Upper San Joaquin River Basin Storage Investigation

Dry Creek Reservoir

Surface Storage Option Technical Appendix to the Phase 1 Investigation Report

A Joint Study by:

Bureau of Reclamation
Mid-Pacific Region

California Department
of Water Resources

In Coordination with:

The California Bay-Delta Authority

October 2003

Upper San Joaquin River Basin Storage Investigation

Dry Creek in the Vicinity of the Reservoir Site

Dry Creek Reservoir

Surface Storage Option Technical Appendix to the Phase 1 Investigation Report

A Joint Study by:

Bureau of Reclamation
Mid-Pacific Region

California Department of Water Resources

In Coordination with:

The California Bay-Delta Authority

Prepared by:

MWH

October 2003

SURFACE WATER STORAGE OPTION
TECHNICAL MEMORANDUM

DRY CREEK RESERVOIR

UPPER SAN JOAQUIN RIVER BASIN STORAGE INVESTIGATION

TABLE OF CONTENTS

Chapter **Page**

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Acronyms and Abbreviations List

CEQA	California Environmental Quality Act
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
Corps	United States Army Corps of Engineers
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
elevation	number of feet above mean sea level
HEP	Habitat Evaluation Procedure
Investigation	Upper San Joaquin River Basin Storage Investigation
NEPA	National Environmental Policy Act
PCB	polychlorinated biphenyl
PMF	probable maximum flood
RCC	roller-compacted concrete
Reclamation	Bureau of Reclamation
ROD	Record of Decision
SAW	sycamore alluvial woodland
TAF	thousand acre-feet
TM	Technical Memorandum
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

EXECUTIVE SUMMARY

The Upper San Joaquin River Basin Storage Investigation (Investigation) considered several potential storage options in the eastern San Joaquin Valley. This document describes a potential new dam and reservoir lity on Dry Creek, which is a tributary to the Kaweah River just downstream and northwest of Terminus Dam. The dam site is in Tulare County, about 25 miles east and north of Visalia, north of the community of Lemon Cove, and about 1¾ miles north of Dry Creek's confluence with the Kaweah River. The dam would be a 175-foot high roller-compacted concrete structure with a crest length of approximately 3,210 feet, and would impound a reservoir with a storage capacity of up to 70 thousand acre-feet.

Water would be diverted from Lake Kaweah through ng gravity tunnel. The new reservoir would also capture natural runoff from Dry Creek. Stored water would be released to Dry Creek, flow down the Kaweah or St. Johns rivers to the Friant-Kern Canal, and be used in lieu of deliveries from Millerton Lake through exchange.

No significant issues related to construction requirements are evident. The dam and reservoir site is generally undeveloped with the exception of a few rural residential properties. The dam site is underlain by competent hard rock, and sufficient sand and gravel would be available from a large nearby active quarry. A road provides direct access to the site; staging and lay-down areas are located immediately upstream and downstream; and electrical power is available from the powerhouse at Terminus Dam or other nearby commercial sources.

Creation of the Dry Creek Reservoir would result in adverse impacts to botany resources. Most notably, a sycamore alluvial woodland (SAW) that exists near the confluence of Dry Creek and the Kaweah River would be adversely affected. Although sycamore trees are common, SAW has been described as a "very rare and essentially irreplaceable habitat type" and the Dry Creek stand is one of the largest in the Central Valley. There are fewer than six viable occurrences and/or less than 2,000 acres of SAW in California and worldwide. Reservoir construction and water diversion are considered threats to SAW, as sycamores have little tolerance to artificially manipulated water levels. Sexual regeneration of SAW depends on substantial scour caused by flood events. Successful replacement of SAW is considered unlikely and its destruction is therefore unmitigable.

Potentially affected riparian habitat may support several listed wildlife species and several special-status plant species are recorded around the Dry Creek area. Principal effects on aquatic biological resources would result from replacing a stream environment with lacustrine habitat. The most likely native fish species to be affected would be the California roach, although its presence in Dry Creek is not known.

Due to the potential adverse and potentially unmitigable impacts to SAW habitat, this option was dropped from further consideration in the Investigation.

THIS PAGE LEFT BLANK INTENTIONALLY

CHAPTER 1. INTRODUCTION

The Bureau of Reclamation, in cooperation with the California Department of Water Resources, is completing the Upper San Joaquin River Basin Storage Investigation (Investigation) consistent with the CALFED Bay-Delta Program Record of Decision (ROD), August 2000. The Investigation will consider opportunities to develop water supplies to contribute to water quality improvements and restoration in the San Joaquin River, and to enhance conjunctive management and exchanges to provide high-quality water to urban areas. The ROD indicated that the Investigation consider enlarging Friant Dam or developing an equivalent storage program to meet Investigation objectives.

The Investigation identified several potential surface storage sites to be initially considered through prefeasibility-level studies of engineering and environmental issues. This Technical Mermorandum (TM), which was prepared as a technical appendix to the Phase I Investigation Report, presents findings from a prefeasibility-level review of the potential Dry Creek Dam and Reservoir.

OPTION SUMMARY

The potential Dry Creek Reservoir would be located in Tulare County, near the community of Lemon Cove, about 25 miles east-northeast of Visalia. The dam site is located on Dry Creek about 1¾ miles north of its confluence with the Kaweah River. The site's general location is shown in Figure 1-1. A map of Dry Creek and vicinity is shown in Figure 1-2.

Dry Creek Reservoir would have the potential to store approximately 70 TAF of water. Excess Kaweah River flows would be diverted from Lake Kaweah to Dry Creek Reservoir via an interconnecting tunnel and would be supplemented by local drainage from the Dry Creek watershed.

Water stored in Dry Creek Reservoir would be released to the Kaweah River and diverted to the Friant-Kern Canal or left instream. These flows would be exchanged for water delivered from Millerton Lake via the Friant-Kern Canal or for releases from Millerton Lake to the San Joaquin River.

EXISTING FACILITIES

No water storage facility presently exists at the site. Terminus Dam, which impounds Lake Kaweah on the main stem of the Kaweah River, is located approximately 1 mile upstream of the Kaweah's confluence with Dry Creek.

An active sand and gravel quarry (Artesia Ready Mix) is located within and downstream of the potential Dry Creek Dam site. Sparse rural development occurs within Dry Creek's valley upstream of the site. Paved and unpaved roads provide access to the dam site. Overhead power and telephone lines are present along Dry Creek Drive.

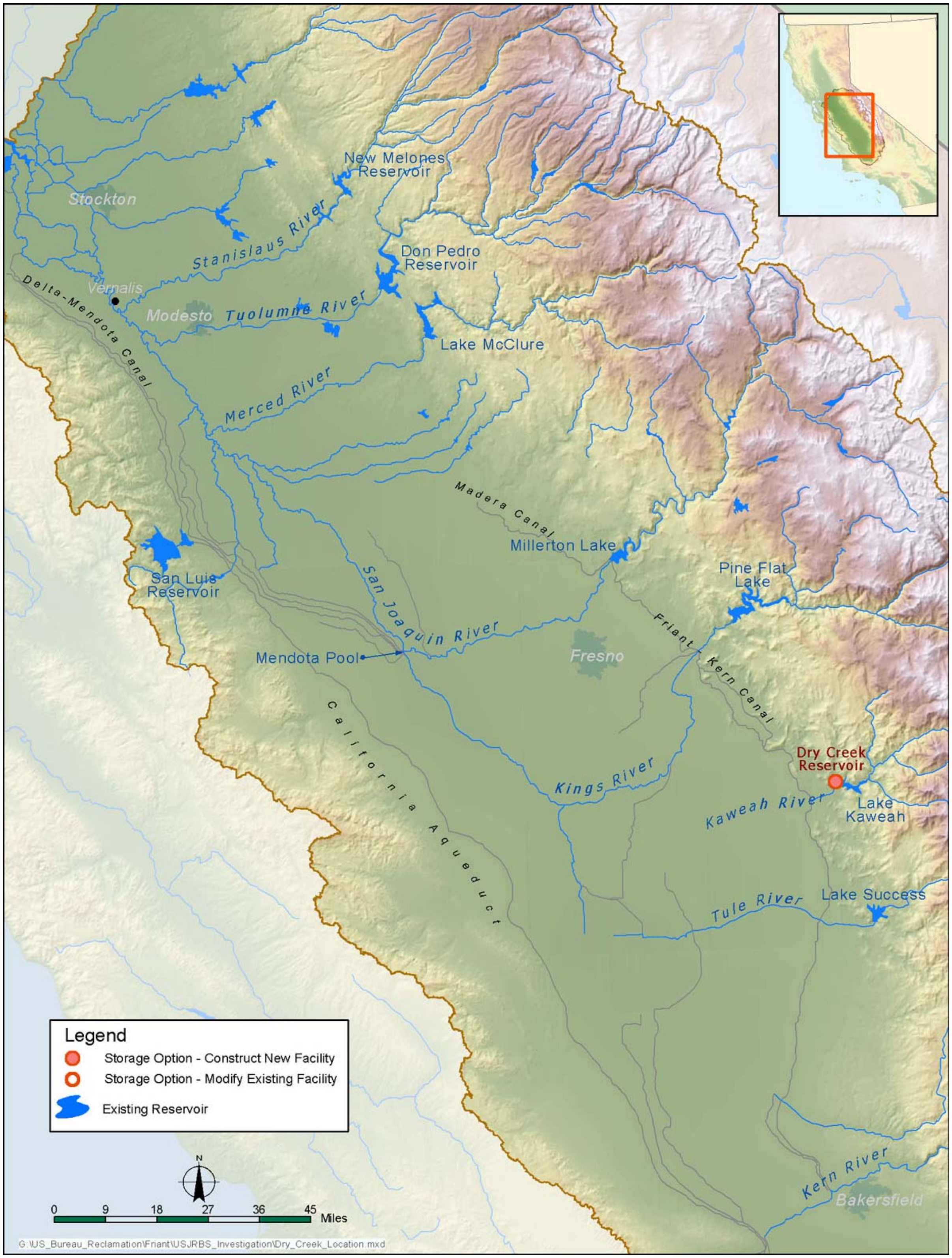


FIGURE 1-1. DRY CREEK SITE LOCATION MAP

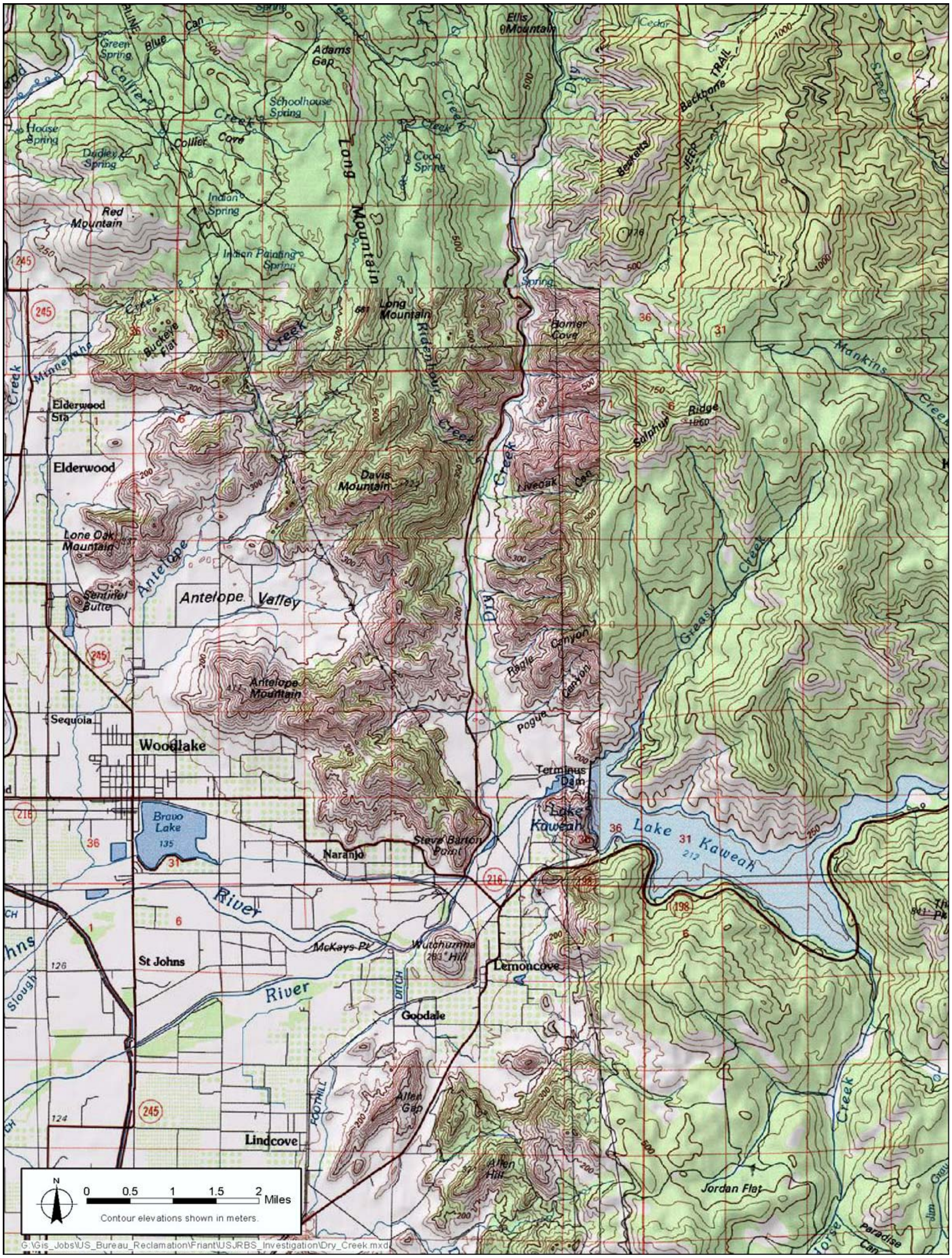


FIGURE 1-2. DRY CREEK AND VICINITY

SUMMARY OF PREVIOUS INVESTIGATIONS

In 1966, the United States Army Corps of Engineers (Corps) produced a planning document summarizing the geology, paleontology, archaeology, flora, fauna, and history of the Terminus Reservoir area. The report was revised 2 years later.

In 1986, the Corps prepared a Hydrology Reconnaissance Study for the Kaweah and Tule Rivers (Corps, 1986), which was an update of a similar report prepared in 1971.

In 1990, the Corps prepared a feasibility-level draft report, Basis of Design and Cost Estimates, for a proposed enlargement of Lake Kaweah (Terminus Dam) and construction of Dry Creek Reservoir (Corps, 1990a). For the Dry Creek dam, both rockfill embankment and roller compacted concrete (RCC) types were investigated, and both were found to be feasible. The RCC structure was recommended on the basis of lower first cost.

Also in 1990, in support of the Basis of Design, the Corps prepared a Hydrology Office Report (Corps, 1990b). The report summarized hydrologic information developed for the Kaweah River and its major tributary, Dry Creek. The information was used to estimate the probability of downstream peak flows and flow volumes resulting from various project configurations. Data were also used to design the spillway and other hydraulic features and to determine freeboard and sediment requirements.

In September 1992, the Corps prepared a Draft Integrated Feasibility Report and Environmental Impact Statement (EIS) describing the results of studies on flooding problems downstream of Terminus Dam (Corps, 1992a). Appendix A of the feasibility report contained the Draft Basis of Design and Cost Estimates (Corps, 1992b). The feasibility report considered 14 structural alternatives for providing increased flood protection and water supply storage for irrigation. These included Lake Kaweah enlargement (raise Terminus Dam spillway); construction of a small (27 TAF) flood control detention basin on Dry Creek in conjunction with enlargement of Lake Kaweah; and construction of a larger (70 TAF) reservoir on Dry Creek connected by tunnel to an enlarged Lake Kaweah. These three structural alternatives were the only alternatives retained for further study. Although all three were considered economically feasible, it was noted that the two alternatives involving a dam on Dry Creek involved extensive environmental and cultural impacts.

Appendix A of the 1992 feasibility report was essentially an updated version of the 1990 Basis of Design. Slight modifications were made to the Lands Values and Basis of Cost Estimates (Summary of First Costs) sections. Costs were apparently updated to 1992 criteria from 1990 and a Basis of Annual Costs section was added for the Terminus Dam raise.

In June 1996, the Corps issued a Draft Feasibility Report (1996a) and a Draft Environmental Impact Statement/Environmental Impact Report (1996b) as a continuation of the Kaweah River Basin Investigation. The Draft EIS evaluated two alternatives involving a 21-foot raise of Terminus Dam's spillway (Corps, 1996b) and reported that other previously considered alternatives had been eliminated. In particular, the two alternatives for constructing a dam on Dry Creek along with enlarging Lake Kaweah were eliminated due to high construction costs and extensive environmental and cultural resource effects and mitigation requirements.

POTENTIAL IMPROVEMENTS CONSIDERED

As proposed in the Corps' 1990 Basis of Design, Dry Creek Dam would be a 175-foot-high RCC structure with a total crest length of 3,210 feet, including a 102-foot-wide, ungated, ogee spillway. From the left abutment (looking downstream), the axis of the dam would extend east-northeast across Dry Creek.

Dry Creek Reservoir would have a storage capacity of approximately 70 TAF at a gross pool elevation of 684 feet above mean sea level (elevation 684). Flow would be diverted to Dry Creek Reservoir via an interconnecting 7,600-foot-long, 12-foot-diameter, concrete-lined tunnel (Figure 1-3). Outlet works could be either ungated or gated. The ungated option would allow the reservoir to be used for flood control storage only; discharge would be through an ungated steel conduit passing through the dam. The gated option, as previously designed, would allow 10 TAF of the total storage capacity to be managed as conservation storage; discharge would be released through a fixed-cone valve.

APPROACH AND METHODOLOGY

This TM was prepared from a brief review of the existing documents identified above, and an engineering field reconnaissance of the dam and reservoir conducted on 13 June 2002 (Appendix A). During the June 2002 field trip, engineers and geologists examined the site under consideration. Locations of existing and potential structures were visually assessed; topography, geology, geotechnical conditions, and utilities were noted; and access routes and possible borrow, staging, and lay-down areas were considered.

The description of environmental considerations for this site was based on a literature and California Natural Diversity Database (CNDDB) review, and input from agencies that had previously considered the option.

The seismotectonic evaluation conducted by Reclamation (2002) for this study was based on readily available information and is considered appropriate for prefeasibility-level designs only. Detailed, site-specific seismotectonic investigations were not conducted and aerial/remotely sensed imagery was not evaluated. More detailed, site-specific studies would be required for higher-level designs.

For prefeasibility-level planning studies, designs and analyses are typically quite general. Extensive efforts to optimize the design have not been conducted, and only limited value engineering techniques have been used.

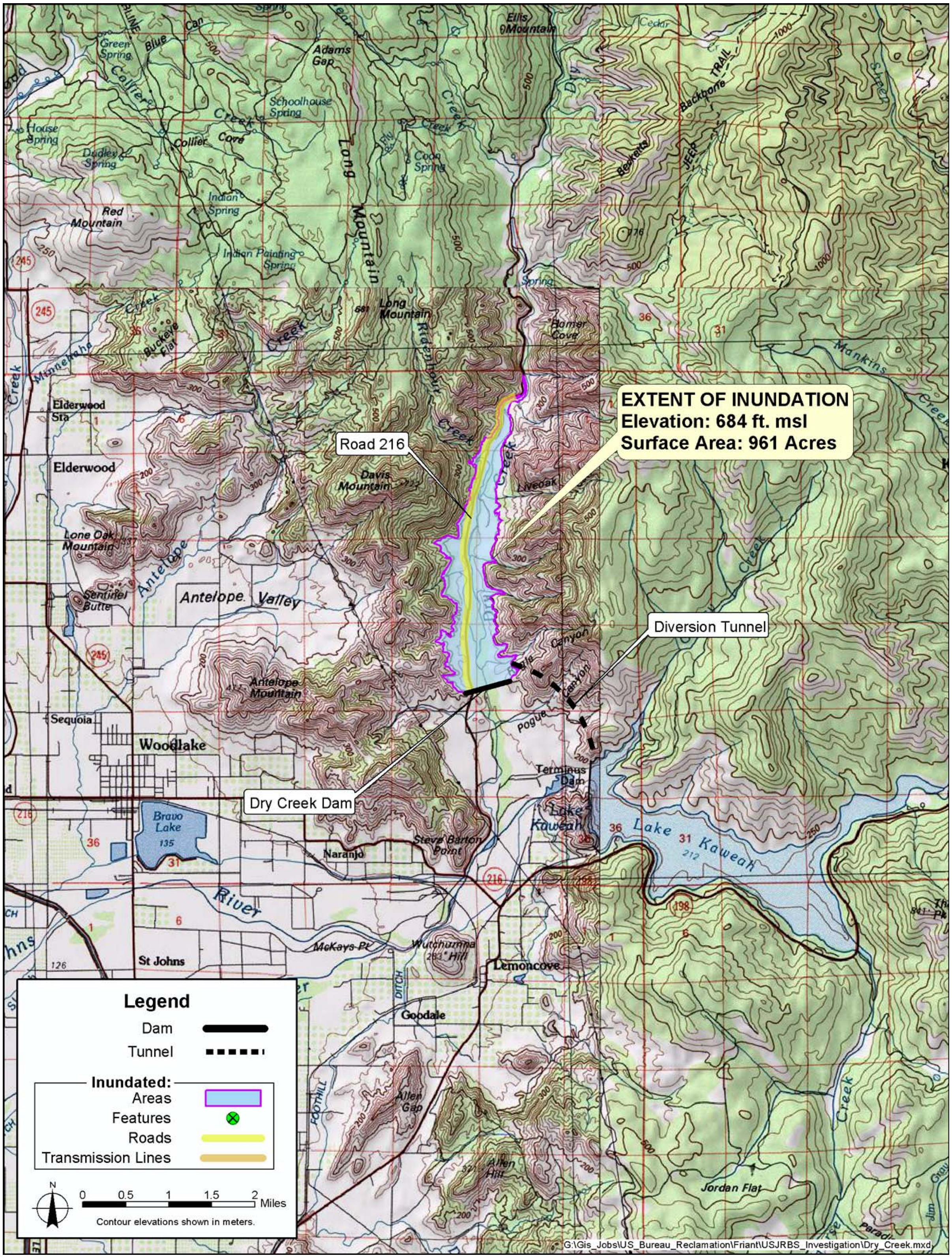


FIGURE 1-3. POTENTIAL FEATURES AND INUNDATED FACILITIES

CHAPTER 2. TOPOGRAPHIC SETTING

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 Dry Creek range from about elevation 530 to over elevation 1,300. Farther east, the terrain steepens and the canyons become more incised. The canyons have been cut by southwest- to west-flowing rivers and associated large tributaries. The Kaweah River is the main river in the area. Dry Creek is a south-flowing tributary to the Kaweah. Its confluence with the Kaweah River is about 1 mile downstream of Terminus Dam, which creates Lake Kaweah.

The potential dam site is located at the southern end of the relatively narrow, south-draining, steep-walled Dry Creek valley. The left abutment slope rises at a relatively steep inclination of 2.5:1 (horizontal to vertical), while the right abutment slope is slightly steeper at about 2:1. The streambed at the axis of the potential dam is at approximately elevation 540. The adjacent abutment ridges rise to nearly elevation 879 (right ridge) and elevation 1,350 (left ridge).

AVAILABLE TOPOGRAPHIC MAPPING

Topographic mapping is publicly available from the United States Geological Survey (USGS). No other topographic mapping is known to be available. It appears that base maps used by the Corps in its investigation were from USGS sources.

AVAILABLE AERIAL PHOTOGRAPHY

Aerial photography of various scales and imagery is available from United States Department of Agriculture, Reclamation, and the Corps. A specific search of available photography was not performed for this TM nor was any aerial photography reviewed.

THIS PAGE LEFT BLANK INTENTIONALLY

CHAPTER 3. GEOLOGIC AND SEISMIC SETTING

The potential Dry Creek Dame and Reservoir site is located near the boundary of the Sierra Nevada Geomorphic Province and the San Joaquin Valley portion of the Great Valley Geomorphic Province. The Great Valley basin is filled with thick accumulations of marine (at depth) and non-marine sediments shed largely from the Sierra Nevada mountain range. Recent alluvium of lake and river origin blankets most of the present-day surface, while dissected remnants of Pleistocene alluvial fans rim the valley margin.

The Sierra Nevada range is characterized by batholiths of Mesozoic granitic rock and Paleozoic roof pendants of the Calaveras Complex and related rocks. The Sierra Nevada foothills take the form of outliers of low to irregular hills of Mesozoic granitic and late Paleozoic to Mesozoic basic and ultrabasic, rock (ophiolites) of the “serpentine belt” of the Kings-Kaweah suture, and other associated Mesozoic metamorphic rocks.

Overall, seismic hazard potential at the site is low. Preliminary earthquake loading analysis for this prefeasibility-level study considered two types of potential earthquake sources: fault sources and areal/background sources (Reclamation, 2002).

Twenty-two potential fault sources for the site were identified, including those associated with the San Andreas fault, seven western Great Valley faults, seven eastern Sierra Nevada faults, the White Wolf fault of the southern San Joaquin Valley, and six faults of the Sierra Nevada Foothills system. No major through-going or shear zones have been identified in this area of the Sierra Nevada and historic seismicity rates are low.

The areal/background seismic source considered was the South Sierran Source Block, the region surrounding the potential dam and resevoir site. This region possesses relatively uniform seismotectonic characteristics.

Probabilistic seismic hazard analysis shows that peak horizontal accelerations to be expected at the site are 0.13g with a 2,500-year return period, 0.17g with a 5,000-year return period, and 0.23g with a 10,000-year return period.

SITE GEOLOGY

The south-trending Dry Creek valley is located in what is probably an erodible zone along a geologic contact between granitic rocks and a Calaveras Complex roof pendant of metamorphic rock and limestone stringers. At the dam site, quartzite and the Lemon Cove Schist Calaveras Complex rocks are exposed along both sides of the valley and along much of the perimeter of the potential reservoir. A small area of Mesozoic granite is exposed along the western margin of the potential reservoir. Relatively thick Pleistocene and recent river alluvium deposits of sand, gravel, and possible silt are found beneath the floor of Dry Creek.

During the Corps' investigation of the Dry Creek site, metamorphic rock was the most common rock class encountered. In particular, exploratory boreholes advanced by the Corps in 1989 found that mica-quartz schist with interbedded quartzite was the most common rock type. Other metamorphic rocks included additional schist species (quartz-mica schist, chlorite schist, biotite chlorite schist, and a fractional amount of biotite quartz schist), schistose quartzite, and marble. Biotite quartz diorite (granite) was the only igneous rock encountered, but it was dominant in the particular portion of the site where it was found. Sedimentary rock was limited to a minor amount of sandstone.

No significant faults or fault zones are known to exist within the potential reservoir basin or dam site.

SITE GEOTECHNICAL CONDITIONS

Metamorphic rocks are present in the locations of the potential spillway, outlet works, along the dam axis and tunnel, and in a potential quarry area located in the area of the western perimeter of the potential reservoir. However, in the potential quarry area, metamorphic rocks are not dominant. Schistose quartize composes about 10 percent of the quarry area rock while biotite quartz schist makes up less than 1 percent. (The balance of the potential quarry area rock is granite.)

Biotite chlorite schist and quartzite are present in the potential spillway and outlet works areas, and to a much lesser extent in the quarry area. Along the dam and tunnel axes, quartz-mica schist is the most common rock type found. Marble was reported in one dam axis boring and quartzite was found in the other dam locations. Quartz-mica schist, quartzite, and marble stringers were encountered in the tunnel locations. Chlorite schist was noted in one tunnel boring.

Granitic rocks were encountered only in a potential quarry site located in the area of the western perimeter of the proposed reservoir. About 90 percent of the rock at the potential quarry area is granite.

CHAPTER 4. HYDROLOGIC SETTING

Dry Creek is one of three main tributaries to the Kaweah River downstream of Terminus Dam. It enters the Kaweah from the north. Mehrten Creek and Yokohl Creek, the other two principal downstream tributaries, are both on the south side of the Kaweah.

Dry Creek extends for about 25 miles and drains approximately 82 square miles. Elevations within the Dry Creek watershed range from about elevation 480 at its confluence with the Kaweah, to about elevation 7,650 in its Sequoia National Forest headwaters.

RAINFALL

Normal annual precipitation over the Dry Creek basin averages 23.4 inches, ranging from about 14 inches at its confluence with the Kaweah River to a little over 40 inches in Dry Creek's headwaters.

EROSION, RUNOFF, AND RECHARGE

Along Dry Creek, the soil series consists mainly of well-drained and gently sloping sandy loam. The surface layer is dark gray and gray sandy loam with moderately rapid permeability and a low erosion hazard. Soils on the bottom of Dry Creek consist of the Tujunga series. This sandy soil is a very deep soil layer of high permeability and low available water capacity. The slope is smooth with a mild erosion hazard (Corps, 1996a).

Sedimentation rates for the potential Dry Creek Reservoir were not evaluated by the Corps. The Corps' analysis of sedimentation conditions downstream of the potential dam indicated that approximately 1.7 feet of streambed degradation could be expected in the process of developing a heavier armor. Streambed degradation could be precluded through use of an existing, low-flow concrete water crossing, located about a mile downstream, that would act as a grade control structure. Near its confluence with the Kaweah River, the Dry Creek channel widens, passing through a broad, sluggish reach that would preclude degradation. Finally, a low level dam on the Kaweah, just downstream of the Dry Creek confluence, and Kaweah bed armoring would also provide grade control.

Flows in Dry Creek are the result of rainfall only, since the watershed is below elevations where significant snow accumulates. Floods from winter rain generally occur from November through April, and are characterized by sharp peaks with most of the volume occurring within a few days.

The average annual runoff from Dry Creek is 19.059 TAF (Corps, 1996a). Historical peak flow at Dry Creek was recorded 6 Dec 1966 at 14,500 cubic feet per second (cfs), with a maximum 1-day flow of 6,300 cfs (based on records from 1960 through 1986).

AVAILABLE FLOOD DATA

Flow frequency data reported by the Corps dates back to 1960. The largest rain flow of record for Dry Creek was in December 1966 (14,500 cfs); the second largest flow of record was January 1969 (6,020 cfs), followed by April 1982 (3,895 cfs).

A standard project flood volume of 33 TAF, and a peak of about 23,000 cfs, were calculated for a specific event over the Dry Creek drainage (Corps, 1996a).

The probable maximum flood (PMF) from a 1971 study was recomputed in 1988 and used as the design flood for Dry Creek. The HEC-1 model was used to calculate the 1988 PMF hydrograph. In the model, a total of 29.35 inches of precipitation occur over the Dry Creek basin over 3.5 days. The peak inflow was determined to be 45,000 cfs and the PMF volume was 64.6 TAF (Corps, 1990b).

Spillway size was selected through routing the PMF through the spillway. Spillway maximum outflow was set at 36,000 cfs.

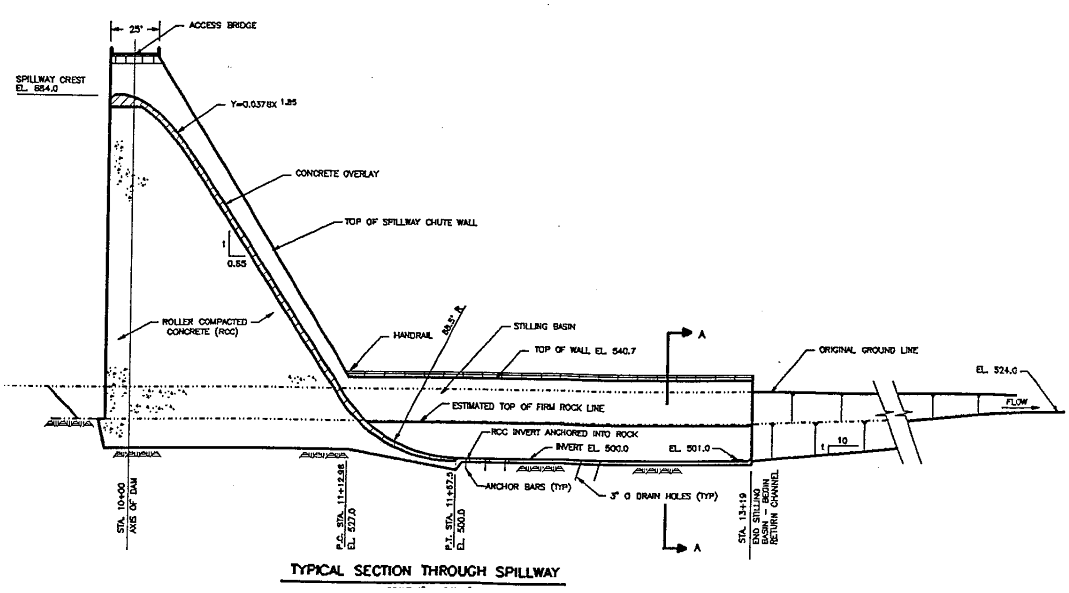
CHAPTER 5. STORAGE STRUCTURES AND APPURTENANT FEATURES

This chapter describes the recommended storage structure and appurtenant features for the Dry Creek site, and the constructibility, cost, and systems operations for this option.

STORAGE STRUCTURE

The potential Dry Creek Dam would consist of a 175-foot-high RCC dam, relative to the excavated stream bed. Relative to the existing stream bed invert, the structure would be 175 feet high. The dam would be founded on firm rock materials with a total crest length of 3,210 feet. The nonflow portion of the dam crest would be about 3,110 feet long and 25 feet wide. A 102-foot-wide, ungated, ogee spillway would crest at elevation 684.

The upstream dam face would be vertical, while the downstream dam face would have a slope of 0.65:1 (horizontal to vertical). The roadway on the dam crest would be at elevation 705 and the top of the parapet wall at elevation 708. The total freeboard (3 feet) is based on total wave run-up and wind set-up of 2.5 feet. Figure 5-1 is a dam cross section from the 1990 Corps study.



Source: Corps, 1990a

FIGURE 5-1. CROSS SECTION OF POTENTIAL DRY CREEK DAM

It is estimated that approximately 1.4 million tons of aggregate and 720,000 tons of sand would be required to construct the RCC dam. An estimated 67,000 tons of Portland cement and 32,000 tons of pozzolan also would be required.

RESERVOIR AREA/ELEVATION/CAPACITY CURVES

Information on reservoir area versus storage data was not contained in the documents reviewed.

APPURTENANT FEATURES

This section describes major appurtenant features that would be associated with the dam.

Conveyance

A 7,600-foot-long, 10-foot-diameter diversion tunnel would be required to divert excess water from Kaweah Lake. It is expected that most of the tunnel would pass through pre-Cretaceous metamorphic rock. Tunnel flow would be regulated by slide gates at the upstream end. A vertical access shaft would be cut from the ground surface to the gate location. The invert at Lake Kaweah would be at elevation 600 and the tunnel would have a minimum slope of 0.001 ft/ft.

Pumping Plants

Water would be diverted from Lake Kaweah by gravity. No pumping plants are therefore planned.

CONSTRUCTIBILITY

This section discusses issues of concern related to constructing the dam, reservoir, and appurtenant features.

Land, Rights-of Way, Access, and Easements

Construction of Dry Creek Dam and Reservoir would require real estate acquisition and relocation of three dwellings (one new) and two corrals, and the acquisition of nine ownerships in fee. Am easement similar to a pipeline easement would be required for the tunnel alignment. The Corps (1992b) estimated real estate costs at $1,151,500.

The existing road into and through the valley, Dry Creek Drive, provides access to the sparsely settled property within the valley. The cost to relocate the access road was previously estimated as $5.2 million (Corps, 1992b). Property within the limits of the gross pool level would require 1,540 acres of light clearing.

Borrow Sources/Materials

Sufficient materials appear to be available within the Dry Creek channel alluvium to meet requirements for this option. The Dry Creek alluvium was investigated through excavation and analysis of samples from 12 backhoe pits to determine its capability for providing the needed borrow materials for construction. An estimated 4.1 million cubic yards of material suitable for the constructing the potential dam were identified within the upper 15 to 24 feet of the existing ground surface. The sand-to-coarse-aggregate ratio ranged from 56 to 44 percent.

Portland cement is available from nearby commercial sources, including six producers within a few hundred miles of the site. Bulk transport to the site could be provided by truck or railcar. Pozzolan is available locally from producers in Stockton or Sacramento.

Foundations

It is anticipated that the dam foundation would be in relatively hard rock with relatively tight, medium to closely spaced, fractures and joints. Presplit drilling and light blasting might be required for excavation. Some soft, sheared zones could be encountered, but they could be backfilled with lean concrete for minor dental preparation of the foundations.

Power Sources

Electrical power is available from the powerhouse at Terminus Dam or other nearby commercial sources.

Staging and Lay-Down Area

Potential staging and lay-down areas are located immediately upstream and downstream of the potential dam and reservoir site.

Contractor Availability and Resources

There are several local general engineering contractors or regionally based general engineering contractors capable of performing the rock excavation, concrete-forming and placement, RCC dam construction, and general grading and excavation.

Construction Schedule and Seasonal Constraints

Because of the relatively low elevation and low rainfall, there would be minimal seasonal constraints. Year-round construction would be expected.

Flood Routing During Construction

A diversion structure or pipe would be required to pass potential rain flows during construction. This diversion structure would be plugged once the RCC dam neared the design height.

Environmental Impacts During Construction

Environmental impacts during construction could be mitigated with proper planning and implementation of best management practices. The work site is not near urbanized areas; therefore, visual impacts would be minimal and few humans would be affected by noise.

The access road would require re-routing. Access by the general public could be restricted during construction, except for those property owners with lands upstream and American Indians requiring access to their tribal lands. Importing construction materials from distant sources would cause traffic impacts, but with proper planning and coordination with Caltrans, major impacts could be mitigated. Truck traffic for importing materials would discharge exhaust to the local air basin, as would excavation equipment. Other air quality issues related to dust from spillway excavation and berm construction could be mitigated by dust control measures.

A cultural survey would be conducted to identify any ancestral American Indian or historic artifacts, and construction activities could be restricted as necessary. All construction equipment should have spark arresters and fire control equipment should be kept readily accessible during construction. Construction water would have to be controlled and provisions for runoff and erosion control would need to be developed and implemented. A spill control plan would be needed to control any construction-related fuels, lubricants, and other materials.

Permits

It is probable that both Federal and non-Federal sponsors would be involved in the potential Dry Creek Dam and Reservoir. Joint sponsorship could complicate the permitting process as Federal projects are not subjected to the same level of permitting that is required for non-Federal projects.

Given the probable duality of sponsorship, and potential environmental and cultural impacts identified, at a minimum, certain permits could be required from the permitting agencies listed in Table 5-1.

In addition, the following agencies could be involved in reviewing permit conditions:

- Bureau of Indian Affairs
- Bureau of Land Management
- State Historic Preservation Office
- Advisory Council on Historic Preservation
- United States Fish and Wildlife Service (USFWS)

TABLE 5-1. POSSIBLE PERMITS REQUIRED

Permit	Permitting Agency
Permit to Construct	DSOD, Tulare County
Encroachment	Caltrans, Tulare County
Air Quality	CARB, Tulare County
Low/No Threat NPDES	RWQCB
Waste Discharge	RWQCB
401 Certification	SWRCB
Blasting	Tulare County
Stream Bed Alteration	CDFG
Fire/Burn	CDF, Tulare County

Key:

CARB	California Air Resources Board
CDF	California Department of Forestry
CDFG	California Department of Fish and Game
DSOD	Department of Safety of Dams
NPDES	National Pollutant Discharge Elimination System
RWQCB	Regional Water Quality Control Board
SWRCB	State Water Resources Control Board

In obtaining these various permits, several plans would have to be prepared and submitted to the responsible agencies for review and approval:

- Construction Plan and Summary Documents
- Quality Control Inspection Plan
- Highway Notification Plan
- Blasting Plan
- Noise Monitoring Plan
- Water Quality Monitoring Plan
- Noxious Weed Control Plan
- Bat Protection Plan
- Management Plan for Avoidance and Protection of Historic and Cultural Properties
- Storm Water Pollution Prevention Plan
- Spill Prevention/Containment Plan
- Visual Quality Control Plan
- Dust Control and Air Quality Plan

Another important regulatory requirement involves compensation /mitigation for habitat loss. In October 1998, USFWS issued its draft Coordination Act Report and Habitat Evaluation Procedure (HEP Analysis). The HEP Analysis delineates how compensation for adversely affected baseline habitat and wildlife conditions is to be determined. Another important regulatory requirement involves compensation/mitigation for habitat loss.

In addition, if power generation is included in a project or is modified for an existing project, the Federal Energy Regulatory Commission may become involved in the permitting process.

COSTS

Based on both the 1990 and 1992 Corps studies, the cost estimate for the proposed Dry Creek Dam and Reservoir was updated to April 2002 unit costs using Reclamation Construction Cost Trends. Costs were modified as warranted to reflect current material costs and standards of practice especially with respect to seismic requirements. Summaries of the estimated costs are presented in Table 5-2 and Appendix B.

Initial Construction Costs

The estimated total first cost for the potential Dry Creek Dam and Reservoir option is $237 million. Field costs represent the estimated cost to construct identified features, plus provisions for unlisted items (15 percent), contingencies (25 percent), and mitigation (5 percent). Total costs include field costs plus estimated costs for future analyses and planning documentation, development of designs, and construction management (15 percent).

Operations and Maintenance Costs

Operations and maintenance costs were not evaluated in any previous studies of the potential dam and reservoir and have not been estimated for this prefeasibility-level report.

SYSTEMS OPERATIONS

Water stored in Dry Creek Reservoir would be released to the Kaweah River and diverted to the Friant-Kern Canal or left instream. These flows would be exchanged for water delivered from Millerton Lake via the Friant-Kern Canal or released from Millerton Lake to the San Joaquin River.

TABLE 5-2.
ESTIMATED INITIAL COSTS

Component	2002 Cost ($Million)
Main Dam, Spillway, Outlet Works	110.0
Diversion and Care of River	1.5
Diversion Tunnel	22.8
Unlisted Items	20.2
Contingency	39
Mitigation	10
Total Field Cost	**204**
Invest/Design/CM	31
Land	2
Total First Cost	**237**

THIS PAGE LEFT BLANK INTENTIONALLY

CHAPTER 6. HYDROELECTRIC POWER OPTIONS

Various hydroelectric power options were considered for each storage site, including Dry Creek.

PUMPED STORAGE CONSIDERATIONS

Pumped storage is not a viable option for this surface storage option.

ADDED HYDROELECTRIC POWER TO EXISTING STRUCTURES

There are no existing water storage or hydroelectric structures on Dry Creek.

NEW HYDROELECTRIC POWER

Hydroelectric power generation could be considered for a new dam on Dry Creek. Past investigations for this site focused on flood control and irrigation water supply purposes.

TRANSMISSION AND DISTRIBUTION

Existing transmission and distribution facilities are located nearby.

THIS PAGE LEFT BLANK INTENTIONALLY

CHAPTER 7. ENVIRONMENTAL CONSIDERATIONS

This chapter describes existing environmental resources at the site and qualitatively describes potential effects of reservoir development. The discussion in this chapter is intended to indicate the extent to which expected or potential environmental effects might pose a constraint to reservoir development. Where evident, opportunities for improving environmental resources or mitigating adverse effects have been noted. Analysis focused on botany, terrestrial wildlife, aquatic biology, water quality, recreational resources, cultural resources, and existing land uses. Mining and other known past activities that might affect site conditions also are briefly discussed, along with the potential presence of hazardous or toxic materials. Temporary construction-related disruptions and impacts are discussed in Chapter 5.

Identification of constraints was conducted at a preliminary, prefeasibility-level of planning, consistent with the current phase of the Investigation. Criteria considered were based, in part, on criteria commonly used to evaluate environmental impacts of projects under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). The application of criteria that may be used for NEPA or CEQA evaluation does not imply that the analysis is at a level necessary to support an EIS or EIR. Considerations included presence of special status species (e.g., species listed as endangered or threatened), species of concern, or sensitive habitats; relative amounts of affected riparian or wetland habitat; effects on native or game fish; conflict with established recreational uses or land uses; presence of nationally registered historic places, sacred Native American sites, or Traditional Cultural Properties; permanent disruption or division of established communities; and loss of energy production facilities.

BOTANY

The potential Dry Creek Dam and Reservoir site has grassland and a small amount of foothill pine and oak woodland habitats. Vernal pools and other wetlands could also be present in the flatter valley bottom.

A substantial strip of riparian vegetation occurs along Dry Creek. The CNDDB reports sycamore alluvial woodland (SAW) near the confluence of Dry Creek and the Kaweah River. Although sycamore trees may be common, SAW has been described as a “very rare and essentially irreplaceable habitat” and the Dry Creek stand in particular as one of the largest in the Central Valley (Carson, 1989). There are fewer than six viable occurrences and/or less than 2,000 acres of SAW in California and worldwide (Prose, 2002).

Thirteen special-status species are recorded around the Dry Creek area. Of these, five have threatened or endangered status. A population of Kaweah brodiaea (state-listed as endangered) occurs along Dry Creek between Kaweah River and Pogue Canyon, slightly downstream of the potential dam site. In addition, a very large population (over 100,000 plants) of spiny-sepaled button-celery, a California Native Plant Society (CNPS) List 1B species, occurs along Dry Creek between Kaweah River and Ragle Canyon, slightly north of the potential dam site.

Constraints

The greatest constraint to creating Dry Creek Reservoir would be the substantial loss of riparian habitat and SAW. Reservoir construction and water diversion are considered threats to SAW, as sycamores have little tolerance to artificially manipulated water levels (Prose, 2002). In addition, sexual regeneration of SAW depends on substantial scour caused by flood events (Enstrom, 2002). Consequently, construction of the potential Dry Creek Dam and Reservoir would be likely to negatively affect this resource. Replacement of SAW is considered unlikely to be successful and its destruction unmitigable (Enstrom, 2002).

Loss of a state-listed endangered species (Kaweah brodiaea) also poses a constraint to development of this storage option. Reservoir creation would also result in loss of a very large population of a CNPS List 1B species (spiny-sepaled button-celery).

Opportunities

The loss of riparian habitat would likely be much too large to mitigate on site, so an off-site location would be needed. It is not clear how to offset the loss of special status plants with particular environmental requirements. Resource agencies consider adverse impacts to SAW to be unmitigable.

WILDLIFE

The wide streambed of Dry Creek hosts relatively well-developed riparian woodland. As mentioned above, a large stand of SAW is found near Dry Creek’s confluence with the Kaweah River. This type of woodland provides important habitat for wildlife (Prose, 2002).

Adjacent foothills are vegetated with grasslands and foothill pine and oak woodland habitats. Known wildlife sensitivities for the area include western pond turtle, a California Species of Special Concern. It is present in Lake Kaweah and Yokohl Valley, so the turtle may also occur in Dry Creek. The San Joaquin kit fox is also known to inhabit the area. Vernal pools occur in adjacent areas and they may occur near Dry Creek, but are not expected within the potential inundation zone. The California condor nests in the Blue Ridge Reserve, but the reserve is several miles from the dam site and should not be affected by construction.

Constraints

Loss of SAW, discussed under botany, and loss of riparian habitat in Dry Creek may be the most critical issues from a wildlife perspective. Riparian habitat may host sensitive species such as willow flycatcher, foothill yellow-legged frog, and western pond turtle. However, the only special status species potentially affected is the San Joaquin kit fox. Although the kit fox is on the Federally listed as endangered, impacts to the kit fox can be mitigated.

AQUATIC BIOLOGY/WATER QUALITY

Information on flow conditions of Dry Creek was not readily available at the time of this environmental review. However, water flow in Dry Creek is expected to be intermittent. Good water quality would be expected during and shortly after significant rainfall events, but would decline as flow recedes.

If the creek is not dewatered during the dry season, it may contain bullfrogs and fish, including California roach and mosquito fish. The San Joaquin form of the California roach has been designated as a California Species of Special Concern. Its presence in Dry Creek would require investigation.

Constraints

The principal effects of this option on aquatic biological resources would result from replacing stream habitat with lacustrine habitat. Populations of fish and other organisms adapted to stream environments would be reduced or eliminated from inundated areas, while those of species adapted to lacustrine conditions would be enhanced. The most likely native fish species to be affected by the measure would be the California roach, which is generally not found in lakes.

Releases from Dry Creek Reservoir would potentially affect habitat and water quality in the lower Kaweah River. However, more information about existing water quality in the lower Kaweah River and about likely water quality of releases from the new Dry Creek Reservoir are needed to evaluate this option.

Opportunities

The principal opportunity afforded by this measure is creation of substantial new fish habitat created by the reservoir. The new habitat would probably support warm-water species only, as the potential Dry Creek Reservoir would be relatively shallow. By way of comparison, Lake Success, an existing shallow reservoir in the region, is weakly stratified with respect to temperature during summer and strongly stratified with respect to dissolved oxygen concentration, and therefore does not support a cold-water fishery. If the potential Dry Creek Reservoir had similar water temperature and dissolved oxygen conditions, it would support a warm-water fishery only.

Most fish populations originally stocked in Dry Creek Reservoir would probably be self-sustaining, assuming sufficient carryover storage. Fish habitat in the potential reservoir could be greatly improved if the dam were operated to minimize water level fluctuations, at least during times of year important for fish spawning and rearing.

RECREATION

The potential dam and reservoir would be situated on private property. No developed recreation facilities occur along Dry Creek and heavy dispersed use along Dry Creek is unlikely owing to private property.

Constraints

Constructing Dry Creek Dam and Reservoir is not expected to result in adverse impacts to recreation resources in the vicinity of Dry Creek.

Dry Creek Reservoir would be filled by diverting water from Kaweah Reservoir and by natural flows from Dry Creek. Assuming only excess flood flows were diverted from Lake Kaweah, which are flows that would otherwise have been released, creation of Dry Creek Reservoir would not affect water levels at Kaweah Reservoir. Consequently, recreation activities and opportunities at Kaweah Reservoir would be unaffected.

Opportunities

Creation of Dry Creek Reservoir would not be expected to result in adverse impacts to recreation, so no mitigation would be required. Given the relatively small reservoir being considered, no new recreation opportunities would be created in the area.

CULTURAL RESOURCES

The Dry Creek drainage north of Liveoak Canyon, about 2 miles north of the potential dam site, was traditional territory of the Waksachi people, a transitional Yokuts-Western Mono group (Spier, 1978). Spier suggests that from Liveoak Canyon south to the Kaweah River confluence, the Dry Creek drainage was traditional territory of the Gawia Foothill Yokuts people (1978). However, Jackson (et al., 1990) documents specific sites in the lower reaches of Dry Creek that are affiliated with Wukchumni Yokuts people. Thus, the upper reaches of the potential Dry Creek Reservoir are within Waksachi territory, while the major portion of the reservoir is in an area that may be either Gawia or Wukchumni.

However, it is important to keep in mind that territorial boundaries were but loosely maintained, and people frequently traveled into adjacent territories to trade and to exploit certain sorts of resources thought of as common property for all residents of a region (Gayton, 1948). Wukchumni people have shown considerable interest in the area immediately south of the potential dam.

Gawia descendants live primarily at the Tule River Indian Reservation. Wukchumni people live in Visalia, Fresno, Farmerville, Selma, and other settlements. Waksachi descendants live scattered around a number of small settlements in the area, including Selma (southeast of Fresno) and Squaw Valley, Dunlap, and Auckland, all north of Lake Kaweah (White, 1996).

The Dry Creek vicinity first came to archaeological attention in the 1920s (Steward, 1929). In the 1980s, R. J. Cantwell surveyed the Artesia Ready Mix sand and gravel site located approximately where the potential Dry Creek Reservoir would be built; no sites were recorded at that time (Cantwell, 1984). A later survey (Jackson et al., 1990) identified 29 archaeological sites in the Dry Creek Valley. Several are within the potential reservoir area, but details are not presently available.

The Dry Creek area history is summarized in an overview document by Meighan (et al., 1988). The earliest documented production activity near Dry Creek was limestone mining at Limekiln Hill, south of the site near Terminus Dam, beginning around 1859. The Homestead Act of 1862 facilitated settlement in the area, and many settlers raised cattle, sheep, or horses. Citrus groves were planted as early as 1877.

Constraints

Some cultural resources are known to be present, and there may be additional sites not yet recorded. Inundation of archaeological sites (prehistoric or historic) can result in loss of important scientific data. As many as 29 archaeological sites (possibly more), could be adversely affected by construction of Dry Creek Reservoir. No properties eligible for the National Register of Historical Places are known in the area that would be affected, but future study would likely identify such properties. No Native American sacred sites or Traditional Cultural Places are known to occur, but Waksachi, Wukchumni, and Gawia Yokuts concerns would be expected.

Opportunities

Inundation damage to archaeological sites can be mitigated with scientific data recovery programs. Reservoir projects also provide an opportunity for public interpretation of the past. For ancillary facilities, such as roads, power lines, or other structures, impact to archaeological sites might be avoided through design or facility placement.

LAND USE

The site is generally undeveloped with the exception of a large, active sand and gravel quarry, and a few rural properties (two dwellings and miscellaneous farm buildings and corrals), including Horner Ranch, as identified on USGS topographic maps.

Constraints

Although it would be undesirable to remove and relocate an active commercial operation, the presence of the quarry is not considered a serious constraint for this option. Further investigation of the Tulare County General Plan and Zoning Ordinance would contribute additional information needed to determine the degree to which this measure would be constrained from a land use point of view.

MINING AND OTHER PAST ACTIVITIES

A sand and gravel quarry operates within the Dry Creek site. Prior mining within the watershed focused on tungsten, gem, minerals, and limestone (Corps, 1992a).

Constraints

Beyond cultural resource concerns discussed above, no constraints related to past activities have been identified.

HAZARDOUS AND TOXIC MATERIALS

The rural and ranch properties may possess, or might once have possessed, underground or aboveground storage tanks containing petroleum hydrocarbons, herbicides, or fertilizers, and/or electrical transformers containing polychlorinated biphenyls (PCBs) . Rural residences usually have septic systems. Pesticide data collected along Dry Creek in 1988 did not indicate impacts (Corps, 1992a).

Constraints

Potential impacts to the site from septic systems, fuel and lubricant hydrocarbons, pesticides, herbicides, and fertilizers, and/or from electrical transformers may exist at the site and could require remediation.

CHAPTER 8. FINDINGS AND CONCLUSIONS

This TM described the issues associated with developing a dam and reservoir on Dry Creek, which is a tributary to the Kaweah River just downstream and northwest of Terminus Dam. A 70 TAF reservoir would be created by constructing a single 175-feet-high RCC dam. Water would be diverted from Lake Kaweah through a 7,600-foot-long gravity tunnel, 10 feet in diameter. The new reservoir would also capture natural runoff from Dry Creek. Stored water would be released to Dry Creek, flow down the Kaweah or St. Johns rivers to the Friant-Kern Canal, and be used in lieu of deliveries from Millerton Lake through exchange.

No significant issues related to construction requirements were identified. The dam and reservoir site is generally undeveloped with the exception of a few rural residential properties. The dam site is underlain by competent hard rock, and sufficient sand and gravel would be available from a large nearby active quarry. A road provides direct access to the site; staging and lay-down areas are located immediately upstream and downstream; and electrical power is available from the powerhouse at Terminus Dam or other nearby commercial sources.

Environmental impacts associated with Dry Creek Dam and Reservoir would be significant. The creation of Dry Creek Reservoir would result in adverse impacts to botany resources. Most notably, a SAW that exists near the confluence of Dry Creek and the Kaweah River would be adversely affected. Although sycamore trees are common, SAW has been described as a “very rare and essentially irreplaceable habitat type” and the Dry Creek stand is one of the largest in the Central Valley. There are fewer than six viable occurrences and/or less than 2,000 acres of SAW in California and worldwide. Reservoir construction and water diversion are considered threats to SAW, as sycamores have little tolerance to artificially manipulated water levels. Sexual regeneration of SAW depends on substantial scour caused by flood events. Successful replacement of SAW is considered unlikely and its destruction is therefore unmitigable.

Potentially affected riparian habitat may support several listed wildlife species and several special-status plant species are recorded around the Dry Creek area. Principal effects on aquatic biological resources would result from replacing a stream environment with lacustrine habitat. The most likely native fish species to be affected would be the California roach, although its presence in Dry Creek is not known.

Due to the potential adverse and potentially unmitigable impacts to SAW habitat, this option was dropped from further consideration in the Investigation.

THIS PAGE LEFT BLANK INTENTIONALLY

CHAPTER 9. LIST OF PREPARERS

NAME	ROLE
MWH	
William Swanson	Project Manager
Stephen Osgood	Planner
David Rogers	Engineering Team Leader
James Herbert	Engineering Geologist
Michael Preszler	Civil Engineer, Hydrologist
Irina Torrey	Environmental Team Leader
Sara Hamm	Environmental Coordination
Philip Unger	Aquatic Biology
David Stevens	Wildlife Biology
Sandra Perry	Recreational Resources
Stephanie Murphy	Wildlife Biology
Barry Anderson	Botany
David White	Cultural Resources
James Darke	GIS Analyst
Steve Irving	GIS Technician
Emily McAlister	Technical Editor
Michelle Irwin	Document Coordinator

ACKNOWLEDGEMENTS

The preparers acknowledge the valuable assistance provided by Mr. Kalvin Urqhart and Phil Diffenbach with the Corps at Terminus Dam, and Ms. Mary Moore at the Corps library in Sacramento.

THIS PAGE LEFT BLANK INTENTIONALLY

CHAPTER 10. REFERENCES

CALFED. 2000a. CALFED Bay-Delta Program Record of Decision. August.

CALFED. 2000b. CALFED Initial Surface Water Storage Screening. August.

California Department of Fish and Game (CDFG). 2001 Wildlife Habitats Relationships.

CDFG. 2002 Natural Diversity Database, Rare Find 2.

California Division of Mines and Geology (CDMG). 1966. Geologic Map of California – Fresno Sheet, 1:250,000. Fourth printing 1991.

CDMG. 1994. Fault Activity Map of California and Adjacent Areas with Locations and Ages of Volcanic Eruptions, 1:750,000, compiled by Charles W. Jennings.

California Public Utilities Commission (CPUC). 2000. Draft Environmental Impact Report for the Pacific Gas and Electric Company's Proposed Divestiture of Hydroelectric Facilities. Sacramento.

Cantwell, R. J. 1984. Survey for PMR 84-01/PSP and 84-62/PSR, Artesian Ready Mix. Bakersfield, California: Southern San Joaquin Valley Information Center, S-13.

Carson, James D. 1989. U. S. Fish and Wildlife Service letter to Corps of Engineers regarding Tule and Kaweah River Basin Investigations. January 23.

Corps of Engineers (Corps). 1957. Design Memorandum No. 5, Terminus Project, Kaweah River California. General Design Memorandum. U.S. Army, Sacramento District. December 15.

Corps. 1966. Terminus Reservoir, Geology, Paleontology, Flora and Fauna, Archeology, History. U.S. Army, Sacramento District. August.

Corps. 1986. Hydrology Reconnaissance for the Kaweah and Tule Rivers. U.S. Army, Sacramento District, South Pacific Division.

Corps. 1990a. Basis of Design and Cost Estimates Office Report, Feasibility Level, Kaweah River Basin Investigation, California. U.S. Army, Sacramento District, South Pacific Division. January.

Corps. 1990b. Hydrology Office Report, Feasibility Level, Kaweah River Basin Investigation, California. U.S. Army Sacramento District, South Pacific Division.

Corps. 1992a. Kaweah River Basin Investigation, California, Draft Integrated Feasibility Report and Environmental Impact Statement. U.S. Army, Sacramento District, South Pacific Division. September.

Corps. 1992b. Kaweah River Basin Investigation, California, Appendix A, Volume I, Draft Basis of Design and Cost Estimates. U. S. Army, Sacramento District, South Pacific Division. August.

Corps. 1996a. Kaweah River Investigation, California, Draft Feasibility Report. U. S. Army, Sacramento District, South Pacific Division. June.

Corps. 1996b. Kaweah River Investigation, California, Draft Environmental Impact Statement/Environmental Impact Report. U. S. Army, Sacramento District, South Pacific Division. June.

Corps. 1999. Sacramento and San Joaquin River Basins, California, Post-Flood Assessment. U.S. Army, Sacramento District, South Pacific Division. March 29.

Davis, James T. 1961. Trade Routes and Economic Exchange among the Indians of California. Berkeley: University of California Archaeological Survey Reports 54.

Drucker, Philip. 1948. Appraisal of the Archeological Resources of Success Reservoir, Tulare County, California. Washington DC: Pacific Coast Area, River Basin Surveys, Smithsonian Institution.

Enstrom, Karen. 2002. Personal communication. December.

Fenenga, Franklin F. 1947. Archaeology of Terminus Reservoir, Tulare County, California. Manuscript report, Berkeley: University of California Archaeological Survey.

Gayton, Anna H. 1948. Yokuts and Western Mono Ethnography. Vol. 2, Northern Foothill Yokuts and Western Mono. Berkeley: University of California Anthropological Records 10(1-2).

Heizer, Robert F. (ed.). 1978. Handbook of North American Indians, vol. 8, California. Washington, DC: Smithsonian Institution.

Heizer, Robert F., and Adan E. Treganza. 1944. Mines and Quarries of the Indians of California. California Journal of Mines and Geology 40:291-359.

Jackson, Thomas L., C. Kristina Roper Wickstrom, Clinton M. Blount, Brian P. Wickstrom, Jeffrey T. Hall, and Jennifer M. Ducat. 1990. Kaweah River Basin Investigation Survey, Tulare County, California: Cultural Resources Inventory and Evaluation. Report. Prepared by BioSystems Analysis, Inc., Santa Cruz California, for the United States Army Corps of Engineers, Sacramento District, California, Contract No. DACW05-89-C-0028.

Latta, Frank F. 1949. Handbook of Yokuts Indians. Oildale, California: Bear State Books.

Levy, Richard. 1978. Eastern Miwok. In Robert F. Heizer, ed., Handbook of North American Indians, vol. 8, California. Washington, DC: Smithsonian Institution. pp. 398-413.

Meighan, Clement W., B. D. Dillon, D. V. Armstrong, P. Farnsworth, D. S. Whitley, E. A. Gehr, L. Conton, and R. H. Dillon. 1988. Lake Kaweah Intensive Cultural Resources Survey. Report prepared by the Institute of Archaeology, University of California, Los Angeles, for the U.S. Army Corps of Engineers, Contract No. DACW05-83-C-0107.

Moratto, Michael. 1984. California Archaeology. San Diego: Academic Press.

Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish Species of Special Concern in California. Department of Wildlife and Fisheries, University of California, Davis.

Moyle, Peter B. 1976. Inland Fishes of California. Berkely: University of California Press.

MWH. 2002. Technical Memorandum, Environmental Constraints and Criteria for Application. February.

Prose, Caroline. 2002. Letter to Corps of Engineers. February 7.

Reclamation. 1966. A Feasibility of Water Supply Development. United States Department of the Interior, Bureau of Reclamation, East Side Division CVP. June.

Reclamation. 1968. A Re-evaluation of the Report on the Feasibility of Water Supply Development. United States Department of the Interior, Bureau of Reclamation, East Side Division CVP. September.

Reclamation 1971. Ground-Water Geology and Resources Appendix. United States Department of the Interior, Bureau of Reclamation.

Reclamation. 2002. Appraisal-Level Probabilistic Ground Motion Evaluation, Technical Memorandum No. D-8330-2002-10. Prepared for the Upper San Joaquin River Basin Investigation, Central Valley Project, California. United States Department of the Interior, Bureau of Reclamation, Technical Service Center, Seismotectonics and Geophysics Group. August.

Sierra Nevada Ecosystem Project (SNEP). 1996. Potential aquatic diversity management areas in the Sierra Nevada. In Sierra Nevada Ecosystem Project: Final Report to Congress, Volume III, Chapter 9. University of California, Davis.

Spier, Leslie. 1978. Monache. In Robert F. Heizer, ed., Handbook of North American Indians, vol. 8, California. Washington, DC: Smithsonian Institution. pp. 426-436.

Steward, Julian H. 1929. Petroglyphs of California and Adjoining States. University of California Publications in American Archaeology and Ethnology 24(2):47-238.

TCR/ACRS. 1984. Cultural Resources Overview of the Southern Sierra Nevada: An Ethnographic, Linguistic, Archaeological and Historical Study of the Sierra National Forest, Sequoia National Forest, and Bakersfield District of the Bureau of Land Management. Submitted to USDA Forest Service, Bishop, California, by Theodoratus Cultural Research and Archaeological Consulting and Research Services.

URS. 2000. Technical Memorandum 4, Draft Long List of Alternatives, Development of Water Supply Alternatives for Use in Habitat Restoration for the San Joaquin River. For Friant Water Users Authority and Natural Resources Defense Council Coalition. November 22.

URS. 2001. Technical Memorandum 5, Analysis of Long List of Alternatives, Development of Water Supply Alternatives for Use in Habitat Restoration for the San Joaquin River. For Friant Water Users Authority and Natural Resources Defense Council Coalition. May 24.

Von Werlhof, Jay C. 1961. Aboriginal Trails of the Kaweah Basin. Berkeley: University of California, Department of Anthropology Archaeological Research Facility Manuscript No. 299.

Wallace, William J. 1978. Southern Valley Yokuts. In Robert F. Heizer, ed., Handbook of North American Indians, vol. 8, California. Washington, DC: Smithsonian Institution. pp. 448-461.

White, David R. M. 1996. Report on Interviews for an Overview of Contemporary Native American Issues Pertaining to the Sequoia National Forest, in Fresno, Tulare and Kern Counties, California. Santa Fe, New Mexico: Applied Cultural Dynamics.

White, David R. M. 2000. Ethnographic Profile of Native American Peoples Associated with the Pacific Gas & Electric Company's Proposed Divestiture of Hydroelectric Generating Facilities. Report prepared for Resource Insights, Sacramento, California, and Aspen Environmental Group, Agoura Hills, California.

APPENDIX A

Engineering Trip Report

Dry Creek Reservoir

Field Trip Log

Trip Log Number:	2	**Project No.:**	1003032.01180502
Dates:	6/11/02	**Times:**	1230-1330
Site Name:	New Dry Creek	**Location:**	Lemon Cove
Prepared By:	DKR/JMH/WAM	**Reviewed By:**	
Date:	6/11/02	**Date:**	

Attendees/Visitors Name	**Organization/Phone/Email**
DKR	MWH, 925.685.6275 x125, david.k.rogers@mwhglobal.com
JMH	MWH, 925.685.6275 x143, james.m.herbert@mwhglobal.com
WAM	MWH, 425.602.4025 x1060, william.a.moler@mwhglobal.com

Weather Conditions:

Clear with slight haze, warm (80s), light breeze

Access Route (attach map):

Highway 99, State highway 198 (E) through Visalia to Lomitas Dr. (N/E), to Dry Creek Dr. (N)

Attachments:	Yes	No
Photo Log	✔	
Photos	✔	
Video Log (available)	✔	
Dictation Log (available)	✔	
Topographic Map	✔	

Purpose:

Review proposed location of new damsite.

Field Observations:

Existing Structures/Cultural Features:

Numerous residential properties are located in the site described as the URS Dry Creek (see discussion below in Item 4). In the USCOE site, active sand and gravel quarry were observed within and downstream of Dry Creek damsite, while sparse rural development observed within valley upstream of the proposed damsite.

Right of Way/Access Restrictions:

Access to the URS damsite is available via paved county roads (Mehrten Drive and Fritz Drive). Access to the USCOE damsite is available via paved county road (Dry Creek Drive) and unpaved quarry roads.

Overhead/Buried Utilities:

Overhead and underground utilities are associated with the URS site. For the USCOE site, overhead power and telephone lines were noted along Dry Creek Drive.

Description of Proposed Structures (attached a field sketch or sketch on a topo map):

Technical Memorandum 4 (URS, 2000) identified the new Dry Creek damsite location as being ~7 miles southwest of Terminus Dam or ~6 miles south of Woodlake Township. URS discussed a new earthfill dam extending to as high as 300 feet, spillway, outlet works, and a 6-mile long, 10-ft diameter, diversion tunnel. According to URS, a 300-ft deep reservoir would store ~444 TAF of excess floodwater diverted via the tunnel from Lake Kaweah (URS, 2000).

A USCOE feasibility level report for the proposed enlargement of Lake Kaweah and construction of new Dry Creek Reservoir (USCOE, 1990) identified the new Dry

Creek damsite location as ~ 2 miles northwest of Terminus Dam. The USCOE document recommended a 200-foot roller compacted concrete (RCC) dam with a crest length of ~3,210 feet. The USCOE reservoir would have a storage capacity of ~70 TAF at a gross pool elevation of 684 ft. Gated and ungated outlets works were evaluated. The gated alternative would allow for carry-over storage of 10 TAF of excess flows from Lake Kaweah. Flow would be diverted to Dry Creek via an interconnecting, concrete-lined, 12-ft diameter, 7,600-ft long, tunnel.

Description of Appurtenant Features (spillways, tunnels, pumping plants, flood routing/coffer dams/dewatering during construction, outlet works, switch yards, transformer yards, transmission lines, conveyance pipelines/canals, access roads, security, operation/maintenance):

The USCOE design shows the axis of the RCC dam extending northeastward across Dry Creek. The upstream dam face would be vertical, while the downstream dam face would be 0.65:1 (h:v).

The proposed spillway crest would be at ~ el. 684. The non-flow portion of the dam crest would be ~3,110 ft long and 25 ft wide. A 102 ft wide, ungated, ogee crest weir spillway was selected through routing of the PMF (36,000 cfs maximum discharge) through the spillway. The spillway and top of roadway elevations would be at ~705 ft and the top of parapet wall would be at ~ 708 ft. The total freeboard (3 ft) is based on total wave runup and wind setup of 2.5 ft.

Two outlets were investigated; a flood control/conservation alternative considered a fixed cone valve for and the flood control only alternative was ungated. Tunnel flow would be regulated by slide gates at the upstream end. A vertical access shaft would be cut from the ground surface to the gate location. The invert elevation at Lake Kaweah would be at el. 600 and the two-way tunnel would have a minimum slope of 0.001 ft/ft.

Briefly Describe Geologic/Geotechnical Site Conditions:

Both the URS and USCOE damsites are located at the boundary of the Sierra Nevada foothills and the Great Valley.

The URS Dry Creek damsite would be located within a northwest-flowing tributary to the Kaweah River alluvial fan. Mesozoic granitic rock would be exposed along the entire east and south shores of the URS Dry Creek Reservoir. Undifferentiated pre-Cretaceous metasedimentary rocks would be exposed along the western lake shore and appears to underlie the proposed URS damsite.

The USCOE Dry Creek damsite would be located in a southerly-flowing tributary to the Kaweah River. Undifferentiated pre-Cretaceous metasedimentary rocks (Calaveras Complex) are exposed along the both sides of the USCOE reservoir and in the proposed USCOE Dry Creek Reservoir footprint, except for a small area along the western lakeshore where Mesozoic granite is exposed. Relatively thick Pleistocene and recent river alluvium deposits of sand, gravel, and possible silt are found in the axis of Dry Creek.

A number of exploratory boreholes were advanced by USCOE in 1989 in the proposed embankment dam spillway, outlet works, left dam abutment, and along the tunnel alignment. Mica-quartz schist with interbedded quartzite where the most common rock types reported. Marble was reportedly encountered in one dam axis boring. In the proposed quarry area, biotite quartz biotite (granite) was the most abundant rock encountered (~90 percent), followed by schistose quartzite (~10 percent) and biotite quartz schist (<1 percent).

Previous studies indicate that there are no faults in the area capable of producing ground motions greater than those generated by four known regional sources that include the San Andreas fault system, the Sierra Frontal fault system, the White Wolf fault, and the Garlock fault (USCOE, 1990)

Metamorphic rocks are present in the locations of the potential spillway, outlet works, along the dam axis and tunnel, and in a potential quarry area located in the area of the western perimeter of the proposed reservoir. However, in the potential quarry area, metamorphic rocks were not dominant. Schistose quartize composed about 10 percent of the quarry area rock while biotite quartz schist made up less than 1 percent. (The balance of the potential quarry area rock was granite.)

Bbiotite chlorite schist and quartzite were encountered in the spillway and outlet works areas, and to a much lesser extent in the quarry area. In the spillway and quarry area, the bc schist was primarily medium gray, hard, slightly weathered, and predominantly aphanitic to fine-grained with traces of pyrite, garnet, and chlorite. Foliation in the schist was steep, reported as 15 to 20 degrees from the core axis. Using the assumption that the core holes were vertical, the foliation dipped at 70 to 75 degrees from horizontal. The orientation of the foliation was not reported, but likely parallels the northwest to southeast trend of the Kings – Kaweah suture.

Metamorphic rocks in the outlet works area were interbedded and closely associated, consisting of light olive gray to brownish black and dark gray quartzite and schist that ranged from soft to hard, slightly to moderately weathered, aphanitic, intensely to moderately fractured, and abundantly stained with iron-oxide. Foliation in the schist was similar to that in the quarry area, 15 to 20 degrees from the core axis. Numerous ptygmatic folds were observed within the cores.

Along the dam and tunnel axes, quartz-mica schist was the most common rock type found. Marble was reported in one dam axis boring and quartzite was found in the other dam locations. Quartz-mica schist, quartzite, and marble stringers were encountered in the tunnel locations. Chlorite schist was noted in one tunnel boring.

The quartz-mica schist in the dam locations varied in coloration from dark to medium dark gray to dark greenish gray to grayish olive. It also varied from soft to hard, slightly to highly weathered, aphanitic to fine-grained, and intensely to highly fractured. Foliations were oriented as in the outlet works area. The quartz-mica schist in the tunnel locations was similar to that in the dam area, but hard to very hard, slightly to moderately weathered, and intensely to moderately fractured, and possessed a micaceous sheen and irregular foliation.

The quartzite varied from moderately hard to hard, unweathered to moderately weathered, aphanitic and fine-grained, and had pyrite. In the tunnel location, the quartzite was also intensely fractured. Quartz stringers were noted in the dam location, while marble stringers were observed in the tunnel location.

Marble, noted in only one dam location, was highly color-variable in shades of gray. It was moderately hard to very hard, slightly to highly weathered, aphanitic to fine-grained, and highly to moderately fractured.

The chlorite schist, noted in only one tunnel location, is light gray to dusky yellow green, hard, slightly weathered, and aphanitic to fine-grained. Trace levels of calcite crystal-filled vugs were also noted.

A minor amount of sandstone, apparently stream-channel-deposited, was noted in one of the spillway borings. The sandstone was light olive brown, soft to moderately soft, coarse to very coarse, slightly to moderately weathered, intensely fractured, and massive. The basal pebble layer consisted of hard, round quartz pebbles.

Granitic rocks were encountered only in a potential quarry site located in the area of the western perimeter of the proposed reservoir. About 90 percent of the rock at the potential quarry area was granite. This rock consisted of light to medium light gray granite that was primarily moderately hard to very hard, slightly weathered, subhedral to euhedral, fine- to medium-grained, and moderately fractured to unfractured. Iron-oxide stain delineated micro-fractures in the granite surrounding xenoliths found in all locations. Iron oxide staining ranged from nonexistent to abundant.

Location/Description of Nearest Borrow Areas (attach map or show on topo map):

In the area of the URS damsite, borrow materials may be found upstream and downstream of the Dry Creek basin.

In the area of the USCOE damsite, active sand and gravel operations were observed in Dry Creek within the approximate axis of the proposed dam. Other potential sources of borrow materials are the alluvium-filled channels upstream and downstream of the proposed dam and the alluvial/colluvial plain located between Terminus Dam and Dry Creek.

Location/Description of Equipment/Material Staging and Lay Down Areas (attach map or show on topo map):

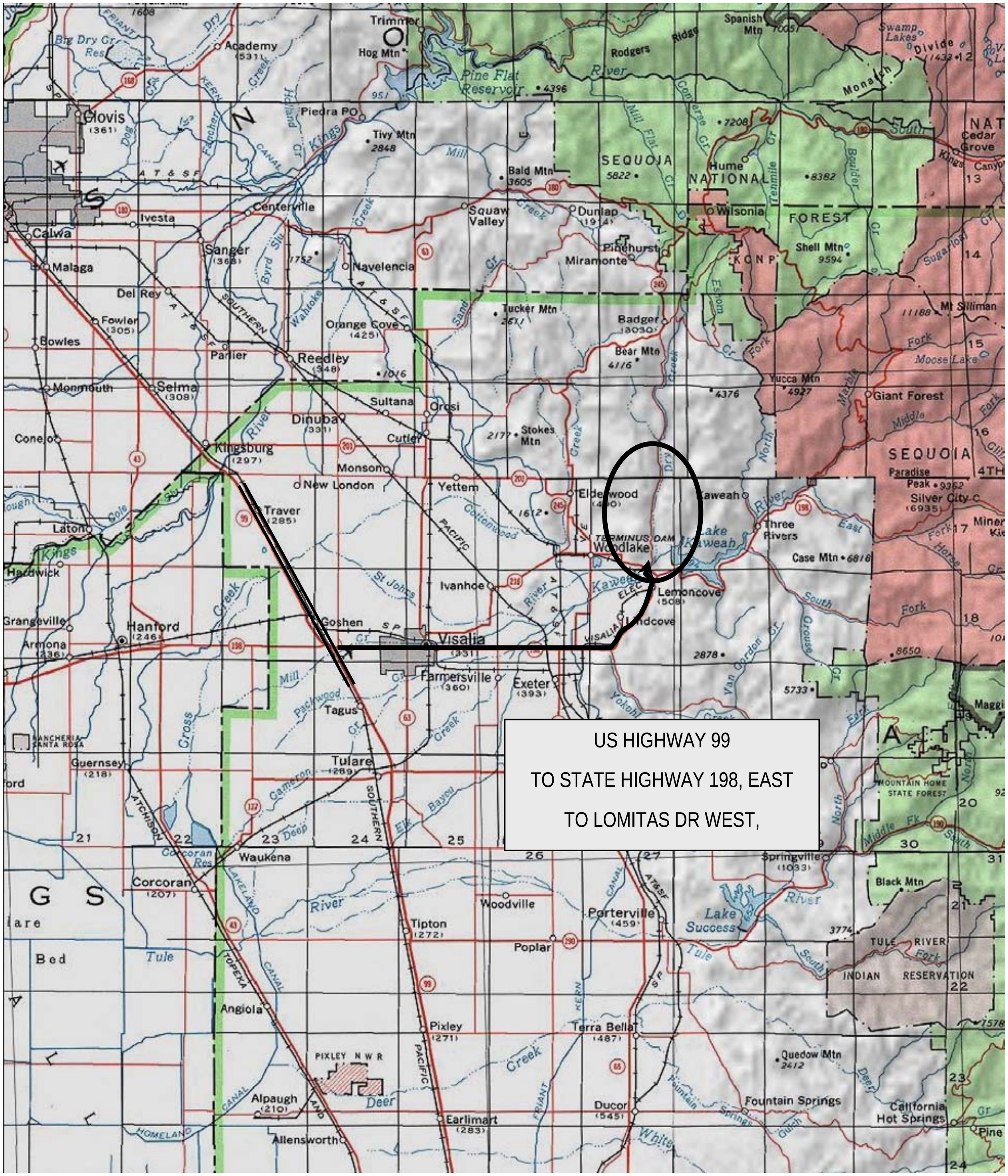
Potential staging and laydown areas are located downstream of the proposed URS Dry Creek damsite. Potential staging and laydown areas are located downstream of the proposed USCOE Dry Creek damsite.

Identification of Environmental Sensitive Areas (wetlands, springs, rivers, streams, endangered/threatened species habitats, etc.):

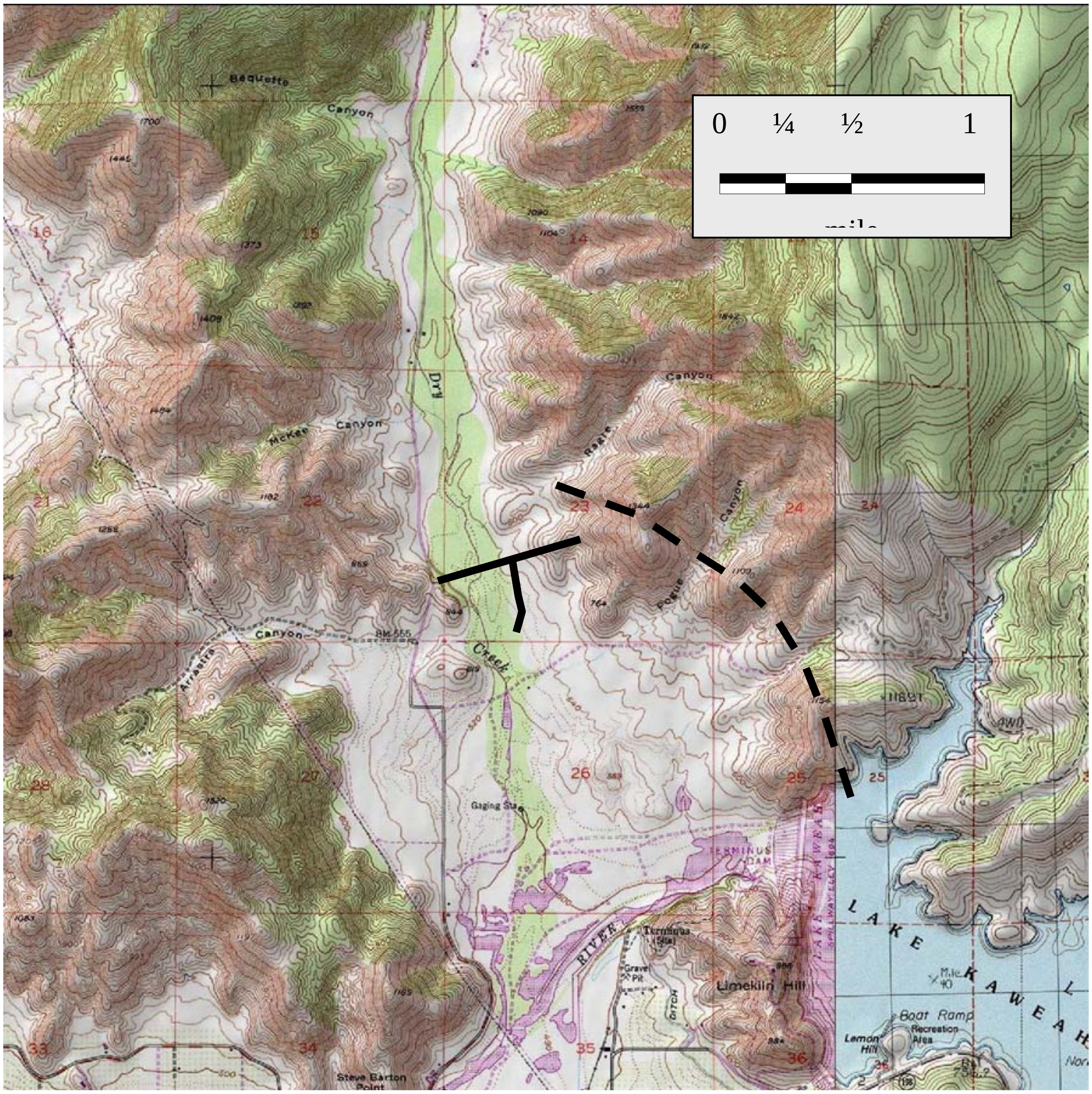
Oak woodland habitat surrounds the URS damsite. Riparian and Oak Woodland habitats would potentially be impacted by either the URS or the USCOE Dry Creek damsites.

Description of Mining or Other Anthropologic Activities:

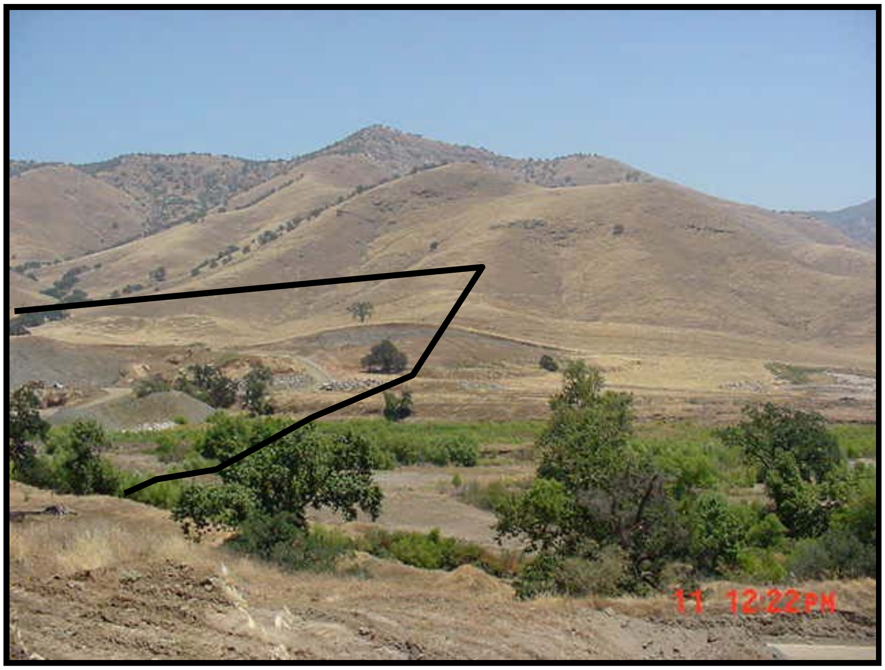
None noted in the URS location. Sand and gravel mining activities were noted in the USCOE location.



DRY CREEK SITE VICINITY MAP



LOCATION OF POTENTIAL DAM



Dry Creek – Left abutment area

Active sand and gravel operation in potential dam area. Note thick Plio-Pleisto alluvial materials being mined.

THIS PAGE LEFT BLANK INTENTIONALLY

APPENDIX B

Cost Estimate Summary

Dry Creek Dam and Reservoir

Upper San Joaquin River Basin Storage Investigation Cost Estimate			
DRY CREEK DAM AND RESERVOIR			
	200 ft high RCC dam 7600 ft long diversion tunnel from Lake Kaweah		
FIRST COST ITEMS		**COST (2002 dollars)**	
DAMS	Diversion Dam/Cofferdam	$	1,500,000
	Main Dam, Spillway, and Outlet Works	$	110,084,125
SUBTOTAL		**$**	**111,584,125**
CONVEYANCE FACILITIES			
	Power intake, tunnels & penstocks	$	-
	Diversion Tunnel	$	22,800,000
	Canals/Pipelines	$	-
	Pumping Stations	$	-
	Regulating Reservoirs	$	-
SUBTOTAL		**$**	**22,800,000**
PERMANENT OPERATING EQUIPMENT			
	Powerplants, generators & turbines	$	-
	Transmission Lines, switchyards, & substns.	$	-
SUBTOTAL		**$**	**-**
TOTAL, LISTED ITEMS (rounded)		**$**	**134,400,000**
UNLISTED ITEMS (15%; rounded)		**$**	**20,200,000**
TOTAL, CONSTRUCTION ITEMS (rounded)		**$**	**155,000,000**
CONTINGENCIES ON CONSTRUCTION (25%; rounded)		**$**	**39,000,000**
TOTAL, CONSTRUCTION COST		**$**	**194,000,000**
MITIGATION (5%; rounded)		**$**	**10,000,000**
TOTAL FIELD COSTS		**$**	**204,000,000**
INVESTIGATION, DESIGN, & CONSTRUCTION MNGMT (15%; rounded)		**$**	**31,000,000**
LAND		**$**	**2,000,000**
TOTAL FIRST COST		**$**	**237,000,000**

THIS PAGE LEFT BLANK INTENTIONALLY