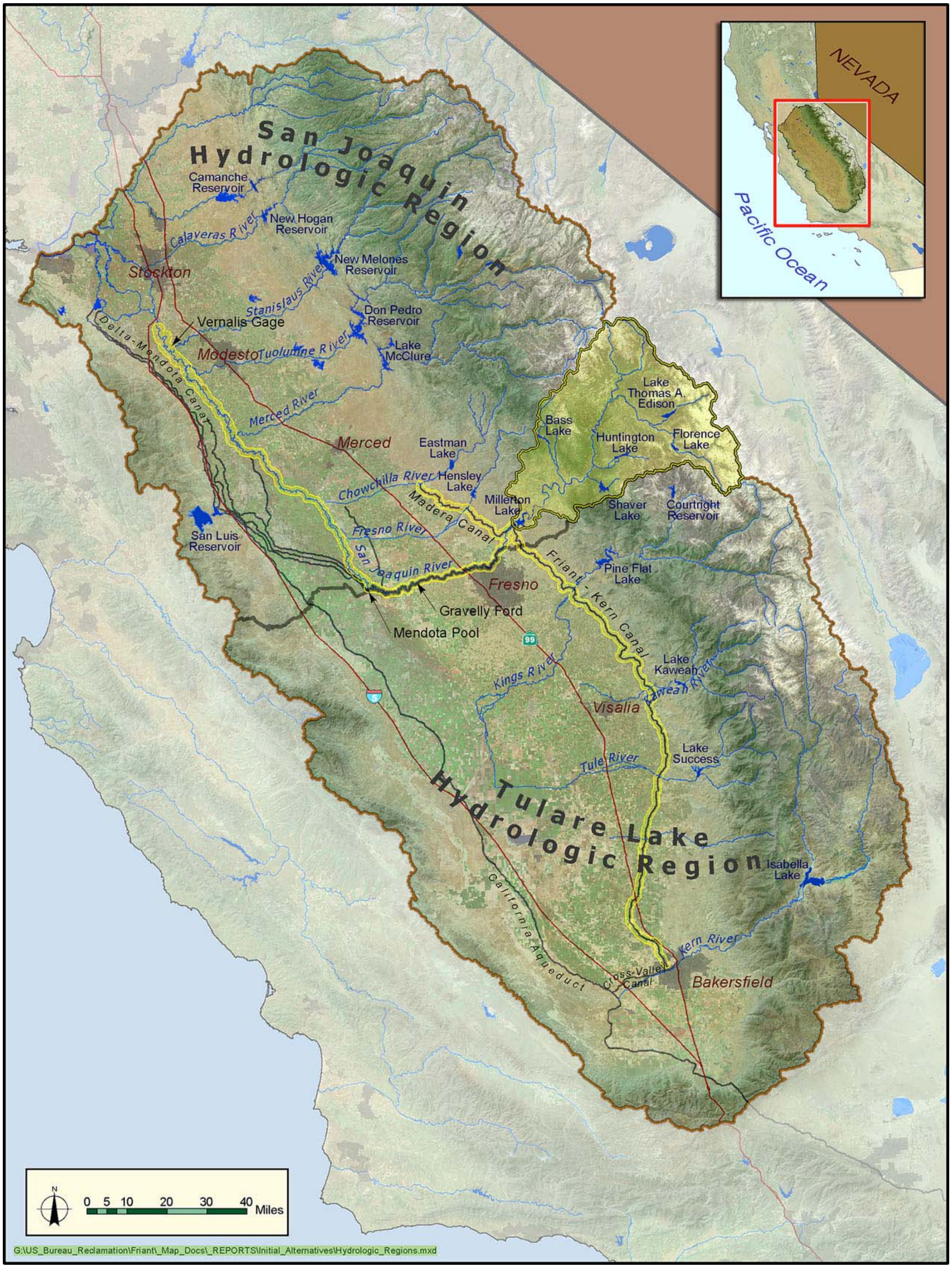

FIGURE 1-1.
UPPER SAN JOAQUIN RIVER BASIN STORAGE INVESTIGATION
STUDY AREA EMPHASIS

STUDY AUTHORIZATION AND GUIDANCE

Federal and State of California authorizations for preparing the FR are described below.

Federal Authorization

Federal authorization for the Investigation was initially provided in Public Law (PL) 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 to conduct feasibility studies for several storage projects identified in the CALFED ROD, including the Upper San Joaquin River Basin Storage 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.

Subsequent authorization for the Investigation was provided in PL 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.

This authorization to prepare a FR on water storage was identified separately from several other provisions in the same act that authorized Federal participation in groundwater management and storage projects and actions to improve water quality in the lower San Joaquin River at or near Vernalis. Reclamation is the responsible Federal agency for preparing the FR and the EIS.

State of California Authorization

DWR is the State lead agency for the Investigation and preparation of the EIR. Section 227 of the State of California Water Code authorizes DWR to participate in water resources investigations:

> The department may investigate any natural situation available for 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. The department may ascertain the feasibility of projects for such reservoirs or reservoir systems, the supply of water that may thereby be made available, and the extent and character of the areas that may be thereby irrigated. The department may estimate the cost of such projects.

Guidance in the CALFED ROD

The principal objective of the CALFED Bay-Delta Program is to develop a comprehensive, long-term strategy to provide reliable water supplies to cities, agriculture, and the environment while restoring the overall health of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta). The CALFED ROD recommended numerous projects and actions to increase water supply reliability, improve ecosystem health, increase water quality, and improve Delta levee stability.

Several program elements were defined that, in combination, would help attain the overall goals of CALFED. The storage program element includes five investigations of potential increased surface storage capabilities at various locations in the Central Valley, including the upper San Joaquin River basin, as well as efforts to increase groundwater storage through conjunctive management. For the upper San Joaquin River basin, the CALFED ROD states:

> … 250-700 [thousand acre-feet (TAF)] of additional storage in the upper San Joaquin watershed… 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.

SURFACE WATER STORAGE MEASURES RETAINED FROM PHASE 1

Six sites for enlarging an existing or developing a new reservoir were retained from Phase 1 of the Investigation. Each site could be configured at various storage sizes, with each configuration identified as a measure. Surface water storage sites retained from Phase 1 include:

- **Raise Friant Dam**. Enlarging Millerton Lake by raising Friant Dam up to 140 feet.
- **Temperance Flat Reservoir**. Constructing Temperance Flat dam and reservoir at one of three potential dam sites on the San Joaquin River, between Friant and Kerckhoff dams, at River Mile (RM) 274, RM 279, or RM 286.
- **Fine Gold Reservoir**. Constructing a dam and reservoir on Fine Gold Creek to store water diverted from the San Joaquin River or pumped from Millerton Lake.
- **Yokohl Valley Reservoir**. Constructing a dam and reservoir in Yokohl Valley to store water conveyed from Millerton Lake by the Friant-Kern Canal and pumped into the reservoir.

SURFACE WATER STORAGE MEASURES SUGGESTED DURING SCOPING

As noted in the Phase 1 Information Report, most of the surface water storage measures retained from Phase 1 would result in a net loss in power generation. In March 2004, Reclamation and DWR held a series of scoping meetings to initiate development of an EIS and EIR. During scoping, power utilities that own and operate hydropower projects in the upper San Joaquin River basin raised concerns about impacts of lost power generation and the ability of retained measures to develop adequate replacement power. These hydropower stakeholders suggested five additional potential reservoir sites that could store water supplies from the upper San Joaquin River without adversely affecting existing hydropower facility operations.

Suggested storage measures include the **Granite Project** (Granite Creek and Graveyard Meadow reservoirs) and **Jackass-Chiquito Project** (Jackass and Chiquito reservoirs) on tributaries to the San Joaquin River upstream of Mammoth Pool, and the **RM 315 Reservoir** on the San Joaquin River between Redinger Lake and Mammoth Pool. The scoping comments also suggested combining these upstream storage measures with a gravity diversion tunnel from Kerckhoff Lake to a Fine Gold Reservoir. The locations of the surface water storage sites retained from Phase 1 and sites suggested during scoping are shown in **Figure 1-2.**

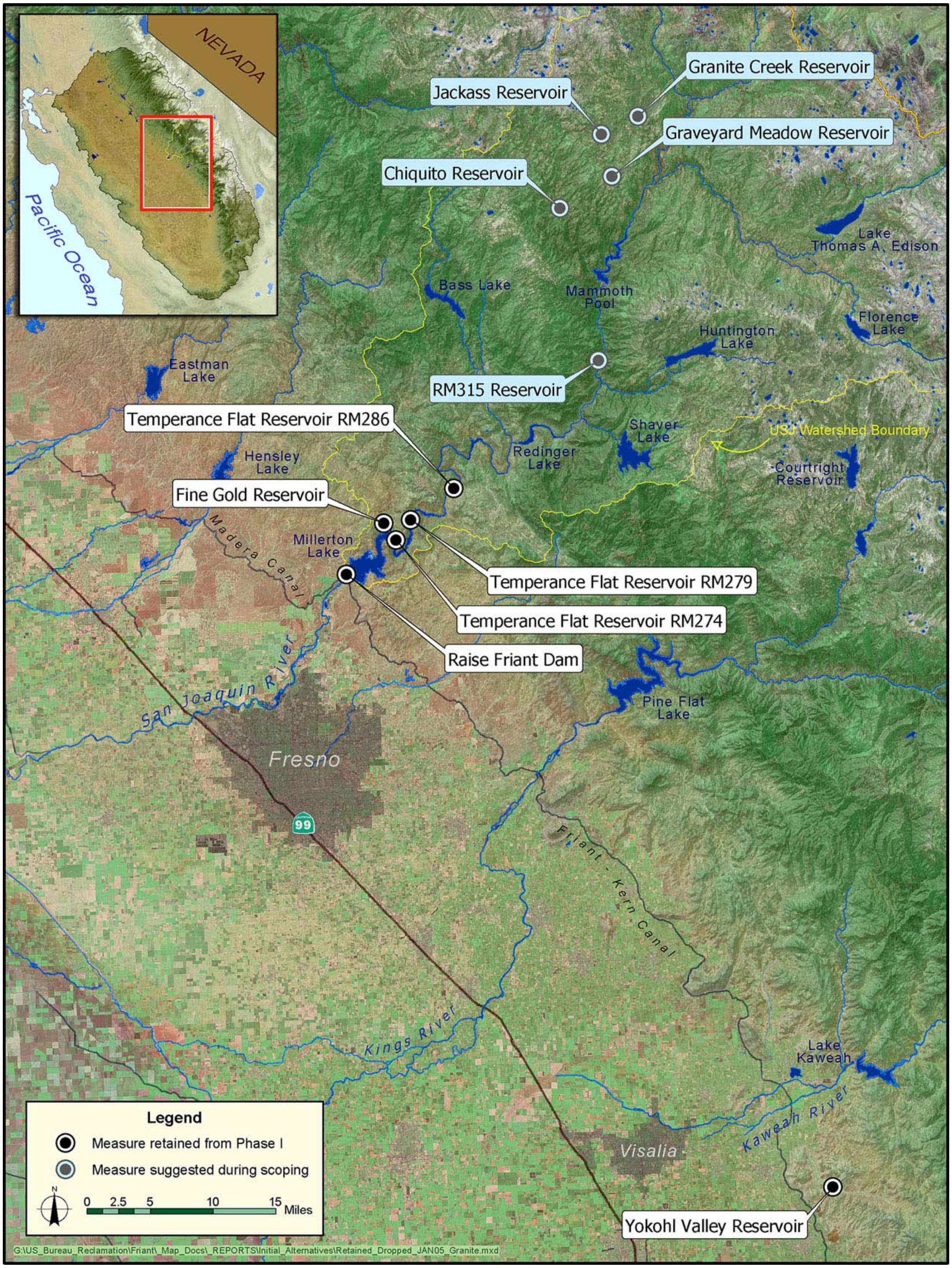

FIGURE 1-2.
SURFACE WATER STORAGE SITES RETAINED FROM PHASE 1 AND SUGGESTED DURING SCOPING

PURPOSE AND SCOPE OF THIS REPORT

The primary purpose of this IAIR is to describe the formulation of initial alternatives to address planning objectives established for the Investigation. From these initial alternatives, detailed alternative plans will be developed in the remainder of the feasibility study. The scope of the report includes the following topics:

- Description of existing and likely future water resources and related conditions in the study area, and related problems, needs, and opportunities being addressed in the study.
- Development of planning objectives to address identified problems, needs, and opportunities.
- Identification of planning constraints, guiding principles, and criteria for the Investigation.
- Identification and evaluation of individual water resources management measures to address the planning objectives.
- Identification of a set of measures and operations scenarios to be included in initial alternatives that will be further developed in the feasibility study.
- Identification of potential major future actions for the feasibility study.

This IAIR will be used as an initial component of the FR. Conclusions and recommendations regarding further evaluations are expected to evolve as the study progresses.

REPORT ORGANIZATION

In addition to this introduction, the IAIR includes several chapters. **Chapters 2, 3,** and **4** highlight related studies, projects, and programs; define existing and projected future without-project water and related resources conditions; and describe fundamental problems being addressed in the Investigation. **Chapter 5** describes the plan formulation process; defines planning objectives for the Investigation; and identifies planning constraints, principles, and criteria. **Chapter 6** describes potential resources management measures that could address the planning objectives and identifies measures carried forward for inclusion into initial alternatives.

Chapter 7 describes storage measures and operations scenarios of initial alternatives for further development. **Chapter 8** describes public stakeholder and agency involvement in the Investigation. **Chapter 9** describes next steps to be completed during plan formulation and several issues that may need to be addressed before completing the FR. **Chapter 10** lists the document preparers. **Chapter 11** presents references used in the preparation of this report. A glossary is provided in **Chapter 12**.

The IAIR also includes several technical appendices that provide detailed information on specific technical topics. An **Engineering Technical Appendix** (TA) presents assumptions, designs, and cost estimates for storage measures and related features. A **Water Operations TA** describes water operations strategies to be included in initial alternatives. A **Hydropower TA** evaluates impacts to existing hydropower facilities, pumping requirements, and potential hydropower generation for the surface water storage measures considered in the IAIR. A **Flood Damage Reduction TA** presents results of preliminary evaluations of additional flood storage at Friant Dam on flood protection in the San Joaquin River basin.

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CHAPTER 2. RELATED STUDIES, PROJECTS, AND PROGRAMS

This chapter describes related activities of various Federal and State agencies and numerous local working groups and private organizations in the study area. Many of these entities, including Reclamation, DWR, and several local entities, are performing current studies, projects, and programs that are important to the Investigation.

RECLAMATION PROGRAMS AND STUDIES

As the owner and operator of Friant Dam and Millerton Lake, and various related components of the CVP in the study area, actions by Reclamation have a significant effect on environmental resources in the region. Ongoing projects, continuing programs, and prior studies relevant to the primary study area are described below.

Central Valley Project Operations

Friant Dam and Millerton Lake are key elements of the CVP. President Franklin Roosevelt approved the CVP, including the Kennett (Shasta), Friant, and Contra Costa (Delta) divisions, on December 2, 1935. The CVP is the largest surface water storage and delivery system in California, with a geographic area covering 35 of the State's 58 counties. The project includes 20 reservoirs with a combined storage capacity of approximately 11 million acre-feet (MAF); 8 powerhouses and 2 pump-generating plants, with a combined generation capacity of approximately 2 million kilowatts (kW); and approximately 500 miles of major canals and aqueducts. The CVP supplies water to more than 250 long-term water contractors in the Central Valley, the Santa Clara Valley, and the San Francisco Bay Area. **Figure 2-1** shows the locations of major CVP facilities, rivers that are controlled or affected by the operation of CVP facilities, and the CVP service area. The CVP has the potential to supply about 7 MAF annually to agricultural and municipal and industrial (M&I) customers and for environmental purposes. Approximately 90 percent of CVP water is delivered to agricultural users, including prior water rights holders. Friant Dam regulates an average annual inflow of about 1.8 MAF and delivers about 1.4 MAF of water annually on average to water users in the eastern San Joaquin Valley.

Operating Divisions

CVP operations are divided into eight divisions. Operations north of the Delta include the Trinity, Shasta, and Sacramento River divisions, known collectively as the Northern CVP System. Those south of the Delta, and the Delta, West San Joaquin, and San Felipe divisions, are known collectively as the Southern CVP System. Both the Eastside and Friant divisions are operated independently of the remainder of the CVP due to the nature of their water supplies and service areas. The Northern and Southern CVP Systems are operated as an integrated system, and demands for water and power can be met by releases from any one of several facilities. Demands in the Delta and south of the Delta can be met by exporting excess water in the Delta, which can result from releases from northern CVP reservoirs. Operational decisions are based on a number of physical and hydrological factors that change depending on conditions.

Source:
(DWR, 1998)

FIGURE 2-1.
MAJOR CVP AND SWP FACILITIES

CVP Water Users

During development of the CVP, the United States entered into two types of long-term agreements with many major water rights holders: the Sacramento River Settlement Contractors, and San Joaquin River Exchange Contractors.

Members of the Sacramento River Settlement Contractors primarily claim water rights on the Sacramento River. Because of the significant influence of Shasta Dam operations on flows in the Sacramento River, these water rights claimants entered into contracts with Reclamation. Most of the agreements established the quantities of water the contractors are allowed to divert from April through October without payment to Reclamation, and a supplemental CVP supply allocated by Reclamation.

The San Joaquin River Exchange Contractors are contractors who receive CVP water from the Delta via the Mendota Pool. Under exchange contracts, the parties agreed not to exercise their San Joaquin River water rights in exchange for a substitute CVP water supply from the Delta. These exchanges allow water to be diverted from the San Joaquin River at Friant Dam for use by water service contractors in the eastern San Joaquin Valley and Tulare Lake basin.

CVP water service contracts were developed with water users in the Central Valley for irrigation and M&I water supplies. For most water users, water service contracts represent a supply supplemental to local sources, including groundwater. In the Friant Division, a two-class contract structure was established to facilitate regional conjunctive water management. Friant Division contracts are described in **Chapter 3**.

Operational Influences

CVP operations are influenced by general operating rules, regulatory requirements, and facility-specific requirements. A complex set of rules, regulations, and policies affect the integrated operation of CVP north-of-Delta (NOD) and SOD facilities. Inflow and release requirements are the principal elements influencing reservoir storage. Operational decisions often consider not only conditions at individual reservoirs, but also downstream flow conditions and conditions at other project reservoirs. SOD storage space that only can be filled with water exported from the Delta is a major operational consideration involving the geographic distribution of water in storage. Other factors that influence the operation of CVP reservoirs include flood control requirements, carryover storage objectives, lake recreation, power production capabilities, coldwater reserves, and pumping costs.

Rivers below some CVP dams support both resident and anadromous fisheries and recreation. While resident fisheries are slightly affected by release fluctuations, anadromous fisheries (e.g., salmon and steelhead) are the most sensitive and are present year-round downstream of some CVP facilities. Maintaining water conditions favorable to spawning, incubation, rearing, and out-migration of juvenile anadromous fish is one of the main objectives of CVP operations. CVP operations are coordinated to anticipate and avoid streamflow fluctuations during spawning and incubation whenever possible.

Operation of CVP NOD and SOD facilities is affected by several regulatory requirements and agreements. Prior to passage of the Central Valley Project Improvement Act (CVPIA), operation of the CVP was affected by State Water Resources Control Board (SWRCB) Decisions 1422 and 1485 (D-1422 and D-1485), and the Coordinated Operations Agreement (COA). D-1422 and

D-1485 identify minimum flow and water quality conditions at specified locations that are to be maintained in part through operation of the CVP. COA specifies responsibilities shared by the CVP and California's State Water Project (SWP) for meeting the requirements of D-1485. In December 1994, representatives of the Federal and State governments and urban, agricultural, and environmental interests agreed to implement a Bay-Delta protection plan through the SWRCB that would protect the ecosystem of the Bay-Delta Estuary. The Bay-Delta Water Quality Control Plan (WQCP), released in May 1995, superseded D-1485.

D-1422, the water rights decision for operation of New Melones Reservoir on the Stanislaus River, requires that some of the water supply developed at New Melones be managed to maintain water quality conditions in the San Joaquin River at Vernalis. The Bay-Delta Water Control Plan specifies salinity levels at Vernalis for irrigation and non-irrigation periods.

Operation of the Friant Division is more straightforward than for many other portions of the CVP. Friant Dam is operated as an annual reservoir, meaning all water supplies available in a given year are allocated with the expectation of delivery. River releases are made to satisfy downstream water rights and contract diversions. Specific releases are not made to the San Joaquin River to maintain fishery conditions downstream of Friant Dam. Consequently, Millerton Lake is not managed for water temperature or to provide carryover to subsequent years. The operations of Friant Dam are described in greater detail in **Chapter 3**.

Prior Studies of Enlarging Friant Dam

Several previous studies examined the potential to provide new water storage at Millerton Lake. In 1952, 10 years after completion of Friant Dam, Reclamation conducted a study to determine the feasibility of raising Friant Dam. The study included designs and costs for raising Friant Dam by 60 feet and constructing four earth saddle dams. Based on a comparison of costs to potential revenue from the sale of increased yield, the study concluded that the raise would be infeasible.

Reclamation revisited the potential cost for a 60-foot raise at a reconnaissance level in 1975, and developed a cost estimate for an approximate 140-foot raise in 1982. In 1997, Reclamation reconsidered the feasibility of raising Friant Dam to provide additional storage capacity in Millerton Lake. Raises of 60 feet and 140 feet were considered. In 2000, a study conducted for the Friant Water Users Authority (FWUA) and Natural Resources Defense Council (NRDC) coalition considered a 20-foot raise of Friant Dam as one of many alternatives for increasing potential water supply to the San Joaquin River (URS).

Central Valley Project Improvement Act

The CVPIA was signed into law in October 1992 as Title 34 of PL 102-575. The CVPIA was developed to address conflicts over water rates, irrigation land limitations, and environmental impacts of the CVP. This legislation mandates changes in management of the CVP, particularly for protection, restoration, and enhancement of fish and wildlife. The CVPIA also addresses the operational flexibility of the CVP and methods to expand the use of voluntary water transfers and improved water conservation. The general purposes of the CVPIA, as identified by Congress in Section 3402, include the following:

- Protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California.
- Address impacts of the CVP on fish, wildlife, and associated habitats.
- Improve the operational flexibility of the CVP.
- Increase water-related benefits provided by the CVP to the State of California through expanded use of voluntary water transfers and improved water conservation.
- Contribute to the State of California's interim and long-term efforts to protect the Bay-Delta.
- Achieve a reasonable balance among competing demands for CVP water, including water requirements for fish and wildlife, agriculture, M&I, and power contractors.

The CVPIA redefined the purposes of the CVP to include protection, restoration, and enhancement of fish, wildlife, and associated habitats and protection of the Bay-Delta at equal priority with other purposes. It identified numerous measures and programs to meet the new project purpose and directed the Secretary to operate the CVP consistent with these purposes.

One of the effects of the CVPIA was the dedication of project yield for fish and wildlife purposes. The combined total amount of water dedicated to the environment by the CVPIA suggests an annual amount of up to 1.2 MAF. This includes reallocation of the 800 thousand acre-feet (TAF) required by Section 3406 (b)(2) of the CVPIA (commonly called (b)(2) water), dedicated deliveries to wildlife refuges of about 250 TAF (called Level 2 Refuge water), and increased flows in the Trinity River, which result in a reduction in imports to the Sacramento Valley of about 150 TAF annually.

Implementation of Section 3406 (b)(2) has been a contentious process, marked by conflict between Federal and State parties, and substantial litigation. The primary dispute has been whether (b)(2) water translates into an automatic reduction in exports under water supply contracts. In May 2003, Reclamation released a final decision on implementation of Section 3406 (b)(2). The intent of the decision was to simplify and clarify the accounting process for (b)(2) water uses and to integrate (b)(2) water dedication and management with CVP operations for other CVP purposes. The decision is divided into sections that address calculations of yield, accounting processes, modifications of CVP operations, water banking and transfers/exchanges of water, water to meet obligations of the 1995 Bay-Delta WQCP and Federal Endangered Species Act (ESA) of 1978, shortage criteria, and coordination.

A primary feature of the CVPIA is the fish, wildlife, and habitat restoration provisions included in Section 3406. One provision requires the Secretary to develop a comprehensive plan that is reasonable, prudent, and feasible to address fish, wildlife, and habitat concerns on the San Joaquin River. The concerns include, but are not limited to, the streamflow, channel, riparian habitat, and water quality improvements that would be needed to reestablish, where necessary, and to sustain naturally reproducing anadromous fisheries in the San Joaquin River from Friant Dam to the Delta. During the time the Secretary is developing such a restoration plan, and until Congress has authorized the Secretary to implement the plan, the Secretary shall not make releases for the restoration of flows between Gravelly Ford and the Mendota Pool for purposes of implementing the CVPIA. Following completion of a restoration plan, the Secretary shall not thereafter make releases from Friant Dam as a measure to implement the CVPIA without a specific Act of Congress authorizing such releases.

The CVPIA established a Restoration Fund based on the application of surcharges on the project-wide sales of water and power to provide funding for required restoration actions. The CVPIA also established an additional surcharge in lieu of a requirement to release water from Friant Dam for CVPIA purposes. The Friant surcharge will be in place until such time as flows of sufficient quantity, quality, and timing are provided at and below Gravelly Ford to meet the anadromous fishery needs identified in the San Joaquin River restoration plan, if any.

CVP Water Supply Improvement Plan

Section 3408 (j) of the CVPIA authorized the Secretary to prepare a plan to increase the yield of the CVP. This section directs the Secretary to develop a least-cost plan to increase the yield of the CVP equal to the amount dedicated to fish and wildlife purposes by the CVPIA. This plan also was intended to assist the State in meeting its future water needs. Further, appropriate cost-sharing arrangements to implement the CVP Water Supply Improvement Plan were to be recommended. One goal of the plan is to minimize the impacts of the CVPIA on existing CVP Water Service Contractors.

In 1995, Reclamation, in conjunction with the United States Fish and Wildlife Service (USFWS) on behalf of the Department of the Interior, developed and submitted the Least-Cost CVP Yield Increase Plan to Congress, as required by 3408(j). The plan broadly defined least-cost as a plan in which all reasonable options, including supply increase and demand reduction, are assessed against an array of cost and impact considerations. Cost and supply estimates for a wide variety of new water supply and management options were identified, including groundwater storage, land fallowing, conservation and reuse, surface water storage, conveyance, and others. The 1995 report concluded a need exists for "a refined set of options that serve to mitigate any adverse impacts… and that are available at the time of authorization [of the Yield Increase Plan]." The plan did not propose a specific CVP yield increase. An update to the 1995 plan is in progress and will address the loss of system flexibility and reduced water supply reliability as a result of the CVPIA, and actions to assist the State of California in meeting future water needs.

CVPIA Contract Renewal Process

In accordance with Section 3404(c) of the CVPIA, Reclamation is negotiating the renewal of long-term water service contracts. It is anticipated that as many as 109 CVP water service contracts in the Central Valley may be renewed at the conclusion of the negotiation process.

Operations Criteria and Plan

In March 2004, Reclamation and DWR prepared a Long-Term CVP and SWP Operations Criteria and Plan (OCAP) to address how the CVP and SWP would be operated in the future as several proposed projects come on-line and as water demands increase. The March 2004 document is a revision of the previous 1992 OCAP release. It incorporates numerous additional constraints and criteria that have arisen since 1992. Incorporations include the 2000 Trinity ROD, Anadromous Fish Restoration Program (AFRP) flow objectives, 1993 Winter Run Biological Opinion (BO), revised decision on CVPIA Section 3406(b)(2) water, Environmental Water Account (EWA), and Joint Point of Diversion (JPOD).

San Luis Drainage Feature Reevaluation

In response to a February 2000 U.S. Court of Appeals court order, Reclamation is reevaluating options for providing drainage service to the San Luis Unit. The San Luis Drainage Feature Reevaluation will allow Reclamation to formulate and implement a plan which provides agricultural drainage service to the San Luis Unit and the general area (of which lands served by the San Luis Unit are a part) that achieves long-term, sustainable salt and water balance in the root zone of irrigated lands. Drainage service is defined as managing the regional shallow groundwater table by collecting and disposing of shallow groundwater from the root zone and/or reducing contributions of water to the shallow groundwater table through land retirement. Proposed drainage service alternatives will be selected on the basis of criteria adopted to maintain environmental quality and provide for continued agricultural production in a manner consistent with a Plan of Action filed April 18, 2001, in Sumner Peck Ranch, Inc., et al., v. Reclamation, et al. The Reevaluation is being conducted pursuant to PL 86-488, which authorized the San Luis Unit. A Notice of Intent (NOI) to prepare an EIS, pursuant to the National Environmental Policy Act (NEPA), was published in the Federal Register October 2, 2001.

Millerton Lake Resource Management Plan and General Plan

Reclamation is preparing a Millerton Lake Resource Management Plan (RMP) and associated PEIS to establish management objectives, guidelines, and actions to protect water quality, and natural and cultural resources, and to provide recreational opportunities and facilities. Alternatives currently under consideration emphasize more passive recreation opportunities upstream of Fine Gold Creek, while emphasizing more intensive recreation activities downstream of Fine Gold Creek. The alternative selected in the Final EIS will serve as the framework for negotiating a management agreement with the managing partner and provide guidance for resource management and recreation on lands managed by the United States department of the Interior, Bureau of Land Management (BLM), in the San Joaquin River Gorge Management Area. Relevant information developed in this planning effort regarding resources and recreational opportunities and impacts in the areas around and upstream of Millerton Lake will be used in the Investigation.

San Joaquin River Riparian Habitat Restoration Program

The purpose of the San Joaquin River Riparian Habitat Restoration Program is to improve riverine and riparian conditions along the San Joaquin River between Friant Dam and the confluence of the Merced River. Specific objectives of the program include developing and implementing activities that would provide or develop information relevant for restoring a continuous riparian corridor along the reach and implementing specific riparian habitat restoration projects. Reclamation undertook this project to support river restoration efforts that are required under Section 3406(c)(1) of the CVPIA, development of a San Joaquin River Comprehensive Plan. Relevant studies and investigations conducted since the inception of this program will be considered by the Investigation.

Environmental Water Account (Short-Term EWA)

The Environmental Water Account (EWA) was established in the CALFED ROD. The purpose of EWA is to protect at-risk fish species of the Bay-Delta through beneficial operational changes to CVP and SWP operations at no uncompensated water cost to CVP and SWP water users. Reclamation is an EWA Project Agency, having the responsibility of acquiring, storing, managing, and conveying water assets of the EWA and implementing the operational changes recommended by the EWA Management Agencies, which include USFWS, National Marine Fisheries Service (NMFS), and DFG. Reclamation shares this responsibility with DWR, also an EWA Project Agency. More detailed information about the EWA is provided later in this chapter under the CALFED Bay-Delta Program section.

BUREAU OF LAND MANAGEMENT

San Joaquin River Gorge Management Area

The BLM San Joaquin River Gorge Management Area straddles the San Joaquin River just upstream from Millerton Lake State Recreation Area State Recreation Area (SRA) and includes lands in both Fresno and Madera counties. BLM management areas are intended to sustain the health, diversity, and productivity of public lands for the use and enjoyment of present and future generations. Several thousand acres of public land are available for public use through access to San Joaquin River Gorge trail. When completed, the San Joaquin River Gorge Trail will allow continuous passage from Friant Dam to the Pacific Crest Trail near Devils Postpile National Monument.

UNITED STATES FOREST SERVICE

Sierra National Forest

The United States Forest Service (USFS) manages much of the land in the upper San Joaquin River watershed as part of the Sierra National Forest (SNF). In 1992, USFS developed the Sierra National Forest Land and Resources Management Plan to develop a fully integrated mix of management practices that provide for use and protection of forest resources, satisfy guiding legislation, and address local, regional, and national issues. The plan directs forest management for producing goods and services to maximize long-term net public benefit in an environmentally sound manner.

The Final Environmental Impact Statement (FEIS) for the Sierra National Forest Plan Amendment, issued in January 2001, proposes the establishment of management direction to address five problem areas in the Sierra Nevada region: old forest ecosystems and associated species; aquatic, riparian, and meadow ecosystems and associated species; fire and fuels; noxious weeds; and lower westside hardwood forest ecosystems (USFS, 2001).

The Backbone Creek Research Natural Area (RNA) was established in 1971 within the SNF to be preserved and protected in perpetuity. The Backbone Creek RNA may be used only for non-manipulative research and education, protected against activities that directly or indirectly modify ecological processes (USFS, 2004).

UNITED STATES GEOLOGICAL SURVEY

National Water Quality Assessment Program

As part of the National Water Quality Assessment (NAWQA) program initiated by the United States Geological Survey (USGS) in 1991, the San Joaquin-Tulare basins study unit was a part of the first decadal cycle of investigations into the quality of water resources to establish existing water quality conditions of streams and aquifers across the nation. Long-term goals of the NAWQA program are to assess the status of and trends in the quality of freshwater streams and aquifers, and to provide a sound understanding of the natural and human factors that affect the quality of these resources. NAWQA again will intensively investigate the quality of water resources in the San Joaquin-Tulare basins, as part of the second 10-year cycle of the program. While long-term goals remain the same, the emphasis of these renewed investigations will shift from status of water quality to trends in water quality and understanding of natural and anthropogenic factors affecting water quality.

STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES

State Water Project

The SWP was authorized in 1959 and designated to readjust geographical imbalances between California's water resources and water needs. The project extends from Plumas County in the north to Riverside County in the south. Completed project elements include 23 dams and reservoirs, 6 powerhouses, 17 pumping plants, and 533 miles of aqueduct. The principal storage feature of the SWP is Lake Oroville, with a gross pool capacity of 3.5 MAF. Lake Oroville is located on the Feather River about 4 miles northeast of Oroville. Water released from Oroville Dam flows though the Feather and Sacramento rivers to reach the Delta. The SWP delivers water to service areas in the Feather River basin, San Francisco Bay area, central coast, San Joaquin Valley, Tulare basin, and Southern California. Major SWP conveyance facilities in the Central Valley include the North Bay, South Bay, and California aqueducts. The North Bay Aqueduct diverts water from the north Delta near Cache Slough for agricultural and M&I use in Napa and Solano counties. The South Bay and California aqueducts carry water from the Delta to the San Francisco Bay area and to Southern California, respectively. In the southern portion of the Delta, the Harvey O. Banks Delta Pumping Plant lifts water into the California Aqueduct from the Clifton Court Forebay. At 444 miles, the California Aqueduct is the State's largest and longest water conveyance system, beginning at Banks Pumping Plant and extending to Lake Perris, south of Riverside in Southern California. **Figure 2-1** shows major SWP facilities.

The SWP has contracted a total of 4.23 MAF for average annual delivery in the San Joaquin River, central coast, and San Francisco and south coast areas. Of this amount, about 2.5 MAF is designated for the Southern California Transfer Area, nearly 1.36 MAF for the San Joaquin Valley, and 370 TAF for San Francisco Bay, the central coast, and Feather River areas. SWP contracts involve the Feather River Settlement Contractors and SWP Contract Entitlements. The Feather River Settlement Contractors are water users who hold riparian and senior appropriative rights on the Feather River. SWP Contract Entitlements are contracts executed in the early 1960s that established the maximum annual water amount (entitlement) that each long-term contractor may request from the SWP.

California Water Plan

In 1957, DWR published Bulletin 3, The California Water Plan, a comprehensive plan to guide and coordinate beneficial use of California's water resources. Bulletin 3 became the foundation for a series of water plan updates, now known as the Bulletin 160 series. The Bulletin 160 series assesses California's agricultural, environmental, and urban water needs and evaluates water supplies to quantify the gap between future water demands and supplies. Seven updates of the plan were published between 1966 and 1998.

DWR, through a highly collaborative process, is currently completing the latest update, Bulletin 160-05. California Water Plan Update 2005 addresses the State's changing water management and better reflects the roles of the State and federal governments and the growing role of regional and local agencies in California water management. The update goes beyond a forecast of statewide water demand and supply. It will include a strategic plan with goals, recommendations, and actions for meeting the challenges of sustainable water use through the year 2030.

Two key initiatives outline the ways the foundational actions will be achieved. The first is to implement integrated regional water management, which is a comprehensive, systems approach for determining the appropriate mix of demand and supply management options that provide long-term, reliable water supply at lowest reasonable cost and with highest possible benefits to customers, economic development, environmental quality, and other social objectives. The second initiative is to improve statewide water management systems. California depends on vast statewide water management systems to provide clean and reliable water supplies, protect lives and property from flood, withstand drought, and sustain environmental values. To improve the efficiency and flexibility of our water systems, water facilities must be maintained and improved.

The Investigation will contribute to both initiatives by evaluating opportunities that can enhance regional objectives and contribute to statewide system flexibility. Consistent with the Water Plan Update, DWR will consider how Investigation alternatives can contribute to broad regional water management issues and an Integrated Regional Water Management Plan.

San Joaquin River Management Program

Assembly Bill 3603 authorized the San Joaquin River Management Program (SJRMP) in 1990. SJRMP has served as a regional forum in the San Joaquin basin for local agencies, environmental groups, agriculture, business, industry, recreation, and other interests and landowners to work directly with Federal and State agencies to identify, discuss, plan, and support projects and programs that address water quality, water supply, flood protection, fisheries, recreation, and wildlife in the San Joaquin River system. The SJRMP (1995) describes and recommends specific projects, studies, and acquisitions that will help revive the San Joaquin River system.

Conjunctive Water Management Program

DWR's Conjunctive Water Management Program is working with local water agencies and stakeholders throughout the State, including the San Joaquin Valley, to develop partnerships and provide assistance for planning and developing locally controlled and managed conjunctive use programs and projects. Project proposals to be pursued by these local agencies may be considered in the Investigation or in the without-project conditions.

CALIFORNIA DEPARTMENT OF PARKS AND RECREATION

Millerton Lake State Recreation Area

California Department of Parks and Recreation (CDPR) manages the Millerton Lake SRA, which includes Millerton Lake and adjacent lands, under an operating agreement with Reclamation for recreation, preservation of biological diversity, and protection of natural and cultural resources.

The Millerton Lake SRA offers interpretive programs for wildlife viewing, tours of the historic Millerton County Courthouse, tours of a fish hatchery downstream of Friant Dam, and various campfire programs in addition to high-quality recreational opportunities. The SRA is one of the most popular recreation areas in the San Joaquin Valley.

CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD

Conditional Waiver of Waste Discharge Requirements for Irrigated Lands

Growers with irrigated lands who discharge waste that can degrade surface water quality must now select one of three options to obtain regulatory coverage under the Water Code:

- Elect to join a Coalition Group approved by the Central Valley Regional Water Quality Control Board (RWQCB)
- File for an Individual Discharger Conditional Waiver
- File a Report of Waste Discharge for the purpose of receiving Waste Discharge Requirements, if appropriate

Impaired Waterbodies 303(d) List and TMDLs

In 2002, the United States Environmental Protection Agency (USEPA) approved the Central Valley RWQCB's 2002 303(d) list for portions of the San Joaquin River downstream of Friant Dam that do not meet, or are not expected to meet water quality standards, or are considered impaired. The Clean Water Act further requires development of a total maximum daily load (TMDL) for each listing.

The Central Valley RWQCB is developing TMDLs and amendments to the Sacramento River and San Joaquin River basins WQCP for portions of the San Joaquin River for dissolved oxygen, organophosphate pesticide (diazinon and chlorpyrifos), salinity (electrical conductivity), boron, and selenium.

CALFED BAY-DELTA PROGRAM

The CALFED Bay-Delta Program is a cooperative effort among Federal and State agencies and California's environmental, urban, and agricultural communities. The Governor of California and the President of the United States initiated work on the program in 1995 to address environmental and water management problems associated with the Bay-Delta system.

CALFED has taken a broad approach to addressing four problem areas: (1) water quality, (2) ecosystem quality, (3) water supply reliability, and (4) levee system integrity. Many of the problems and solutions in the Bay-Delta system are interrelated. Program implementation began following circulation of the final PEIS/R and signing of the ROD in August 2000.

The Preferred Program Alternative described in the CALFED ROD consists of programmatic elements that set the long-term direction of the CALFED Program to meet the Mission Statement[1] and objectives.[2] The Preferred Program Alternative includes several interrelated programs and a series of actions to execute the programs.

Implementation of the CALFED programs depends on authorization and funding for participating Federal and State agencies. The Preferred Program Alternative is expected to take 25 to 30 years to complete. Implementation is divided into stages, with Stage 1 lasting 7 years, through Federal fiscal year 2007.

The California Bay-Delta Act of 2003 established the CBDA as the new governance structure and charged it with providing accountability, ensuring balanced implementation, tracking and assessing CALFED Program progress, using sound science, assuring public involvement and outreach, and coordinating and integrating related government programs. The CBDA helps coordinate the actions of and provides general oversight to 23 Federal and State agencies working cooperatively to implement the CALFED Preferred Program Alternative.

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[1] **CALFED Mission Statement -** The mission of the CALFED Bay-Delta Program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system.

[2] **CALFED Objectives -** CALFED developed the following objectives:

Provide good water quality for all beneficial uses.

Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.

Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system.

Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees.

CALFED Program Elements

Major CALFED program elements include Storage, Conveyance, Water Use Efficiency, Water Transfers, EWA, Drinking Water Quality, Watershed Management, Levee System Integrity, Ecosystem Restoration, and Science. Each program element is briefly described in the following sections.

Storage

The Storage Program seeks to develop additional storage capacity to help meet the needs of California's growing population and to provide increased system flexibility for helping to improve water quality and restore ecosystems. The first stage of the program consists of increasing the storage capacity at existing reservoirs and strategically located offstream sites by approximately 950 TAF and implementing major expansion of groundwater storage for an additional 0.5 to 1.0 MAF. As described in detail in a later section, the Investigation is one of five surface water storage studies under way in the CALFED Storage Program.

Conveyance

The Conveyance Program is aimed primarily at increasing export pumping capacity at SWP facilities in the south Delta from their current limit of 6,680 cubic feet per second (cfs) to 8,500 cfs and eventually to 10,300 cfs. Several major projects include new fish screens at the Clifton Court Forebay and Tracy Pumping Plant; operable barriers to improve south Delta water levels and quality; the Tracy Fish Test Facility; Delta Cross Channel Reoperation; Clifton Court Forebay/Tracy Pumping Plant Intertie; CVP/SWP Aqueduct Intertie; and the San Luis Reservoir Low Point Improvement Project.

Water Use Efficiency

The goal of the Water Use Efficiency Program is to aggressively make the best use of existing water supplies through defining appropriate water measurement; certifying urban best management practices (BMP); and refining quantifiable objectives for agricultural water use efficiency. The program supports local water conservation and recycling projects. Savings resulting from the Water Use Efficiency Program will be accomplished through incentive-based, voluntary programs.

Water Transfers

Potential water transfers are being evaluated to minimize the effects of a drought. Work is continuing on promoting an effective water transfer market that protects water rights, the environment, and local economies.

Environmental Water Account

The CALFED ROD defined the EWA as a short-term, 4-year program (2001 to 2004) to help resolve one of the Bay-Delta's most fundamental conflicts: the competing needs of water management operations and the environment. In September 2004, the EWA agencies extended the program through 2007, in accordance with the CALFED ROD. The EWA provides an institutional framework through which water managers can acquire, store, transfer, and release water strategically to respond to fishery and ecosystem needs in the Delta, and in upstream tributaries. Federal legislation enacted in October 2004 authorized appropriations for six years for the EWA. Reclamation is leading development of an EIS/EIR for a proposed long-term EWA program, which is anticipated for completion in winter 2006/2007. The proposed long-term EWA, if extended beyond 2007, is likely to be an acquisitions-based program similar to the short-term EWA.

Drinking Water Quality

The focus of the Drinking Water Quality Program is to improve water quality from source to tap for Californians whose drinking water supplies come from the Bay-Delta watershed. The program includes (1) developing source improvements and drainage management programs, (2) investing in treatment technology projects, (3) developing a Bay Area Blending and Exchange Program, (4) facilitating efforts to develop alternative sources of water supply for Southern California, and (5) improving dissolved oxygen conditions in the San Joaquin River.

Watershed Management

The Watershed Management Program promotes locally led watershed management activities and protections that contribute to the achievement of CALFED goals for ecosystem restoration, water quality improvement, and water supply reliability. Watershed plans and actions were developed to achieve the multiple objectives of improved water supply reliability, flood management, environmental restoration, and water quality. The major elements of the Watershed Program included establishment of a grant program to solicit, evaluate and fund local projects that contribute to achieving goals, and development of watershed program performance measures and monitoring protocols.

Levee System Integrity

The purpose of the Levee System Integrity Program is to reduce the threat of levee failure and seawater intrusion to protect water supplies, water quality, major roadways, cities, towns, agricultural lands, and environmental and aquatic habitat, primarily in the Delta. The program includes funding for local reclamation districts to reconstruct Delta levees to a base level of protection, develop BMPs for beneficial reuse of dredged material, and refine Delta Emergency Management plans and a Delta Risk Assessment.

Ecosystem Restoration

The Ecosystem Restoration Program (ERP) goal is to improve aquatic and terrestrial habitats and natural processes to support stable, self-sustaining populations of diverse and valuable plant and animal species throughout the Bay-Delta's watershed through an adaptive management process. ERP actions include, but are not limited to (1) implementation of large-scale restoration projects on selected streams and rivers, (2) recovery of species listed under the Federal and State ESAs, (3) fish passage improvements through modification or removal of dams, improved bypasses, and ladders, (4) habitat restoration in the Delta and its tributary watersheds, (5) integration of flood management and ecosystem restoration, (6) stream flow augmentation in upstream areas through voluntary water purchases, (7) implementation of an invasive species program, including prevention, control and eradication, and (8) assistance for existing agency programs to reduce water quality impairments in the Bay-Delta and its tributaries.

Science

The long-term goal of the Science Program is to establish an unbiased, relevant, and authoritative body of knowledge that is integrated across Program elements and communicated to the scientific community, CALFED agency managers, stakeholders, and the public. The program aims to integrate world-class science and peer review into every aspect of CALFED to develop the best scientific information possible to guide decisions and evaluate actions critical to success.

CALFED Surface Water Storage Program

As noted previously, the Investigation is being developed consistent with CALFED ROD guidance as part of the CALFED Storage Program. Results of initial evaluations to formulate this program were presented in the Integrated Storage Investigation Report - Initial Surface Water Storage Screening (August 2000), which assessed and screened numerous potential reservoir sites. Of many potential surface water storage projects considered, 12 were retained for more detailed evaluation. For these 12 retained sites, 5 were included in the Preferred Program Alternative for consideration during Phase 1 of CALFED Program implementation. DWR and Reclamation committed to assume lead agency roles for investigation of these sites and to work with other CALFED agencies in pursuing their implementation. The five surface water storage projects include Enlarge Shasta, In-Delta Storage, Los Vaqueros Reservoir Enlargement, Sites Reservoir (a.k.a. North-of-the-Delta Offstream Storage (NODOS)), and Upper San Joaquin River Basin Storage. The first four of these projects are described in the following sections.

Enlarge Shasta Lake

The Enlarge Shasta Lake project described in the CALFED ROD consists of expanding Shasta Lake by approximately 300 TAF through raising Shasta Dam 6.5 feet. The ROD indicates that this action would provide potential benefits such as increasing the pool of cold water available in Shasta Lake to maintain lower Sacramento River temperatures needed by certain fish and providing other water management benefits, such as water supply reliability.

In-Delta Storage

The In-Delta Storage Project (IDSP) would provide capacity to store approximately 217 TAF of water in the south Delta for a wide array of water supply, water quality, and ecosystem benefits. The project would include two storage islands (Webb Tract and Bacon Island) and two habitat islands (Holland Tract and Bouldin Island), similar to what was proposed by Delta Wetlands over a decade ago, but also would include new embankment design, consolidated inlet and outlet structures, new project operations, and revised Habitat Management Plans. DWR completed the Draft State Feasibility Study and released the Draft Executive Summary Report for the IDSP for stakeholder and public reviews in February 2004. These reviews indicated the need for further analysis of the water quality, risk of failure, operations, and economic viability of the project. The IDSP could provide a variety of benefits and contribute to meeting each of the CALFED Program's four objectives for water supply reliability, water quality, ecosystem restoration, and levee system integrity. The project could meet the water supply and operational flexibility needs of the SWP and the CVP.

Los Vaqueros Reservoir Enlargement

The Los Vaqueros Reservoir Enlargement project consists of enlarging the existing 100 TAF reservoir up to 500 TAF. The objectives of the project include improving the quality and reliability of Bay Area drinking water supplies, and improving Delta aquatic resources by reducing the effects of water deliveries from the Delta. The Contra Costa Water District (CCWD), Reclamation, and DWR are conducting feasibility studies and supporting technical evaluations. The focus of current studies is defining alternatives to address identified problems, environmental review, public input and outreach, and operations and water quality modeling.

North-of-the-Delta Offstream Storage

The NODOS (identified in the CALFED ROD as Sites Reservoir) investigation focuses on potential projects on the west side of the Sacramento Valley, including Sites Reservoir. Storing water in offstream reservoirs during excess flow periods provides opportunities to increase water storage in an environmentally sensitive manner. The stored water then could be made available for beneficial uses, including enhancing water management flexibility, reducing water diversion on the Sacramento River during critical fish migration periods, increasing the reliability of supplies for a significant portion of the Sacramento Valley, and providing storage and operational benefits for other CALFED programs, including Delta water quality and EWA. Public scoping for NODOS has been completed and planning, environmental, engineering, and other related work is progressing.

LOCAL AGENCY PROGRAMS AND STUDIES

San Joaquin River Exchange Contractors Water Authority Water Transfer Program

The San Joaquin River Exchange Contractors Authority recently completed an EIR to support a 10-year program, from 2005 to 2014, to allow the transfer of up to 130 TAF of substitute water from the Exchange Contractors to other water users. A maximum of 80 TAF would developed water from conservation measures, including tailwater recovery and groundwater pumping, and a maximum of 50 TAF would be developed from temporary land fallowing. Potential recipients of the water include CVP contractors, Reclamation for delivery to the San Joaquin Valley wetland habitat areas (wildlife refuges), and Reclamation and/or DWR to support EWA.

Vernalis Adaptive Management Program

The Vernalis Adaptive Management Program (VAMP) is an experimental study on the impact of flow, non-flow, and export rates on salmon fisheries in the lower San Joaquin River. The primary objective of VAMP is to implement a pulse flow for a 31-day period in the San Joaquin River at Vernalis during April and May to temporarily enhance the river's assimilative capacity for salt, thereby improving water quality for fisheries, such as spring-run Chinook salmon. Water will be used over the period of 1999 to 2010 and flows will vary annually depending on hydrological and biological conditions.

Water for achieving the VAMP 31-day pulse flow (April-May) is provided by the San Joaquin River Group Authority (SJRGA) member agencies. Total water supply to support VAMP is capped at 110 TAF in any year. Reclamation and DWR compensate SJRGA to ensure that water supplies are available for instream flows, as needed, up to prescribed limits.

Additional water in excess of 110 TAF can be acquired from willing sellers who are members of the SJRGA. The additional water would be used for ramping around the pulse flow to assist in protecting salmon redds, control any water temperature, and improving water quality. Because the water released would increase instream flows in the lower San Joaquin River, it also would contribute to compliance with the 1995 WQCP Vernalis objectives and with the San Joaquin River component of the Delta Smelt BO (Reclamation and SJRGA, 1999).

San Joaquin River Agreement

The San Joaquin River Agreement (SJRA), adopted in 2000, is a water supply program to provide increased instream flows in the San Joaquin River. The water would provide protective measures for fall-run Chinook salmon in the San Joaquin River under VAMP. Parties to the Agreement include the following:

- **California Resources Agency departments** – DWR, and California Department of Fish and Game (DFG).
- **United States Department of the Interior (DOI) agencies** – Reclamation and USFWS.
- **San Joaquin River Group Authority agencies** – SJRGA and its member agencies, including the Modesto Irrigation District, Turlock Irrigation District, Merced Irrigation District, South San Joaquin Irrigation District, and Oakdale Irrigation District; the San Joaquin River Exchange Contractors Water Authority and its member agencies, including the Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water District, and Columbia Canal Company; the Friant Water Users Authority on behalf of its member agencies; and the City and County of San Francisco (CCSF).
- **CVP and SWP Contractors** – State Water Contractors, Kern County Water Agency, Tulare Lake Basin Water Storage District, Santa Clara Valley Water District, San Luis and Delta-Mendota Water Authority, Westlands Water District, and Metropolitan Water District of Southern California.
- **Environmental Interest Groups** – Natural Heritage Institute and The Bay Institute of San Francisco.

Friant Water Users Authority and Natural Resources Defense Council Studies

In 2000, FWUA and NRDC jointly began developing a restoration plan to support natural production of a salmon fishery and a water supply replacement plan that would not adversely affect the Friant water users. This work was intended to contribute to settling litigation between Reclamation and a coalition of environmental organizations led by NRDC regarding the operation of Friant Dam. These collaborative efforts were broken off in 2003 without agreement on a suitable restoration plan or water supply strategy.

Some of the information developed in this process is relevant to the Investigation. The studies, pilot projects, and investigations were funded by Reclamation to assist Interior in meeting its requirements under the CVPIA; DWR provided support through the state's Proposition 13 funding. The surface storage sites identified by this process were considered and evaluated during Phase 1 of the Investigation. Ongoing revisions to the restoration plan (now termed "Draft Restoration Strategies for the San Joaquin River Report") will be considered by the Investigation when the report is completed and released.

Upper San Joaquin River Conceptual Restoration Plan

The San Joaquin River Resources Management Coalition, which includes a group of local landowners, water and irrigation districts, the San Joaquin River Exchange Contractors Water Authority (SJRECWA), FWUA, environmental community representatives, farm bureaus, and a USFWS National Wildlife Refuge system representative, is currently developing a restoration plan for the San Joaquin River. The objective of the Upper San Joaquin River Conceptual Restoration Plan is to develop a set of actions that enhance current human and environmental functions of the upper San Joaquin River. This effort, funded in part through USEPA, will be developed in several phases.

The initial phase of study, completed in August 2003, included a description of current ecosystem conditions in the San Joaquin River from Friant Dam to the confluence of the Merced River and a process for developing a restoration plan. The current phase of work is focusing on refining the framework for developing restoration plan goals and identifying restoration actions that could implemented. Model simulations are being conducted to evaluate alternative means to provide the flows necessary to meet life stage requirements for targeted species and fish assemblages in the San Joaquin River.

Friant Water Authority and Metropolitan Water District of Southern California Partnership Studies

FWA and Metropolitan Water District of Southern California (MWDSC) have entered into a partnership, based on an approved set of principles, to investigate the potential of enhancing water supply and affordability in eastern San Joaquin Valley while improving water quality for Southern California water users. FWA and MWDSC are studying possible projects that would benefit each region while creating no adverse impacts.

The partnership is based on the desire by both parties to work together in an effort to investigate joint water management projects that can be implemented to benefit both agencies, their members, and water users. To date, a set of technical memoranda have been prepared that present pre-feasibility analysis of existing facilities and potential constraints. Two ongoing studies include potential enlargement of Mammoth Pool Reservoir and exchange opportunities between Friant Division and Delta water supplies.

Mammoth Pool Enlargement Study

FWA and the Metropolitan Water District of Southern California are conducting a reconnaissance-level investigation of enlarging of Mammoth Pool Reservoir. The study entails revisiting a former Southern California Edison (SCE) proposal to enlarge Mammoth Pool by installing eight 25-foot radial gates across the natural rock spillway to raise the maximum lake level, and constructing a 5-foot parapet on top of the existing dam to maintain freeboard under emergency storage conditions. Enlarging of Mammoth Pool would create 30 TAF of additional water storage.

Friant Division and Delta Water Supply Exchange Study

Ongoing studies are focusing on operations simulations to accomplish exchanges that would deliver high quality water from the Friant Division to MWDSC in exchange for water supplies delivered from the Delta. Studies are also underway to identify potential long-term effects of Delta water supplies on groundwater quality in the Friant Division. Information from these studies on operational assumptions to support water quality exchanges will be considered by the Investigation as it becomes available.

Millerton Area Watershed Coalition

The Millerton Area Watershed Coalition (MAWC) is a collaborative organization that includes property owners and other stakeholders within the upper San Joaquin River watershed area between Friant and Kerckhoff dams. The MAWC was established through a CALFED Watershed Program grant to conduct a comprehensive assessment of the Millerton area watershed. The objective of the watershed assessment is to describe baseline conditions. Other activities required under the grant include administrative and organizational support for the expanded community-based coalition, training and outreach, collaboration and coordination with local, State, and Federal agencies, watershed organizations and others, continuance of the Coalition, development of a comprehensive Watershed Work Plan, and monthly program status reports to CALFED. In fulfillment of CALFED contract requirements, MAWC submitted a Draft Millerton Area Watershed Assessment (Upper San Joaquin River) in December 2003. Relevant information from this and other related studies completed by MAWC will be considered in the Investigation.

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CHAPTER 3. WITHOUT-PROJECT CONDITIONS

One of the most important elements of any water resources evaluation is defining the scope of the problems to be solved and opportunities to be addressed. Significant in this process is defining existing resources conditions and how these conditions may change in the future. The magnitude of change not only influences the scope of the problems, needs, and opportunities, but the extent of related resources that could be influenced by possible actions taken to address them. Accordingly, this chapter presents a brief assessment of existing conditions and estimated future without-project baseline conditions in the primary study area.

EXISTING CONDITIONS

This section describes the primary study area and existing physical, biological, social and economic, and cultural conditions in the study area. Additional information on these conditions, and conditions in an extended study area that includes the Sacramento-San Joaquin Delta, will be contained in future Investigation documents.

Study Area

As described in **Chapter 1**, the area of emphasis for the Investigation includes the San Joaquin River watershed upstream of Friant Dam, the San Joaquin River from Friant Dam to the Delta, and the portions of the San Joaquin and Tulare Lake hydrologic regions served by the Friant-Kern and Madera canals. These areas are highlighted in **Figure 1-1** and include all potential storage sites under consideration, the region served by the Friant Division of the CVP, the eastern San Joaquin Valley groundwater basins, and the portion of the San Joaquin River most directly affected by the operation of Friant Dam.

Because of the large geographic extent of the area of emphasis for the Investigation, the study area is described in two parts: a primary study area and an extended study area. In general, the primary study area includes specific locations that would be affected by the implementation of project actions. At this time, the primary study area includes locations that would be affected by reservoir sites evaluated in this report. This includes Friant Dam and Millerton Lake, several potential storage locations on the San Joaquin River upstream of Friant Dam, potential offstream locations in the San Joaquin River watershed, and potential off-canal locations in Yokohl Valley. As the Investigation proceeds, the primary study area will continue to be revised to include specific sites that would be affected by surface water and groundwater storage components of alternatives.

The extended study area is defined as areas potentially affected by operations of Friant Dam, deliveries from the Friant-Kern and Madera canals, and releases to the San Joaquin River. At this time, the extended study area includes the San Joaquin River downstream of Friant Dam, including the Delta, lands with San Joaquin River water rights, the Friant Division service area, and the eastern San Joaquin Valley groundwater basins. Operational changes at Friant Dam also could affect the broader geographic area served by the CVP and SWP. Information on conditions in the extended study area will be included in future documents for the Investigation.

Friant Dam and Millerton Lake

This section describes existing conditions for Friant Dam and Millerton Lake water control facilities, recreation facilities, and other reservoir area infrastructure.

Existing Water Control Facilities

Friant Dam is located on the San Joaquin River on the border between Fresno and Madera counties, near the community of Friant, about 20 miles northeast of Fresno. Friant Dam, owned and operated by Reclamation, was constructed between 1939 and 1942. It is a concrete gravity dam that impounds Millerton Lake on the San Joaquin River. Three small saddle dams that close low areas along the reservoir rim are located on the southern side of the reservoir. The reservoir, with a gross storage capacity of 520 TAF at an elevation of 578 feet above mean sea level (elevation 578), is operated for water supply and flood control. Water deliveries, principally for irrigation, are made through outlet works to the Friant-Kern and Madera canals, which were completed in 1949 and 1944, respectively. Physical data pertaining to Friant Dam and Millerton Lake are presented in **Table 3-1.**


Friant Dam

The spillway consists of an ogee overflow section, chute, and stilling basin at the center of the dam. The spillway is controlled by one 18-foot-high by 100-foot-wide drum gate, and two comparably sized Obermeyer gates. Outlets to the Madera Canal are located on the right abutment; outlets to the Friant-Kern Canal are located on the left abutment. A river outlet works is located to the left of the spillway within the lower portion of the dam.

Three powerhouses, owned and operated by the Friant Power Authority, are located on the downstream side of Friant Dam. A powerhouse on each canal generates hydroelectricity as water is released to the Friant-Kern and Madera canals for delivery. A third powerhouse located at the base of the dam adjacent to the spillway generates hydroelectricity as water is released to the San Joaquin River. The combined capacity of the three powerhouses is 30 megawatts (MW).

Recreation Facilities and Other Reservoir Area Infrastructure

Lands around Millerton Lake have been developed for recreational, residential, and power development purposes. The general locations of facilities and developed lands around Millerton Lake are shown in **Figure 3-1** and summarized in **Table 3-2**.

TABLE 3-1. PERTINENT PHYSICAL DATA – FRIANT DAM AND MILLERTON LAKE

General			
Drainage Areas		Unimpaired Flows of Friant Dam	
Friant Dam	1,638 square miles	Mean annual runoff (1873-1977)	1,790,300 acre-feet
Mono Creek at Lake Thomas A. Edison	95.2 square miles	Average flow	2,470 cfs
South Fork San Joaquin River at Florence Lake	171 square miles	Min mean daily inflow (10 Oct 1977)	0 cfs
		Max mean daily inflow (23 Dec 1955)	61,700 cfs
Big Creek at Huntington Lake	80.5 square miles	Max instantaneous inflow (23 Dec 1955)	97,000 cfs
North Fork Willow Creek at Bass Lake	50.4 square miles		
Stevenson Creek at Shaver Lake	29.1 square miles	Max mean daily outflow (6 Jun 1969)	12,400 cfs
San Joaquin River at Mammoth Pool Reservoir	1,003 square miles	Min mean daily outflow (20 Oct 1940)	5.5 cfs
San Joaquin River at Redinger Lake	1,295 square miles	Spillway design flood	
San Joaquin River at Kerckhoff Diversion	1,461 square miles	Peak inflow	197,000 cfs
San Joaquin River at Mendota	3,943 square miles	Peak outflow	158,500 cfs
Friant Dam and Millerton Lake[1]			
Friant Dam (concrete gravity)		**Millerton Lake**	
Elevation, top of parapet	585.0 feet above msl	Elevations	
Freeboard above spillway flood pool	3.25 feet	Minimum operating level[2]	466.1 feet above msl
Elevation, crown of roadway	581.25 feet above msl	Gross pool	578.0 feet above msl
Max height, foundation to crown of roadway	319 feet	Spillway flood pool	585.0 feet above msl
Length of crest		Area	
Left abutment, non-overflow section	1,478 feet	Minimum operating level	2,100 acres
Overflow river section	332 feet	Gross pool	4,850 acres
Right abutment, non-overflow section	1,678 feet	Spillway flood pool	5,085 acres
Total length	3,488 feet	Storage capacity	
Width of crest at elevation 581.25	20.0 feet	Minimum operating level	130,000 acre-feet
Total concrete in dam and appurtenances	2,135,000 yd^3	Gross pool	520,500 acre-feet
		Spillway flood pool	555,450 acre-feet
Spillway (gated ogee)		**Friant-Kern Canal**	
Crest length		Length	152 miles
Gross	332 feet	Operating capacity below Friant Dam	4,000 cfs
Net	300 feet	Operating capacity at terminus of canal	2,000 cfs
Crest elevation	560 feet above msl		
Discharge capacity (height = 18.0 feet)	83,160 cfs	**Madera Canal**	
Crest gates (1 drum and 2 Obermeyer)		Length	35.9 miles
Number and size	3 @ 100 feet by 18 feet	Capacity below Friant Dam	1,000 cfs
Top elevation when lowered	560 feet above msl	Capacity at Chowchilla River	625 cfs
Top elevation when raised	578 feet above msl		
Outlets			
River outlets (110-inch dia. w/ 96-inch hollow jet valves)			
Number and elevation	4 @ 380 feet above msl		
Capacity at minimum pool	4,000 cfs		
Capacity at gross pool	12,300 cfs		
Diversion outlets, Madera (91-inch dia. w/ 86-inch needle valve)			
Number and elevation	2 @ 446 feet above msl		
Capacity at minimum pool	1,000 cfs		
Capacity at gross pool	4,600 cfs		

Key:
cfs – cubic feet per second
kW – kilowatt
yd^3 – cubic yard
hp – horsepower
msl – mean sea level

Notes:

[1] Elevations given are in vertical datum NGVD 1929.

[2] Minimum operating level generally corresponds with elevation of Madera Canal outlets. Minimum storage for Friant-Kern Canal diversion is about 135 TAF.

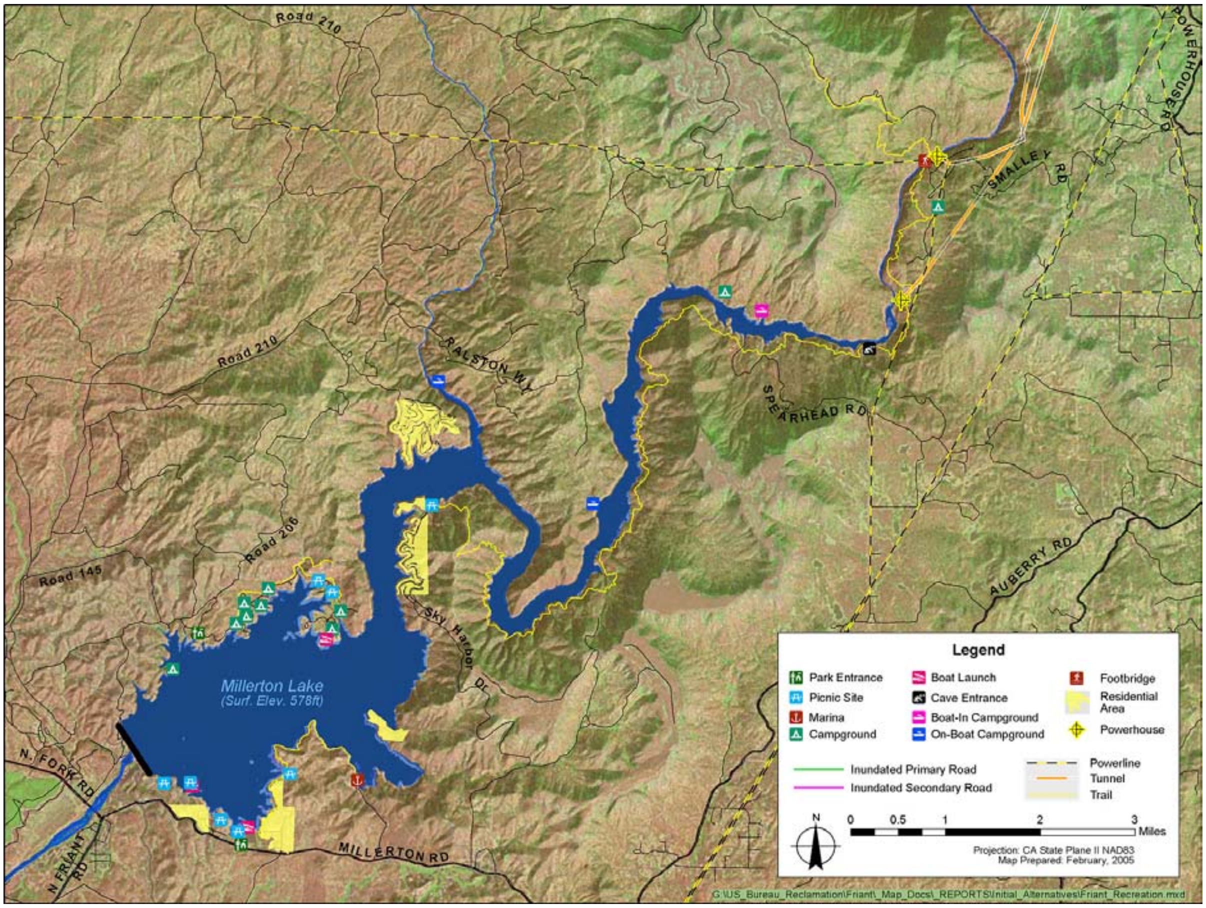


FIGURE 3-1.
MILLERTON LAKE AREA FACILITIES AND DEVELOPED LANDS

The Millerton Lake SRA, managed by the CDPR, contains numerous recreation facilities on both the north and south sides of the reservoir. These include 10 camping areas, 6 boat ramps, a privately operated marina, 3 picnic and day-use areas, 4 trails, and parking, telephone, and toilet facilities.

The San Joaquin River Gorge, a management area administered by BLM, is situated upstream from the SRA. It contains a replicated Native American village, trails, a footbridge across the San Joaquin River, and a primitive campground. The most prominent trail is the San Joaquin River Gorge Trail, which connects the South Fine Gold picnic area in the SRA to the BLM primitive campground off Smalley Road, crosses the footbridge, and climbs the terrain north of the river.

The Fresno County Courthouse was removed from an area now within Millerton Lake at the time of Friant Dam construction. The brick and stone building now overlooks the lake from a site on the south side of the reservoir.

TABLE 3-2.
MILLERTON LAKE AREA FACILITIES ABOVE FRIANT DAM

Approximate Elevation (feet above msl)	Approximate Location (SJR River Mile)	Facility
569	269	Boat Ramps Nos. 2-5
580	268	Boat Ramp No. 1
580	269	South Bar Picnic Area
580 – 765	267.5 - 268.5	Lakeview Estates Residential Area (west)
580 – 971	271 - 273	Sky Harbor Residential Development
580 – 883	272.5 - 273	Hidden View Residential Development
580	273	Fine Gold Day Use Area
580 – 600	269 - 270	SRA Blue Oak Trail
580 – 650	269 - 270	SRA North Shore Trail
580 – 1,240	273 - 284	San Joaquin River Trail (SRA to SJR Gorge portion)
582	270	Boat Ramp No. 6
585	269.5	Millerton Marina
589	281	Temperance Flat Boat-In Campground
590	268	Rocky Point Campground
590	268.5	North Shore Area Park Entrance
590	269	Dumna Strand Campground
592 – 705	280.5 - 281	Temperance Flat Residences
594 – 640	269 - 269.5	Lakeview Estates Residential Area (east)
597 – 705	270	Winchell Bay Residential Area
600	268	Historic Courthouse
600	268	Picnic Facilities at South Shore of Millerton Lake
600	268	South Shore Area Park Entrance
600	269	Fort Miller Campground
600	270	Valley Oak Campground
600	277	On-Boat Camping
605	282.5	Kerckhoff No. 2 Powerhouse Access Tunnel Entrance
620	269	Rocky Point Campground
620	269	Group Campground
630	269	Mono Campground
630	281	Toilet Facility
640	Fine Gold Creek, RM1	N. Fine Gold On-Boat Camping Area
650	280	Hewitt Valley Environmental Camps
650 – 1,088	269.5 - 270	SRA Buzzards Roost Trail
675	284.5	Kerckhoff Powerhouse Main Floor
680	284.5	BLM Footbridge
680 – 2,120	283.5 - 284.5	San Joaquin River Trail (SJR Gorge portion)
778	283	Substation for Kerckhoff No. 2 Powerhouse
889	292.5	Base of Kerckhoff Dam
921	284.5	Surge Chamber for Kerckhoff Powerhouse
960	285	BLM Native American Village (reproduction)
971	292.5	Kerckhoff Dam Crest
1,030	284	BLM Primitive Campground

Key:
BLM – Bureau of Land Management
msl – mean sea level
RM – river mile
SJR – San Joaquin River
SRA – State Recreation Area

Several residential areas have been established around Millerton Lake. Three residential developments are located in Fresno County (Lakeview Estates, Winchell Bay, and Sky Harbor); one major development, Hidden View Estates, is located in Madera County. Each of these residential areas includes developed and undeveloped parcels. Other residential sites include two homes in the Temperance Flat area.

Winchell Cove Marina

Several roads in the Millerton Lake area provide access to residential areas and recreation facilities. Millerton Road skirts the south side of the reservoir, connecting the community of Friant with Auberry Road. Winchell Cove Road and Sky Harbor Road extend from Millerton Road north into residential areas. Madera County Road 206 and Road 145 on the north side of the lake lead to recreational facilities in the SRA. County Road 216 provides access from north of Millerton Lake into the Hidden View residential area near the confluence of Fine Gold Creek and Millerton Lake.

Two Pacific Gas and Electric (PG&E) powerhouses, the Kerckhoff Powerhouse and Kerckhoff No. 2 Powerhouse, are located within a mile of the upstream end of Millerton Lake. Water is diverted from Kerckhoff Lake at Kerckhoff Dam and conveyed through tunnels and penstocks to serve the powerhouses. The Kerckhoff Powerhouse was commissioned in 1920, has a generation capacity just under 40 MW, and is located on the San Joaquin River at RM 284.5, about a mile upstream of the upper limit of Millerton Lake. The Kerckhoff No. 2 Powerhouse is a relatively modern facility, commissioned in 1983, with a capacity of 155 MW. It discharges directly to the upstream portion of Millerton Lake at RM 282.5.

Physical Environment

Elements of the physical environment in the upper San Joaquin River basin are described in this section and include topography, geology, climate, hydrology, geomorphology, soils, sedimentation and erosion, flood control, water quality, groundwater resources, air quality, and noise.

Topography

Regional topography consists of the nearly level floor of the San Joaquin Valley rising abruptly to moderately steep, northwest-trending foothills with rounded canyons. Elevations in the immediate area of Millerton Lake range from about elevation 310 at Friant dam to over elevation 2,100 at the upper end of the reservoir.

Farther east, the terrain becomes steeper and the canyons become more incised. The canyons were cut by southwest- to west-flowing rivers and associated large tributaries. The topography of the San Joaquin River basin rises to over elevation 12,000 in the upper watershed, located in the Sierra Nevada.

Geology

The Investigation study area is located along the western border of the central portion of the Sierra Nevada Province at its boundary with the eastern edge of the Great Valley province of California. The Sierra Nevada batholith comprises primarily intrusive rocks, including granite and granodiorite, with some metamorphosed granite and granite gneiss. Intrusive Sierra Nevada batholith rocks underlie most of Millerton Lake and the Temperance Flat area dam sites. Occasional remnants of lava flows and layered tuff are present in the area at the highest elevations.

The central Sierra Nevada has a complex history of uplift and erosion. The greatest uplift tilted the western flank of the Sierra Nevada to the west. At the western border, alluvium and sedimentary rocks of the Great Valley Province overtop the Sierra Nevada. Metamorphic rocks in the Friant Dam area dip steeply downstream to the west, and strike northwesterly. The contact of these metamorphic rocks with the Sierra Nevada batholith lies just east of the dam in Millerton Lake. Friant Dam is founded on metamorphic rocks consisting of quartz biotite schist intruded by aplite and pegmatite dikes and by inclusions of dioritic rocks. Erosion has resulted in thin colluvial cover (Reclamation, 2002).

Table Top Formation, near Temperance Flat

The west- to northwest-trending Yokohl Valley is located in what may be an erodible zone along a geologic contact between granitic rocks and a roof pendant of pre-Cretaceous metasedimentary rock. At the dam site, an undated Reclamation geologic map shows that pre-Cretaceous metagabbro and Mesozoic ultrabasic intrusive (serpentenite and talcose serpentenite) rocks are found in both proposed dam abutments. Pre-Cretaceous amphibolite also is found in the right abutment. The perimeter of the potential reservoir is surrounded by Mesozoic granitics (quartz diorite), basic and ultrabasic intrusive rocks, and pre-Cretaceous metasedimentary rocks.

Climate and Hydrologic Setting

The climate of the San Joaquin River Valley is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures on the valley floor often exceed 100 degrees Fahrenheit (°F) for extended periods of time, while winter temperatures only occasionally fall below freezing. Higher elevation portions of the watershed have distinct wet and dry seasons. Most of the precipitation falls from November to April, with rain at the lower elevations and snow in the higher regions. On the valley floor, precipitation decreases from north to south, ranging from 14 inches in Stockton to 8 inches at Mendota.

The San Joaquin River originates in the Sierra Nevada at over elevation 12,000 and flows into the San Joaquin Valley at Friant. Snowmelt is the main contributor to flow in the upper San Joaquin River. Large areas of high elevation watershed supply snowmelt runoff during the late spring and early summer months. Downstream of Friant Dam, the river flows westward toward the center of the valley floor, where it turns sharply northward and flows through the San Joaquin Valley to the Delta. Along the valley floor, the San Joaquin River receives additional flow from the Merced, Tuolumne, and Stanislaus rivers and numerous smaller tributaries.

The upper San Joaquin River section, upstream of the confluence with the Merced River, was historically characterized by runoff from the San Joaquin River. During the past 100 years, development in this area has resulted in groundwater overdraft conditions, and the river loses much of its flow through percolation.

Flows in the upper San Joaquin River are regulated by Friant Dam, which was completed in 1941 to store and divert water to the Madera and Friant-Kern canals for irrigation and M&I water supplies in the eastern portion of the San Joaquin Valley. In the reach between Friant Dam and Gravelly Ford, flow is influenced by releases from Friant Dam, with minor contributions from agricultural and urban return flows. Average monthly releases from Friant Dam to the San Joaquin River since 1941 are generally limited to minimum releases to satisfy water rights, instream flows above Gravelly Ford, and flood control releases.

Millerton Lake, formed by Friant Dam, has a capacity of 520 TAF. Above Friant Dam, the San Joaquin River drains an area of approximately 1,676 square miles and has an annual average unimpaired runoff of 1.7 MAF. The median historical unimpaired runoff is 1.4 MAF, with a range of 0.4 to 4.6 MAF. Several reservoirs in the upper portion of the San Joaquin River watershed, including Mammoth Pool and Shaver Lake, are used primarily for hydroelectric power generation. Operation of these reservoirs affects the inflow to Millerton Lake.

The California Data Exchange Center (CDEC) maintains estimates of unimpaired flow (flow that would occur at a specific location if upstream facilities were not in place) at four locations in the upper San Joaquin River basin. As indicated in **Table 3-3**, annual runoff from the upper San Joaquin River basin (at Friant Dam) varies widely, ranging from about 362 TAF in 1977 to 4,642 TAF in 1983.

Normal annual precipitation over the Yokohl Creek watershed averages 20 inches, ranging from about 11.5 inches at its confluence with the Kaweah River to about 30 inches in its headwaters.

TABLE 3-3.
RUNOFF IN THE UPPER SAN JOAQUIN RIVER BASIN

Station (CDEC ID)	Record Period	Annual Runoff (TAF)		
		Maximum	Average	Minimum
Big Creek below Huntington Lake (BHN)	2/1905 – 9/1980	297.8	110.6	14.4
San Joaquin South Fork near Florence (SFR)	10/1900 – 9/1980	248.9	652.5	71.3
San Joaquin River at Mammoth Pool (SJM)	10/1905 – 9/1980	2,964.1	1,323.8	307.9
San Joaquin River below Friant Dam (SJF)	10/1900 – present	4,641.9	1,830.3	361.6

Key:
CDEC – California Data Exchange Center TAF – thousand acre-feet

Hydrology and Geomorphology

This section describes hydrology and geomorphology in discrete river reaches along the San Joaquin River, Granite, Jackass, Chiquito and Fine Gold creeks, and in Yokohl Valley. These river reaches were identified to support evaluations presented in later chapters of this report. The geographic extent of the river reaches is described in **Table 3-4** and shown in **Figure 3-2** (Yokohl Valley is not shown in **Figure 3-2**).

TABLE 3-4.
RIVER REACHES IN THE INVESTIGATION PRIMARY STUDY AREA

River Reach	From	To
Millerton Lake and Big Bend	Friant Dam	RM 280
Temperance Flat and Millerton Bottoms	RM 280	RM 284
Patterson Bend	RM 284	Kerckhoff Dam
Kerckhoff Lake and Horseshoe Bend	Kerckhoff Dam	Redinger Dam
Mammoth Reach	RM 315	Mammoth Pool Dam
Granite Creek	San Joaquin River	Granite Creek Headwaters
Jackass Creek	Mammoth Pool	Jackass Creek Headwaters
Chiquito Creek	Mammoth Pool	Chiquito Creek headwaters
Fine Gold Creek	Millerton Lake	Fine Gold Creek headwaters
Yokohl Valley	Friant-Kern Canal	Yokohl Creek headwaters

Key:
RM – river mile

Millerton Lake and Big Bend

Millerton Lake is the largest reservoir on the San Joaquin River. The lake is set in the lower foothills of the Sierras, is fairly open, and mostly surrounded by low hills. These reservoir facilities are part of the Friant Division of the CVP, and their operation significantly affects the flow in the San Joaquin River. Inflow to Millerton Lake is influenced by the operation of several upstream hydropower generation projects. Friant Dam is operated to supply water to agricultural and urban areas in the eastern San Joaquin Valley and to provide flood protection to downstream areas.

The narrow and steep-sided Big Bend area, also referred to as upper Millerton Lake, is immediately downstream of Temperance Flat. The shoreline in much of this portion of the reservoir is steep-sided and rocky, with little vegetation.

Temperance Flat and Millerton Bottoms

Temperance Flat is the only substantial area in upper Millerton Lake with a gently sloping shoreline, shallow water, and well-developed shoreline vegetation. The stretch of the river downstream of the Kerckhoff powerhouses, flowing into Temperance Flat, is referred to as Millerton Bottoms.

FIGURE 3-2.
RIVER REACHES IN THE INVESTIGATION PRIMARY STUDY AREA

Patterson Bend

The San Joaquin River upstream of Temperance Flat lies in a steep and narrow canyon that is particularly steep in the upper portion, and is known as the Patterson Bend reach. The river channel is bedrock-controlled with little gradient and many long, narrow pools. Average channel gradient in the reach is relatively low, at about 33 feet per mile. Stream flow in the reach usually results from flow releases mandated by the Federal Energy Regulatory Commission (FERC) for instream habitat: 15 cfs in dry water years and 25 cfs in normal water years (PG&E, 1999). Water is directed at Kerckhoff Dam through tunnels to downstream powerhouses and thus bypasses the reach, resulting in low flow.

Kerckhoff Lake and Horseshoe Bend

Kerckhoff Lake is a narrow, 2.5-mile-long reservoir with a capacity of about 4 TAF. The upper portion is shallow with a well-vegetated shoreline due to deposition of silt. The lower portion is in a steep-walled canyon with shoreline consisting mostly of bedrock.

Horseshoe Bend runs through a steep-sided canyon similar to the canyon below Kerckhoff Lake. The river channel has a low gradient and is bedrock-controlled, forming a series of long, deep pools and runs separated by rockfall debris. Average gradient is about 35 feet per mile, similar to that in the reach from Kerckhoff Reservoir to Millerton Reservoir. Much of the natural flow of the San Joaquin River is diverted at Redinger Dam to the Big Creek No. 4 Powerhouse. The FERC-mandated minimum flow for most of the reach is 20 cfs.

Mammoth Reach

For purposes of this Investigation, the Mammoth reach of the San Joaquin River extends from RM 315 to the base of the Mammoth Pool Dam (RM 322). The river is at elevation 3,052 at Mammoth Pool Dam and drops to elevation 2,340 at RM 315, running through a deep granitic canyon. Sediment supply in this reach tends to exceed transport capacity, resulting in net deposition and storage of sediments (SCE, 2003b). The segment from about Rock Creek to Ross Creek is somewhat wider and less confined than all other segments of Mammoth reach. Rock and Ross creeks are designated transport reaches (SCE, 2003b). Pools dominate habitat, with many riffles and a mixture of other habitat types, including several boulder and cobble bars that provide sediment storage (SCE, 2003b).

Granite Creek

The Granite Creek drainage basin totals 69.5 square miles and is entirely within the SNF, mostly contained within the Minarets Wilderness Area. Two major forks, East Fork and West Fork, originate from alpine lakes at elevations 9,000 to 10,000. Peak flows in Granite Creek occur in May or June and drop quickly through the summer months to very low flow conditions by early August (USJRWPA, 1982c).

In upstream sections of Granite Creek, the streambeds of the forks are wide, with cobble and gravel substrates. Banks in downstream sections are steep, and streambeds are heavily scoured with large boulder and granite bedrock substrates (USJRWPA, 1982c).

Jackass Creek

Jackass Creek flows approximately 15 miles from its source in Jackass lakes to Mammoth Pool Reservoir. The main stem has a watershed area of 24 square miles, and its lone major tributary, West Fork, adds 11 square miles of drainage (USJRWPA, 1982c). Elevations in the Jackass drainage exceed 9,750 in some areas; and average elevation 7,050 (USJRWPA, 1982c). Data from a gaging station indicate peak flows occur during May with average daily flows between 75 to 200 cfs, and drop steadily to no surface flow by early August (USJRWPA, 1982c).

Jackass Creek has a highly variable gradient. The streambed is primarily gravel and sand, with some cobble in faster stretches, and very little exposed bedrock. Banks generally have gradual slopes, and are heavily forested.

Chiquito Creek

Chiquito Creek flows north to south from its headwaters near Chiquito Lake, just west of the Ansel Adams Wilderness Area, to Mammoth Pool Reservoir. Elevation in the watershed ranges from 3,400 at Mammoth Pool Reservoir to 9,000 at the creek's source in the Sierra. The USGS maintained a gaging station on Chiquito Creek, near Arnold Meadow, from 1922 to 1928, and again from 1956 to 1970. Flow records from the gage, which was situated mid-watershed, indicate that peaks flows ranging from 300 to 410 cfs occur during the month of May and taper off to a base flow of about 10 cfs through the summer months.

Fine Gold Creek

The drainage area at the Fine Gold Dam site covers approximately 90 square miles. The terrain is mostly mountainous with steep slopes and moderate to heavy forest cover. Elevations range from about 600 at the dam site, to about 4,400 along the northern basin boundary. Fine Gold Creek is a largely intermittent foothill stream, with many of its smaller tributaries drying completely during summer months (Moyle et al., 1996). Most reaches of Fine Gold Creek consist of a few bouldery pools, 1 to 2 meters deep in summer, connected by long sandy-bottomed sections of stream (Moyle et al., 1996).

Yokohl Valley

Flows in Yokohl Creek are the result of rainfall only, since the watershed is below elevations where significant snow accumulates. Winter rain floods generally occur from November through April and are characterized by sharp peaks with most of the volume occurring within a few days. Average annual runoff from Yokohl Creek was not reported. The modeled Standard Project Flood for Yokohl Creek was reported as 10,400 cfs, with a maximum 1-day flow of 9,111 cfs (Corps, 1990b). Detailed flood data were not identified in the documents reviewed.

Soils

The primary study area for the Investigation is in the Upland Soils Physiographic Region of the Central Valley. Upland soils are found on hilly to mountainous topography on the perimeter of the Central Valley and are formed in place through the decomposition and disintegration of the underlying parent material. The more widespread upland soil groups include shallow depth, moderate depth, and deep depth to bedrock. Two upland soil groups, shallow depth and deep depth, are found in this geographic region and typically developed on igneous rocks.

Shallow Depth to Bedrock

This group of upland soils is found in the Sierra Nevada foothills that surround the Central Valley. The soil has a loam-to-clay-loam texture with low organic matter, and some areas have calcareous subsoils. These soils usually have a shallow depth to weathered bedrock of less than 2 feet and are found in areas of low to moderate rainfall that support grasslands used primarily for grazing. Tilled areas are subject to considerable erosion.

Deep Depth to Bedrock

These soils are found at the higher elevations in the Sierra Nevada on hilly to steep topography. This group of upland soils is characterized by moderate to strongly acidic reactions, especially in the subsoils, which can extend 3 to 6 feet in thickness before reaching bedrock. Bedrock consists of metasedimentary and granitic rocks. Soils forming on granitic rocks contain decomposed granitic sands. These soils receive 35 to 80 in/yr of precipitation and support extensive forests.

Sedimentation and Erosion

The substrate in the streams and river originating from the erosion of resistant granite in the upper San Joaquin River watershed generally comprises large boulders, larger cobbles of 4 inches or larger, and fine sand, with a small number of intermediate size gravels (SCE, 2003a). Since natural and cut slopes in decomposed granite erode readily and produce these coarse materials, soil erosion potential is high (FERC, 2002). Direct erosion and mass wasting into the watercourses is the primary reason that angular to subangular, medium-to coarse-grained sands, and large boulders make up most of the substrate of granitic watersheds (SCE, 2003a). The lack of favorable conditions for chemical weathering in the watershed results in the absence of fine-grained silts and clays. Land-disturbing activities such as road building and timber harvesting have the greatest potential to increase erosion, resulting in sedimentation in watercourses (SCE, 2003a). Sedimentation rates were not evaluated for the potential Yokohl Valley Reservoir, nor were downstream sedimentation issues.

Flood Control

Friant Dam is the principal flood storage facility on the San Joaquin River, with a dedicated flood management pool of 170 TAF. During flood conditions, Friant Dam is operated to maintain releases to the San Joaquin River at or below a flow objective of 8,000 cfs. Several flood events in the past few decades resulted in flows greater than 8,000 cfs downstream from Friant Dam and, in some cases, flood damages resulted.

Other flood management facilities of the San Joaquin River basin, shown in **Figure 3-3**, include levees along the San Joaquin River, Chowchilla Canal Bypass, and Eastside Bypass; levees along the lower portions of the Fresno River and Ash and Berenda sloughs; Bear Creek; and the Merced, Tuolumne, and Stanislaus rivers. The Chowchilla Canal Bypass diverts San Joaquin River flood flow and conveys it to the Eastside Bypass, which also intercepts flows from minor tributaries and rejoins the San Joaquin River between Fremont Ford and Bear Creek. Flood flows from the Kings River North enter Mendota Pool via the James Bypass. Dedicated flood storage space also is provided in Lake McClure (Merced River), Lake Don Pedro (Tuolumne River) and New Melones Reservoir (Stanislaus River). It should be noted that the San Joaquin River levee and diversion system is not designed to contain the release objective from each project reservoir simultaneously.

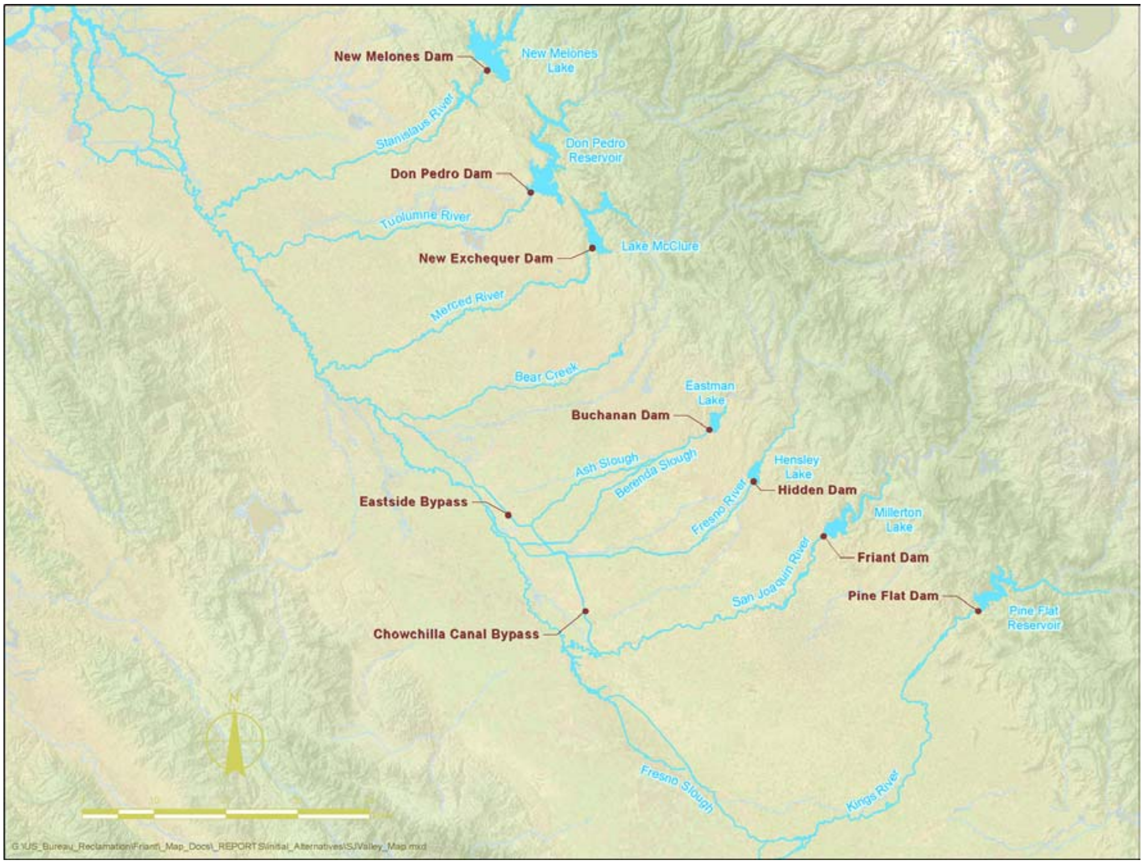


FIGURE 3-3.
EXISTING FLOOD MANAGEMENT FACILITIES IN THE SAN JOAQUIN RIVER BASIN

Water Quality

Water quality in the San Joaquin River varies considerably along the river's length. Above Millerton Lake and downstream towards Mendota Pool, water quality is generally excellent. The upper reaches of the rivers draining to the San Joaquin River basin originate in large drainage areas high on the west side of the Sierra Nevada. The water in these rivers is generally soft with low mineral concentrations. Water is nutrient- and mineral- poor due to the insolubility of the granite substrate. As these streams flow from the Sierra Nevada foothills across the eastern valley floor, their mineral concentration steadily increases. This increase in concentration is fairly uniform for each of the east side streams.

The reach from Gravelly Ford to Mendota Pool (about 17 miles) is frequently dry, except during flood control releases because all water released from Millerton Lake is diverted upstream to satisfy water rights agreements, or percolates to groundwater. As mentioned previously, flow in the reach between Friant Dam and Gravelly Ford is influenced by releases from Friant Dam, with minor contributions from agricultural and urban return flows.

During the irrigation season, most of the water released from the Mendota Pool to the San Joaquin River is imported from the Delta via the Delta-Mendota Canal, and generally has higher concentrations of total dissolved solids (TDS) than water in the upper reaches of the San Joaquin River. Most of the water released from the Mendota Pool to the San Joaquin River is diverted at or above Sack Dam for agricultural uses. Between Sack Dam and the confluence with Salt Slough, the San Joaquin River is often dry. From Salt Slough to Fremont Ford, most of the flow in the San Joaquin River is derived from irrigation return flows carried by Salt and Mud sloughs. This reach typically has the poorest water quality of any reach of the river.

As the San Joaquin River progresses downstream from Fremont Ford, water quality generally improves at successive confluences, specifically at those with the Merced, Tuolumne, and Stanislaus rivers. In the relatively long reach between the Merced and Tuolumne rivers, mineral concentrations tend to increase due to inflows of agricultural drainage water, other wastewaters, and effluent groundwater (DWR, 1965). TDS in the San Joaquin River near Vernalis has historically ranged from 52 milligrams per liter (mg/L) (at high flows) to 1,220 mg/L from 1951 to 1962 (DWR, 1965). During the mid to late 1960s, San Joaquin River water quality continued to decline. In 1972, the SWRCB included a provision in D-1422 that Reclamation maintain average monthly concentrations of TDS in the San Joaquin River at Vernalis of 500 mg/L as a condition of the operating permit for New Melones Reservoir on the Stanislaus River.

Section 303(d) of the Clean Water Act requires the identification of waterbodies that do not meet or are not expected to meet water quality standards, or are considered impaired. An affected waterbody and associated pollutant or stressor is prioritized in the 303(d) list. The Clean Water Act further requires the development of a TMDL for each listing. The current 303(d) list, prepared in 2002 and approved by the USEPA, includes segments of the San Joaquin River, as listed in **Table 3-5**. TMDL and Basin Plan Amendments for portions of the San Joaquin River are under development by the Central Valley RWQCB for dissolved oxygen, organophosphate pesticide (diazinon and chloropyrifos), salinity (electrical conductivity) boron, and selenium.

In the higher elevation portions of the watershed within the SNF, USFS has identified sedimentation as the greatest threat for increasing turbidity, degrading water quality, and subsequently impacting aquatic habitat within the SNF (USFS, 1991).

Groundwater Resources

The San Joaquin Valley groundwater basin is a structural trough up to 200 miles long and 70 miles wide filled with up to 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and erosion of surrounding mountains.

Continental deposits form an alluvial wedge that thickens from the valley margins toward the axis of the structural trough, which is generally oriented along a north-south alignment (DWR, 2003a). The top 2,000 feet of these sediments consist of continental deposits that generally contain freshwater (Page, 1986). As these sediments accumulated over the last 24 million years, large lakes periodically filled and drained, resulting in deposition of laterally extensive clay layers, which formed significant barriers to the vertical movement of groundwater in the basin (Westlands Water District, 1995). The most extensive of these is the Corcoran Clay (a member of the Tulare Formation, deposited about 600,000 years ago), which consists of a clay layer zero to 160 feet thick, found at depths of 100 to 400 feet below ground surface in the San Joaquin River region.

The Corcoran Clay divides the groundwater system into two major aquifers: a confined aquifer below the clay layer and a semiconfined aquifer above the layer (Williamson et al., 1989). **Figure 3-4** shows the locations of groundwater sub-basins underlying the San Joaquin Valley within the study area.

TABLE 3-5.
SAN JOAQUIN RIVER WATER QUALITY IMPAIRMENTS BY SEGMENT

Waterbody / Reach	Pollutant/Stressor	Affected Area / Reach Length	Information Source
Mendota Pool[1]	Selenium	3,045 acres	2002 Clean Water Act §303(d) List
San Joaquin River: Mendota Pool to Bear Creek	Boron	67 miles	2002 Clean Water Act §303(d) List
	Chlorpyrifos		
	DDT		
	Diazinon		
	Electrical Conductivity		
	Group A Pesticides		
	Unknown Toxicity		
San Joaquin River: Bear Creek to Mud Slough	Boron	14 miles	2002 Clean Water Act §303(d) List
	Chlorpyrifos		
	DDT		
	Diazinon		
	Electrical Conductivity		
	Group A Pesticides		
	Mercury		
	Unknown Toxicity		
San Joaquin River: Mud Slough to Merced River	Boron	3 miles	2002 Clean Water Act §303(d) List
	Chlorpyrifos		
	DDT		
	Diazinon		
	Electrical Conductivity		
	Group A Pesticides		
	Mercury		
	Selenium		
	Unknown Toxicity		
San Joaquin River: Merced River to South Delta Boundary	Boron	43 miles	2002 Clean Water Act §303(d) List
	Chlorpyrifos		
	DDT		
	Diazinon		
	Electrical Conductivity		
	Group A Pesticides		
	Mercury		
	Unknown Toxicity		
Delta Waterways: Stockton Ship Channel	Chlorpyrifos	952 acres	2002 Clean Water Act §303(d) List
	DDT		
	Diazinon		
	Group A Pesticides		
	Mercury		
	Organic Enrichment / Low Dissolved Oxygen		
	Unknown Toxicity		

Notes:
[1] Includes 3-mile reach of San Joaquin River and 8-mile reach of Fresno Slough upstream of Mendota Dam.

FIGURE 3-4.
SAN JOAQUIN VALLEY GROUNDWATER SUB-BASINS

Hydrogeology

Recharge to the semiconfined upper aquifer generally occurs from stream seepage, deep percolation of rainfall, and subsurface inflow along basin boundaries. As agricultural practices expanded in the region, recharge was augmented with deep percolation of applied agricultural water and seepage from the distribution systems used to convey this water. Recharge of the lower confined aquifer consists of subsurface inflow from the valley floor and foothill areas to the east of the eastern boundary of the Corcoran Clay Member. Present information indicates that the clay layers, including the Corcoran Clay, are not continuous in some areas, and some seepage from the semiconfined aquifer above does occur through the confining layer.

Historically, the interaction of groundwater and surface water resulted in net gains to the streams. This condition existed on a regional basis through about the mid-1950s. Since that time, groundwater level declines have resulted in some stream reaches losing flow through seepage to the groundwater systems below. Where hydraulic connections have been maintained, the amount of seepage has varied because groundwater levels and stream flows have fluctuated. Areas in the San Joaquin River hydrologic region where these dynamics have changed include eastern San Joaquin and Merced counties, western Madera County, and other local areas. The largest stream losses have occurred during the drought periods of 1976 to 1977 and 1987 to 1992.

During predevelopment conditions, groundwater in the San Joaquin River hydrologic region flowed from the valley flanks to the axis, then north toward the Delta. Large-scale groundwater developments during the 1960s and 1970s, combined with the introduction of imported surface water supplies, have modified the natural groundwater flow pattern. Groundwater pumping and recharge from imported irrigation water has resulted in a change in regional flow patterns. Flow largely occurs from areas of recharge towards areas of lower groundwater levels due to groundwater pumping (Bertoldi et al., 1991). The vertical movement of water in the aquifer has been altered in this region as a result of thousands of wells constructed with perforation above and below the confining unit (Corcoran Clay Member), where present, providing a direct hydraulic connection (Bertoldi et al., 1991). This may have been partially offset by a decrease in vertical flow resulting from the inelastic compaction of fine-grained materials within the aquifer system.

Groundwater Production

Groundwater is a major source of agricultural and urban water supplies in the study area. Expansion of agricultural practices between 1920 and 1950 caused declines in groundwater levels in many areas of the San Joaquin River hydrologic region. Along the east side of the region, declines have ranged between 40 and 80 feet since predevelopment conditions (1860) (Williamson et al., 1989). Groundwater levels declined substantially in the Madera County area, which depends heavily on groundwater for irrigation (Williamson et al., 1989). The cities of Fresno and Visalia are entirely dependent on groundwater supplies, with Fresno being the second largest city in the United States solely reliant on groundwater (DWR, 2003b). Typical groundwater production conditions for each sub-basin are listed in **Table 3-6** based on information from DWR Bulletin 160-98 (1998). At a 1995 level of development, annual average groundwater overdraft is estimated at about 240 TAF per year in the San Joaquin River hydrologic region and at about 820 TAF per year in the Tulare Lake hydrologic region (DWR, 1998). Historical groundwater use has resulted in some land subsidence in the southwest portion of the region.

**TABLE 3-6.
PRODUCTION CONDITIONS IN SAN JOAQUIN VALLEY
GROUNDWATER SUB-BASINS**

Basin Number[1]	Basin Name[1]	Extraction (TAF/year)[2]	Well Yields (gpm)[1]	Pumping Lifts (feet)[2]
San Joaquin River Hydrologic Region				
5-22.02	Modesto	230	1,000 – 2,000	90
5-22.07	Delta-Mendota	510	800 – 2,000	35 – 150
5-22.03	Turlock	450	1,000 – 2,000	90
5-22.04	Merced	560	1,500 – 1,900	110
5-22.06	Madera	570	750 – 2,000	160
5-22.05	Chowchilla	260	750 – 2,000	110
Tulare Lake Hydrologic Region				
5-22.08	Kings	1,790	500 – 1,500	150
5-22.09	Westside	210	1,100	200 – 800
5-22.11	Kaweah	760	100 – 2,500	125 – 250
5-22.12	Tulare Lake	670	300 – 1,000	270
5-22.13	Tule	660	50 – 3,000	150 - 200
5-22.10	Pleasant Valley	100	35 – 3,300	350
5-22.14	Kern County	1,400	1,200 – 1,500	200 – 250

Key:
gpm – gallons per minute
TAF – thousand acre-feet
Note:
[1] – *Source: California Department of Water Resources Bulletin 118-03.*
[2] – *Source: California Department of Water Resources Bulletin 160-98.*

Conjunctive Management

Groundwater has been used conjunctively with surface water to meet water needs since near the beginning of the region's agricultural development. The Friant Division of the CVP was developed as a conjunctive management project, with a contract structure designed to recognize the variability of water supplies that would be available for delivery in lieu of groundwater pumping or direct groundwater recharge. Groundwater is used when surface water is unable to fully meet demands. For several decades, conjunctive use was more incidental than formal in many areas of the San Joaquin Valley. Currently, the cities of Fresno, Bakersfield, and Visalia have groundwater recharge programs to sustain groundwater conditions for a viable water supply in the future. Extensive groundwater recharge programs also are in place in the south valley where water districts have recharged several MAF for future use and transfer through water banking programs. DWR is working with local agencies and stakeholders in the valley to develop partnerships and provide assistance for planning and developing locally controlled and managed conjunctive use programs and projects.

Groundwater Quality

Groundwater quality throughout the region is suitable for most urban and agricultural uses. Local water quality impairments do exist for such constituents as TDS, nitrate, boron, chloride, and organic compounds (DWR, 2003b).

Air Quality

Air quality in the San Joaquin Valley Air Basin (SJVAB) is regulated by the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), which consists of Merced, Madera, Fresno, Kern, Kings, San Joaquin, Stanislaus, and Tulare counties. The entire SJVAB is designated nonattainment with respect to the National and State ozone (O_3) and particulate matter 10 microns in aerometric diameter or less (PM_{10}) standards, and the urban areas of Fresno, Modesto, and Stockton are nonattainment for the National and State carbon monoxide (CO) standards (ARB, 1996). A summary of recent air quality conditions for specific pollutants of concern in the SJVAB is provided below.

Carbon Monoxide

The number of days each year that the SJVAB was over the national and State CO 8-hour standard declined in the mid- to late-1980s, was higher in 1989, and then declined to no exceedences in 1992 to 1994. The 1-hour standard is violated much less frequently. Mobile sources accounted for approximately 83 percent (1,351 tons/day) and 77 percent (1,178 tons/day) of total CO in 1980 and 1990, respectively. Agricultural sources (fuel combustion by farm equipment, waste burning, and range management) contributed approximately 8 percent (138 tons/day) and 10 percent (160 tons/day) of total CO emissions in 1980 and 1990, respectively. Waste burning was the single largest agricultural source (ARB, 1989).

Ozone

National and State O_3 standards have been exceeded on a fairly regular basis. Precursors of O_3 (nitrogen oxides (NO_x), and reactive organic gases (ROG)) are almost evenly emitted by mobile and stationary sources in the SJVAB. Mobile sources contributed approximately 56 percent (315 tons/day) and 51 percent (292 tons/day) of total NO_x in 1980 and 1990, respectively. Stationary sources contributed approximately 74 percent (695 tons/day) and 74 percent (435 tons/day) of total ROG in 1980 and 1990, respectively. Of all ROG stationary sources, agricultural operations contributed approximately 12 percent (115 tons/day) and 14 percent (85 tons/day) in 1980 and 1990, respectively. Pesticide application was the single largest agricultural source of ROG in both years (ARB, 1989).

Nitrogen Dioxide

Average nitrogen dioxide (NO_2) concentrations have been consistently below the average annual national and 1-hour state standard. Petroleum processing was the largest stationary source of NO_x in both years. The agricultural contribution of NO_x was negligible.

Particulate Matter and Total Suspended Particulates

Total suspended particulate concentrations generally declined between 1978 and 1987, with an exception in 1985. PM_{10} concentrations show considerable variation between 1985 and 1994. Stationary sources contributed approximately 93 percent (459 tons/day) and 94 percent (580 tons/day) of total PM_{10} emissions in 1980 and 1990, respectively. Of the total stationary source contribution, agricultural sources contributed approximately 37 percent (229 tons/day) of total PM emissions in 1990. The single largest agricultural source of particulate matter was farming operations (ARB, 1989).

Sulfur Dioxide

Maximum sulfur dioxide (SO_2) concentrations decreased considerably between 1978 and 1994. The State standard was exceeded frequently in the early 1970s, but this decreased to only a few times in the late 1970s, following the concentration trend. Stationary sources contributed approximately 82 percent (120 tons/day) and 67 percent (73 tons/day) of total sulfur oxides (SO_x) emissions. Oil and gas production was the largest stationary source of SO_x (ARB, 1989).

Lead

The National and State lead standards were exceeded in the SJVAB in the late 1970s and 1980.

Noise

Noise levels in densely populated areas of the State are influenced predominantly by the presence of limited-access highways carrying extremely high volumes of traffic, particularly heavy trucks. Noise in rural areas where traffic generally is low to moderate is measured at considerably lower decibels. Noise at Millerton Lake is generally affected by the presence of boats and personal watercraft.

Biological Environment

Elements of the biological environment for the upper San Joaquin River basin described in this section include vegetation, wildlife, aquatic and fishery resources, and special status species.

Vegetation

Vegetation around Millerton Lake is mostly foothill woodland and grassland habitat, and riparian vegetation along the shoreline. Adjacent hillsides are foothill pine (*Pinus sabiniana*) - blue oak (*Quercus douglasii*) woodland with abundant grass/forb and shrub understory. Open grassland and savanna type habitat conditions also exist in some areas. Vernal pools and associated special status plant and animal species do not occur along this stretch of the San Joaquin River. Several large basalt tables known to have vernal pools surround the canyon, well above elevation 1,600.

Upland vegetation is dominated by foothill woodland with areas of open grassland and rock outcroppings. The predominant vegetation includes foothill pine, blue oak, and interior live oak (*Q. wislizeni*).

Montane coniferous forest constitutes the higher elevations upstream of Mammoth Pool. Habitat types in this area are meadow, riparian deciduous, lodgepole pine, mixed conifer, ponderosa pine, rock outcrop, and brush (USJRWPA, 1982c). Riparian deciduous vegetation comprises willows (*Salix sp.),* alder (*Alnus rhombefolia*), aspen (*Populus tremuloides*), dogwood (*Cornus stolonifera*), azalea *(Rhododendron occidentalis*), Indian rhubarb (*Peltiphyllum peltatum*), mountain spiraea (*Spiraea densiflora*), groundsel (*Senecio trangularis*) and tiger lily (*Lilium pardalinum*) (USJRWPA, 1982c). Meadow habitat is particularly prevalent in the Jackass and Chiquito watersheds (USJRWPA, 1982c).

Fine Gold Creek is surrounded by foothill pine–oak woodland habitat with pockets of grassland, wetland, and riparian habitat associated with numerous tributaries, hillside seeps and vernal pools. Varying degrees of riparian habitat occur along the stream. Riparian vegetation includes Oregon ash (*Fraxinus latifolia*), cottonwood (*Populus* sp.), willow (*Salix* sp.), and buttonwillow

(*Cephalanthus* sp.). Annual vegetation in the streambed includes monkeyflower (*Mimulus* sp.), rabbit's-foot grass (*Polypogon monospeliensis*), pennyroyal (*Mentha pulegium*), nutsedge (*Cyperus* sp.), and clover. Upland habitats have been seriously degraded due to cattle grazing.

Annual grassland, meadow, and possibly oak woodland habitats are found in Yokohl Valley. USGS mapping shows riparian vegetation along the upper stretches of Yokohl Creek. Adjacent foothills of Yokohl Valley are vegetated with grasslands, and foothill pine and oak woodland habitats. In addition, the possibility of vernal pools in the flatter valley bottoms is high.

Wildlife

Millerton Lake hosts a diverse wildlife community, both resident and seasonal. The upper San Joaquin River area is a relatively rich wildlife region of the Sierra foothills. Forest canopy varies considerably by slope and aspect, while the shrub and ground cover layer is greatly affected by land uses such as cattle grazing. Wildlife in the higher elevation portions of the watershed is typical of the mid-elevation Sierra Nevada.

Important deer winter ranges and bear habitat exist in the Temperance Flat area. San Joaquin mule deer (*Odocoioleus hemionus*) are year-round residents of the area and mix with migratory herds from higher elevations (USFS, 2004). Generally, migratory deer move from summer range, elevation 5,000 to 8,000, to lower elevations from mid-October, or later with any significant winter storm (DFG, 2004). Four major river crossings used by mule deer during migration in the Mammoth reach of the San Joaquin River include near Chawanakee at Dam 6, below the confluence of Rock Creek and the river, the confluence of Shake Flat Creek and the river, and the Mammoth Pool area. Additionally, mule deer cross the San Joaquin River at the confluence of Jackass Creek (SCE, 2003).

Avian guilds comprise a number of bird species for oak woodland, and riparian habitats occur throughout the area (USFS, 2004). Along with mule deer, avian guilds are considered Management Indicator Species, or a group of species with special habitat requirements.

The Fine Gold Creek watershed is expected to have a diverse wildlife community. Yokohl Valley hosts a relatively well-developed mesic grassland habitat. Several special status wildlife species may be present in the project area and are addressed later in this chapter.

Aquatic and Fishery Resources

Aquatic and fishery resources in the San Joaquin River upstream of Millerton Lake vary by river reach. (Refer to **Figure 3-2** and **Table 3-4** for descriptions of river reaches.)

Millerton Lake and Big Bend

Millerton Lake becomes thermally stratified during summer months and therefore supports a two-stage fishery with coldwater species residing in deep water and warmwater species inhabiting surface waters and areas near shore. Of the large number of fish species that inhabit Millerton Lake, most are introduced game species or forage species (USFWS, 1983). The principal warmwater game species are largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieui*), spotted bass (*M. punctulatus*), bluegill sunfish (*Lepomis macrochirus*), and striped bass (*Morone saxatilits*); the principal forage species is threadfin shad (*Dorosoma pretense*). Coldwater game species include rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*).

The only known landlocked population of American shad (*Alosa sapidissima*) is present in Millerton Lake. American shad spawn in the San Joaquin River upstream of Millerton Lake and in the portion of the reservoir upstream of Temperance Flat, which is the most riverine portion of the reservoir with turbulent flows (PG&E, 1990).

Several native species also reside in Millerton Lake, including Sacramento sucker (*Catostomus occidentalis*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento blackfish (*Orthodon microlepidotus*), hitch (*Lavinia exilicauda*), and hardhead (*Mylopharodon conocephalus*).

Temperance Flat and Millerton Bottoms

Temperance Flat is the only substantial area in upper Millerton Lake with a gently sloping shoreline, shallow water, and well-developed shoreline vegetation. It is likely that this area provides good spawning and nursery habitat for important game fish species such as largemouth bass and spotted bass.

Patterson Bend

With a relatively low channel gradient, and stream flow resulting from FERC-mandated flow releases for instream habitat, summer temperatures in the Patterson Bend reach increase sharply from Kerckhoff Dam to the powerhouses. This reach contains spawning habitat for American shad and striped bass. Fish species in the Patterson Bend reach include hardhead, Kern Brook lamprey (*Lamperta hubbsi)*, Sacramento pikeminnow, and Sacramento sucker, and of the non-natives, smallmouth bass and green sunfish (*Lepomis cyanellus*).

According to the California Natural Diversity Database (CNDDB, 2004), and Moyle and Ellison (1991), this area is designated as a Central Valley Drainage Rainbow Trout/Cyprinid Stream and Central Valley Drainage Hardhead/Squawfish Stream.

Kerckhoff Lake and Horseshoe Bend

Kerckhoff Dam separates fish communities in Kerckhoff Lake and Horseshoe Bend from predatory centrarchid basses downstream. The upper portion of Kerckhoff Lake is shallow with a well-vegetated shoreline due to deposition of silt, which probably provides good fish habitat. The lower portion is in a steep-walled canyon with a shoreline consisting mostly of bedrock and with little useful habitat for fish. Kerckhoff Lake has many of the same native fish species as the Patterson Bend reach downstream, including hardhead, Sacramento pikeminnows, and Sacramento suckers. Additionally, the reservoir has native three-spined stickleback (*Gasterosteus aculeatus*), and an introduced smelt, wagasaki (*Hypomesus nipponensis*). Kerckhoff Lake does not contain American shad or striped bass, and because of its relatively cold water temperatures, it has no warmwater game species.

The fish fauna of Horseshoe Bend are mostly native species, with hardhead the most abundant. Temperatures in the lower portion of the Horseshoe Bend reach might rise to 70°F or more for much of the summer. These temperatures are too warm for coldwater species, but suitable for native coolwater species such as hardhead, Sacramento pikeminnow, and Sacramento sucker (SCE, 1997). CNDDB (2004) and Moyle and Ellison (1991) designate Horseshoe Bend as a Central Valley Drainage Resident Rainbow Trout Stream, Central Valley Drainage Rainbow Trout/Cyprinid Stream, and Central Valley Drainage Hardhead/Squawfish Stream.

Mammoth Reach

Fish communities of the Mammoth reach segment of the San Joaquin River predominantly comprise Sacramento sucker. Rainbow and brown trout also are present, but less abundant (SCE, 2003).

Granite Creek

Granite Creek provides excellent habitat for brown trout, rainbow trout, and brook trout (*Salvelinus fontinalis*). The simple communities present are maintained almost entirely by natural reproduction and represent a valuable recreational fishing source (USJRWPA, 1982c).

Jackass Creek

Lower reaches of Jackass Creek are dominated by rainbow trout. Further upstream, brook trout dominate rainbow trout in Jackass Meadow (USJRWPA, 1982c).

Chiquito Creek

Chiquito Creek hosts a productive population of brown trout, and is a popular fishing stream due to large numbers of fish and accessibility to roads and campgrounds (USJRWPA, 1982c). Steep bedrock sheets at the confluence of Mammoth Pool and Chiquito Creek are impassable for fish in the reservoir (USJRWPA, 1982c).

Fine Gold Creek

The arm of Millerton Lake that presently inundates lower Fine Gold Creek channel is narrow and moderately steep-sided. Riparian vegetation is well developed, especially in the upstream end of the arm. Oaks, digger pines, and willows shade most of the stream, but many areas also are heavily grazed with collapsed banks. Native fishes include Sacramento sucker and hitch. California roach, with its San Joaquin Valley subspecies (or “form”) on the “Watch List” of the State of California Fish Species of Special Concern, also may be present. Nonnative fishes dominate most of the drainage, especially green sunfish, which invade from Millerton Reservoir. Little Fine Gold Creek is dominated by Sacramento hitch (Moyle et al., 1996).

The Fine Gold Creek watershed was designated as an Aquatic Diversity Management Area (ADMA) through the Sierra Nevada Ecosystem Project (Moyle et al., 1996). According to Moyle et al. (1996), an ADMA watershed has a high value for aquatic biodiversity because it is rich in native aquatic species and communities and/or contains a particularly rare or unusual biotic element. The Fine Gold Creek designation was made on the basis that roads, grazing, and Millerton Reservoir have reduced diversity in the watershed, but with efforts to restore the riparian habitats and pools of the creek, much of the drainage can be recolonized by native hitch (Moyle et al., 1996).

Yokohl Valley

Yokohl Creek had little or no flow at the time of the May 2002 field reconnaissance, and is likely dry during summer months.

Special Status Species

Federally listed and State-listed species and species of concern occur throughout the San Joaquin River watershed. **Attachment A** provides a catalog of species, their current listing status, and an indication of the geographic area where they are reported or potentially present. Habitat descriptions for each of the special status species are presented in **Attachment B**. **Tables 3-7** and **3-8** summarize findings and provide sums of special status plant, wildlife, and fishery species reported or potentially present in the geographic reaches of the study area, respectively, as reported by USFS and BLM through scoping comments and CNDDB search queries. Species information will be verified through consultation with Federal and State resource agencies.

Vegetation

Six special status plant species are known to occur in the Millerton Lake/Big Bend region. Hartweg's pseudobahia (a.k.a. Hartweg's golden sunburst, *Pseudobahia bahiifolia*) is reported present, and Federally listed as endangered. Federally listed threatened species include San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*) and fleshy owl's-clover (a.k.a. succulent owl's-clover, *Castilleja campestris* ssp. *succulenta*). Tree anemone (*Carpenteria californica*) is an extremely localized species endemic to the region, and is California-listed as threatened and a USFS sensitive species. Bogg's Lake hedge-hyssop (*Gratiola heterosepala*), California-listed as an endangered species, along with San Joaquin Valley Orcutt grass and fleshy owl's clover, are found in vernal pools and lake margins. Several populations of Madera leptosiphon (*Leptosiphon serrulatus*, formerly Madera linanthus, *Linanthus serrulatus*), on the California Native Plant Society (CNPS) List 1B, are recorded along the shores of Millerton Lake, with one known population near Big Bend. Suitable conditions for this species probably exist in other parts of the study area also.

Many of the plant species of concern found near the Millerton Lake/Big Bend area are potentially present in Temperance Flat/Millerton Bottoms and Patterson Bend. In the Horseshoe Bend reach, one of the largest populations of tree anemone occurs along Backbone Creek near its confluence with the San Joaquin River, within the USFS Backbone Creek RNA. Other plant species of concern potentially present near Horseshoe Bend and Kerckhoff Lake include flaming trumpet (*Collomia rawsoniana*), orange lupine (*Lupinus citrinus* var. *citrinus*), mariposa pussypaws (*Calyptridium pulchellum*), and oval-leaved viburnum (*Viburnum ellipticum*).

Blue elderberry (*Sambucus mexicanus*), a shrub often associated with riparian habitat, occurs in the watershed from Big Bend upstream to Horseshoe Bend. Elderberry shrubs, including blue elderberry, are host plants for the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), Federally listed as threatened.

**TABLE 3-7.
SPECIAL STATUS SPECIES REPORTED PRESENT IN THE
PRIMARY STUDY AREA**

	Millerton Lake/ Big Bend	Temperance Flat/ Millerton Bottoms	Patterson Bend	Kerckhoff Lake/ Horseshoe Bend	Mammoth Reach	Granite Creek	Jackass Creek	Chiquito Creek	Fine Gold Creek	Yokohl Valley
PLANTS										
Federally Listed and/or State-Listed	5		1	1						2
Federal and/or State Rare										
Species of Concern	1					3	3	3		2
WILDLIFE AND FISHERIES										
Amphibians and Reptiles										
Federally Listed and/or State-Listed	1								1	
Federal and/or State Candidate for Listing										
Federal and/or State Candidate for Delisting										
Species of Concern	1	2	2	2					2	3
Birds										
Federally Listed and/or State-Listed	1	1	1	1	1					
Federal and/or State Candidate for Listing	1	1	1	1	1					
Federal and/or State Candidate for Delisting	1	1	1	1	1					
Species of Concern	1	2	2			2	2	2		
Fisheries										
Federally Listed and/or State-Listed										
Federal and/or State Candidate for Listing										
Federal and/or State Candidate for Delisting										
Species of Concern	1	1	1	1	1					
Invertebrates										
Federally Listed and/or State-Listed	1	1	1	1						
Federal and/or State Candidate for Listing										
Federal and/or State Candidate for Delisting										
Species of Concern										
Mammals										
Federally Listed and/or State-Listed										1
Federal and/or State Candidate for Listing										
Federal and/or State Candidate for Delisting										
Species of Concern	1	1	1							
TOTAL WILDLIFE AND FISHERIES										
Federally Listed and/or State-Listed	2	2	2	2	1				1	1
Federal and/or State Candidate for Listing	1	1	1	1	1					
Federal and/or State Candidate for Delisting	1	1	1	1	1					
Species of Concern	4	6	6	3	1	2	2	2	2	3

TABLE 3-8. SPECIAL STATUS SPECIES POTENTIALLY PRESENT IN THE PRIMARY STUDY AREA

	Millerton Lake/ Big Bend	Temperance Flat/ Millerton Bottoms	Patterson Bend	Kerckhoff Lake/ Horseshoe Bend	Mammoth Reach	Granite Creek	Jackass Creek	Chiquito Creek	Fine Gold Creek	Yokohl Valley
PLANTS										
Federally Listed and/or State-Listed	6	6	6	2					6	3
Federal and/or State Rare						1	1	1		
Species of Concern	3	3	3	3	5	16	16	17	2	4
WILDLIFE AND FISHERIES										
Amphibians and Reptiles										
Federally Listed and/or State-Listed	1	1	1	2	2	2	2	2	1	
Federal and/or State Candidate for Listing						1	1	1		
Federal and/or State Candidate for Delisting										
Species of Concern	2	3	3	4	3	3	3	3	3	3
Birds										
Federally Listed and/or State-Listed	2	3	3	3	3	2	2	2		1
Federal and/or State Candidate for Listing	1	1	1	1	1					
Federal and/or State Candidate for Delisting	1	1	1	1	1					
Species of Concern	4	6	6		2	6	6	6	1	
Fisheries										
Federally Listed and/or State-Listed						1	1	1		
Federal and/or State Candidate for Listing										
Federal and/or State Candidate for Delisting										
Species of Concern	2	2	2	1	1					
Invertebrates										
Federally Listed and/or State-Listed	3	3	3	1						1
Federal and/or State Candidate for Listing										
Federal and/or State Candidate for Delisting										
Species of Concern	4	3	3	2						1
Mammals										
Federally Listed and/or State-Listed				1	1	1	1	2		2
Federal and/or State Candidate for Listing					1	1	1	1		1
Federal and/or State Candidate for Delisting										
Species of Concern	1	1	1	5	10	6	6	6		
TOTAL WILDLIFE AND FISHERIES										
Federally Listed and/or State-Listed	8	9	9	9	7	6	6	7	2	4
Federal and/or State Candidate for Listing	2	2	2	2	3	2	2	2		1
Federal and/or State Candidate for Delisting	2	2	2	2	2					
Species of Concern	15	21	21	15	16	17	17	17	6	4

Five species of concern potentially occur through the Mammoth reach, including flaming trumpet, Madera leptosiphon, Mono Hot Springs evening-primrose (*Camissonia sierrae* ssp. *Alticola*), orange lupine, and Yosemite ivesia (*Ivesia unguiculata*, CNPS List 4).

Parasol (Bolander's) clover (*Trifolium bolanderi*, CNPS List 1B), Fresno mat (*Ceanothus fresnensis*, CNPS List 4), and Yosemite ivesia are known to be present near Granite, Jackass, and Chiquito creeks (USJRWPA, 1982c). Fourteen additional special status species are potentially present in the Granite, Jackass, and Chiquito creek areas.

Eight special status plant species may occur in the Fine Gold Creek watershed, including many species found near the Millerton Lake/Big Bend area.

Four special status species occur around Yokohl Valley. Tulare pseudobahia (a.k.a. San Joaquin Adobe sunburst, *Pseudobahia peirsonii*), Federally listed as threatened and State-listed as endangered, and Kaweah brodiaea (*Brodiaea insignis*), State-listed as endangered, have moderate to high probability of being present. Spiny-sepaled button-celery (*Eryngium spinosepalum*, CNPS List 1B), grows in Yokohl Creek downstream from the potential dam site. Recurved larkspur (*Delphinium recurvatum*), a BLM sensitive species, also may be present near vernal pools in the area. The presence of ultra basic and metagabbro rock makes serpentine-specific plants possible, although none were reported from the CNDDB query.

Wildlife

Several special status wildlife species are known to occur in the Millerton Lake/Big Bend region. Species include California red-legged frog (*Rana aurora draytonii), w*estern pond turtle (*Emys (=Clemmys) marmorata*), western spadefoot (*Spea (=Scaphiopus) hammondii*), northern harrier (*Circus cyaneus*), prairie falcon (*Falco mexicanus*), southern bald eagle (*Haliaeetus leucocephalus leucocephalus*), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), and western (California) mastiff bat (*Eumops perotis californicus*). Similar wildlife species of concern occur in the Temperance Flat, Patterson Bend, and Horseshoe Bend reaches of the watershed.

Many special status species potentially occur in the higher elevation portions of the study area near Mammoth Reach, Granite, Jackass, and Chiquito creeks. Species confirmed present include the California spotted owl (*Strix occidentalis occidentalis*) and golden eagle (*Aquila chrysaetos*). Both birds are designated DFG species of concern, USFS sensitive, USFWS birds of conservation concern, BLM sensitive and California Department of Forestry and Fire Protection sensitive.

In the Fine Gold Creek area, California tiger salamander (*Ambystoma californiense*), western spadefoot, and western pond turtle are known to be present.

Foothill yellow-legged frog (*Rana boylii*), western pond turtle, western spadefoot, and San Joaquin kit fox are known to inhabit the Yokohl Valley area. The California condor nests in the Blue Ridge Reserve, several miles away.

Aquatic and Fishery Resources

Hardhead, classified as a State of California species of special concern and a USFS sensitive species, inhabits the San Joaquin River upstream of Millerton Lake. Hardhead can colonize reservoirs, but will persist only if exotic species, especially centrarchid basses, are not abundant.

Another State species of special concern, Kern Brook lamprey*,* may occur in the area. Data collected to date suggest this species is endemic to the San Joaquin drainage, with isolated populations thinly distributed in lower reaches of the Merced, Kaweah, Kings, and San Joaquin rivers (Moyle et al., 1995; Brown and Moyle 1992, 1993).

Vernal pool special status species California linderiella fairy shrimp (Linderiella occidentalis), Midvalley fairy shrimp (Branchinecta mesovallensis), vernal pool fairy shrimp (Branchinecta lynchi), and vernal pool tadpole shrimp (Lepidurus packardi) are potentially present in vernal pools on basalt tables that surround the canyon. These vernal pools are above elevation 1,600 and will likely be unaffected by the storage measures considered for the Investigation.

The SNF designated the Horseshoe Bend segment of the San Joaquin River as a Critical Aquatic Refuge (CAR). CARs contain localized populations of rare native species, at-risk native species, or both and have high priority for watershed restoration. The Horseshoe Bend designation is based on the presence of hardhead.

Further upstream, Lahonton cutthroat trout (Oncorhynchus clarki henshawi), a Federally listed threatened species, may be found in the Granite, Jackass, and Chiquito creeks watersheds (CNDDB 2004; USJRWPA, 1982c).

In Yokohl Valley, vernal pool fairy shrimp may be present in vernal pools in the flatter valley bottoms.

Social and Economic Resources

This section describes social and economic resources in the primary study area of the Investigation.

Surface Water Resources in the Study Area

The east side of the San Joaquin Valley includes numerous streams and rivers that drain the western slope of the Sierra Nevada Mountains and flow into the Central Valley. During the past 50 years, water resources of all major rivers have been developed through construction of dams and reservoirs for water supply, flood control, and hydropower generation. **Table 3-9** and **Figure 3-5** summarize major reservoirs in the eastern San Joaquin Valley and their purposes. With the exception of the San Joaquin River, the table lists only the largest water supply and flood control reservoir on each river.

Friant Division of the CVP

The Friant Division of the CVP provides water to over 1 million acres of irrigable land on the east side of the southern San Joaquin Valley, from near the Chowchilla River in the north to the Tehachapi Mountains in the south. Principal features of the Friant Division were completed in the 1940s, including Friant Dam and Millerton Lake northeast of Fresno on the San Joaquin River and the Madera and Friant-Kern canals, which convey water north and south to agricultural and urban water contractors. The dam is operated to supply water to agricultural and urban areas in the eastern San Joaquin Valley and to provide flood protection to downstream areas.

TABLE 3-9.
RESERVOIRS ON THE EAST SIDE OF THE SAN JOAQUIN VALLEY

Name	River or Creek	Owner	Storage (TAF)	Year Built	Operational Objectives				
					FC	WS	HP	RF	WQ
Reservoirs in the Upper San Joaquin River Watershed									
Millerton	San Joaquin	Reclamation	520	1942	X	X	n/a	n/a	n/a
Kerckhoff	San Joaquin	PG&E	4	1920	n/a	n/a	X	X	n/a
Redinger	San Joaquin	SCE	35	1951	n/a	n/a	X	X	n/a
Florence	South Fork San Joaquin	SCE	64	1926	n/a	n/a	X	X	n/a
Huntington	Big Creek	SCE	89	1917	n/a	n/a	X	X	n/a
Shaver	Stevenson Creek	SCE	135	1927	n/a	n/a	X	X	n/a
Thomas Edison	Mono Creek	SCE	125	1954	n/a	n/a	X	X	n/a
Mammoth Pool	San Joaquin	SCE	123	1960	n/a	n/a	X	X	n/a
Reservoirs in Other San Joaquin Valley Watersheds									
New Melones	Stanislaus	Reclamation	2,420	1978	X	X	X	X	X
Don Pedro	Tuolumne	MID/TID	2,030	1970	x	X	X	X	n/a
Lake McClure	Merced	MID	1,025	1967	X	X	X	X	n/a
Eastman	Chowchilla	Corps	150	1975	X	X	n/a	n/a	n/a
Hensley	Fresno	Corps	90	1975	X	X	n/a	n/a	n/a
Pine Flat	Kings	Corps	1,000	1954	X	X	n/a	n/a	n/a
Kaweah[1]	Kaweah	Corps	143	1962	X	X	n/a	n/a	n/a
Success[1]	Tule	Corps	82	1961	X	X	n/a	n/a	n/a
Isabella	Kern	Corps	568	1953	X	X	n/a	n/a	n/a

Key:
Owners

Corps	U.S. Army Corps of Engineers
MID	Merced Irrigation District
MID/TID	Modesto Irrigation District/Turlock Irrigation District
PG&E	Pacific Gas and Electric
SCE	Southern California Edison
Reclamation	Bureau of Reclamation

Operational Objectives

FC	Flood control (these reservoirs have dedicated flood control storage space)
HP	Hydropower generation
RF	Downstream river instream flow requirements
WQ	Delta water quality
WS	Water supply for irrigation, domestic, municipal, and industrial uses

n/a – operational objective not applicable   TAF – thousand acre-feet

Notes:
[1] Enlargement of Kaweah and Success lakes has been authorized. Existing capacity listed.

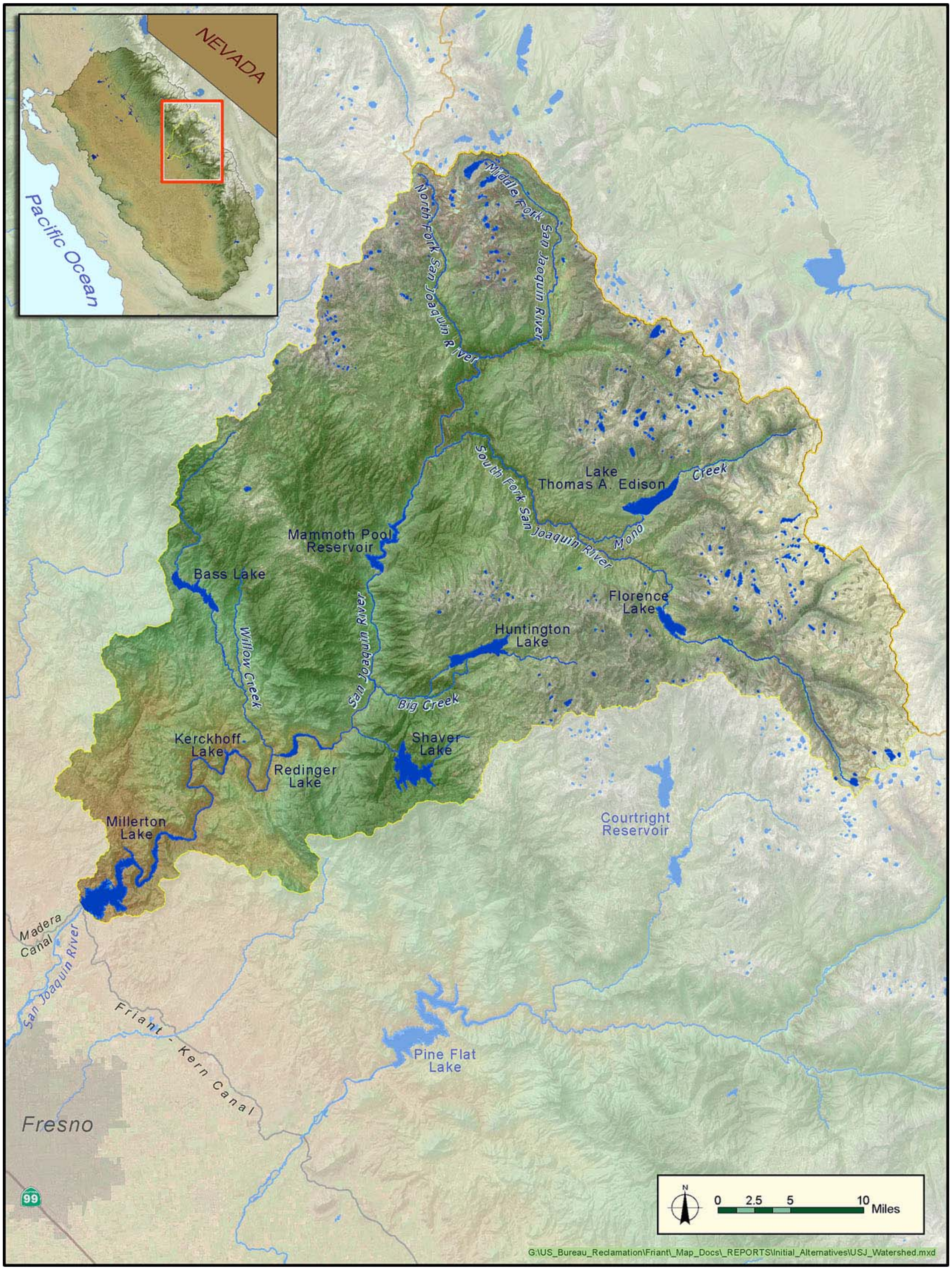


FIGURE 3-5.
RESERVOIRS UPSTREAM FROM MILLERTON LAKE

Millerton Lake has a storage capacity of 520.5 TAF. Minimum storage for canal diversion is about 130 TAF (135 TAF for the Friant-Kern Canal, 130 TAF for the Madera Canal), resulting in active conservation storage of about 390 TAF. During the flood season of October through March, up to 170 TAF of available storage space must be maintained for control of rain floods. Under present operating rules, up to 85 TAF of the flood control storage required in Millerton Lake may be provided by an equal amount of space in Mammoth Pool, as shown in **Figure 3-6.**

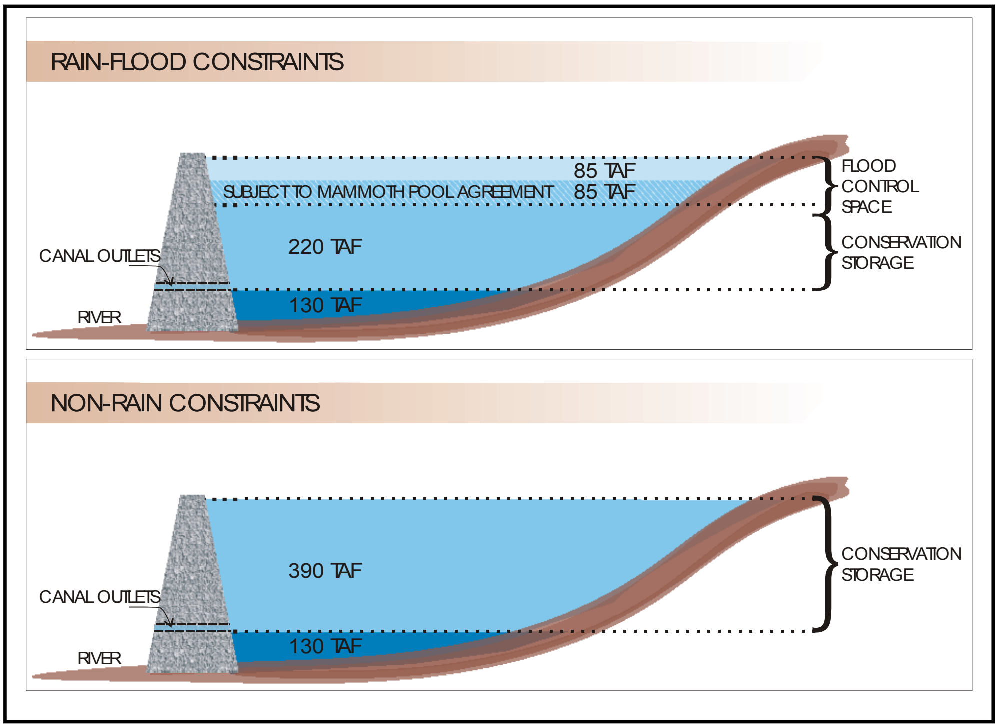


FIGURE 3-6.
SCHEMATIC OF MILLERTON LAKE STORAGE REQUIREMENTS

The limited active conservation storage and requirement for flood space reservation result in very little opportunity for carryover storage. Millerton Lake is operated as an annual reservoir with no specific provision for carryover storage. Annual water allocations and release schedules are developed with the intent of drawing reservoir storage to minimum levels by the end of September. When demands are lower or inflow is greater than typical, end-of-year storage may be above minimum levels, resulting in incidental carryover storage.

Reclamation obtained the majority of the water rights on the San Joaquin River, allowing for diversion of water at Friant Dam through purchase and exchange agreements with entities that held those rights at the time the project was developed. The agreement involving the largest amount of water requires annual delivery of approximately 840 TAF of water to Mendota Pool to water rights holders along the San Joaquin River. This obligation is met with water exported from the Delta via the Delta-Mendota Canal in accordance with San Joaquin River exchange contracts. If Delta water were not available to meet these commitments, Reclamation would be required to release water from Friant Dam to meet these water rights obligations. With the exception of flood control operations, water released from Friant Dam to the San Joaquin River is limited to that necessary to satisfy riparian water rights along the San Joaquin River between Friant Dam and Gravelly Ford.

Friant Division Contract Types and Water Deliveries

The Friant Division was designed and is operated to support conjunctive water management in an area that was subject to groundwater overdraft prior to construction of Friant Dam, and which remains in a state of overdraft today. Reclamation employs a two-class system of water allocation to take advantage of water during wetter years. **Figure 3-7** shows the locations and acreage of the 28 long-term Friant Division water service contractors. **Table 3-10** lists Friant Division contract amounts for each contractor. Class 1 contracts, which are based on a firm water supply, are generally assigned to M&I and agricultural water users who have limited access to good-quality groundwater. Lands served by Class 1 contracts primarily include upslope areas planted in citrus or deciduous fruit trees. During project operations, the first 800 TAF of annual water supply are delivered under Class 1 contracts.

Class 2 water is a supplemental supply and is delivered directly for agricultural use or for groundwater recharge, generally in areas that experience groundwater overdraft. Class 2 contractors typically have access to good-quality groundwater supplies and can use groundwater during periods of surface water deficiency. Many Class 2 contractors are in areas with high groundwater recharge capability and operate dedicated groundwater recharge facilities.

In addition to Class 1 and Class 2 water deliveries, Reclamation is authorized to deliver water that otherwise would be released for flood control purposes. Section 215 of the Reclamation Reform Act of 1982 authorizes the delivery of unstorable irrigation water that would be released in accordance with flood control criteria or unmanaged flood flows. Delivery of Section 215 water has enabled groundwater replenishment at levels higher than otherwise could be supported with Class 1 and Class 2 contract deliveries.

Historically, the Friant Division has delivered an average of about 1,300 TAF of water annually. Since 1949, Reclamation has made annual releases of 117 TAF from Friant Dam to the San Joaquin River to meet downstream water rights diversions above Gravelly Ford. Additional flows occur during years when releases are made to the San Joaquin River for flood control purposes.

Figure 3-8 shows the historical allocation of water to Friant Division contractors, estimated by applying historical allocation percentages to total Class 1 and Class 2 contracts amounts. As shown, annual allocation of Class 1 and Class 2 water varies widely in response to hydrologic conditions.

During the period from 1957 through 2002, annual allocations of Class 1 water were typically at or above 75 percent of contract amounts, except in three extremely dry years. In this same period, full allocation of Class 2 water supplies occurred in about one-fourth of the years. During the extended drought from 1987 through 1992, no Class 2 water was available and Class 1 allocations were below full contract amounts, except in one year. During this and other historical drought periods, water contractors relied heavily on groundwater to meet water demands.

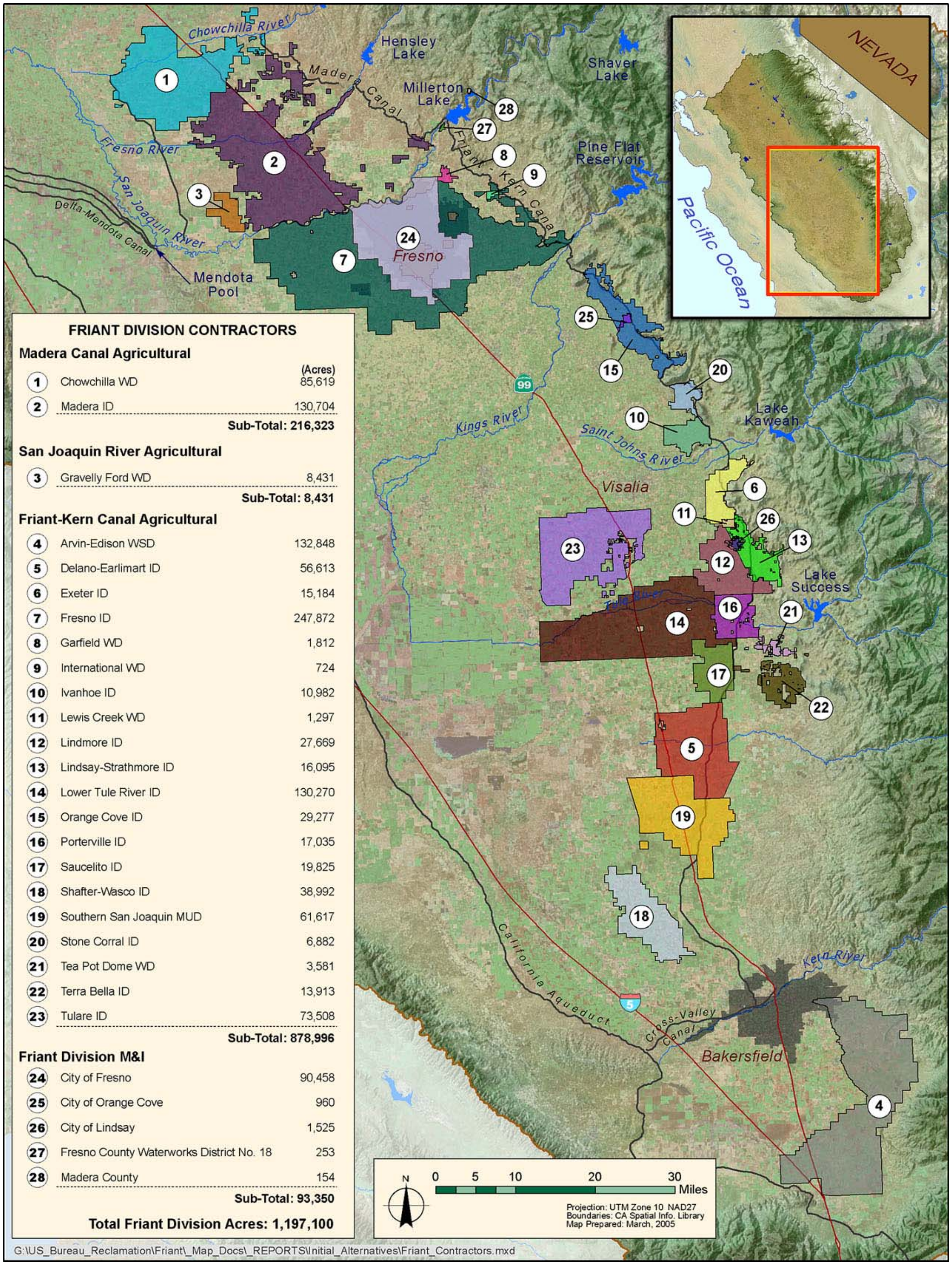


FIGURE 3-7.
FRIANT DIVISION CONTRACTORS

TABLE 3-10.
FRIANT DIVISION LONG-TERM CONTRACTS

CONTRACT TYPE/CONTRACTOR	Class 1	Class 2	Cross-Valley
Madera Canal Agricultural			
Chowchilla WD	55,000	160,000	
Madera ID	85,000	186,000	
Total Madera Canal Agricultural	**140,000**	**346,000**	
San Joaquin River Agricultural			
Gravelly Ford WD	0	14,000	
Friant-Kern Canal Agricultural			
Arvin-Edison WSD	40,000	311,675	
Delano-Earlimart ID	108,800	74,500	
Exeter ID	11,500	19,000	
Fresno ID	0	75,000	
Garfield WD	3,500	0	
International WD	1,200	0	
Ivanhoe ID	7,700	7,900	
Lewis Creek WD	1,450	0	
Lindmore ID	33,000	22,000	
Lindsay-Strathmore ID	27,500	0	
Lower Tule River ID	61,200	238,000	
Orange Cove ID	39,200	0	
Porterville ID	16,000	30,000	
Saucelito ID	21,200	32,800	
Shafter-Wasco ID	50,000	39,600	
Southern San Joaquin MUD	97,000	50,000	
Stone Corral ID	10,000	0	
Tea Pot Dome WD	7,500	0	
Terra Bella ID	29,000	0	
Tulare ID	30,000	141,000	
Total Friant-Kern Canal Agricultural	**595,750**	**1,041,475**	
Total Friant Division Agricultural	**735,750**	**1,401,475**	
Friant Division M&I			
City of Fresno	60,000		
City of Orange Cove	1,400		
City of Lindsay	2,500		
Fresno County Water Works District No. 18	150		
Madera County	200		
Total Friant Division M&I	**64,250**		
Total Friant Division Contracts	**800,000**	**1,401,475**	
Cross-Valley Canal Exchange			
Fresno County			3,000
Tulare County			5,308
Hills Valley ID			3,346
Kern-Tulare WD			40,000
Lower Tule River ID			31,102
Pixley ID			31,102
Rag Gulch WD			13,300
Tri-Valley WD			1,142
Total Cross-Valley Canal Exchange			**128,300**

Key:
ID – Irrigation District; M&I – municipal and industrial; MUD – Municipal Utility District
WD – Water District; WSD – Water Storage District

Source: Friant Water Users Authority Informational Report

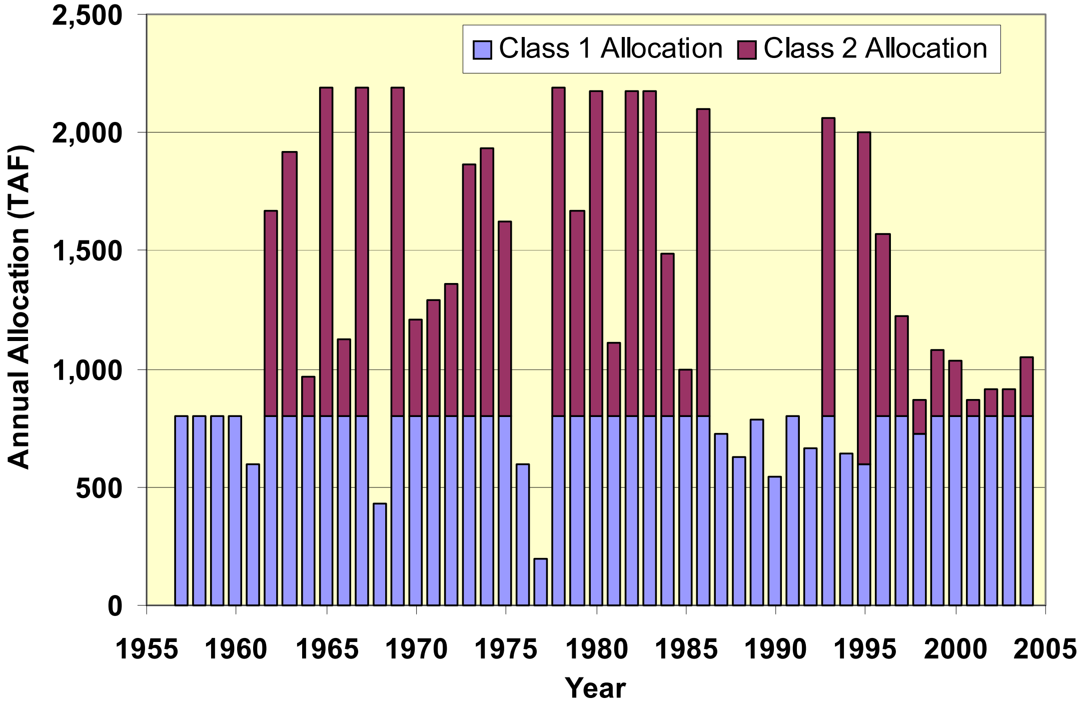


FIGURE 3-8.
HISTORICAL ALLOCATION TO FRIANT DIVISION CONTRACTS

In addition to the Class 1, Class 2, and conjunctive management aspects of Friant Division operations, a productive program of transfers between districts takes place annually. This program provides opportunities to improve water management within the Friant service area. In wet years, water surplus to one district's need can be transferred to other districts with the ability to recharge groundwater. Conversely, in dry years, water is returned to districts with little or no groundwater supply, thereby providing an ongoing informal groundwater banking program within the Friant Division.

The Cross-Valley Canal, a locally financed facility completed in 1975, enables delivery of water from the California Aqueduct to the east side of the southern San Joaquin Valley near the City of Bakersfield. A complex series of water purchase, transport, and exchange agreements allows the exchange of equivalent amounts of water between Arvin-Edison Water Storage District, near Bakersfield, and eight entities with contracts for CVP water exported from the Delta. When conditions permit, water is delivered to Arvin-Edison from the California Aqueduct in exchange for water that would have been delivered from Millerton Lake.

Power/Energy

The San Joaquin River watershed upstream of Millerton Lake is extensively developed for hydroelectric generation. In this area, PG&E and SCE own and operate several hydropower generation facilities, as shown in **Figure 3-9**. Both the PG&E and SCE systems consist of a series of reservoirs that provide water through tunnels to downstream powerhouses. Hydropower also is generated by the Friant Power Authority at the Friant Power Project; water is released from Friant Dam to the Friant-Kern Canal, Madera Canal, and San Joaquin River. In total, the upper San Joaquin River basin has 19 powerhouses with an installed capacity of almost 1,300 MW, which represents approximately 9 percent of the hydropower generation capacity in California. **Table 3-11** summarizes generation capacity and date of installation for PG&E and SCE power facilities from Millerton Lake upstream to Redinger Lake. This table also summarizes annual reported energy generation from the PG&E and SCE facilities for 1994 through 2002. As indicated by minimum and maximum values, annual energy generation varies widely.

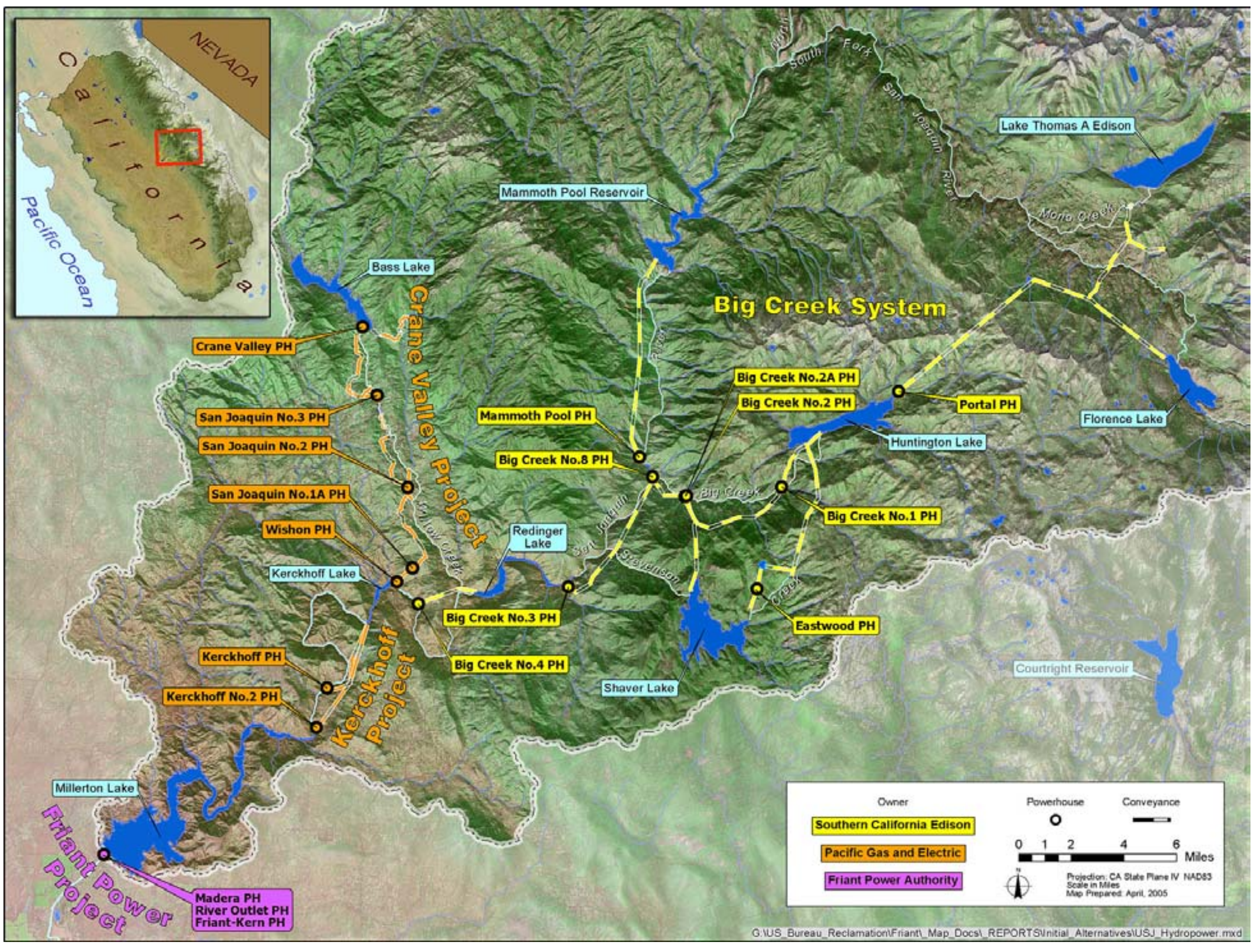


FIGURE 3-9.
EXISTING HYDROPOWER FACILITIES AT AND UPSTREAM OF FRIANT DAM

TABLE 3-11.
RECENT HYDROELECTRIC GENERATION AT SELECTED FACILITIES UPSTREAM FROM MILLERTON LAKE

	Pacific Gas and Electric			Southern California Edison		
	Wishon	**Kerckhoff**	**Kerckhoff No. 2**	**Big Creek No. 3**	**Big Creek No. 4**	**Mammoth Pool**
Number & Type of Units	4 – Impulse	3 – Francis	1 – Francis	5 – Francis	2 – Francis	2 – Francis
Capacity (MW)	20	38	155	175	100	187
Year Constructed	1910	1920	1983	1923	1952	1960
Reported Annual Generation (MWh)[1]						
1994	27,904	10,348	275,752	567,399	294,398	358,510
1995	113,411	115,930	803,490	1,195,652	623,186	819,824
1996	93,551	52,273	696,653	1,050,192	608,066	867,187
1997	45,475	72,350	695,775	898,483	589,812	835,857
1998	117,762	75,657	735,830	1,094,868	613,169	760,690
1999	73,369	31,959	410,567	539,673	435,868	604,340
2000	73,642	37,632	482,279	837,543	448,810	616,530
2001	47,942	10,768	316,602	570,805	301,216	428,951
2002	54,588	19,639	368,396	717,201	352,915	486,423
Min. 1994-2002	**27,904**	**10,348**	**275,752**	**539,673**	**294,398**	**358,510**
Max. 1994-2002	**117,762**	**115,930**	**803,490**	**1,195,652**	**623,186**	**867,187**
Avg. 1994-2002	**71,960**	**47,395**	**531,705**	**830,202**	**474,160**	**642,035**

Key:
FERC – Federal Energy Regulatory Commission
MW – megawatt
MWh – megawatt – hour
Note:
[1] Exclusive of plant use, data source – annual FERC licensee reports.

Developing new storage for water supply, water quality, ecosystem restoration, and flood damage reduction creates opportunities to add hydropower features and increase power generation in the basin. Developing new storage also has the potential to decrease power generation in the basin if existing facilities are impacted.

Land Use

Land ownership around and upstream from Millerton Lake includes privately owned parcels, lands, and facilities owned by power utilities, public lands managed by the State, lands managed by the BLM, and lands managed by USFS, as shown in **Figure 3-10**. This section describes land management and use type in the primary study area. Descriptions are provided by reach.

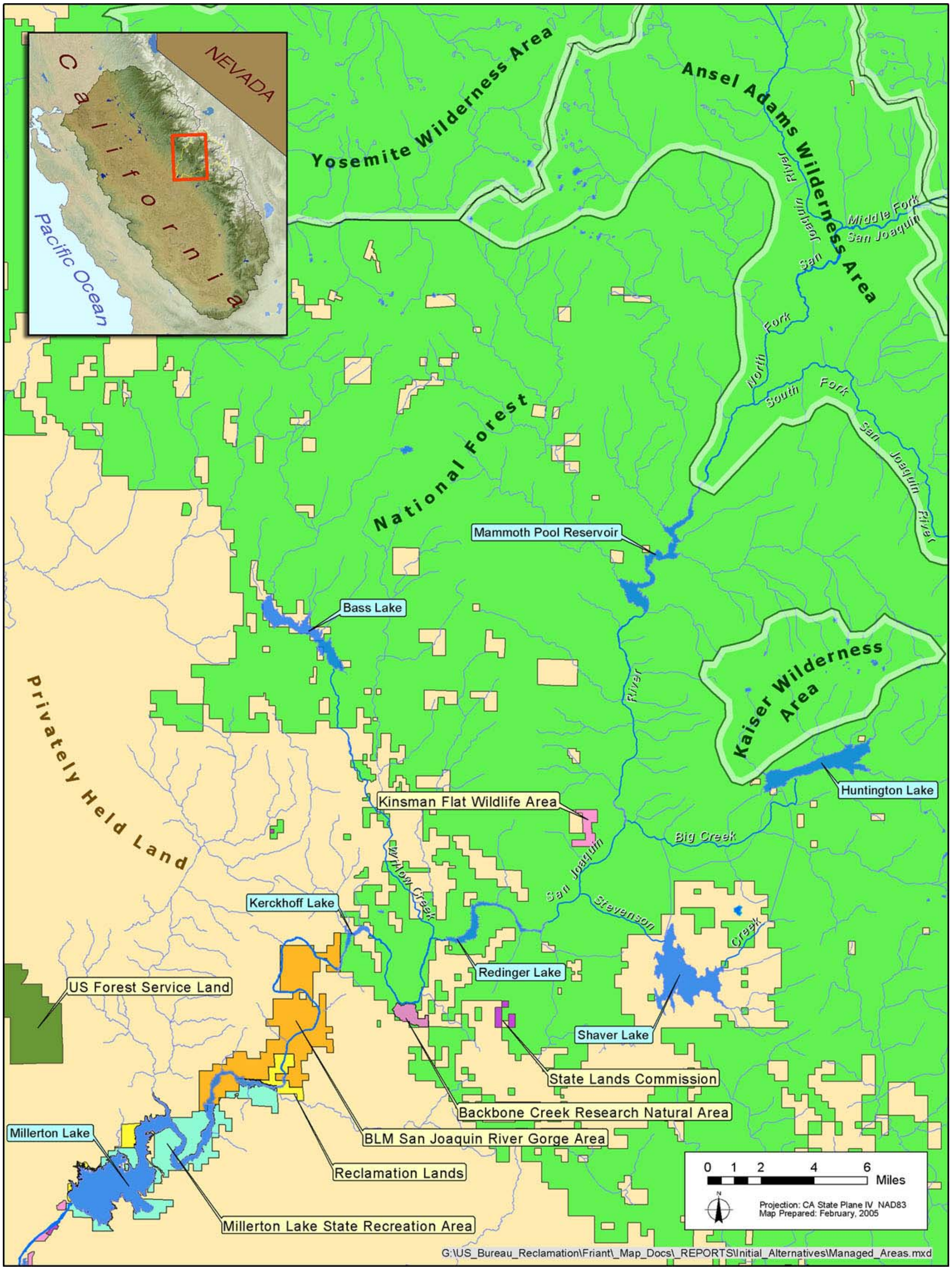


FIGURE 3-10.
DESIGNATED MANAGEMENT LANDS IN THE UPPER SAN JOAQUIN RIVER BASIN

Millerton Lake and Big Bend

Much of the land surrounding Millerton Lake and in the Big Bend area is within the Millerton Lake State Recreation Area (SRA). A total of over 440 parcels surround Millerton Lake. Based on an initial inventory using aerial photography, it is estimated that over 150 structures exist below elevation 720, which corresponds to the elevation that would be inundated if Millerton Lake level were raised 140 feet.

Temperance Flat and Millerton Bottoms

In the Temperance Flat area, a few residences and structures exist that may be affected by some of the storage measures. BLM manages lands in Temperance Flat and Millerton Bottoms as part of the San Joaquin River Gorge Management Area.

Patterson Bend

Portions of the Patterson Bend reach of the San Joaquin River are managed by BLM as the San Joaquin River Gorge Management Area, and other portions by USFS as the SNF. Structures in the Patterson Bend reach include powerhouses and ancillary facilities associated with the PG&E Kerckhoff Project, and a footbridge over the San Joaquin River near RM 284 in the San Joaquin River Gorge Management Area.

Kerckhoff Lake and Horseshoe Bend

Upstream of Kerckhoff Dam, the San Joaquin River is managed by the USFS as part of the SNF. The USFS Backbone Creek RNA represents 262 acres of chaparral and riparian habitat along the San Joaquin River to be preserved and protected in perpetuity (USFS, 2004). No known residences are present along the river upstream of Kerckhoff Dam. In the reach between Kerckhoff and Redinger dams, structures include powerhouses and ancillary facilities associated with the PG&E Wishon and SCE Big Creek projects. A bridge at Powerhouse Road spans the upper reach of Kerckhoff Lake.

Further upstream, and a short distance below Redinger Lake Dam, an improved road crossing traverses the channel of Willow Creek. Structures upstream of Redinger Dam include Big Creek No. 3 Powerhouse and ancillary facilities. Numerous structures of the Chawanakee community are upstream of Redinger Lake.

Mammoth Reach

Near Mammoth Reach, SCE Dam 6 provides an afterbay for the Mammoth Pool Powerhouse. Structures include the Mammoth Pool powerhouse and ancillary facilities, and Mammoth Pool Dam.

Granite, Jackass, and Chiquito Creeks

The remainder of the primary study area on the upper San Joaquin River is entirely within the SNF, with a small number of private properties interspersed (USJRWPA, 1982c). Land uses in the SNF include timber production, cattle grazing, mining, hydroelectric power generation, recreation, and fish and wildlife habitat (USJRWPA, 1982c).

Fine Gold Creek

The Fine Gold Creek watershed appears to be largely undeveloped and grazed by cattle. Some scattered single-family homes, related farm structures, and access roads are present in the area. Road 210, Hidden Lake Boulevard, and Ralston Way traverse the watershed.

Yokohl Valley

Land use in the Yokohl Valley area is predominantly grazing, including many substantial ranch houses with established vegetation along Yokohl Drive. Two parallel transmission lines traverse Yokohl Valley, and a large new hillside housing development would overlook the potential dam off Route 217.

Traffic and Transportation

Several roads in the Millerton Lake area provide access to residential areas and recreation facilities. Millerton Road skirts the south side of the reservoir, connecting the community of Friant with Auberry Road. Winchell Cove Road and Sky Harbor Road extend from Millerton Road north into residential areas. Madera County roads 206 and 145 on the north side of the lake lead to recreational facilities in the SRA. County Road 216 provides access from north of Millerton Lake into the Hidden View residential area near the confluence of Fine Gold Creek and Millerton Lake. Sky Harbor Drive, on the south side of Millerton Lake, provides access to private property in the Sky Harbor development and to the South Fine Gold picnic area within the SRA.

Wellbarn Road, extending to Spearhead Road from Auberry Road, provides access to Temperance Flat. Smalley Road, which spurs off Auberry Road, provides the main access to the San Joaquin River Gorge Management Area and to the PG&E Kerckhoff and Kerckhoff No. 2 powerhouses. Smalley Road, a paved road, provides access to the Kerckhoff Powerhouse and switchyard, the BLM primitive campground, and San Joaquin River Trail.

Powerhouse Road and Bridge connect Fresno and Madera counties across Kerckhoff Lake. Extending from Auberry Road in Fresno County to Road 222 in Madera County, the road and bridge provide access to Wishon Powerhouse for PG&E staff in Fresno County and to schools in Fresno County for residents in the North Fork area.

Redinger Lake Road spurs off Powerhouse Road, providing access to the Big Creek No. 4 Powerhouse, and winding to Redinger Lake. Italian Bar Road crosses over Redinger Lake and provides access to numerous structures of the Chawanakee community.

Bridge over San Joaquin River at Kerckhoff Lake

County roads 210 and 216 provide access from north of Millerton Lake into Hidden Lake Estates. Ralston Way and Hidden Lake Boulevard are other roads in the Fine Gold Creek watershed.

In Yokohl Valley, Yokohl Drive and private, unpaved roads provide access to grazing lands.

The Granite Creek area contains about 9 miles of unpaved roads that serve as access for recreation (USJRWPA, 1982c).

Mammoth Pool Road traverses the Chiquito Creek watershed, providing access to recreation and facilities.

Recreation and Public Access

Recreation facilities around and upstream of Millerton Lake are shown in **Figure 3-11**. Recreational uses for each river reach are described in the following sections.

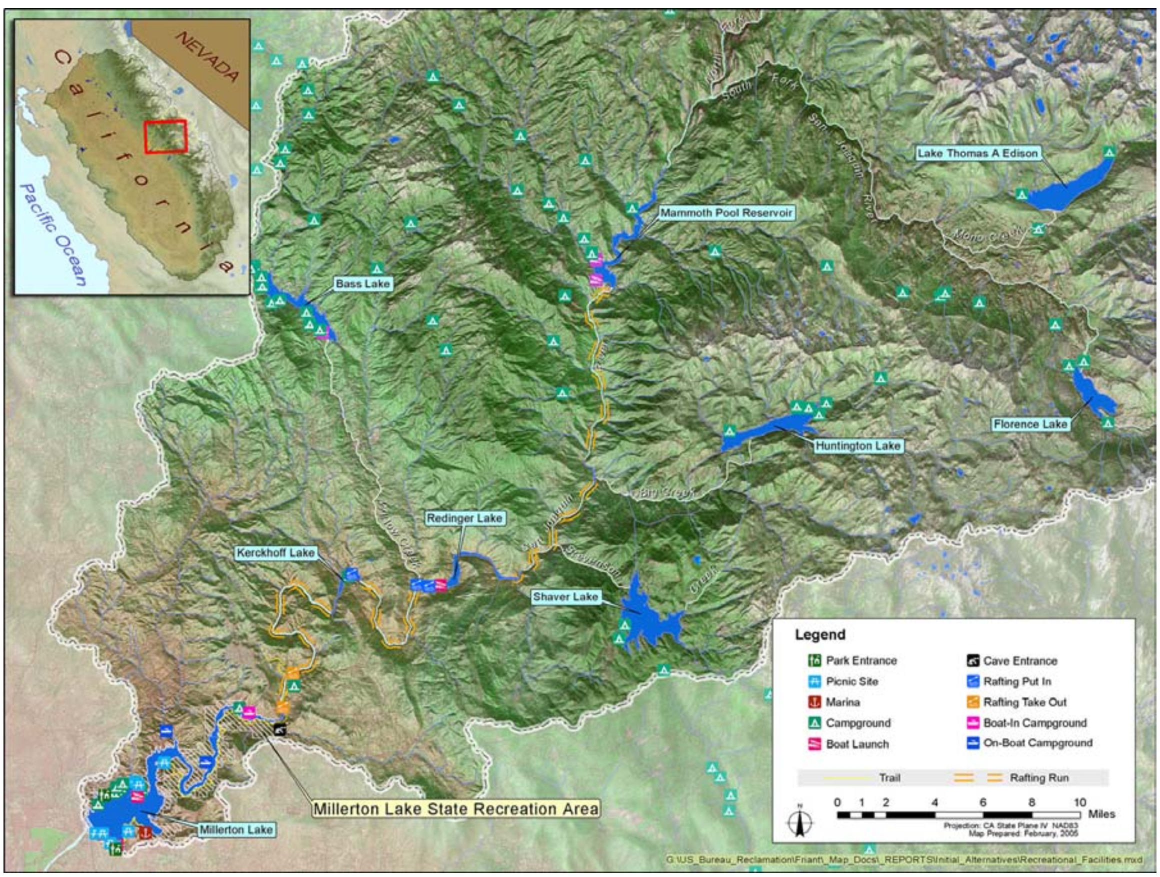


FIGURE 3-11.
RECREATIONAL FACILITIES IN THE UPPER SAN JOAQUIN RIVER BASIN

Millerton Lake and Big Bend

Millerton Lake is a major low-elevation recreation destination in the region, providing a variety of recreation opportunities, including fishing, swimming, boating, and water skiing. Several developed recreation facilities associated with the Millerton Lake SRA are present along the reservoir margins, including boat launching areas, developed campgrounds and day use areas, and recreation residences. The primary launching area is located on the south side of the reservoir near Friant Dam. This launch area is accessible by paved road and includes large paved parking areas and several boat ramps. Smaller, less heavily used boat launches are located elsewhere on the lake. Paved and unpaved roads provide access to the lake's shoreline.

The area upstream of Big Bend, beginning at about RM 274.5, is relatively remote and accessible only by boat or unpaved roads. Dispersed use occurs along the entire shoreline and along the San Joaquin River upstream from Millerton Lake. The San Joaquin River Trail traverses the southern portion of Millerton Lake to Temperance Flat.

Temperance Flat and Millerton Bottoms

The Temperance Flat area is relatively undeveloped and is accessible only by boat or a few mostly unpaved roads. Developed shoreline recreation areas are limited to the Hewitt Valley Environmental Camp and Temperance Flat Boat-In Camp, located on the north side of the lake between RM 280 and RM 281. In addition, a toilet facility is located at about RM 281. Several trails and four-wheel drive roads traverse both the north and south sides of the lake and provide access for dispersed activities such as fishing, hiking, horseback riding, and hunting.

The Millerton Lake SRA adjoins large tracts of public land managed by BLM. The majority of non-water-oriented recreation use in the area occurs within the boundaries of the BLM San Joaquin River Gorge Management Area, formerly known as the Squaw Leap Management Area. BLM has constructed and/or restored several buildings within the San Joaquin River Gorge Management Area, including a Native American village and presentation centers. These buildings are used as part of a program for school-aged children to learn about the natural and cultural resources of the area.

The Millerton Lake Caves, along Big Sandy Creek, are situated just above the high water mark of Millerton Lake. Sculpted by the creek, the cave system formed through scour and enlargement of fractures in the granite, continuous from the point where it captures the creek to the edge of the San Joaquin River (Snyder, 2004). Blocks have closed off two portions of the crevice, dividing it into three portions. The upper cave is listed as the sixth deepest and ninth longest granite cave in the US. Middle cave is listed as 20th longest. The Western Cave Conservancy regards the Millerton Lake Caves system as world class, and the most photogenic of its type in the United States, attracting the interest of cavers around the world (Snyder, 2004).

Millerton Bottoms run is a boatable portion of the river used in late summer and fall when Millerton Lake storage has dropped sufficiently to reveal up to 3 miles of riverbed. This section is classified as Class III and offers dependable whitewater recreation in late summer and fall, when no other local rivers have boatable flows (Martzen, 2004).

Patterson Bend

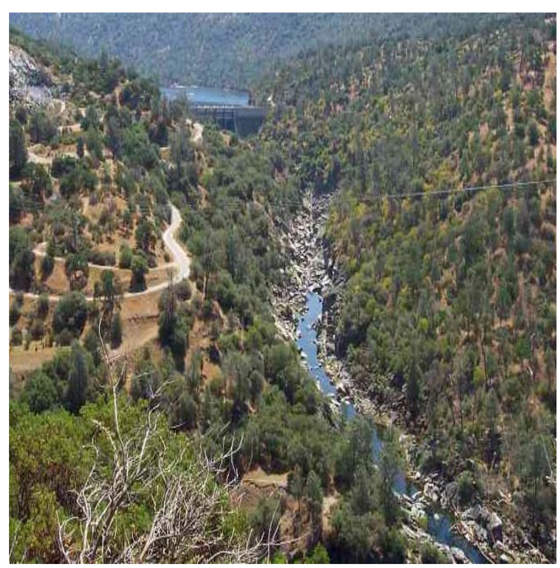
San Joaquin River Trail near Temperance Flat, Madera County

Portions of the Patterson Bend reach of the San Joaquin River are managed by BLM as the San Joaquin River Gorge Management Area, and other portions by the USFS as the SNF. The San Joaquin River Trail terminates within the Patterson Bend reach. No developed recreation facilities exist along the San Joaquin River between the Kerckhoff Powerhouse and Kerckhoff Lake.

Several unpaved roads and trails diverge from Smalley Road and provide access for hunting, fishing, mountain biking, hiking, and equestrian use. Off-road vehicle use is not allowed within the boundaries of the San Joaquin River Gorge Management Area. A four-wheel drive road provides river access at about RM 287 and another four-wheel drive road provides access to the river at about RM 290. The absence of roads and developed facilities limits recreation use, but both warmwater and coldwater fish species draw fishermen, particularly where four-wheel drive roads or trails provide river access.

Whitewater boating also occurs along the San Joaquin River between Kerckhoff Lake and the Kerckhoff No. 2 Powerhouse. This run is referred to as the Patterson Bend run and is rated Class V on the International Scale of Difficulty. Due to infrequent and erratic flows, Patterson Bend is not boated frequently. The last mile of Patterson Bend, known as Squaw Leap and considered Class IV+ to V, is boated in the fall of each year on the outflows of the Kerckhoff Powerhouse.

Kerckhoff Lake and Horseshoe Bend



San Joaquin River below Redinger Dam

Most of the Horseshoe Bend area is situated within or bordered by the SNF. PG&E has developed recreation facilities at Kerckhoff Lake, including a car-top boat launch, a day-use area, and campground at Smalley Cove, on the north side of the lake, and a parking area at the BLM San Joaquin River Gorge Management Area. According to PG&E, these facilities are used primarily for picnicking, fishing, hunting, and primitive camping.

No developed recreation facilities exist between the Big Creek No. 4 Powerhouse and Redinger Lake. A primitive trail, referred to as the Horseshoe Bend Trail, traverses the north side of the San Joaquin River, providing access to upland areas for horseback riding, hunting, and hiking. An unpaved road provides river access where Willow Creek enters the San Joaquin River, about one-half mile downstream of Redinger Dam (Big Creek Dam No. 7).

The river between Redinger Dam and Kerckhoff Lake is used for whitewater boating. This run is known as the Horseshoe Bend run and is considered Class III-IV on the International Scale of Difficulty.

Mammoth Reach

Situated in the SNF, Mammoth Reach hosts recreation activities such as fishing, hunting, hiking, horseback riding, and dispersed camping. Tied for First Run, a Class V whitewater run, is 7 miles long and starts at Mammoth Pool Dam. The take-out is at the Mammoth Pool Powerhouse. The run is reported to be an excellent whitewater run, and provides “pleasant wilderness scenery” (SCE, 2003).

Granite Creek

The Granite Creek area serves as important staging and access for area wilderness users (USJRWPA, 1982c). Recreation activities include fishing, hunting, hiking, horseback riding, dispersed camping, off-road vehicle use, and gathering of forest products. Two developed campgrounds exist in the area.

Granite Creek, Sierra National Forest
(Source: Yosemite-Madera County Film Commission)

Jackass Creek

One four-unit developed campground exists in the Jackass Creek area.

Chiquito Creek

Mammoth Pool Campground near the Chiquito Creek inflow to Mammoth Pool has 47 camp units. Further upstream, Sweetwater and Placer campgrounds offer additional developed campsites, while the Upper Chiquito campground provides undeveloped sites. Chiquito Creek is a popular recreational destination due to its proximity to population centers, accessibility on good roads, and good fishing.

Fine Gold Creek

Fine Gold Creek traverses private property. No developed recreation facilities are within the immediate site area. It is likely, however, that some recreation occurs in the area, particularly where unpaved roads provide access to undeveloped areas along Fine Gold Creek. Recreation activities may include angling, hiking, nature viewing, picnicking, camping, mountain biking, and off-highway vehicle use. Some recreational mining, such as gold dredging or panning, also may occur. Boaters using Millerton Lake can access the lower portion of Fine Gold Creek.

Yokohl Valley

No developed recreation facilities are present in Yokohl Valley, and dispersed use along Yokohl Creek is unlikely owing to the predominance of private property.

Cultural Environment

This section describes the archaeology, ethnography, and history of the primary study area, with particular emphasis on the Temperance Flat area upstream to Redinger Lake and its immediate vicinity. This reach is emphasized primarily because of previous work done in the area related to FERC relicense applications. Other portions of the primary study area are described based on available information from existing sources. No site-specific research was conducted for preparation of this section, but will be prepared for future reports.

Archaeology

California is rich in archaeological remains. Archaeological sites can be found almost anywhere in the State, although some areas have more sites than others, often reflecting more favorable living conditions and more attractive natural resources. Due to California's relatively arid climate, archaeological sites tend to be concentrated near major rivers and reliable water supplies.

A recent archaeological records search by Reclamation archaeologists indicates the presence of 33 archaeological sites within or near the existing pool of Millerton Lake (Welch, 2002). Sites include habitation sites with housepits, sweathouses, and human burials, bedrock mortars (BRM), rock rings, and lithic scatters. Some of the sites are within the Squaw Leap National Register District. Three of the archaeological sites are associated with mining.

Farther upriver, portions of the area were surveyed for PG&E hydroelectric relicensing (Varner and Bernal, 1976; Varner, 1977) and documented as inhabited as early as AD 500 (Moratto, 1984). In Exhibit W of the relicensing application, PG&E stated that 13 archaeological sites were present, 2 of which were found to be significant (PG&E, n.d.). Later reports, reflecting additional survey efforts (Varner, 1983; Wren, 1994), identified 23 sites but only 1 property on the National Register of Historic Places (NRHP). It is likely that additional sites occur near Kerckhoff Lake at elevations higher than those surveyed in connection with PG&E relicensing, and additional sites are expected farther upstream.

Hindes (1962) gave early attention to the San Joaquin River canyon upstream from the Big Creek No. 4 Powerhouse, where ephemeral use sites are likely. Blue oak/foothill pines vegetation present diverse natural resources for use by former occupants of the area. Redinger Lake inundated 22 archaeological sites (Wallace and Lathrap, 1950; White, 1986). Known archaeological sites also are present in the vicinity of the SCE Big Creek No. 3 Powerhouse, including a small village known as Somhau (Theodoratus, 1978; McCarthy et al., 1985). According to surveys of the Big Creek No. 3 Powerhouse area (Varner and Beatty, 1980) and Big Creek No. 3 and No. 4 powerhouses (White, 1986), a high probability exists of archaeological sites, including BRMs, and hunting and fishing camps, throughout the area.

Archaeological sites near Granite Creek include suspected habitation areas, temporary and seasonal campsites, specialized resource procurement areas, trails, and lithic reduction stations (USJRWPA, 1982c).

A recent archaeological records search by Reclamation archaeologists indicates the presence of three known archaeological sites in the Fine Gold Creek watershed (Welch, 2002). Two of the sites have BRMs and lithics, and the third is a standing two-story house.

An archaeological survey of Yokohl Valley was undertaken in 1975 covering an area of approximately 5,000 acres below the elevation 800 contour. The survey documented polychrome pictographs at 2 sites and 33 gathering and processing sites, most of the latter being defined by bedrock milling features. The locations with pictographs were probably semipermanent occupation sites (Varner and Stuart, 1975). The sites have been badly damaged by agricultural activities (ibid.; Moratto, 1984).

Ethnography

The San Joaquin River was a very important resource for the Native American people who lived along its reaches. Societies depended heavily on salmon and acorns for their subsistence, along with other plant foods, game, and other river fish. Foot trails along the San Joaquin River were important to the Mono people (Hindes, 1959). Western Mono had hamlets along major streams, including the San Joaquin, Kings, and Kaweah rivers, and traded across the Sierra Nevada for pine nuts.

Millerton Lake is at the approximate border between Foothill Yokuts traditional territory and traditional territory of the Western Mono or Monache people. Spier (1978a) indicated that the territory of the Northfork Mono extended into the upper part of Millerton Lake, but Spier also showed the area from Millerton to North Fork as territory of the Dumna Foothill Yokuts. Kroeber separated the Northfork Mono into two groups; an unnamed band north of the San Joaquin River and the Posgisa on Big Sandy Creek. He placed the Toltichi Foothill Yokuts along the San Joaquin River as far upstream as North Fork and identified another Foothill Yokuts group, the Kechayi, as having been on the south side of the San Joaquin River. Kroeber (1925) indicates that the village of Tsopotipau at the A. G. Wishon Powerhouse site belonged to Toltichi Yokuts. Rivers (1988), on the other hand, discusses the ethnography of the Millerton Lake area in some detail, and suggests that the Toltichi might have been Mono.

Yokuts currently live at the Table Mountain Rancheria in Friant. Northfork Mono now live primarily at the North Fork Rancheria, and the Posgisa live at the Big Sandy Rancheria in Auberry. The river at the SCE Big Creek No. 3 Powerhouse was a traditional fishing spot for Posgisa people from the Big Sandy Rancheria.

The lower portion of Fine Gold Creek is within traditional territory of either the Northfork Mono people (Spier, 1978a) or the Dumna/Toltichi Yokuts (Kroeber, 1925), while the upper portion of the drainage is in Chuckchansi Foothill Yokuts territory (Spier, 1978b). Some Northfork Mono hamlets are known to have been located on lower Fine Gold Creek (Gifford, 1932; Spier, 1978a). Chuckchansi people presently live on and around the Picayune Rancheria in Coarsegold.

Yokohl Creek is named after the Yokol or Yokod Yokuts, a band of Foothill Yokuts people who lived in the area. One of the most important natural resources for the Yokod was a diatomaceous earth used for white pigment, found on Rocky Hill (Hawshaw Shido, “Paint Place”) northwest of the potential dam site. Another important resource was steatite, mined near Lindsay Peak immediately south of the potential reservoir (Heizer and Treganza, 1944; Latta, 1949; Varner and Stuart, 1975). Von Werlhof (1961) documented information on Indian trails in the Yokohl Valley area. The majority of Southern Valley and Foothill Yokuts people now live on the Tule River Indian Reservation, near Porterville.

History

Numerous archaeological sites testify to a long and varied use of the area by native peoples and indicate an important cultural, social, and economic link between the inhabitants of the western and eastern sites of the Sierra Nevada crest (USJRWPA, 1982c). American fur trappers entered the San Joaquin River drainage as early as 1827, and mining began along the river in 1850. In 1851, Fort Miller was established, and in 1852, a mining supply town called Rootville was settled. This later became Millerton, named after nearby Fort Miller. Millerton became County Seat in 1856 and held this status until 1874 when the County Seat moved to Fresno. Fort Miller was decommissioned in 1866 and became part of a cattle ranch. Friant Dam was constructed in the early 1940s.

One property of historic interest is a former State of California courthouse. This structure was relocated from an original site within present-day Millerton Lake when Friant Dam was constructed to its current location. Fairly diverse mining features occur around Temperance Flat. These features include remains from Chinese placer mining, an arrastra, and two mine portals associated with the Sullivan Mine, where mining began in 1853 and continued into the 1930s (Stammerjohan, 1979). On the north side of the river, the Patterson Mine presents an exceptionally diverse set of remains, including an arrastra, mine portals, remains of cabins, and can/equipment dumps. A two-stamp lift wheel and various other mining remains, including a ball mill, ore car, and rail tracks, are present near a contemporary cabin on the north side of the river a short distance upstream from the Patterson Mine. Wallace and Lathrap (1950) noted historic mining sites in the vicinity of Italian Bar, upstream of Redinger Lake.

The PG&E Kerckhoff Powerhouse, constructed in 1920, is a potentially significant historic property. The Wishon Powerhouse has been evaluated for eligibility on the NRHP, along with four other powerhouses associated with the PG&E Crane Valley Project. The structure is ineligible based on a loss of historic integrity (PG&E, 1986b). The SCE Big Creek Hydroelectric System long has been noted for its engineering significance (Redinger, 1949; Johnston, 1965; Myers, 1983) and may be eligible as a district for the NRHP (White, 1986; Shoup et al., 1988).

The general area of Granite, Jackass, and Chiquito creeks lies within 30 miles of the Casa Diablo Obsidian Source, one of the major sources of obsidian for populations living west of the Sierra Nevada crest and south of the Tuolumne River (USJRWPA, 1982c). The historic French Trail traverses across portions of the upper watershed, near Granite and Chiquito creeks (USJRP&WA, 1982).

Spanish soldiers and missionaries entered Yokohl Valley, and oral history suggests Spanish mining occurred in the area. Cattle and sheep were grazed in the valley as early as the 1850s, and permanent settlement began by the 1860s. Talc, magnetite, and granite were mined or quarried; oaks were cut and made into charcoal; and much historic activity occurred related to mixed farming and ranching (Varner and Stuart, 1975). During site reconnaissance in May 2002, a historic marker was seen noting that the Jordan Toll Trail ran through Yokohl Valley, providing access across the Sierra to Owens Lake and silver mines in the Coso Range. Rock walls were observed on the lower slopes of Rocky Hill, and piles of quarried granite and mounds of soil were seen closer to the stream.

FUTURE WITHOUT-PROJECT BASELINES

Assessment of the magnitude of potential water resources and related problems and needs in the study area is not only based on the existing conditions described in this chapter, but also on an estimate of how these conditions may change in the future. Two baselines are being identified to help define the extent of potential resources problems/needs and for use in identifying the relative effectiveness of alternative plans to be formulated to address these problems/needs:

- **National Environmental Policy Act (NEPA) Baseline** – Under this without-project future condition, only actions reasonably expected to occur in the future would be included such as projects and actions that are currently authorized, funded, permitted, and/or highly likely to be implemented. The NEPA Baseline, commonly called the No-Action Alternative, includes the CEQA Baseline for existing conditions.
- **California Environmental Quality Act (CEQA) Baseline** – This baseline, commonly called the No-Project Alternative, is important for developing the EIR to meet requirements of CEQA. Under this baseline, future conditions are assumed to be similar to existing conditions.

Both the No-Action and the No-Project alternative will be defined in detail in the EIS and EIR. The projected effects of specific projects, actions, and policies in relationship to existing conditions will be developed in coordination with other CALFED programs through the Common Assumptions effort.

FUTURE WITHOUT-PROJECT CONDITIONS

Summarized below are some of the expected physical, environmental, and socioeconomic conditions generally expected to occur in the future in the primary study area.

Physical Environment

Physical conditions in the 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 (which are unlikely) hydrologic conditions will probably remain unchanged. Some speculation exists that regional hydrology would be altered should there be significant changes in global climatic conditions. Scientific work by others in this field of study is continuing.

Groundwater pumping, a major source of supply in the region, continues to increase in response to growing urban and agricultural demands. Over the long-term, groundwater extraction cannot continually meet the portion of water demands that are not met by surface water supplies without causing negative impacts on the groundwater basin. A serious consequence of long-term groundwater overdraft 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. 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 are expected to generally remain unchanged and similar to existing conditions.

Most of the air pollutants in the study area will 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.

Biological Environment

Significant planning and management efforts are underway by numerous agencies and groups to protect and restore biological conditions throughout the primary study area. It is expected that significant efforts of Federal and State wildlife agencies will maintain populations of special status species in the study area at generally the same levels as existing conditions.

Socioeconomic Environment

California's population is estimated to increase from about 34 million in 2000 to about 48 million by 2030. The population of the San Joaquin Valley is expected to increase from approximately 3.6 million people in 2000 to about 6.5 million people by 2030. In the San Joaquin River basin, the population is expected to nearly double from about 1.8 million to nearly 3.4 million by 2030. The ongoing rapid rate of urbanization in the region will generate significant land and water use challenges for the entire San Joaquin Valley.

One of the greatest current and future challenges is providing water in the right places at the right time. In the future, water management challenges will be more complex as demand patterns shift, environmental needs are better understood, and global climate change and other effects on the state's water resources and systems become more evident.

Water supply available for urban, agricultural, and environmental uses in any given year depends on rainfall, snow pack, runoff, carryover storage, pumping capacity from the Delta, regulatory constraints, and water management strategies implemented by water managers. Many different conditions or scenarios can develop, to which the water community will respond. Possible scenarios include two kinds of water use efficiency actions: those that water users take on their own (self-initiated water conservation), and those encouraged by water agency programs.

In the April 2005 Draft version of Bulletin 160, DWR describes the potential effects on future water demands that would result under three different future scenarios – a Current Trends scenario, a Less Resources Intensive scenario, and a More Resources Intensive scenario. Each scenario describes a different base condition for 2030 to which the water community would need to respond by implementing various management strategies. The Draft presents a portfolio of 25 resource management strategies that can be used to sustain California's communities, economy, and environment. New water storage is a critical component. Not only can new water storage improve water supply reliability and quality, it can enhance other strategies such as ecosystem restoration, conjunctive management, water transfers, and operation efficiency.

Cultural Environment

Any cultural resources currently affected by erosion due to reservoir fluctuations would continue to be impacted. Fossils and artifacts located around the perimeter of existing reservoirs and other accessible locations within the primary study area will continue to be subject to collection by recreationalists.

CHAPTER 4. PROBLEMS, NEEDS, AND OPPORTUNITIES

This chapter describes major identified water resources problems, needs, and opportunities in the study area. Water resource problems, needs, and opportunities provide a framework for plan formulation and help establish objectives that a project would attempt to meet. Water resources problems in the San Joaquin Valley are associated with changing water needs, hydrologic variations in water availability, and the capacity of current water storage and conveyance facilities.

PROBLEMS AND NEEDS

Problems and needs to be addressed by the Investigation were identified in the CALFED ROD and from stakeholder input. The primary purposes for developing and managing additional water supplies from the upper San Joaquin River basin identified in the CALFED ROD include contributing to restoration of the San Joaquin River; improving water quality in the San Joaquin River; and facilitating conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities. These problems form the basis for initial plan formulation. All three problems could be addressed by increasing water supply reliability in the upper San Joaquin River basin through the development and management of additional water supply. This section describes water resources problems and needs for the Investigation in greater detail.

Problems and Needs

- San Joaquin River ecosystem
- San Joaquin River water quality
- Water supply reliability

Opportunities

- Flood control
- Long-term EWA water supply
- Hydropower generation
- Recreation

San Joaquin River Ecosystem

The reach of the San Joaquin River from Friant Dam to the Merced River confluence does not currently support a continuous natural riparian and aquatic ecosystem. Friant Dam was authorized and is operated to support two primary purposes: irrigation and M&I water supplies, and flood protection. Since completion of Friant Dam, most of the water in the river has been diverted for agricultural and M&I uses, with the exceptions of releases to satisfy riparian water rights upstream of Gravelly Ford and flood releases. Consequently, the reach from Gravelly Ford to Mendota Pool is often dry.

Flow in the San Joaquin River from Mendota Pool to Sack Dam contains Delta water for delivery to the San Luis Canal Company and wildlife refuges. Between Sack Dam and the confluence with Salt Slough, the primary source of flow in the San Joaquin River is groundwater seepage from adjacent agricultural lands. The reach from Sack Dam to Bear Creek is operationally dry, but it benefits from managed wetland development, whereas marshes have been drained between Bear Creek and the Merced River. Lack of reliable flows and poor water quality in the San Joaquin River result in generally unhealthy ecosystem conditions.

During the past few decades, societal views toward the ecosystem health of rivers in the Central Valley and elsewhere in the nation have changed. This shift in viewpoint is evident in the numerous programs addressing ecosystem restoration in the Central Valley and along the San Joaquin River as well as in ongoing litigation between a coalition of environmental interests represented by NRDC, and Reclamation and FWUA *(NRDC v. Rodgers)*. For several years, NRDC and FWUA considered various river restoration ideas that could be used as part of a settlement of *NRDC v. Rodgers.* On August 27, 2004, the U.S. District Court, Eastern District of California, found that Friant Dam has been operated in violation of California Fish and Game Code Section 5937, which requires that water be released from a dam to maintain downstream fish in good condition. The ruling specified that a remedy to the violation will be determined at a later date.

As indicated in **Chapter 2**, several ongoing studies are considering flow and water quality requirements and river channel modifications that would be needed to support a variety of river restoration objectives. Specific water quantity and temperature requirements to support San Joaquin River restoration have not been finalized. In all cases, however, restoration of the San Joaquin River would require the release of additional water supplies from Friant Dam. For some potential restoration plans, water released from Friant Dam would need to be at or below specified temperatures to support fishery requirements and not adversely affect anadromous fishery conditions in the lower San Joaquin River downstream of the confluence of the Merced River.

San Joaquin River Water Quality

As described in **Chapter 3**, water quality in various segments of the San Joaquin River has been a problem for several decades due to low flow and discharges from agricultural areas, wildlife refuges, and M&I treatment plants. **Table 3-5** summarizes the types of pollutant stresssors that have been identified in each reach of the San Joaquin River from Mendota Pool to the Delta.

Regulatory requirements for water quality in the San Joaquin River have been developed for downstream areas and are under development for upstream areas. Initial locations of concern for water quality include areas near Stockton and at Vernalis, downstream of the Stanislaus River as the San Joaquin River enters the Delta. Over time, 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 has increased.

In 1998, the Central Valley RWQCB adopted a WQCP for the Sacramento and San Joaquin river basins (Basin Plan) as the regulatory reference for meeting Federal and State requirements. The Basin Plan lists existing and potential beneficial uses of the lower San Joaquin River, including agricultural uses, M&I uses, recreation, fishery migration and spawning, and wildlife habitat. Specific water quality standards associated with the lower San Joaquin River apply to boron, molybdenum, selenium, dissolved oxygen, pH, pesticides, and salinity as measured at Vernalis and other locations along the San Joaquin River as it enters the Delta. The Basin Plan is undergoing a triennial review for beneficial use and water quality standard updates.

One of the high priority issues of the Basin Plan review is the regulatory guidance for TMDL standards at locations along the San Joaquin River. Section 303(d) of the Federal Clean Water Act requires the identification of waterbodies that do not meet, or are not expected to meet, water quality standards, or are considered impaired. The current 303(d) list (1998) identifies Mud and Salt sloughs and the San Joaquin River from Mendota Pool downstream to Vernalis as impaired waterbodies.

The Clean Water Act further requires developing a TMDL for each listing. The Basin Plan (including TMDL allocation) is subject to future review and revision. Although it is likely that future versions will address more restrictive water quality objectives than the current version, existing water quality objectives will be used in the Investigation. Additional water supplies and other land and water use management practices are needed to address water quality problems in the San Joaquin River.

Water Supply Reliability

The Friant Division of the CVP provides surface water supplies to many areas that also rely on groundwater. As described in **Chapter 3**, the Friant Division was designed and is operated to support conjunctive water management to reduce groundwater use in the eastern San Joaquin Valley. Although the 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).

As discussed in **Chapter 3**, surface water supply reliability problems are associated with large hydrologic variations in water availability from year to year and the limited capacity of current water storage and conveyance facilities. As a result, the continued general downward trend of groundwater levels reveals that significant water supply reliability problems remain.

In an effort to reduce groundwater overdraft in the eastern San Joaquin Valley, FWA and MWD are exploring opportunities to increase water supply reliability to the Friant Division and improve the quality of water deliveries to urban areas through water exchanges involving Friant and Delta water supplies. Preliminary findings by FWA and MWD suggest that limited opportunities exist to increase water supply reliability with these exchanges without the development and management of additional water from the San Joaquin River. These findings are consistent with the recommendation in the CALFED ROD to consider how additional storage could facilitate additional conjunctive management and exchanges to increase the delivery of high quality water to urban areas.

Future operations of the Friant Division are anticipated to be similar to recent historic operations. Water supply reliability in some areas of the Central Valley will continue to be lower than historical levels and future long-term average water deliveries will likely be less than full contract amounts.

OPPORTUNITIES

CALFED documents also indicate that opportunities to address other regional water resources needs should be considered in the evaluation of potential projects. **Table 3-1** of the CALFED EIS Implementation Plan states that local participation is desired in the Upper San Joaquin River Basin Storage Investigation to identify how additional storage would improve flood protection and improve the conjunctive management of surface water and groundwater resources. Local input provided prior to and during scoping suggested the Investigation should consider opportunities for flood damage reduction, power generation, and recreation, to the extent possible. This section describes other potential water resources opportunities that could be addressed through development and management of San Joaquin River supplies.

Flood Control

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 two decades have demonstrated that Friant Dam, among many other Central Valley dams, may not provide the level of flood protection that was intended at the time the flood management system was designed. 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 for the Sacramento and San Joaquin River Basins (Comprehensive Study), the United States Army Corps of Engineers (Corps) prepared a post-flood assessment of system performance during four major floods in the last two decades. The study found that Friant Dam was effective in reducing damages during floods, but that significant damages were still experienced (Corps, 2002) during recent flood events, as summarized in **Table 4-1**. The Comprehensive Study also developed a set of system-wide tools to simulate flood system performance for the entire San Joaquin River Basin. As described in the **Flood Damage Reduction TA** to this report, without-project conditions for the study area include expected annual damages from flooding of $29.0 million in the San Joaquin River basin.

TABLE 4-1.
RECENT FLOOD DAMAGES IN THE SAN JOAQUIN RIVER BASIN

County	1983 ($1,000)[1]	1986 ($1,000)[1]	1995 ($1,000)[1]	1997 ($1,000)[1]
Fresno	13,424	1,290	21,236	5,414
Kern	11,934	-----	22,966	-----
Kings	97,968	-----	2,484	38,857
Madera	40,300	248	2,299	4,187
Merced	614	70	38,854	8,180
San Joaquin	122,772	13,738	4,499	79,455
Stanislaus	12,887	-----	52,447	78,362
Tulare	24,731	20	48,515	8,836
Total	**$324,630**	**$15,366**	**$193,300**	**$223,291**

Notes:
[1] Damages reported in thousands of dollars for year of flood (1983, 1986, 1995, 1997); Source: Corps, 2002

Water Supply for Long-Term EWA

The Bay-Delta is the largest estuary on the West Coast and provides essential habitat for a diverse array of fish and wildlife. A variety of factors have contributed to the decline of fish species in the Delta, including loss of habitat and water resources development, resulting in the listing of these species as threatened or endangered. Because the Delta is unlikely to return to known historic conditions, Delta fisheries recovery will depend on continued legal mandates as well as operational mechanisms to ensure success in the face of continually changing conditions.

Several programs and practices to address Delta fisheries have been developed in response to ESA listings, the CVPIA, and other regulatory requirements. These programs, which include CVPIA (b)(2), SWQCB D1641, VAMP and EWA, allow water managers to meet and/or exceed regulatory requirements contained in the biological opinions.

Water deliveries from the Delta have been curtailed in recent years to help protect threatened and endangered fish populations and their habitat. However, while pumping curtailments and other actions in the Delta have been beneficial to fish, they often have adverse impacts on cities, farms, and businesses that depend on water supplies pumped from or through the Delta. As described in **Chapter 2**, the EWA was developed to provide water managers with additional flexibility in meeting or exceeding regulatory requirements in the Delta without uncompensated losses to water users.

It is expected that, under without-project future conditions, CVP and SWP pumping at Banks and Tracy will increase to meet south of Delta demands, resulting in greater impacts to Delta fisheries and the potential for more frequent pumping curtailments. Consequently, it is also likely that the long-term EWA, or a similar program, will continue to operate in the future to allow fisheries actions in the Delta without adverse impacts to urban and agricultural water users.

Currently, the short-term EWA Program relies primarily on water acquisitions to obtain water supplies. However, there is a great deal of uncertainty associated with the future of the California water market in the face of ever-growing demands in the state. Increased competition for limited water supplies will likely drive up the cost of water on the open market in the future. For an acquisitions-based program such as the EWA, the increasing cost of water would be compounded by future budget constraints.

As described in **Chapter 3**, the Friant Division generally operates independently from the South-of-Delta export area. Because potential restoration or water quality flows in the San Joaquin River could provide a water supply to Mendota Pool, there is an opportunity to evaluate if the development and management of additional water supplies from the upper San Joaquin River could provide less costly water to the EWA or a similar long-term program.

Hydropower

Hydropower long has been an important element of power supply in California. On average, hydropower generation constitutes between 10 to 27 percent of California's annual energy supply, depending on the type of water year. The United States receives between 7 and 12 percent of its electricity from hydropower. Due to its ability to rapidly increase and decrease power generation rates, hydropower often has been used to support peak power loads in addition to base power loads.

As population, industry, and associated infrastructure growth occurs in the future, demands for power will also increase. Although some new power generation capacity likely will be developed in California during the next few decades, it is expected that additional new generation capacity will still be required. The Investigation will consider opportunities for additional hydropower generation capacity in association with the development and management of San Joaquin River water supplies.

Recreation

Demands for water-oriented 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 Mountains. As population increases in the San Joaquin Valley, demands for water-based and land-based recreation are expected to increase.

CHAPTER 5. PLAN FORMULATION APPROACH

This chapter presents the identified planning objectives, principles, constraints, and used criteria to guide the Investigation.

PLAN FORMULATION PROCESS

The basic plan formulation process for Federal water resources studies and projects consists of the following steps:

- Inventory existing conditions and forecast likely without-project future resource conditions.
- Specify water resources problems and needs.
- Develop planning objectives, constraints, and criteria.
- Identify resources management measures and formulate potential alternative plans to meet study objectives.
- Compare and evaluate alternative plans.
- Select a plan for recommended implementation.

As described in **Chapter 1**, Phase 1 of the Investigation began in 2001 and included preliminary definition of problems and needs, objectives, and initial screening of storage sites. Phase 2 began in January 2004 with formal initiation of environmental review processes consistent with Federal and State of California regulations. The Investigation will culminate in a FR and supporting environmental documents consistent with the P&G, Reclamation directives, DWR guidance, and applicable environmental laws. Reclamation and DWR are coordinating the Investigation with the BDPAC, which provides advice to the Secretary regarding the implementation of the CALFED Program, and the CBDA, which provides general oversight and coordination of all CALFED activities.

To facilitate coordination with other agencies and related ongoing studies, preparation of the FR will include two interim planning documents: an IAIR and a subsequent PFR. The IAIR describes without-project conditions and water resources problems and needs; defines study objectives and constraints; screens surface water storage measures; describes groundwater storage measures development; and identifies preliminary water operations rules and scenarios. Retained storage measures and preliminary water operations scenarios will be included in initial alternatives.

This IAIR will be used as an initial component of the FR. The PFR will present the results of initial alternatives evaluation, identify refinements of the alternatives, and define a set of final alternatives. A Draft FR will evaluate and compare the final alternatives and identify a recommended plan. A Draft EIS and EIR will be included with the Draft FR. Following public review and comment, a final FR/EIS/EIR will be prepared. The approach for developing the FR is shown in **Figure 5-1** and described below.

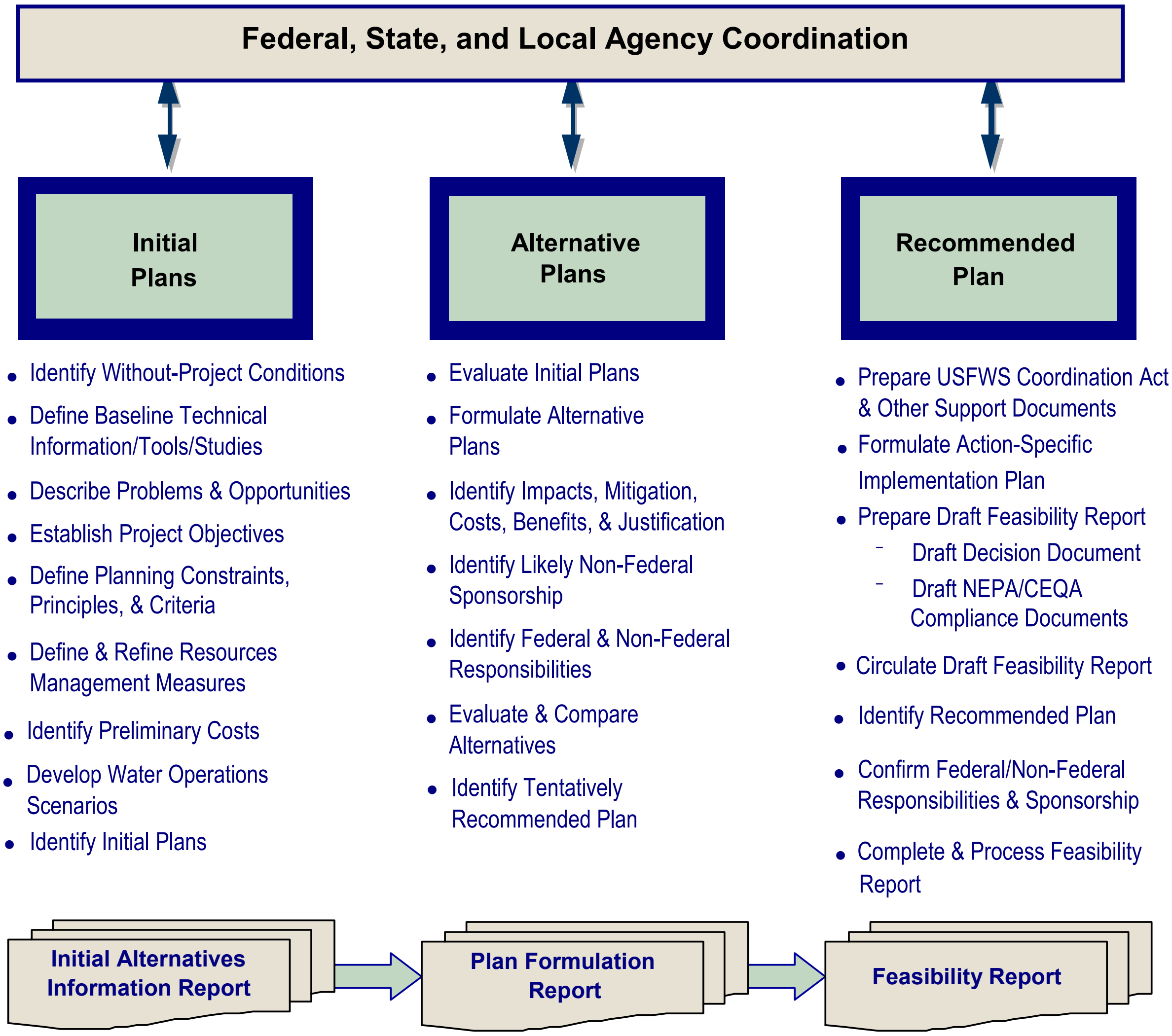


FIGURE 5-1.
PLAN FORMULATION PROCESS

Initial Plans – Identify without-project future conditions, define resulting resources problems and opportunities, define a specific set of planning objectives, identify the constraints and criteria in addressing the planning objectives, identify potential resources management measures to address planning objectives, and formulate, coordinate, and compare a set of initial plans. The Initial Plans stage, documented herein, is nearing completion. A summary of existing and potential future without-project conditions (consistent with the NEPA Baseline) and problems, needs, and opportunities is included in **Chapters 3** and **4**, respectively.

Alternative Plans – From the initial plans, formulate specific alternative plans to address the planning objectives, evaluate, coordinate, and compare the plans, and identify a plan for tentative recommendation.

Recommended Plan – Complete development of a tentatively recommended plan and prepare, coordinate, and process supporting decision documentation.

PLANNING OBJECTIVES

Planning objectives were developed based on CALFED Program and Investigation-specific goals as described in the ROD. CALFED Program goals include increasing water supply reliability, improving water quality for all beneficial uses, improving ecosystem conditions for Delta-dependent species, and improving Delta levee stability. Investigation-specific considerations include identified problems and needs in the study area in relation to study authorities, study planning principles, and requirements in the P&G, as described in **Chapter 4**. From this review, primary and secondary planning objectives were established for the Investigation. Alternatives will be formulated to address primary objectives. Secondary objectives address opportunities that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary planning objectives.

Primary Objectives

As described in **Chapter 4,** and recognized in the CALFED ROD and supporting documents, increasing the reliability of managed water supplies from the San Joaquin River is integral in addressing ecosystem restoration, water quality, and water management problems in the study area. Therefore, alternatives will be formulated with a focus on developing and managing new water supplies from the San Joaquin River that address the following primary objectives:

- Contribute to San Joaquin River restoration
- Improve San Joaquin River water quality
- Facilitate additional conjunctive water management in the eastern San Joaquin Valley to reduce groundwater overdraft and support exchanges that improve the quality of water delivered to urban areas

To date, quantifiable restoration, water quality, and water management targets have not been established. Therefore, the Investigation will identify the extent to which alternatives can contribute to the primary objectives.

Secondary Objectives

To the extent possible, through pursuit of the primary planning objectives, alternatives will include features to help accomplish the following secondary objectives:

- Increase control of flood flows at Friant Dam
- Contribute to long-term EWA water supply
- Develop hydropower generation capacity in the upper San Joaquin River basin
- Develop additional recreational opportunities in the study area

PLANNING CONSTRAINTS

Fundamental to the plan formulation process is identifying and developing basic constraints specific to the Investigation. Planning constraints are used to help guide the conduct of the feasibility study. Some planning constraints are rigid, such as Congressional direction, current applicable laws, and physical conditions (topography, hydrology, etc.). Other planning constraints, such as agency regulations and policies, are less stringent but are still influential in guiding the Investigation. Major constraints in formulating and ultimately implementing a plan to meet Investigation study objectives are described below.

Study Authorization – In 2003, Federal authorization was provided to prepare a feasibility report for storage in the upper San Joaquin River basin (PL 108-7, Division D, Title II, Section 215). Congress again authorized the Secretary to conduct planning and feasibility studies for storage in the upper San Joaquin River basin in the October 2004 Water Supply, Reliability, and Environmental Improvement Act (PL 108-361). State of California 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.

Laws, Regulations, and Policies – Numerous laws, regulations, executive orders, and policies need to be considered, including NEPA, the Fish and Wildlife Coordination Act, Clean Water Act, Clear Air Act, Federal and State ESAs, CEQA, and the CVPIA.

Reallocation of Contract Water Supplies – As described in **Chapter 3**, Friant Dam was authorized and is operated for water supply and flood protection purposes. Federal authorization for the Investigation focuses on development of additional water supplies and management of new and existing supplies to support CALFED objectives, and does not provide authorization to reallocate water supplies from long-term contractual commitments. As described in **Chapter 2**, the CVPIA requires the Secretary to develop a comprehensive restoration plan address fish, wildlife, and habitat concerns on the San Joaquin River. During the time the Secretary is developing such a restoration plan, and until Congress has authorized the Secretary to implement the plan, the Secretary shall not make releases for the restoration of flows between Gravelly Ford and the Mendota Pool for purposes of implementing the CVPIA. Following completion of a restoration plan, the Secretary shall not thereafter make releases from Friant Dam as a measure to implement the CVPIA without a specific Act of Congress authorizing such releases. The Investigation will evaluate approaches to managing existing supplies in conjunction with developing new supplies; however, reallocation of existing supplies will not be included in the plan formulation process. Water operations evaluations that involve development and management of water supplies for additional releases to the San Joaquin River will demonstrate that without-project water delivery quantities are maintained.

PLANNING PRINCIPLES

In addition to the planning constraints, a series of planning principles were identified to help guide plan formulation. Many of the planning principles result from the Federal P&G and other Federal planning regulations. Planning principles and guidelines relate to economic justification, environmental compliance, technical standards, etc. Also, many of the principles result from local policies, practices, and conditions. Several examples of principles in the Investigation for use in formulating, evaluating, and comparing initial alternatives, and later, detailed alternatives, include the following:

- Alternatives and their major elements are to be consistent with the identified planning constraints.
- A direct and significant geographical, operational, and physical dependency must exist between major components of alternatives.
- Each alternative should address primary planning objectives at minimum and, to the extent possible, address the secondary planning objectives.
- Measures to address secondary objectives should be either directly or indirectly related to the primary objectives (i.e., plan features should not be independent increments).
- Alternatives should avoid unmitigated adverse impacts to hydrologic and/or hydraulic systems such as water supply pumping and conveyance facilities, flood control works, hydropower generation, recreation facilities, or other significant water resource uses in the study area.
- Alternatives should strive to either avoid potential adverse impacts to environmental resources, or to include features to mitigate unavoidable impacts through enhanced designs, construction methods, and/or facilities operations.
- Alternatives should strive to avoid potential adverse impacts to present or historical cultural resources, or to include features to mitigate unavoidable impacts.
- Alternatives should recognize the purposes, operations, and limitations of existing and without-project future projects and programs.
- Alternatives will be formulated and evaluated based on a 100-year period of analysis.
- First costs for alternatives are to reflect current prices and an allowance for interest during construction, and annual costs are to include the current Federal discount rate.
- Alternatives should have a high certainty for achieving the intended benefits and not significantly depend on long-term actions (past the initial construction period) for success.

CRITERIA FOR FORMULATING AND EVALUATING ALTERNATIVES

Federal planning criteria were defined to help formulate and evaluate alternative plans and to assess which alternatives best address the planning objectives. Initial alternatives will be developed and evaluated consistent with four criteria based on P&G, including (1) effectiveness, (2) efficiency, (3) acceptability, and (4) completeness. Each criterion is described in the following sections with examples of the types of metrics that will be considered. Initial alternatives will be evaluated on their relative ability to meet each of the criteria.

Effectiveness

Effectiveness is the extent to which a plan alleviates problems and achieves objectives. For example, effectiveness may be considered according to a water supply reliability measurement or water quality goal. Effectiveness will be evaluated in terms of the ability to develop and manage San Joaquin River water supplies to support the primary purposes. Specific criteria may include new water supply at Friant Dam, ability to carry over stored water to dry periods, ability to develop a cold water pool to support potential restoration requirements, ability to manage supplies for diversion when canal capacity is available, and quality of stored water to support restoration, river water quality, and water quality exchanges.

Efficiency

Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating specified problems and realizing specified opportunities, consistent with protecting the Nation’s environment. Some potential ways to evaluate efficiency include dollars per unit of economic benefit, least cost of attaining a given objective, or reduced opportunity costs relative to accomplishments of other alternatives. Specific criteria may include long-term average water supply cost, potential to develop pumped storage, water supply relative to inundation-related environmental impacts, and potential to increase control of flood flows at Friant Dam.

Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public, and compatibility with existing laws, regulations, and public policies. Specific criteria will be developed in coordination with other Federal and State agencies, local stakeholders, and potential non-Federal sponsors. Criteria likely will include impacts to natural, cultural, and socioeconomic resources, potential to develop adequate mitigation in the vicinity, willingness of private parties to sell affected lands and facilities, and consistency with existing authority.

Completeness

Completeness is an indication of the extent to which an alternative provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. The completeness of each alternative will be identified through a determination that all necessary components and actions are identified, including the adequate mitigation of significant adverse impacts, and the degree of uncertainty (or reliability) of achieving the intended objectives.

CHAPTER 6. RESOURCES MANAGEMENT MEASURES

Following development of the planning objectives, constraints, and criteria for the Investigation, the next major step in formulating initial alternatives is to identify and evaluate potential resources management measures. A resources management measure is any structural or non-structural action that could address the planning objectives.

Numerous potential resources management measures have been identified as part of previous studies, projects, and programs to address water resources and related problems and needs in the study area. These measures were developed and reviewed during study team meetings, field inspections, and outreach for the Investigation for their ability to address the planning objectives listed in **Chapter 5**. This chapter generally describes the measures considered, and presents summary information related to their potential new water supplies, construction costs, environmental considerations, hydropower generation effects, and reasons for either retaining or eliminating measures from further development in the Investigation. Surface water storage measures that appear to contribute the least to the planning objectives are dropped from further consideration in this chapter. Several measures are carried forward for further evaluation, comparison, and screening in **Chapter 7**.

The measures discussed in this chapter include surface water and groundwater storage measures to address the primary study objectives and hydropower replacement and flood damage reduction measures to address secondary study objectives. As explained in **Chapter 2**, the study of potential storage measures in the upper San Joaquin River basin is part of a larger CALFED program to address multiple objectives for managing water resources in California involving several subprograms that include a wide array measure types, including water efficiency, water transfers, water quality, conveyance, levee improvements, and other structural and nonstructural measures.

CHAPTER ORGANIZATION

This chapter is organized into the following major sections:

Storage Measures Background. This section presents background on the need for storage to address the primary planning objectives and how surface water and groundwater storage measures are being approached.

Initial Surface Water Storage Measures. This section summarizes the surface water storage measures retained and dropped in Phase 1 of the Investigation, and additional surface water storage measures that were proposed during the scoping process.

Evaluation of Surface Water Storage Measures Retained from Phase 1. This section presents more detailed information related to the surface water storage measures retained from Phase 1 of the Investigation, including their potential new water supply, hydropower generation effects, estimated costs, environmental considerations, and reasons for either retaining or eliminating measures from further development in the Investigation. Many of the surface water storage measures include optional approaches for developing hydropower generation capacity to replace hydropower generation adversely affected by the storage measure. The surface water storage measures address the primary planning objectives.

Surface Water Storage Measures Suggested During Scoping. This section describes components and preliminary evaluations of the upstream surface water storage measures suggested during scoping.

Groundwater Storage and Conjunctive Management Measures. This section summarizes work done during Phase 1 of the Investigation to determine the potential for conjunctive management opportunities. It also describes work performed since Phase 1 in identifying potential conjunctive management projects.

Flood Damage Reduction Measures. This section describes potential changes in flood management that could address one of the secondary planning objectives. Flood management measures included increasing dedicated flood management storage and reducing objective releases from Friant Dam.

STORAGE MEASURES BACKGROUND

As noted in **Chapter 4**, the primary problems in the study area related to the San Joaquin River ecosystem, San Joaquin River water quality, and water supply reliability, require development and management of additional water supplies in the upper San Joaquin River basin. Development and management of new water supplies, consistent with the constraints described in **Chapter 5**, could be accomplished only with additional storage and resulting changes in project operation. In addition, Federal authorization for the Investigation specifically requested a FR for storage.

All of the storage measures presented could support multiple objectives. New water supply developed by increasing storage of San Joaquin River water could be used for any or all of the primary objectives. Because specific restoration, water quality, and water supply reliability objectives have not been established for the Investigation, the quantitative degree to which the storage measures could contribute to any of the objectives is not yet known. Therefore, measures will be evaluated on the basis that they could develop and manage water supplies to contribute to San Joaquin River restoration, improve San Joaquin River water quality, and facilitate additional conjunctive water management in the eastern San Joaquin Valley to reduce groundwater overdraft and support exchanges that improve the quality of water delivered to urban areas.

In general terms, San Joaquin River water could be stored either in surface water reservoirs or in groundwater basins, and a variety of approaches is available for either of these two methods. Surface water storage of San Joaquin River water could be accomplished through enlarging existing reservoirs or developing new reservoirs that could directly receive water from the upper San Joaquin River basin. Examples include raising Friant Dam, potential offstream reservoirs in the upper San Joaquin River basin, or potential off-canal reservoirs served by the Madera or Friant-Kern canals, which receive water diverted at Friant Dam.

Storage of San Joaquin River water also could be achieved through exchanges that involve increasing the storage of water from other watersheds. This approach would require that water from another watershed be captured and held so that water from Millerton Lake could be released earlier for delivery to areas otherwise served by other watersheds, thereby lowering storage levels and allowing the capture of more San Joaquin River water. Water captured in the other watersheds then would be used for later delivery. Implementation of water storage exchange options would require participation by water rights holders in other watersheds and participation by water users who would be affected by changes in delivery sources and patterns.

Groundwater storage could be accomplished by several methods, including increasing deliveries to existing water users in the Friant Division in lieu of groundwater pumping; increasing the rate of groundwater recharge; and developing groundwater banks that would accept water during wet periods and make it available during dry periods. Implementation of groundwater storage measures would require participation by water users who would be affected by changes in the sources and patterns of supplies, and landowners in the vicinity of groundwater storage and extraction facilities.

INITIAL SURFACE WATER STORAGE MEASURES

During Phase 1 of the Investigation, a review of previous regional water resources studies identified 17 potential surface water storage sites for initial consideration (see **Figure 6-1**). Information considered was obtained from multiple sources, including previous studies, field observations by study team members, and from stakeholders. In some cases, the configuration of a surface water storage measure was modified from the project described in previous studies, and information was updated as appropriate. Most sites could be configured at various storage sizes, with each configuration identified as a measure.

The initial list of surface water storage measures included enlarging two existing reservoirs, Lake Kaweah and Lake Success. These measures were dropped from further consideration because they have been authorized for construction. The remaining measures included enlarging existing reservoirs and constructing new reservoirs. Some measures are located in the upper San Joaquin River basin; others are located in watersheds that are served by the Friant Division or would be operated as off-canal storage.

A technical memorandum (TM) was prepared for each surface water storage site considered during Phase 1. Although cost was not a criterion for initial screening, cost information was provided in all of the TMs, which were included as TAs to the October 2003 Phase 1 Investigation Report. Initial review focused on potential construction-related issues that could preclude constructing required facilities, create environmental impacts that could not be mitigated, or create conditions under which permits issued by regulatory agencies or approved by decision-makers would be unlikely. Six surface water storage measures were retained for further analysis and one measure, enlarging Mammoth Pool, is under study by others.

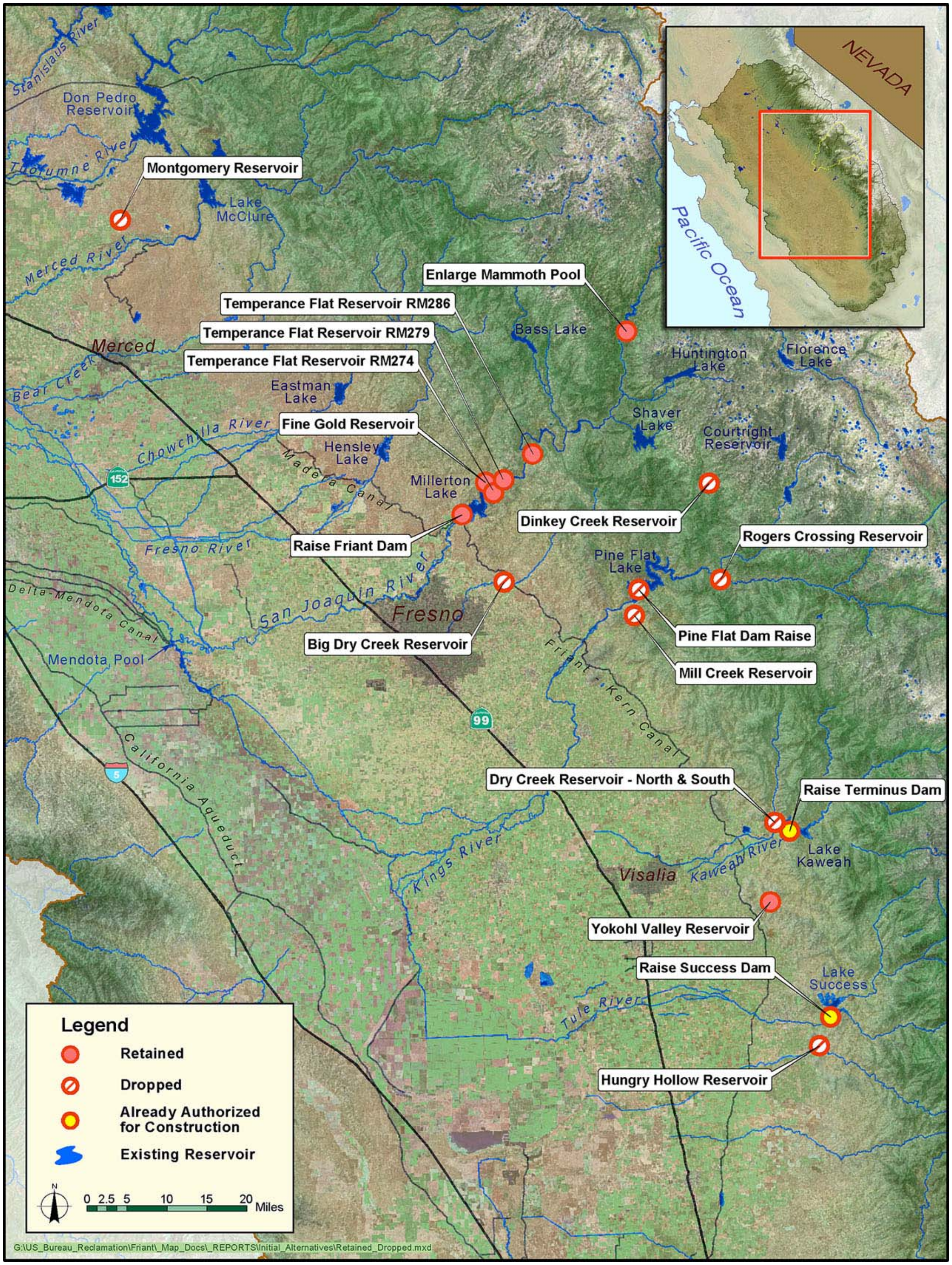


FIGURE 6-1.
SURFACE WATER STORAGE SITES CONSIDERED IN PHASE 1

Surface Water Storage Measures Dropped in Phase 1

This section briefly describes the eight surface storage sites dropped from further consideration during Phase 1. Additional details regarding these measures are provided in the Phase 1 Investigation Report and TAs.

Merced River Watershed - Montgomery Reservoir

Montgomery Reservoir would be an offstream reservoir on Dry Creek, a northern tributary to the Merced River, with a storage capacity of about 240 TAF. It would store flood flows released or spilled from Lake McClure at New Exchequer Dam and diverted from the Merced River at Merced Falls. Water stored in Montgomery Reservoir would be used to meet water needs in Merced Irrigation District (MID), allowing water stored in Lake McClure to be used in exchange for other purposes. 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 dropped from further consideration because MID expressed concern regarding the quality of the water and indicated it would not be interested in pursuing this measure.

San Joaquin River Dry Creek Watershed - Big Dry Creek Reservoir

Big Dry Creek Reservoir, an existing flood detention basin near Clovis, is operated by the Fresno Metropolitan Flood Control District. The 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 yet been tested. Consequently, uncertainty remains regarding the existing dam's ability to store more than a few thousand acre-feet of water. Modifications to enable long-term storage may require extensive reconstruction. Based on these concerns, enlarging the Big Dry Creek Flood Control Basin for long-term water storage was dropped from further consideration.

Kings River Watershed - Raise Pine Flat Dam

Raising the gross pool elevation of Pine Flat Reservoir by 20 feet would provide 124 TAF of additional storage. Additional water developed from an enlarged Pine Flat Reservoir would be exchanged for Friant Division water. Early in the year, water from 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 Corps and the Kings River Conservation District (KRCD), which represents the users of water stored in Pine Flat Reservoir. This measure was dropped from further consideration because it was not supported by KRCD.

Kings River Watershed - Mill Creek Reservoir

Measures at this site would involve construction of a 250-foot-high dam on Mill Creek, which joins the Kings River approximately 1.7 miles downstream of 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. This measure would require participation by KCRD to facilitate water exchanges similar to the approach described for the Raise Pine Flat Dam measure. KCRD is not interested in this measure. In addition, an extensive sycamore alluvial woodland is located in the lower reaches of Mill Creek near its confluence with the Kings River (Corps, 1994). This is a rare and sensitive habitat type that hosts a diverse assemblage of wildlife, particularly birds. It is anticipated that creation of Mill Creek Reservoir would result in unmitigable negative impacts to the sycamore alluvial woodland habitat. This measure was dropped from further consideration.

Kings River Watershed - Rodgers Crossing Reservoir

A dam at Rodgers Crossing would be located on the main stem of the Kings River, above Pine Flat Reservoir, approximately one-half mile upstream of the confluence with the North Fork. 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 Raise 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 of Pine Flat Reservoir, the Kings River also supports whitewater recreation. Both measures would inundate a portion of the Kings River Special Management Area, and the larger measure 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 also would affect a Wild Trout Fishery, as designated by DFG. This measure was dropped from further consideration.

Kings River Watershed - Dinkey Creek Reservoir

A dam and reservoir on Dinkey Creek, in the upper watershed of the North Fork of the Kings River, would be located within the SNF at over elevation 5,400. It would create a 90 TAF reservoir that would be operated to exchange with Millerton Lake water, similar to the approach described for the Raise Pine Flat Dam measure. Dinkey Creek is a popular recreation area and trout fishing destination; developing this measure would fundamentally alter the existing recreation-based community in the region. A flow reduction also 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. This measure was dropped from further consideration.

Kaweah River Watershed - Dry Creek Reservoir

Measures at this site would include a new dam and reservoir on Dry Creek, which is a tributary to the Kaweah River, just downstream and northwest of Lake Kaweah at Terminus Dam. A 70 TAF 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. A sycamore alluvial woodland exists near the confluence of Dry Creek and the Kaweah River. As with the Mill Creek Reservoir measure, it is anticipated that adverse effects to the sycamore alluvial woodland could not be mitigated. Consequently, this measure was dropped from further consideration.

Tule River Watershed - Hungry Hollow Reservoir

Measures at this site would involve construction of a dam and reservoir on Deer Creek, a tributary to the Tule River about 3 miles south and downstream of 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 Friant-Kern Canal or water diverted from Lake Success. This would involve exchanging water with Millerton Lake water and would require participation by Lake Success water users. Phase 1 studies found that construction of a dam at this site could 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. This measure was dropped from further consideration because of likely cost and environmental considerations.

Surface Water Storage Measures Retained from Phase 1

This section briefly describes the six surface water storage sites retained from Phase 1. The locations of surface water storage sites retained from Phase 1 studies are shown in **Figure 6-2**. Each site could be configured at various storage sizes, with each configuration identified as a measure. Detailed evaluation of these measures is presented later in this chapter. In addition, the potential enlargement of Mammoth Pool was retained from Phase 1. Because this site is under study by others, it is not addressed in this report.

Raise Friant Dam

Measures at this site would involve raising the height of Friant Dam and constructing necessary saddle dams to enlarge Millerton Lake. Three reservoir enlargement measures considered include a 25-foot, 60-foot, or 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 raise sizes would increase reservoir storage capacity by between 125 TAF and 920 TAF.

Temperance Flat Reservoir

Measures at this site would involve constructing a new dam and reservoir at one of three potential dam sites on the San Joaquin River mainstem, between the existing Friant and Kerckhoff dams, at RM 274, RM 279, or RM 286. The RM 274 and RM 279 sites are situated in a narrow portion of upper Millerton Lake, above the confluence with Fine Gold Creek and below Temperance Flat proper. RM 286 is about 5 miles upstream from Temperance Flat itself, in a narrow portion of the San Joaquin River canyon. Potential reservoir sizes range from 460 TAF to over 2.7 MAF.

Fine Gold Reservoir

Measures at this site would involve constructing a dam and reservoir on Fine Gold Creek, which flows into Millerton Lake about 5 miles upstream of Friant Dam. Water would be pumped from Millerton Lake and supplemented by local inflow from Fine Gold Creek. Reservoir sizes range from approximately 130 TAF to 800 TAF.

Yokohl Valley Reservoir

Measures at this site would involve constructing a dam and reservoir with a capacity of up to 800 TAF in Yokohl Valley. The reservoir would store water pumped from the Friant-Kern Canal and a minor amount of local runoff from Yokohl Creek.

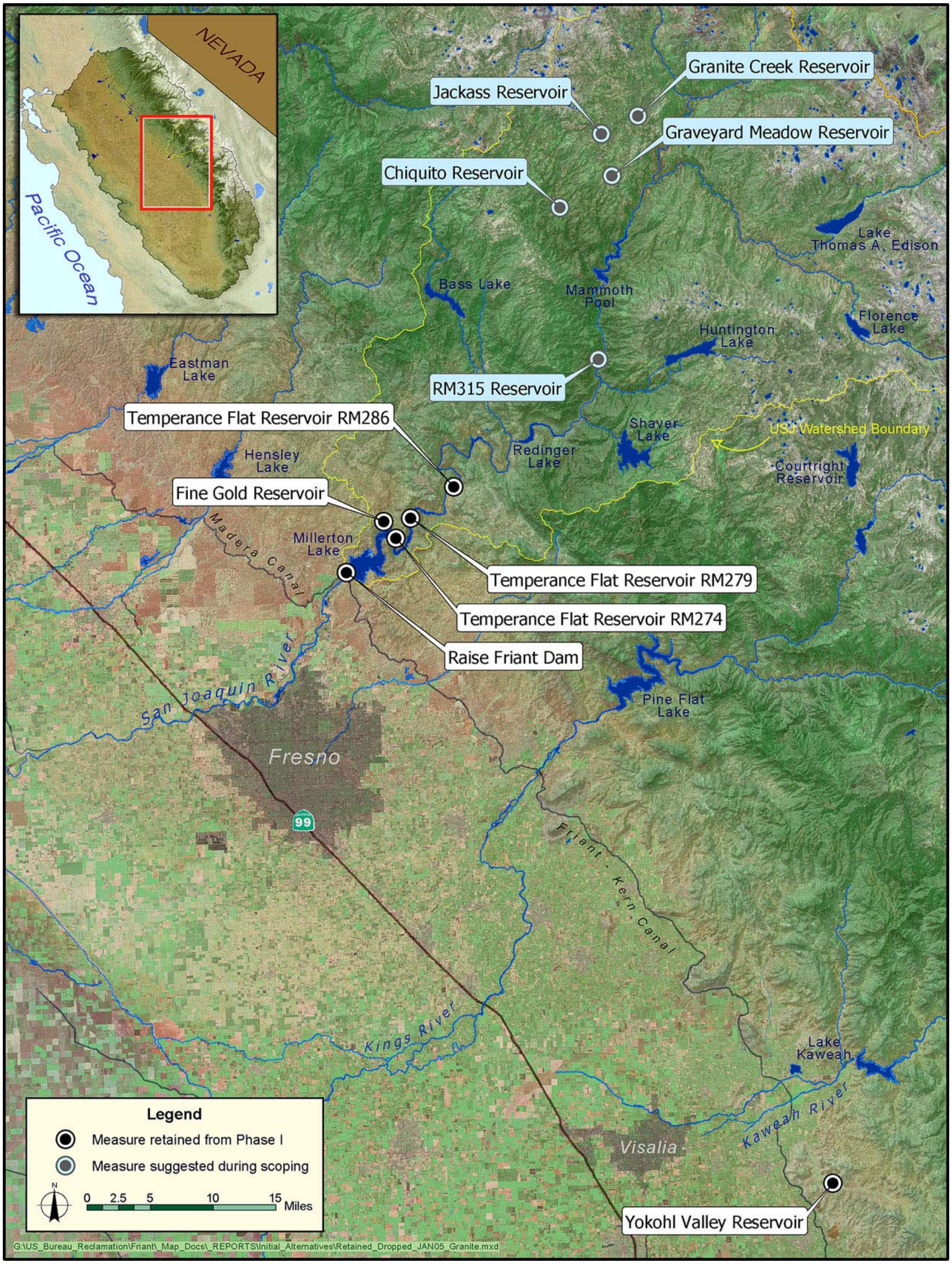


**FIGURE 6-2.
SURFACE WATER STORAGE SITES RETAINED FROM PHASE 1
AND SUGGESTED DURING SCOPING**

Surface Water Storage Measures Suggested During Scoping

As noted in the October 2003 Phase 1 Investigation Report, most of the surface water storage measures retained from Phase 1 would result in a net loss in power generation. In March 2004, Reclamation and DWR held a series of scoping meetings to initiate development of an EIS and EIR. During scoping, power utilities that own and operate hydropower projects in the upper San Joaquin River basin raised concerns about impacts of lost power generation and the ability of retained measures to develop adequate replacement power. These hydropower stakeholders suggested additional potential reservoir sites that could store water supplies from the upper San Joaquin River without adversely affecting existing hydropower facility operations.

Four of the suggested reservoir sites were considered in previous studies of the Granite and Jackass-Chiquito hydroelectric projects by the Upper San Joaquin River Water and Power Authority (USJRWPA) in the late 1970s and early 1980s. These projects have not been constructed. Granite Creek and Graveyard Meadow reservoirs are storage components of the Granite Project and Jackass and Chiquito reservoirs are storage components of the Jackass-Chiquito Project. These reservoir sites are located upstream of Mammoth Pool and would store water diverted from the North Fork San Joaquin River and other tributaries to Mammoth Pool reservoir. A fifth reservoir site, located on the San Joaquin River at RM 315 downstream of Mammoth Pool Reservoir, was suggested based on a conceptual understanding of historical flood spills over Mammoth Dam. All of these suggested sites are located upstream of Redinger Lake, as shown in **Figure 6-2**.

The reservoir sites suggested during scoping were evaluated as three surface water storage measures: the Granite Project, Jackass-Chiquito Project, and RM 315 Reservoir. Total storage capacities for these suggested measures range from 9 to approximately 200 TAF. The scoping comments also suggested combining these upstream storage measures with a gravity diversion tunnel from Kerckhoff Lake to a Fine Gold Reservoir.

EVALUATION OF SURFACE WATER STORAGE MEASURES RETAINED FROM PHASE 1

This section describes the technical characteristics of surface water storage measures retained from Phase 1. The evaluation is based on technical studies completed during and after Phase 1 and a review of previous studies. Each size and/or configuration of a storage site is considered a separate measure. For each surface water storage measure, information is presented related to site characteristics, dam design considerations, potential new water supply, hydropower generation effects, estimated costs, and environmental considerations. Based on this information, recommendations are made regarding whether the measure will be dropped from further consideration in the Investigation, or retained for comparison with other measures that provide similar new water supply in **Chapter 7**.

All cost estimates are represented at July 2004 price levels. Construction cost estimates for the surface water storage measures represent the sum of field costs and indirect costs for planning, engineering, design, and construction management, which are estimated at 25 percent of field costs. Cost estimates for each measure do not include environmental mitigation, new or relocated recreation facilities, or acquisition of impacted power generation facilities and compensation for loss of future power generation associated with the Raise Friant Dam and three Temperance Flat Reservoir locations. These costs will be estimated during a later stage of the Investigation. Information on engineering assumptions and cost estimates is included in the **Engineering TA** and information on hydropower evaluations is included in the **Hydropower TA**.

Raise Friant Dam

Friant Dam impounds Millerton Lake and is a 319-foot-high concrete gravity dam on the San Joaquin River, located about 20 miles northeast of Fresno. Options for increasing storage in Millerton Lake involve raising the dam up to 140 feet. Three specific optional dam raise heights were considered, including 25-foot, 60-foot and 140-foot raises. For all three sizes considered, Friant Dam would be raised by adding an overlay of RCC on the downstream face, as illustrated in **Figure 6-3**.

The dam crest would be extended vertically and defining features of the spillway and stilling basin would be reconstructed. In addition to the dam raise, up to three earthfill saddle dams would be required to contain the reservoir. The most extensive would be a saddle dam on the southwest rim of the reservoir (i.e., left side, looking downstream). Two additional, but considerably smaller, saddle dams would be required on the northwest side of Millerton Lake. Up to 2 miles of Millerton Road would need to be rerouted.

A 25-foot raise, which would increase storage capacity by about 130 TAF, would require a saddle dam approximately 3,000 feet long at the southwest shoreline. A 60-foot raise would increase capacity by 340 TAF and entail raising the dam crest and constructing approximately 8,500 feet of new saddle dams. A 140-foot raise would increase the storage capacity of Millerton Lake by approximately 920 TAF and would require new saddle dams of approximately 9,500 feet in total length. **Figure 6-4** shows the extent of an enlarged Millerton Lake and facilities associated with raising Friant Dam 140 feet.

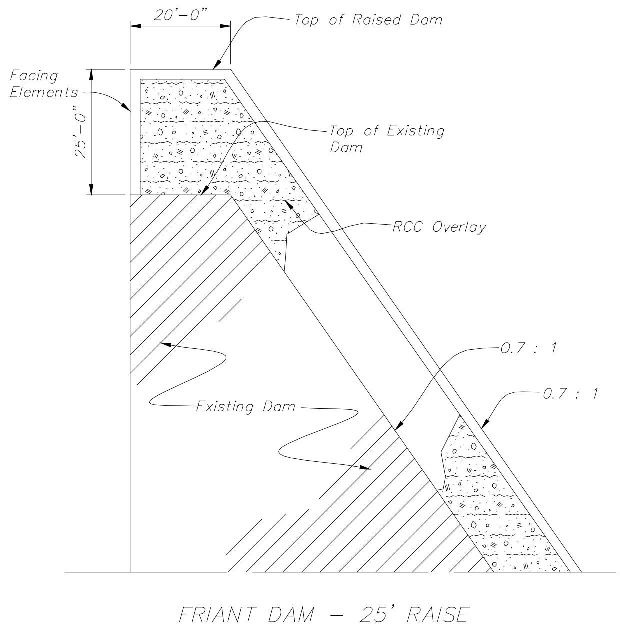


FIGURE 6-3.
FRIANT DAM RAISE SIMPLIFIED CROSS SECTION

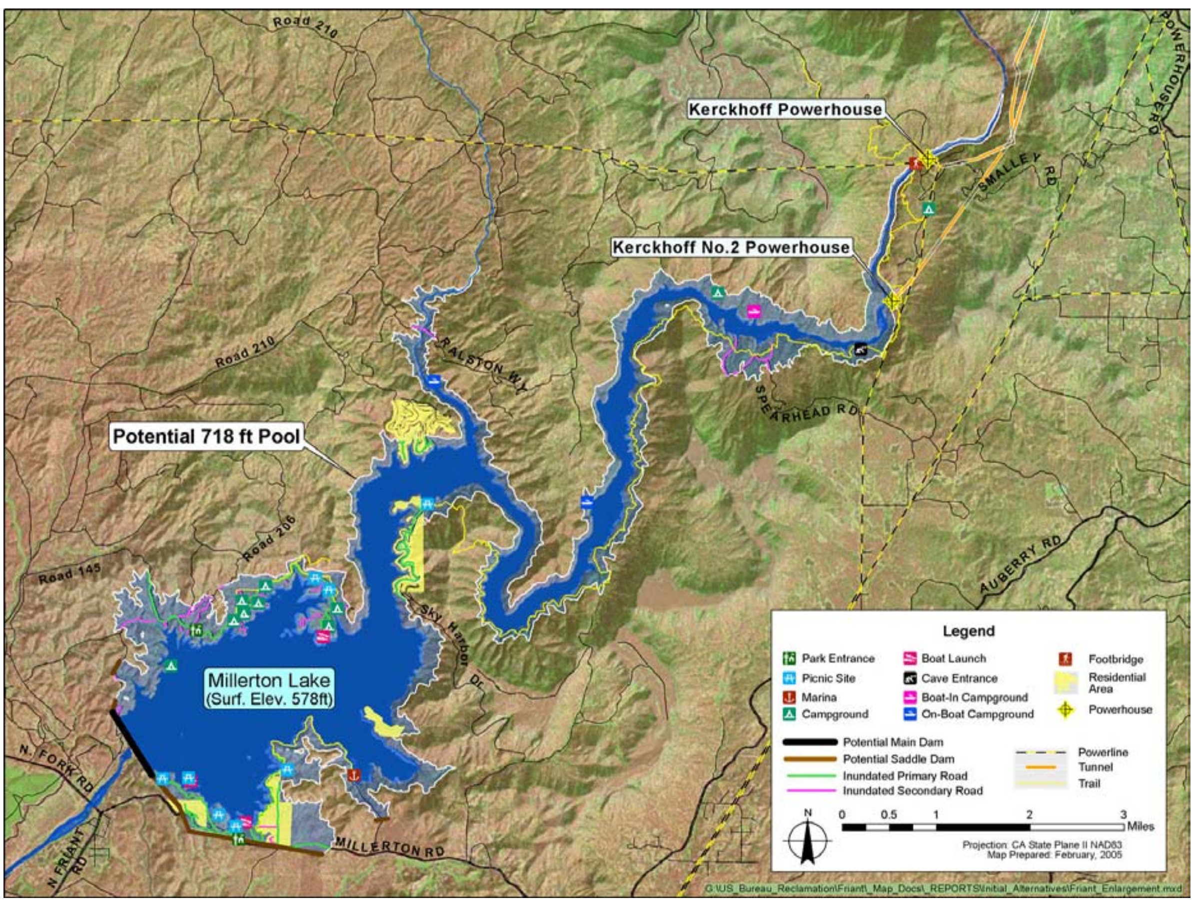


FIGURE 6-4.
POTENTIAL ENLARGEMENT OF MILLERTON LAKE

Potential New Water Supply

An enlarged Friant Dam and Millerton Lake would capture additional flow on the San Joaquin River. Additional storage capacity would provide opportunities to store larger flood volumes than with the current reservoir. Stored water would be available for diversion to the Friant-Kern Canal, the Madera Canal, and/or released to the San Joaquin River.

CALSIM water operations model simulations completed during Phase 1 indicate that the potential new water supply resulting from raising Friant Dam 140 feet could be up to about 150 TAF/year on average. As summarized in **Table 6-1**, development of new water supplies varies in relationship to the amount of new storage created and management of the new water. The table shows that releasing water to the San Joaquin River could result in developing more new water supply than releasing new water supplies to the Friant-Kern and Madera canals only. This is because water deliveries are limited by contract amounts and available conveyance capacity, whereas simulated releases to the river were maximized to the extent that they would not reduce water deliveries from without-project levels. The new water supply for restoration flow single-purpose analysis is higher than that for water quality analysis because releases would be made earlier in the year, providing more opportunity to capture San Joaquin River inflow during late spring months. A more detailed description of the single-purpose analyses is presented in the Phase 1 Investigation Report.

TABLE 6-1.
NEW WATER SUPPLY FROM FRIANT DAM RAISE SIZES

Friant Dam Raise Height (feet)	Gross Pool Elevation (feet above msl)	New Storage Capacity (TAF)	New Water Supply Estimated in Single-Purpose Analysis (average TAF/year)		
			RF	WQ	WS
25	603	130	n/s	n/s	24
45	623	250	n/s	n/s	51
60	638	340	n/s	n/s	68
75	653	440	n/s	n/s	93
112	690	700	152	139	128
140	718	920	n/s	n/s	146

Key:
msl – mean sea level
n/s – not simulated
RF – San Joaquin River restoration flow single-purpose analysis
TAF – thousand acre-feet
WQ – San Joaquin River water quality single-purpose analysis
WS – water supply reliability single-purpose analysis

Hydropower Generation Effects and Potential Replacement Power Options

As shown schematically in **Figure 6-5**, any raise of Friant Dam would affect power generation at the Kerckhoff No. 2 Powerhouse. For a 25-foot raise, it is anticipated that a concrete wall would be constructed to protect the Kerckhoff No. 2 Powerhouse adit from raised water surfaces; however, energy generation would be reduced due to increased tailwater elevation. For any raise substantially greater than a 25-foot raise, it is anticipated that the Kerckhoff No. 2 Powerhouse would be inundated, resulting in the loss of all existing generation at this facility.

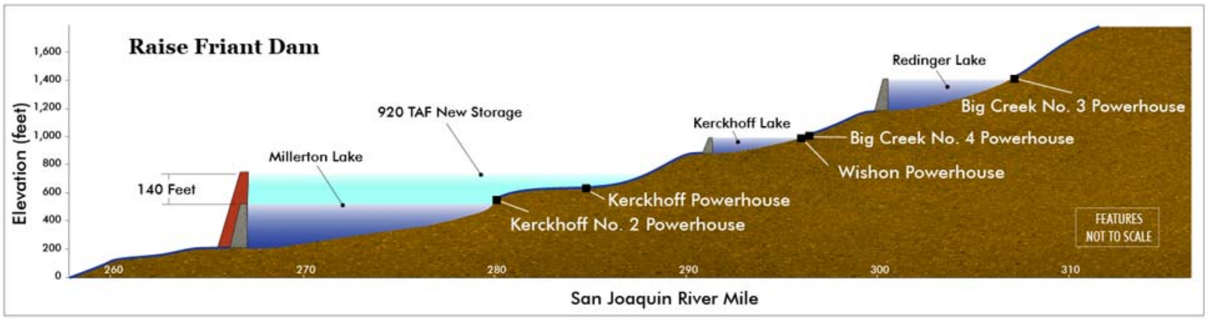


FIGURE 6-5.
HYDROPOWER FEATURES AFFECTED BY
FRIANT DAM RAISE

Raises of Friant Dam above about 60 feet would begin to affect power generation at the Kerckhoff Powerhouse due to increased tailwater elevation. It is expected that the Kerckhoff Powerhouse would be inundated for raises greater than about 90 feet, resulting in the loss of all existing generation from the Kerckhoff Hydroelectric Project.

Table 6-2 summarizes estimated energy generation and losses for each of the three sizes considered for raising Friant Dam. Generation and loss estimates were made using a monthly timestep spreadsheet model that accounts for flow and head at each affected and potential new or modified power facility. Raising Friant Dam up to about 25 feet would not significantly affect power generation. Reduced power generation at the Kerckhoff No. 2 Powerhouse due to increased tailwater elevations would be offset by increased generation at the Friant Power Project on Friant Dam as a result of increased flows through the powerhouses, increased head, and new, larger turbine-generator units.

Raising Friant Dam more than 25 feet would significantly affect power generation and would likely require replacement power generation measures. As noted in **Table 6-2**, a raise of 60 feet would reduce existing generation by 473 gigawatt-hours (GWh) per year on average due to the loss of the Kerckhoff No. 2 Powerhouse, and a raise of 140 feet would reduce existing generation by 507 GWh/year on average due to the loss of the Kerckhoff No. 2 and Kerckhoff powerhouses. For both of these options, the potential to develop replacement power was considered through a possible replacement of the Kerckhoff No. 2 Powerhouse to an elevation corresponding with the gross pool of a raised Millerton Lake and new larger turbine-generator units at the Friant Power Project powerhouses. As shown, generation from a relocated Kerckhoff No. 2 Powerhouse, in combination with additional generation at the Friant Power Project, would result in a decrease in net power generation of about 40 GWh/year for a 60-foot raise and a net loss of more than 100 GWh/year, on average, for the 140-foot raise.

TABLE 6-2.
ESTIMATED ENERGY GENERATION AND LOSSES FOR FRIANT DAM RAISE HEIGHTS

Dam Raise (feet)	New Storage Capacity (TAF)	Gross Pool Elevation (feet above msl)	Estimated Additional Energy Generation			Estimated Losses of Energy Generation		Net Energy Generation (GWh/year)
			Operating Scenario	Estimated Additional Generation at Friant Power Project (GWh/year)[1]	Estimated Generation at Kerckhoff No. 2 Replacement Powerhouse (GWh/year)	Powerhouses Potentially Affected	Estimated Reduction in Existing Energy Generation (GWh/year)[2]	
25	130	603	WS	32	---[4]	Kerckhoff No. 2 reduced head (25 feet)	-32 [3]	0
60	340	638	WS	65	365	Kerckhoff No. 2	-473	-43
140	920	718	WS	112	274	Kerckhoff, Kerckhoff No. 2	-507	-121

Key
GWh/year – gigawatt-hour per year
msl – mean sea level
TAF – thousand acre-feet
WS – water supply single-purpose analysis

Notes:
[1] Generation above estimated without-project Friant Power Project generation.
[2] Based on estimated generation numbers from without-project spreadsheet simulations.
[3] Without-project Kerckhoff No. 2 Powerhouse generation times ratio of head reduction to present head.
[4] A 25-foot raise of Friant Dam does not inundate any powerhouses; no replacement generation needed.

Cost Estimates

Construction costs associated with raising Friant Dam increase substantially as the level of raise is increased. Increases in construction costs are attributed in part to the amount of concrete work needed and the volume of material needed for constructing new saddle dams around the reservoir. In addition, construction costs for replacement energy generation facilities are included with the higher raise options, and property acquisition costs increase as dam crest elevation increases. **Table 6-3** summarizes construction costs for Friant raise measures.

Privately owned lands, including numerous residential properties around Millerton Lake and existing improvements on those lands, would need to be acquired in the expanded reservoir area associated with a raise of Friant Dam. Acquisition costs are included in the construction costs shown for the dam raise (RCC overlay and saddle dams), along with an allowance of 20 percent of the property costs for indirect costs associated with property acquisition transactions. It is assumed that no land acquisition is required for the construction site since lands are already public and held either by Reclamation or other Federal agencies.

TABLE 6-3.
CONSTRUCTION COSTS FOR RAISE FRIANT DAM MEASURES
($ MILLION)

Dam Raise Height (feet)	**25**	**60**	**140**
New Storage Capacity (TAF)	**130**	**340**	**920**
Storage Components			
RCC Overlay, Saddle Dams, Reservoir Lands	170	390	970
Concrete Wall to protect Kerckhoff No. 2 Powerhouse Access	2	-	-
Abandon Kerckhoff No. 2 Powerhouse	-	2	2
Abandon and Restore Kerckhoff Powerhouse	-	-	4
Abandon Intake for Kerckhoff Powerhouse	-	-	1
Millerton Road Relocation	28	28	28
Construction Cost, Storage Components	**200**	**420**	**1,005**
Replacement Power Components			
Additional Generation Capacity at Friant Dam (5, 13 or 30 MW)[1]	18	49	115
New Kerckhoff No. 2 Powerhouse (40 to 90 MW)	-	130	88
Construction Cost, Replacement Power Components	**18**	**179**	**203**
Construction Cost[2, 3]	**218**	**599**	**1,208**

Key:
RCC – roller-compacted concrete
TAF – thousand-acre feet
Notes:
[1] Additional generation capacity provided by replacing one or more existing units with new larger units.
[2] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design and construction management, estimated at 25 percent of field costs.
[3] Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

Costs are included in **Table 6-3** for relocating Millerton Road and constructing a replacement powerhouse that would discharge to Millerton Lake. For the 60-foot raise, it is estimated that the reduced head would support a 90 MW powerhouse, which is significantly less than the installed capacity of 155 MW at the existing Kerckhoff No. 2 Powerhouse. For the 140-foot raise, the reduced head would support a 40 MW powerhouse. Costs also are included for new turbine-generator units at the Friant powerhouses.

Figure 6-6 shows construction cost in relation to the new storage capacity that would be developed by the Raise Friant Dam measures. As evident, costs increase significantly above a 25- foot raise because the Kerckhoff No. 2 Powerhouse would be inundated and additional costs would be incurred to construct replacement generation facilities.

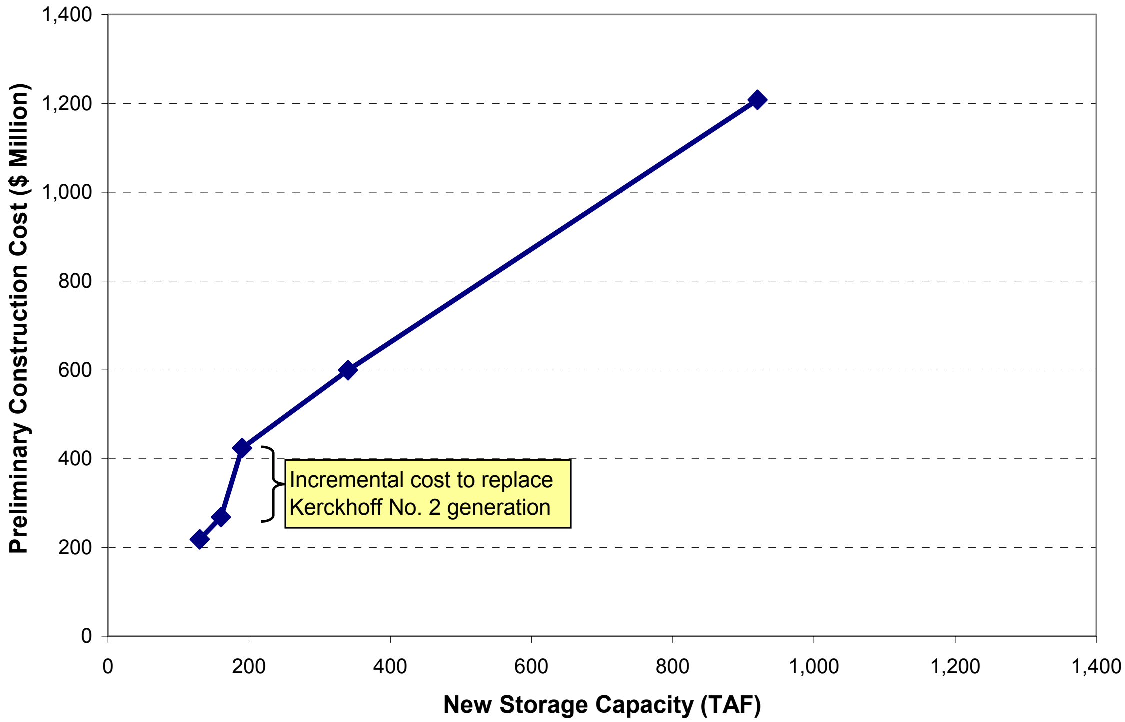


FIGURE 6-6.
CONSTRUCTION COSTS FOR RAISE FRIANT DAM MEASURES VS. NEW STORAGE CAPACITY

Environmental Considerations

Raising Friant Dam and the level of Millerton Lake would impact vegetation, wildlife and fisheries, recreation, land use, and cultural resources. Affected river reaches, as described in **Chapter 3**, include the Millerton Lake and Big Bend, Temperance Flat and Millerton Bottoms, and Patterson Bend reaches of the San Joaquin River. Raising Millerton Lake also would affect the lower portions of Fine Gold Creek, an ADMA.

Any raise of Friant Dam would extend Millerton Lake beyond its current shoreline and decrease the length of river between Millerton Lake and Kerckhoff Dam. The extent of habitat loss and the combined numbers of vegetation and wildlife species that may be affected would increase in magnitude as larger reservoir sizes are considered, and could result in design or operational constraints. Several special status species occur in the region. **Table 6-4** summarizes the special status species, identified in **Chapter 3,** occurring in each river reach potentially affected by a raise of Friant Dam. For convenience, information pertaining to additional storage measures is also provided in **Table 6-4**. Potential impacts to vegetation and wildlife species are anticipated to be proportional to the increase in the mean pool elevation of Millerton Lake.

TABLE 6-4.
SPECIAL STATUS SPECIES TOTALS BY RIVER REACH POTENTIALLY AFFECTED BY SURFACE STORAGE MEASURES

	Millerton Lake/ Big Bend	Temperance Flat/ Millerton Bottoms	Patterson Bend	Kerckhoff Lake/ Horseshoe Bend	Mammoth Reach	Granite Creek	Jackass Creek	Chiquito Creek	Fine Gold Creek	Yokohl Valley
SPECIAL STATUS PLANT SPECIES REPORTED PRESENT IN THE STUDY AREA										
Federally Listed and/or State-Listed	5		1	1						2
Federal and/or State Rare										
State/Management Agency Species of Concern	1									2
Special Interest Species of Concern						3	3	3		
SPECIAL STATUS PLANT SPECIES POTENTIALLY PRESENT IN THE STUDY AREA										
Federally Listed and/or State-Listed	6	6	6	2					6	3
Federal and/or State Rare						1	1	1		
State/Management Agency Species of Concern	3	3	3	2	5	6	6	6	2	2
Special Interest Species of Concern				1		10	10	11		2
SPECIAL STATUS ANIMAL SPECIES REPORTED PRESENT IN THE STUDY AREA										
Federally Listed and/or State- Listed	2	2	2	2	1				1	1
Federal and/or State Candidate for Listing	1	1	1	1	1					
Federal and/or State Candidate for Delisting	1	1	1	1	1					
State/Management Agency Species of Concern	4	6	6	3	1	2	2	2	2	3
SPECIAL STATUS ANIMAL SPECIES POTENTIALLY PRESENT IN THE STUDY AREA										
Federally Listed and/or State-Listed	8	9	9	9	7	6	6	7	2	4
Federal and/or State Candidate for Listing	2	2	2	2	3	2	2	2		1
Federal and/or State Candidate for Delisting	2	2	2	2	2					
State/Management Agency Species of Concern	15	21	21	15	16	17	17	17	6	4
STORAGE MEASURE	POTENTIALLY AFFECTED AREA									
Raise Friant Dam 25 feet										
Raise Friant Dam 60-140 feet										
Temperance Flat RM 274 900-985 feet above msl										
Temperance Flat RM 274 1100 feet above. msl										
Temperance Flat RM 279 900-985 feet above msl										
Temperance Flat RM 279 1100 feet above msl										
Temperance Flat RM 286 1200-1400 feet above msl										
RM 315 Reservoir 3000 feet above msl										
Granite Creek Reservoir										
Jackass and Chiquito Reservoirs										
Fine Gold Reservoir										
Yokohl Valley Reservoir										

The 60-foot and 140-foot raises of Friant Dam would inundate additional lotic habitat of native fishes between Friant Dam and Kerckhoff Dam, and likely establish lentic habitat favored by introduced game fishes. Additionally, a raise of Friant Dam would extend the inundation pool of Millerton Reservoir into the Fine Gold Creek watershed, and may lead to increased invasion of non-native fishes, such as bass species. Potential impacts to fisheries are expected to be proportional to the storage size considered for the Raise Friant measure, with the lower raise measure likely creating lesser impacts to fisheries.

Any raise of Millerton Lake would affect numerous recreational facilities associated with the Millerton Lake SRA on the current shoreline. It is anticipated that recreation facilities would be relocated and would remain accessible, although specific locations for replacement recreation facilities and corresponding costs have not been identified yet. Opportunities for additional recreational opportunities would result from higher or longer storage levels in Millerton Lake; these would increase the reservoir surface area during peak recreation months. Raising Friant Dam could impact the Millerton Bottoms and Patterson Bend whitewater runs, depending on how the enlarged reservoir is operated. A 60-foot raise or higher would inundate several mines associated with the abandoned Sullivan mine in Temperance Flat. A 25-foot raise of Millerton Lake would inundate the lower segment of the Millerton Lake Caves near the shoreline of Millerton Lake, and raises of 60 and 140 feet would inundate all entrances to the Millerton Lake Caves system.

Raising the level of Millerton Lake would affect residential properties around the reservoir. All private property subject to inundation would be acquired. A 25-foot raise would begin to inundate portions of four residential developments at Millerton Lake and portions of residential property at Temperance Flat. All developed property in the portion of Lakeview Estates east of the SRA boat launch area would be inundated by a 60-foot raise. A 140-foot raise also would completely inundate the developed portion of the Winchell Bay development and Temperance Flat residences.

Archaeological sites within or near the existing pool of Millerton Lake, as well as sites upstream to the Patterson Bend reach, would be adversely affected by raising the level of Millerton Lake up to 140 feet.

Recommendations for Further Study

Friant Dam raises of 25 and 60 feet will be retained for further evaluation and comparison with other measures that provide similar water supply, as described in **Chapter 7**. Raises of Friant Dam above 60 feet do not appear to be viable measures for continued study. Key concerns include extensive residential relocation, significant losses of power generation, and environmental impacts around Millerton Lake, along the San Joaquin River, and in the Fine Gold Creek watershed. Therefore, raises of Friant Dam greater than 60 feet are dropped from further consideration in the Investigation.

Temperance Flat Reservoir Measures

Temperance Flat is a wide, bowl-shaped topographic feature in the upper portion of Millerton Lake, approximately 13 miles upstream of Friant Dam, at about RM 281. Initially, four potential dam sites were identified between Friant Dam and Kerckhoff Dam on the basis of topographic characteristics and previous studies. Three of these sites, at RM 274, RM 279, and RM 280, would result in the inundation of Temperance Flat. A fourth site, at RM 286, is upstream of Temperance Flat and could be considered a downstream enlargement of Kerckhoff Lake. For purposes of the Investigation, all potential dam sites on the mainstem of the San Joaquin River between Friant Dam and Kerckhoff Dam are referred to as Temperance Flat sites.

Temperance Flat Reservoir would capture the flow of the San Joaquin River before it enters Millerton Lake. Water would be released from Temperance Flat Reservoir to Millerton Lake for canal diversion and/or release to the San Joaquin River. Operating criteria for the two reservoirs could be influenced by ecosystem needs in the reservoirs, recreation opportunities, and hydropower generation.

An initial comparison of site features showed that the RM 279 site is superior to the RM 280 site. These sites are close in proximity and would result in similar environmental effects for a reservoir at a given elevation. Both sites have similar geologic conditions, would be accessed in the same manner, would use a portion of the Temperance Flat area as a construction lay-down area, would have similar cofferdam and river diversion requirements, and would obtain dam materials from the same general borrow area. A dam at RM 280, however, would require more material than a dam at RM 279 to create the same storage capacity at a higher cost. Therefore, RM 280 was dropped from further consideration. The remaining three Temperance Flat dam sites are shown in **Figure 6-7**, and are described in the following sections.

Foundation conditions at all of the dam sites considered for Temperance Flat measures would be competent granitic rock. Foundation preparation would be typical for each measure.

Potential New Water Supply

Constructing a dam at any of the three Temperance Flat locations could create a reservoir of up to 2 MAF or greater in storage capacity, depending on the height of the dam. Reservoir operations simulations completed during Phase 1 considered a range of storage capacities for a Temperance Flat Reservoir. Because the relationship of storage volume to surface area is similar for the three reservoir measures, estimated losses to evaporation would be similar for all three measures and modeling results would be generally applicable to all three sites. Initial estimates of new water supplies that could be developed with a Temperance Flat Reservoir are listed in **Table 6-5**. As indicated, preliminary results show that the average annual new water supply, measured as additional water available for delivery or controlled releases to the river, would approach 200 TAF/year for a reservoir in excess of 2 MAF storage capacity.

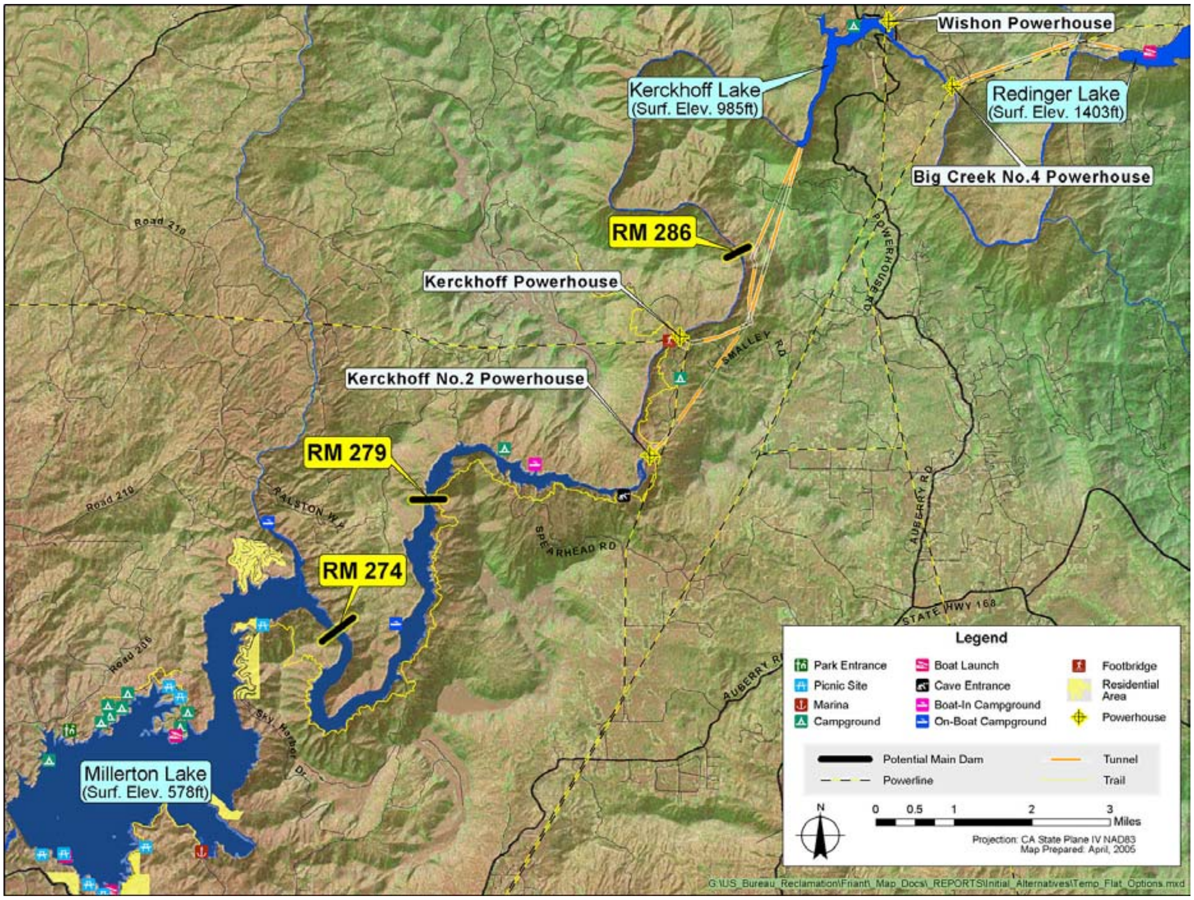


FIGURE 6-7.
POTENTIAL TEMPERANCE FLAT DAM SITES

TABLE 6-5.
NEW WATER SUPPLY FROM TEMPERANCE FLAT RESERVOIR SIZES

New Storage Capacity (TAF)	New Water Supply Estimated in Single-Purpose Analysis (average TAF/year)		
	WS	WQ	RF
725	122	123	146
1,350	168	187	185
2,100	197	n/s	n/s

Key:
n/s – not simulated
RF – San Joaquin River restoration flow single-purpose analysis
TAF – thousand acre-feet
WQ – San Joaquin River water quality single-purpose analysis
WS – water supply reliability single-purpose analysis

Potentially Affected Hydropower Facilities

As described in **Chapter 3**, the upper San Joaquin River basin upstream from Millerton Lake is extensively developed for hydropower generation. PG&E and SCE own and operate multi-facility hydropower projects that affect inflow to Millerton Lake. In the evaluation of Temperance Flat Reservoir measures, several hydropower impact and potential replacement evaluations were completed, as described in the **Hydropower TA**.

To facilitate the evaluation, approximate break points were identified that would correspond to storage capacities for each Temperance Flat measure that would impact power generation facilities. In general, a break point was identified for storage capacities that would inundate powerhouses that discharge into Kerckhoff Lake and capacities that would inundate powerhouses that discharge into Redinger Lake.

Storage capacities above 1,310 TAF for the RM 274 site and above 725 TAF for the RM 279 site would result in inundation of powerhouses that discharge into Kerckhoff Lake. A capacity of about 725 TAF at the RM 286 site would correspond to a reservoir elevation at about the lower part of the spillway at Redinger Dam. A reservoir capacity greater than 1,360 TAF at the RM 286 site would begin to affect the Big Creek No. 3 Powerhouse, which discharges into Redinger Lake.

Because impacts to existing hydropower facilities from the various Temperance Flat Reservoir measures change substantially at storage capacities of approximately 725 TAF and 1,350 TAF, water operations simulations were conducted for a Temperance Flat Reservoir at those two sizes. Data from the reservoir operations simulations were then used in hydropower evaluations of the Temperance Flat measures specific to each potential dam site. The following sections describe site characteristics, dam design considerations, impacts to hydropower generation, and potential for replacement power, costs, and environmental considerations for the three Temperance Flat Reservoir measures.

Temperance Flat RM 274 Reservoir

The RM 274 site is located in Millerton Lake approximately 1 mile upstream of the confluence of Fine Gold Creek and Millerton Lake. It was one of three sites in the original planning studies for Friant Dam in the 1930s, when it was referred to as the Temperance Flat site. From a water storage perspective, it was considered superior to both the Friant Dam site and a site at Fort Miller (just downstream of Fine Gold Creek). The Friant Dam site was selected, however, because construction of a dam at RM 274 would have required canals around the current Millerton Lake area or a diversion dam at Friant.

Site Characteristics and Dam Design Considerations

The topography of the RM 274 site is fairly uniform on both the left and right abutments. The San Joaquin River channel at the site is at elevation 385. The left abutment rises uniformly to elevation 1,582 at Pincushion Mountain and the right abutment rises uniformly to elevation 1,473 at an unnamed peak.

A low point along a ridge making up part of the left abutment adjacent to RM 275 limits the maximum reservoir level to elevation 1,100 for the RM 274 site. This elevation would correspond to a dam height of about 715 feet and a reservoir capacity of about 2,110 TAF of new storage. The potential reservoir for the RM 274 site at elevation 985, which corresponds to a capacity of approximately 1,310 TAF of new storage, is shown in **Figure 6-8**.

From an engineering geology perspective, the RM 274 site is suitable for a concrete arch, concrete gravity, or concrete face rockfill (CFRF) dam. A concrete arch dam was not considered in the prefeasibility-level review because the relatively flat slopes would result in a wide canyon with potentially large volumes of concrete. However, this measure should not be excluded from future consideration since further studies may show that an arch dam is economical. A design for an RCC type dam was not developed in detail for this site but would be similar to the structure considered for the RM 279 site. Preliminary designs and cost estimates were prepared for rockfill dams at elevations 800 and 1,100 at the RM 274 site. Cost estimates for intermediate sizes were developed by interpolation of the lower and higher cost estimates.

Upstream and downstream cofferdams would be required for diverting river 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. A significant portion of both cofferdams would be constructed within the existing reservoir to a maximum depth of nearly 200 feet.


Temperance Flat RM 274 Site in Millerton Lake

Diversion tunnels through both abutments of the new dam would be required to pass San Joaquin River flows around the construction site. One of the diversion tunnels would be used for the outlet works, and the other would be plugged at the end of construction or could be used as part of the spillway, depending on the dam height.

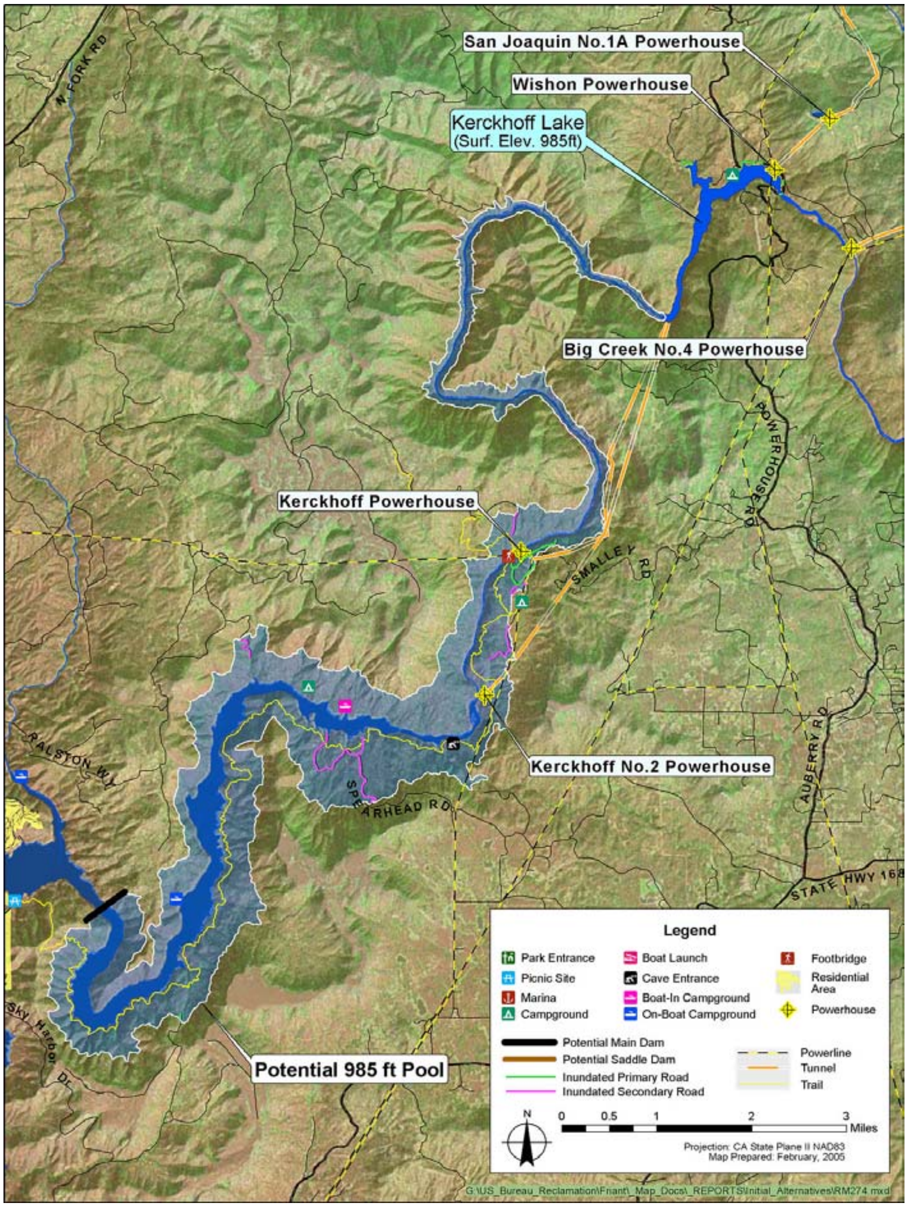


FIGURE 6-8.
POTENTIAL TEMPERANCE FLAT RM 274 RESERVOIR

Hydropower Generation Effects and Potential Replacement Power Options

Construction of a dam at RM 274 would adversely affect energy generation at existing hydropower facilities upstream of Millerton Lake, as shown in **Figure 6-9**. All storage capacities considered would completely inundate both the Kerckhoff and Kerckhoff No. 2 powerhouses, which have a combined installed generation capacity of 193 MW. Lost annual generation at impacted facilities is estimated at 507 GWh/year.

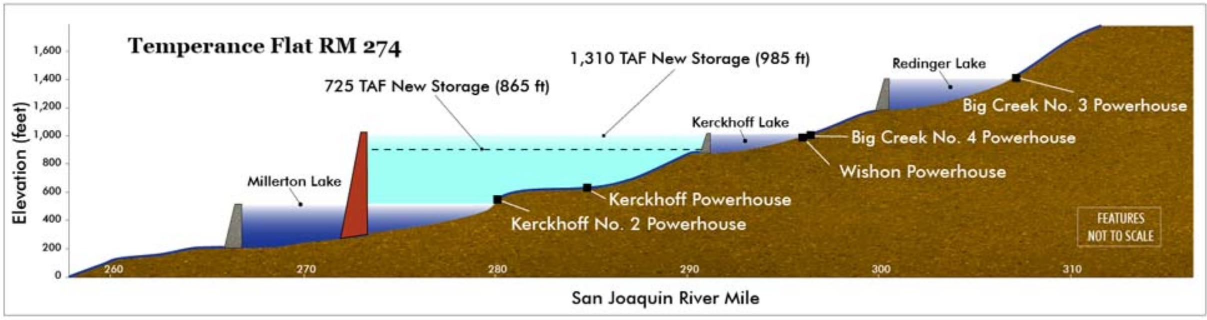


FIGURE 6-9.
HYDROPOWER FEATURES AFFECTED BY TEMPERANCE FLAT RM 274 RESERVOIR

A RM 274 Reservoir above elevation 985, which corresponds to the elevation of Kerckhoff Lake and would have a net storage capacity of about 1,310 TAF, also would 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.

Potential options identified for developing replacement energy generation include a powerhouse at the base of the dam, development of a new powerhouse at the base of Kerckhoff Dam for storage sizes up to 725 TAF, or extending the Kerckhoff No. 2 tunnel to a new powerhouse downstream of the dam. Extending the Kerckhoff No. 2 tunnel was not considered because it would require approximately 10 miles of tunnel and a siphon under the San Joaquin River.

The principal power generation feature would be a powerhouse at the dam or at the base of an abutment, with an intake structure and a short conduit leading to the turbines. Discharge from the powerhouse would be directly into Millerton Lake. Potential for power generation for this option would be limited compared to existing generation from impacted facilities. The net head available for generation would be lower than that currently available from the Kerckhoff Project under most conditions. The existing head from the Kerckhoff Project would be matched only when the new reservoir was generating power under full (1,310 TAF) conditions. Typical storage levels would be considerably less, and the corresponding head would be lower.

The powerhouse capacity would vary depending on the storage capacity and corresponding head and flow characteristics of the RM 274 Reservoir. For a 1,310 TAF capacity reservoir (elevation 985), a 100 MW powerhouse was assumed. For a 725 TAF capacity reservoir (elevation 865), an 80 MW powerhouse at the base of the dam and a supplemental 20 MW powerhouse at the base of Kerckhoff Dam were assumed.

As shown in **Table 6-6**, replacement energy generation would be significantly less than lost energy generation from existing powerhouses that would be inundated, based on simulated generation for the Kerckhoff Hydroelectric Project. As described previously in this chapter, hydrologic reservoir simulations were completed for Temperance Flat Reservoir sizes of 725 TAF and 1,350 TAF of new storage and used as input to the hydropower analysis for the specific dam sites. At RM 274, a storage capacity of 1,310 TAF corresponds to the elevation of Kerckhoff Lake.

TABLE 6-6.
ESTIMATED ENERGY GENERATION AND LOSSES FOR TEMPERANCE FLAT RM 274 RESERVOIR SIZES

New Storage Capacity (TAF)	Gross Pool Elev. (feet above msl)	Estimated New Energy Generation				Estimated Losses of Energy Generation		Net Energy Generation	
		Operating Scenario	Estimated Generation at RM 274 Dam Powerhouse (GWh/year)	Estimated Generation at Kerckhoff Dam Powerhouse (GWh/year)	Additional Generation at Friant (GWh/year)	Powerhouses Potentially Affected	Estimated Reduction in Existing Energy Generation (GWh/year)[1]	Net Generation for WQ or RF Operating Scenario (GWh/year)	Average Net Generation (GWh/year)
725	865	WQ	206	108	5	Kerckhoff, Kerckhoff No. 2	-507	-188	-175
		RF	207	108	30			-162	
1,310[2]	985	WQ	273	---[3]	6	Kerckhoff, Kerckhoff No. 2	-507	-228	-216
		RF	266	---[3]	36			-205	

Key:
GWh/year – gigawatt-hour per year
msl – mean sea level
RF – restoration flow single-purpose analysis
TAF – thousand acre-feet
WQ – water quality single-purpose analysis
Notes:
[1] Based on estimated power generation numbers from without-project spreadsheet simulations.
[2] Power generation analysis based on water operations data for a net storage capacity of 1,350 TAF, which is assumed to be roughly equivalent to the power impact break point of 985 feet (1,310 TAF).
[3] Gross pool for a reservoir size of 1,310 TAF would be at the elevation of Kerckhoff Lake; no potential for Kerckhoff Project replacement generation.

Cost Estimates

Construction cost estimates for dams, appurtenant features, and power replacement facilities, and relocations for other impacted infrastructure were developed for capacities up to about 2,110 TAF of new storage at the RM 274 site. Sizes greater than about 1,310 TAF capacity would inundate Kerckhoff Lake and the Wishon and Big Creek No. 4 powerhouses. **Table 6-7** summarizes construction costs for all components associated with several sizes of the RM 274 measure, up to a capacity of 1,310 TAF.

All storage sizes considered for the RM 274 site would require abandoning the Kerckhoff powerhouses and intakes. For the elevation 800 and 865 measures, the cost for a new replacement powerhouse at the base of Kerckhoff Dam, with a single 20 MW generating unit, has been included for consistency with the hydropower generation analysis. No replacement powerhouse at Kerckhoff Dam would be constructed for measures with a dam crest at elevation 960 or above.

The dam and appurtenant structures would be located on public land. Parcels of land immediately upstream from the construction area and in the potential area of inundation are privately owned and would need to be acquired, including a few residences at Temperance Flat. Costs to acquire private property in the reservoir area are included with the cost of the dam and appurtenances.

**TABLE 6-7.
CONSTRUCTION COSTS FOR TEMPERANCE FLAT RM 274 MEASURES
($ MILLION)**

Gross Pool Elevation (feet above msl)	800	865	985	1,100
New Storage Capacity (TAF)	**460**	**725**	**1,310**	**2,110**
Storage Components				
CFRF Dam, Spillway, Outlet Works, River Diversion, Reservoir Lands	560	650	810	970
Abandon Kerckhoff Powerhouse	2	2	2	2
Abandon Intake for Kerckhoff Powerhouse	1	1	1	1
Abandon Kerckhoff No. 2 Powerhouse	2	2	2	2
Abandon Intake for Kerckhoff No. 2 Powerhouse	1	1	1	1
Remove Kerckhoff Dam Outlet Works and Gates	-	-	2	2
Abandon Wishon Powerhouse	-	-	-	2
Abandon Big Creek No. 4 Powerhouse	-	-	-	4
Powerhouse Road Relocation	-	-	-	18
Powerhouse Bridge Relocation	-	-	-	21
Construction Cost, Storage Components	**566**	**656**	**818**	**1,023**
Replacement Power Components				
New Powerhouse at RM 274 Dam (80 to 100 MW)	170	170	195	195
New Powerhouse at Kerckhoff Dam (20 MW)	59	59	-	-
New Wishon Powerhouse (18 MW)	-	-	-	46
New Big Creek No. 4 Powerhouse (80 MW)	-	-	-	115
Construction Cost, Replacement Power Components	**229**	**229**	**195**	**356**
Construction Cost[1, 2]	**795**	**885**	**1,013**	**1,379**

Key:
CFRF – concrete-face rockfill
msl – mean sea level
MW – megawatt
RM – river mile
TAF – thousand acre-feet
Notes:
[1] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design and construction management, which are estimated at 25 percent of field costs.
[2] Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

Figure 6-10 shows the relationship between new storage capacity that would be developed with a reservoir at RM 274 versus construction cost. Costs increase when the storage capacity exceeds 1,310 TAF because costs would be incurred to replace generation capacity lost by the inundation of Wishon and Big Creek No. 4 powerhouses and to rebuild at a higher elevation a bridge that crosses the San Joaquin River at Kerckhoff Lake. It is expected that the incremental cost increase associated with sizes that exceed 1,310 TAF would not be justified in relationship to the additional storage and water supply that could be developed.

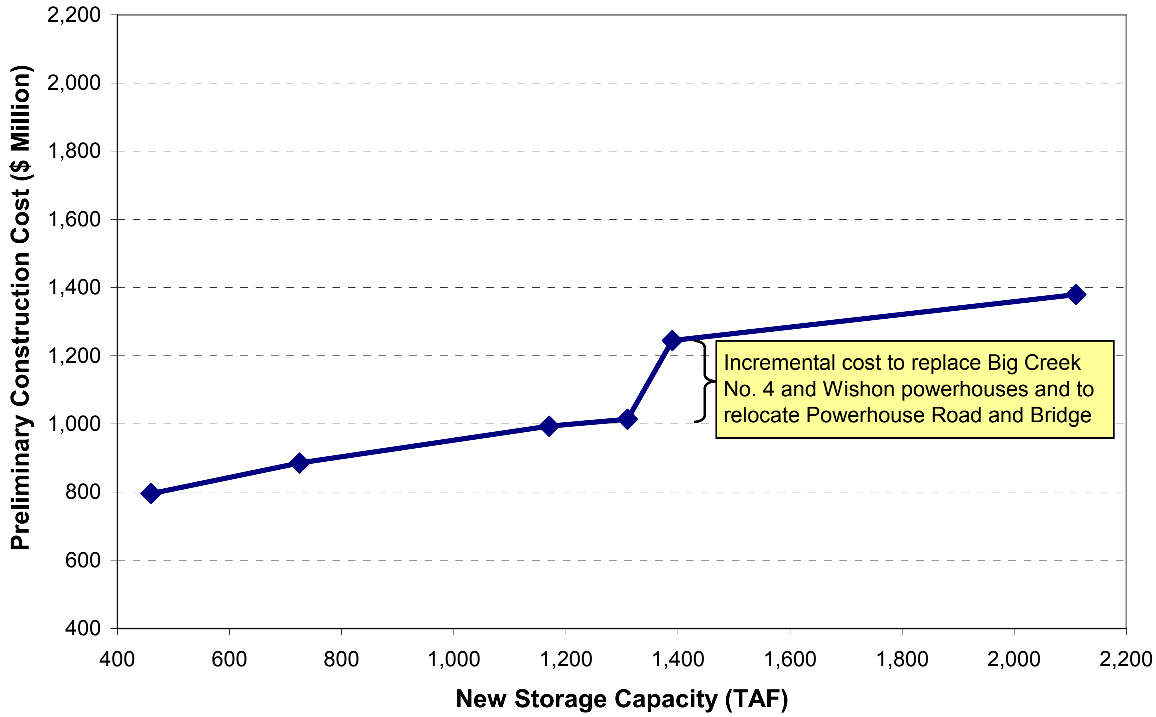


FIGURE 6-10.
CONSTRUCTION COSTS FOR TEMPERANCE FLAT RM 274 MEASURES VS. NEW STORAGE CAPACITY

Environmental Considerations

A reservoir at RM 274 may impact vegetation, wildlife and fisheries, recreation, land use and cultural resources. Discrete river reaches defined in **Chapter 3** potentially affected by a dam at RM 274 include the Millerton Lake and Big Bend, Temperance Flat and Millerton Bottoms, and Patterson Bend reaches of the San Joaquin River.

Several special status species occur in the region and are identified in **Chapter 3**. **Table 6-4** provides a sum of special status species occurring in each river reach potentially affected by a RM 274 Reservoir. The extent of habitat loss and the combined numbers of vegetation and wildlife species that may be affected would increase in magnitude as larger reservoir sizes are considered, and could result in design or operational constraints. Potential impacts to vegetation and wildlife species are anticipated to be proportional to the increase in mean pool elevation of the RM 274 Reservoir.

Existing fisheries in Millerton Lake and the Big Bend reach of the San Joaquin River would be affected by a dam at RM 274. Millerton Lake would be divided into upper and lower portions, separated by the dam. Impacts associated with this barrier are not likely to vary with measures on the size of the reservoir to be created. With a dam at RM 274, a permanent pool would be established in Big Bend and extend to Patterson Bend, replacing lotic habitat of native fishes with lentic habitat favored by introduced game fishes.

All reservoir sizes considered for RM 274 would inundate entrances to the Millerton Lake Caves located in the Temperance Flat area, and would affect whitewater recreation at Millerton Bottoms and Patterson Bend. A RM 274 Reservoir also may inundate several mines associated with the abandoned Sullivan mine.

A few residences in the Temperance Flat area, along with recreational facilities associated with the Millerton Lake SRA and BLM San Joaquin River Gorge, would be inundated by a RM 274 Reservoir. Archaeological sites within or near the existing pool of Millerton Lake and upstream to Kerckhoff dam would be adversely affected with a dam at RM 274.

Recommendations for Further Study

Temperance Flat RM 274 Reservoir measures ranging in size from 460 TAF to 1,310 TAF (elevations 800 to 985) will be retained for further evaluation and comparison with other measures in **Chapter 7**. Sizes greater than 1,310 TAF would adversely affect all reaches of the San Joaquin River from Millerton Lake to Horseshoe Bend, including Millerton Bottoms and Big Bend. Measures exceeding 1,310 TAF of storage also would inundate four powerhouses representing nearly 1,000 GWh/year of generation, at considerable additional expense and with limited opportunity to replace the lost generation. The additional impacts and expenses are considered unlikely to be justified by the additional water supply that would be created when other measures are available that could provide the same new water supply. Thus, sizes of Temperance Flat RM 274 Reservoir larger than 1,310 TAF are dropped from further consideration in the Investigation.

Temperance Flat RM 279 Reservoir

The RM 279 site also is located in Millerton Lake approximately 2 miles downstream of the Temperance Flat area. The RM 279 site rises uniformly from elevation 460 in the original San Joaquin River channel to elevation 1,080 on the left abutment, and then through a saddle at elevation 1,040 before continuing to elevation 1,416 at an unnamed peak. The right abutment rises uninterrupted to elevation 1,566 at an unnamed peak. The potential reservoir for the RM 279 site at elevation 1,000 feet is shown in **Figure 6-11**.

Site Characteristics and Dam Design Considerations

The RM 279 site is appropriate for concrete arch, concrete gravity, and CFRF types. A central-core earthfill dam is not considered economically viable, due to the limited availability of plastic, fine-grained materials for the core. A concrete arch dam was not considered for prefeasibility-level designs because the abutments have relatively flat slopes, which would result in a wide canyon requiring potentially large volumes of concrete. However, this design option was not evaluated sufficiently to exclude it from future consideration.

Upstream and downstream cofferdams would be required for diverting stream flows during construction and to prevent inundation of the site from Millerton Lake. Cofferdams were sized for estimated diversion flows and to allow normal operation of Millerton Lake during construction. The upstream cofferdam would have a crest at elevation 635, and a height of approximately 185 feet. The downstream cofferdam would have a crest at about elevation 578, and height of about 125 feet.

Temperance Flat RM 279 Site in Millerton Lake

Diversion tunnels through both abutments of the new dam would be required to pass San Joaquin River flows around the construction site. One of the diversion tunnels would be used for the outlet works, and the other would be plugged at the end of construction or could be used as part of the spillway, depending on the dam type and height.

Access to the RM 279 site would require constructing new roads on the Fresno County side of the river. Construction staging and lay-down would be located in the reservoir area.

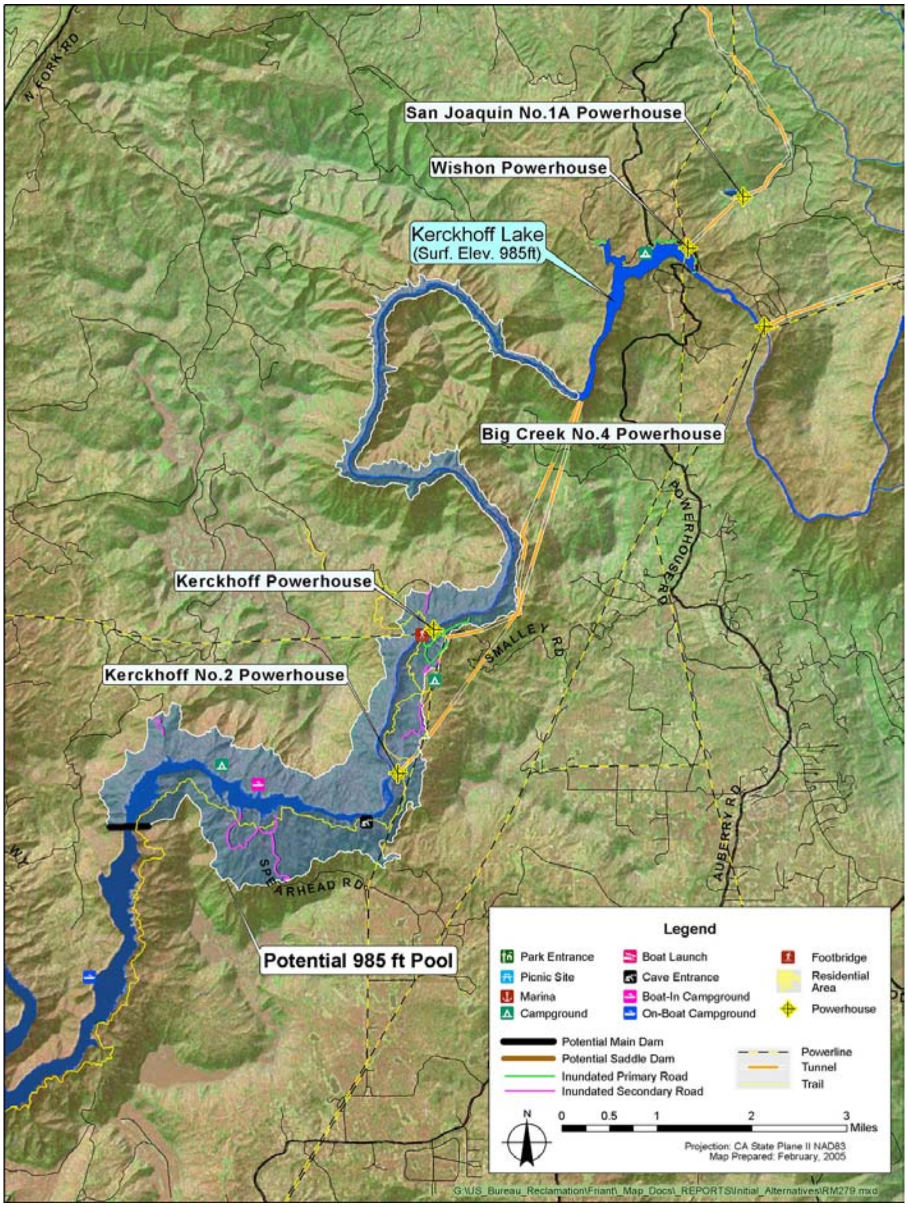


FIGURE 6-11.
POTENTIAL TEMPERANCE FLAT RM 279 RESERVOIR

Hydropower Generation Effects and Potential Replacement Power Options

Construction of a dam at RM 279 would adversely affect energy generation at existing hydropower facilities upstream of Millerton Lake, as shown in **Figures 6-11** and **6-12**. All storage capacities considered would completely inundate both the Kerckhoff and Kerckhoff No. 2 powerhouses, which have a combined installed generation capacity of 193 MW. Impacted annual generation at these facilities is estimated at 507 GWh/year. In addition, a reservoir at RM 279 above elevation 985 would inundate the Wishon and Big Creek No. 4 powerhouses, with installed generation capacities of 20 MW and 100 MW, respectively.

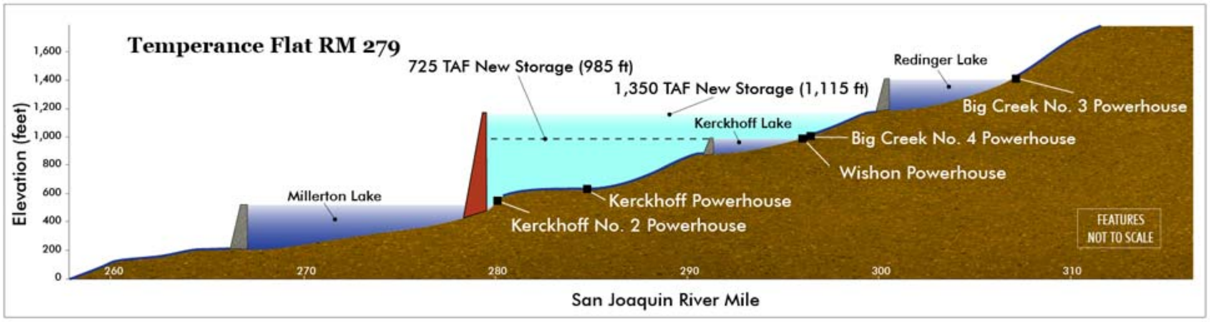


FIGURE 6-12.
HYDROPOWER FEATURES AFFECTED BY
TEMPERANCE FLAT RM 279 RESERVOIR

Two replacement power options were considered for the RM 279 Reservoir, each at two storage capacities. A capacity of 725 TAF corresponds to a reservoir surface at elevation 985, which is at the elevation of Kerckhoff Lake. A capacity of 1,350 TAF corresponds to a reservoir surface at approximately elevation 1,115.

The two power configurations for the RM 279 Reservoir site were evaluated to identify a range of replacement power opportunities. One option involves developing new power generation facilities at the base of the dam and abandoning the Kerckhoff Project facilities. The second involves a new powerhouse on an extension of the Kerckhoff No. 2 tunnel and a new, smaller powerhouse at the dam.

For the 1,350 TAF size RM 279 Reservoir for both replacement power options, new powerhouses could be constructed to replace some of the generation lost from the Big Creek No. 4 and Wishon powerhouses.

The Big Creek No. 4 replacement powerhouse could be constructed farther upstream on the Big Creek No. 4 penstock and the Wishon replacement powerhouse could be constructed farther upstream on the Wishon penstock. Both powerhouses would have a tailwater level at elevation 1,115. The replacement powerhouses for Big Creek No. 4 and Wishon are assumed to have capacities of 80 MW and 18 MW, respectively.

Results of replacement power evaluations for the RM 279 site are summarized in **Table 6-8**. Descriptions of replacement power options are provided in the following sections.

TABLE 6-8.
ESTIMATED ENERGY GENERATION AND LOSSES FOR TEMPERANCE FLAT RM 279 RESERVOIR SIZES

New Storage Capacity (TAF)	Gross Pool Elev. (feet above msl)	Estimated New Energy Generation				Estimated Losses of Energy Generation		Net Energy Generation	
		Operating Scenario	Estimated New Energy Generation (GWh/year)	Estimated Generation at Big Creek No. 4 and Wishon Powerhouse Replacements (GWh/year)	Additional Generation at Friant (GWh/year)	Powerhouses Potentially Affected	Estimated Reduction in Existing Energy Generation (GWh/year)[1]	Net Generation for WQ or RF Operating Scenario (GWh/year)	Average Net Generation (GWh/year)
Replacement Power Option 1 – New large powerhouse at dam									
725	985	WQ	368	2	5	Kerckhoff, Kerckhoff No. 2	-507	-134	-121
		RF	368	2	30			-109	
1,350	1,115	WQ	440	384	6	Kerckhoff, Kerckhoff No. 2, Wishon, Big Creek No. 4	-981	-151	-141
		RF	429	384	36			-132	
Replacement Power Option 2 – New large powerhouse on extended Kerckhoff No. 2 tunnel, new small powerhouse at dam									
725	985	WQ	460	---[2]	5	Kerckhoff, Kerckhoff No. 2	-507	-42	-23
		RF	472	---[2]	30			-5	
1,350	1,115	WQ	543	384	6	Kerckhoff, Kerckhoff No. 2, Wishon, Big Creek No. 4	-981	-48	-48
		RF	513	384	36			-48	

Key:
GWh/year – gigawatt-hour per year
msl – mean sea level
RF – restoration flow single-purpose analysis
TAF – thousand acre-feet
WQ – water quality single-purpose analysis

Notes:
[1] Based on estimated energy generation numbers from without-project spreadsheet simulations.
[2] The 725 TAF size of a RM 279 Reservoir would not impact Big Creek No. 4 or Wishon powerhouses.

RM 279 Replacement Power Option 1

This option includes constructing a large powerhouse at the base of the RM 279 dam, as shown in **Figure 6-13**. For a 725 TAF reservoir, the powerhouse would have a capacity of 120 MW. For a 1,350 TAF reservoir, the powerhouse would have a capacity of 120 MW and would be supplemented with replacement powerhouses for the Wishon and Big Creek No. 4 powerhouses, with combined capacities of 98 MW.

As shown in **Table 6-8**, this option would not provide full replacement power for either the 725 TAF or 1,350 TAF storage capacity reservoir, resulting in a new loss ranging from about 100 to about 150 GWh/year, depending on the reservoir size and water operations. This option would result in net energy losses because the head available for replacement generation would be lower than the head available to the existing projects under most conditions.

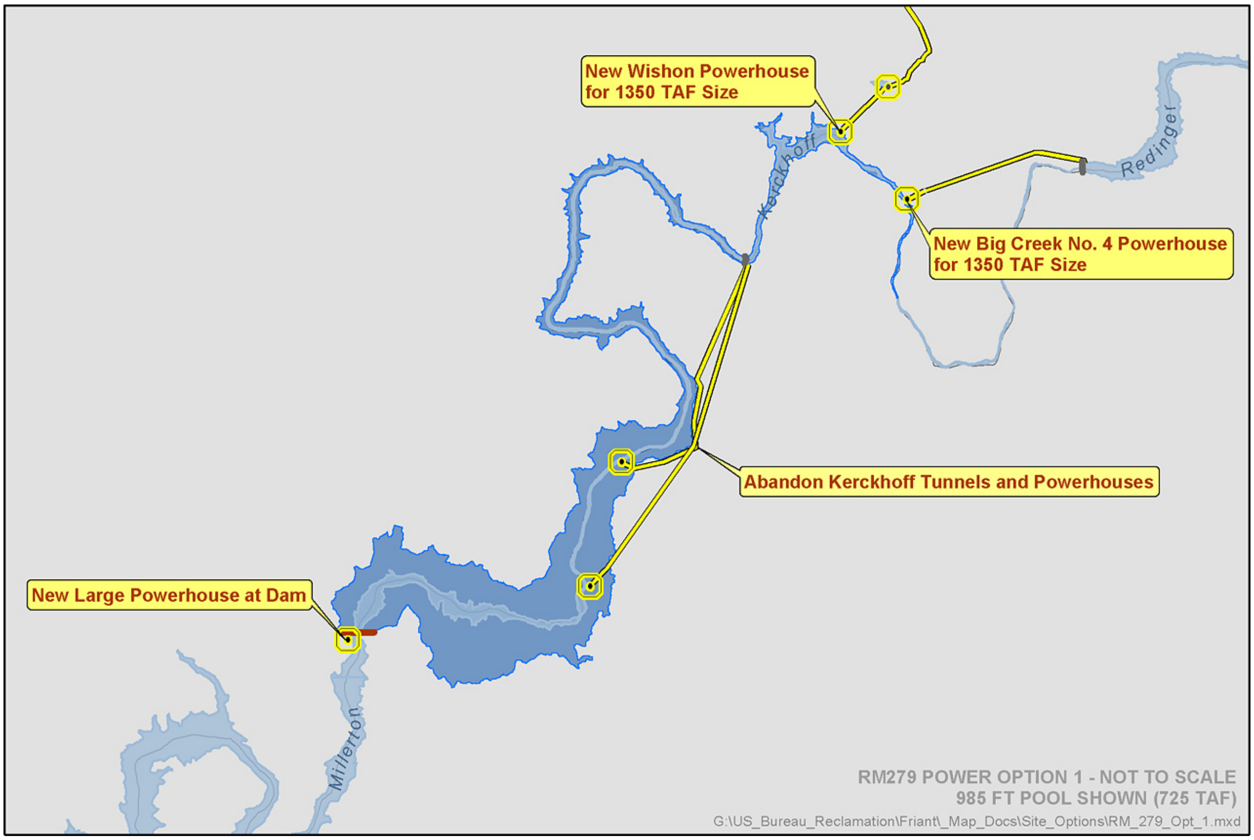


FIGURE 6-13.
REPLACEMENT POWER OPTION 1 FOR TEMPERANCE FLAT RM 279 RESERVOIR

RM 279 Replacement Power Option 2

This option would involve extending the Kerckhoff No. 2 tunnel and constructing a new powerhouse downstream of the RM 279 dam that discharges into Millerton Lake, as shown in **Figure 6-14**. Kerckhoff Dam would be retained and flows would continue to be diverted to the Kerckhoff No. 2 tunnel in a similar manner as for the without-project condition. Flood flows that spill over Kerckhoff Dam would flow into the RM 279 Reservoir for storage and release.

The powerhouse is assumed to have an installed capacity of approximately 120 MW. Inflow to Kerckhoff Lake in excess of the Kerckhoff No. 2 tunnel capacity would be released into the RM 279 Reservoir and stored. A small, single-unit powerhouse with an assumed installed capacity of approximately 15 MW would be constructed at the dam for generation from RM 279 releases to Millerton Lake. For the 725 TAF storage capacity, generation at the relocated Kerckhoff No. 2 powerhouse would similar to the historic generation of Kerckhoff No. 2 because the constant head of Kerckhoff Lake would be maintained and flows would be similar to existing project operations. Lost generation from the Kerckhoff Powerhouse would be replaced by additional generation at the Friant Power Project and by generation at a new, small powerhouse at the base of the RM 279 dam.

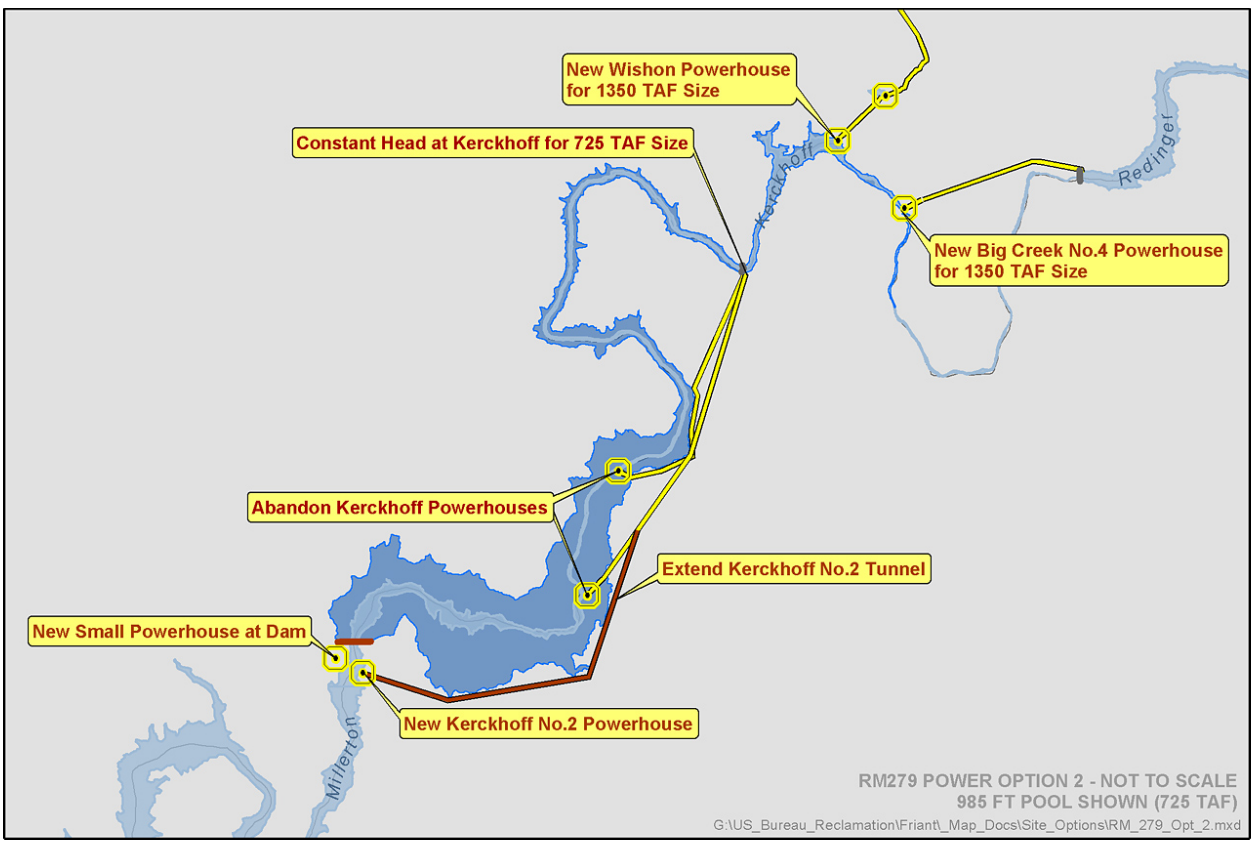


FIGURE 6-14.
REPLACEMENT POWER OPTION 2 FOR TEMPERANCE FLAT RM 279 RESERVOIR

Replacement Power Option 2 would result in a very small net loss of power generation for the 725 TAF size reservoir, depending on the water management scenario. For the 1,350 TAF reservoir size, replacement Power Option 2 would not fully replace lost power generation, and would result in a net loss of approximately 50 GWh/year. This is because the Wishon and Big Creek No. 4 powerhouses generate power under relatively constant head conditions. A constant, but lower, head could be maintained through relocating smaller versions of these powerhouses to elevation 1,115. The remaining reduction in power generation would not be replaced with higher head generation at a relocated Kerckhoff No. 2 powerhouse and a small powerhouse at the base of RM 279 dam because water levels in the RM 279 Reservoir would vary.

Cost Estimates

Construction costs for dams, appurtenant features, and power replacement facilities, and relocations for other impacted infrastructure were developed for capacities up to about 2,700 TAF of new storage at the RM 279 site. This capacity would correspond to a reservoir at elevation 1,300 that would inundate Kerckhoff Lake and the Wishon and Big Creek No. 4 powerhouses.

Construction costs for RM 279 storage measures at several sizes, combined with Power Replacement Options 1 and 2, are summarized in **Tables 6-9** and **6-10**, respectively. These costs include constructing the main dam and appurtenant features, and costs for abandoning, modifying, or relocating existing facilities.

The dam and appurtenant structures would be located on public land. Parcels of land immediately upstream from the construction area and in the potential area of inundation are privately owned and would need to be acquired, including a few residences at Temperance Flat. Costs to acquire private property in the reservoir area are included with the cost of the dam and appurtenances.

A comparison of cost estimates prepared during Phase 1 of the Investigation suggests that RCC is the lower cost dam type up to elevation 1,100, after which the CFRF type becomes less expensive. Accordingly, only costs for the apparent lower cost dam type are included in **Tables 6-9** and **6-10**. However, cost differences between dam types are not great enough to conclusively identify the most cost-efficient design at all crest elevations.

Costs for many of the construction components vary according to hydropower configuration or elevation. For both power replacement options, relocating and abandoning existing powerhouses that currently discharge to Kerckhoff Lake are treated identically, as are road and bridge relocations. For measures above elevation 985, costs for abandoning the Wishon and Big Creek No. 4 powerhouses are included. This would involve constructing a replacement Big Creek No. 4 Powerhouse below Redinger Dam with 30 MW to 80 MW of generating capacity, depending on reservoir elevation, and an 18 MW powerhouse to partially replace Wishon generating capacity at a higher elevation. The costs to relocate Powerhouse Road and Bridge to a higher elevation also are included for reservoir elevations above 985.

TABLE 6-9.
CONSTRUCTION COSTS FOR TEMPERANCE FLAT RM 279 MEASURES WITH REPLACEMENT POWER OPTION 1 ($ MILLION)

Gross Pool Elevation (feet above msl)	900	985	1,115	1,200	1,300
New Storage Capacity (TAF)	**450**	**725**	**1,350**	**1,910**	**2,740**
Dam Type	**RCC**	**RCC**	**CFRF**	**CFRF**	**CFRF**
Storage Components					
RCC Dam, Spillway, Outlet Works, River Diversion, Reservoir Lands	450	650	940	1,200	1,550
Abandon Kerckhoff Powerhouse	2	2	2	2	2
Abandon Intake for Kerckhoff Powerhouse	1	1	1	1	1
Abandon Kerckhoff No. 2 Powerhouse	2	2	2	2	2
Abandon Intake for Kerckhoff No. 2 Powerhouse	1	1	1	1	1
Remove Kerckhoff Dam Outlet Works and Gates	2	2	2	2	2
Abandon Wishon Powerhouse	-	-	2	2	2
Abandon Big Creek No. 4 Powerhouse	-	-	4	4	4
Powerhouse Road Relocation	-	-	18	18	40
Powerhouse Road Bridge Relocation	-	-	21	34	38
Construction Cost, Storage Components	**458**	**658**	**993**	**1,266**	**1,642**
Replacement Power Components					
New Powerhouse at RM 279 Dam (120 MW)	210	210	210	210	210
New Wishon Powerhouse (18 MW)	-	-	46	46	46
New Big Creek No. 4 Powerhouse (30 to 80 MW)	-	-	115	69	69
Construction Cost, Replacement Power Components	**210**	**210**	**371**	**325**	**325**
Construction Cost[1, 2]	**668**	**868**	**1,364**	**1,591**	**1,967**

Key:
CFRF – concrete face rockfill
RCC – roller-compacted concrete
msl – mean sea level
RM – river mile
MW – megawatt
TAF – thousand acre-feet

Notes:
[1] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design, and construction management, estimated at 25 percent of field costs.
[2] Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

TABLE 6-10.
CONSTRUCTION COSTS FOR TEMPERANCE FLAT RM 279 MEASURES WITH REPLACEMENT POWER OPTION 2 ($ MILLION)

Gross Pool Elevation (feet above msl)	900	985	1,115	1,200	1,300
New Storage Capacity (TAF)	450	725	1,350	1,910	2,740
Dam Type	RCC	RCC	CFRF	CFRF	CFRF
Storage Components					
RCC Dam, Spillway, Outlet Works, River Diversion, Reservoir Lands	450	650	940	1,200	1,550
Abandon Kerckhoff Powerhouse	2	2	2	2	2
Abandon Intake for Kerckhoff Powerhouse	1	1	1	1	1
Abandon Kerckhoff No. 2 Powerhouse	2	2	2	2	2
Remove Kerckhoff Dam Outlet Works and Gates	2	2	2	2	2
Abandon Wishon Powerhouse	-	-	2	2	2
Abandon Big Creek No. 4 Powerhouse	-	-	4	4	4
Powerhouse Road Relocation	-	-	18	18	40
Powerhouse Road Bridge Relocation	-	-	21	34	38
Construction Cost, Storage Components	**457**	**657**	**992**	**1,265**	**1,641**
Replacement Power Components					
New Powerhouse at RM 279 Dam (15 MW)	75	75	75	75	75
New Powerhouse on Extended Kerckhoff No. 2 Tunnel (120 MW)	150	150	150	150	150
Kerckhoff No. 2 Diversion Tunnel Extension	120	120	120	120	120
Kerckhoff No. 2 Diversion Tunnel, Steel Liner	-	-	45	85	125
Kerckhoff No. 2 Diversion Tunnel, Backfill Concrete	-	-	3	3	3
Modify Kerckhoff No. 2 Diversion Intake	-	-	18	33	39
New Wishon Powerhouse (18 MW)	-	-	46	46	46
New Big Creek No. 4 Powerhouse (30 to 80 MW)	-	-	115	69	69
Construction Cost, Replacement Power Components	**364**	**364**	**591**	**600**	**646**
Construction Cost[1, 2]	**802**	**1,002**	**1,564**	**1,846**	**2,268**

Key:
CFRF – concrete face rockfill　　msl – mean sea level　　MW – megawatt

Notes:
[1] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design, and construction management, estimated at 25 percent of field costs.
[2] Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

Costs for the two replacement power options differ in several respects. The cost for Replacement Power Option 1 includes a powerhouse at the end of the RM 279 dam diversion tunnel and decommissioning and abandonment of the intake for the Kerckhoff No. 2 Powerhouse.

Replacement Power Option 2 involves extending the Kerckhoff No. 2 diversion tunnel to a new 120 MW powerhouse downstream of the RM 279 dam that would discharge to Millerton Lake. It also involves a 15 MW powerhouse at the end of the RM 279 dam diversion tunnel. For Option 2, **Table 6-10** includes costs for these features and costs to extend and partially line the Kerckhoff No. 2 diversion tunnel.

Figure 6-15 shows the relationship between new storage capacity that would be developed with a reservoir at RM 279 versus construction cost. Costs increase when storage capacity exceeds about 725 TAF because costs would be incurred to replace generation capacity lost by the inundation of Wishon and Big Creek No. 4 powerhouses and to rebuild at a higher elevation a bridge that crosses the San Joaquin River at Kerckhoff Lake.

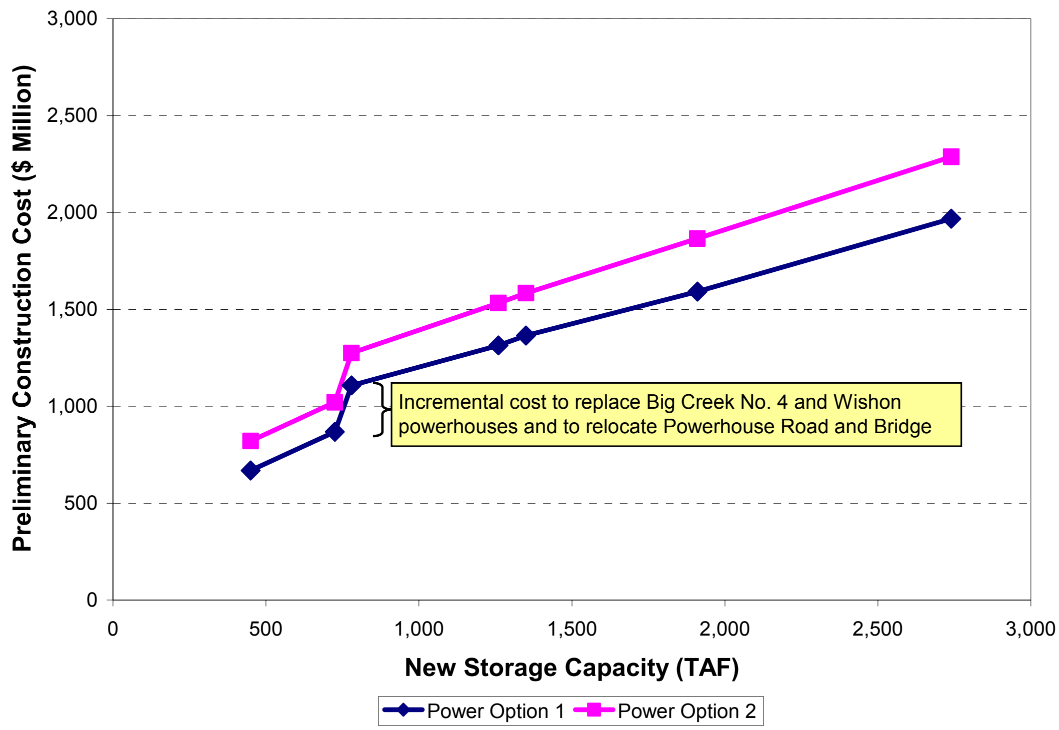


FIGURE 6-15.
CONSTRUCTION COSTS FOR TEMPERANCE FLAT RM 279 MEASURES VS. NEW STORAGE CAPACITY

Environmental Considerations

A reservoir at RM 279 may impact vegetation, wildlife and fisheries, recreation, land use, and cultural resources. River reaches potentially affected by a dam at RM 279 include Temperance Flat and Millerton Bottoms, Patterson Bend, and Kerckhoff Lake and Horseshoe Bend.

Reservoir measures for RM 279 are anticipated to have similar impacts on habitat, vegetation and wildlife species as for the RM 274 measures. **Table 6-4** provides a sum of special status species, identified in **Chapter 3**, occurring in each river reach potentially affected by a RM 279 Reservoir. A RM 279 Reservoir with a pool elevation greater than the crest elevation of Kerckhoff Dam would require management of fisheries to prevent the introduction of non-native centrarchid species to Kerckhoff Lake and Horseshoe Bend, a designated CAR.

RM 279 Reservoir measures that exceed elevation 1,000 could impact the USFS Backbone Creek RNA, which hosts one of the largest populations of tree anemone. The Backbone Creek RNA includes 262 acres of chaparral and riparian habitat along the San Joaquin River to be preserved and protected in perpetuity (USFS, 2004).

Environmental considerations for a dam at RM 279 related to social and cultural resources are expected to be similar to those for RM 274. Either of the RM 279 measures would inundate entrances to the Millerton Lake Caves system located in the Temperance Flat area, and potentially affect whitewater recreation in the Millerton Bottoms, Patterson Bend, and Horseshoe Bend reaches of the river. A RM 279 Reservoir also may inundate several mines associated with the abandoned Sullivan mine and Patterson mine. In addition to cultural resources mentioned above near Kerckhoff Lake, a high probability exists of archaeological sites, including BRMs and hunting and fishing camps, throughout the Horseshoe Bend reach (White, 1986).

Recommendations for Further Study

Temperance Flat RM 279 Reservoir measures ranging in size from 450 TAF to 1,350 TAF (elevations 900 to 1,115) will be retained for further evaluation and comparison with other measures in **Chapter 7**. Temperance Flat RM 279 Reservoir measures above 1,350 TAF up to 2,740 TAF (elevations above 1,115 up to 1,300) will be dropped from further consideration in the Investigation because such large reservoir sizes are likely not justifiable based on the small incremental water supply above about 1,400 TAF, increased environmental impacts, and increased construction costs. A specific size of 1,350 TAF was chosen so it would be comparable to the maximum sizes at the other Temperance Flat sites. Tradeoffs exist between the two replacement power options for Temperance Flat RM 279 Reservoir. Replacement Power Option 1 appears to be more efficient for developing replacement power based on the ratio of cost for replacement facilities to new generation, but does not provide full replacement power. Replacement Power Option 2 can provide full replacement power at a higher cost. Therefore, Replacement Power Options 1 and 2 will be included with the RM 279 measures retained for further comparison in **Chapter 7**.

Temperance Flat RM 286 Reservoir

Unlike the RM 274 and RM 279 sites, the RM 286 site is not located in Millerton Lake, but is approximately 6 miles downstream of Kerckhoff Dam, between the dam and the Kerckhoff powerhouses. The RM 286 site rises uniformly from elevation 740 in the San Joaquin River channel to elevation 1,450 on the left abutment, and then through a flatter slope at elevation 1,450 to 1,650 before continuing to elevation 2,100. The right abutment rises uninterrupted and uniformly to beyond elevation 1,850 at an unnamed peak.

Site Characteristics and Dam Design Considerations

A dam crest up to elevation 1,400 was considered, which would result in a dam height of 660 feet and a reservoir capacity of 1,360 TAF of new storage. Although the topography would support a higher dam at the RM 286 site, it would create a reservoir that would inundate the Big Creek No. 3 Powerhouse. The incremental cost of impacts to the Big Creek No. 3 Powerhouse were not considered justified by the additional new water supply associated with larger sizes. The potential reservoir for the RM 286 site at elevation 1,400 is shown in **Figure 6-16**.

Temperance Flat RM 286 Dam Site on the San Joaquin River

Upstream and downstream cofferdams would be required for diverting stream flows during construction. The downstream cofferdam would have a crest at about elevation 770, and height of about 30 feet. The upstream cofferdam would have a crest at about elevation 850, and a height of approximately 110 feet.

Diversion tunnels through both abutments of the new dam would be required to pass San Joaquin River flows around the construction site. One of the diversion tunnels would be used for the outlet works, and the other would be plugged after construction.

Prefeasibility-level designs and cost estimates were prepared for concrete arch and RCC dam types at the RM 286 site with crests at elevations 1,200, 1,300, and 1,400. Designs and cost estimates also were developed for CFRF measures at elevations 1,200 and 1,400. Costs for a 1,275 TAF capacity measure were developed by interpolating costs for each line item.

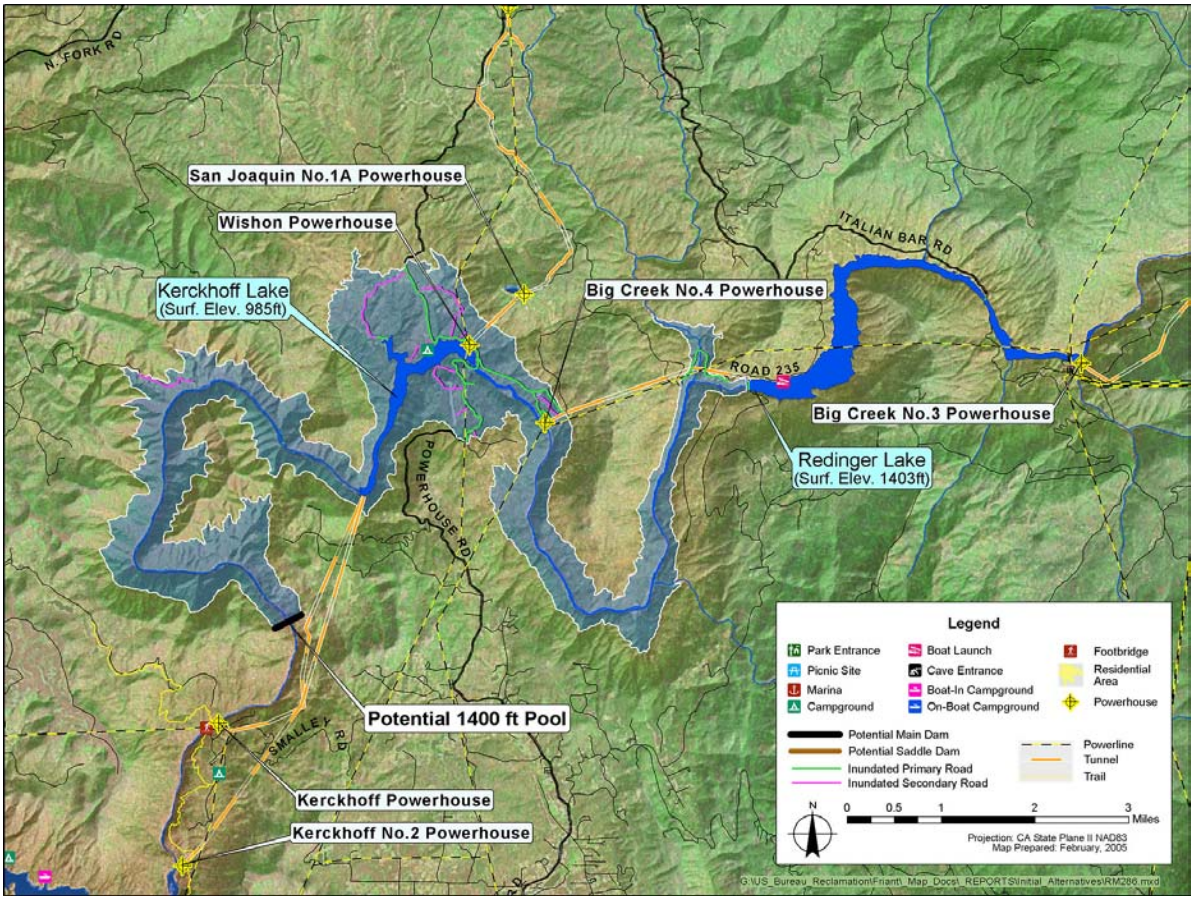


FIGURE 6-16.
POTENTIAL TEMPERANCE FLAT RM 286 RESERVOIR

Hydropower Generation Effects and Potential Replacement Power Options

Construction of a dam at RM 286 would adversely affect energy generation at existing hydropower facilities upstream of Millerton Lake, as shown in **Figures 6-16** and **6-17**. All storage capacities considered would completely inundate Kerckhoff Lake. The Kerckhoff Project powerhouses, however, would not be inundated, although 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 Kerckhoff Project powerhouses. In addition, a reservoir at RM 286 would inundate the Wishon and Big Creek No. 4 powerhouses, with installed generation capacities of 20 MW and 100 MW, respectively.

Three replacement power options were considered for the RM 286 Reservoir, each at two storage capacities. A capacity of 725 TAF corresponds to a reservoir surface at elevation 1,275, which is close to the base of the Redinger Dam spillway. A capacity of 1,360 TAF corresponds to a reservoir surface at elevation 1,400, which approximately represents the existing normal maximum water surface elevation of Redinger Lake (1,403).

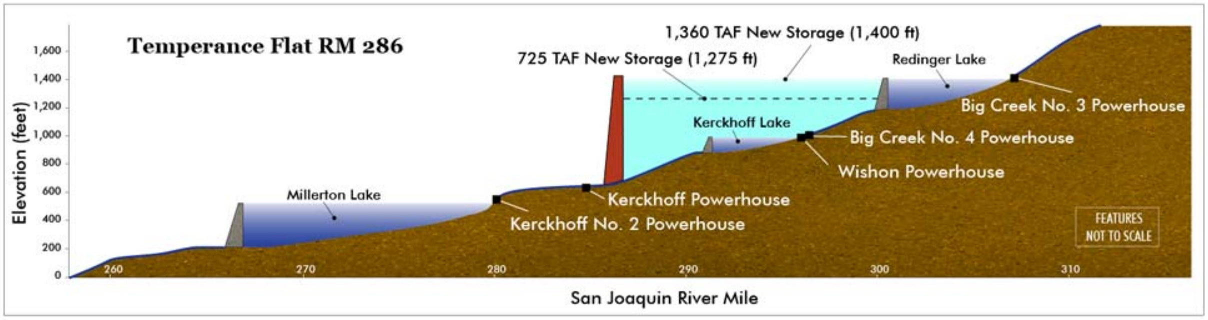


FIGURE 6-17.
HYDROPOWER FEATURES AFFECTED BY
TEMPERANCE FLAT RM 286 RESERVOIR

The three power configurations for the RM 286 Reservoir site were evaluated to identify a range of replacement power opportunities. One option involves developing new power generation facilities at the base of the dam and abandoning the Kerckhoff Project facilities. The second involves constructing a new, multiple-unit powerhouse to replace Kerckhoff No. 2. The third involves modifying the Kerckhoff No. 2 power facilities and a powerhouse at the dam.

For the 725 TAF size RM 286 Reservoir for all three power options, new powerhouses could be constructed to replace some of the generation lost from the Big Creek No. 4 and Wishon powerhouses. The Big Creek No. 4 replacement powerhouse could be constructed at Redinger Dam and the Wishon replacement powerhouse could be constructed farther upstream on the Wishon penstock. Both powerhouses would have a tailwater elevation of 1,275 feet. Replacement powerhouses for Big Creek No. 4 and Wishon are assumed to have capacities of 30 MW and 16 MW, respectively.

For the 1,360 TAF size, a replacement for the Wishon Powerhouse could be constructed upstream on the Wishon penstock with a tailwater elevation of nearly 1,400 feet and an installed capacity of approximately 14 MW. Big Creek No. 4 Powerhouse would not be able to be replaced with a 1,360 TAF RM 286 Reservoir (elevation 1,400) feet because the new reservoir level would be equal to Redinger Lake, which is the forebay for the Big Creek No. 4 Powerhouse.

Results of replacement power evaluations for the RM 286 site are summarized in **Table 6-11.** Descriptions of replacement power options are provided in the following sections.

TABLE 6-11.
ESTIMATED ENERGY GENERATION AND LOSSES FOR TEMPERANCE FLAT RM 286 RESERVOIR SIZES

New Storage Capacity (TAF)	Gross Pool Elev. (feet above msl)	Estimated New Energy Generation				Estimated Losses of Energy Generation		Net Energy Generation	
		Operating Scenario	Estimated New Energy Generation (GWh/year)	Estimated Generation at Big Creek No. 4 and Wishon Powerhouse Replacements (GWh/year)	Additional Generation at Friant (GWh/year)	Powerhouses Potentially Affected	Estimated Reduction in Existing Energy Generation (GWh/year)[1]	Net Generation for WQ or RF Operating Scenario (GWh/year)	Average Net Generation (GWh/year)
Replacement Power Option 1 – New large Powerhouse at dam									
725	1,275	WQ	532	178	5	Kerckhoff, Kerckhoff No. 2 Wishon, Big Creek No. 4	-981	-266	-252
		RF	534	178	30			-239	
1,360[2]	1,400	WQ	597	39	6	Kerckhoff, Kerckhoff No. 2 Wishon, Big Creek No. 4	-981	-339	-326
		RF	592	39	36			-314	
Replacement Power Option 2 – New Kerckhoff No. 2 Powerhouse									
725	1,275	WQ	662	178	5	Kerckhoff, Kerckhoff No. 2, Wishon, Big Creek No. 4	-981	-136	-122
		RF	665	178	30			-108	
1,360[2]	1,400	WQ	736	39	6	Kerckhoff, Kerckhoff No. 2, Wishon, Big Creek No. 4	-981	-200	-187
		RF	731	39	36			-175	
Replacement Power Option 3 – New small powerhouse at dam, turbine-generator replacement at Kerckhoff No. 2 Powerhouse									
725	1,275	WQ	637[3]	178	5	Kerckhoff, Kerckhoff No. 2, Wishon, Big Creek No. 4	-981	-161	-147
		RF	640[3]	178	30			-133	
1,360[2]	1,400	WQ	697[3]	39	6	Kerckhoff, Kerckhoff No. 2, Wishon, Big Creek No. 4	-981	-239	-222
		RF	700[3]	39	36			-206	

Key:
GWh/year – gigawatt-hour per year
RM – river mile
msl – mean sea level
TAF – thousand acre-feet
RF – restoration flow single-purpose analysis
WQ – water quality single-purpose analysis

Notes:
[1] Based on estimated generation numbers from without-project spreadsheet simulations.
[2] Power generation analysis based on water operations data for a net storage capacity of 1,350 TAF, which is assumed to be roughly equivalent to the power impact break point of 1,400 feet (1,360 TAF).
[3] New generation values for Replacement Power Option 3 include generation at modified Kerckhoff No. 2 facility.

RM 286 Replacement Power Option 1

This option includes a multiple-unit powerhouse located on the right abutment diversion tunnel just downstream of the dam and abandonment of all Kerckhoff facilities. Installed capacities for the powerhouse are assumed to be 160 MW for the 725 TAF size and 180 MW for the 1,360 TAF size. The powerhouse would have four turbine-generator units to take greatest advantage of various flow and head conditions. An opportunity may exist with this option to move the powerhouse farther downstream and gain up to 50 feet more head; however, additional study is needed to identify how much farther the powerhouse can be moved downstream without requiring a surge chamber. A conceptual layout of the components of this option is shown in **Figure 6-18**.

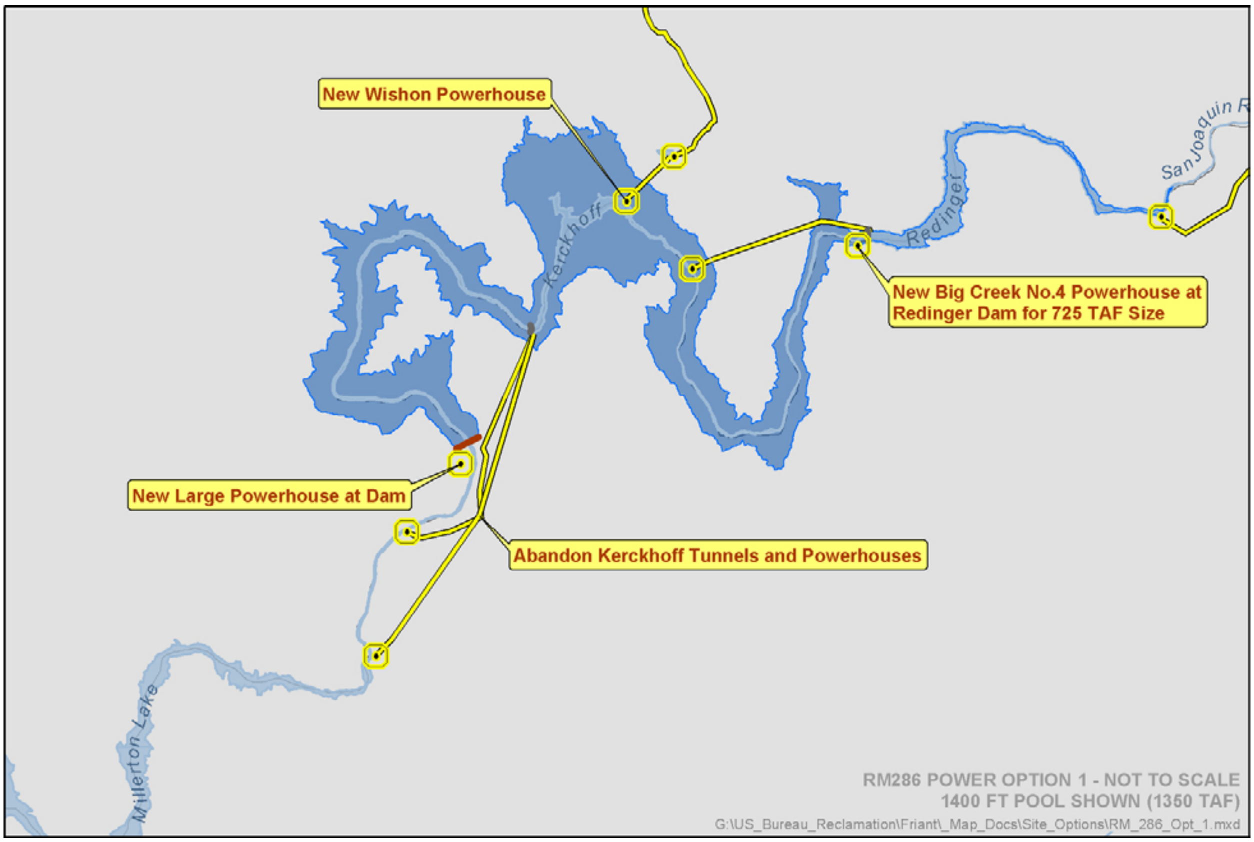


FIGURE 6-18.
REPLACEMENT POWER OPTION 1 FOR TEMPERANCE FLAT RM 286 RESERVOIR

RM 286 Replacement Power Option 2

This option would involve constructing a new multiple-unit powerhouse that would be located at Millerton Lake at about RM 283 to replace Kerckhoff No. 2. Installed capacities for the powerhouse are assumed to be 180 MW for the 725 TAF size and 200 MW for the 1,360 TAF size. The powerhouse would have four turbine-generator units to take greatest advantage of variable flow and head conditions. The existing Kerckhoff No. 2 intake and tunnel would be modified to supply water to the new powerhouse. A new surge chamber on the Kerckhoff No. 2 tunnel also would be required. Both existing Kerckhoff Project powerhouses would be abandoned. The longer conveyance tunnel and need for a surge chamber and penstocks also would result in a greater head loss. A conceptual layout of the components for this option is shown in **Figure 6-19**.

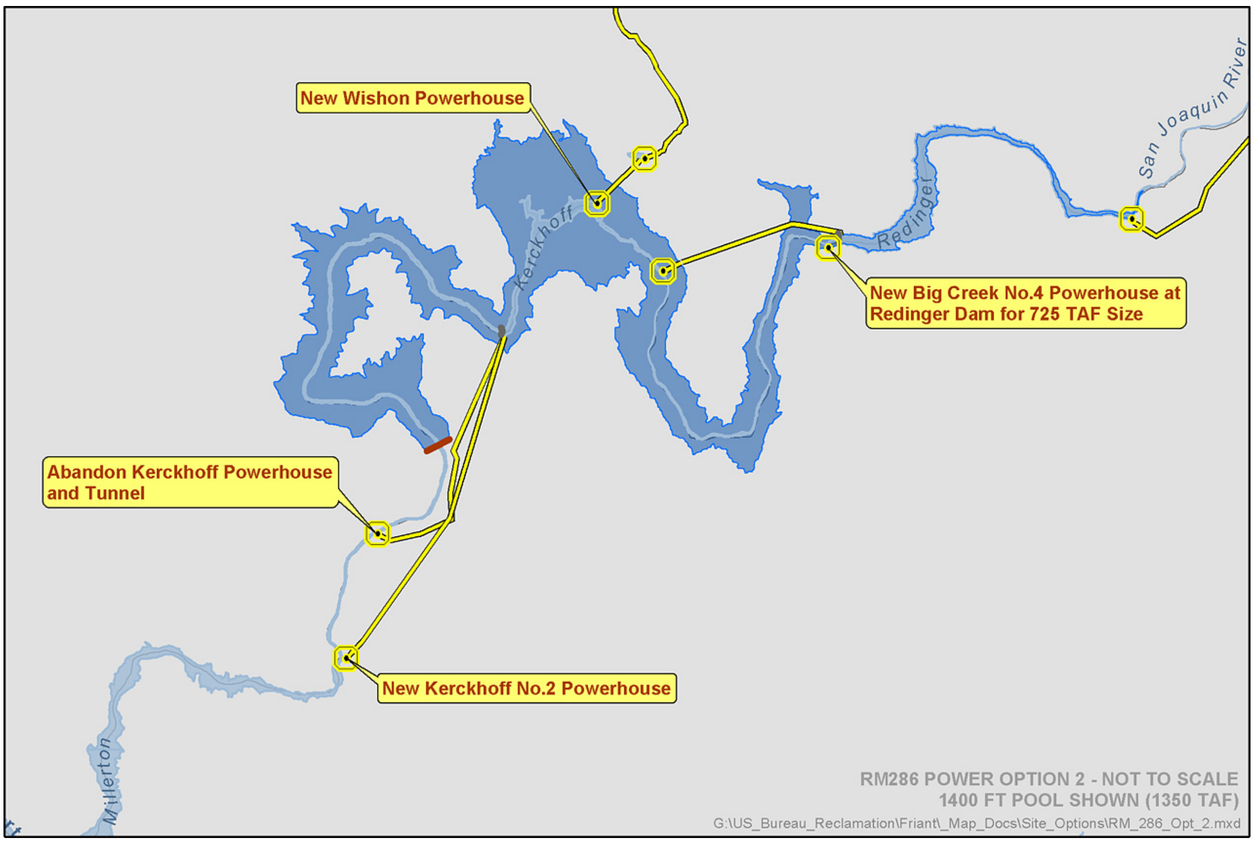


FIGURE 6-19.
REPLACEMENT POWER OPTION 2 FOR TEMPERANCE FLAT RM 286 RESERVOIR

RM 286 Replacement Power Option 3

This option would use existing Kerckhoff No. 2 facilities to the maximum extent by replacing the single-unit turbine and generation equipment in the Kerckhoff No. 2 Powerhouse with appropriate equipment to accommodate greater head. The Kerckhoff No. 2 intake and tunnel would be modified and a new surge chamber and single new turbine-generator would be installed. The longer conveyance tunnel and need for a surge chamber and penstocks would result in a greater head loss. Installed capacities for a new Kerckhoff No. 2 unit are assumed to be 155 MW for the 725 TAF size and 186 MW for the 1,360 TAF size.

The Kerckhoff powerhouse, intake, and tunnel would be abandoned, and a small, single-unit powerhouse would be constructed at the base of the RM 286 dam. Installed capacities for the dam powerhouse would be 45 MW for the 725 TAF size and 50 MW for the 1,360 TAF size. A conceptual layout of the components for this option is shown in **Figure 6-20**.

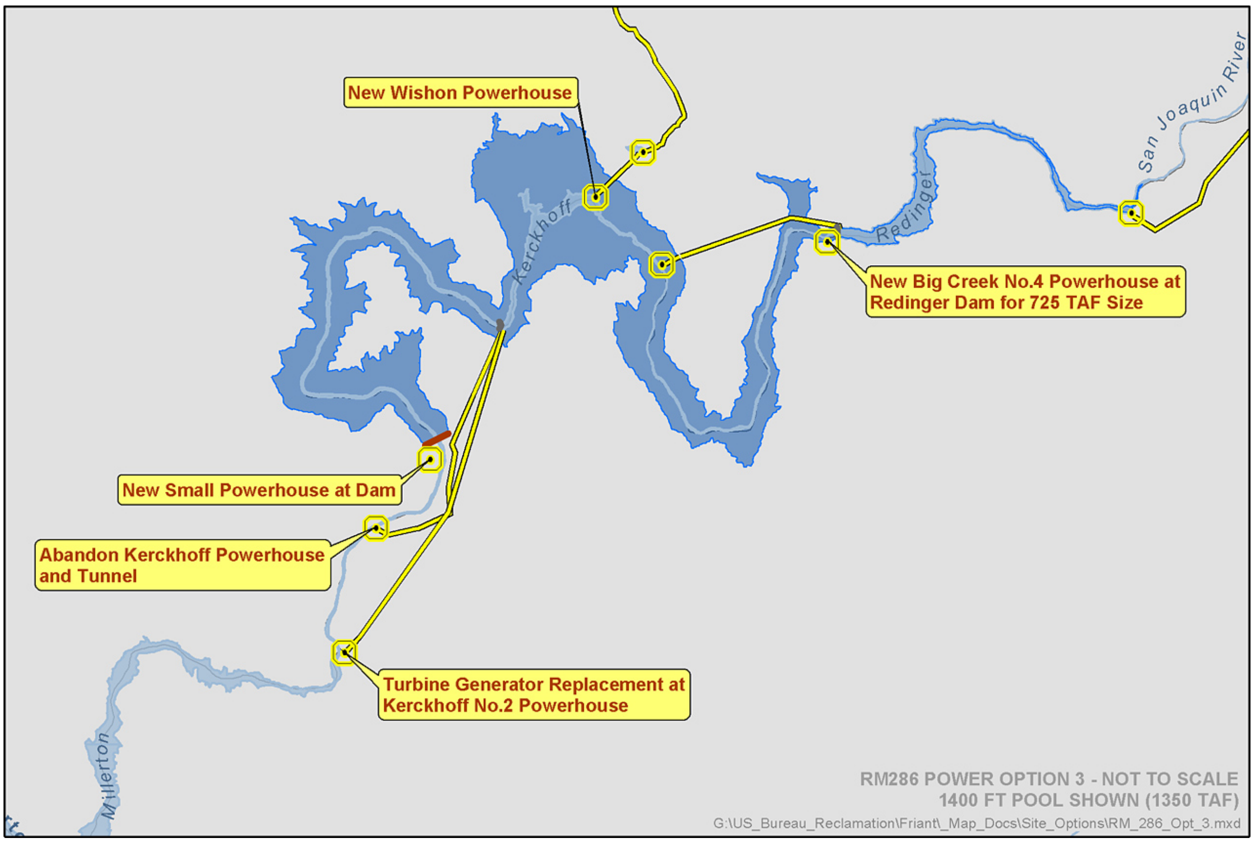


**FIGURE 6-20.
REPLACEMENT POWER OPTION 3 FOR
TEMPERANCE FLAT RM 286 RESERVOIR**

Cost Estimates

Construction costs for dams, appurtenant features, power replacement facilities, and other impacted infrastructure were developed for storage capacities up to 1,360 TAF at the RM 286 site. This capacity would correspond to a reservoir at elevation 1,400, which would be at the top of Redinger Dam, and would inundate Kerckhoff Lake and the Wishon and Big Creek No. 4 powerhouses.

Costs for constructing RM 286 storage measures at several sizes, combined with Power Replacement Options 1 through 3, are summarized in **Tables 6-12** through **6-14**. These costs include constructing the main dam and appurtenant features, and costs for abandoning, modifying, or relocating existing facilities. The dam and appurtenant structures would be located on public land. Parcels of land immediately upstream from the construction area and in the potential area of inundation are privately owned and would need to be acquired. Property acquisition costs are included in the construction costs shown in **Tables 6-12** through **6-14**.

A comparison of cost estimates prepared during Phase 1 of the Investigation suggests that RCC has the lowest cost of the dam types examined for RM 286, except at elevation 1,200, where the concrete arch design would have a slightly lower cost. However, cost differences between dam types are not great enough to conclusively identify the most cost-efficient design at all crest elevations. For simplicity and ease of comparison, only costs for the RCC dam type are included in **Tables 6-12** through **6-14**.

Tables 6-12 through **6-14** show construction costs for RM 286 dam and reservoir measures with each of the three replacement powerhouse configurations. Costs include dam and appurtenant features; abandonment, modification, or relocation of existing facilities; land acquisition; and indirect costs.

Costs for all storage measures include costs for relocating Powerhouse Road and Bridge and for decommissioning and abandoning the Kerckhoff Powerhouse and its intake structure; Kerckhoff Dam, gates, hoist, and outlet works; the Wishon Powerhouse; and Big Creek No. 4 Powerhouse. All power configurations include the cost to construct a 14 to 16 MW replacement Wishon Powerhouse at a higher elevation, and for reservoir elevations up to and including 1,300, the cost to construct a 30 MW powerhouse at Redinger Dam to replace the Big Creek No. 4 Powerhouse.

Construction costs for the three replacement power options at the various storage sizes are shown in **Figure 6-21**.

TABLE 6-12.
CONSTRUCTION COSTS FOR TEMPERANCE FLAT RM 286 MEASURES WITH REPLACEMENT POWER OPTION 1 ($ MILLION)

Gross Pool Elevation (feet above msl)	**1,200**	**1,275**	**1,400**
New Storage Capacity (TAF)	**460**	**725**	**1,360**
Storage Components			
RCC Dam, Spillway, River Diversion, Reservoir Lands	320	360	560
River Outlet Works at RM 286	70	88	105
Abandon Kerckhoff No. 2 Powerhouse	2	2	2
Abandon Intake for Kerckhoff No. 2 Powerhouse	1	1	1
Abandon and Restore Kerckhoff Powerhouse	4	4	4
Abandon Intake for Kerckhoff Powerhouse	1	1	1
Remove Kerckhoff Dam Outlet Works and Gates	2	2	2
Abandon Wishon Powerhouse	2	2	2
Abandon Big Creek No. 4 Powerhouse	4	4	4
Remove Redinger Dam Operating Equipment	-	-	8
Powerhouse Road Relocation	18	36	55
Powerhouse Road Bridge Relocation	34	35	49
Construction Cost, Storage Components	**458**	**535**	**793**
Replacement Power Components			
New Powerhouse at RM 286 Dam (150 to 180 MW)	115	120	125
RM 286 Switchyard and Transmission Line	18	18	18
New Wishon Powerhouse (14 to 16 MW)	46	46	46
New Big Creek No. 4 Powerhouse at Redinger Dam (30 MW)	69	69	-
Construction Cost, Replacement Power Components	**248**	**253**	**189**
Construction Cost[1, 2]	**706**	**788**	**982**

Key:
msl – mean sea level
MW – megawatt
RCC – roller-compacted concrete
RM – river mile
TAF – thousand acre-feet

Notes:

[1] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design and construction management, estimated at 25 percent of field costs.

[2] Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

TABLE 6-13.
CONSTRUCTION COSTS FOR TEMPERANCE FLAT RM 286 MEASURES WITH REPLACEMENT POWER OPTION 2 ($ MILLION)

Gross Pool Elevation (feet above msl)	1,200	1,275	1,400)
New Storage Capacity (TAF)	**460**	**725**	**1,360**
Storage Components			
RCC Dam, Spillway, River Diversion, Reservoir Lands	320	360	560
River Outlet Works at RM 286	70	88	105
Abandon Kerckhoff No. 2 Powerhouse	2	2	2
Abandon and Restore Kerckhoff Powerhouse	4	4	4
Abandon Intake for Kerckhoff Powerhouse	1	1	1
Remove Kerckhoff Dam Outlet Works and Gates	2	2	2
Abandon Wishon Powerhouse	2	2	2
Abandon Big Creek No. 4 Powerhouse	4	4	4
Remove Redinger Dam Operating Equipment	-	-	8
Powerhouse Road Relocation	18	36	55
Powerhouse Road Bridge Relocation	34	35	49
Construction Cost, Storage Components	**457**	**534**	**792**
Replacement Power Components			
New Kerckhoff No. 2 Powerhouse (170 to 200 MW)	175	180	190
Kerckhoff No. 2 Diversion Tunnel, Steel Liner	85	115	165
Kerckhoff No. 2 Diversion Tunnel, Backfill Concrete	3	3	3
Modify Kerckhoff No. 2 Diversion Intake	33	36	45
New Wishon Powerhouse (14 to 16 MW)	46	46	46
New Big Creek No. 4 Powerhouse at Redinger Dam (30 MW)	69	69	-
Construction Cost, Replacement Power Components	**411**	**449**	**449**
Construction Cost[1, 2]	**868**	**983**	**1,241**

Key:
msl – mean sea level; MW – megawatt; RCC – roller-compacted concrete
RM – river mile; TAF – thousand acre-feet

Notes:

[1] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design and construction management, estimated at 25 percent of field costs.

[2] Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

TABLE 6-14.
CONSTRUCTION COSTS FOR RM 286 MEASURES WITH REPLACEMENT POWER OPTION 3 ($ MILLION)

Gross Pool Elevation (feet above msl)	1,200	1,275	1,400
New Storage Capacity (TAF)	**460**	**725**	**1,360**
Storage Components			
RCC Dam, Spillway, River Diversion, Reservoir Lands	320	360	560
River Outlet Works at RM 286	70	88	105
Abandon and Restore Kerckhoff Powerhouse	4	4	4
Abandon Intake for Kerckhoff Powerhouse	1	1	1
Remove Kerckhoff Dam Outlet Works and Gates	2	2	2
Abandon Wishon Powerhouse	2	2	2
Abandon Big Creek No. 4 Powerhouse	4	4	4
Remove Redinger Dam Operating Equipment	-	-	8
Powerhouse Road Relocation	18	36	55
Powerhouse Road Bridge Relocation	34	35	49
Construction Cost, Storage Components	**455**	**532**	**790**
Replacement Power Components			
New Powerhouse at RM 286 Dam (40 to 60 MW)	130	145	155
RM 286 Switchyard and Transmission Line	18	18	18
Kerckhoff No. 2 Turbine Generator Replacement (140 to 186 MW)	68	70	78
Kerckhoff No. 2 Penstock, Ring Follower Gate	28	28	28
Kerckhoff No. 2 Diversion Tunnel, Steel Liner	85	115	165
Kerckhoff No. 2 Diversion Tunnel, Backfill Concrete	3	3	3
Modify Kerckhoff No. 2 Diversion Intake	33	36	45
New Wishon Powerhouse (14 to 16 MW)	46	46	46
New Big Creek No. 4 Powerhouse at Redinger Dam (30 MW)	69	69	-
Construction Cost, Replacement Power Components	**480**	**530**	**538**
Construction Cost[1, 2]	**935**	**1,062**	**1,328**

Key:
msl – mean sea level　MW – megawatt　RCC – roller-compacted concrete
RM – river mile　TAF – thousand acre-feet

Notes:

[1] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design and construction management, estimated at 25 percent of field costs.

[2] Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

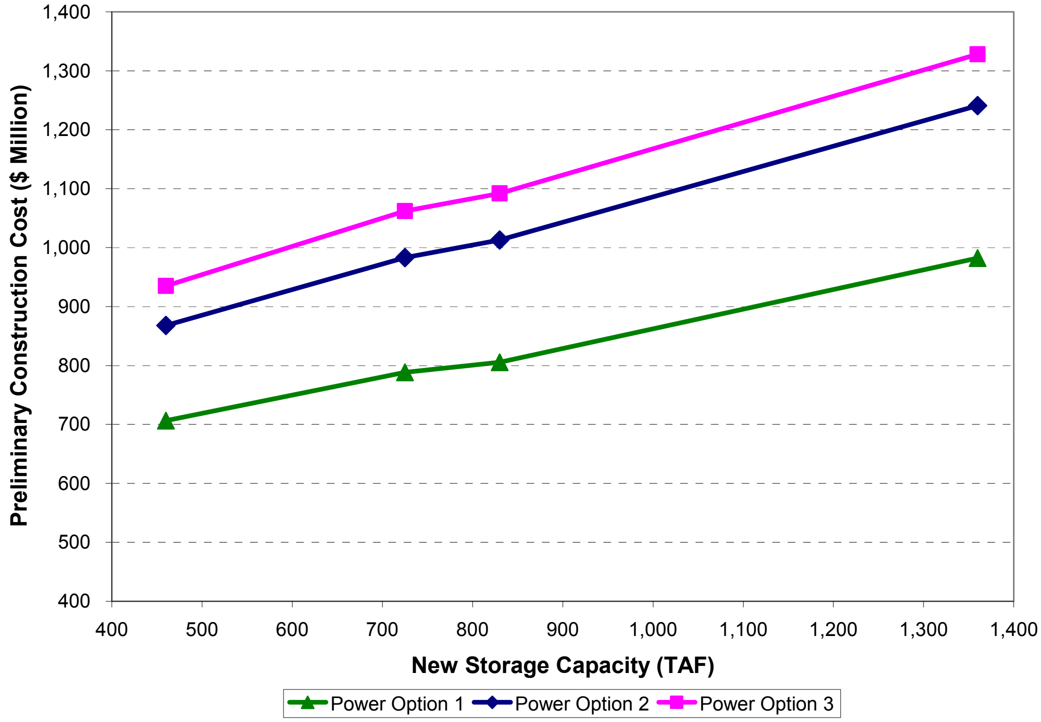


FIGURE 6-21.
CONSTRUCTION COSTS FOR TEMPERANCE FLAT RM 286 MEASURES VS. NEW STORAGE CAPACITY

Environmental Considerations

A reservoir at RM 286 may impact vegetation, wildlife and fisheries, recreation, land use, and cultural resources but will not affect most environmental resources in Millerton Lake, in contrast to the other Temperance Flat reservoir measures. River reaches potentially affected by a dam at RM 286 include Patterson Bend and Kerckhoff Lake and Horseshoe Bend.

Special status species associated with the above river reaches are described in **Chapter 3**. **Table 6-4** provides a sum of special status species occurring in each river reach potentially affected by a RM 279 Reservoir. A dam at RM 286 would present a barrier to fish populations between Friant Dam and Redinger Dam, but would replace only the existing Kerckhoff Dam located a few miles upstream. As described above for a potential dam at RM 279, fisheries management would be required with a new reservoir at RM 286 to prevent the introduction of non-native fishes to Kerckhoff Lake and Horseshoe Bend, a designated CAR.

Lands potentially affected by a dam at RM 286 contain no residences, and are managed by either the BLM as the San Joaquin River Gorge Management Area or the USFS as the SNF. Within the Horseshoe Bend reach, the USFS Backbone Creek RNA, described above, may be partially inundated with the considered RM 286 measures. Road 222 and Powerhouse Road Bridge, which crosses over Kerckhoff Lake, the Patterson mine, and facilities associated with the Wishon and Big Creek No. 4 powerhouses also may be affected by a RM 279 Reservoir.

The maximum pool elevation considered for RM 286 is just below the crest elevation of Big Creek Dam No. 7, also referred to as Redinger Dam. Whitewater recreation would be affected in the Patterson Bend and Horseshoe Bend reaches of the river. Environmental considerations for a dam at RM 286 related to cultural resources are expected to be similar to those of RM 279.

Recommendations for Further Study

No large changes in incremental cost or impacts to hydropower and environmental resources were evident for the three evaluated RM 286 reservoir measures ranging from 460 to 1,360 TAF (elevations 1,200 to 1,400). All three measures will be retained for comparison to other measures providing similar amounts of new water supply in **Chapter 7**. Tradeoffs exist between the three Replacement Power Options for a Temperance Flat RM 286 Reservoir. Replacement Power Option 1 appears to be the most efficient at developing replacement power based on the ratio of cost for replacement facilities to new generation. Replacement Power Option 2 provides more replacement power at a lower cost than Replacement Power Option 3 for all storage sizes considered. Therefore, Replacement Power Options 1 and 2 will be included with the RM 286 measures retained for further comparison in **Chapter 7**.

Fine Gold Reservoir

Fine Gold Creek watershed north of Millerton Lake

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. Fine Gold Reservoir could be filled by pumping water from Millerton Lake or fed by water diverted through a tunnel from Kerckhoff Lake. Options for storing water pumped from Millerton Lake are discussed in this section of the chapter. The concept of diverting San Joaquin River water from Kerckhoff Lake was suggested during the scoping process and is discussed later in this chapter.

Options for developing storage in the Fine Gold Creek watershed involve building a dam and reservoir with a gross pool of up to approximately elevation 1,110. Preliminary designs and cost estimates were developed for potential dam and reservoir sizes between elevations 900 and 1,110. A gross pool at elevation 900 would correspond to a dam 380 feet high with 120 TAF of storage capacity. A gross pool at elevation 1,110 would correspond to a dam 590 feet high with 800 TAF of storage capacity. Two potential dam types were considered: CFRF and RCC gravity dams. A reservoir with 800 TAF of storage and an intermediate 400 TAF reservoir were considered for hydrologic modeling purposes.

The elevation 1,100 measure would require constructing a saddle dam approximately 100 feet high and 3,200 feet long on the west rim of the reservoir. **Figure 6-22** shows the extent of a Fine Gold Reservoir at elevation 1,100.

During construction, a temporary cofferdam approximately 80 feet high would be required above the permanent dam site on Fine Gold Creek to divert flows, and a second cofferdam approximately 60 feet high would be required to keep water from Millerton Lake out of the construction zone. One or more tunnels would be required to divert flood flows in Fine Gold Creek during construction; the number and placement of tunnels would depend on the dam type selected.

Potential New Water Supply

Fine Gold Reservoir as a pump-back project would involve pumping water from Millerton Lake in the winter or spring, thereby evacuating space for the capture of additional San Joaquin River inflow to Millerton Lake. Water stored in Fine Gold Reservoir subsequently would be released to Millerton Lake, then diverted to the Friant-Kern or Madera canals and/or released to the San Joaquin River.

CALSIM water operations model simulations completed during Phase 1 indicate that the potential new water supply resulting from developing a Fine Gold Reservoir of 800 TAF could be up to almost 140 TAF/year on average. As summarized in **Table 6-15**, development of new water supplies varies in relationship to the amount of new storage created and management of the new water.

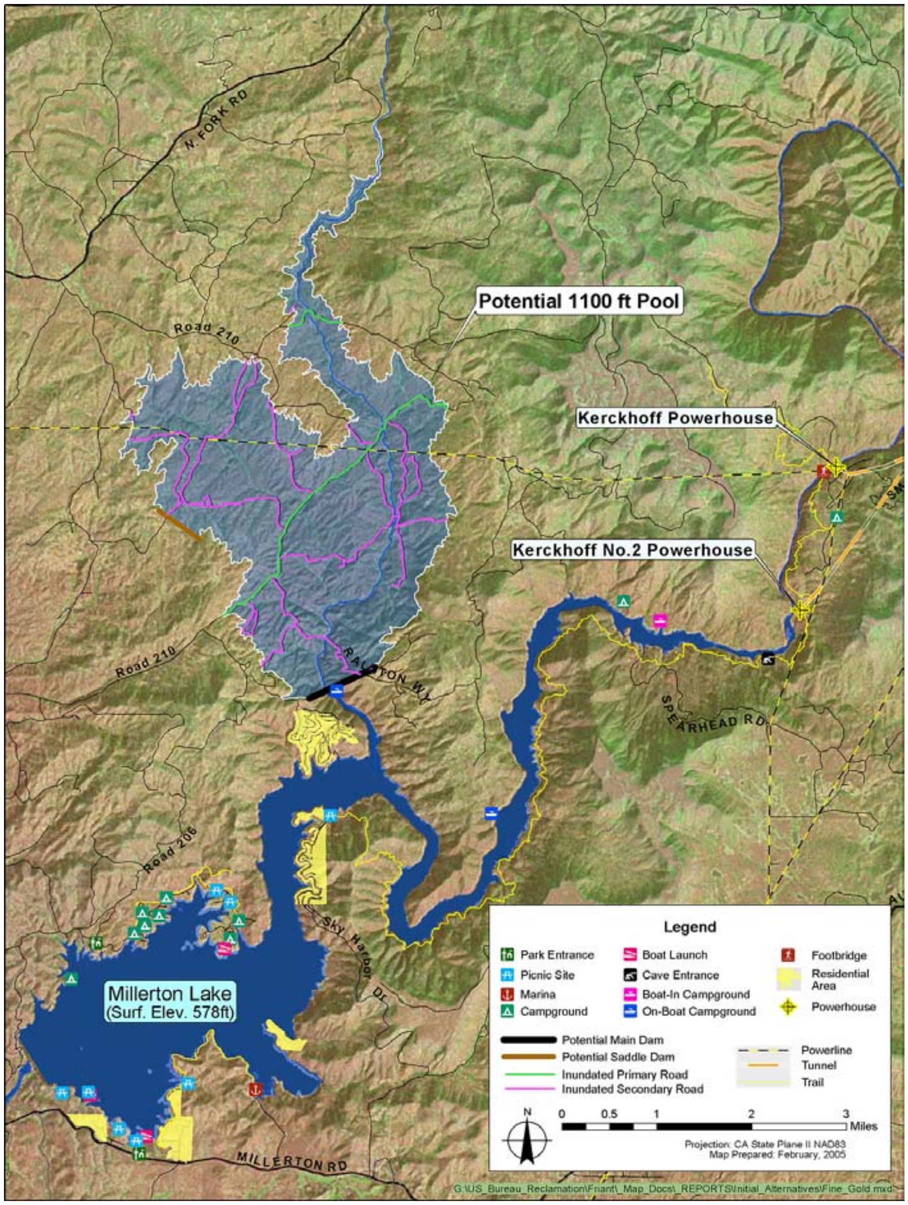


FIGURE 6-22.
POTENTIAL FINE GOLD RESERVOIR

Table 6-15 shows that releasing water to the San Joaquin River could result in developing more new water supply than releasing new water supplies to the Friant-Kern and Madera canals only. This is because water deliveries are limited by contract amounts and available conveyance capacity, whereas simulated releases to the river were maximized to the extent that they would not reduce water deliveries from without-project levels. The smaller dam size considered at elevation 900 has only a fifth of the storage capacity of the elevation 1,110 reservoir measure, and would not be expected to produce more than 20 TAF/year on average.

TABLE 6-15.
NEW WATER SUPPLY FROM FINE GOLD RESERVOIR SIZES

Gross Pool Elevation (feet above msl)	New Storage Capacity (TAF)	New Water Supply Estimated in Single-Purpose Analysis (average TAF/year)		
		RF	WQ	WS
1,020	400	n/s	n/s	65
1,110	800	136	124	113

Key:
msl – mean sea level
n/s – not simulated
TAF – thousand acre-feet
RF – San Joaquin River restoration flow single-purpose analysis
WQ – San Joaquin River water quality single-purpose analysis
WS – water supply reliability single-purpose analysis

Hydropower Generation Effects and Pumping Requirements

Fine Gold Reservoir would not impact power generation at any existing hydropower facilities. Power generation and use were estimated for a Fine Gold Reservoir of 800 TAF to enable comparisons to other potential sites of similar size, such as Yokohl Valley Reservoir at 800 TAF and the Temperance Flat measures at 725 TAF. Water would be pumped from Millerton Lake to the new reservoir and later released back to Millerton Lake. The pump head would range from a minimum of 60 feet (full Millerton Lake) up to 580 feet (full Fine Gold Reservoir). Electricity would need to be supplied to power the pump-turbine units when pumping. This energy requirement would be partially offset by generating electricity from the pump-turbine units when water was released back to Millerton Lake. **Figure 6-23** shows Fine Gold Reservoir in profile and highlights the pumping and generating features.

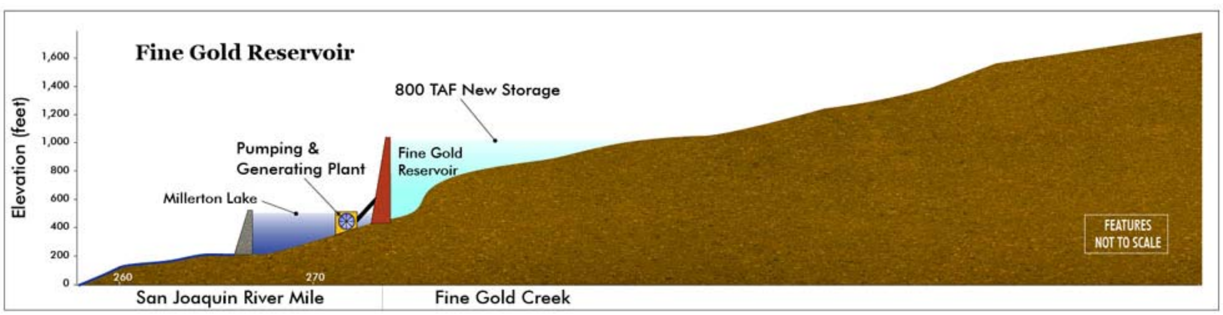


FIGURE 6-23.
FINE GOLD RESERVOIR PROFILE

Table 6-16 summarizes estimated energy generation and pumping energy requirements for Fine Gold Reservoir at 800 TAF. Generation and pumping energy requirement estimates were made using a monthly timestep spreadsheet model that accounts for flow and head at each potential new power facility. As shown in **Table 6-16**, pumping energy requirements would exceed generation potential by 25 to 50 percent, resulting in a net energy requirement of up to about 50 GWh/year.

TABLE 6-16.
ESTIMATED PUMPING REQUIREMENTS AND GENERATING POTENTIAL FOR FINE GOLD RESERVOIR

New Storage Capacity (TAF)	Gross Pool Elev. (feet above msl)	Estimated New Energy Generation			Estimated Losses of Energy Generation		Net Energy Generation	
		Operating Scenario	Estimated New Energy Generation (GWh/year)	Additional Generation at Friant (GWh/year)	Estimated Reduction in Existing Energy Generation (GWh/year)	Avg. Annual Pumping Energy Requirement (GWh/year)	Net Generation for WQ or RF Operating Scenario (GWh/year)	Average Net Generation (GWh/year)
800	1,110	WQ	103	8	---[1]	-164	-53	-40
		RF	91	25	---[1]	-144	-28	

Key:
GWh/year – gigawatt-hour per year
msl – mean sea level
RF – restoration flow single-purpose analysis
TAF – thousand acre-feet
WQ – water quality single-purpose analysis

Notes:
[1] Fine Gold Reservoir would not impact any existing hydropower facilities.

Cost Estimates

Construction costs associated with building Fine Gold Dam and Reservoir increase with elevation. This is due in part to the dam volume and also to the need for construction of a saddle dam on the reservoir rim for reservoir elevations greater than 1,000.

Table 6-17 summarizes construction costs of the Fine Gold Reservoir measures considered. Appurtenant features bundled with the cost of the dam include spillway, diversion during construction, outlet works, and pumping-generating plant. Cost estimates for the elevation 900 and 1,100 dam measures are based on preliminary designs; CFRF measures at other elevations were interpolated or projected. Costs have been estimated separately for road relocations, completion of which would involve constructing one or two short crossings over a neck of the reservoir, depending on the reservoir elevation and relocation route.

Privately owned lands, including up to 10 residences, would be acquired in the reservoir area. An estimate of these acquisition costs is included in the construction costs shown for the dam and appurtenances, along with an allowance of approximately 20 percent of the property costs for indirect costs associated with property acquisition transactions.

Figure 6-24 shows construction costs in relation to the new storage capacity that would be developed by the Fine Gold Reservoir measures.

**TABLE 6-17.
CONSTRUCTION COSTS FOR FINE GOLD RESERVOIR MEASURES
($ MILLION)**

Gross Pool Elevation (feet above msl)	900	1,020	1,110
New Storage Capacity (TAF)	120	400	800
Dam Type	CFRF	CFRF	CFRF
Components			
Dam, Appurtenant Features, Reservoir Lands[1]	240	430	610
Road 210 Relocation	28	23	18
Road 210 Bridges	15	15	15
Construction Costs[2,3]	**283**	**468**	**643**

Key:
CFRF – concrete face rockfill
msl – mean sea level
RCC – roller-compacted concrete
TAF – thousand acre-feet

Notes:
[1] Appurtenant features include spillway, diversion during construction, outlet works, and pumping-generating plant.
[2] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design and construction management, estimated at 25 percent of field costs
[3] Costs do not include environmental mitigation, new or relocated recreation facilities.

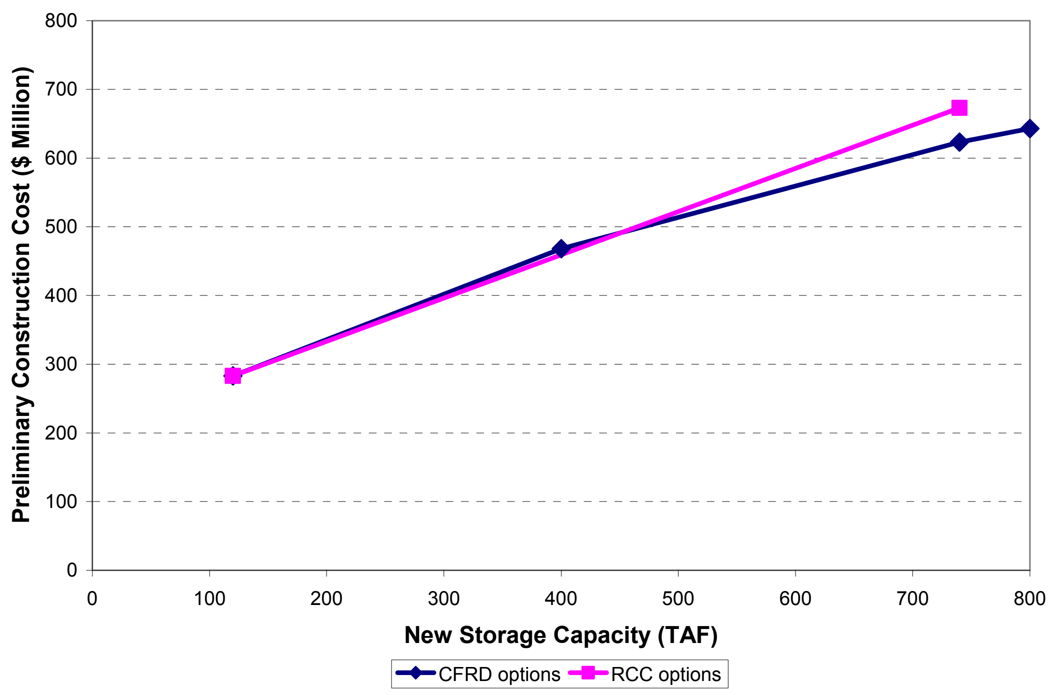


**FIGURE 6-24.
CONSTRUCTION COSTS FOR FINE GOLD RESERVOIR MEASURES
VS. NEW STORAGE CAPACITY**

Environmental Considerations

Creation of Fine Gold Creek Reservoir may result in adverse environmental impacts to physical and biological resources, and some social and cultural resources. River reaches potentially affected include Fine Gold Creek and Millerton Lake. The relatively pristine watershed of Fine Gold Creek supports many biological resources, and is considered an ADMA. A reservoir would replace the largely intermittent foothill stream, comprising bouldery pools connected by long sandy-bottomed sections of stream (Moyle et al., 1996).

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, described in **Chapter 3**, may be present in the inundation area. **Table 6-4** summarizes special status species occurring in each river reach potentially affected by a Fine Gold Creek reservoir. Pumped storage operations could affect water temperatures in Millerton Lake and cause fluctuations in water levels in both Millerton Lake and the new Fine Gold Creek reservoir.

Impacts to social and economic resources are anticipated to be minimal since the Fine Gold Creek watershed appears to be largely undeveloped. Some scattered single-family homes, related farm structures and access roads are present in the area. Road 210, Hidden Lake Boulevard, and Ralston Way traverse the watershed. Additionally, three archaeological sites were identified in the Fine Gold Creek watershed (Welch, 2002).

Recommendations for Further Study

A Fine Gold Reservoir of 120 TAF (elevation 900) does not appear to be cost-effective. It has the highest unit cost of water of any of the surface storage measures under consideration. The topography of the site is such that at elevation 900 a large dam (380 feet high) is required, but only a small amount of storage is developed. Therefore, the 120 TAF size of Fine Gold Reservoir is dropped from further consideration in the Investigation. A threshold size between 120 TAF and 800 TAF where the reservoir becomes more cost-effective has yet to be determined; however, a 400 TAF size will be used in the evaluation. Fine Gold Reservoir measures ranging in size from 400 TAF to 800 TAF will be retained for further evaluation and comparison with other measures in **Chapter 7**.

Yokohl Valley Reservoir

Yokohl Valley (looking toward Lindsay Peak)

Yokohl Valley Reservoir would be located approximately 15 miles east of Visalia and 8 miles south of Lake Kaweah (**Figure 6-25**). Yokohl Valley Reservoir would be operated as a pump-back project served by the Friant-Kern Canal. This is a variation of an option that was described initially in a study of the Mid-Valley Canal by Reclamation (1964). Options for developing storage in Yokohl Valley Reservoir involve building a dam with a gross pool at up to elevation 860. Two potential dam and reservoir sizes were considered. A gross pool at elevation 790 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 would correspond to a dam 330 feet high with 800 TAF of storage capacity. **Figure 6-25** shows the extent of a Yokohl Valley Reservoir at elevation 860. Two small saddle dams in the hills west of the main dam site would be required.

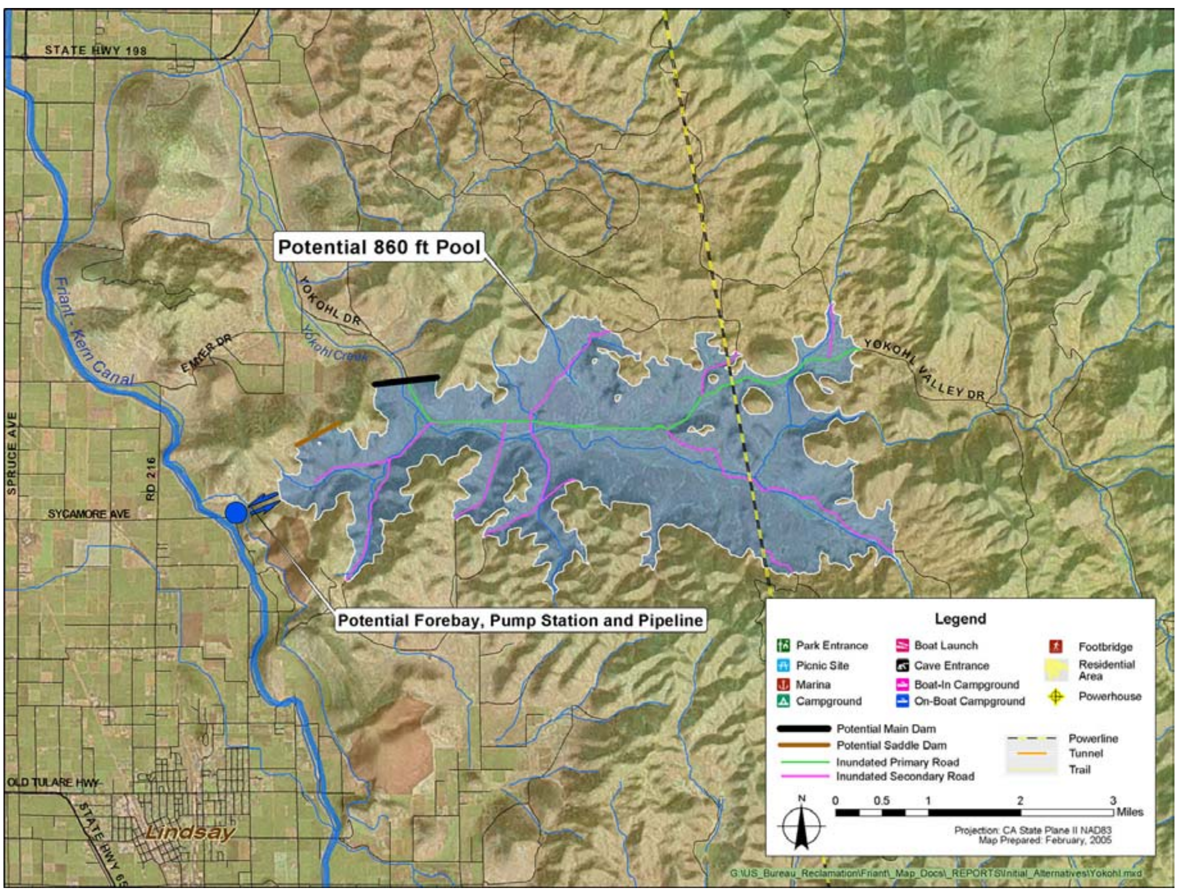


FIGURE 6-25.
POTENTIAL YOKOHL VALLEY RESERVOIR

Site characteristics at the Yokohl Valley dam site appear to pose no barriers to construction. Underlying rock conditions would be adequate for a dam foundation; sufficient impervious, pervious, and riprap materials exist within 2 miles of the proposed dam site; and potential staging and lay-down areas are located immediately upstream and downstream of the project site. An improved road provides access directly to the dam site and electrical power would likely be available from sources in Exeter or along Highway 198.

Potential New Water Supply

Yokohl Valley Reservoir would operate as a pump-back storage reservoir served by the Friant-Kern Canal, as shown in **Figure 6-26**. This offstream and off-basin storage would rely on Friant-Kern Canal diversion as the only water source for the pump-storage operation. In wet months, any water that exceeded demand would be diverted to the Friant-Kern Canal and stored in Yokohl Valley Reservoir to free up Millerton Lake for capture of floodwater. During irrigation season, water released from Yokohl Valley Reservoir could supplement Millerton Lake diversions to satisfy demand along the Friant-Kern Canal. To avoid significant fluctuation in Friant-Kern Canal water levels, pumping and releasing would be through a forebay off the canal (see **Figure 6-26**).

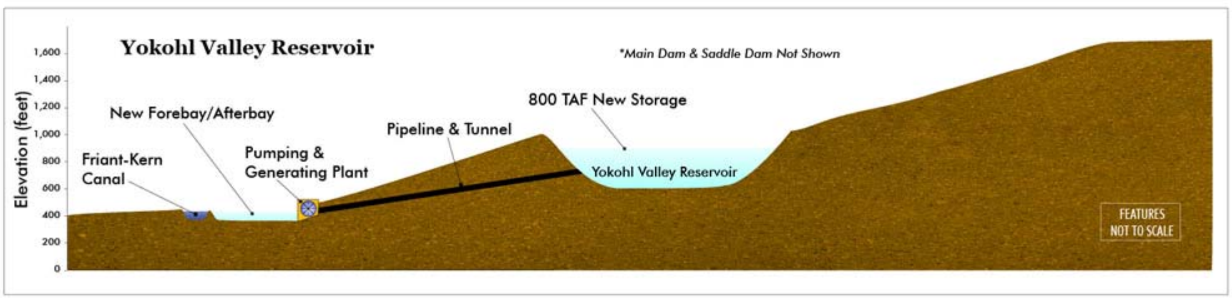


FIGURE 6-26.
POTENTIAL YOKOHL VALLEY RESERVOIR PROFILE

CALSIM water operations model simulations completed during Phase 1 indicate that the potential new water supply resulting from developing a Yokohl Valley Reservoir of 800 TAF could be up to almost 100 TAF/year on average. As summarized in **Table 6-18**, development of new water supplies varies in relationship to the amount of new storage created and management of the new water. Pumping capacity to Yokohl Valley Reservoir was assumed at 2,000 cfs. The new water supply from Yokohl Valley Reservoir would be similar to, but lower than, similar reservoir sizes at Fine Gold Creek because of conveyance constraints in the Friant-Kern Canal and because evaporation losses from Yokohl Valley Reservoir are higher.

**TABLE 6-18.
NEW WATER SUPPLY FROM YOKOHL VALLEY RESERVOIR SIZES**

New Storage Capacity (TAF)	New Water Supply Estimated in Single-Purpose Analysis (average TAF/year)		
	RF	WQ	WS
400	n/s	n/s	60
800	88	82	97

Key:
n/s – not simulated
RF – San Joaquin River restoration flow single-purpose analysis
TAF – thousand acre-feet
WQ – San Joaquin River water quality single-purpose analysis
WS – water supply reliability single-purpose analysis

Hydropower Generation Effects and Pumping Requirements

Yokohl Valley Reservoir would not impact power generation at any existing hydropower facilities. Power generation and use were estimated for a Yokohl Valley Reservoir of 800 TAF to enable comparisons to other potential sites of similar size. Water would be pumped from the Friant-Kern Canal to the new reservoir and later released back to the Friant-Kern Canal. The water surface level at the Friant-Kern Canal was assumed to be constant at elevation 410. Electricity would need to be supplied to power the pump-turbine units when pumping. This energy requirement would be partially offset by generating electricity from the pump-turbine units when water was released back to the Friant-Kern Canal.

Table 6-19 summarizes estimated energy generation and pumping energy requirements for Yokohl Valley Reservoir at 800 TAF of storage. Generation and pumping energy requirement estimates were made using a monthly timestep spreadsheet model that accounts for flow and head at each potential new power facility. As shown in **Table 6-19**, pumping energy requirements would exceed generation potential by 65 to 100 percent, resulting in a net energy loss of up to about 70 GWh/year.

**TABLE 6-19.
ESTIMATED PUMPING REQUIREMENTS AND GENERATING POTENTIAL FOR YOKOHL VALLEY RESERVOIR**

New Storage Capacity (TAF)	Gross Pool Elev. (feet above msl)	Potential New Energy Generation			Potential Losses of Energy Generation		Net Energy Generation	
		Operating Scenario	Potential New Energy Generation (GWh/year)	Additional Generation at Friant (GWh/year)	Potential Reduction in Existing Energy Generation (GWh/year)	Avg. Annual Pumping Energy Requirement (GWh/year)	Net Generation for WQ or RF Operating Scenario (GWh/year)	Average Net Generation (GWh/year)
800	860 [1]	WQ	76	-7	---[2]	-139	-70	-60
		RF	69	8	---[2]	-127	-50	

Key:
GWh/year – gigawatt-hour per year
msl – mean sea level
RF – restoration flow single-purpose analysis
TAF – thousand acre-feet
WQ – water quality single-purpose analysis

Notes:
[1] Elevation capacity data not available above 740 TAF; elevation corresponding to 800 TAF extrapolated.
[2] Yokohl Valley Reservoir would not impact any existing hydropower facilities.

Cost Estimates

Table 6-20 summarizes construction costs for the Yokohl Valley Reservoir measures considered. Appurtenant features included with the cost of the dam are a spillway, diversion during construction, outlet works, pumping-generating plant, and conveyance between the Friant Kern Canal and reservoir. Costs for relocation of Yokohl Drive and power transmission lines are listed separately.

Construction costs for Yokohl Valley Dam and appurtenant features for a 450 TAF reservoir are based on a 1975 design and cost estimate, revised to reflect current price levels. The index-adjusted cost estimate shown in **Table 6-20** is likely low because the 1975 design would not conform to current design standards.

Reservoir area lands are privately owned and would need to be acquired. An estimate of these acquisition costs is included in the construction cost shown for the dam and appurtenances, along with an allowance of approximately 20 percent of the property costs for indirect costs associated with property acquisition transactions.

TABLE 6-20.
CONSTRUCTION COSTS FOR YOKOHL VALLEY RESERVOIR MEASURES
($ MILLION)

Gross Pool Elevation (feet above msl)	**790**
New Storage Capacity (TAF)	**450**
Components	
Dam, Appurtenant Features, Reservoir Lands[1]	400
Yokohl Drive Relocation	56
Transmission Lines Relocation	12
Construction Cost [2,3,4,5]	**468**

Key:
msl – mean sea level
TAF – thousand acre-feet
Notes:

[1] Appurtenant features include spillway, diversion during construction, outlet works, pumping-generating plant, and conveyance between the Friant Kern Canal and the reservoir.

[2] Costs for the 450 TAF size are based on an index-adjusted cost estimate prepared in 1975 and are likely low because design features do not include current standards.

[3] Costs for the 800 TAF size have not been estimated.

[4] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design and construction management, estimated at 25 percent of field costs.

[5] Costs do not include environmental mitigation or potential recreation facilities.

Environmental Considerations

A reservoir in Yokohl Valley may result in impacts to vegetation, wildlife, and cultural resources. Yokohl Creek, from its headwaters to the Friant-Kern Canal, potentially may be affected by a Yokohl Valley reservoir. Yokohl Valley hosts a relatively well-developed mesic grassland habitat, with several special status plant and wildlife species potentially present, as described in **Chapter 3**. **Table 6-4** provides a sum of special status species potentially affected by a Yokohl Valley reservoir. The annual grassland, meadow, and oak woodland habitats found in Yokohl Valley, and vernal pools possibly present in the flatter valley bottoms, would be replaced by a reservoir supplied by the Friant-Kern Canal and supplemented by Yokohl Creek.

Numerous cultural resources, as described in **Chapter 3**, are known to be present in the area and may be affected by a Yokohl Valley reservoir. Mitigation strategies for inundation damage to archaeological sites could include recovery, indexing, and cataloging of artifacts. Further site investigations and research would be needed to evaluate the significance of environmental impacts and associated mitigation requirements for biological and cultural resources. Potential land use impacts would be relatively low, and anticipated to be mitigable. No recreational resources would be affected.

Recommendations for Further Study

Yokohl Valley Reservoir appears to be the least effective surface storage measure retained from Phase 1 of the Investigation. The new water supply from an 800 TAF Yokohl Valley Reservoir would be less than a Temperance Flat Reservoir, a raise of Friant Dam, or a Fine Gold Reservoir of comparable size because of conveyance restrictions along the Friant-Kern Canal.

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 warm to a greater extent than under without-project condition. This could decrease the potential for water released from Friant Dam to contribute to restoration of fish species that require cold water.

Because Yokohl Valley Reservoir would be shallower than any other comparably sized surface storage measure considered, it presents the highest potential for warming stored water and algae formation. The presence of algae in water supplies could adversely affect the ability of Friant contractors to beneficially irrigate or to exchange high-quality water with urban areas.

Public acceptance of the Yokohl Valley Reservoir measure is likely low with limited willingness of landowners in Yokohl Valley to participate. Yokohl Valley also is outside the area of study authorized by PL 108-361, 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, Yokohl Valley Reservoir is dropped from further consideration in the Investigation.

SURFACE WATER STORAGE MEASURES SUGGESTED DURING SCOPING

Most of the surface water storage measures retained from Phase 1 would result in a net loss in power generation. Five additional potential reservoir sites that would avoid adverse hydropower impacts were proposed by stakeholders after completion of Phase 1 and during the scoping process. This section describes the technical characteristics of the surface water storage measures suggested during scoping. The evaluation is based on a review of previous studies and preliminary technical evaluations completed after Phase 1.

Comments received during scoping from power utilities that own and operate hydropower projects in the upper San Joaquin River basin raised concerns about impacts of lost power generation and the ability of retained measures to develop adequate replacement power. They suggested surface storage measures not considered during Phase 1 that may provide water storage and new hydropower generation without adversely affecting existing hydropower facility operations. These measures include RM 315 Reservoir, Granite Project, and Jackass-Chiquito Project. All of these measures are located upstream of Redinger Lake. The scoping comments also suggested combining these upstream storage measures with a gravity diversion tunnel from Kerckhoff Lake to a Fine Gold Reservoir. Locations for the measures suggested during scoping are shown in **Figure 6-27**.

No new designs or cost estimates were prepared for these measures, which were not included in Phase 1 of the Investigation. Some preliminary water supply and hydropower simulations were completed for these measures, and where information was available, summaries of previous cost and hydropower studies are given in this chapter.

RM 315 Reservoir

A RM 315 Reservoir would be formed by a dam on the San Joaquin River at RM 315, about one mile upstream of the Mammoth Pool Powerhouse. A maximum pool at elevation 3,000 would correspond to a storage capacity of about 200 TAF, and the reservoir would extend upstream to the base of Mammoth Pool Dam. The dam would be approximately 620 feet high with a crest width of 1,700 feet. Preliminary designs and costs have not been developed for this dam. However, the dam height and crest length are similar to the RM 286 dam site at elevation 1,400 (capacity 1,360 TAF); thus, costs may be roughly equivalent. **Table 6-21** summarizes the dam height, gross pool elevation, and storage capacity for a RM 315 Reservoir.

Water that flows through a tunnel from Mammoth Pool Reservoir to the Mammoth Pool Powerhouse currently bypasses the RM 315 Reservoir area. The RM 315 Reservoir would be designed to capture spills from Mammoth Pool Reservoir, which occur in about 50 percent of the years. In many cases, spills from Mammoth Pool are captured in Millerton Lake downstream, and do not represent potential additional water supply that could be developed.

In addition to power that could be generated at a powerhouse at the RM 315 Dam, controlled releases from the RM 315 Reservoir also 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. These increments of additional generation have not been quantified. A RM 315 Reservoir would not adversely affect existing hydropower facilities.

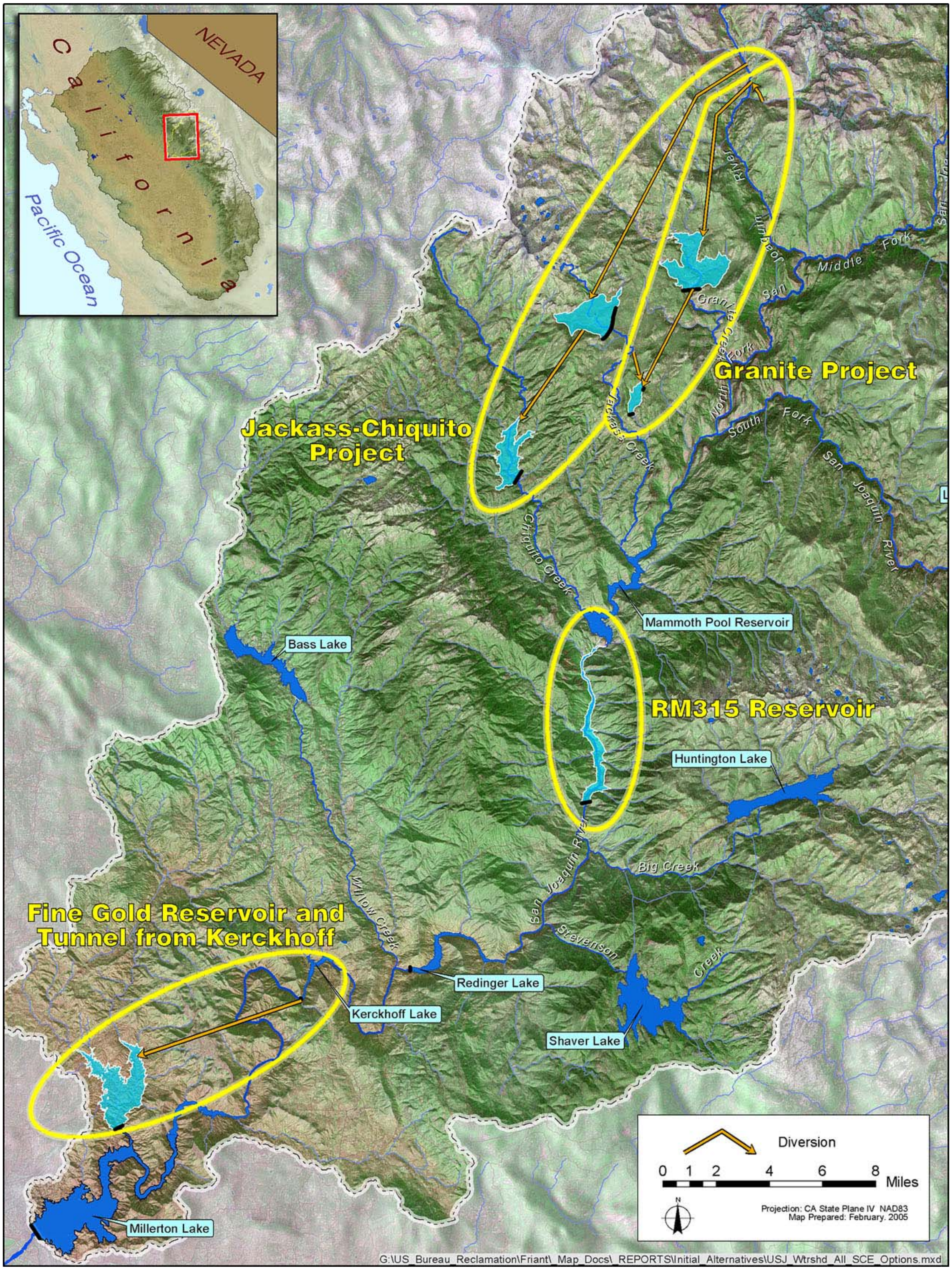


FIGURE 6-27.
SURFACE WATER STORAGE MEASURES SUGGESTED DURING SCOPING

**TABLE 6-21.
RM 315 RESERVOIR SUMMARY**

Storage Measure	Dam Height (feet)	Gross Pool Elevation (feet above msl)	New Storage Capacity (TAF)
RM 315 Reservoir [1]	620	3,000	200

Key:
msl – mean sea level
RM – river mile
TAF – thousand acre-feet
Note:
[1] The RM 315 Dam would be located at RM 315 on the San Joaquin River, just upstream from the Mammoth Pool Powerhouse. The RM 315 Reservoir would back up to just below the base of Mammoth Pool dam and would store Mammoth Pool Reservoir spills. No hydropower facilities would be impacted with this measure.

No previous studies have been done for this reservoir site; thus, the hydropower generation potential has not been previously quantified. A spreadsheet hydrologic analysis model that mimics CALSIM logic was used to establish preliminary numbers for new water supply from RM 315 Reservoir. The preliminary average annual water supply was estimated at approximately 40 TAF. Preliminary data from the hydrologic analysis were used in the hydropower spreadsheet. Potential average annual hydropower generation at the RM 315 powerhouse was estimated at about 14 GWh/year.

Recommendations for Further Study

The RM 315 Reservoir does not appear to be cost-effective as a water supply measure and will be dropped from further consideration in the Investigation. Construction costs would be comparable to those for a dam at the Temperance Flat RM 286 site to elevation 1,400 (capacity 1,360 TAF). However, this measure would provide only about 25 percent of the new water supply of a 1,360 TAF reservoir. Further consideration of this measure would require participation by a non-Federal sponsor with an interest in power development.

Granite Project

Granite Creek, Sierra National Forest
(Source: Yosemite-Madera County Film Commission)

The Granite Project would be located upstream of Mammoth Pool Reservoir on the west side of the basin. The project would include a major dam and storage reservoir on Granite Creek, a forebay dam and reservoir (Graveyard Meadow), 5 diversion dams (North Fork San Joaquin River, Iron Creek, Cora Creek, Chetwood Creek, and Jackass Creek), 2 powerhouses, 18 miles of pipeline and tunnel, and a pumping plant.

This project was originally studied as a hydroelectric project by the USJRWPA in the late 1970s and early 1980s. In contrast to a RM 315 Reservoir, which would capture spills from Mammoth Pool Reservoir, the Granite Project would capture inflow to Mammoth Pool Reservoir and would reduce spills. **Table 6-22** summarizes the dam height, gross pool elevation, and storage capacity for Granite Creek Reservoir and Graveyard Meadow Reservoir, the two storage components of the Granite Project.

TABLE 6-22.
GRANITE PROJECT SUMMARY

Storage Component of Granite Project[1]	Dam Height (feet)	Gross Pool Elevation (feet above msl)	New Storage Capacity (TAF)
Granite Creek Reservoir	355	7,020	105
Graveyard Meadow Reservoir	90	6,800	9

Key:
msl – mean sea level
TAF – thousand acre-feet
Notes:
[1] Previous studies proposed the Granite Hydroelectric Project as a hydropower project with two storage reservoirs, multiple diversion dams, several miles of tunnel, and two powerhouses. Not all of these facilities would necessarily be considered for development in this Investigation. Hydropower generation figures given in previous studies are only valid with all components in place and operated to maximize power generation, not necessarily water supply.

The California Wilderness Act of 1984 designated various lands in California as wilderness and as components of the National Wilderness Preservation System, including the Ansel Adams Wilderness, which is in the SNF in the northern portion of the upper San Joaquin River basin. The Act specifically allows for development of the Granite Creek Project or the Jackass-Chiquito Project (described in the next section), both of which would divert water from the North Fork of the San Joaquin River, which is within the Ansel Adams Wilderness Area. The Act states the following:

> …nothing in this title shall be construed to prejudice, alter, or affect in any way, any rights or claims of right to the diversion and use of waters from the North Fork of the San Joaquin River, or in any way to interfere with the construction, maintenance, repair, or operation of a hydroelectric project similar in scope to the Jackass-Chiquito hydroelectric power project (or the Granite Creek-Jackass alternative project) as initially proposed by the Upper San Joaquin River Water and Power Authority.

The main source of data available for this project comes from the document entitled Definitive Report: Granite Hydroelectric Project (USJRWPA, 1982b). The report includes preliminary cost estimates, designs, hydrology data, environmental data, and hydropower estimates. Hydropower estimates were derived from a project operation study with a monthly timestep and simulation period from 1922 to 1978. As estimated in the 1982 report, the project would generate an average annual energy of 489 GWh and would have a dependable capacity of 284 MW. The generation estimate does not include additional energy that could be generated at downstream powerhouses.

If a project in this area were planned for water supply, as opposed to the hydropower-focused project detailed in the 1982 report, the magnitude of hydropower generation would be much less due to greater fluctuations in storage reservoirs and likely changes in project configuration. A spreadsheet hydrologic analysis model that mimics CALSIM logic was used to establish preliminary numbers for new water supply from the Granite Project. The preliminary average annual water supply was estimated at approximately 23 TAF. Preliminary data from the hydrologic analysis were used in the hydropower spreadsheet. Potential average annual hydropower generation at the Granite Project was estimated at about 116 GWh/year. This represents a power generation reduction of about 75 percent due to operations for water supply.

Recommendations for Further Study

The Granite Project does not appear to be cost-effective as a water supply measure and will be dropped from further consideration in the Investigation. Cost estimates developed in the early 1980s indexed to 2004 would be comparable to those for a dam at the Temperance Flat RM 286 site to elevation 1,400 (capacity 1,360 TAF). However, this measure would provide only about 25 percent of the new water supply of a 1,360 TAF reservoir. Further consideration of this measure would require participation by a non-Federal sponsor with an interest in power development.

Jackass-Chiquito Project

The Jackass-Chiquito Project would be located upstream of Mammoth Pool Reservoir on the west side of the basin. It would use essentially the same sources of water as the Granite Project. The project would include a major dam and storage reservoir on Jackass Creek, a major dam and storage reservoir on Chiquito Creek, 5 diversion dams (North Fork San Joaquin River, Cora Creek, East Fork, Middle Fork, and West Fork of Granite Creek), 2 powerhouses, and 18 miles of pipeline and tunnel.

Jackass Creek northwest of Mammoth Pool Reservoir

This project was originally studied by USJRWPA as a hydroelectric project in the late 1970s and early 1980s as an alternative to the Granite Hydroelectric Project. **Table 6-23** summarizes the dam height, gross pool elevation, and storage capacity for Jackass Reservoir and Chiquito Reservoir, the two storage components of the Jackass-Chiquito Project.

TABLE 6-23.
JACKASS-CHIQUITO PROJECT SUMMARY

Storage Component of Jackass-Chiquito Project[1]	Dam Height (feet)	Gross Pool Elevation (feet above msl)	New Storage Capacity (TAF)
Chiquito Reservoir	227	5,013	80
Jackass Reservoir	160	7,070	100

Key:
msl – mean sea level
TAF – thousand acre-feet
Notes:
[1] Previous studies proposed the Jackass-Chiquito Hydroelectric Project as a hydropower project with two storage reservoirs, multiple diversion dams, several miles of tunnel, and two powerhouses. Not all of these facilities would necessarily be considered for development in this Investigation. Hydropower generation figures given in previous studies are only valid with all components in place and operated to maximize power generation, not necessarily water supply.

Very little data are available regarding the Jackass-Chiquito Project. The main source of data is from a 1984 Preliminary Permit Application to FERC (USJRWPA, 1984). This application contains a brief description of project facilities, but no designs, cost estimates, environmental data, or hydropower estimates. The Granite Hydroelectric Project Definitive Report (USJRWPA, 1982b) contains a comparison of various alternatives to the Granite Project, and reports that the Jackass-Chiquito Project would generate an average annual energy of 508 GWh, and would cost about 10 percent more than the Granite Project. The generation estimate does not include additional energy that could be generated at downstream powerhouses.

If a project in this area were planned for water supply, as opposed to the hydropower-focused project detailed in the 1984 preliminary application, the magnitude of hydropower generation would be much less due to greater fluctuations in storage reservoirs and likely changes in project configuration. A spreadsheet hydrologic analysis model that mimics CALSIM logic was used to establish preliminary numbers for new water supply from the Jackass-Chiquito Project. The preliminary average annual water supply was estimated at approximately 37 TAF. Potential average annual hydropower generation of the Jackass-Chiquito Project has not been estimated. The order of magnitude of generation from this project (operated for water supply) is assumed to be similar to the Granite Project.

Recommendations for Further Study

The Jackass-Chiquito Project does not appear to be cost-effective as a water supply measure and will be dropped from further consideration in the Investigation. Cost estimates developed in the early 1980s indexed to 2004 would be comparable to those for a dam at the Temperance Flat RM 286 site to elevation 1,400 (capacity 1,360 TAF). However, this measure would provide only about 25 percent of the new water supply of a 1,360 TAF reservoir. Further consideration of this measure would require participation by a non-Federal sponsor with an interest in power development.

Fine Gold Reservoir with Diversion from Kerckhoff Lake

Fine Gold Reservoir, as evaluated in Phase 1 and discussed earlier in this chapter, would be a pump-back project from Millerton Lake. Another configuration for Fine Gold Reservoir suggested during the scoping would involve constructing a tunnel to divert water by gravity from Kerckhoff Lake to Fine Gold Reservoir. The tunnel would be about 7 miles long and possibly 12 to 15 feet in diameter. Diverted water would consist of spills from upstream power projects.

A maximum storage capacity of 230 TAF could be served by a gravity-driven tunnel from Kerckhoff Lake assuming a minimum 10 feet of elevation drop to overcome tunnel head losses. Fine Gold Reservoir would have a gross pool at approximately elevation 960. Further study is needed to determine tunnel design parameters. No engineering studies have been performed for the tunnel route. Provisions for crossing the San Joaquin River (near RM 288), such as a siphon, would need to be considered in the tunnel design.

This measure could be operated in combination with one of the upstream storage measures proposed during scoping to increase the amount of water that could be regulated through the tunnel from Kerckhoff. Without additional upstream storage, the tunnel from Kerckhoff to Fine Gold would not be capable of capturing a large volume of water during flood events. With additional upstream storage, flood flows could be regulated into Fine Gold more effectively.

A spreadsheet hydrologic analysis model that applies the same logic as CALSIM was used to establish preliminary numbers for new water supply from a gravity-fed Fine Gold Reservoir in combination a RM 315 Reservoir with a new storage capacity of 200 TAF. As described in the previous sections, all three storage measures upstream of Redinger Lake suggested during scoping would have a cost similar to or greater than the Temperance Flat RM 286 measure with a new storage capacity of 1,360 TAF. The RM 315 Reservoir measure was used for this evaluation because it appeared to provide the greatest new water supply and be the least costly of the three upstream storage measures considered. The preliminary average annual water supply for Fine Gold Reservoir with a tunnel from Kerckhoff and a RM 315 Reservoir was estimated at approximately 80 TAF. Water supply operations data (dam releases and heads) were reviewed to assess the level of potential for hydropower development.

Neither configuration for Fine Gold Reservoir would impact existing hydropower facilities. A powerhouse could be located at Fine Gold Dam, with discharge directly into Millerton Lake. Water released from Fine Gold Reservoir would provide additional generation at the Friant Power Project by increasing controlled flows from Friant Dam. Hydropower evaluations assumed that the existing Friant Power Project units could continue to be operated.

Results from the preliminary water supply operations modeling indicate that releases from Fine Gold Dam would not be able to support cost-effective hydropower development. Fine Gold would store spills from upstream power projects, which would not be consistent, resulting in a wide variation of heads and intermittent releases occurring on average about 2 months per year. Some small amount of hydropower could be developed, but this measure does not appear cost-effective for development of hydropower facilities. Thus, units have not been sized for this measure and hydropower generation has not been specifically estimated. Hydropower generation at this site is assumed to be of a similar magnitude to potential generation at the RM 315 site.

This measure also could include a raise of Kerckhoff Dam by installing gates or raising the dam crest. The maximum likely elevation for a raise of Kerckhoff Dam would be limited to about elevation 1,000 to avoid impacts to the Big Creek No. 4 and Wishon powerhouses. Raising Kerckhoff Dam to elevation 1,000 would add about 810 acre-feet of new storage capacity. A Fine Gold Reservoir with a gross pool at elevation 990 would have a capacity of about 305 TAF. The Kerckhoff-Fine Gold tunnel also could be pressurized by pumping to Fine Gold for elevations above 1,000. Water would be pumped to a head of about 100 feet to reach a Fine Gold Reservoir storage of 800 TAF.

Table 6-24 summarizes the dam height, gross pool elevation, and storage capacity for Fine Gold Reservoir with diversion by gravity from Kerckhoff Lake. Information presented in **Table 6-24** assumes no raise of Kerckhoff Dam and a gravity tunnel only.

TABLE 6-24.
FINE GOLD RESERVOIR WITH DIVERSION FROM KERCKHOFF LAKE SUMMARY

Storage Measure	Dam Height (feet)	Gross Pool Elevation (feet above msl)	New Storage Capacity (TAF)
Fine Gold Reservoir (Gravity-Fed by Tunnel from Kerckhoff Lake)	440	960	230[1]

Key:
msl – mean sea level
TAF – thousand acre-feet
Notes:
[1] 230 TAF storage capacity is largest size that could be developed without pressurizing the diversion tunnel from Kerckhoff Lake to Fine Gold Reservoir or raising Kerckhoff Dam.

Recommendations for Further Study

Fine Gold Reservoir with a diversion from Kerckhoff Lake does not appear to be a cost-effective water supply measure as a stand-alone measure or in combination with additional upstream storage. By itself, the new water supply from this measure would be very low because of an inability to capture a large volume of water from upstream storage spills through a tunnel during flood events. If combined with development of additional upstream storage, such as the RM 315, Granite, or Jackass-Chiquito projects described above, the new water supply from this measure would increase, but costs and environmental impacts would rise dramatically. Therefore, Fine Gold Reservoir with a diversion from Kerckhoff Lake is dropped as a water supply measure in the Investigation. Further consideration of this measure would require participation by a non-Federal sponsor with an interest in power development.

GROUNDWATER STORAGE AND CONJUNCTIVE MANAGEMENT MEASURES

As described in **Chapter 3**, the Friant Division supports conjunctive management of surface water and groundwater supplies in the eastern San Joaquin Valley. Water deliveries under Class 2 contracts and Section 215 during wetter years reduce groundwater pumping and, in many locations, are used for groundwater recharge. In this manner, eastern San Joaquin Valley groundwater basins are used for water storage.

During Phase 1, many stakeholders suggested that the potential to develop and operate additional groundwater storage facilities should be considered as measures. In response, an approach to identifying potential groundwater storage and conjunctive management components of the Investigation was developed in coordination with DWR's Conjunctive Water Management Program and with stakeholder input.

The approach began with conducting a theoretical analysis to evaluate the potential for groundwater recharge and determine if groundwater storage was a measure that should be further considered. 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 outcome of this evaluation as presented in the Phase 1 Investigation Report suggested that groundwater storage may be possible to support Investigation purposes, but that specific facilities had not been identified. Following the completion of the theoretical analysis, DWR initiated a regional Conjunctive Management Opportunities Study (Study), which is being conducted in parallel with the Investigation. The objective of the Study is to identify potential conjunctive management projects and programs in the San Joaquin River and Tulare Lake hydrologic regions that could contribute to the overall CALFED Program objectives of water supply reliability, water quality, and ecosystem restoration.

The first phase of the Study identified the groundwater sub-basins in the San Joaquin Valley that possess the greatest potential for groundwater recharge, and assessed potential conjunctive management opportunities within these regions. Preliminary results from the first phase of the Study identified 12 potential projects.

Upon completion of the Study, the Investigation will review projects recommended in the Study for potential conjunctive management and groundwater storage measures. This will include an evaluation of the extent to which a project could contribute to Investigation objectives, either individually or in combination with surface water storage measures.

A set of evaluation criteria will be applied to assess the applicability of each recommended conjunctive management or groundwater storage project for inclusion as a measure in the Investigation. The following sections describe the current findings by the Study, and present criteria that will be used to evaluate recommended projects for application to the Investigation.

Groundwater Basins with Significant Potential for Development of Additional Conjunctive Management Actions and Projects

Most of the groundwater use in the San Joaquin and Tulare Lake hydrologic regions is within the San Joaquin Valley, which overlies the San Joaquin Valley groundwater basin (Basin). The Basin comprises 16 groundwater sub-basins, of which nine underlie the San Joaquin River hydrologic region and seven underlie the Tulare Lake hydrologic region (**Figure 3-4**). Groundwater is an important resource in the region, and accounts for approximately 35 percent of the total overall water supply.

Many groundwater recharge programs are already in place throughout the Basin, but these current efforts do not take full advantage of existing storage space in many sub-basins. Several of the sub-basins have either experienced significant overdraft and, as a result, have available aquifer storage space, or are naturally hydrogeologically situated for groundwater banking. As part of the Study, an initial evaluation of potential storage capacity was made using information presented in DWR Bulletin 118-03 (DWR, 2003b). On the basis of this review, six sub-basins were identified with the greatest potential for large-scale conjunctive management enhancement and development opportunities. The six sub-basins identified are the Eastern San Joaquin, Merced, Madera, Westside, Kings, and Kern County sub-basins.

Preliminary Projects Identified in the Conjunctive Management Opportunities Study

During preparation of the Study, DWR interviewed a broad array of stakeholders to identify conjunctive management concepts and projects for initial consideration. In general, all interviewed stakeholders were supportive of expanding conjunctive management opportunities in the region. During the initial screening process, over 100 projects and programmatic concepts were identified. Some projects are well defined with detailed information on water sources, required facilities, and operational objectives. Some projects are described as concepts that had been identified in previous studies of theoretical opportunities by others, but have not been sufficiently developed to identify specific project features. In addition to the defined and conceptual projects, stakeholders suggested programmatic concepts that would address institutional issues that may be limiting conjunctive management opportunities.

The projects and programmatic concepts were screened based on three types of criteria, including the following:

- Potential project water supply – Projects with the potential to provide the greatest new water supply were retained. No minimum water supply was established.
- Ability to provide multiple benefits – Projects that present the opportunity to address multiple local and regional needs and CALFED objectives were considered preferable to projects that provided limited benefits or served local needs only.
- Potential stakeholder acceptance and support – Projects with local support that satisfied the above criteria were retained to assure consistency with the CALFED solution principle that conjunctive management and groundwater storage projects be locally supported and controlled.

Through the application of the above criteria, 12 conjunctive management and groundwater storage projects were preliminarily identified for consideration. The locations of preliminary recommended projects listed below are shown in **Figure 6-28**.

- Eastern San Joaquin County Groundwater Bank
- Gravelly Ford
- Madera Ranch
- Merced Irrigation District Groundwater Banking
- Westlands Water District Conjunctive Use Water Management Project
- Waldron Banking Facility Expansion
- Raisin City Recharge
- Arvin-Edison Water Storage District Expansion
- Kern Water Bank Expansion
- Semitropic Water Bank Expansion
- Poso Creek
- Deer Creek Expansion

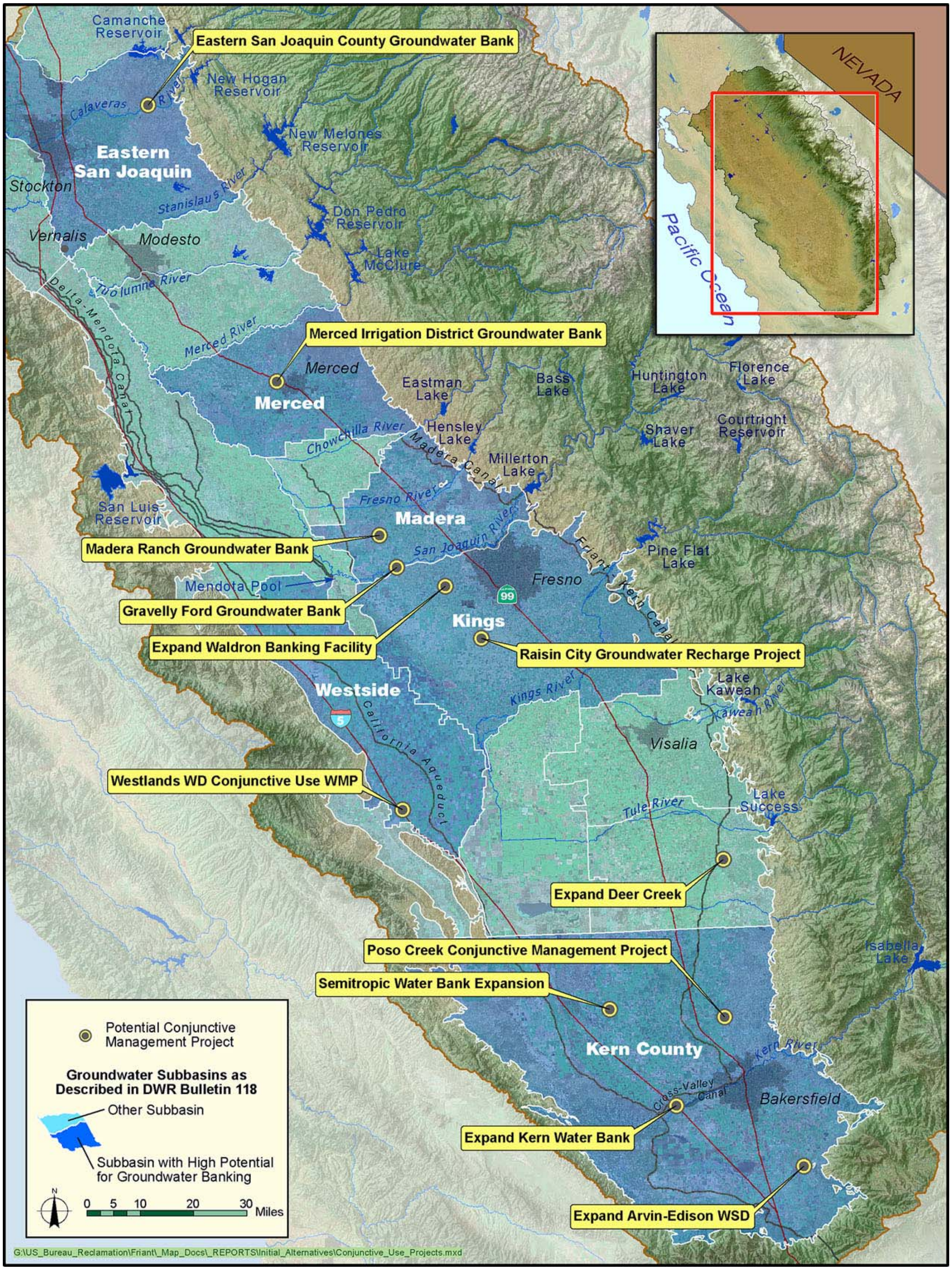


FIGURE 6-28.
POTENTIAL CONJUNCTIVE MANAGEMENT PROJECTS

Criteria to Be Applied in the Evaluation of Potential Projects

Conjunctive management projects recommended in the final Study report will be evaluated to determine if they are applicable for consideration in the Investigation. A set of hydrologic, physical, institutional, and legal criteria will be applied to identify how recommended projects could contribute to the purposes of the Investigation. Each project will be evaluated according to the following criteria and considerations:

- Increase water supply reliability – The potential projects selected for further consideration were initially identified with the principal objective of increasing local and regional water supply reliability. The quantity of increased supply for local and regional uses will be estimated.
- Geographic location – The location of a conjunctive management project in relation to the San Joaquin River downstream of Friant Dam could affect its ability to contribute to Investigation objectives. Projects located a significant distance from Friant Dam may require multiple linked institutional agreements for implementation.
- Cost – Some of the retained projects would include developing new infrastructure, including recharge and extraction facilities. Some projects also include or would require expanding regional conveyance facilities. Costs of conjunctive management projects will include all facility and operating costs.
- Reduce groundwater overdraft and subsidence – Many retained projects were formulated to reduce groundwater overdraft and reduce the rate of subsidence. The ability of a project to replenishment groundwater could be reduced if it is reformulated to support Investigation objectives.
- Improve groundwater quality – Some projects were formulated, in part, to address local and regional groundwater quality problems. The ability of a project to reduce groundwater quality problems while addressing Investigation objectives will be identified.
- Contribute to river releases for restoration and water quality – Some of the retained projects would derive water from multiple sources, including Millerton Lake. The evaluation will consider the extent that the project would make water available at Millerton Lake for river releases to contribute to restoration and improve river water quality
- Contribute to other local and regional benefits – Some of the retained projects have the potential to contribute to other local and regional objectives, including developing upland, riparian, and wetland habitat.
- Reduce local flooding – Although no retained projects were formulated specifically to reduce local flooding, some projects could provide local flood protection benefits.
- Stakeholder acceptance and support – Consistent with CALFED solution principles, each retained project will be reviewed to identify the level of stakeholder acceptance and support.
- Local control – Retained projects that have the ability to contribute to meeting Investigation objectives would be included in project alternatives only if a local entity is identified that would be responsible for development and control of the project.

FLOOD DAMAGE REDUCTION MEASURES

Friant Dam – January 1997 Flood Release

Additional storage in the upper San Joaquin River basin could provide opportunities to increase flood protection to areas downstream of Friant Dam. As described in **Chapter 5**, increased flood control is a secondary planning objective of the Investigation and therefore will not be the focus of plan formulation. Opportunities for additional flood protection will be considered, however, to the extent they can be implemented consistent with plans that address the primary planning objectives.

Several measures were identified that could reduce flood damages along the San Joaquin River. These include increasing the dedicated flood management space and operating the new space to existing or modified objective flood releases from Friant Dam, strengthening levees or otherwise increasing the flood carrying capacity of floodways downstream of Friant Dam, and modifying or removing damageable property in the floodplain. Only measures that would increase flood management space or modify objective flows from Friant Dam were considered because they would be directly related to changes in total available storage.

Potential flood damage reduction benefits are identified as changes in expected annual damages (EAD) that would result from flooding. Evaluations were completed using hydrologic, hydraulic, and economic models and data developed by the Corps and The Reclamation Board of the State of California for the 2002 Comprehensive Study. These models are based on a system-wide approach that considers the combined effect of equally probable storm events located at various locations in the San Joaquin Valley. The models consider the combined effects of flood flows on all major river systems. Additional information on flood damage reduction evaluations can be found in the **Flood Damage Reduction TA**. This section describes preliminary evaluations of the potential changes in flood damages that could result from increasing dedicated flood management space at Friant Dam and operating the space under existing and reduced objective releases.

Development of new storage, either through raising Friant Dam or implementation of other surface water storage measures, could trigger a change to the Corps Water Control Manual for Friant Dam. Changes could include descriptions of how existing flood management objectives would be attained with a new or modified storage facility. They also could include the establishment of changes in dedicated flood management space or objective flood releases from Friant Dam.

Additional Flood Management Space – Existing Objective Releases

A series of model evaluations were completed with various amounts of increased dedicated flood management space at Friant Dam. All simulations assume water conservation storage space is at capacity at the beginning of each flood event, therefore only the dedicated flood management space would be available. The evaluations assumed the flood management space would be increased from the current level of 170 TAF to a maximum of 500 TAF. The enlarged space would be subject to the same seasonal flood management rules as the current space. Four increments of additional flood management space were evaluated, as summarized in **Table 6-25**. The results in **Table 6-25** show that additional flood management space could reduce EAD by up to 13 percent.

TABLE 6-25.
EVALUATIONS OF ADDITIONAL FLOOD MANAGEMENT SPACE

Evaluation	Total Flood Space (TAF)	Existing Objective Release (cfs)	Total Expected Annual Damages ($1,000)[1]	Change in Expected Annual Damages ($1,000)[1]
Without-Project	170	8,000	29,010	---
Existing Objective Release 40 TAF Additional Flood Space	210	8,000	27,646	-1,364
Existing Objective Release 80 TAF Additional Flood Space	250	8,000	27,201	-1,809
Existing Objective Release 170 TAF Additional Flood Space	340	8,000	26,427	-2,583
Existing Objective Release 330 TAF Additional Flood Space	500	8,000	25,258	-3,752

Key:
cfs – cubic feet per second
TAF – thousand acre-feet

Notes:
[1] October 2001 prices.

Additional Flood Management Space – Reduced Objective Releases

A review of the results from the initial evaluations described above revealed that flood damages would result under nearly all flow conditions, including releases below the objective flow of 8,000 cfs. This is because the levees along the flood conveyance channels downstream of Friant Dam are subject to underseepage at flow rates at or below the current objective flow. On the basis of these findings, a series of model evaluations were completed with various amounts of increased dedicated flood management space and a reduction in the objective flood release at Friant Dam. These evaluations were completed to determine if reducing objective flows downstream of Friant Dam, in combination with additional dedicated flood storage space, would reduce flood damages and to determine how reducing objective flows would impact the effectiveness of additional dedicated flood management space.

All simulations assume water conservation storage space is at capacity at the beginning of each flood event, therefore only the dedicated flood management space would be available. The evaluations assumed the flood management space would be increased from the current level of 170 TAF to a maximum of 500 TAF, and that the objective flood release would be reduced from 8,000 cfs to 4,000 cfs. The enlarged space would be subject to the same seasonal flood management rules as the current space. Two increments of additional flood management space were evaluated in combination with a 50 percent reduction in objective release, as summarized in **Table 6-26**. The results in **Table 6-26** show that additional flood management space and reduction in objective release could reduce EAD by up to 18 percent. In particular, reduction in EAD would be greater for the 340 TAF flood space managed with reduced objective flows than a similar flood space operated at the current objective flows. Similar findings also apply for the 500 TAF flood space evaluations.

TABLE 6-26.
EVALUATIONS OF REDUCED OBJECTIVE FLOW WITH ADDITIONAL FLOOD MANAGEMENT SPACE

Evaluation	Total Flood Space (TAF)	Reduced Objective Release (cfs)	Total Expected Annual Damages ($1,000)[1]	Change in Expected Annual Damages ($1,000)[1]
Without-Project	170	8,000	29,010	---
Reduced Objective Release 170 TAF Additional Flood Space	340	4,000	24,503	-4,507
Reduced Objective Release 330 TAF Additional Flood Space	500	4,000	23,870	-5,140

Key:
cfs – cubic feet per second
TAF – thousand acre-feet

Notes:
[1] October 2001 prices.

CHAPTER 7. INITIAL ALTERNATIVES

This chapter describes components of initial alternatives that will be evaluated during the plan formulation stage of the Investigation. Initial alternatives will combine one or more storage measures with operations scenarios for the management and use of new water supplies. Because river restoration, river water quality, and exchange and conjunctive management actions have not been established, minimum accomplishments that each alternative must satisfy also have not yet been defined.

A two-step approach was used to screen surface water storage measures for inclusion in initial alternatives. The first step, described in **Chapter 6**, focused on characteristics of individual reservoir sites. The second step, described in this chapter, compares measures that provide similar amounts of new water supply based on construction cost, environmental impacts, hydropower facility impacts, and potential to develop replacement power generation capacity.

As plan formulation proceeds, it is anticipated that several restoration plans under development by others will be used to support the refinement, evaluation, and comparison of alternatives. Water quality operations evaluations made during plan formulation will provide information on the relationship between releases from Friant Dam to the San Joaquin River and downstream river water quality and guide the formulation of water quality operations objectives for each alternative. Operations approaches to support water quality exchanges with urban areas being developed by others will be used to the extent possible in formulating alternatives. Information on operational aspects to support additional conjunctive management actions will be developed as conjunctive management and groundwater storage measures are further refined.

The first section of this chapter compares surface storage measures retained from **Chapter 6** that provide similar accomplishments in developing new water supplies. Through this comparison, measures are either retained for inclusion in initial alternatives or dropped from further consideration in the Investigation. The second section of this chapter describes initial water operations components based on scenarios that address river restoration, river water quality and enhanced conjunctive management and exchanges. It concludes with results from the initial operations scenarios applied to one reservoir size.

COMPARISON OF SURFACE WATER STORAGE MEASURES

In **Chapter 6**, surface water storage measures were described and evaluated for each site retained from Phase 1 and for sites suggested during scoping. At several potential reservoir locations, multiple sizes and configurations were considered to address a range of dam designs, heights, and replacement power options. On the basis of these evaluations, some sites were dropped from further consideration, thereby reducing the range of sizes to be considered at each retained site. In most cases, the range of sizes to be evaluated at each site was reduced because of significant changes in impacts to environmental resources and hydropower generation. **Table 7-1** summarizes the results from step one of measures screening that was documented in **Chapter 6**.

TABLE 7-1.
SUMMARY OF SURFACE WATER STORAGE MEASURES SCREENING – STEP 1

Surface Water Storage Measure	New Storage Capacity (TAF)	New Water Supply (TAF/year)	Status Following Site Evaluations[1]	Key Findings from Site Evaluations
Raise Friant Dam				
25-foot Raise	130	24	Retained	A raise greater than 60 feet would result in extensive residential relocation, significant power generation losses, and environmental impacts around Millerton Lake, along the San Joaquin River, and in the Fine Gold Creek watershed.
60-foot Raise	340	68	Retained	
140-foot Raise	920	146	Dropped	
Temperance Flat RM 274				
Elevation 800	460	88	Retained	Measures larger than 1,310 TAF storage capacity were dropped because the small incremental new water supply would be associated with significant additional impacts to power generation and environmental resources, and higher construction costs.
Elevation 865	725	122	Retained	
Elevation 985	1,310	165	Retained	
Elevation 1,100	2,110	197	Dropped	
Temperance Flat RM 279				
Elevation 900	450	86	Retained	Measures larger than 1,350 TAF storage capacity were dropped because the small incremental new water supply would be associated with significant additional impacts to environmental resources and higher construction costs.
Elevation 985	725	122	Retained	
Elevation 1,115	1,350	168	Retained	
Elevation 1,200	1,910	188	Dropped	
Elevation 1,300	2,740	215	Dropped	
Temperance Flat RM 286				
Elevation 1,200	460	88	Retained	No measures ranging from 460 to 1,360 TAF were dropped because large changes in incremental cost or impacts to hydropower and environmental resources were not evident in the evaluation.
Elevation 1,275	725	122	Retained	
Elevation 1,400	1,360	169	Retained	
Fine Gold Reservoir Measures				
Elevation 900	120	17	Dropped	The 120 TAF measure was dropped because it has a significantly higher unit cost than larger sizes of Fine Gold Reservoir.
Elevation 1,020	400	65	Retained	
Elevation 1,110	800	113	Retained	
Yokohl Valley Reservoir				
Elevation 790	450	60	Dropped	Yokohl Valley Reservoir is the least cost-effective surface storage measure retained from Phase 1 due to operational constraints and conveyance limitations along the Friant-Kern Canal.
Elevation 860	800	97	Dropped	
Storage Measures Suggested During Scoping				
Granite Project	114	23	Dropped	No storage measures suggested during scoping were found cost-effective as water supply measures. Further consideration would require participation by a non-Federal sponsor with an interest in power development.
Jackass-Chiquito Project	180	37	Dropped	
RM 315 Reservoir	200	40	Dropped	
Fine Gold Reservoir Elevation 960[2]	230	80	Dropped	

Key:
elevation – elevation in feet above mean sea level
RM – river mile
TAF – thousand acre-feet
Notes:
[1] Status following evaluation of surface water storage measures at a specific reservoir site.
[2] Fine Gold Reservoir at elevation 960 (230 TAF capacity) was evaluated in combination with RM 315 Reservoir at 200 TAF capacity and a gravity diversion tunnel from Kerckhoff Lake.

Step two in the screening compares surface water storage measures retained from **Chapter 6** and further reduces the number of measures to be included in initial alternatives. The comparison uses information presented in **Chapter 6** for measures retained from the step one screening. Retained measures could provide average annual new water supply ranging from less than 30 TAF/year to more than 200 TAF/year. To facilitate site-by-site comparison, storage measures are grouped and compared based on water supply ranges of 0 to 50 TAF/year, 50 to 100 TAF/year, 100 to 150 TAF/year, and greater than 150 TAF/year. **Tables 7-2** through **7-4** present results from comparisons of measures providing similar new water supply. The comparison considers, construction cost, potential environmental impacts, effects to existing hydropower generation, and potential to develop replacement power generation capacity.

New Water Supply Range of 0 to 50 TAF/year

Several surface water storage measures considered in this report could provide up to 50 TAF/year of new water supply. These include raising Friant Dam up to 25 feet, Fine Gold Reservoir with a capacity of 120 TAF, and the three storage measures upstream of Redinger Lake suggested during scoping – RM 315 Reservoir, Granite Project, and Jackass-Chiquito Project. As concluded in **Chapter 6**, Fine Gold Reservoir with a capacity of 120 TAF and all three upstream options were dropped from further consideration because of cost and environmental issues. Therefore, only one storage measure that provides less than 50 TAF/year of new water supply, a 25-foot raise of Friant Dam, was retained for further consideration in the formulation of initial alternatives.

As described previously, specific restoration and water quality objectives have not been established; therefore, the quantity of additional water releases from Friant Dam to support restoration has not been quantified. Preliminary estimates of seepage to groundwater at Gravelly Ford, however, suggest that annual losses associated with seasonal or year-round releases from Friant Dam could range from about 35 to 70 TAF/year. Therefore, it is anticipated that storage measures providing less than 50 TAF/year of new water supply would not be formulated as stand-alone storage components of alternatives, and would have to be combined with other storage measures to develop alternatives.

New Water Supply Range of 50 to 100 TAF/year

All six surface water storage sites retained from Phase 1 could be configured at sizes that would provide 50 to 100 TAF/year of new water supply. As described in **Chapter 6** and shown in **Table 7-1**, five of these sites were retained for comparison in this chapter. Key characteristics of the five surface storage measures that would provide new water supply in the range of 50 to 100 TAF/year are listed in **Table 7-2.**

Two measures identified in **Table 7-2**, a 60-foot raise of Friant Dam and Fine Gold Reservoir with a capacity of 400 TAF, would provide approximately 65 TAF/year of new water supply. A 60-foot raise of Friant Dam would adversely affect existing hydropower generation and, with the inclusion of replacement power features, would result in a loss of energy generation of about 43 GWh/year. Raising Friant Dam 60 feet would require acquisition of dozens of developed residential parcels and several undeveloped parcels zoned for residential development around Millerton Lake, would submerge portions of the Millerton Lake Caves system, and would inundate significant portions of the Fine Gold Creek ADMA.

TABLE 7-2.
STORAGE MEASURES PROVIDING 50 TO 100 TAF/YEAR

		Raise Friant Dam 60 feet	Fine Gold Reservoir	Temperance Flat RM 274[1]	Temperance Flat RM 279[1, 2]		Temperance Flat RM 286[1, 2]	
Capacity and Water Supply	New Storage Capacity (TAF)	340	400	460	450		460	
	Gross Pool Elevation (feet above mean sea level)	638	1,020	800	900		1,200	
	Average New Water Supply (TAF/year)	68	65	88	86		88	
Environmental	Number of Potentially Impacted Regulated Species	24	10	24	24		36	
	Inundation of Aquatic Diversity Management Area	Partial	Yes	No	No		No	
	No. Buildings/Structures Inundated (other than hydropower facilities)	109	10	6	6		0	
	Total Inundated Acres[3]	1,400	3,400	2,200	2,300		3,200	
Power	Affected Hydropower Facilities							
	Kerckhoff (38 MW)	No	No	Yes	Yes		Yes	
	Kerckhoff No. 2 (155 MW)	Yes	No	Yes	Yes		Yes	
	Wishon (20 MW)	No	No	No	No		Yes	
	Big Creek No. 4 (100 MW)	No	No	No	No		Yes	
	Potential Replacement Power Facilities	New 90 MW K2 PH, Additional 13 MW capacity at Friant	N/A[5]	Up to 80 MW PH at RM 274 Dam, Up to 20 MW PH at Kerckhoff Dam	Up to 120 MW PH at RM 279 Dam	Up to 120 MW PH on ext. K2 tunnel, 15 MW PH at RM 279 Dam	Up to 160 MW PH at RM 286 Dam, Replace Wishon and BC4 PHs	Up to 180 MW New K2 PH, Replace Wishon and BC4 PHs
	Lost Generation (GWh/year)[4]	-473	N/E[6]	-507	-507	-507	-981	-981
	New Generation (GWh/year)[5]	430	N/E[6]	N/E	N/E	N/E	N/E	N/E
	Net Generation (GWh/year)	-43	N/E[6]	N/E	N/E	N/E	N/E	N/E
	Construction Cost ($ Million)[3,7]	600	470	800	670	800	710	870
Key Findings		**High residential and environmental impacts**	**No power impacts, small residential impacts**	**Highest cost for similar environmental impacts and water supply**	**Highest potential for replacement power**		**Greatest power and environmental impacts**	
Result from Comparative Screening		**DROPPED**	**RETAINED**	**DROPPED**	**RETAINED**		**DROPPED**	

Key:
BC4 - Big Creek No. 4 PH
GWh – gigawatt hour
K2 - Kerckhoff No. 2 PH
MW – megawatt
N/A – not applicable
N/E – not evaluated
PH – powerhouse
RM – River mile
TAF – Thousand acre-feet

Notes:

1 Replacement hydropower evaluations were not performed for RM 274, RM 279, or RM 286 with a capacity of about 450 TAF. Unit sizes and cost for replacement power facilities estimated from 725 TAF reservoir sizes for each site.

2 The two sets of replacement power facilities, power generation values, and cost values for the RM 279 and RM 286 measures represent two different power replacement options. See Chapter 6 for more details.

3 Cost and acreage values have been rounded to two significant figures.

4 Lost generation represents the estimated average future without-project generation at the affected power generation facilities.

5 New generation represents the average generation at the potential replacement power facilities.

6 Fine Gold Reservoir would not impact any existing power facilities. More energy would be required for the pump-back than would be generated by releases through a new powerhouse at the base of Fine Gold Dam.

7 All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design, and construction management, estimated at 25 percent of field costs. Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

Fine Gold Reservoir with a storage capacity of about 400 TAF would not adversely affect existing hydropower generation, although it would require more energy for pumping than could be generated. Fine Gold Reservoir also would affect habitat in the Fine Gold Creek ADMA more significantly than a 60-foot raise of Friant Dam but would require acquisition of fewer developed properties. In consideration of these issues, a 60-foot raise of Friant Dam is dropped from further consideration and Fine Gold Reservoir at a capacity of about 400 TAF is retained for inclusion in initial alternatives.

Each of the three Temperance Flat measures with a storage capacity of about 460 TAF would provide approximately 85 TAF/year new water supply. Key distinctions between these measures relate to environmental impacts in areas upstream of Millerton Lake, impacts to existing power facilities, potential replacement power opportunities, and resulting project costs. Among the three measures, RM 286 would potentially affect the greatest number of regulated species and would have the most significant effect on existing hydropower generation. Although replacement power evaluations were not completed for the 460 TAF size configurations, it is expected that this measure would result in the greatest net loss of hydropower generation based on evaluations completed for larger sizes at these three sites. In comparison to the RM 274 and RM 279 sites, the RM 286 site with a capacity of 460 TAF would be more costly and more environmentally damaging, and therefore is dropped from further consideration.

The RM 274 and RM 279 sites with a capacity of about 460 TAF would result in similar environmental impacts. Both would inundate the reach of the San Joaquin River from Millerton Lake to Kerckhoff Dam, including the Millerton Lake Caves system, and RM 279 would create a deeper reservoir than RM 274. The RM 274 and RM 279 measures would both have similar adverse effects on hydropower generation; however, it may be possible to configure RM 279 to result in almost no net loss of generation (described later in this section, capacity of 725 TAF). RM 274 could not likely be configured to develop replacement power generation, would require dam construction in Millerton Lake and construction access through or near established residences around Millerton Lake, and would result in a reduction in the extent of Millerton Lake. On the basis of this comparison, RM 274 with a capacity of 460 TAF is dropped from further consideration, and RM 279 with a capacity of 450 TAF is retained for inclusion in initial alternatives.

It is anticipated that storage measures providing 50 to 100 TAF/year of new water supply would be combined with other storage or operational measures in formulating initial alternatives.

New Water Supply Range of 100 to 150 TAF/year

Five of the six storage sites retained from Phase 1 could be configured at sizes that would provide 100 to 150 TAF/year of new water supply. As described in **Chapter 6** and shown in **Table 7-1**, four of these sites were retained for comparison. Key characteristics of the four surface storage measures that would provide new water supply in the range of 100 to 150 TAF/year are listed in **Table 7-3.** All four measures identified in **Table 7-3**, Fine Gold Reservoir with a capacity of 800 TAF, and the three Temperance Flat measures each with a capacity of 725 TAF, would provide approximately 120 TAF/year new water supply.

TABLE 7-3.
STORAGE MEASURES PROVIDING 100 TO 150 TAF/YEAR

		Fine Gold Reservoir	**Temperance Flat RM 274**	**Temperance Flat RM 279[1]**		**Temperance Flat RM 286[1]**	
Capacity and Water Supply	New Storage Capacity (TAF)	800	725	725		725	
	Gross Pool Elevation (feet above mean sea level)	1,110	865	985		1,275	
	Average New Water Supply (TAF/year)	113	122	122		122	
Environmental	Number of Potentially Impacted Regulated Species	10	24	24		36	
	Inundation of Aquatic Diversity Management Area	Yes	No	No		No	
	No. Buildings/Structures Inundated (other than hydropower facilities)	10	6	6		0	
	Total Inundated Acres[2]	5,400	3,100	3,500		4,300	
Power	Affected Hydropower Facilities						
	Kerckhoff (38 MW)	No	Yes	Yes		Yes	
	Kerckhoff No. 2 (155 MW)	No	Yes	Yes		Yes	
	Wishon (20 MW)	No	No	No		Yes	
	Big Creek No. 4 (100 MW)	No	No	No		Yes	
	Potential Replacement Power Facilities	N/A[5]	80 MW PH at RM 274 Dam, 20 MW PH at Kerckhoff Dam	120 MW PH at RM 279 Dam	120 MW PH on ext. K2 tunnel, 15 MW PH at RM 279 Dam	160 MW PH at RM 286 Dam, Replace Wishon and BC4 PHs	New 180 MW K2 PH, Replace Wishon and BC4 PHs
	Lost Generation (GWh/year)[3]	-154[5]	-507	-507	-507	-981	-981
	New Generation (GWh/year)[4]	114[5]	332	386	484	729	859
	Net Generation (GWh/year)	-40[5]	-175	-121	-23	-252	-122
	Construction Cost ($ Million)[2,6]	640	890	870	1,000	790	980
Key Findings		**No impact to power generation**	**Greater power and environmental impacts than RM 279 site**	**Greatest potential to develop replacement power**		**Greatest power and environmental impacts of sites considered**	
Result from Comparative Screening		**RETAINED**	**DROPPED**	**RETAINED**		**DROPPED**	

Key:
BC4 - Big Creek No. 4 PH
GWh – gigawatt hour
K2 - Kerckhoff No. 2 PH
MW – megawatt
N/A – not applicable
PH – powerhouse
RM – River mile
TAF – Thousand acre-feet

Notes:
1 The two sets of replacement power facilities, power generation values, and cost values for the RM 279 and RM 286 measures represent two different power replacement options. See Chapter 6 for more details.
2 Cost and acreage values have been rounded to two significant figures.
3 Lost generation represents the estimated average future without-project generation at the affected power generation facilities.
4 New generation represents the average generation at the potential replacement power facilities.
5 Fine Gold Reservoir would not impact any existing power facilities. More energy would be required for the pump-back than would be generated by releases through a new powerhouse at the base of Fine Gold Dam.
6 All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design, and construction management, estimated at 25 percent of field costs. Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

In general, costs for water storage and replacement power features would be similar at all sites but net energy generation would vary considerably. As described earlier, only the RM 279 site has the potential to develop full replacement power to offset losses to existing generation. Both RM 274 and RM 286 at 725 TAF storage capacity would result in net losses of hydropower generation in the upper San Joaquin River basin. Fine Gold Reservoir would not adversely affect the operation of hydropower facilities in the region but would require power for pumping. Energy requirements for Fine Gold Reservoir would be significantly less than the net losses associated with RM 274 or RM 286 for this storage capacity range.

Environmental impacts associated with RM 274 would be similar to, but more extensive than, those resulting from RM 279 at the 725 TAF storage capacity. Both measures would inundate the Millerton Lake Caves system in Temperance Flat. Environmental impacts for RM 286 are expected to be more varied and extensive than those associated with RM 274 or RM 279. A RM 286 reservoir would affect a Critical Aquatic Refuge and USFS Backbone Creek RNA near Horseshoe Bend, four powerhouses and require the relocation of Powerhouse Road and bridge. Fine Gold Reservoir would adversely affect the Fine Gold ADMA. Development of suitable nearby mitigation sites for this measure could present a challenge and needs to be considered as the Investigation proceeds.

In consideration of cost, environmental impacts, potential for replacement hydropower and net power generation, the RM 274 at 725 TAF and the RM 286 at 725 TAF measures are dropped from further consideration. The Fine Gold Reservoir at 800 TAF and the RM 279 at 725 TAF measures are retained for inclusion in initial alternatives.

It is anticipated these storage measures could be formulated as stand-alone alternatives or combined with other storage or operational measures to develop initial alternatives.

New Water Supply Range Greater than 150 TAF/year

Each of the three Temperance Flat reservoir sites retained from Phase 1 could be configured at sizes that would provide greater than 150 TAF/year of new water supply, although the costs, effects on hydropower generation, and environmental impacts would vary considerably between the sites. As described in **Chapter 6**, the largest sizes retained for each of the Temperance Flat sites range from 1,310 TAF to 1,360 TAF, generally because of adverse impacts to existing hydropower generation facilities. Key characteristics of the surface storage measures that would provide new water supply in this range are listed in **Table 7-4**, and discussed below.

Comparing the three Temperance Flat measures with storage capacities ranging from 1,310 TAF to 1,360 TAF shows that construction costs for storage and replacement power features for RM 279 significantly exceed costs for similarly sized RM 274 and RM 286 measures. Although net power loss would be lower for the RM 279 measure it is unlikely that the additional cost compared to the RM 274 measure would be justified by the difference in net power loss. The RM 279 site also would have the greatest environmental impacts of the measures considered for this storage capacity because it would affect all of the Temperance Flat and Millerton Bottoms and Patterson Bend reaches and portions of the Horseshoe Bend reach. The Temperance Flat and Millerton Bottoms reach of the San Joaquin River includes the Millerton Lake Caves system. The Horseshoe Bend reach of the San Joaquin River includes a Critical Aquatic Refuge and USFS Backbone Creek RNA. It also would require the abandonment and replacement of four powerhouses and the relocation of Powerhouse Road and bridge over Kerckhoff Lake.

TABLE 7-4.
STORAGE MEASURES PROVIDING GREATER THAN 150 TAF/YEAR

		Temperance Flat RM 274	Temperance Flat RM 279[1]		Temperance Flat RM 286[1]	
Capacity and Water Supply	New Storage Capacity (TAF)	1,310	1,350		1,360	
	Gross Pool Elevation (feet above mean sea level)	985	1,115		1,400	
	Average New Water Supply (TAF/year)	165	168		169	
Environmental	Total Regulated Species Potentially Impacted	24	36		36	
	Inundation of Aquatic Diversity Management Area	No	No		No	
	No. Buildings/Structures Inundated (other than hydropower facilities)	6	7		0	
	Total Inundated Acres[2]	5,000	5,500		6,300	
Power	Affected Hydropower Facilities					
	Kerckhoff (38 MW)	Yes	Yes		Yes	
	Kerckhoff No. 2 (155 MW)	Yes	Yes		Yes	
	Wishon (20 MW)	No	Yes		Yes	
	Big Creek No. 4 (100 MW)	No	Yes		Yes	
	Potential Replacement Power Facilities	100 MW PH at RM 274 Dam	120 MW PH at RM 279 Dam, Replace Wishon, and BC4 PHs	120 MW PH on ext. K2 tunnel, 15 MW PH at RM 279 Dam, Replace Wishon, and BC4 PHs	180 MW PH at RM 286 Dam, Replace Wishon PH	New 200 MW K2 PH, Replace Wishon PH
	Lost Generation (GWh/year)[3]	-507	-981	-981	-981	-981
	New Generation (GWh/year)[4]	291	840	933	655	794
	Net Generation (GWh/year)	-216	-141	-48	-326	-187
	Construction Cost ($ Million)[2,5]	1,000	1,400	1,600	980	1,200
Key Findings		**Least cost and lowest environmental impact**	**Highest cost and environmental impacts**		**Greater power and environmental impacts than RM 274 site**	
Result from Comparative Screening		**RETAINED**	**DROPPED**		**DROPPED**	

Key:
BC4 - Big Creek No. 4 PH
GWh – gigawatt hour
K2 - Kerckhoff No. 2 PH
MW – megawatt
PH – powerhouse
RM – River mile
TAF – Thousand acre-feet

Notes:
[1] The two sets of replacement power facilities, power generation values, and cost values for the RM 279 and RM 286 measures represent two different power replacement options. See Chapter 6 for more details.
[2] Cost and acreage values have been rounded to two significant figures.
[3] Lost generation represents the estimated average future without-project generation at the affected power generation facilities.
[4] New generation represents the average generation at the potential replacement power facilities.
[5] All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design, and construction management, estimated at 25 percent of field costs. Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

In contrast, the RM 274 measure would affect the Patterson Bend reach of the San Joaquin River from Millerton Lake to Kerckhoff Dam, would affect two powerhouses, and would not affect the area around or upstream of Kerckhoff Lake. On the basis of this comparison, the RM 279 at 1,350 TAF measure is dropped from further consideration.

Further comparison of similarly sized RM 274 and RM 286 measures results in dropping the RM 286 measure with a capacity of 1,360 TAF because of environmental, cost, and replacement power considerations. The RM 286 measure at 1,360 TAF would affect the upper portion of Patterson Bend and the Horseshoe Bend reach to Redinger Dam, impacting four powerhouses and requiring the relocation of Powerhouse Road and bridge. The Horseshoe Bend reach of the San Joaquin River includes a Critical Aquatic Refuge and USFS Backbone Creek RNA.

Configurations at RM 286 would result in larger power losses or are more costly than similarly sized configurations at RM 274. For example, a configuration at RM 274 costing approximately $1 billion would result in a net power loss of about 216 GWh/year, whereas a configuration at RM 286 with similar cost ($980 million) would result in a significantly greater net power loss of about 326 GWh/year. The lowest net power loss configuration for the RM 286 measure, which results in a loss of 187 GWh/year would cost about $200 million more than the configuration at RM 274 that results in a net loss of 216 GW/year. It is unlikely that this difference in cost would be justified by such a small difference in additional power generation. On the basis of this comparison, the RM 286 measure with a capacity of 1,360 TAF is dropped from further consideration.

The RM 274 site with a storage capacity of about 1,310 TAF is the only measure retained in the water supply range greater than 150 TAF/year for inclusion in initial alternatives. It is anticipated that this measure could be considered as stand-alone alternative and may also be combined with other storage or operational measures to develop initial alternatives.

Surface Water Storage Measures Retained for Initial Alternatives

The two-step approach applied for screening surface water storage measures resulted in retaining six measures for inclusion initial alternatives. **Table 7-5** presents summary information about surface water storage measures retained for inclusion in initial alternatives. Retained surface storage measures range in size from 130 TAF (raise Friant Dam 25 feet) to about 1,310 TAF (Temperance Flat RM 274). These storage measures could provide average annual new water supply ranging from about 24 to 165 TAF/year and would have construction costs ranging from about $220 million to $1 billion. Construction costs are preliminary and do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation. As shown in **Table 7-5,** four retained surface water storage measures would affect the operation of existing hydropower facilities upstream of Millerton Lake.

TABLE 7-5.
SURFACE WATER STORAGE MEASURES IN INTIAL ALTERNATIVES

		Raise Friant Dam 25 feet	**Fine Gold Reservoir**		**Temperance Flat RM 274**	**Temperance Flat RM 279[1]**			
Capacity and Water Supply	New Storage Capacity (TAF)	130	400	800	1,310	450		725	
	Gross Pool Elevation (feet above mean sea level)	603	1,020	1,110	985	900		985	
	Average New Water Supply (TAF/year)[2]	24	65	113	165	86		122	
Environmental	Number of Potentially Impacted Regulated Species	24	10	10	24	24		24	
	Inundation of Aquatic Diversity Management Area	Yes	Yes	Yes	No	No		No	
	Total Inundated Acres[3]	870	3,400	5,400	5,000	2,300		3,500	
Power	Affected Hydropower Facilities								
	Kerckhoff (38 MW)	No	No	No	Yes	Yes		Yes	
	Kerckhoff No. 2 (155 MW)	Yes[4]	No	No	Yes	Yes		Yes	
	Wishon (20 MW)	No	No	No	No	No		No	
	Big Creek No. 4 (100 MW)	No	No	No	No	No		No	
	Potential Replacement Facilities	Additional 5 MW capacity at Friant	N/A[8]	N/A[8]	100 MW PH at RM 274 Dam	Up to 120 MW PH at RM 279 Dam[5]	Up to 120 MW PH on ext. K2 tunnel, 15 MW PH at RM 279 Dam[5]	120 MW PH at RM 279 Dam	120 MW PH on ext. K2 tunnel, 15 MW PH at RM 279 Dam
	Lost Generation (GWh/year)[6]	-32	N/E[8]	-154[8]	-507	-507	-507	-507	-507
	New Generation (GWh/year)[7]	32	N/E[8]	114[8]	291	N/E	N/E	386	484
	Net Generation (GWh/year)	0	N/E[8]	-40[8]	-216	N/E	N/E	-121	-23
	Construction Cost ($ Million)[3,9]	220	470	640	1,000	670	800	870	1,000

Key:
GWh – gigawatt hour
K2 - Kerckhoff No. 2 PH
MW – megawatt
N/A – not applicable
N/E – not evaluated
PH – powerhouse
RM – river mile
TAF – thousand acre-feet

Notes:
1 The two sets of replacement power facilities, power generation values, and cost values for the RM 279 measures represent different replacement power options. See Chapter 6 for more details.
2 New water supply is defined as the average annual supply that could be developed in excess of historic water deliveries from Friant Dam.
3 Cost and acreage values have been rounded to two significant figures.
4 Kerckhoff No. 2 powerhouse would remain operational with a 25-foot raise of Friant Dam. A concrete wall to protect K2 access would be constructed.
5 Replacement hydropower evaluations were not performed for RM 279 with a capacity of 450 TAF. Unit sizes estimated from 725 TAF reservoir size.
6 Lost generation represents the estimated average future without-project generation at the affected power generation facilities. For Fine Gold Reservoir, it represents energy to pump water from Millerton Lake.
7 New generation represents the average generation at the potential replacement power facilities.
8 Fine Gold Reservoir would not impact any existing power facilities. More energy would be required for pump-back than would be generated by releases through a new powerhouse at the base of Fine Gold Dam.
9 All cost estimates are preliminary. Construction cost represents the sum of field costs and indirect costs for planning, engineering, design, and construction management, estimated at 25 percent of field costs. Costs do not include environmental mitigation, new or relocated recreation facilities, acquisition of impacted power facilities, or compensation for lost future power generation.

WATER OPERATIONS FOR INITIAL ALTERNATIVES

Implementing any of the storage measures and operating the new water supply for release to the San Joaquin River or diversion to the Friant-Kern and Madera canals could cause significant changes in water management in the San Joaquin Valley. Significant effects could result in Friant Division canal delivery, San Joaquin River flow and water quality, project operations on tributaries to the San Joaquin River, New Melones Reservoir operations, South-of-Delta CVP and SWP deliveries, and Delta and upstream system operations. This section describes an approach to developing operations scenarios for inclusion in the initial alternatives. Detailed descriptions of preliminary operations scenario development and application described in this section are presented in the **Water Operations TA**.

Approach and Methodology

Water operations evaluations began during Phase 1 and continued through preparation of the IAIR. Two distinct evaluations were completed. These included single-purpose analyses to estimate available new water supplies as presented in the Phase 1 Investigation Report, and the development of operations scenarios focused on water supply allocation and reservoir storage rules. New water supply is defined as the average annual supply that could be developed in excess of historic water deliveries from Friant Dam.

Phase 1 Single-Purpose Analyses

Phase 1 evaluations focused only on estimating the amount of new water that could be developed with surface water and groundwater storage measures. Several reservoir sizes were evaluated using a series of single-purpose analyses focused on releasing water to support restoration, improving water quality, or increasing water supply reliability in the Friant Division. Results from Phase 1 single-purpose analyses were used to identify the new water supply of storage measures described in **Chapter 6**. A significant limitation of Phase 1 modeling was the application of a constraint that maintained average annual canal deliveries the same as for the without-project condition for each year type. The use of the constraint limited the opportunity to manage water supplies in a manner that could support new demands in all years. Phase 1 modeling did not consider downstream effects of releasing water from additional storage.

Development of Operations Scenarios for Initial Alternatives

Water operations evaluations completed during the preparation of the IAIR focused on developing new criteria for managing existing and new water supplies to support Investigation objectives through the operation of additional storage. Operations scenario development began by identifying decision points associated with managing an enlarged or new reservoir. An operational screening tool was developed to evaluate preliminary scenarios and to test the effectiveness of changing operational variables, such as allocation and reservoir storage rules, to meet the objectives of the scenarios. A three-step process was established to develop operations scenarios for initial alternatives:

Step 1 – Allocate Water Supplies at Friant Dam and Mendota Pool

This step was completed with the development and application of an operations screening model. The screening model was developed using data and logic from CALSIM to assure consistency with accepted models. The screening model was used to evaluate the effect of several operational decisions before the decision criteria would be implemented in CALSIM. Alternative reservoir carryover targets were established to cause changes in the year-to-year delivery of new water supply to the canals or river. Water supply allocation variables were established to support supply-dependent decisions on the allocation of water to new project purposes, such as river releases for restoration or water quality.

The operations screening model includes features to allow simulation of alternative patterns of releasing new water supply to the river, alternative patterns of delivering new water supply to the canals, alternative storage allocations for flood control, and alternative bypass requirements (if any) for water reaching Mendota Pool. Each of these features can be modified in combination with or independently of other features, providing flexibility in the development and evaluation of alternatives. A set of water operations scenarios was developed and evaluated during development of the screening model, as described in later sections in this chapter.

Step 2 – Estimate San Joaquin River Water Quality Effects

The next step in formulating and evaluating operations scenarios for initial alternatives involves estimating the effect of new water supplies on water quality in the San Joaquin River and southern Delta. Technical studies are under way to refine the hydrologic and water quality characteristics of CALSIM in river reaches between Friant Dam and the Delta. This step was not completed during preparation of the IAIR.

Step 3 – Identify System-Wide Responses

Following completion of a refined water quality estimation approach, the CALSIM model will be used to identify the extent of effects that releasing water from Friant Dam could have on water project operations in the Central Valley. Water released from Friant Dam that reaches Mendota Pool coincident with demands would be treated as an additional supply and thereby reduce the need for water from the DMC. Additional supplies at Mendota Pool could result in an alteration of west side operations. As described above, changes in water quality or quantity in the San Joaquin River could affect New Melones Reservoir operations or other San Joaquin River tributary operations, which in turn could affect inflow to the Delta. Changes in Delta pumping in response to increased San Joaquin River flow or reduced demands could affect storage conditions in CVP and SWP reservoirs. System-wide effects of alternatives will be evaluated following completion of the San Joaquin River water quality estimation.

Initial Water Operations Scenarios

Operations scenarios were defined and evaluated during preparation of the IAIR to aid in developing evaluation tools and to guide further development and evaluation of initial alternatives. Several operations scenarios were developed to illustrate a range of potential allocation strategies for the water supply developed by new storage. The objectives in formulating initial scenarios was to illustrate water allocation and management decisions, identify assumptions needed to describe water demands (e.g., restoration requirements), demonstrate an approach for year-to-year management of water supplies (carryover), and illustrate interdependencies between water management decisions.

All operations scenarios were developed and evaluated using a common set of assumptions regarding existing institutional conditions. These include the current contract and allocation structure for Class 1, Class 2, and Section 215 supplies, existing flood control rules, and existing minimum downstream riparian and contractual requirements (116.7 TAF). For scenarios that would release new water supplies to the San Joaquin River, a methodology was developed to maintain existing long-term basin supplies. New water supply available for river release was identified by comparing long-term average canal deliveries with new storage to the without-project canal deliveries. This approach can shift water deliveries from year to year, but does not result in reallocating existing supplies from Friant water users. All operations scenarios assume 1,400 TAF additional storage at Millerton Lake.

Operations scenarios were grouped into two themes, as summarized in **Table 7-6**. Four scenarios were developed that would provide water supply for river uses and two scenarios were developed that would provide water supply for canal uses. Operations scenarios are described in the following sections.

TABLE 7-6.
INITIAL WATER OPERATIONS SCENARIOS

San Joaquin River Supply Scenarios	
Scenario 1	Allocate new supply for San Joaquin River restoration, with Mendota Pool diversions
Scenario 2	Allocate new supply for San Joaquin River restoration, with Mendota Pool bypass flow
Scenario 3	Allocate new supply for San Joaquin River restoration, constant annual allocation
Scenario 4	Allocate new supply to improve San Joaquin River water quality
Canal Supply Scenarios	
Scenario 5	Allocate new supply for canal delivery
Scenario 6	Allocate new supply for canal delivery emphasizing multiyear reliability

Scenario 1 – Allocate New Supply for River Restoration with Mendota Pool Diversions

This scenario would allocate new water supply for additional releases to the San Joaquin River in excess of those required for existing riparian and contractual uses. The approach used to allocate additional water supplies for river releases is shown in **Figure 7-1**. Similar to the approach used in Phase 1, the monthly pattern for releases of additional supply from Friant Dam was based on the natural flow distribution of the San Joaquin River at Friant. Alternative patterns for distribution of supplemental releases may be described in restoration plans developed by others.

The annual allocation in this scenario is based on total annual water supply available with no provision for carryover storage other than the current minimum operating level of 130 TAF in Millerton Lake. Supplemental releases to the river would be made in all years, increasing in volume as water supply increases in wetter years. This water supply allocation approach may not result in a reliable annual water supply to support restoration of the San Joaquin River because little or no new supply would be available in dry years.

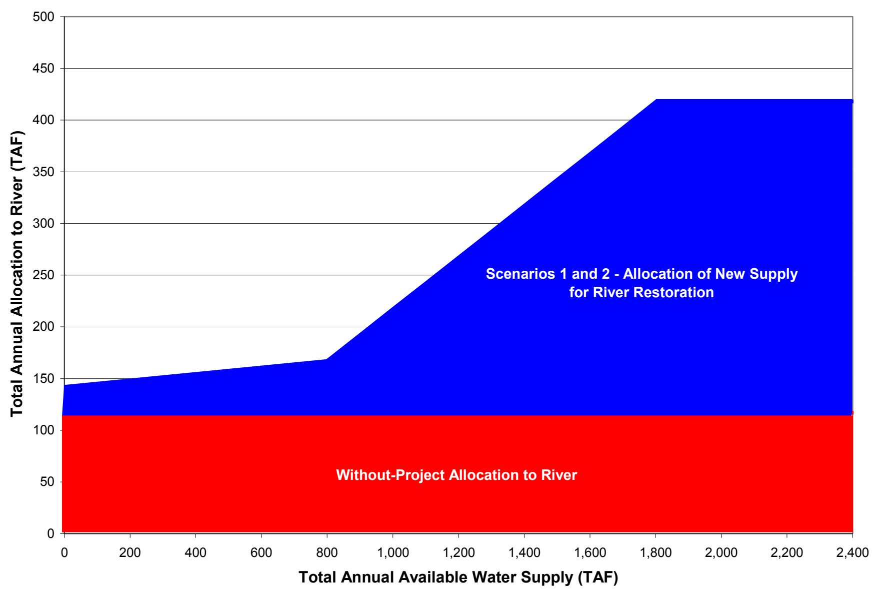


FIGURE 7-1.
SCENARIOS 1 AND 2 ALLOCATION RULES

In Scenario 1, supplemental releases made from Friant Dam to the San Joaquin River that reach Mendota Pool (after additional seepage losses) would be available for diversion at Mendota Pool. The screening model identifies the quantity of water that would be considered a new supply at Mendota Pool, thereby reducing the amount of water that would be delivered to Mendota Pool from the DMC. The effects to the remainder of the CVP or SWP were not evaluated, however any change that occurs would be considered an effect of releasing new supply from Friant Dam.

A model is being developed that will facilitate evaluation of changes to San Joaquin River water quality due to altering the source water to Mendota Pool. During the plan formulation stage, this tool will be applied and the potential benefits to water quality will be determined.

Scenario 2 – Allocate New Supply for River Restoration and Bypass Mendota Pool

Scenario 2 is a variation of Scenario 1, with only a change to the route of water downstream of Gravelly Ford. Similar to Scenario 1, supplemental water would be released to the San Joaquin River based on the water allocation and pattern assumptions described above, with no provision for carryover storage, other than the current minimum operating level of 130 TAF in Millerton Lake. In Scenario 2, it was assumed that the released water would not be available to offset deliveries from the DMC but would continue downstream of Mendota Pool. No site-specific assumptions were made regarding the manner in which water would flow past Mendota Pool and measures to allow bypass have not been considered.

Scenario 3 – Allocate New Supply for River Restoration with Constant Annual Allocation and Mendota Pool Diversions

In Scenario 3, a constant amount of new water supply would be released to the San Joaquin River each year. In the case of a 1,400 TAF reservoir, the long-term average new water supply would be about 175 TAF/year. To facilitate an annual supplemental water demand, a variable carryover storage target approach was used to assure that 175 TAF would be available for river release each year. The approach for allocating annual water supplies for river release for Scenario 3 is shown in **Figure 7-2** and the carryover storage target is shown in **Figure 7-3**. The use of carryover storage in Scenario 3 has the effect of reducing the average annual new water supply resulting from new storage, as compared to a scenario where all water supplies are allocated each year (Scenarios 1 and 2). Carried-over water would be available in dry years, thereby increasing dry year water supplies.

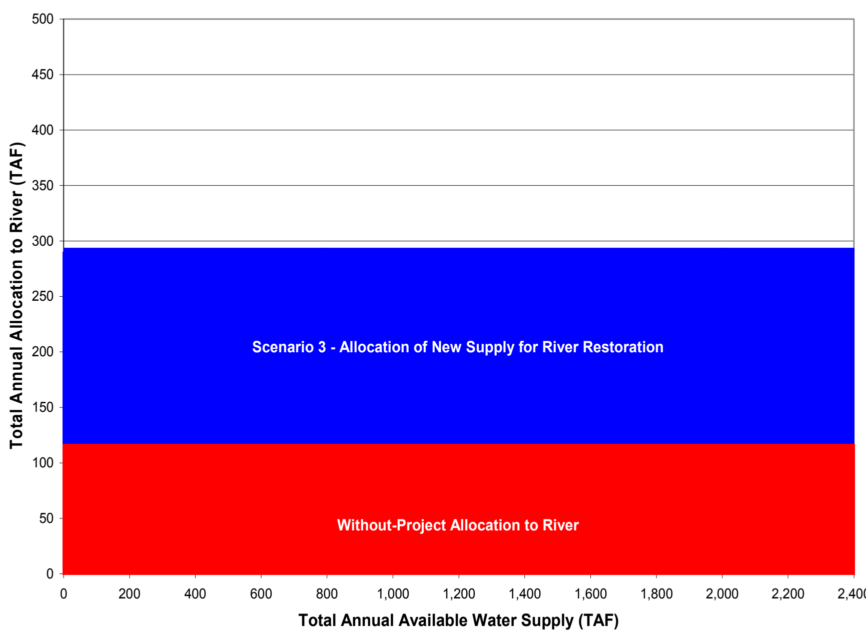


FIGURE 7-2.
SCENARIO 3 ALLOCATION RULES

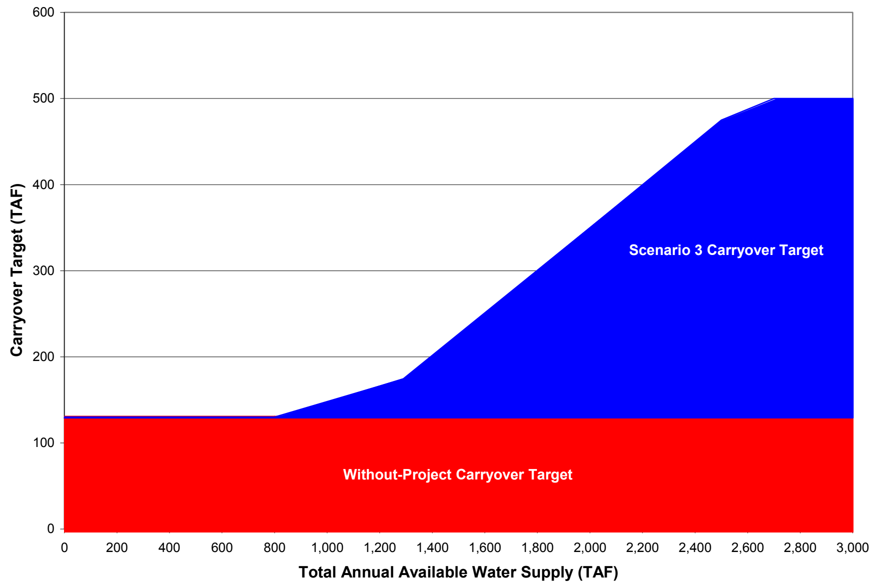


FIGURE 7-3.
SCENARIO 3 END-OF-SEPTEMBER CARRYOVER STORAGE TARGET

Scenario 4 – Allocate New Supply for River Water Quality Enhancement

Scenario 4 was developed to assess how water supplies from new storage could be released from Friant Dam specifically to improve San Joaquin River water quality. Carryover and allocation rules were used to emphasize the availability of new water supply in dry and below-normal years, when water quality problems are prevalent, as shown in **Figures 7-4** and **7-5**.

It should be noted that water quality responses have not been estimated because the model has not yet been developed. In dry years, water supply allocation for water quality would be low because of the limited availability of water supplies. A relatively low allocation in wet years was established based on an assumption that water quality problems are relatively minor in years when significant water supplies are available to the San Joaquin River from multiple tributary streams. By combining the allocation and carryover target rules, wet year water supplies are held in storage for use in subsequent years.

For this analysis, it is assumed that the monthly pattern of release of any volume of water quality allocation occurs evenly during the June through September period (irrigation pattern and presumed water quality concern season). This pattern may be revised as additional information is developed regarding water quality enhancement goals.

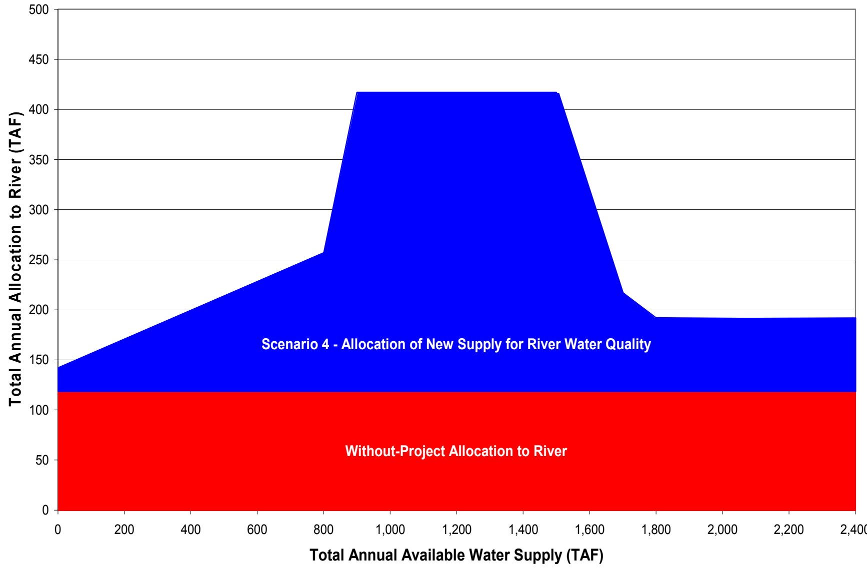


FIGURE 7-4.
SCENARIO 4 ALLOCATION RULES

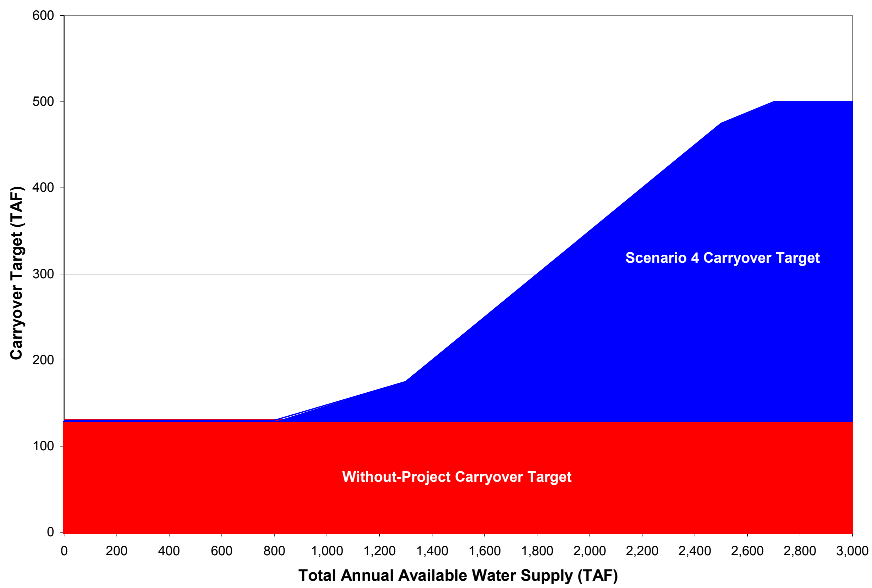


FIGURE 7-5.
SCENARIO 4 END-OF-SEPTEMBER CARRYOVER STORAGE TARGET

Scenario 5 – Allocate New Supply for Canal Delivery

This scenario represents an operation for which all new water supply would be allocated to the Friant-Kern and Madera canals similar to existing project operations, but with additional storage capacity. The existing annual water supply allocation procedure for Friant Dam is assumed, which establishes water deliveries based on the annual full drawdown of Millerton Lake. This operational objective would maximize the delivery of water supplies, only constrained by physical and contractual limitations inherent in current Friant contract deliveries.

Scenario 6 – Allocate New Supply for Canal Delivery Emphasizing Multiyear Reliability

This scenario represents a variation of Scenario 5 with all new water supplies allocated to the Friant-Kern and Madera canals, but managed to provide additional deliveries for longer duration, particularly during drier years. This is accomplished by applying a carryover storage target in the annual water delivery allocation procedure. **Figure 7-6** shows how the carryover storage target would be raised for this scenario as available water supplies increase. The use of carryover storage in this scenario would have a minimal effect on Class 1 deliveries during dry years because the carryover target was set to current minimum operating storage levels for years when the total available supply is less than 800 TAF.

During normal and wet years, additional water supply allocation would be less than in Scenario 5 because a portion of the water supply would be held in storage for use in subsequent years. Accordingly, the average annual new water supply resulting from new storage is less when carryover storage is in place, as compared to a scenario where all water supplies are allocated each year. The carried-over water would be available in dry years, thereby increasing dry year water supplies.

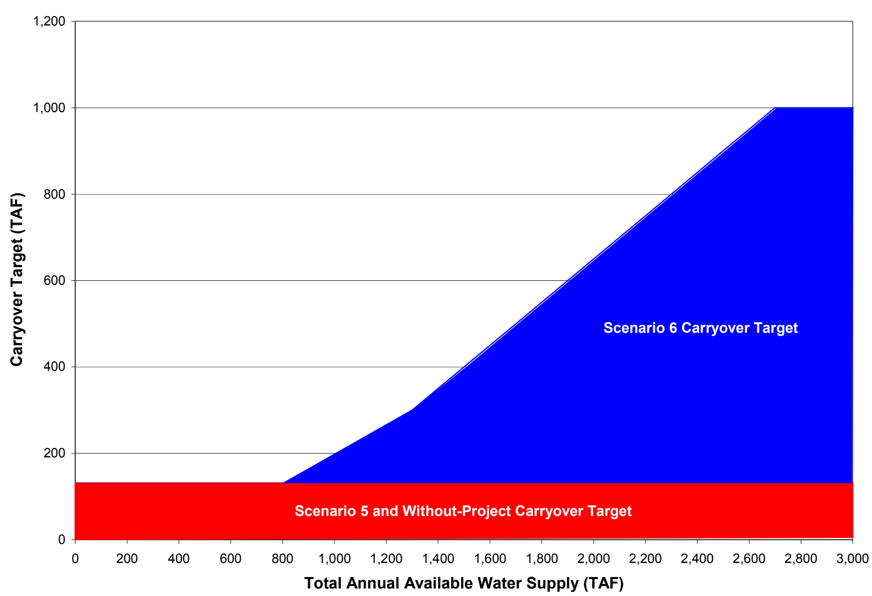


FIGURE 7-6.
SCENARIOS 5 AND 6 END-OF-SEPTEMBER CARRYOVER TARGETS

Results From Initial Operations Scenarios

The six operations scenarios described above were developed and evaluated using a screening tool based on the CALSIM model.. As the Investigation proceeds, the CALSIM model will be modified to include multiple purpose operations rules to support evaluation of the initial alternatives. Although the primary purpose of the analysis performed for the IAIR was identifying key decisions and assumptions to be included in the plan formulation stage of analysis, results also were derived. Preliminary results summarized in **Table 7-7.** provide a preview of the general magnitude of results that could be expected when alternatives are more thoroughly defined and analyzed.

Analyses and results presented in this section illustrate the range of water supply effects in relation to the different operational objectives represented in the scenarios. The initial operations scenarios and preliminary results are informational only and are not intended to represent the final set of operations rules or project accomplishments.

As described above, Scenarios 1 through 4 were designed to provide additional controlled releases to the San Joaquin River for restoration and water quality uses. Minor changes in canal diversions for these scenarios result from the modeling assumption to maintain average historical canal diversions, consistent with the planning constraint described in **Chapter 5**. These scenarios result in relatively minor differences in average river releases, but differ significantly in their ability to sustain releases over a series of years. Scenarios 3 and 4, which apply carryover rules to assure water supplies are available for release during dry years, result in lower average annual releases to the San Joaquin River than Scenarios 1 and 2, which do not include carryover provisions.

Scenario 5 results show that operating an additional 1,400 TAF of new storage under current water allocation rules could increase water deliveries by an average of about 165 TAF/year with a corresponding decrease in current flood control river releases. Comparing Scenarios 5 and 6 shows that increasing carryover storage in Millerton Lake would increase dry year water supplies but would reduce available active storage space, reduce the annual new water supply, and result in more flood control releases. For example, the average annual new water supply developed by Scenario 6, which includes carryover storage, would be about 25 percent lower than in Scenario 5 for a similar size reservoir but would provide more new water supply during dry years.

The six water operations scenarios will provide the basis for initial alternatives analysis as the Investigation proceeds. They will be applied to the retained storage measures, and will be modified as needed to evaluate the contribution of new storage to meeting specific restoration, water quality, or water supply reliability objectives, as plans developed through other studies become available.

TABLE 7-7.
PRELIMINARY RESULTS FROM INITIAL OPERATIONS SCENARIOS

	Operations Scenario[1] Difference from Without-Project Results (TAF)[2]					
	1	**2**	**3**	**4**	**5**	**6**
Operations Scenario Criteria						
Operating Objective	San Joaquin River Restoration			SJR Water Quality	Canal Delivery	
	Diversions at Mendota Pool	Flow Past Mendota Pool	Diversions at Mendota Pool	Diversions at Mendota Pool	Increase Annual Delivery	Increase Multiyear Reliability
Annual Water Supply Allocation	Variable		Constant	Variable		
Reservoir Carryover Storage Rule	Existing[3]		Proportional to Supply[4]		Existing[3]	Prop. to Supply[4]
Change in Friant Operations						
Total Canal Diversion	-1	-1	-1	0	+165	+128
Friant Class 1 Delivery[5]	-3	-3	-16	-12	+11	+34
Friant Class 2 Delivery[6]	+116	+116	+127	+119	+261	+187
Section 215 Delivery[7]	-114	-114	-112	-107	-107	-92
Friant Dedicated Release to SJR	+194	+194	+175	+161	0	0
Friant Spills to SJR	-198	-198	-183	-172	-174	-148
Total Friant Release to SJR	-4	-4	-8	-11	-174	-148
Change in San Joaquin River Flow and Operations						
SJR Flow to Mendota Pool	-44	-44	-51	-19	-162	-137
DMC Flow to Mendota Pool	-72	+45	-61	-97	+43	+39
SJR Flow Upstream from Merced River	-116	+1	-112	-117	-119	-98
Groundwater Recharge from Gravelly Ford to Merced River	Increase				Minor decrease from reduction in flood flow	
SJR Flood Flow at Vernalis	Decrease in all scenarios					
SJR Flow at Vernalis (non-flood periods)	No change	Potential increase	No change			
Effect on April/May SJR Flow w/o VAMP	Potential decrease	Potential decrease or increase	Potential decrease			

Key:
DMC – Delta-Mendota Canal
MP – Mendota Pool
SJR – San Joaquin River
TAF – thousand acre-feet
TDS – total dissolved solids
VAMP – Vernalis Adaptive Management Plan
w/o – without

Notes:

[1] All operations scenarios assume existing contracts, existing flood control operations, existing Friant minimum downstream riparian and contractual requirements (116.7 TAF), no reallocation of existing supplies, and 1,400 TAF additional storage.

[2] Results and scenarios are preliminary and will change in the future.

[3] The existing end-of-September carryover target is 130 TAF.

[4] End-of-September carryover target increases above existing target in proportion to supply when supply exceeds 800 TAF.

[5] Class 1 contracts are based on a firm water supply and represent the first 800 TAF of annual water supply delivered. These contracts are generally assigned to M&I and agricultural water users who have limited access to good-quality groundwater.

[6] Class 2 water is a supplemental supply and is delivered directly for agricultural use or for groundwater recharge, generally in areas that experience groundwater overdraft. Class 2 contractors typically have access to good-quality groundwater supplies and can use groundwater during periods of surface water deficiency.

[7] Section 215 water is defined under Section 215 of the Reclamation Reform Act of 1982 as unstorable irrigation water to be released because of flood control criteria or unmanaged flood flows.

CHAPTER 8. PUBLIC AND AGENCY INVOLVEMENT

The Investigation is addressing issues of interest and concern to stakeholders engaged in local and regional water resource planning and several Federal and State agencies with regulatory and management responsibilities related to natural resources in the study area. From the inception of Phase 1 in late 2001, the Investigation has maintained a very active public and agency involvement program that has included a wide range of activities. This chapter briefly describes public and agency involvement completed to date and describes how cooperating agencies will be involved as the Investigation proceeds in the Plan Formulation Phase.

PUBLIC INVOLVEMENT

A public involvement program for the Investigation was initiated at the beginning of Phase 1 that is designed to provide meaningful opportunities for stakeholder participation and to inform the public about the Investigation. Specifically, the public involvement program is designed to address issues of interest and concern to stakeholders engaged in local and regional water resource planning. The public involvement program will support Reclamation's efforts to work with all stakeholders to develop a community consensus alternative. To date, the public involvement program has been comprised of both interactive and outreach components, including the following:

- Structured series of interactive public meetings and workshops
- Briefings for governmental and nongovernmental agencies and coalitions
- Briefings for tribal representatives
- Coordination with local water resources planning and management groups
- Coordination with agencies
- Interviews with water management agency representatives
- Tours of Millerton Lake and portions of the upper San Joaquin River
- Distribution of informative brochures, fact sheets, and documents that provided background and updates on the Investigation's progress
- Distribution of Investigation documents via a Web site

The interactive components of the public involvement program focused on involving those with a stake in the outcome of the Investigation. Stakeholders in the Investigation study area bring a high level of experience and local knowledge to the process, and provided a variety of recommendations, responses, and reviews that likewise informed the plan formulation process. Outreach components are designed to provide information and materials to a broad group of interested parties. The outreach components disseminate information widely, bring additional stakeholders and interested parties to the process, and enhance coordination with related water resources planning and management groups.

Phase 1 Workshops

During Phase 1, a structured series of workshops and meetings were held at which participants had opportunities to hear presentations by the study team, take part in discussions regarding preliminary plan formulation, and provide input about the planning process, analyses, and project documents. This process included six general workshops and one topic-oriented working session. Workshop participants included representatives of water agencies, counties, State and Federal agencies, water districts, environmental interest groups, and others with an interest in the Investigation. The workshops, which were held in a variety of locations within the study area, and were announced via E-mail, mailed postcards, and the project Web site, were well attended. Each workshop included multiple interactive segments during which participants expressed their concerns, asked questions, and discussed issues central to the Investigation. The workshops are summarized briefly below.

Workshop 1 – Introduction

The first workshop, held in Fresno on May 29, 2002, initiated stakeholder participation in the Investigation. The workshop included presentations and discussions on Investigation purposes and a review of the origins and authorities for the study. The study team presented the Phase 1 approach and explained the types of water resources problems the Investigation would focus on during analyses. During a brainstorming session, participants described problems they wanted the study to address and noted special considerations for the planning process.

Workshop 2 – Approach and Options

Workshop 2, held on July 31, 2002, in Modesto, provided an overview of the study approach and clarified the goals of the Investigation. Participants commented on the approach for addressing water quality, ecosystem, and water supply reliability problems and discussed the initial analysis approach. During this workshop, participants identified a need for a separate discussion of Friant Dam release patterns to use in the initial evaluation of ecosystem restoration opportunities.

Working Session – Ecosystem Restoration Flows

A working session focused on Ecosystem Restoration Flows was held on September 4, 2002, in Madera. Participants provided recommendations on Friant Dam release patterns for inclusion in preliminary analyses to identify the quantity of new water that could be developed to support restoration. Participants suggested modeling a river flow release that was patterned after the unimpaired San Joaquin River hydrograph – an approach that was used in the Investigation.

Workshop 3 – Options

Workshop 3, held in Los Banos on October 18, 2002, updated participants on Investigation progress and presented preliminary results of option screening and model simulations. Participants were provided draft results of the initial Phase 1 surface storage option screening. A presentation and accompanying discussion centered on the Integrated Storage Investigation (ISI) Conjunctive Water Management Program and integration of conjunctive management in the Investigation.

Workshop 4 – Initial Phase 1 Results

The fourth workshop, held in Fresno on February 11, 2003, reviewed the overall Investigation approach and presented components and working status of the in-progress Phase 1 Investigation Report. The presentation covered a preliminary framework for comparing storage options, and discussions revisited the potential inclusion of conjunctive management options. Assumptions used for the model were presented along with preliminary results of the single-purpose analyses.

Workshop 5 – Appraisal Phase

At Workshop 5, held in Fresno on April 30, 2003, participants were informed that Congress had authorized Reclamation to prepare a feasibility study for new storage in the upper San Joaquin River basin. Screening results for initial surface storage options were reviewed and first cost estimates for retained sites were provided. Participant recommendations included requests for analyses of potential impacts to Millerton Lake residences and upstream hydropower projects.

Workshop 6 – Phase 1 Summary

Workshop 6, held in Modesto August 27, 2003, was the final workshop held during Phase 1. It included a review of all information developed during Phase 1 and a summary of surface storage options carried forward for further study. An update was provided on the formulation of potential groundwater storage options, which generated discussion and questions from several stakeholders. Participants were provided an overview of the feasibility study schedule and activities and encouraged to remain involved actively as the feasibility study continues.

Scoping Meetings

An environmental review process consistent with NEPA and CEQA was initiated in January 2004 when Reclamation issued an NOI and DWR issued a Notice of Preparation (NOP). During the week of March 15, 2004, Reclamation and DWR convened a set of public scoping meetings in Sacramento, Modesto, Friant, and Visalia, California, to inform interested groups and individuals about the Investigation and to solicit ideas and comments.

The scoping process allows stakeholders and interested parties to suggest potential issues that may require environmental review, reasonable alternatives to consider, and potential mitigation strategies to reduce or avoid significant adverse environmental impacts. Scoping also allows lead agencies to clearly set the parameters of the environmental review process by determining which issues will or will not be addressed and rationale for those determinations. Scoping also provides decision makers with insight on the analyses that the public believes should be considered as part of the decision-making process.

Scoping meetings were conducted in an "open house" format. Project team members from Reclamation and DWR and their consultants staffed informational displays and interacted with meeting participants to receive comments and answer questions. Participants provided comments on flip charts at each meeting and on comment cards provided by the project team. The opportunity for submitting additional written comments extended through April 16, 2004. A Scoping Report was prepared consistent with Reclamation guidance and in compliance with NEPA requirements and released in December 2004.

Public Meetings

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Interviews with Local Stakeholders

As part of the approach to identify and evaluate conjunctive management opportunities that have the potential to support Investigation purposes, Investigation staff conducted one-on-one interviews with local stakeholders regarding regional, cooperative opportunities for groundwater storage and banking. These interviews identified a high level of interest among the stakeholders. During the interviews, some possible projects were identified that will be considered for their applicability to support Investigation objectives. In addition, many stakeholders made note of significant physical and legal constraints that could affect implementation of conjunctive management options and suggested programmatic concepts to address institutional and financial barriers to increasing conjunctive management.

Study Area Tours

From the onset of the Investigation, staff members have participated in several tours of Millerton Lake, the upper San Joaquin River, and the Friant service area. With the exception of two tours of Millerton Lake that were organized by the Investigation, all other events were organized by other groups with an interest in regional water resources issues. During each tour, Investigation staff provided updates on Investigation status and recent technical findings. The tours provided interested parties a firsthand view of several of the surface storage sites under consideration, the San Joaquin River, and other features of interest in the eastern San Joaquin Valley. As the Investigation proceeds, staff will continue to participate in regional events that address water and other natural resources management issues to the extent possible.

AGENCY INVOLVEMENT

During Phase 1, the involvement of Federal, State, and regional agencies in the Investigation was considered informal. Agency representatives attended numerous public meetings and stakeholder workshops, and participated in tours. Following initiation of the NEPA/CEQA compliance process, a more formalized approach to agency coordination and participation was established.

Cooperating Agency Technical Teams

Several cooperating agency technical teams are being formed to focus on specific technical issues of importance in the Investigation. Reclamation is preparing agreements that identify roles, responsibilities and technical team assignments for each cooperating agency. Each technical team will have a defined set of objectives and will be responsible for development of specific deliverables for use in the Investigation.

Cooperating agency technical teams are being formed to address water operations, reservoir area environmental resources, river restoration, hydropower, flood damage reduction, engineering, economics, and conjunctive management. To date, only the engineering, water operations, and power technical groups have been established. The water operations technical group met on three occasions during preparation of the IAIR and provided input on operations scenario development and preliminary results. The water operations technical group also reviewed and provided comments on the draft **Water Operations TA**. The hydropower technical group met on two occasions during preparation of the IAIR to discuss assumptions on hydropower generation at existing facilities in the upper San Joaquin River Basin and to review preliminary results of replacement power generation options. The hydropower technical group reviewed and provided comments on a draft version of the **Hydropower TA**.

As the Investigation proceeds, involvement of other cooperating agency technical groups will become increasingly important. The reservoir area environmental resources group will provide an inventory of existing information related to biological, cultural, and social resources in the potential reservoir areas. These agencies will aid in developing impact analysis methodologies and will provide comments on the results of preliminary findings. The river restoration cooperating agency technical group will provide guidance on incorporating restoration plan information from other sources, aid in developing impact and benefit analysis methodologies, and review preliminary findings.

Coordination with Native American Representatives

Several tribes in the vicinity of Millerton Lake and elsewhere in the study area have expressed interest in the Investigation. Investigation representatives meet regularly with tribal representatives on an informal basis to provide updates on Investigation progress and to receive input on issues of concern to the tribes. Through completion of the IAIR, a total of six briefings and one field tour were held with tribal representatives. In general, tribal briefings coincide with public meetings at key Investigation milestones. As the Investigation proceeds, coordination will continue at the request of the tribes. Formal consultation will be initiated at the request of the tribes and will be conducted in accordance with Department of Interior guidance.

INFORMATIONAL MATERIALS AND DOCUMENT ACCESS

An Investigation Web site, hosted by Reclamation at http://www.usbr.gov/mp/sccao/storage, contains technical documents prepared for the Investigation to date, presentations used at public workshops and meetings, the Phase 1 Investigation Report, the IAIR and technical appendices, contact information for the study team, and a gateway for contacting the study team. The Web site has been a key feature in outreach efforts and will continue to be expanded as the Investigation proceeds.

CHAPTER 9. NEXT STEPS AND KEY ISSUES

The plan formulation stage will identify alternatives to be carried forward for detailed environmental review. The plan formulation approach will include technical evaluations to identify the beneficial and adverse effects of alternatives. A broader range of technical evaluations than those completed for the IAIR will be required to support evaluation, comparison, and refinement of initial alternatives. Analytical methods and tools to support evaluations of monetary and non-monetary benefits and impacts will be developed, cost estimates will be refined, operations scenarios will be applied, and initial alternatives will be refined and screened. Plan formulation will culminate with a set of complete alternatives that appear feasible in meeting the planning objectives.

This chapter includes two sections. The first describes technical studies and activities that will be completed during the plan formulation stage. The second section describes key issues that will need to be addressed during plan formulation and resolved prior to the completion of a final FR.

TECHNICAL STUDIES TO SUPPORT PLAN FORMULATION

Studies to support plan formulation will proceed in several key technical areas. As described in **Chapter 8**, technical teams are being established, each with a unique area of technical responsibility, comprising Reclamation, DWR, and cooperating agency staff that possess technical knowledge and skills to assist the Investigation. Technical teams include engineering, water operations, environmental resources, economics, conjunctive management, hydropower, and flood protection. Specific areas of focus for each technical team are described below.

Water Operations

Water operations results presented in the IAIR are based on preliminary evaluations that will be revised and expanded during the plan formulation stage. Estimates of new water supply for storage measures presented in **Chapter 6** are based on preliminary CALSIM simulations completed in Phase 1, which quantified the amount of new water supply that could be developed with additional storage. Operations scenarios described in **Chapter 7** were developed using an operations screening model to identify the range of operational decisions to be considered. As the Investigation proceeds, considerable additional work will be needed to evaluate potential uses of new water supplies and to identify project benefits. To support these needs, water operations evaluations initially will focus on the areas described below.

CALSIM Model Refinements

Several refinements will be made to the CALSIM model to incorporate operational criteria that will be developed and evaluated through use of the operations screening model. Model refinements will involve extending the hydrologic period through 2003 and better defining the interactions of hydrology and water quality upstream from the Merced River. Further refinements to methodology and assumptions will likely be identified during the plan formulation stage as guidance and comments are received from cooperating agencies, stakeholders, and interested participants, and as the breadth of analysis is better defined.

Water Quality Modeling

Evaluations during plan formulation will focus on how storage can be operated to contribute to restoration and improve water quality in the San Joaquin River. Water-quality-related models for river water quality, and reservoir and river water temperature will be required to support these evaluations.

San Joaquin River Water Quality

Using results from the hydrology development described above, representation of the San Joaquin River from Friant Dam to the Merced River will be disaggregated for calculating San Joaquin River water quality. Water quality attributes will be assigned to each hydrologic component and a linkage between source water and return flows will be established. This evaluation will rely on information from other studies, such as the Exchange Contractors' work in relating the quality of delivered water and resulting return flows and information collected by Reclamation and others during a sustained flood release from Friant Dam during spring 2005.

The CALSIM model will be modified to include water quality calculations for the reach from Mendota Pool to the Merced River. In addition, the CALSIM model will be used to identify the effects of changes in San Joaquin River flow and quality on the lower San Joaquin River near Vernalis. Reclamation is currently revising the CALSIM water quality module for the lower San Joaquin River in a separate study. It estimates water quality in the San Joaquin River upstream of the confluence of the Stanislaus River and simulates the operation of New Melones Reservoir to meet water quality standards in the San Joaquin River as it enters the Delta. The Investigation will utilize the most current versions of the models to identify water flow and quality effects to the Delta.

Reservoir and San Joaquin River Water Temperature

It is anticipated that some restoration plans will include water temperature requirements for releases from Friant Dam. Evaluating how storage can contribute to restoration will require developing and applying reservoir water temperature models for existing and potential expanded configurations of Millerton Lake, and for all other surface storage measures included in initial alternatives. Temperature evaluations also will be needed at key downstream locations in the San Joaquin River.

A river temperature model will be required that can estimate changes in water temperature along the river in response to releases from Friant Dam, losses, gains from local streams, inflow from the DMC, agricultural return flows, and ambient atmospheric conditions. Both the reservoir and river temperature models will be developed in close coordination with agencies and stakeholders, and will use information from other ongoing studies to the extent possible.

Development of Multiple-Purpose Operations Scenarios

Preliminary evaluations demonstrated that water allocated to a specified project purpose also could contribute to other purposes. As the investigation proceeds, scenarios will be developed to address multiple operational objectives rather than targeting single purposes.

Allocation and Storage Rules to Support Multiple Purposes

Developing multiple-purpose operations scenarios will require the addition of several key decision-making features to the CALSIM model. The scenarios will integrate a set of rules to guide allocation and reservoir storage levels based on a broad range of objectives that could include river restoration needs, reservoir water temperature, water delivery objectives, reservoir biological conditions, hydropower operations, flood management, and recreation. The screening model will continue to be used for this purpose as operations objectives for multiple purposes are developed. Information to guide reservoir operations in support of some of the possible operations objectives will be developed through the cooperating agency technical teams.

Project-Specific Operations

Integrated operations of proposed facilities with the existing system for various objectives will be evaluated. Proposed facilities will be integrated into the existing system and their unique characteristics will be reflected. Integrated operations will evaluate strategies to balance storage levels among facilities in a manner that maximizes the ability to meet project objectives.

Potential Downstream Recapture of Released Water

It is possible that water supply that could be developed with additional storage would not be sufficient to support the flow objectives of all restoration plans. The Investigation also may consider opportunities to release some currently allocated water supplies that could be recaptured at downstream locations, thereby increasing flows for restoration and potentially improving water quality in the San Joaquin River. Recapture provides an opportunity to convey all or a portion of the water released for restoration or water quality purposes to Friant Division water users. Downstream recapture will not be included in initial alternatives, but may be added to address specific restoration flow and water delivery objectives.

Environmental Resources Evaluations and Issues

Evaluation of initial alternatives will include more detailed descriptions of environmental effects. This will include potential impacts to environmental resources that would be affected by development of surface storage measures and potential beneficial or adverse effects in areas downstream from Friant Dam. Two cooperating agency technical teams will be formed to address these issues; one focused on reservoir area environmental resources, another on downstream environmental resources. Brief descriptions of initial areas of focus for these teams are described below.

Reservoir Area Environmental Resources

A preliminary summary of environmental resources in the potential reservoir areas, derived from readily available published information and comments received during scoping, is presented in **Chapter 3**. This information was used for preliminary comparisons of storage measures presented in the IAIR. As the Investigation proceeds, more detailed information will be needed to identify potential impacts to biological, cultural, and social resources, and to develop potential mitigation measures. In coordination with cooperating agencies, the Investigation team will develop an inventory of aquatic, botanic, wildlife, cultural, historic, and archeological resources in and around Millerton Lake upstream to Kerckhoff Lake, and the Fine Gold Creek watershed.

Impact assessment methodologies will be developed for each resource that will be based, in part, on output from water operations evaluations. Operations objectives to minimize adverse effects or provide desirable conditions for specific species will be developed and provided to the water operations team. Initial alternatives will be evaluated to identify the type and extent of changes that would affect species health and abundance, and potential impacts to cultural resources. Preliminary mitigation measures will be developed as the investigation proceeds.

Downstream Environmental Resources

As described in **Chapter 2**, restoration plans for the San Joaquin River are under various stages of development through other ongoing efforts. Although the Investigation is not developing a restoration plan for the San Joaquin River, alternatives will be evaluated, in part, based on their ability to support ecosystem restoration. It is expected that multiple plans will become available for consideration in the Investigation during the coming months. These plans will likely identify various flow and water temperature requirements for Friant Dam releases and potential physical modifications to the river system downstream of Friant Dam to achieve a specified level of ecosystem restoration.

Potential restoration strategies may range from targeting a resident fishery in a limited portion of the San Joaquin River to a naturally producing anadromous fishery from Friant Dam to the Delta. Evaluating the manner in which storage could contribute to various restoration plans will require development and application of additional models, such as reservoir and river temperature models, as described above.

The downstream environmental resources technical team will review restoration strategies and plans developed through other studies and will identify a range of specific operations objectives to be considered in the Investigation. Evaluation of preliminary alternatives will require development and application of hydraulic and temperature models and other analytical tools to identify the extent to which an alternative could support restoration objectives.

Based on the potential new water supply that could be developed with additional storage, as described in this report, it is likely that additional storage alone may not be adequate to fully support the needs of all possible restoration plans. It is likely that other actions would be needed to provide additional water supplies and implement potential modifications to river channels and structures that may be described in the restoration plans. The Investigation will identify the extent to which an alternative can contribute to a given restoration plan, but will not identify specific additional actions that would be included for a comprehensive restoration plan and water supply alternative. It is anticipated that each alternative will consider a range of operations to identify the manner in which the restoration plan could be most reliably supported with the development and management of additional water supplies in the upper San Joaquin Rive Basin. However, a mechanism for comprehensive evaluation, comparison, and decision-making regarding San Joaquin River restoration will be needed.

Ongoing litigation regarding potential releases from Friant Dam will continue during preparation of the PFR. The current assumption, that without-project conditions would be a continuation of existing operations, could be changed by judicial decision. Under such circumstances, plan formulation efforts would be modified to reflect the then-current without project conditions, and project objectives would be reviewed and revised as necessary.

Engineering

The engineering technical team will update designs and cost estimates for retained storage measures, as needed, to support evaluation of initial alternatives. Refinements will include enhancements of dam and associated infrastructure designs for specific elevations, establishing consistent levels of design for all features, and a common price level for all costs. All designs and cost estimates will be developed in accordance with Reclamation standards for feasibility studies. Initial work will focus on standardizing at a pre-feasibility level of detail. The level of detail will be increased as the number of alternatives is reduced during plan formulation. Feasibility-level cost estimates will be prepared for the preferred alternative when it is identified.

Hydropower Evaluations and Issues

Power generation results presented in the IAIR are considered preliminary and subject to change because of simplifying assumptions, including large time step and preliminary facility sizes considered in the analyses. Hydropower studies to be completed during plan formulation will address the affects of multiple-purpose water operations on hydropower generation, ancillary benefits of hydropower facilities, regional transmission, time-step refinement, and pumped storage opportunities for peak and off-peak conditions. These studies will require close coordination with PG&E and SCE to assure proper consideration of system effects associated with the loss of existing generating capabilities and to evaluate approaches to integrate new power generation with existing power systems.

As described in Chapter 6, several storage measures would result in significant impacts to the operation of existing hydropower generation facilities and include various options for the generation of replacement power. Project alternatives that include development of new hydroelectric generating facilities would likely require non-Federal partnership for the long-term operation of the facilities.

Flood Control Evaluations and Issues

As discussed in **Chapter 6**, development of additional storage provides opportunities for additional control of flood flows through the dedication of additional flood management space. Preliminary evaluations presented in the IAIR identified potential changes in flood damages that could result from increasing dedicated flood management space at Friant Dam and operating the space under existing and reduced objective releases.

Additional evaluations to be completed during plan formulation will address trade-offs between dedicated flood management space and new water supply. These evaluations will help refine the definition of flood management in the formulation of multiple-purpose alternatives.

The flood protection scenarios did not consider the potential incidental flood benefits that would accrue from enlarging storage with no change in dedicated storage space or objective releases. These benefits are likely significant in comparison to the additional benefits provided by enlarging dedicated storage or changing objective flows. A methodology to identify flood benefits that would result with no change in flood management space will be considered.

The flood protection evaluations also did not consider downstream channel modifications. Channel modifications to support restoration could involve relocating and strengthening levees, thereby increasing their ability to provide flood protection. Future studies will need to consider the flood protection effects that would result from channel and levee modifications to support ecosystem restoration.

Economics

Economic analyses will focus on developing and applying methodologies to estimate benefits of a broad range of monetary and non-monetary outputs. These outputs include water supply reliability, river restoration, improved river water quality, improved urban water quality, lost and replacement hydropower generation, flood damage reduction, and recreation. Issues to be considered will include seasonal and multiyear effects resulting from changes in the availability of water for irrigation, municipal, and environmental uses. Development of economic methods will be coordinated with the water operations, environmental resources, hydropower, and flood protection technical teams.

Groundwater Storage and Conjunctive Management

As described in **Chapter 6**, additional work is needed to develop specific conjunctive management and groundwater storage measures for inclusion in Investigation alternatives. Next steps will include a set of evaluations and more rigorous screening criteria. An analysis of surface water availability for use in conjunctive management projects will be performed as the next step in further evaluation of retained conjunctive management projects. The evaluation would include development and application of a screening model to determine which rivers (or combinations of rivers) have the greatest potential to supply water for conjunctive management projects that could support Investigation goals and objectives. Those with the greatest potential would be subjected to detailed modeling and analyses, including the application of water quality standards and Delta operating rules, to quantify the amount of surface water available.

Specific projects also will be evaluated for consideration in alternatives. Evaluation criteria will be developed to quantify additional water supply, estimate capital and annual project costs, identify specific institutional arrangements that would be required for implementation, and identify local entities that would implement the project to support Investigation objectives. Potential evaluation criteria are described in **Chapter 6**. Once specific groundwater storage and conjunctive management measures are selected for consideration in the Investigation, they will be combined with surface water storage measures in project alternatives.

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CHAPTER 12. GLOSSARY

This glossary was prepared to support the IAIR and includes terms used in this report and supporting appendices. It also includes commonly used terms that may be included in future Investigation documents.

A

Acre-foot—The volume of water necessary to cover 1 acre to a depth of 1 foot. Equal to 43,560 cubic feet, 325,851 gallons, or 1,233 cubic meters. Depending on location and lot size, an acre-foot is generally considered enough water to meet the needs of up to two California single-family households.

Affected environment—Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as a result of a proposed human action.

Afterbay—A pool of water at the base of a dam, specifically, water after it has passed through a turbine.

Air quality—Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances.

Alternative Plan—A complete plan that describes all necessary physical, operations, financial and institutional actions necessary to accomplish specific objectives. Alternative plans include a combination of measures and operating rules formulated to address primary study objectives. Alternative plans are commonly called alternatives.

Aluvium—Soil particles transported and deposited by water.

Anthropogenic—Human-created.

Anadromous—In general, this term refers to fish such as salmon or steelhead trout that hatch in fresh water, migrate to and mature in the ocean, and return to freshwater as adults to spawn. Section 3403(a) of the CVPIA defines anadromous as "those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean".

Anadromous Fish Restoration Program (AFRP)—A program authorized by the CVPIA to address anadromous fish resource issues in Central Valley streams that are tributary to the Delta. This program is lead by the United States Fish and Wildlife Service.

Applied Water (AW)—The quantity of water delivered to the intake of a city's water system or a farm headgate, the amount of water supplied to a marsh or other wetland, either directly or by incidental drainage flows.

Appropriative water rights—Water rights based upon the principle of prior appropriations, or "first in time, first in right."

Aquatic—Living or growing in or on the water.

Aquifer—A geological formation capable of producing and storing water.

Authorization—An act by the Congress of the United States which authorizes use of public funds to carry out a prescribed action.

B

Baseload—Most commonly referred to as baseload demand, this is the minimum amount of power that a utility or distribution company must make available to its customers, or the amount of power required to meet minimum demands based on reasonable expectations of customer requirements. Baseload values typically vary from hour to hour in most commercial and industrial areas.

Basin Irrigation Efficiency—Evapotranspiration of applied water divided by the net diversion.

Bay-Delta Plan Accord—In December 1994, representatives of the State and Federal governments and urban, agricultural, and environmental interests agreed to the implementation of a Bay-Delta protection plan through the SWRCB, to provide ecosystem protection for the Bay-Delta Estuary. The Draft Bay-Delta Water Control Plan, released in May 1995, superseded D-1485.

Beneficial use—Those uses of water as defined in the State of California Water Code (Chapter 10 of Part 2 of Division 2), including but not limited to agricultural, domestic, municipal, industrial, power generation, fish and wildlife, recreation, and mining.

Benthic—Bottom of rivers, lakes, or oceans; organisms that live on the bottom of water bodies.

Biological assessment—An evaluation, in accordance with Section 7 of the Endangered Species Act, to determine the potential presence of threatened or endangered species and the potential for a proposed action to affect its habitat.

Biological opinion—Document issued under the authority of the Endangered Species Act stating the United States Fish and Wildlife Service and/or the National Marine Fisheries Service finding as to whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat. This document may include:

Critical habitat—A description of the specific areas with physical or biological features essential to the conservation of a listed species and which may require special management considerations or protection. These areas have been legally designated via Federal Register notices.

Jeopardy opinion—The United States Fish and Wildlife Service or National Marine Fisheries Service opinion that an action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. The finding includes reasonable and prudent alternatives, if any.

No jeopardy opinion—U.S. Fish and Wildlife Service or NMFS finding that an action is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat.

C

CALFED—Joint Federal and State program to address water-related issues in the Delta of the Sacramento-San Joaquin rivers.

Candidate species—Plant or animal species not yet officially listed as threatened or endangered, but which is undergoing status review by the United States Fish and Wildlife Service or the National Marine Fisheries Service.

Carryover storage—Water remaining in storage at the end of the water year.

Catch—At a recreational fishery, refers to the number of fish captured.

Central Valley Habitat Joint Venture—As defined by Section 3403(c) of the CVPIA, "the association of Federal and State agencies and private parties established for the purpose of developing and implementing the North American Waterfowl Management Plan as it pertains to the Central Valley of California."

Central Valley Project (CVP)—As defined by Section 3403(d) of the CVPIA, "all Federal reclamation projects located within or diverting water from or to the watershed of the Sacramento and San Joaquin rivers and their tributaries as authorized by the Act of August 26, 1937 (50 Stat. 850) and all Acts amendatory or supplemental thereto ...."

Central Valley Project service area—As defined by Section 3403(e) of the CVPIA, "that area of the Central Valley and San Francisco Bay Area where water service has been expressly authorized pursuant to the various feasibility studies and consequent congressional authorizations for the Central Valley Project."

Central Valley Project water—As defined by Section 3403(f) of the CVPIA, "all water that is developed, diverted, stored, or delivered by the Secretary in accordance with the statutes authorizing the Central Valley Project in accordance with the terms and conditions of water rights acquired pursuant to California law".

Central Valley Project Water Service Contractor—Water users that have contracted with the United States Bureau of Reclamation for water developed by and conveyed through CVP facilities.

Channel—Natural or artificial watercourse, with a definite bed and banks to confine and conduct continuously or periodically flowing water.

Confined aquifer—An aquifer bounded above and below by confining layers of distinctly lower permeability than the aquifer itself.

Confluence—The flowing together of two or more streams; the place of meeting of two streams.

Conjunctive water management—The planned and managed operation of a groundwater basin and a surface storage system combined through a coordinated conveyance infrastructure to maximize the efficient use of surface and groundwater resources. **Conserved water—** That water resulting from the contractor operations and practices that results in less use of the allocated supply.

Conveyance capacity—The rate at which water can be transported by a canal, aqueduct, or ditch. In this document, conveyance capacity is generally measured in cubic feet per second.

Conveyance losses—Evaporation, evapotranspiration, and seepage losses in major conveyance canals.

Cooperating agency—An agency that meets the following criteria: (1) is included in 40 CFR Chapter V, Council on Environmental Quality (CEQ) Rules and Regulations, Appendix 1 - Federal and Federal-State agency National Environmental Policy Act (NEPA) contacts; and/or (2) has study area-wide jurisdiction by law or special expertise on environmental quality issues; (3) has been invited by the lead agency to participate as a cooperating agency; and (4) has made a commitment of resources (staff and/or funds) for regular attendance at meetings, participation in workgroups, in actual preparation of portions of the programmatic environmental impact statement (PEIS), and in providing review and comment on activities associated with the PEIS as it progresses. The role of the cooperating agency is documented in a formal memorandum of agreement with the lead agency.

Cost-of-service water rates—The water rate charged to recover all operating and capital costs, and individual contractor operating deficits, associated with the providing of water service. Components of operation and maintenance (O&M) and capital cost vary by contractor depending on services required for water delivery. Differs from full cost in that no charge for interest on capital is included.

Cubic feet per second—A measure of water flow. As a rate of streamflow, a cubic foot of water passing a reference section in 1 second of time. One cubic foot per second equals 0.0283 m^3/s (7.48 gallons per minute). One cubic foot per second flowing for 24 hours produces approximately 2 acre-feet of water.

D

Decision -1641 (D-1641)—The SWRCB decision specifying water quality standards for the Sacramento-San Joaquin Delta and Suisun Marsh.

Dedicated Water—Refers to the 800,000 acre feet of CVP yield identified in Section 3406(b)(2) of the CVPIA that the Secretary must dedicate and manage for the primary purpose of implementing the fish and wildlife purposes and measures of the act, to help California protect the Bay-Delta estuary, and to help meet legal obligations imposed on the CVP under State and Federal law, including the Federal Endangered Species Act (ESA).

Deep Percolation—Percolation of applied water and precipitation below the root zone of plants.

Deficiencies—Reductions in deliveries of contracted water. The amount of the reduction is expressed as the percent of full annual contract amount.

Delta—A low, nearly flat alluvial tract of land formed by deposits at or near the mouth of a river. In this report, delta usually refers to the delta formed by the Sacramento and San Joaquin rivers.

Density—The mass of a substance per unit of volume of that substance.

Depletion—Represents water consumed in a service area or no longer available as a source of supply.

Depletion study area—An analysis unit defined by the California Department of Water Resources for water resources planning investigations. Defined as the division of large drainage areas into smaller drainage and service areas from which water supplies and demands can be evaluated.

Dissolved oxygen (DO)—The concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation. DO levels are considered the most important and commonly employed measurement of water quality and indicator of a water body's ability to support desirable aquatic life.

Dry-farmed—Crop production without the use of irrigation.

E

Endangered species—Any species or subspecies of bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion of its range. Federally endangered species are officially designated by the United States Fish and Wildlife Service or the National Marine Fisheries Service and published in the Federal Register.

Endemism—Native or limited to a certain region (endemic).

Enhancement—Measures which develop or improve the quality or quantity of existing conditions or resources beyond a condition or level that would have occurred without an action (i.e., beyond compensation).

Entrainment—The drawing of fish and other aquatic organisms into water diversions.

Environmental consequences—The impacts to the affected environment that are expected from implementation of a given alternative.

Environmental Impact Statement (EIS)—An analysis required by the National Environmental Policy Act (NEPA) for all major Federal actions, which evaluates the environmental effects of alternative actions.

Ephemeral stream—Intermittent or seasonal flow.

Epilimnion—The upper, wind-mixed layer of a thermally stratified lake. This water is turbulently mixed throughout at least some portion of the day and because of its exposure, can freely exchange dissolved gases (such as O_2 and CO_2) with the atmosphere.

Escapement—Number of salmon that actually return to a stream to spawn.

Estuary—A water passage where the tide meets a river current; an arm of the sea at the lower end of a river.

Evaporation—The change of a substance from the solid or liquid phase to the gaseous (vapor) phase.

Evapotranspiration (ET)—Water evaporated from plant surfaces or transpired by plant tissues.

Evapotranspiration of Applied Water (ETAW)—Portion of the evapotranspiration provided by the applied water.

Exotic species—Any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem, and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

Extirpated species—A species that has become extinct in a given area.

F

Fallowed land—Cultivated land that lies idle during a growing season.

Feasibility Report—A report for consideration by Congress on the technical and financial feasibility of potential water resources project alternatives. For the Investigation, the Feasibility Report is being developed through several interim documents including the Initial Alternatives Information Report and a Plan Formulation Report.

Feasibility Study—A structured study to develop a Feasibility Report. Feasibility studies are initiated with congressional authorization to address specified objectives.

Field Irrigation Efficiency—The efficiency of water application. Computed by dividing the evapotranspiration of applied water by applied water and converting the result to a percentage. Efficiency may be computed at three levels: farm, district, or basin.

Fill—A man-made deposit of soil or other materials.

Fish ladders—A series of ascending pools constructed to enable salmon or other fish to swim upstream around or over a dam.

Fish passage facilities—Features of a dam that enable fish to move around, through, or over without harm. Generally an upstream fish ladder or a downstream bypass system.

Flow—The volume of water passing a given point per unit of time.

Instream flow requirements—Amount of water flowing through a stream course needed to sustain instream values.

Minimum flow—Lowest flow in a specified period of time.

Peak flow—Maximum instantaneous flow in a specified period of time.

Return flow—Portion of water previously diverted from a stream and subsequently returned to that stream or to another body of water.

Forebay – Water stored behind a dam, specifically, water intended to go through a turbine.

Fry—Life stage of fish between the egg and fingerling stages.

G

Geographic Information System (GIS)—A computer system which allows for input and manipulation of geographic data to allow researchers to manipulate, analyze and display the information in a map format.

Groundwater—Water stored below the ground surface.

Groundwater banking – Storage of water in the groundwater basin for later and planned use by intentionally recharging the basin.

Groundwater level—Refers to the water level in a well, and is defined as a measure of the hydraulic head in the aquifer system.

Groundwater management – The planned and coordinated management of a groundwater basin or portion of a groundwater basin with a long-term sustainability of the resource.

Groundwater overdraft—A condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years.

Groundwater pumping—Quantity of water extracted from groundwater storage.

Groundwater recharge – The natural or intentional infiltration of surface water into the zone of saturation.

Groundwater storage – The quantity of water in the zone of saturation.

Groundwater table—The upper surface of groundwater.

H

Habitat—Area where a plant or animal lives.

Hypolimnion—The bottom, and most dense layer of a stratified lake. It is typically the coldest layer in the summer and warmest in the winter. It is isolated from wind mixing and typically too dark for much plant photosynthesis to occur.

I

Indicator species—Organism, species, or community that indicates presence of certain environmental conditions.

Interest group—An agency or other entity that has expressed an interest, verbally or in writing, in becoming more involved in the development of a planned project.

Intermittent or seasonal stream—Stream on or in contact with the groundwater table that flows only at certain times of the year when the groundwater table is high.

Irrigation water—Water used primarily in the production of agricultural crops or livestock, including domestic use incidental thereto, and the watering of livestock. Irrigation water does not include water used for domestic uses such as the watering of landscaping or pasture for animals (e.g., horses) which are kept for personal enjoyment. It generally applies only to landholdings greater than 2 acres.

J

Juvenile—Young fish older than 1 year but not having reached reproductive age.

L

Land classification—An economic classification of variations in land reflecting its ability to sustain long-term agricultural production.

Land retirement—Permanent or long-term removal of land from agricultural production.

Level 2—A term used to refer to refuge water supply deliveries. The 1989 and 1992 Refuge Water Supply Studies define Level 2 refuge water supplies as the average amount of water the refuges received between 1974 and 1983.

Level 4—A term used to refer to refuge water supply deliveries. Level 4 refuge water supplies are defined in the 1989 and 1992 Refuge Water Supply Studies as the amount of water for full development of the refuges based on management goals developed in the 1980s. The CVPIA authorized purchase of the Level 4 increment, the difference between Level 2 and Level 4 amounts.

Limnology—Scientific study of the physical characteristics and biology of lakes, streams, and ponds.

Long-term contract—Contracts with terms of more than 10 years.

M

Main stem—The main course of a stream.

Measure—A structural or non-structural action that could address the planning objectives.

Mitigation—One or all of the following: (1) Avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating an impact over time by preservation and maintenance operations during the life of an action; and (5) compensating for an impact by replacing or providing substitute resources or environments.

Model—A tool used to mathematically represent a process that could be based on empirical or mathematical functions. Mathematical models can be computer programs, spreadsheets, or statistical analyses.

N

Natural production—As defined by Section 3403(h) of the CVPIA, "fish produced to adulthood without direct human intervention in the spawning, rearing, or migration processes."

Nonconsumptive water use—Water uses, including swimming, boating, waterskiing, fishing, maintenance of stream-related fish and wildlife habitat, hydropower generation, and other uses that do not substantially deplete water supplies.

Nonrecoverable Loss—Losses to salt sinks, or evaporation and evapotranspiration in conveyance and drainage canals. Expressed as a percentage of evapotranspiration of applied water.

O

Operating non-Federal entity—A non-Federal entity, such as a water district, that operates and maintains Federal facilities pursuant to an agreement with the United States.

P

Percolation—The downward movement of water through the soil to the groundwater table.

Perennial stream—Flows continuously throughout the year.

Place of use—The geographic area specified in a water right permit or license issued by the California State Water Resources Control Board, wherein the water may be used.

Point of diversion—The point along a river or stream that a water right permit or license specifies water may be diverted to areas away from the river.

Programmatic environmental impact statement—EIS prepared prior to a Federal agency's decision regarding a major program, plan, or policy. It is usually broad in scope and followed by subsequent more narrowly focused NEPA compliance documents such as site-specific environmental assessments and environmental impact statements.

Project repayment—The return to the Treasury of the reimbursable funds expended to construct, operate, maintain, and replace project facilities under the terms and conditions authorized by Congress plus other costs assigned by Congress.

Proposed action—Plan that a Federal agency intends to implement or undertake and which is the subject of an environmental analysis. Usually, but not always, the proposed action is the agency's preferred alternative for a project.

Public involvement—Process of obtaining citizen input into each stage of the development of planning documents. Required as a major input into any EIS.

R

Range—Geographic region in which a given plant or animal normally lives or grows.

Reasonableness criteria—Parameters established by the AFRP for determining the “reasonableness” of restoration actions. These parameters include consideration of potential adverse economic and social impacts, public sentiment, the magnitude of benefits, the certainty that an action will achieve projected benefits, and the authority established by existing laws and regulations.

Recharge—The processes of water reentering the voids in an aquifer, which causes the water table to rise in elevation.

Reclamation laws—As defined by Section 3403(I) of the CVPIA, “the Act of June 17, 1902 (82 Stat. 388) and all Acts amendatory thereof or supplemental thereto.”

Reclamation Reform Act—The Reclamation Reform Act of 1982 (Public Law 97-293, 96 Stat. 1263) was signed by the President on October 12, 1982. While retaining the basic principle of limiting the amount of owned land that may receive irrigation water deliveries from Reclamation projects, the Act introduced the concept of full-cost pricing (including interest on the unpaid plant investment) for certain irrigation water deliveries to leased lands.

Record of Decision (ROD)—Concise, public, legal document that identifies and publicly and officially discloses the responsible official's decision on the alternative selected for implementation. It is prepared following completion of an EIS.

Redd—Depression in river or lake bed dug by fish for the deposition of eggs.

Refuge Water Supply Report—As defined by Section 3403(j) of the CVPIA, "the report issued by the Mid-Pacific Region of the Bureau of Reclamation of the United States Department of the Interior entitled Report on Refuge Water Supply Investigations, Central Valley Hydrologic Basin, California (March 1989)."

Repayment contract—As defined by Section 3403(k) of the CVPIA, "the same meaning as provided in sections 9(d) and 9(e) of the Reclamation Project Act of 1939 (53 Stat. 1187, 1195), as amended." See water service contract.

Reservoir—Artificially impounded body of water.

Reservoir storage capacity—Reservoir capacity normally usable for storage and regulation of reservoir inflows to meet established reservoir operating requirements.

Flood control storage capacity—Reservoir capacity dedicated for the purpose of regulating flood inflows to reduce flood damage downstream. Flood control storage capacity generally varies through the year.

Restoration Fund—As defined in Section 3403(l) of the CVPIA, "the Central Valley Project Restoration Fund established by this title."

Return flows—Water returned to the natural surface water system after use by the water user.

Riparian—Areas along or adjacent to a river or stream bank the waters of which provide soil moisture significantly in excess of that otherwise available through local precipitation.

Riparian water rights—Exists for lands which abut a waterway, or which overly an underground stream.

S

Sacramento River Settlement Contractors—Various irrigation districts, mutual water companies and other water users that hold Sacramento River Water Rights Settlement Contracts with the United States. The Settlement Contracts provide for the recognition of the contractors' underlying water rights to divert the natural flow of the Sacramento River, while also providing for a supplemental supply of Central Valley Project (CVP) project water during the summer months. Approximately 2.2 million acre-feet of water are diverted under the Settlement Contracts, serving approximately 440,000 acres between Redding and Sacramento.

Salmonids—Fish of the family *Salmonidae*, such as salmon, trout (including steelhead), and whitefish.

Scoping—The process of defining the scope of a study, primarily with respect to the issues, geographic area, and alternatives to be considered. The term is typically used in association with environmental documents prepared under the National Environmental Policy Act.

Secretary—The Secretary of the United States Department of the Interior.

Section 215 Water—Water defined under Section 215 of the Reclamation Reform Act of 1982 as unstorable irrigation water to be released due to flood control criteria or unmanaged flood flows.

Seepage—Water that passes through canal lining, stream banks, or other holding or conveyance systems. Groundwater flow is a type of seepage.

Shasta Criteria—Establishes when a water year is considered critical, based on inflow to Shasta Lake. When inflows to Shasta Lake fall below the defined thresholds, the water year is defined as critical, and water deliveries to Sacramento River Water Rights and San Joaquin River Exchange Contractors may be reduced up to 25 percent. A year is critical when the full natural inflow to Shasta Lake for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year) is equal to or less than 3.2 million acre-feet. This is considered a single-deficit. A year is also critical when the accumulated difference (deficiency) between 4 million acre-feet and the full natural inflow to Shasta Lake for successive previous years, plus the forecasted deficiency for the current water year, exceeds 800,000 acre-feet.

Short-term contract—Contracts with a term of more than 5 years but less than 10 years.

Semiconfined aquifer—A condition where the movement of groundwater is restricted sufficiently to cause differences in head between different depth zones of the aquifer during periods of heavy pumping, but during periods of little draft the water levels recover to a level coincident with the water table.

Smolt—A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.

Spawning—The releasing and fertilizing of eggs by fish.

Spill—Water released from reservoirs to comply with flood control criteria.

Spillway—Overflow structure of a dam.

Stream—Natural water course.

Subsidence—A local ground movement that involves principally the gradual downward settling or sinking of the earth's surface with little or no horizontal motion.

Surface water diversion—Total quantity of water removed from a stream.

Surface Water Return Flow—Percent of water that directly returns by surface to the stream.

T

Tailwater—Water immediately downstream of a dam.

Target Flows—Flow goals used in development of the Draft PEIS alternatives. The goals were based upon preliminary information developed for the AFRP Restoration Plan.

Temporary contract—Contract with a term of less than 5 years.

Threatened species—Legal status afforded to plant or animals species that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range, as determined by the United States Fish and Wildlife Service or the National Marine Fisheries Service.

Tiering—Procedure which allows an agency to avoid duplication of paperwork through incorporation by reference of the general discussions and relevant specific discussions from an environmental compliance document of broader scope into a subsequent document of narrower scope.

Total supply—Total water supply available to area (surface water plus groundwater).

Transfers, sales, and exchanges—A transfer or sale is a one-way transaction to another contractor usually on an annual basis, but could be on a permanent basis. An exchange is a two-way transaction wherein a contractor transfers water to another contractor to be returned at a later date.

Tributary—A stream feeding into a larger stream or a lake.

Turn outs—Structures along main canal systems for distribution of water.

W

Warren Act—The Warren Act of February 1, 1911, provides authority to convey and store nonproject water within project facilities. Both nonproject M&I and irrigation water can be stored or conveyed in project facilities. Section 1 of the Warren Act requires Reclamation to charge water contractors for the cost of conveying nonproject water through project facilities. Unlike virtually all other CVP rates, Warren Act rate revenues are not creditable to project repayment and are returned directly to the United States Treasury.

Water acquisition—The purchase of water from willing sellers.

Watershed—A region or area bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water.

Water year—Usually when related to hydrology, the period of time beginning October 1 of one year and ending September 30 of the following year and designated by the calendar year in which it ends.

Wetland—A zone periodically or continuously submerged or having high soil moisture, and which has aquatic and/or riparian vegetation components, and is maintained by water supplies significantly in excess of those otherwise available through local precipitation.

Wildlife habitat—An area that provides a water supply and vegetative habitat for wildlife.

Willing sellers—A term used to describe individuals who would be interested in selling water supplies under transfer guidelines established by SWRCB and other regulatory agencies.

Without-Project Conditions—A planning baseline for alternatives comparison that is developed by projecting the effects of reasonably foreseeable changes on existing physical, biological, cultural, and socioeconomic conditions. In NEPA documents, the without-project condition is generally the same as the No-Action Alternative.

X

X2—Salinty criteria of two parts per thousand (2 ppt), which must be maintained in Suisun Bay during the spring runoff period (February through June).

Y

Yield—As defined in P.L. 108-361, firm yield is defined as the quantity of water from a project or program that is projected to be available on a reliable basis, given a specified level of risk, during a critically dry period. Average yield is generally measured as long-term average annual water supply. Firm yield generally measured as dry year reliability, and is similar to firm water supply.

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Attachment A

Special Status Species Potentially Present in the Study Area

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Attachment A1

Special Status Plant Species
Potentially Present in the Study Area

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ATTACHMENT A1. SPECIAL STATUS PLANT SPECIES POTENTIALLY PRESENT IN THE STUDY AREA

	Species Status						Potentially Present in River Reach									
Plants **Common Name** **(*Genus species*)**	**FE**	**FT**	**SE**	**ST**	**SR**	**Other**	**Millerton Lake/ Big Bend**	**Temperance Flat/ Millerton Bottoms**	**Patterson Bend**	**Kerckhoff Lake/ Horseshoe Bend**	**Mammoth Reach**	**Granite Creek**	**Jackass Creek**	**Chiquito Creek**	**Fine Gold Creek**	**Yokohl Valley**
Boggs Lake hedge-hyssop (*Gratiola heterosepala*)			●			CNPS List 1B	**R[1]**	**P[1,3]**	**P[1,3]**						**P[1]**	
Bolander's clover (*Trifolium bolanderi*)						CNPS List 1B						**R[4]**	**R[4]**	**R[4]**		
Brewer's clarkia (*Clarkia breweri*)						CNPS List 4						**P[4]**	**P[4]**	**P[4]**		
California pinefoot (*Pityopus californicus*)						CNPS List 4						**P[4]**	**P[4]**	**P[4]**		
Congdon's lewisia (*Lewisia condonii*)					●	CNPS List 1B						**P[4]**	**P[4]**	**P[4]**		
Cut-leaved monkey flower (*Mimulus lanciniatus*)						CNPS List 3						**P[4]**	**P[4]**	**P[4]**		
Flaming trumpet (*Collomia rawsoniana*)						FWS-SC CNPS List 1B				**P[1]**	**P[1,4]**	**P[4]**	**P[4]**	**P[1,4]**		
Fresno mat (ceanothus) (*Ceanothus fresnensis*)						CNPS List 4						**R[4]**	**R[4]**	**R[4]**		
Gray's monkey flower (*Mimulus grayi*)						CNPS List 4						**P[4]**	**P[4]**	**P[4]**		
Hall's wyethia (*Wyethia elata*)						CNPS List 4						**P[4]**	**P[4]**	**P[4]**		
Hartweg's golden sunburst (*Pseudobahia bahiifolia*)	●		●			CNPS List 1B	**R[1]**	**P[3]**	**P[3]**						**P[1]**	
Kaweah brodiaea (*Brodiaea insignis*)			●			CNPS List 1B										**R[1]**
Kaweah monkeyflower (*Mimulus norrisii*)						CNPS List 1B										**P[1]**
Madera leptosiphon (*Leptosiphon serrulatus*)						FWS-SLC CNPS List 1B	**R[1]**	**P[1,3]**	**P[3]**		**P[1]**	**P[4]**	**P[4]**	**P[4]**	**P[1]**	
Mariposa pussypaws (*Calyptridium pulchellum*)		●				CNPS List 1B	**P[3]**	**P[3]**	**P[3]**	**P[1,3]**					**P[1]**	
Mono Hot Springs evening-primrose (*Camissonia sierrae ssp. Alticola*)						FWS-SLC CNPS List 1B					**P[1]**	**P[4]**	**P[1,4]**	**P[1,4]**		
Mouse buckwheat (*Eriogonum nudum* var. *murinum*)						CNPS List 1B										**P[1]**
Oak-leaved nenophila (*Nemophila parviflora ssp. quercifolia*)						CNPS List 4						**P[4]**	**P[4]**	**P[4]**		
Orange lupine (*Lupinus citrinus var. citrinus*)						FWS-SC BLM-S CNPS List 1B	**P[3]**	**P[3]**	**P[3]**	**P[1]**	**P[1]**	**P[4]**	**P[4]**	**P[4]**		
Oval-leaved viburnum (*Viburnum ellipticum*)						CNPS List 2				**P[1]**						

SPECIAL STATUS PLANT SPECIES POTENTIALLY PRESENT IN THE STUDY AREA (continued)

Plants	Species Status						Potentially Present in River Reach									
Plants **Common Name** **(*Genus species*)**	**FE**	**FT**	**SE**	**ST**	**SR**	**Other**	**Millerton Lake/ Big Bend**	**Temperance Flat/ Millerton Bottoms**	**Patterson Bend**	**Kerckhoff Lake/ Horseshoe Bend**	**Mammoth Reach**	**Granite Creek**	**Jackass Creek**	**Chiquito Creek**	**Fine Gold Creek**	**Yokohl Valley**
Recurved larkspur (*Delphinium recurvatum)*						FWS-SC BLM-S CNPS List 1B										**R**[1]
San Joaquin adobe sunburst (*Pseudobahia peirsonii*)		●	●			CNPS List 1B										**R**[1]
San Joaquin Valley orcutt grass (*Orcuttia inaequalis*)		●	●			CNPS List 1B	**R**[1,3]	**P**[1,3]	**P**[1,3]						**P**[1]	
Short-leaved hulsea (*Hulsea brevifolia*)						CNPS List 1B						**P**[4]	**P**[4]	**P**[4]		
Shuteye Peak fawn lily (*Erythronium pluriflorum*)						CNPS List 1B								**P**[1]		
Spiny-sepaled button-celery (*Eryngium spinosepalum*)						FWS-SC CNPS List 1B	**P**[1]	**P**[1]	**P**[1]						**P**[1]	**R**[1]
Springville clarkia (*Clarkia springvillensis*)		●	●			CNPS List 1B										**P**[1]
Succulent owl's-clover (*Castilleja campestris ssp. Succulenta*)		●	●			CNPS List 1B	**R**[1]	**P**[1,3]	**P**[1,3]						**P**[1]	
Tehipite Valley jewel flower (*Streptanthus fenestrus*)						CNPS List 1B						**P**[4]	**P**[4]	**P**[4]		
Tree-anemone (*Carpenteria californica*)				●		FS-S CNPS List 1B	**R**[1]	**P**[1,3]	**R**[1,3]	**R**[1,2]					**P**[1]	
Yosemite ivesia (*Ivesia unguiculata*)						CNPS List 4						**R**[4]	**R**[4]	**R**[4]		
Yosemite lewisia (*Lewisia disepala*)						FWS-SC CNPS List 1B					**P**[1]	**P**[1]	**P**[1]	**P**[1]		

Key:
R- Reported present
P- Potentially present
[1]-California Department of Fish and Game, California Natural Diversity Database
[2]-USDA, Forest Service (Forest Service), 2004.
[3]-US Bureau of Land Management (BLM), 2004.
[4]-USJRW&PA, 1982
Red= not found in CNDDB, but in TM's

Status Abbreviations:
FE: Federally listed as Endangered
FT: Federally listed as Threatened
SE: State-listed as Endangered
ST: State-listed as Threatened
SR: State-listed as Rare
FS-S: Forest Service Sensitive Species
FWS-SC: Fish and Wildlife Service Species of Concern
FWS-SLC: Fish and Wildlife Service Species of Local Concern
BLM-S: Bureau of Land Management Sensitive
CNPS List 1B: Rare, Threatened, or Endangered in CA and Elsewhere.
CNPS List 2: Rare, Threatened, or Endangered in CA, More Common Elsewhere
CNPS List 3: Plants About Which We Need More Information – A Review list
CNPS List 4: Plants of Limited Distribution - A Watch list

Attachment A2

Special Status Amphibian and Reptile Species
Potentially Present in the Study Area

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ATTACHMENT A2. SPECIAL STATUS AMPHIBIAN AND REPTILE SPECIES POTENTIALLY PRESENT IN THE STUDY AREA

	Species Status								Potentially Present in River Reach									
Amphibians and Reptiles **Common name** **(*Genus Species*)**	**FE**	**FT**	**FPD**	**FC**	**SE**	**ST**	**SCE**	**Other**	**Millerton Lake/ Big Bend**	**Temperance Flat/ Millerton Bottoms**	**Patterson Bend**	**Kerckhoff Lake/ Horseshoe Bend**	**Mammoth Reach**	**Granite Creek**	**Jackass Creek**	**Chiquito Creek**	**Fine Gold Creek**	**Yokohl Valley**
California Red-legged Frog (*Rana aurora draytonii)*		●						DFG-SC				P[2]	P[2]	P[2]	P[2]	P[2]		
California tiger salamander (*Ambystoma californiense*)		●						DFG-SC	R[1]	P[1,3]	P[3]	P[1,2]	P[2]	P[2]	P[2]	P[2]	R[1]	
Foothill yellow-legged frog (*Rana boylii*)								DFG-SC FS-S BLM-S	P[1,3]	P[1,3]	P[1,3]	P[1,2]	P[1]					R[1]
Mountain yellow-legged frog (*Rana muscosa*)				●				DFG-SC FS-S						P[2,4]	P[4]	P[4]		
Relictual slender salamander (Batrachoseps relictus)								DFG-SC FS-S				P[2]	P[2]	P[2]	P[2]	P[2]	P[2]	
Western pond turtle (*Emys (=Clemmys) marmorata*)								DFG-SC FS-S	R[1,3]	R[1,3]	R[1,3]	R[1,2]	P[1]	P[4]	P[4]	P[1,4]	R[1]	R[1]
Western spadefoot (*Spea (=Scaphiopus) hammondii*)								DFG-SC FS-S BLM-S	R[1]	R[1,3]	R[1,3]	R[2]					R[1]	R[1]
Yosemite toad (*Bufo canorus*)								DFG-SC BLM-S						P[4]	P[1,4]	P[1,4]		

Key:
R- Reported present
P- Potentially present
[1]-California Department of Fish and Game, California Natural Diversity Database
[2]-USDA, Forest Service (Forest Service), 2004.
[3]-US Bureau of Land Management (BLM), 2004.
[4]-USJRW&PA, 1982

Status Abbreviations:
FE: Federally listed as Endangered
FT: Federally listed as Threatened
FPD: Federally proposed for delisting
FC: Federal candidate species
SE: State-listed as Endangered
ST: State-listed as Threatened
SCE: State candidate for listing as Endangered
FS-S: Forest Service Sensitive Species
DFG-CSC: California Special Concern Species
DFG-FP: California Fully Protected
BLM-S: Bureau of Land Management Sensitive

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Attachment A3

Special Status Bird Species
Potentially Present in the Study Area

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ATTACHMENT A3. SPECIAL STATUS BIRD SPECIES POTENTIALLY PRESENT IN THE STUDY AREA

	Species Status								Potentially Present in River Reach									
Birds **Common name** **(*Genus Species*)**	**FE**	**FT**	**FPD**	**FC**	**SE**	**ST**	**SCE**	**Other**	**Millerton Lake/ Big Bend**	**Temperance Flat/ Millerton Bottoms**	**Patterson Bend**	**Kerckhoff Lake/ Horseshoe Bend**	**Mammoth Reach**	**Granite Creek**	**Jackass Creek**	**Chiquito Creek**	**Fine Gold Creek**	**Yokohl Valley**
California condor (*Gymnogyps californianus*)	●				●			CDF:S DFG: FP										P[1]
California spotted owl (*Strix occidentalis occidentalis*)								DFG-SC FS-S FWS-BCC BLM-S						R[4]	R[4]	R[4]		
Cooper's hawk (*Accipter cooperi*)								DFG-SC	P[3]	P[3]	P[3]							
Golden eagle (*Aquila chrysaetos*)								DFG-SC FS-S FWS-BCC BLM-S CDF-S	P[3]	P[3]	P[3]			R[4]	R[4]	R[4]		
Great gray owl (*Strix nebulosa*)					●			FS-S CDF-S				P[1,2]	P[1,2]	P[4]	P[4]	P[1,4]		
least Bell's vireo (*Vireo bellii pusillus*)	●				●			FWS-BCC	P[3]	P[3]	P[3]							
Northern goshawk (*Accipiter gentilis*)								DFG-SC FS-S CDF-S					P[1]	P[1,4]	P[1,4]	P[1,4]		
Northern harrier (Circus cyaneus)								DFG-CSC	R[3]	R[3]	R[3]							
Osprey (Pandion haliaetus)								DFG-CSC CDF-S	P[3]	P[3]	P[3]		P[4]	P[4]	P[4]	P[4]		
Prairie falcon (*Falco mexicanus*)								DFG-CSC FWS-BCC	R[3]	R[3]	R[3]			P[4]	P[4]	P[4]		
Sharp-shinned hawk (Accipter striatus)								DFG-CSC	P[3]	P[3]	P[3]							
Southern bald eagle (Haliaeetus leucocephalus leucocephalus)		●	●		●			DFG-FP CDF-S	R[1,3]	R[1,3]	R[1,3]	R[2]	R[4]					
Swainson's hawk (Buteo swainsoni)						●		FS-S FWS-BCC	P[3]	P[3]	P[3]							
Tri-colored blackbird (*Agelaius tricolor*)								DFG-CSC FWS-BCC BLM-S									P[1]	
Willow flycatcher (*Empidonax traillii*)					●			FS-S				P[2]	P[2]	P[4]	P[4]	P[1,4]		
Yellow warbler (*Dendroica petechia brewsteri*)								DFG-CSC						P[4]	P[4]	P[4]		

Key:	Status Abbreviations:
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Attachment A4

Special Status Fish Species
Potentially Present in the Study Area

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ATTACHMENT A4. SPECIAL STATUS FISH SPECIES POTENTIALLY PRESENT IN THE STUDY AREA

	Species Status								Potentially Present in River Reach									
Fisheries **Common name** **(*Genus Species*)**	**FE**	**FT**	**FPD**	**FC**	**SE**	**ST**	**SCE**	**Other**	**Millerton Lake/ Big Bend**	**Temperance Flat/ Millerton Bottoms**	**Patterson Bend**	**Kerckhoff Lake/ Horseshoe Bend**	**Mammoth Reach**	**Granite Creek**	**Jackass Creek**	**Chiquito Creek**	**Fine Gold Creek**	**Yokohl Valley**
Hardhead (*Mylopharodon conocephalus*)								DFG-CSC	**R**[1]	**R**[1]	**R**[1]	**R**[1]	**R**[1]					
Kern Brook lamprey *(Lamperta hubbsi)*								DFG-CSC	**P**[1]	**P**[1]	**P**[1]							
Paiute cutthroat trout (*Oncorhynchus clarki seleniris*)		●												**P**[1]				
Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*)		●													**P**[1]	**P**[1,4]		

Key:
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Attachment A5

Special Status Invertebrate Species Potentially Present in the Study Area

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ATTACHMENT A5. SPECIAL STATUS INVERTEBRATE SPECIES POTENTIALLY PRESENT IN THE STUDY AREA

	Species Status								Potentially Present in River Reach									
Invertebrates **Common name** **(*Genus Species*)**	**FE**	**FT**	**FPD**	**FC**	**SE**	**ST**	**SCE**	**Other**	**Millerton Lake/ Big Bend**	**Temperance Flat/ Millerton Bottoms**	**Patterson Bend**	**Kerckhoff Lake/ Horseshoe Bend**	**Mammoth Reach**	**Granite Creek**	**Jackass Creek**	**Chiquito Creek**	**Fine Gold Creek**	**Yokohl Valley**
California linderiella fairy shrimp (*Linderiella occidentalis*)								FWS-SC	P^{1}	P^{1}	P^{1}							
Dry Creek cliff strider bug (*Oravelia pege*)								FWS-SC				P^{1}						
Midvalley fairy shrimp (*Branchinecta mesovallensis*)								FWS-SC	P^{1}									
Moesta blister beetle (*Lytta moesta*)								FWS-SC	P^{3}	P^{3}	P^{3}							
Molestan blister beetle (*Lytta molesta*)								FWS-SC	$P^{1.3}$	$P^{1.3}$	$P^{1.3}$	$P^{1.3}$						P^{1}
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)		●							R^{3}	R^{3}	R^{3}	R^{2}						
Vernal pool fairy shrimp (*Branchinecta lynchi*)		●							$P^{1,3}$	$P^{1,3}$	$P^{1,3}$							P^{1}
Vernal pool tadpole shrimp (*Lepidurus packardi*)	●								P^{1}	P^{1}	P^{1}							

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Attachment A6

Special Status Mammal Species
Potentially Present in the Study Area

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ATTACHMENT A6. SPECIAL STATUS MAMMAL SPECIES POTENTIALLY PRESENT IN THE STUDY AREA

Mammals **Common Name** **(*Genus species*)**	Species Status: FE	FT	FPD	FC	SE	ST	SCE	Other	Potentially Present in River Reach: Millerton Lake/ Big Bend	Temperance Flat/ Millerton Bottoms	Patterson Bend	Kerckhoff Lake/ Horseshoe Bend	Mammoth Reach	Granite Creek	Jackass Creek	Chiquito Creek	Fine Gold Creek	Yokohl Valley
American (=pine) marten (*Martes americana*)								FS-S					P[1]	P[4]	P[4]	P[1,4]		
California wolverine (*Gulo gulo*)						●		DFG-FP FS-S								P[1]		P[1]
Fringed myotis (*Myotis thysanodes*)								BLM-S					P[1]	P[4]	P[4]	P[4]		
Long-eared myotis (*Myotis evotis*)								BLM-S				P[1]	P[1]	P[4]	P[4]	P[4]		
Long-legged myotis (*Myotis volans*)								FWS-SC				P[1]	P[1]	P[4]	P[4]	P[4]		
Pacific fisher (*Martes pennanti pacifica*)				●				DFG-CSC FS-S BLM-S					P[1]	P[4]	P[1,4]	P[1,4]		P[1]
Pallid bat (*Antrozous pallidus*)								DFG-CSC FS-S BLM-S				P[2]	P[1,2]	P[4]	P[4]	P[4]		
San Joaquin kit fox (*Vulpes macrotis mutica)*	●					●												R[1]
Sierra Nevada red fox (*Vulpes vulpes necator*)						●		FS-S				P[1]	P[1]	P[1,4]	P[1,4]	P[1,4]		
Spotted bat (*Euderma maculatum*)								DFG-CSC BLM-S					P[1]					
Townsend's western big-eared bat (*Corynorhinus townsendii townsendii*)								DFG-CSC FS-S BLM-S					P[1]					
Western (California) mastiff bat (*Eumops perotis californicus*)								DFG-CSC FS-S BLM-S	R[3]	R[3]	R[3]		P[1]					
Western red bat (*Lasiurus blossevillii*)								FS-S				P[2]	P[2]					
Yuma myotis (*Myotis yumanensis*)								BLM-S				P[1]	P[1]	P[4]	P[4]	P[4]		

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[3]-US Bureau of Land Management (BLM), 2004.
[4]-USJRW&PA, 1982

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SCE: State candidate for listing as Endangered
FS-S: Forest Service Sensitive Species
DFG-CSC: California Special Concern Species
DFG-FP: California Fully Protected
BLM-S: Bureau of Land Management Sensitive

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Attachment B

Special Status Species and Habitat Descriptions

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Attachment B1

Special Status Plant Species
and Habitat Descriptions

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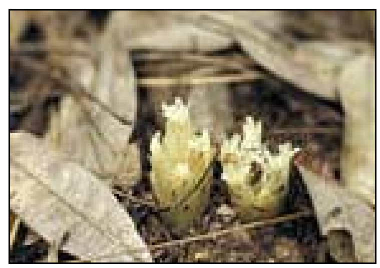
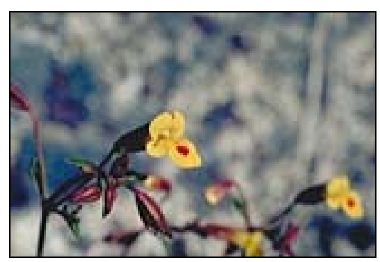
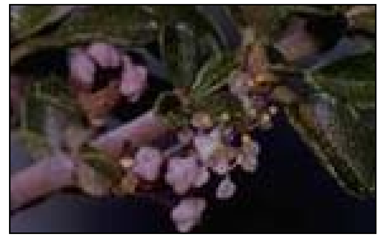
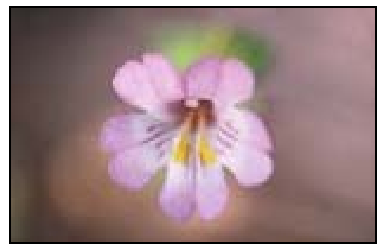
ATTACHMENT B1. SPECIAL STATUS PLANT SPECIES AND HABITAT DESCRIPTIONS

Plants **Common name** **(*Genus species*)**	**Habitat**	
Boggs Lake hedge-hyssop (*Gratiola heterosepala*)	Vernal Pools and lake margins.[1]	 Copyright © 2004 Carol W. Witham (Courtesy of CalPhotos)
Bolander's clover (*Trifolium bolanderi*)	Wet meadows; about 7,000 ft.[6]	No Photo Available
Brewer's clarkia (*Clarkia breweri*)	Dry ridges, yellow pine forest; 3,000-6,500 ft. [6]	 Copyright © Roxanne Bittman and CNPS (Courtesy of CalPhotos)
California pinefoot (*Pityopus californicus*)	Deep shade of mixed evergreen or yellow pine forest; 1,000-5,000 ft.[6]	 Copyright © 1981 Robert E. Preston, Ph.D. (Courtesy of CalPhotos)
Congdon's lewisia (*Lewisia congdonii*)	Rocky places, red fir forest; 6,000-9,000 ft.[6]	No Photo Available
Cut-leaved monkey flower (*Mimulus laciniatus*)	Damp sandy places, yellow pine and red fir forest; 3,300-8,700 ft. [6]	 Copyright © 2001 Steve Schoenig (Courtesy of CalPhotos)

ATTACHMENT B1. SPECIAL STATUS PLANT SPECIES AND HABITAT DESCRIPTIONS (continued)

Plants **Common name** **(*Genus species*)**	**Habitat**	
Fresno mat (ceanothus) (*Ceanothus fresnensis*)	Dry ridges, yellow pine forest; 3,000-6,500 ft.[6]	 Copyright © 1998 Charles Webber California Academy of Sciences (Courtesy of CalPhotos)
Gray's monkeyflower (*Mimulus grayi*)	Moist places, montane coniferous forest; 1,800-9,500 ft.[6]	 Copyright © 1994 Dean Wm. Taylor (Courtesy of CalPhotos)
Hall's wyethia (*Wyethia elata*)	Dry open slopes, foothill woodland, yellow pine forest; 3,000-4,000 ft.[6]	 Copyright © 1995 Brother Alfred Brousseou Saint Mary's College of California (Courtesy of CalPhotos)
Hartweg's golden sunburst (*Pseudobahia bahiifolia*)	North or northeast-facing slopes of mima mounds, with the highest densities on upper slopes with minimal grass cover, Amador and Rocklin soil series.[1]	 Copyright © 2001 John Game (Courtesy of CalPhotos)
Kaweah brodiaea (*Brodiaea insignis*)	Granitic substrates and deep, clayey soils on south- and southwest-facing slopes.[1]	No Photo Available

ATTACHMENT B1. SPECIAL STATUS PLANT SPECIES AND HABITAT DESCRIPTIONS (continued)

Plants **Common name** **(*Genus species*)**	**Habitat**	
Kaweah monkeyflower (*Mimulus norrisii*)	Marble crevices. Elevation 1168 - 4160 feet.[3]	 http://www.ca.blm.gov/
Madera leptosiphon (*Leptosiphon serrulatus*)	Dry slopes, yellow pine forest; 1,000-4,000 ft.[6]	No Photo Available
Mariposa pussypaws *(Calyptridium pulchellum*)	Small, barren areas on decomposed granitic sands in annual grasslands and woodlands; 1,500-3,600 ft.[4]	 Copyright © 1994 Dean Wm. Taylor (Courtesy of CalPhotos)
Mono Hot Springs evening-primrose (*Camissonia sierrae ssp. Alticola*)	Gravel and sandy soil in pans and ledges of granite outcrops.[4]	No Photo Available
Mouse buckwheat (*Eriogonum nudum* var. *murinum*)	Dry, sandy slopes. Chaparral, cismontane woodland, valley and foothill grassland.[3]	No Photo Available
Oak-leaved nemophila (*Nemophila parviflora var. quercifolia*)	Dry shade, foothill woodland, yellow pine forest; 1,000-5,000 ft.[6]	 Copyright © 1995 Brother Alfred Brousseou Saint Mary's College of California (Courtesy of CalPhotos)

ATTACHMENT B1. SPECIAL STATUS PLANT SPECIES AND HABITAT DESCRIPTIONS (continued)

Plants **Common name** **(*Genus species*)**	**Habitat**	
Orange lupine *(Lupinus citrinus var. citrinus*)	Open granitic areas; 3,000-5,000 ft.[6]	 Copyright © 1985 Dean Wm. Taylor (Courtesy of CalPhotos)
Oval-leaved viburnum *(Viburnum ellipticum*)	Chapparral, yellow pine, upper montane coniferous forests 3,600-7,000 ft.[1]	No Photo Available
Recurved larkspur (*Delphinium recurvatum)*	Poorly drained, fine alkaline soils in grassland. Elevation 9.6 - 2400 feet.[3]	 http://www.ca.blm.gov/
San Joaquin adobe sunburst (*Pseudobahia peirsonii*)	Heavy adobe clay soils[5]	 Copyright © 1986 Dean Wm. Taylor (Courtesy of CalPhotos)
San Joaquin Valley orcutt grass (*Orcuttia inaequalis*)	Vernal pools[1]	 Copyright © 2002 Joshua D. Boldt (Courtesy of CalPhotos)

ATTACHMENT B1. SPECIAL STATUS PLANT SPECIES AND HABITAT DESCRIPTIONS (continued)

Plants **Common name** **(*Genus species*)**	**Habitat**	
Short-leaved hulsea (*Hulsea brevifolia*)	Forest openings, red fir forest[6]	 Copyright © 2001 Jeff Abbas (Courtesy of CalPhotos)
Shuteye Peak fawn lily (*Erythronium pluriflorum*)	Rocky and meadow-type sites in red-fir, lodgepole pine and/or subalpine forest dominated by western white pine and Jeffrey pine[4]	 Copyright © 2004 Aaron Schusteff (Courtesy of CalPhotos)
Spiny-sepaled button-celery (*Eryngium spinosepalum*)	Vernal pools.[1]	No Photo Available
Springville clarkia (*Clarkia springvillensis*)	Chaparral; Cismontane Woodland.[1]	No Photo Available
Succulent owl's-clover (*Castilleja campestris ssp. Succulenta*)	Drying vernal pools in valley grassland areas.[1]	 Copyright © 2000 Robert E. Preston, Ph.D. (Courtesy of CalPhotos)
Tehipite Valley jewel flower (*Streptanthus fenestratus*)	Sandy decomposed granite slopes; 4,000-6,000 ft.[6]	 Copyright © 1994 Dean Wm. Taylor (Courtesy of CalPhotos)

ATTACHMENT B1. SPECIAL STATUS PLANT SPECIES AND HABITAT DESCRIPTIONS (continued)

Plants **Common name** **(*Genus species*)**	**Habitat**	
Tree-anemone *(Carpenteria californica)**	Well-drained granitic soils, most abundant on north-facing ravines and drainages in chaparral and cismontane woodland communities.[1]	 Copyright © 1999 Charles Webber California Academy of Sciences (Courtesy of CalPhotos)
Yosemite ivesia (*Ivesia unguiculata*)	Open slopes, red fir to lodgepole pine forest; 5,000-8,000 ft.[6]	 Copyright © 1995 Brother Alfred Brousseau Saint Mary's College of California (Courtesy of CalPhotos)
Yosemite lewisia (*Lewisia disepala*)	Pans and shelves of granite gravel found on and next to outcrops surrounded by coniferous forest.[4]	 Copyright © 1995 Brother Alfred Brousseau Saint Mary's College of California (Courtesy of CalPhotos)

[1]California Department of Fish and Game
[2]California Department of Water Resources
[3]US Bureau of Land Management
[4]US Forest Service, Sierra National Forest Management Plan
[5]US Fish and Wildlife Service, Sacramento Fish & Wildlife Office Species Account
[6]Granite Hydroelectric Project

Attachment B2

Special Status Amphibian and Reptile Species and Habitat Descriptions

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ATTACHMENT B2. SPECIAL STATUS AMPHIBIAN AND REPTILE SPECIES AND HABITAT DESCRIPTIONS

Amphibians and Reptiles Common name (*Genus species*)	**Habitat**	
California Red-legged Frog (*Rana aurora draytonii)*	Dense, shrubby riparian vegetation associated with deep (2.3 ft.), still or slow-moving water.[1]	 Copyright © 2003 Pierre Fidenci
California tiger salamander (*Ambystoma californiense*)	Lowland species restricted to grasslands and lowest foothill regions with long-lasting rain pools present.[1]	 Copyright © 1999 Gerald and Buff Corsi California Academy of Sciences
Foothill yellow-legged frog (*Rana boylii*)	Shallow, flowing water in small to moderate-sized streams situations with at least some cobble-sized substrate.[1]	 Copyright © 1999 Frank E. (Ed) Ely California Academy of Sciences
Mountain yellow-legged frog (*Rana muscosa*)	Mountain meadow, riparian deciduous, and alpine meadow. Found year-round from 5,000 to 13,000 ft.[6]	 Copyright © 2004 William Flaxington
Relictual slender salamander (*Batrachoseps relictus*)	Oak woodland-mixed conifer, moist forest with downed wood and deep litter layer; rocks and bark used for cover.[4]	 Copyright © 2003 William Flaxington

ATTACHMENT B2. SPECIAL STATUS AMPHIBIAN AND REPTILE SPECIES AND HABITAT DESCRIPTIONS (continued)

Amphibians and Reptiles Common name (*Genus species*)	**Habitat**	
Western pond turtle *Emys (=Clemmys) marmorata*)	Slack- or slow-water aquatic habitat. Local distributions limited in high gradient streams probably because water temperatures, current velocity, food resources, or any combination thereof.[1]	 www.enature.com © Allen Blake Sheldon
Western spadefoot (*Spea (=Scaphiopus) hammondii*)	Grassland situations, and occasionally in valley-foothill hardwood woodlands; Some orchard-vineyard habitats.[1]	 Copyright © 2001 Joyce Gross
Yosemite toad (*Bufo canorus*)	Restricted to central high Sierra Nevada. Prefers mountain, alpine meadow, lodgepole pine, successional stages of mixed conifer, Jeffrey pine, red fir. Elev. 6,400 to 11,300 ft.[6]	 Copyright © 1999 John H. Tashjian California Academy of Sciences

[1]California Department of Fish and Game
[2]California Department of Water Resources
[3]US Bureau of Land Management
[4]US Forest Service, Sierra National Forest Management Plan
[5]US Fish and Wildlife Service, Sacramento Fish & Wildlife Office Species Account
[6]Granite Hydroelectric Project

Attachment B3

Special Status Bird Species
and Habitat Descriptions

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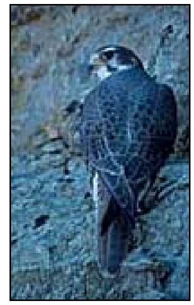
ATTACHMENT B3. SPECIAL STATUS BIRD SPECIES AND HABITAT DESCRIPTIONS

Birds Common name (*Genus species*)	**Habitat**	
California condor (*Gymnogyps californianus*)	Arid foothills and mountain ranges of southern and central California.[1]	 http://endangered.fws.gov/
California spotted owl (*Strix occidentalis occidentalis*)	Wide variety of forest types with moderate to high canopy closure, large accumulations of fallen trees and other debris and sufficient open space below the canopy.[5]	
Cooper's hawk (*Accipiter cooperii*)	Ranges from sea level to above 2700 m (0-9000 ft). Dense stands of live oak, riparian deciduous, or other forest habitats near water used most frequently.[1]	 http://www.delta.dfg.ca.gov
Golden eagle (*Aquila chrysaetos*)	Ranges from sea level up to 11,500 ft. Habitat typically rolling foothills, mountain areas, sage-juniper flats, desert.[1]	 http://www.dfg.ca.gov/
Great gray owl (*Strix nebulosa*)	Old-growth red fir, mixed conifer, or lodgepole pine habitats, always in the vicinity of wet meadows, 4,500-7,500 ft. in the Sierra Nevada.[1]	

ATTACHMENT B3. SPECIAL STATUS BIRD SPECIES AND HABITAT DESCRIPTIONS (continued)

Birds **Common name** **(*Genus species*)**	**Habitat**	
least Bell's vireo (*Vireo bellii pusillus*)	Low, dense riparian growth along water or along dry parts of intermittent streams. Typically associated with willow, cottonwood, baccharis, wild blackberry, or mesquite in desert localities.[1]	 http://www.bird-friends.com/
Northern goshawk (*Accipiter gentilis*)	Dense, mature conifer and deciduous forest, interspersed with meadows, other openings, and riparian areas required. Nesting habitat includes north-facing slopes near water.[1]	
Norther harrier (*Circus cyaneus*)	Annual grassland up to lodgepole pine and alpine meadow habitats, as high as 10,000 ft. Mostly found in flat, or hummocky, open areas of tall, dense grasses, moist or dry shrubs, and edges for nesting, cover, and feeding.[1]	
Osprey (*Pandion haliaetus*)	Wide range of habitats near water, primarily lakes, rivers, and coastal waters with adequate supplies of fish.[4]	 California Academy of Sciences

ATTACHMENT B3. SPECIAL STATUS BIRD SPECIES AND HABITAT DESCRIPTIONS (continued)

Birds Common name (*Genus species*)	**Habitat**	
Prairie falcon (*Falco mexicanus*)	Annual grasslands to alpine meadows, but associated primarily with perennial grasslands, savannahs, rangeland, some agricultural fields, and desert scrub areas.[1]	 © 2004 Don Getty
Sharp-shinned hawk (*Accipter striatus*)	Prefers, but not restricted to, riparian habitats. North facing slopes, with plucking perches are critical requirements. Usually nests in dense, pole and small-tree stands of conifers, which are cool, moist, well shaded, with little ground-cover, near water.[1]	 © 2004 Tom Greer
Southern bald eagle (*Haliaeetus leucocephalus leucocephalus*)	Requires large bodies of water, or free flowing rivers with abundant fish, and adjacent snags or other perches.[1]	 © 2004 Don Getty
Swainson's hawk (*Buteo swainsoni*)	Large, open grasslands with abundant prey in association with suitable nest trees such as oaks, cottonwoods, walnuts, and willows in the Central Valley, and juniper in the Great Basin.[1]	 © 2004 Don Getty

ATTACHMENT B3. SPECIAL STATUS BIRD SPECIES AND HABITAT DESCRIPTIONS (continued)

Birds **Common name** **(*Genus species*)**	**Habitat**	
Tri-colored blackbird (*Agelaius tricolor*)	Emergent wetland vegetation, especially cattails and tules; also in trees and shrubs. Roosts in large flocks in emergent wetland or in trees.[1]	 http://www.llnl.gov/
Willow flycatcher (*Empidonax traillii*)	Summer resident in wet meadow and montane riparian habitats at 2000-8000 ft.; broad river valleys or large mountain meadows with lush shrubby willows.[1]	 http://www.ronausting.com Copyright © 1997 Ron Austing
Yellow warbler (*Dendroica petechia brewsteri*)	Riparian habitats in the San Joaquin and Colorado River valleys.[1]	 http://www.pnl.gov/

[1]California Department of Fish and Game
[2]California Department of Water Resources
[3]US Bureau of Land Management
[4]US Forest Service, Sierra National Forest Management Plan
[5]US Fish and Wildlife Service, Sacramento Fish & Wildlife Office Species Account
[6]Granite Hydroelectric Project

Attachment B4

Special Status Fish Species
and Habitat Descriptions

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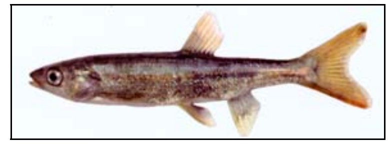
ATTACHMENT B4. SPECIAL STATUS FISH SPECIES AND HABITAT DESCRIPTIONS

Fisheries Common name (*Genus species*)	**Habitat**	
Hardhead (*Mylopharodon conocephalus*)	Undisturbed areas of larger middle- and low-elevation streams, found in association with Sacramento squawfish and usually with Sacramento suckers.[1]	 Rene Reyes, US Bureau of Reclamation
Kern Brook lamprey *(Lamperta hubbsi)*	Thinly scattered throughout the San Joaquin drainage and isolated from one another.[1]	No Photo Available
Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*)	Lakes and streams and require spawning and nursery habitat characterized by cool water, pools in close proximity to cover and velocity breaks, well vegetated and stable stream banks, and relatively silt free rocky substrate in riffle-run areas.[1]	 http://www.dfg.ca.gov/
Paiute cutthroat trout (*Oncorhynchus clarki seleniris*)	The extant pure populations all occur in headwater stream environments that are isolated from other fish species by barrier falls.[5]	 http://www.dfg.ca.gov/

[1]California Department of Fish and Game
[2]California Department of Water Resources
[3]US Bureau of Land Management
[4]US Forest Service, Sierra National Forest Management Plan
[5]US Fish and Wildlife Service, Sacramento Fish & Wildlife Office Species Account
[6]Granite Hydroelectric Project

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Attachment B5

Special Status Invertebrate Species and Habitat Descriptions

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ATTACHMENT B5. SPECIAL STATUS INVERTEBRATE SPECIES AND HABITAT DESCRIPTIONS (continued)

Invertebrates Common name (*Genus species*)	**Habitat**	
California linderiella fairy shrimp (*Linderiella occidentalis*)	Large, fairly clear vernal pools and lakes[5]	No Photo Available
Dry Creek cliff strider bug (*Oravelia pege)*	*Information being developed*	No Photo Available
Midvalley fairy shrimp (*Branchinecta mesovallensis*)	Shallow vernal pools, vernal swales and various artificial ephemeral wetland habitats[5]	 http://sacramento.fws.gov
Moesta blister beetle *(Lytta moesta*)	*Information being developed*	No Photo Available
Molestan blister beetle (*Lytta molesta*)	Annual grassland, foothill woodland, and atriplex scrub, dried vernal pools.[2]	No Photo Available
Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)	Elderberry plants, present in Great Valley Valley Oak Riparian Forests, are the sole host plant for nesting	 Richard A. Arnold, http://sacramento.fws.gov/
Vernal pool fairy shrimp (*Branchinecta lynchi*)	A variety of different vernal pool habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools[5]	 http://www.vernalpools.org/
Vernal pool tadpole shrimp (*Lepidurus packardi*)	Vernal pools containing clear to highly turbid water, ranging in size[5]	 Larry Serpa, http://sacramento.fws.gov/

[1]California Department of Fish and Game
[2]California Department of Water Resources
[3]US Bureau of Land Management
[4]US Forest Service, Sierra National Forest Management Plan
[5]US Fish and Wildlife Service, Sacramento Fish & Wildlife Office Species Account
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Attachment B6

Special Status Mammal Species and Habitat Descriptions

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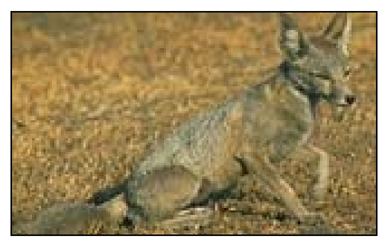
ATTACHMENT B6. SPECIAL STATUS MAMMAL SPECIES AND HABITAT DESCRIPTIONS (continued)

Mammals **Common name** **(*Genus species*)**	**Habitat**	
American (=pine) marten (*Martes americana*)	Coniferous forest habitat with large diameter trees and snags, large down logs, moderate-to-high canopy closure, and an interspersion of riparian areas and meadows.[4]	
California wolverine (*Gulo gulo*)	Southern Sierra Nevada habitats include red fir, mixed conifer, lodgepole, subalpine conifer, alpine dwarf-shrub, barren, and probably wet meadows, montane chaparral, and Jeffrey pine; elevations mostly from 6,400-10,800 ft.[1]	
Fringed myotis (*Myotis thysanodes*)	Pinyon-juniper, valley foothill hardwood and hardwood conifer forest from 4,000 to 7,000 ft.[1]	 http://www.werc.usgs.gov
Long-eared myotis (*Myotis evotis*)	Nearly all brush, woodland, and forest habitats, from sea level to at least 9000 ft., but coniferous woodlands and forests seem to be preferred. It avoids the arid Central Valley and hot deserts.[1]	 http://www.werc.usgs.gov

ATTACHMENT B6. SPECIAL STATUS MAMMAL SPECIES AND HABITAT DESCRIPTIONS (continued)

Mammals Common name (*Genus species*)	**Habitat**	
Long-legged myotis (*Myotis volans*)	Woodland, forest, chaparral, shrub and coastal scrub habitats and is uncommon in arid grassland and desert habitats[1]	 www.enature.com Copyright © Roger W. Barbour/ Morehead State University
Pacific fisher (*Martes pennanti pacifica*)	Intermediate to large-tree stages of coniferous forests and deciduous-riparian habitats with a high percent canopy closure.[1]	 http://www.sierracampaign.org
Pallid bat (*Antrozous pallidus*)	Grasslands, shrublands, woodlands, and forests from sea level up through mixed conifer forests. Most common in open, dry habitats with rocky areas for roosting. [1]	 Copyright © 1999 Dr. Lloyd Glenn Ingles California Academy of Sciences
San Joaquin kit fox (*Vulpes macrotis mutica)*	Occur in the remaining native valley and foothill grasslands and chenopod scrub communities of the valley floor and surrounding foothills.[1]	 Copyright © 1999 Dr. Lloyd Glenn Ingles California Academy of Sciences

ATTACHMENT B6. SPECIAL STATUS MAMMAL SPECIES AND HABITAT DESCRIPTIONS (continued)

Mammals **Common name** **(*Genus species*)**	**Habitat**	
Sierra Nevada red fox (*Vulpes vulpes necator*)	Red fir and lodgepole pine forests in the subalpine zone and alpine fell-fields of the Sierra Nevada.[1]	 http://www.pitriveralliance.
Spotted bat (*Euderma maculatum*)	Mostly in foothills, mountains and desert regions of southern California. Occasionally occurs outside this range. Habitats occupied range from arid deserts and grasslands through mixed conifer forests.[1]	 www.enature.com Copyright © Merlin D. Tuttle/ Bat Conservation International
Townsend's western big-eared bat (*Corynorhinus townsendii townsendii*)	Found in all but subalpine and alpine habitats, and may be found at any season throughout its range. It is most abundant in mesic habitats.[1]	 http://www.werc.usgs.gov
Western (California) mastiff bat (*Eumops perotis californicus*)	Open, semi-arid to arid habitats, including conifer and deciduous woodlands, coastal scrub, annual and perennial grasslands, palm oases, chaparral, desert scrub, and urban.[1]	 www.enature.com Copyright © Merlin D. Tuttle/ Bat Conservation International

ATTACHMENT B6. SPECIAL STATUS MAMMAL SPECIES AND HABITAT DESCRIPTIONS (continued)

Mammals Common name (*Genus species*)	**Habitat**	
Western red bat (Lasiurus blossevillii)	Forests and woodlands from sea level up through mixed conifer forests. Feeds over a wide variety of habitats including grasslands, shrublands, open woodlands and forests, and croplands.[1]	 http://www.werc.usgs.gov
Yuma myotis (*Myotis yumanensis*)	A variety of habitats ranging from sea level to 11,000 ft, but it is uncommon to rare above 2560 m (8000 ft). Optimal habitats are open forests and woodlands with sources of water over which to feed.[1]	 http://www.werc.usgs.gov

[1]California Department of Fish and Game
[2]California Department of Water Resources
[3]US Bureau of Land Management
[4]US Forest Service, Sierra National Forest Management Plan
[5]US Fish and Wildlife Service, Sacramento Fish & Wildlife Office Species Account
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