Chapter 4
Management Measures and Initial Alternatives

Once water resources problems, needs, and opportunities have been identified, and planning objectives, constraints, considerations, and criteria have been developed, the next major elements of the plan formulation process are (1) identifying management measures, (2) formulating alternative plans to meet planning objectives, and (3) comparing and evaluating alternative plans. Described below are management measures considered in the Investigation, refinement of initial alternative plans formulated, and evaluation of surface water storage measures in refined initial alternatives.

As described in Chapter 2, plan formulation is an iterative process. In this document, use of the term initial alternatives refers to the alternatives identified in the IAIR (Reclamation, 2005). The term alternative plan refers to alternatives described in Chapter 5. During the plan formulation phase, the initial alternatives were subject to further refinement and comparison, resulting in a reduction in the surface water storage measures retained for the formulation of alternative plans. The complete feasibility study process for the Investigation, including identification and evaluation of management measures, and formulation, evaluation, and comparison of alternatives, is illustrated in Figure 4-1.

The first interim planning document, the Phase 1 Investigation Report, completed in October 2003 (Reclamation), identified and addressed 17 possible reservoir sites in the eastern San Joaquin Valley and selected six for continued study. The second interim planning document, the IAIR was completed in June 2005 (Reclamation). Twenty-four reservoir measures (based on location and size), many with multiple alternative hydropower generation options, were evaluated in the IAIR. The evaluations considered construction cost, potential new water supply that could be developed, hydropower impacts, potential replacement power generation, and preliminary environmental impacts. In addition, several initial water operations scenarios that could address various study objectives were identified and evaluated at a preliminary level of detail. The IAIR recommended continued study of four reservoir sites that, when combined with a set of operating rules, constitute initial alternatives.

This chapter describes management measures considered for initial alternatives to address the planning objectives and opportunities of the Investigation, refinement of initial alternatives, and evaluation of surface water storage measures in refined initial alternatives. As the Investigation continues, it is likely that additional management measures will be identified, incorporated, and addressed in the Feasibility Report and EIS/EIR.

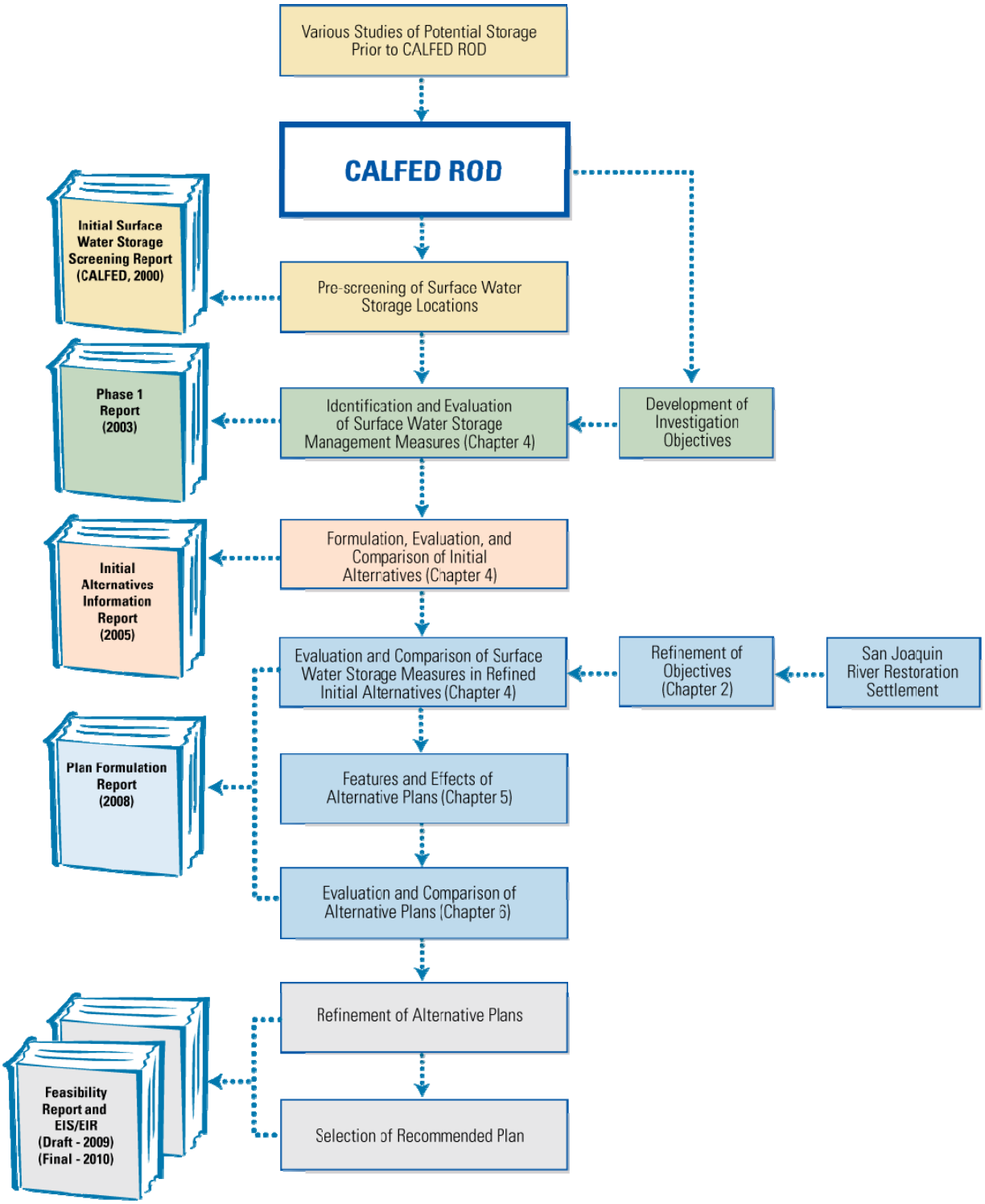

Figure 4-1. Feasibility Study Process for the Investigation

Management Measures

A management measure is any structural or nonstructural action or feature that could address the planning objectives and satisfy the other planning constraints, considerations, and criteria. Alternative plans are formulated by combining the most applicable measures that address the planning objectives, and adding measures that address opportunities. Following is a summary of measures initially considered and those selected for further development into alternative plans for the Investigation.

Measures Considered

Numerous potential measures were identified based on information from previous studies, environmental scoping, and outreach that could address the planning objectives. Measures were reviewed and refined through Study Management Team (SMT) meetings, field inspections, and coordination with stakeholders. Of the measures considered, several were selected for development into initial alternatives and alternative plans. Identification of management measures for the Investigation was limited by the planning constraints and considerations described in Chapter 3.

During Phase 1, several surface water storage measures were deleted because of potential unmitigable environmental impacts, lack of necessary participation by non-Federal entities, or cost in comparison to other measures with similar accomplishments (Reclamation, 2003). The IAIR presented incremental and comparative evaluations of surface water storage measures using cost, power generation and use, and environmental impacts criteria (Reclamation, 2005).

Tables 4-1 and 4-2 list all management measures considered during previous phases of the Investigation and during plan formulation that address the planning objectives of enhancing water temperature and flow conditions in the San Joaquin River, and improving water supply reliability, respectively. Many measures were deleted during Phase 1 and the initial alternatives phase of the Investigation, and will not be reconsidered in this PFR, but are summarized in this chapter.

Following are descriptions of management measures considered for the Investigation, and the rationale for retaining or deleting each measure from the Investigation.

Measures to Address Planning Objectives

Measures to address the planning objectives are described below. These measures include the following:

- Enhance water temperature and flow conditions in the San Joaquin River (31 measures)
- Increase water supply reliability and system operational flexibility (37 measures)

Table 4-1. Management Measures Addressing Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River

Measure	Status	Rationale
Perform Reservoir Operations and Water Management		
Balance water storage in Millerton Lake and new upstream reservoirs	**Retained**	Balancing water storage levels between multiple reservoirs could improve water temperature management and affect hydropower generation and recreation.
Modify storage and release operations at Friant Dam	**Retained**	Potential to combine with other measures involving development of San Joaquin River supplies. Consistent with other planning objective and opportunities. Consistent with CALFED goals.
Increase conservation storage in Millerton Lake by encroaching on dam freeboard	Deleted	Operable gates on the spillway allow for storage in the portion of the top of active storage capacity above the spillway crest. The remaining height to the top of the parapet walls is about 7.5 feet, providing very limited potential to encroach on existing freeboard.
Increase conservation storage in Millerton Lake by reducing flood space	Deleted	The flood management capacity of Friant Dam is lower than originally anticipated. Evaluations suggest that additional flood space would be beneficial in reducing flood damages in downstream areas. Reducing flood space would increase flood damages.
Increase Surface Water Storage in the Upper San Joaquin River Basin		
Enlarge Millerton Lake by raising Friant Dam	**Retained**	Raises of up to 140 feet (920 TAF additional storage) were considered. Retained maximum raise of 25 feet (130 TAF additional storage) in IAIR because higher raises would result in extensive residential relocation, power generation losses, and environmental impacts along the San Joaquin River and in the Fine Gold Creek watershed, and were not considered cost effective compared to other retained water storage measures.
Enlarge Millerton Lake by dredging lake bottom	Deleted	Very high cost and substantial environmental impacts for a small potential benefit.
Construct Temperance Flat RM 274 Reservoir	**Retained**	Reservoir sizes up to elevation 1,100 feet (2,110 TAF additional storage) at this site were considered. Retained maximum size at about elevation 985 (1,260 TAF new storage capacity) in IAIR because the incremental new water supply did not appear justified because of substantial additional impacts to environmental resources, additional impacts to hydropower generation, and higher construction costs.
Construct Temperance Flat RM 279 Reservoir	**Retained**	Reservoir sizes up to elevation 1,300 feet (2,740 TAF additional storage) at this site were considered. Retained maximum size at about elevation 985 (690 TAF new storage capacity) in IAIR because the incremental new water supply did not appear justified because of substantial additional impacts to environmental resources, additional impacts to hydropower generation, and higher construction costs.
Construct Temperance Flat RM 280 Reservoir	Deleted	Similar to Temperance Flat RM 279 Reservoir. Would result in similar effects on environmental resources, hydropower generation, and water supplies. Total storage capacity would be less and cost would be greater than at RM 279.
Construct Temperance Flat RM 286 Reservoir	Deleted	Reservoir sizes up to elevation 1,400 feet (1,360 TAF additional storage) at this site were considered. Deleted because environmental impacts and net impacts to hydropower generation would be greater and construction costs would be similar to comparable storage capacities at other Temperance Flat locations.

Table 4-1. Management Measures Addressing Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River (continued)

Measure	Status	Rationale
Increase Surface Water Storage in the Upper San Joaquin River Basin (continued)		
Construct Fine Gold Reservoir	**Retained**	A configuration that includes pumpback from Millerton Lake of up to 800 TAF of new storage capacity was retained in IAIR. A configuration that would involve diversion from San Joaquin River in combination with additional upstream storage was deleted because of substantial impacts to environmental resources and high cost of water supply.
Enlarge Mammoth Pool Reservoir	Retained in Concept Only	Under study by the Friant Water Users Authority and Metropolitan Water District of Southern California in study of water quality exchange opportunities. Retained in concept only. Could contribute to opportunities of flood damage reduction and hydropower generation.
Construct RM 315 Reservoir	Deleted	This reservoir, with a maximum storage capacity of about 200 TAF, would cause greater environmental impacts and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as water supply measure.
Construct Granite Project reservoirs	Deleted	Total storage capacity of about 110 TAF from multiple dams and reservoirs would cause greater environmental impacts and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as water supply measure.
Construct Jackass and Chiquito Creek reservoirs	Deleted	Total storage capacity of about 180 TAF from multiple dams and reservoirs would cause greater environmental impacts and cost more than other retained storage measures with greater storage capacity. Would require additional downstream storage. Not considered cost effective as water supply measure.
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds		
Construct Montgomery Reservoir	Deleted	An offstream reservoir with a storage capacity of up to about 240 TAF on Dry Creek would store water diverted from the Merced River and provide water in exchange for Friant Division deliveries. Potential exchange partners were not interested in a water supply with potential water quality problems, such as algae, associated with warm water.
Modify Big Dry Creek Reservoir for water storage	Deleted	An offstream reservoir with a storage capacity up to about 240 TAF on Dry Creek would store water diverted from the Merced River and provide water in exchange for Friant Division deliveries. Potential exchange partners were not interested in a water supply with potential water quality problems, such as algae, associated with warm water.
Enlarge Pine Flat Lake by raising Pine Flat Dam	Deleted	Water stored in about 120 TAF of additional storage space in Pine Flat Lake would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights.
Construct reservoir on Mill Creek	Deleted	Water diverted from Pine Flat Reservoir and stored in this new offstream reservoir with a storage capacity of up to 200 TAF would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure could cause immitigable environmental impacts to sycamore alluvial woodland habitat.

Table 4-1. Management Measures Addressing Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River (continued)

Measure	Status	Rationale
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds (continued)		
Construct Rogers Crossing Reservoir on the Kings River	Deleted	Water stored in Rogers Crossing Reservoir, with a storage capacity of up to 950 TAF, would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure would inundate a Federally designated Wild and Scenic River and a California-designated Wild Trout Fishery.
Construct Dinkey Creek Reservoir on a tributary to the Kings River	Deleted	Water stored in Dinkey Creek Reservoir, with a storage capacity of up to 90 TAF, would be exchanged for Friant Division deliveries. Potential partners were not interested in exchanges that would affect Kings River water rights. In addition, this measure would cause substantial impacts to regional transportation and adversely affect high value fishery areas in downstream areas.
Construct Dry Creek Reservoir on a tributary to the Kaweah River	Deleted	Water diverted from Lake Kaweah and stored in a 70 TAF offstream reservoir would be exchanged for Friant Division deliveries. This measure could cause immitigable environmental impacts to sycamore alluvial woodland habitat.
Raise Terminus Dam	Deleted	Previously authorized for construction by the U.S. Army Corps of Engineers.
Raise Success Dam	Deleted	Previously authorized for construction by the U.S. Army Corps of Engineers.
Increase Surface Water Storage off the Friant-Kern Canal		
Construct reservoir in Yokohl Valley	Deleted	A new reservoir with a capacity of up to about 800 TAF would store water conveyed from Millerton Lake via the Friant-Kern Canal. Deleted because of conveyance limitations in the Friant-Kern Canal, potential that water quality problems associated with warm water would preclude water transfers, potential environmental impacts, and likely low willingness of local landowners to participate.
Construct Hungry Hollow Reservoir on Deer Creek	Deleted	A new reservoir with a capacity of up to about 800 TAF would store water conveyed from Millerton Lake via the Friant-Kern Canal. Deleted because of potential high costs associated with poor foundation conditions, conveyance limitations in the Friant-Kern Canal, and the presence of a potentially immitigable sycamore alluvial woodland habitat.
Construct Water Temperature Management Devices		
Construct temperature control devices on Friant Dam canal outlets	**Retained**	Selective withdrawal for releases to the Madera and Friant-Kern canals from upper levels of Millerton Lake could preserve cold water in Millerton Lake.
Construct temperature control device on Friant Dam river outlet	**Retained**	Selective withdrawal for releases to the San Joaquin River could improve the management of cold water in Millerton Lake.
Construct selective level intake structures on new upstream dams	**Retained**	Selective withdrawal for releases to Millerton Lake from new upstream reservoirs could help manage cold water in Millerton Lake.

Table 4-1. Management Measures Addressing Planning Objective of Enhancing Water Temperature and Flow Conditions in the San Joaquin River (continued)

Measure	Status	Rationale
Increase Groundwater Storage		
Increase conjunctive management of water in the Friant Division	Retained in Concept Only	Conjunctive management in the Friant Division occurs by increasing groundwater recharge with additional Class 2 deliveries or the development of local surface water supplies. Potential to combine with other measures involving development of San Joaquin River supplies, such as increasing surface water storage in the upper San Joaquin River basin. Because specific potential conjunctive management projects have not been identified, this measure is retained in concept only.
Construct and operate groundwater banks in the Friant Division	Retained in Concept Only	Groundwater banks operated as allocable water supplies in the Friant Division could provide water for river releases. Because specific potential projects have not been identified, this measure is retained in concept only.

Key:
CALFED = CALFED Bay-Delta Program
elevation xxxx = elevation in feet above mean sea level
IAIR = Initial Alternatives Information Report
RM = river mile
TAF = thousand acre-feet

Table 4-2. Management Measures Addressing Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility

Measure	Status	Rationale
Perform Reservoir Operations and Water Management		
Modify storage and release operations at Friant Dam	**Retained**	Same as described in Table 4-1.
Integrate Friant Dam operations with SWP and/or CVP outside Friant Division	**Retained**	Integrating operations of Friant Division facilities with SWP and/or CVP facilities through water exchanges could improve water supply reliability and urban water quality. Opportunities with existing facilities are limited. Potential to combine with other measures relating to increasing surface water storage in the upper San Joaquin River basin and increasing transvalley conveyance capacity.
Modify diversion to Madera and Friant-Kern canals	Retained in Concept Only	Modifying the timing and quantity of water diverted to Madera and Friant-Kern canals would increase water supply reliability to Friant Division contractors and may provide opportunities for groundwater banking. Would support planning objectives. Because specific operations for groundwater banking have not been defined, this measure is retained in concept only.
Capture downstream San Joaquin River flow released from Friant Dam	Retained in Concept Only	Downstream capture of regulated San Joaquin River flows could increase water supply reliability in the Friant Division. Currently under separate evaluation by the SJRRP. Because specific operations have not been developed to date, this measure is retained in concept only.
Increase conservation storage in Millerton Lake by encroaching on dam freeboard	Deleted	Same as described in Table 4-1.
Increase conservation storage in Millerton Lake by reducing flood space	Deleted	Same as described in Table 4-1.
Increase Surface Water Storage in the Upper San Joaquin River Basin		
Enlarge Millerton Lake by raising Friant Dam	**Retained**	Same as described in Table 4-1.
Enlarge Millerton Lake by dredging lake bottom	Deleted	Same as described in Table 4-1.
Construct Temperance Flat RM 274 Reservoir	**Retained**	Same as described in Table 4-1.
Construct Temperance Flat RM 279 Reservoir	**Retained**	Same as described in Table 4-1.
Construct Temperance Flat RM 280 Reservoir	Deleted	Same as described in Table 4-1.
Construct Temperance Flat RM 286 Reservoir	Deleted	Same as described in Table 4-1.

Table 4-2. Management Measures Addressing Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility (continued)

Measure	Status	Rationale
Increase Surface Water Storage in the Upper San Joaquin River Basin (continued)		
Construct Fine Gold Reservoir	**Retained**	Same as described in Table 4-1.
Enlarge Mammoth Pool Reservoir	Retained in Concept Only	Same as described in Table 4-1.
Construct RM 315 Reservoir	Deleted	Same as described in Table 4-1.
Construct Granite Project reservoirs	Deleted	Same as described in Table 4-1.
Construct Jackass and Chiquito Creek project reservoirs	Deleted	Same as described in Table 4-1.
Increase Surface Water Storage in Other Eastern Sierra Nevada Watersheds		
Construct Montgomery Reservoir	Deleted	Same as described in Table 4-1.
Modify Big Dry Creek Reservoir for water storage	Deleted	Same as described in Table 4-1.
Enlarge Pine Flat Lake by raising Pine Flat Dam	Deleted	Same as described in Table 4-1.
Construct Reservoir on Mill Creek	Deleted	Same as described in Table 4-1.
Construct Rogers Crossing Reservoir on the Kings River	Deleted	Same as described in Table 4-1.
Construct Dinkey Creek Reservoir on a tributary to the Kings River	Deleted	Same as described in Table 4-1.
Construct Dry Creek Reservoir on a tributary to the Kaweah River	Deleted	Same as described in Table 4-1.
Raise Terminus Dam	Deleted	Same as described in Table 4-1.
Raise Success Dam	Deleted	Same as described in Table 4-1.
Increase Surface Water Storage off the Friant-Kern Canal		
Construct reservoir in Yokohl Valley	Deleted	Same as described in Table 4-1.
Construct Hungry Hollow Reservoir on Deer Creek	Deleted	Same as described in Table 4-1.
Increase Groundwater Storage		
Increase conjunctive management of water in the Friant Division	Retained in Concept Only	Conjunctive management in the Friant Division occurs by increasing groundwater recharge with additional Class 2 deliveries or the development of local surface water supplies. Under the SJRRP, Class 2 deliveries will decrease. Potential to combine with other measures involving development of San Joaquin River supplies. Because specific potential projects have not been identified, this measure is retained in concept only.

Table 4-2. Management Measures Addressing Planning Objective of Increasing Water Supply Reliability and System Operational Flexibility (continued)

Measure	Status	Rationale
Increase Groundwater Storage (continued)		
Construct and operate groundwater banks in the Friant Division	Retained in Concept Only	Groundwater banks operated as allocable water supplies in the Friant Division could provide water additional water storage, but Friant Division water supplies are projected to decrease through implementation of the SJRRP. Potential to combine with other measures involving development of San Joaquin River supplies. Because specific potential projects have not been identified, this measure is retained in concept only.
Reduce Water Demand		
Implement water conservation and water use efficiency methods in excess of those in the Without-Project Condition	Deleted	Opportunities to apply large-scale water conservation measures in the Friant Division are limited because conveyance losses and excess water application returns to groundwater for use in subsequent years.
Retire agricultural lands	Deleted	Does not address planning objectives and consideration/criteria. On a large scale, could have substantial negative impacts on agricultural industry.
Increase Transvalley Conveyance Capacity		
Construct Trans Valley Canal	**Retained**	Potential to combine with other measures, including integration of Friant Dam operations with CVP and SWP, and increasing surface water storage in the upper San Joaquin River basin.
Perform Water Transfers and Purchases		
Transfer water between Friant Division water users	Deleted	Does not address planning objectives or considerations/criteria. An ongoing practice among Friant Division water users to maximize use of Friant Division water deliveries.
Enhance Delta Export and Conveyance		
Expand Banks Pumping Plant	Deleted	Does not address planning objectives or considerations/criteria. Would likely be accomplished with or without additional efforts to develop new sources.
Construct DMC/CA Intertie	Deleted	Does not address planning objectives or considerations/criteria. Would likely be accomplished with or without additional efforts to develop new sources.
Improve Delta export and conveyance capability through coordinated CVP and SWP operations	Deleted	JPOD is being actively pursued in other programs.

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

Enhance Water Temperature and Flow Conditions in the San Joaquin River As mentioned, 31 potential management measures were identified to address water temperature and flow conditions in the San Joaquin River. These measures were separated into six categories: (1) perform reservoir operations and water management, (2) increase surface water storage in the upper San Joaquin River basin, (3) increase surface water storage in other eastern Sierra Nevada watersheds, (4) increase surface water storage off the Friant-Kern Canal, (5) construct water temperature management devices, and (6) increase groundwater storage. Of the 31 measures identified specifically to address the planning objective of enhancing water temperature and flow conditions in the San Joaquin River, as shown in Table 4-1, three measures were retained in concept only, and nine measures were retained for initial alternative plan formulation.

Increase Water Supply Reliability and System Operational Flexibility Within the study area, geographic regions that may be targeted for increasing water supply reliability include the Friant Division of the CVP, non-Friant Division contractors in the eastern San Joaquin Valley, the lower San Joaquin River area, and areas served by Delta exports (CVP and SWP SOD). The scope of management measures addressing water supply reliability are limited by planning constraints and considerations described in Chapter 2.

Broad categories of management measures for the Investigation that may increase water supply reliability include (1) perform reservoir operations and water management, (2) increase surface water storage in the upper San Joaquin River basin, (3) increase surface water storage in other eastern Sierra Nevada watersheds, (4) increase surface water storage off the Friant-Kern Canal, (5) increase groundwater storage, (6) reduce water demand, (7) increase transvalley conveyance capacity, (8) perform water transfers and purchases, and (9) enhance Delta export and conveyance. Many of the specific management measures identified in Table 4-1 for enhancing water temperature and flow conditions in the San Joaquin River are common to measures provided for improving water supply reliability. Of the 37 measures identified to increase water supply reliability, as shown in Table 4-2, five measures were retained in concept only, and seven measures were retained for alternative plan formulation.

Measures to Address Opportunities

Numerous potential measures were identified that could contribute to the opportunities of (1) improving management of flood flows at Friant Dam, (2) preserving and increasing energy generation and improving energy management, (3) preserving and increasing recreation opportunities in the study area, (4) improving San Joaquin River water quality, and (5) improving quality of water supplies delivered to urban areas. Management measures that address opportunities that could be implemented in coordination with measures that address planning objectives are listed in Table 4-3. Descriptions of each measure and details of the rationale for retaining or deleting the measure from the Investigation follow.

Improve Management of Flood Flows at Friant Dam Flood damage reduction measures in general involve several types of actions, including improving the management of flood flows at dams by changing objective flows or adding flood storage space, improving the reliability of downstream flood conveyance channels, or removing damageable property from floodplain areas. For the Investigation, it is recognized that the SJRRP will include numerous modifications to downstream flood conveyance channels, but that these modifications have not yet been identified. Because this opportunity is being considered to the extent that it can be implemented in conjunction with actions to achieve objectives, it is limited to modifications to reservoir operations at Friant Dam to the extent that these changes would improve the management of flood flows at Friant Dam to the San Joaquin River. Measures that could contribute to improving the management of flood flows at Friant Dam are listed in Table 4-3.

Preserve and Increase Energy Generation and Improve Energy Generation Management As described in Chapter 3, the upper San Joaquin River basin has been highly developed for hydropower generation with projects that serve base and peak loads in the San Joaquin Valley and Southern California. The development and management of additional water supplies in the upper San Joaquin River basin provide an opportunity to add hydropower generation capacity and improve energy generation management in the study area. Management measures to preserve and increase energy generation and improve energy generation management are shown in Table 4-3.

Preserve and Increase Recreation Opportunities in the Study Area Two management measures were identified to preserve and increase recreation opportunities at Millerton Lake and within the upper San Joaquin River basin. Additionally, the management measure to balance water storage in Millerton Lake and new upstream reservoirs, described in Table 4-1, may also increase recreation opportunities in the study area.

Table 4-3. Management Measures Addressing Opportunities

Measure	Status	Rationale
Opportunity – Improve Management of Flood Flows at Friant Dam		
Change objective flood release from Friant Dam	Retained in Concept Only	Could be compatible with any potential new storage measure. Would not conflict with other opportunities or planning constraints/criteria. Because specific operations have not been defined, this measure was retained in concept only.
Increase flood storage space in or upstream from Millerton Lake	**Retained**	May be compatible with the planning objectives. Would not conflict with other opportunities or planning constraints/criteria.
Opportunity – Preserve and Increase Energy Generation and Improve Energy Generation Management		
Modify existing or construct new generation facilities at Friant Dam canal outlets	**Retained**	Would only be combined with raising Friant Dam to utilize potential increased water elevation generation head.
Modify existing or construct new generation facilities at Friant Dam river outlet	Deleted	Orange Cove Irrigation District filed on April 19, 2006, requesting Federal Energy Regulatory Commission approval of an amendment of license for the Fishwater Release Project to add a powerhouse with a single turbine generator with a capacity of 1.8 megawatts.
Construct new hydropower generation facilities on retained new surface water storage measures	**Retained**	Would increase the capability to recover lost generation capacity at each retained Temperance Flat Reservoir site and recover pumping energy at Fine Gold Reservoir. Would not conflict with other opportunities or planning constraints/criteria.
Extend Kerckhoff No. 2 tunnel around new surface water storage measures	**Retained**	Would involve extending the Kerckhoff No. 2 tunnel and constructing a new powerhouse downstream from either the Temperance Flat RM 279 or RM 274 dam sites. Would increase capability to recover lost generation. Would not conflict with other opportunities or planning constraints/criteria.
Construct pumped-storage facilities	Retained in Concept Only	Could be combined with hydropower generation facilities associated with Temperance Flat and Fine Gold reservoirs. Would not conflict with other opportunities or planning constraints/criteria. This measure was retained in concept only because specific operations have not been defined, it would add additional cost, and it would require participation by a non-Federal sponsor with an interest in power development and management. Pumped-storage could be added to an alternative plan at a later time if it is determined to be a beneficial increment.
Opportunity – Preserve and Increase Recreation Opportunities in the Study Area		
Replace or upgrade recreation facilities	**Retained**	Compatible with any potential modification of Millerton Lake. Would be consistent with established planning guidelines for Federal water storage projects and with existing recreation uses at Millerton Lake State Recreation Area.
Develop new management plan for Millerton Lake State Recreation Area	Deleted	Management plan update under development by Reclamation under separate study.

Table 4-3. Management Measures Addressing Opportunities (continued)

Measure	Status	Rationale
Opportunity – Improve San Joaquin River Water Quality		
Reduce salt discharge to San Joaquin River	Deleted	Currently being implemented under the San Joaquin Valley Drainage Management Program.
Recirculate Delta-Mendota Canal deliveries to the San Joaquin River	Deleted	Would increase flows and could improve water quality from Mendota Pool to the Delta. Would not provide flows in the reach from Friant Dam to Mendota Pool. Independent ongoing study authorized by Public Law 108-573.
Increase flows in tributaries to lower San Joaquin River	Deleted	Would increase flows and improve water quality from Mendota Pool to the Delta, but would not provide flows to the reach from Friant Dam to Mendota Pool.
Release water from Friant Dam during the late irrigation season to improve river water quality	Deleted	Conflicts with planning objective of increasing water supply reliability.
Opportunity – Improve Quality of Water Supplies Delivered to Urban Areas		
Treat poor quality groundwater	Deleted	High implementation costs, limited application and benefits.
Integrate Friant Dam operations with State Water Project and/or Central Valley Project outside the Friant Division	**Retained**	Same as described in Table 4-2. The operations of this measure would be formulated for water supply benefits but would also have incidental urban water quality benefits.
Construct desalination facility	Deleted	Limited application as a dry-year supply, high unit cost, and potential environmental impacts from treatment byproducts.

Key:
Delta = Sacramento-San Joaquin Delta
RM = river mile

Improve San Joaquin River Water Quality All three management measures identified to improve San Joaquin River water quality were not retained for further consideration. Reclamation is currently implementing measures to eliminate salt discharge from drainage-impaired lands to the San Joaquin River under the San Joaquin Valley Drainage Management Program. Because the measure to recirculate Delta-Mendota Canal deliveries is being implemented under a separate authority, it was deleted from further consideration in the Investigation. Settlement Restoration Flows are also anticipated to result in improved water quality conditions in the San Joaquin River below Friant Dam to the Merced River confluence.

Improve Quality of Water Supplies Delivered to Urban Areas Three management measures were identified to improve water quality delivered to urban areas. These measures were identified to reduce the levels of constituents that can cause health concerns in drinking water.

Measures Retained for Further Development

Measures retained for further development are summarized below, including measures to address planning objectives and opportunities.

Measures Retained Addressing Planning Objectives

Following is a brief description of the management measures retained for initial alternatives and potential further consideration in alternative plans that specifically address the planning objectives of the Investigation. Additionally, measures to increase groundwater storage retained in concept only are described in more detail. The remaining measures retained in concept only are not discussed because they are either under evaluation in another study or have unspecified operations, as mentioned in Tables 4-1 and 4-2.

Perform Reservoir Operations and Water Management Reservoir operations and water management measures retained for further consideration are described below.

Balance Water Storage in Millerton Lake and New Upstream Reservoirs

The management of water supplies between Millerton Lake and additional upstream surface water storage in the upper San Joaquin River basin could affect water temperature management, hydropower generation, and recreation. Reservoir balancing scenarios were developed for inclusion in alternatives that also include additional upstream storage. Separate reservoir balancing scenarios were developed for surface water storage measures in the upper San Joaquin River basin, as described below:

- **Millerton Lake Baseline Scenario –** This balancing scenario strives to maintain storage levels in Millerton Lake similar to levels in the without-project condition. It is believed this scenario would have the minimum effect on changes to recreation conditions at Millerton Lake.

- **Millerton Lake High Scenario –** This balancing scenario strives to maintain high storage levels in Millerton Lake throughout the summer season. It is believed this scenario would provide the least hydropower generation at potential upstream reservoirs and enhance recreation opportunities at Millerton Lake.

These reservoir balancing scenarios will continue to be refined as operational studies proceed in the feasibility study.

Modify Storage and Release Operations at Friant Dam Modifications to storage and release operations at Friant Dam may be combined with other measures involving developing water supplies in the upper San Joaquin River basin to enhance San Joaquin River water temperature and flow conditions and increase water supply reliability.

Integrate Friant Dam Operations with State Water Project and/or Central Valley Project Outside Friant Division Integration of Friant Dam operations with the SWP and CVP outside the Friant Division could provide opportunities for exchange of water supplies, allowing greater optimization of system operations for improved water supply reliability. The extent to which water supply reliability improvements can be realized may be limited by available conveyance capacity in existing transvalley conveyance facilities and available SOD storage capacity. Increasing surface water storage in the upper San Joaquin River basin, along with expansion of existing conveyance facilities and/or construction of additional transvalley conveyance, would substantially increase potential water supply.

Increase Surface Water Storage in the Upper San Joaquin River Basin
During Phase 1 and the Initial Alternatives Phase of the Investigation, several potential surface water storage sites in the upper San Joaquin River basin were identified and evaluated for potential inclusion in alternatives (Reclamation, 2003; 2005). At many sites, multiple sizes and configurations were considered. Evaluations considered water supply operations, general environmental consequences, construction costs, and energy generation and use. General locations of each measure considered are shown in Figure 4-2. Following is a brief description of each measure retained in the IAIR for plan formulation. These measures were subjected to further evaluation and comparison during the plan formulation phase, as described later in this chapter.

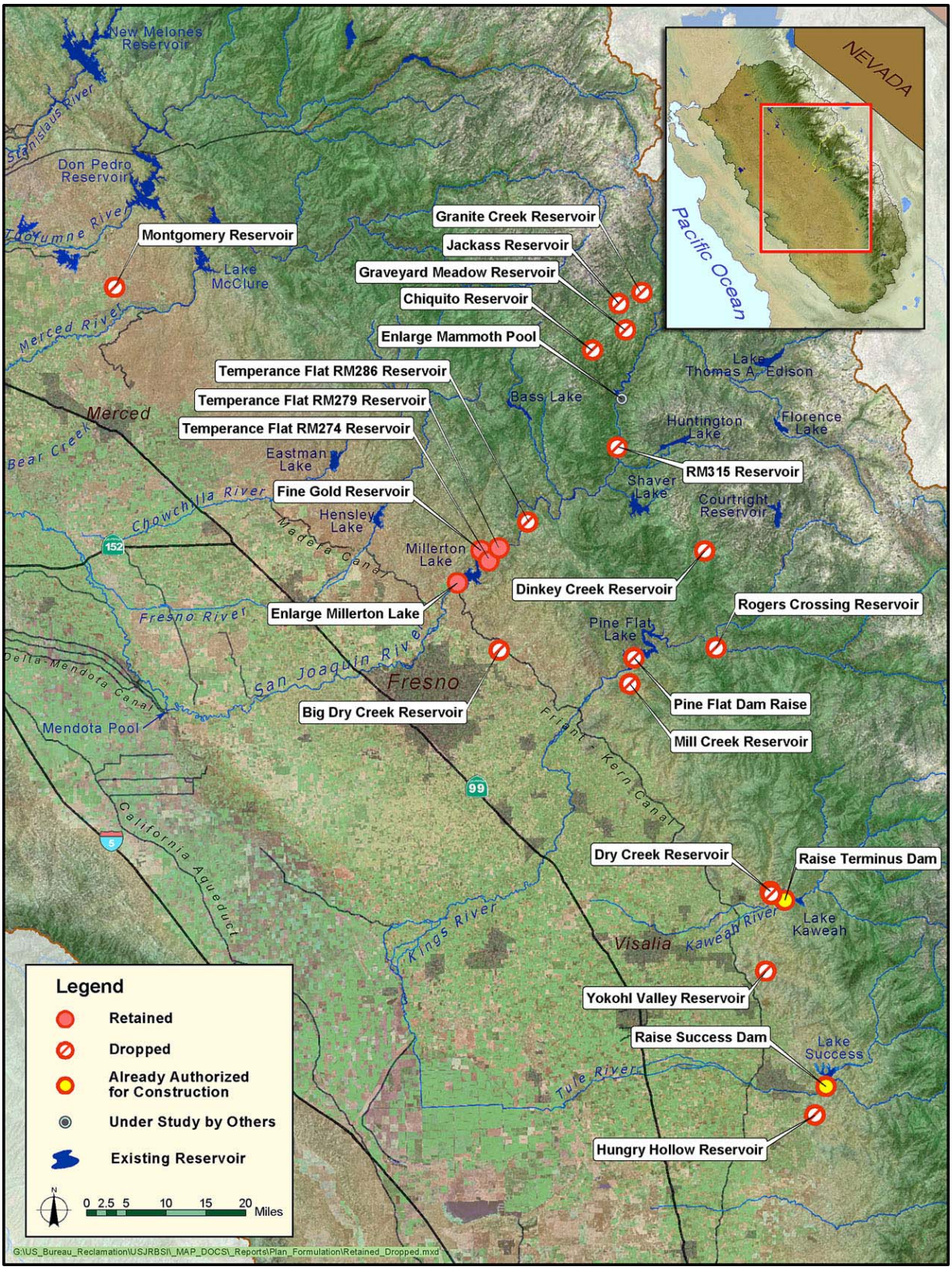

Figure 4-2. Surface Water Storage Measures Considered

Enlarge Millerton Lake by Raising Friant Dam This measure would involve raising the height of Friant Dam and constructing necessary saddle dams to enlarge Millerton Lake. The enlargement retained in the IAIR was a 25-foot raise of Friant Dam, which would increase reservoir storage capacity in Millerton Lake by 120 TAF. Friant Dam would be raised by adding an overlay of roller-compacted concrete (RCC) on the downstream face of the dam, and enlarging two earthfill saddle dams. Evaluations completed during the Initial Alternatives Phase of the Investigation concluded that this measure would not be carried forward as a stand-alone alternative because the new water supply that could be developed would not likely contribute to river restoration or water supply reliability (Reclamation, 2005).

Construct Temperance Flat RM 274 Reservoir Temperance Flat RM 274 Reservoir would be created through construction of a dam in the upstream portion of Millerton Lake at RM 274. The dam site is located approximately 6.8 miles upstream from Friant Dam and 1 mile upstream from the confluence of Fine Gold Creek and Millerton Lake. Reservoir sizes up to elevation 1,100 at this site were considered in previous phases of the Investigation. Sizes corresponding to elevations higher than 985 were not retained because the incremental new water supply provided did not appear justified in light of substantial additional impacts to environmental resources, additional impacts to hydropower generation, and higher construction costs (Reclamation, 2005). The retained measure, a reservoir with a top of active storage capacity at elevation 985, would provide 1,260 TAF of new storage capacity and extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. At top of active storage capacity, the reservoir level would reach about 12 feet below the crest of Kerckhoff Dam.

Construct Temperance Flat RM 279 Reservoir Temperance Flat RM 279 Reservoir would be created through construction of a dam in the upstream portion of Millerton Lake at RM 279. The dam site is located approximately 11.6 miles upstream from Friant Dam. Reservoir sizes up to elevation 1,300 at this site were considered in previous phases of the Investigation (Reclamation, 2005). Sizes corresponding to elevations higher than 985 were not retained because the incremental new water supply provided did not appear justified in light of substantial additional impacts to environmental resources, additional impacts to hydropower generation, and higher construction costs. The retained measure, a reservoir with a top of active storage capacity at elevation 985, would provide 690 TAF of new storage capacity and extend about 13.6 miles upstream from RM 279 to Kerckhoff Dam. At top of active storage capacity, the reservoir level would reach about 12 feet below the crest of Kerckhoff Dam.

Construct Fine Gold Reservoir Constructing a dam on Fine Gold Creek would create a reservoir with a storage capacity of 780 TAF that could store water pumped from Millerton Lake. Water would be pumped from Millerton Lake to create additional storage capacity in Millerton Lake. Water would be released from Fine Gold Creek Reservoir to Millerton Lake during periods of highest demand for releases from Friant Dam to the San Joaquin River and Friant-Kern and Madera canals.

Construct Water Temperature Management Devices Installation of water temperature management devices could assist in the management of cold water in Millerton Lake or new upstream reservoirs and thereby contribute to restoration of the San Joaquin River through enhancing temperature conditions for species that require cold water during specific life stages.

Construct Temperature Control Devices on Friant Dam Canal Outlets Temperature control devices (TCD) could be constructed on each of the canal outlets to allow the diversion of water from upper levels of the reservoir to preserve colder water for release to the river. Similar designs of steel TCDs could be installed on either the current configuration or a raised Friant Dam.

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

Construct Selective Level Intake Structures on New Upstream Dams Selective level intake structures (SLIS) could be constructed on the intakes for dams associated with measures to increase surface water storage in the upper San Joaquin River basin. The SLIS would allow selective withdrawal of water from these upper reservoirs for temperature management and discharged into Millerton Lake.

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

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

During plan formulation, DWR conducted a San Joaquin Valley Conjunctive Water Management Opportunities analysis and identified several potential conjunctive management or groundwater storage projects in the San Joaquin Valley that could be considered in any regional water resources study (DWR, 2006c). Fifteen potential groundwater storage projects in the San Joaquin Valley were identified that appear to have high potential for implementation. As shown in Figure 4-3, recommended potential conjunctive management and groundwater storage projects are located in the Madera, Kings, and Kern county groundwater basins (DWR, 2006c). These potential projects have not yet been evaluated to determine their ability to contribute to Investigation objectives, and would require considerable additional data development for site-specific analysis. Thus, the measures described below related to increasing groundwater storage were retained in concept only.

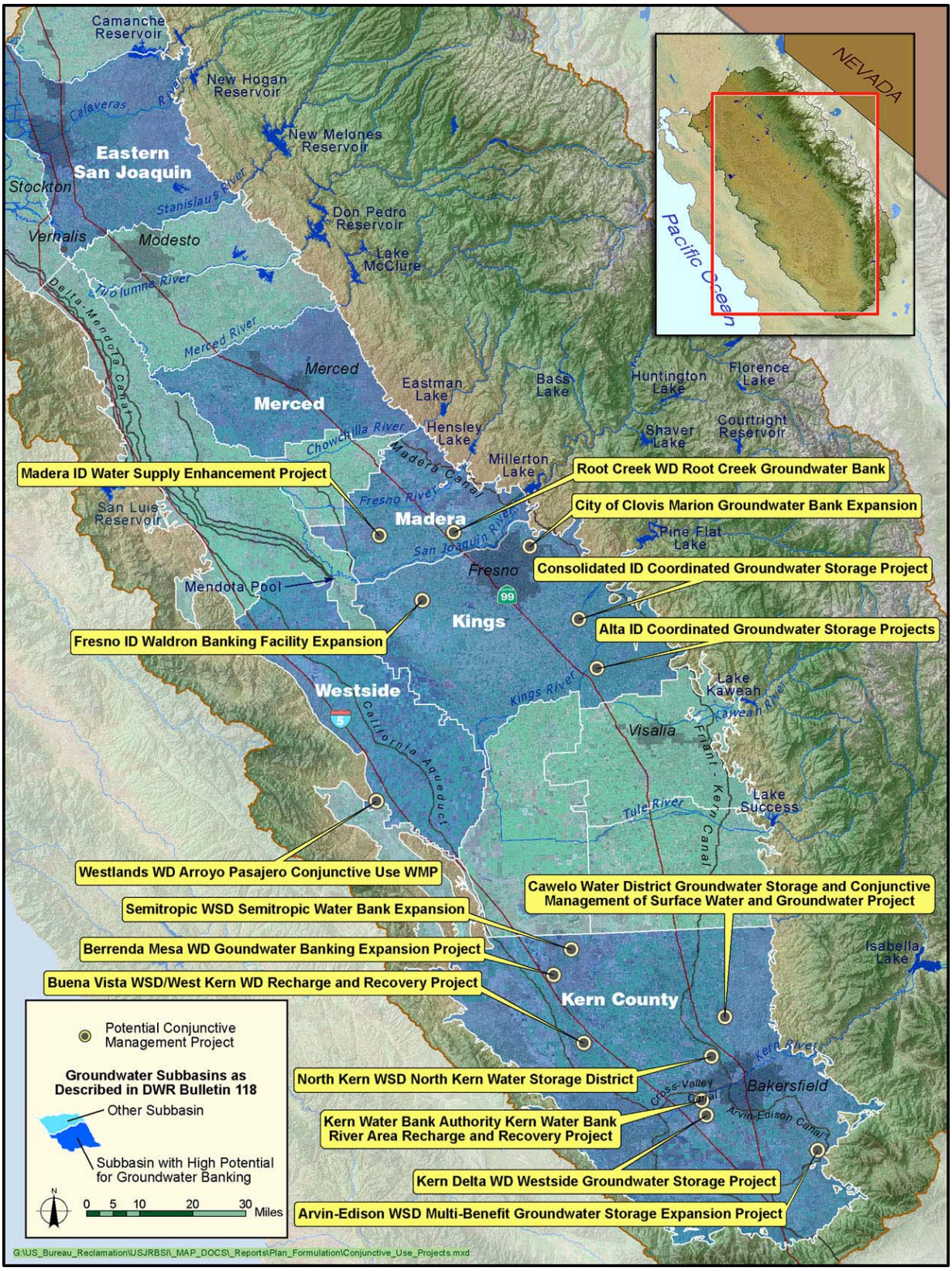

Figure 4-3. Potential Groundwater Storage Measures

Increase Conjunctive Management of Water in the Friant Division As noted above, the Friant Division is a regional conjunctive management project. Water deliveries under long-term Class 2 contracts are specifically intended for delivery to areas with access to groundwater. In wet years, Class 2 water and water delivered under Section 215 contracts are recharged to groundwater or delivered directly in lieu of groundwater pumping. Measures that increase the total delivery of Class 2 water and Section 215 supplies to Friant Division contractors, such as surface water storage measures, would increase conjunctive management and help reduce groundwater overdraft in the region.

Development of local surface water supplies for groundwater recharge, or direct delivery in lieu of groundwater pumping, would increase groundwater storage and help reduce regional overdraft. Increasing groundwater recharge through additional Class 2 deliveries or developing local surface water supplies could help facilitate exchange agreements between Friant Division water users and others. Potential measures identified in the San Joaquin Valley Conjunctive Water Management Opportunities analysis (DWR, 2006c) have not been reviewed to assess their ability to support planning objectives of the Investigation. As mentioned, because specific groundwater recharge facilities have not been defined, this measure is retained in concept only.

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

This measure would involve development of groundwater banks that could support one or more planning objectives. Through the San Joaquin Valley Conjunctive Management Opportunities Study (DWR, 2006c), DWR has begun to identify potential participants who may be interested in groundwater banks that could support Friant contractors. However, as mentioned, because specific potential projects have not been identified, this measure is retained in concept only.

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

Results indicated that an average annual new water supply of up to 17 TAF could be developed through groundwater banking at a put capacity of up to 1,500 cfs without additional surface water storage. Groundwater banking opportunities to support Investigation objectives would diminish as surface water storage capacity increases, and the additional water supply developed with conjunctive management above the supply developed with surface storage is quite small. The evaluation indicated that with new surface water storage of 690 TAF and 1,260 TAF, the incremental amount of additional water supply developed with groundwater banking at a put capacity of up to 1,500 cfs would be up to 8 TAF and 3 TAF, respectively. Typically, reservoir storage capacity would be used before water would be recharged to avoid losses and the additional costs of extraction. To date, specific projects have not been defined sufficiently to allow their evaluation for inclusion in alternatives. Therefore, as mentioned, this measure is retained in concept only at this time.

Increase Transvalley Conveyance Capacity Developing new facilities to convey water across the southern San Joaquin Valley east to west, or west to east, between the Friant-Kern Canal and California Aqueduct, could increase water supply reliability. The measure retained to increase transvalley conveyance capacity is described below.

Construct Trans Valley Canal Increasing transvalley conveyance capacity through construction of a new major transvalley canal would enable potential integration between the Friant Division with the SWP and/or CVP system outside the Friant Division through water exchanges. The Trans Valley Canal would have a conveyance capacity of 1,000 cfs. A conceptual alignment for the canal is more than 50 miles long, and includes a connection to the Friant-Kern Canal near Porterville and a connection to the California Aqueduct south of the Tulare Lake bed. This measure is also being studied at a preliminary level of detail by the FWUA-MWDSC Partnership and the SJRRP.

Measures Retained Addressing Opportunities

Measures retained to address opportunities are described below. These measures include one measure to improve management of flood flows at Friant Dam, three measures to increase energy generation management, one measure to preserve and increase recreation opportunities in the area, and one measure to improve quality of water supplies delivered to urban areas. The measures retained in concept only are not included in this discussion because they have undefined operations, as mentioned in Table 4-3.

Improve Management of Flood Flows at Friant Dam A potential measure that could contribute to increasing the management of flood flows at Friant Dam through increasing flood storage space, as described below.

Increase Flood Storage Space in or Upstream from Millerton Lake
Development of additional storage for water supply provides opportunities for additional dedicated or incidental flood storage space. Evaluations completed during the Initial Alternatives Phase considered the benefits associated with additional dedicated flood space in or upstream from Friant Dam (Reclamation, 2005).

Preserve and Increase Energy Generation and Improve Energy Generation Management Potential measures that could contribute to development of hydropower generation capacity include the three measures described below.

Modify Existing or Construct New Generation Facilities at Friant Dam Canal Outlets This measure would only be combined with the Enlarge Millerton Lake by raising Friant Dam measure, and would provide a potential increase in hydropower output.

Construct New Hydropower Generation Facilities on Retained New Surface Water Storage Measures The construction of new surface water storage facilities presents an opportunity to add hydropower generation facilities and improve energy generation management in the study area.

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

Preserve and Increase Recreation Opportunities in the Study Area Potential measures retained for the Investigation that could preserve and increase recreation opportunities in the study area include replacing or upgrading recreation facilities, as described below. A management measure to balance water storage in Millerton Lake and new upstream reservoirs for recreation was discussed above.

Replace or Upgrade Recreation Facilities Implementation of surface water storage and reservoir operations measures would affect existing recreation facilities at Millerton Lake. This measure includes developing suitable replacement facilities, with necessary upgrades to meet current standards and codes, to provide similar or greater recreational opportunities. It is recognized that some recreational experiences, such as whitewater rafting and caving, may not be replaceable for some alternatives.

Improve Quality of Water Supplies Delivered to Urban Areas One measure for improving urban water quality was retained for plan formulation, as described below.

Integrate Friant Dam Operations with State Water Project and/or Central Valley Project Outside of the Friant Division Integrating operations of Friant Dam with operations of SWP and CVP systems would allow for increased Delta exports during wet conditions, and the potential to reduce exports during dry periods, through exchange of water supplies. Water exported during wet periods would be of higher quality. Improvements in raw water quality can benefit urban water areas through a reduction in the treatment costs required to attain a given level of finished water quality.

Refinement of Initial Alternatives

Eighty-four management measures have been identified during the Investigation, as described in previous sections of this chapter. Combinations of retained measures formed various initial alternatives that were developed to address the planning objectives. Many measures that either are not well defined at this time or are under study by others were retained in concept only and, therefore, will not be explicitly defined for inclusion in alternative plans.

Because of these limitations, initial alternatives developed to date fundamentally consist of constructing new surface water storage facilities and operating them primarily to enhance temperature and flow conditions in the San Joaquin River, and increase water supply reliability. Additional retained measures include constructing water temperature management devices, and increasing transvalley conveyance capacity.

Further evaluation and comparison of initial alternatives was performed early during the plan formulation phase. Initial plan formulation efforts concluded that combining an enlargement of Millerton Lake with one of the other storage sites (Temperance Flat RM 274, Temperance Flat RM 279, or Fine Gold reservoirs) would not be effective because very limited additional water supply would be provided and because of the impacts to private property and recreation facilities. Thus, the Enlarge Millerton Lake management measure will not be considered further in this PFR or the Investigation. Other measures addressing opportunities associated with the Enlarge Millerton Lake measure, such as modified or new generation facilities at Friant Dam canal outlets, are also not being considered for further evaluation in the Investigation.

As discussed in Chapter 2, planning considerations were specifically identified to help formulate, evaluate, and compare alternative plans. One important consideration is that alternative plans would include project features for mitigating impacted power generation through developing additional power generation facilities in preference to purchasing replacement energy. This consideration leads to the inclusion of the following measures in initial alternatives considered during plan formulation to replace impacted generation: construct new hydropower generation facilities on retained new surface water storage measures, and extend Kerckhoff No. 2 tunnel around new surface water storage measures.

On the basis of these evaluations, the refined initial alternatives listed below were retained for further evaluation during plan formulation. For each initial alternative, several configurations were formulated to assess the incremental costs and benefits that would result from additional storage, reservoir operations, multiple reservoir elevations, and water temperature management, where relevant.

- Fine Gold Reservoir up to 380 TAF of new storage capacity (380 TAF) with pump-generating facility
- Fine Gold Reservoir up to 780 TAF of new storage capacity (780 TAF) with pump-generating facility
- Temperance Flat RM 279 Reservoir up to 430 TAF of new storage capacity (430 TAF) with extended Kerckhoff No. 2 tunnel
- Temperance Flat RM 279 Reservoir up to 690 TAF of new storage capacity (690 TAF) with extended Kerckhoff No. 2 tunnel
- Temperance Flat RM 274 Reservoir up to 1,260 TAF of new storage capacity (1,260 TAF) with extended Kerckhoff No. 2 tunnel

Evaluation of Surface Water Storage Measures in Refined Initial Alternatives

The surface water storage measures of refined initial alternatives discussed above are listed in Table 4-4. These surface water storage measures are evaluated in a two-step process. Ranges of potential sizes at each site are evaluated to identify incremental cost effectiveness (Step 1). Surface water storage measures retained through Step 1 are comparatively evaluated across sites in Step 2 consistent with four criteria based on the P&G: (1) effectiveness, (2) efficiency, (3) acceptability, and (4) completeness (WRC, 1983). Surface water storage measures retained in plan formulation comparisons through Step 2 are carried forward for development of alternative plans described in Chapter 5.

Table 4-4. Surface Water Storage Measures in Refined Initial Alternatives Subjected to Two-Step Comparison

Step 1 – Incremental Cost Effectiveness		
Fine Gold Reservoir (380 TAF)	Compared to:	Fine Gold Reservoir (780 TAF)
Temperance Flat RM 279 Reservoir (430 TAF)	Compared to:	Temperance Flat RM 279 Reservoir (690 TAF)
Step 2 – Surface Water Storage Measures Site Comparison		
Temperance Flat RM 279 Reservoir (690 TAF)		
Fine Gold Reservoir (780 TAF)		
Temperance Flat RM 274 Reservoir (1,260 TAF)		

Key:
RM = river mile
TAF = thousand acre-feet

Step 1 Incremental Cost Effectiveness of Surface Water Storage Measures in Refined Initial Alternatives

The following sections briefly summarize findings of technical evaluations performed during initial plan formulation for incremental cost effectiveness at a range of potential sizes across surface water storage sites, and conclusions regarding comparison and selection for the Temperance Flat RM 279 Reservoir (430 TAF) and Fine Gold Reservoir (380 TAF) measures.

Temperance Flat RM 279 Reservoir

The Temperance Flat RM 279 Reservoir (430 TAF) storage measure is less cost effective for water supply than larger size measures at this site. The Temperance Flat RM 279 Reservoir (690 TAF) storage measure provides about 30 percent (almost 25 TAF) more new water supply than the 430 TAF size, with an increase in annual cost of about 20 percent. The larger size measure also results in greater power generation and has similar environmental impacts compared with the smaller size measure. Results of analyses performed during plan formulation suggest that storage measures with smaller storage capacities provide less operational flexibility, fewer improvements to water supply

reliability, and less ability to manage cold water supplies for release to the San Joaquin River. Therefore, the Temperance Flat RM 279 Reservoir (430 TAF) storage measure is not retained for further evaluation in the Investigation.

Fine Gold Reservoir

Compared to the Fine Gold Reservoir (780 TAF) storage measure, the Fine Gold Reservoir (380 TAF) measure is less cost effective for water supply. The larger size of Fine Gold Reservoir provides almost 40 percent (over 30 TAF) more new water supply than the smaller size, with an increase in annual cost of about 20 percent. The Fine Gold Reservoir (780 TAF) measure also results in a smaller difference between power generation and pumping energy requirements. Based on results of analyses conducted during initial plan formulation, the smaller size Fine Gold Reservoir (380 TAF) measure would likely provide less operational flexibility, fewer improvements to water supply reliability, and less ability to manage cold water supplies for release to the San Joaquin River compared to the Fine Gold Reservoir (780 TAF) measure. For these reasons, the Fine Gold Reservoir (380 TAF) measure is not retained for further evaluation in the Investigation.

Step 2 Site Comparison of Surface Water Storage Measures in Refined Initial Alternatives

Surface water storage measures of refined initial alternatives retained through Step 1 were comparatively evaluated in Step 2 on their relative ability to meet the four P&G criteria. Each criterion is described in the following sections with examples of the types of metrics considered for comparison and selection. The comparative ranking of each storage measure within the four criteria and overall ranking was used as a basis to delete surface water storage measures from further evaluation in the PFR that ranked lower than the other measures.

Effectiveness

Effectiveness is the extent to which a surface water storage measure in refined initial alternatives alleviates specified problems and achieves specified opportunities. Planning objectives for the Investigation were developed to address the identified problems and opportunities, and the extent to which a measure can meet the planning objectives represents its effectiveness. Temperance Flat RM 274 (1,260 TAF) was ranked high for effectiveness, while Temperance Flat RM 279 (690 TAF) ranks medium to high, and Fine Gold Reservoir (780 TAF) ranks low to medium. The effectiveness of each storage measure related to the planning objectives and opportunities is described below.

Planning Objective – Enhance Water Temperature and Flow Conditions in the San Joaquin River Increasing reservoir storage capacity and managing cold-water releases with the use of TCDs would help preserve cold water during winter and spring months for release to the San Joaquin River later in the summer and early fall. Based on water temperature modeling performed during initial plan formulation, Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF) generally provide greater total cold-water volume than Fine Gold Reservoir and are ranked high and medium to high, respectively. Total cold-water volume with Temperance Flat RM 274 Reservoir (1,260 TAF) would be greater than with Temperance Flat RM 279 Reservoir (690 TAF), primarily due to its larger storage capacity.

Fine Gold Reservoir (780 TAF), ranked low, would provide the least amount of cold water, and have the greatest number of months when the volume of cold water would be less than the without-project condition. It is not known if the reduction in cold water would adversely affect river conditions for fish restoration and maintenance, but results suggest a reduction in flexibility in the management of cold-water reserves. This measure would also be the most sensitive to changes in assumed downstream water temperature requirements for anadromous fisheries.

The Settlement does not include Restoration Flow releases to the San Joaquin River during critical-low years, but additional flow in those years could be provided by additional storage. All storage measures in refined initial alternatives are comparable in their ability to provide flows to the San Joaquin River below Friant Dam during critically low years, therefore, were ranked the same for this criterion.

Planning Objective – Increase Water Supply Reliability and System Operational Flexibility Temperance Flat RM 279 Reservoir (690 TAF) and Fine Gold Reservoir (780 TAF) both rank medium and would provide a similar average annual new water supply. Temperance Flat RM 274 Reservoir (1,260 TAF) is ranked medium to high and would yield the greatest average annual new water supply and provide the most system operational flexibility.

Opportunity – Improve Management of Flood Flows at Friant Dam Temperance Flat RM 274 Reservoir (1,260 TAF), ranked high, would provide the greatest end-of-month flood storage and highest flood damage reduction values; Fine Gold Reservoir (780 TAF), ranked low, would provide the least end-of-month flood storage and lowest flood damage reduction values.

All storage measures would provide incidental flood damage reduction benefits; however, the extent of flood damage reduction benefits is closely related to incidental flood space and additional storage capacity. Temperance Flat RM 274 Reservoir (1,260 TAF) would provide the largest volume of available flood storage space and Fine Gold Reservoir (780 TAF) would provide the least flood storage space among the storage measures.

Opportunity – Preserve and Increase Energy Generation and Improve Energy Management in the Study Area Temperance Flat RM 274 Reservoir (1,260 TAF) and RM 279 Reservoir (690 TAF), which include an extension of the Kerckhoff No. 2 tunnel around new surface water storage, would mitigate for power generation losses and are both ranked high. Fine Gold Reservoir (780 TAF), ranked low, would require ongoing power purchases for energy required for pumping to fill the reservoir. Subsequent generation at the Fine Gold Reservoir site would be inadequate to recover the energy used for pumping. All storage measures appear to have similar capacity to add pumped storage operations.

Opportunity – Preserve and Increase Recreation Opportunities in the Study Area All storage measures have the potential for affecting recreation at existing reservoirs, including Millerton Lake, or creating recreation opportunities at or near new reservoirs. Changes to recreation can generate benefits if new recreation sources are created, or if existing recreation is enhanced or improved. Recreation opportunities would generally not be many for the storage measures under consideration. Limited access, steep slopes, and reservoir water levels subject to large fluctuations create constraints that would limit recreation development. Across the measures, Fine Gold Reservoir (780 TAF) would have the lowest potential for recreation opportunity development. Opportunities could be moderately better with Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF), but would strongly depend on operating scenarios.

Opportunity – Improve San Joaquin River Water Quality Improvement to San Joaquin River water quality with the Settlement has not been evaluated for the surface water storage measures in refined initial alternatives, and is not being considered as a criterion for evaluations. It is not anticipated that storage measures would demonstrate differing potential improvements to San Joaquin River water quality.

Opportunity – Improve the Quality of Water Supplies Delivered to Urban Areas Urban water quality improvements have not yet been evaluated for surface water storage measures in refined initial alternatives, and are not being considered as a criterion for evaluations. It is not anticipated that storage measures would demonstrate differing potential improvements to water quality delivered to urban areas.

Efficiency

Efficiency is the extent to which a surface water storage measure in refined initial alternatives is the most cost-effective means of alleviating specified problems and realizing specified opportunities, consistent with protecting the Nation's environment. The most efficient measures would best address the objectives with the least cost and adverse environmental effects. Subfactors pertinent to this criterion include (1) cost effectiveness, (2) preliminary monetary and environmental benefits, and potential environmental impacts to

(3) biological resources and (4) cultural resources. Potential impacts to biological resources are based on inundated acreage for the surface water storage measure in refined initial alternatives and ecological diversity of habitat types within inundated areas. Rankings related to cultural resources impacts are based on known and simulated occurrences of archaeological sites within the inundated areas.

Based on preliminary benefits and cost estimates, Temperance Flat RM 279 (690 TAF), Fine Gold Reservoir (780 TAF), and Temperance Flat RM 274 (1,260 TAF) all ranked medium for cost effectiveness. Fine Gold Reservoir (780 TAF) was ranked medium for preliminary monetary and environmental benefits. Temperance Flat RM 274 Reservoir (1,260 TAF) was ranked high for preliminary monetary and environmental benefits, and Temperance Flat RM 279 (690 TAF) was ranked medium to high. Although detailed field investigations have not been conducted within the Fine Gold Reservoir area, biological resources impacts are anticipated to be greater for Fine Gold Reservoir than for the other measures because of a greater inundated land area and likely more diverse habitats. Cultural resources impacts, based on modeled information for potential archaeological sites, were higher for Fine Gold Reservoir (780 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF).

Overall, Fine Gold Reservoir (780 TAF) ranks low to medium for efficiency, while Temperance Flat RM 279 Reservoir (690 TAF) was ranked medium to high, and Temperance Flat RM 274 Reservoir (1,260 TAF) was ranked medium.

Acceptability

Acceptability is the workability and viability of the surface water storage measure in refined initial alternatives with respect to acceptance by Federal, State, and local entities and the public, and compatibility with existing laws, regulations, and public policies. A measure with less support is not infeasible or unacceptable; rather, it is simply less preferred. All surface water storage measures in refined initial alternatives are compatible with existing laws, regulations, and public policies. Subfactors pertinent to acceptability evaluations include (1) relative stakeholder concerns regarding biological resources, (2) potential to develop adequate mitigation in the vicinity of potential impacts, and (3) relative stakeholder concerns regarding cultural resources. In general, impacts to biological and cultural resources would be as described under the section on efficiency.

For Subfactor 1, concerns over habitat within the Fine Gold Reservoir area were raised by USFWS during plan formulation. As described above, biological resources impacts are anticipated to be greater for Fine Gold Reservoir than for the other measures. Fine Gold Reservoir (780 TAF) ranks high for Subfactor 1. Relating to Subfactor 2, the Fine Gold Reservoir area would likely provide suitable mitigation for environmental impacts associated with implementation of either the Temperance Flat RM 279 or RM 274 measures, but it would be

more difficult to find suitable mitigation for environmental impacts from implementation of the Fine Gold Reservoir measures. Therefore, Fine Gold Reservoir (780 TAF) ranks low for Subfactor 2, while Temperance Flat RM 279 Reservoir (690 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) rank medium. For Subfactor 3, Native Americans have expressed that inundation-related impacts to cultural resources would be less acceptable in either of the Temperance Flat RM 279 Reservoir (690 TAF) or Temperance Flat RM 274 Reservoir (1,260 TAF) areas compared to the Fine Gold Reservoir area.

Considering all subfactors for acceptability, Temperance Flat RM 279 (690 TAF) was ranked medium, while Fine Gold Reservoir (780 TAF) and Temperance Flat RM 274 (1,260 TAF) were ranked low to medium.

Completeness

Completeness is the extent to which a surface water storage measure in refined initial alternatives provides and accounts for all necessary investments and other actions to ensure the realization of the planned effects. Completeness will be identified through a determination that all necessary components of actions are identified, including adequate mitigation of adverse impacts, and the degree of uncertainty (or reliability) of achieving the intended objectives. Pertinent subfactors that are important in measuring this criterion include (1) reliability, and (2) constructibility. This criterion is not expected to differentiate the surface water storage measures because each has been defined at a consistent level, but some subtle differences do exist that distinguish their characteristics. At this phase of the feasibility study, assessing completeness is conceptual, and lacks information such as specific mitigation needs, and detailed designs and cost estimates.

Subfactor 1 is a measure of a surface water storage measure's capability to provide, over the life of a project, the specific and sustained benefits for which the measure was intended. It also includes a determination of whether other projects, programs, or actions are necessary to implement the project and to develop the full level of benefit for which the storage measure was intended. It includes determining whether future actions, other than normal and identified operations and maintenance (O&M), are required for full and successful implementation of the plan. Fine Gold Reservoir (780 TAF) would require a (new) reliable source of electricity for pumping water into the reservoir to meet the objectives, would reduce cold-water volume compared to the baseline conditions, and provide limited ability to capture flood flows. Therefore, Fine Gold Reservoir (780 TAF) ranks low to medium among the storage measures for this subfactor. Temperance Flat RM 274 Reservoir (1,260 TAF) ranks medium to high for the reliability subfactor, while Temperance Flat Reservoir (690 TAF) ranks medium.

Fine Gold Reservoir (780 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) rank medium for Subfactor 2 because of questions/uncertainties relating to construction of very large coffer dams in deep water, while Temperance Flat

RM 279 Reservoir (690 TAF) was ranked medium to high. To date, initial engineering studies indicate that the large coffer dams can be constructed. Constructibility issues will be further addressed as the Investigation progresses.

Considering all subfactors for completeness, Temperance Flat RM 279 Reservoir (690 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) were ranked medium to high, compared to a medium ranking for Fine Gold Reservoir (780 TAF).

Summary of Evaluation of Surface Water Storage Measures of Refined Initial Alternatives

Based on technical evaluations performed during initial plan formulation for incremental cost effectiveness at a range of potential sizes across surface water storage measures of refined initial alternatives, Temperance Flat RM 279 Reservoir (430 TAF) and Fine Gold Reservoir (380 TAF) measures were not retained for further evaluation in the Investigation. At a lesser incremental cost, the larger size storage measures provide more operational flexibility, more improvements to water supply reliability, and greater ability to manage cold water supplies for release to the San Joaquin River.

A summary comparison of the surface water storage measures of refined initial alternatives for each of the four P&G criteria evaluated in Step 2 is presented in Table 4-5. The table includes rankings for how each measure meets the comparison criteria and also shows the relative ranking between all storage measures. Table 4-6 summarizes results of the surface water storage measures comparison, and a combined ranking from the relative ranking against all four P&G criteria. The combined rankings are followed by a recommendation whether or not to retain each surface water storage measure for further evaluation. In developing a combined ranking and recommendation for each storage measure, the effectiveness criterion was given twice the weight compared to each of the efficiency, acceptability, and completeness criteria.

The Fine Gold Reservoir (780 TAF) surface water storage measure was considered inferior to the Temperance Flat RM 274 and RM 279 surface water storage measures based on the evaluation criteria. This surface water storage measure provides fewer water supply and cold water management benefits (the primary purposes), and results in more reservoir area environmental consequences. The retained surface water storage measures of refined initial alternatives, Temperance Flat RM 274 Reservoir (1,260 TAF) and Temperance Flat RM 279 Reservoir (690 TAF), are shown in Figure 4-5, rank consistently higher than Fine Gold Reservoir (780 TAF), based on initial plan formulation evaluations. Temperance Flat RM 279 Reservoir (690 TAF) and Temperance Flat RM 274 Reservoir (1,260 TAF) are further evaluated and described in more detail in Chapter 5.

Table 4-5. Comparison of Surface Water Storage Measures of Refined Initial Alternatives

CRITERIA	Temperance Flat RM 279 Reservoir (690 TAF)	Fine Gold Reservoir (780 TAF)	Temperance Flat RM 274 Reservoir (1,260 TAF)
Effectiveness			
Objectives			
Temperature management	Medium to High	Low	High
Critical-low year Restoration Flow	High	High	High
Water supply	Medium	Medium	Medium to High
Opportunities			
Management of flood flows	Medium	Low	High
Energy generation	High	Low	High
Recreation opportunities	Low to Medium	Low	Low to Medium
Efficiency			
Cost effectiveness	Medium	Medium	Medium
Preliminary monetary and environmental benefits	Medium to High	Medium	High
Relative impacts to biological resources	Low to Medium	High	Medium
Relative impacts to cultural resources	Medium	High	High
Acceptability			
Relative stakeholder concerns regarding biological resources	Low to Medium	High	Medium
Potential to develop mitigation in vicinity of potential impacts	Medium	Low	Medium
Relative stakeholder concerns regarding cultural resources	High	Medium	High
Completeness			
Reliability	Medium	Low to Medium	Medium to High
Constructibility	Medium to High	Medium	Medium

Key:
RM = river mile
TAF = thousand acre-feet

Scale

Less Desirable — More Desirable

Table 4-6. Surface Water Storage Measures Comparison and Selection Summary

CRITERIA	Temperance Flat RM 279 Reservoir (690 TAF)	Fine Gold Reservoir (780 TAF)	Temperance Flat RM 274 Reservoir (1,260 TAF)
Effectiveness	Medium to High	Low to Medium	High
Efficiency	Medium	Low to Medium	Medium
Acceptability	Medium	Low to Medium	Low to Medium
Completeness	Medium to High	Medium	Medium to High
COMBINED RANKING[1]	Medium	Low to Medium (LOWEST)	Medium to High (HIGHEST)
STATUS	RETAINED FOR FURTHER CONSIDERATION	NOT RETAINED FOR FURTHER CONSIDERATION[2]	RETAINED FOR FURTHER CONSIDERATION

Notes:

[1] In developing a combined ranking, the effectiveness criterion was given twice the weight compared to each of the efficiency, acceptability, and completeness criteria.

[2] The Fine Gold Reservoir (780 TAF) surface water storage measure was not retained for further consideration because it is considered inferior to the Temperance Flat RM 279 and RM 274 surface water storage measures. This surface water storage measure would provide less water supply and cold water management benefits, and result in more reservoir area environmental consequences.

Key:
RM = river mile
TAF = thousand acre-feet

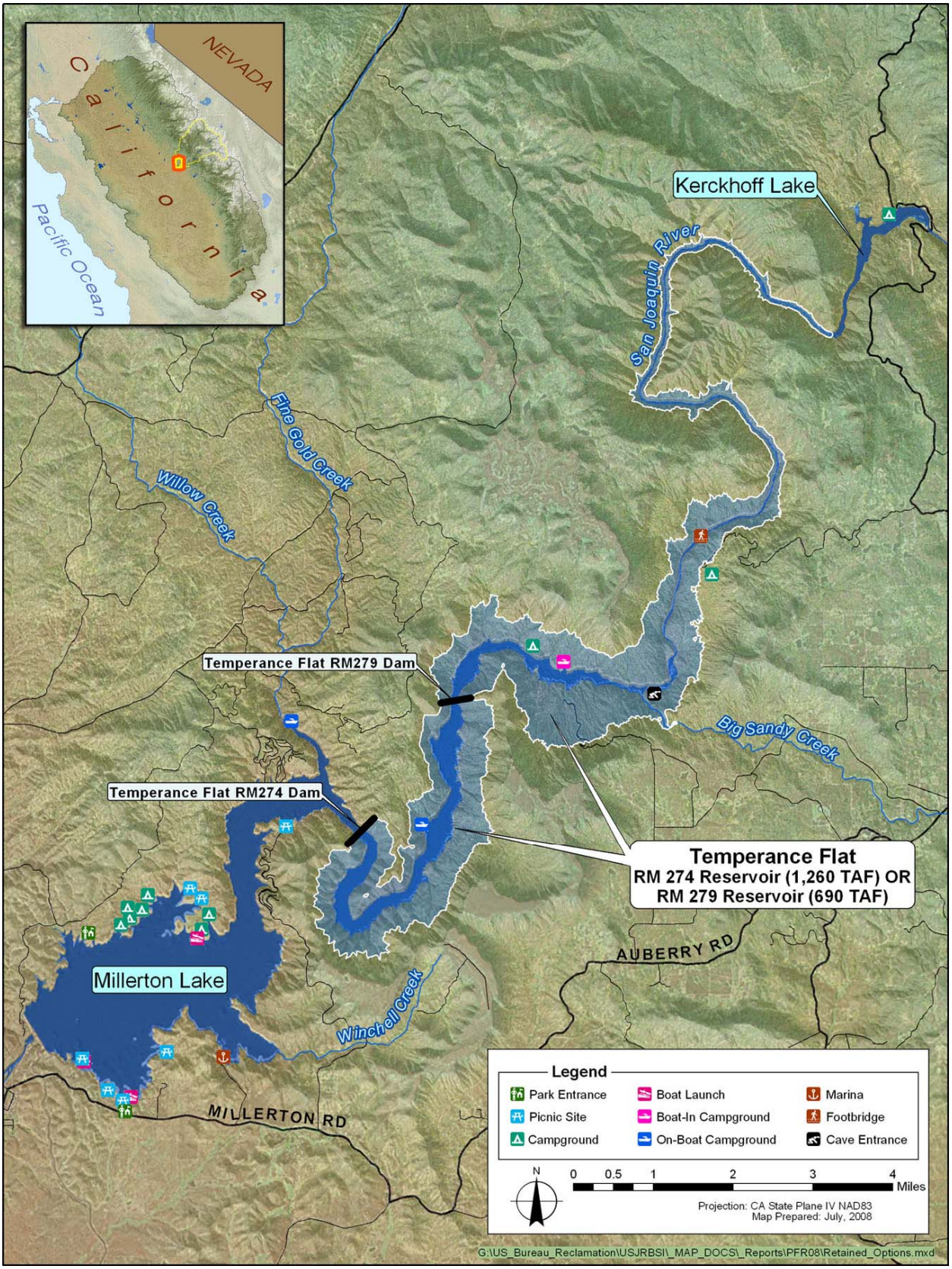

Figure 4-4. Retained Surface Water Storage Measures for Alternative Plans Formulation