Mendota Pool Bypass and Reach 2B Improvements Project

Project Description Technical Memorandum

SAN JOAQUIN RIVER
RESTORATION PROGRAM

October 2012

Table of Contents

Tables

Figures

Attachments

List of Abbreviations and Acronyms

ACHP	Advisory Council on Historic Preservation
Act	San Joaquin River Restoration Settlement Act
AIA	Air Impact Assessment
CAA	Clean Air Act
CCAA	California Clean Air Act
CCID	Central California Irrigation District
CCR	California Code of Regulations
CDF	California Department of Finance
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CNPS	California Native Plant Society
Court	U.S. Eastern District Court of California
CRHR	California Register of Historical Resources
CVFED	Central Valley Floodplain Evaluation and Delineation
CVFPB	Central Valley Flood Protection Board
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
Delta	Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DOE	California Department of Water Resources, Division of Engineering
DSOD	California Department of Water Resources, Division of Safety of Dams
DWR	California Department of Water Resources
EA	Environmental Assessment
EFH	essential fish habitat
EIS/R	Environmental Impact Statement/Environmental Impact Report
ESA	Endangered Species Act
Exchange Contractors	San Joaquin River Exchange Contractors

FONSI	Finding of No Significant Impact
Flood Control Project	Lower San Joaquin River Flood Control Project
Flood Operation Manual	Flood Control Project’s Operation and Maintenance Manual for Levee, Irrigation and Drainage Structures, Channels and Miscellaneous Facilities
fps	feet per second
FWCA	Fish and Wildlife Coordination Act
FWUA	Friant Water Users Authority
IS	Initial Study
ISMP	Invasive Species Management Plan
ISR	Indirect Source Review
Levee District	Lower San Joaquin Levee District
MBTA	Migratory Bird Treaty Act
MMRP	Mitigation Monitoring and Reporting Program
MND	Mitigated Negative Declaration
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOE	Notice of Exemption
NOI	Notice of Intent
NOP	Notice of Preparation
NRCS	Natural Resources Conservation Service
NRDC	Natural Resources Defense Council
NRHP	National Register of Historic Places
NWP	Nationwide Permit
OHV	off-highway vehicle
OHWM	ordinary high water mark
PEIS/R	Program Environmental Impact Statement/ Environmental Impact Report
Pool	Mendota Pool
PRC	Public Resources Code
PRD	Permit Registration Documents
Project	Mendota Pool Bypass and Reach 2B Improvements Project

RA	Restoration Administrator
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Restoration Area	the San Joaquin River Restoration area from Friant Dam to the Merced River confluence
RHA	Rivers and Harbors Act
RM	river mile
RWA	Recovered Water Account
RWQCB	Regional Water Quality Control Board
Secretary	Secretary of the U.S. Department of the Interior
Settlement	Stipulation of Settlement
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SJRRP	San Joaquin River Restoration Program
SMARA	Surface Mining and Reclamation Act of 1975
State	State of California
SWP	State Water Project
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TM	Technical Memorandum
USACE	U.S. Army Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Definitions

For the purposes of the discussion in this technical memorandum, the following terms are defined.

The Project – The Project refers to the portion of Reach 2B that will convey Restoration Flows, the Mendota Pool Bypass, and all facilities related to implementation.

Reach 2B – Reach 2B refers either to the existing San Joaquin River between the Chowchilla Bifurcation Structure and the Mendota Dam or to the future portion of that reach which will contain Restoration Flows. Reach 2B does not include the Mendota Pool Bypass.

Mendota Pool Bypass – Refers to the portion of the Project (channels, structures, and other facilities) that will enable conveyance of Restoration Flows around the Mendota Pool.

Pre-appraisal level themes – Pre-appraisal level themes are concepts used in an iterative process of modeling coupled with public outreach and concept refinement. Themes were refined and presented as initial options in the Initial Options Technical Memorandum (TM) (SJRRP 2010e).

Initial Options – Initial options represent building blocks for future development of Project Alternatives. Initial options were prepared for each Project component and presented in the Initial Options TM as a “menu” of preliminary ideas to meet the Project goals for each component. The initial options were further refined into Initial Alternatives by subsequent data collection, analysis and analytical tools.

Initial Alternatives – Initial Alternatives are refined versions of the initial options and were used to conduct the alternatives evaluation presented here. The evaluation assesses the effects of the Initial Alternatives in several key resource areas (costs, schedule, fish habitat and passage, habitat restoration, geomorphology, economics, socioeconomics, land use, and threatened and endangered plants and wildlife). Initial Alternatives present a range of alternatives for each major component of the Project, both the Reach 2B improvements (Floodplain Initial Alternatives) and the Mendota Pool Bypass (Bypass Initial Alternatives).

Final Alternatives (Alternatives) – The Final Alternatives are those Floodplain Initial Alternatives and Bypass Initial Alternatives that were selected following the alternatives evaluation and paired to form a whole (complete) Project Alternative. They are presented in the Project Description TM as Alternatives, which will feed into the Environmental Impact Statement/Environmental Impact Report (EIS/R). Alternatives are of a sufficient detail to evaluate benefits and impacts, including Project costs, land acquisition, and mitigation needs. Each Alternative for the Project includes actions for both the Mendota Pool Bypass and the Reach 2B improvements.

This Draft Technical Memorandum (TM) was prepared by the San Joaquin River Restoration Program (SJRRP) Team as a draft document in support of preparing an Environmental Impact Statement/Environmental Impact Report (EIS/R) for the Mendota Pool Bypass and Reach 2B Improvements Project (Project). The purpose for circulating this document at this time is to facilitate early coordination regarding initial approaches currently under consideration by the SJRRP Team with the Settling Parties, Third Parties, other stakeholders, and interested members of the public. Therefore, the content of this document may not necessarily be included in the Project EIS/R. While the SJRRP Team is not requesting formal comments on this document, comments received will be considered to the extent possible.

This page left blank intentionally.

1.0 Introduction

This Project Description Technical Memorandum (TM) documents the process and results of the Draft and Final Alternatives formulation to implement the Mendota Pool Bypass and Reach 2B Improvements Project (Project), a component of Phase 1 of the overall San Joaquin River Restoration Program (SJRRP). The SJRRP was established in late 2006 to implement the Stipulation of Settlement (Settlement) in *Natural Resources Defense Council (NRDC), et al,. v. Kirk Rodgers, et al*.

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation), as the Federal lead agency under the National Environmental Policy Act (NEPA), and the California Department of Water Resources (DWR), as the State lead agency under the California Environmental Quality Act (CEQA), prepared this TM as an initial step in preparation of an Environmental Impact Statement/ Environmental Impact Report (EIS/R) for the Project. Federal authorization for implementing the Settlement is provided in the San Joaquin River Restoration Settlement Act (Act) (Public Law 111-11).

1.1 Purpose of this TM

This TM is intended to:

- Explain the purpose and need of the Project
- Define the Project study area
- Describe the No-Action/No-Project Alternative
- Describe the Action/Project Alternatives to be evaluated in the Project EIS/R
- Document the alternatives formulation process
- Document the alternatives evaluation methods and results
- Serve as the basis for future discussions with the Implementing Agencies, Technical Work Groups, landowners, and other stakeholders involved in the Project

1.2 Background

Originating high in the Sierra Nevada Mountains, the San Joaquin River carries snowmelt from mountain meadows to the valley floor before turning north and becoming the backbone of tributaries draining into the San Joaquin Valley. The San Joaquin River is California's second longest river and discharges to the Sacramento-San Joaquin Delta (Delta) and, ultimately, to the Pacific Ocean through San Francisco Bay.

Historically, the San Joaquin River supported a rich and diverse ecosystem influenced by seasonal runoff patterns. During winter and spring months, runoff from Sierra Nevada streams would spread over the valley floor and slowly drain to the Delta, providing rich habitat supporting numerous aquatic and wildlife species, including Chinook salmon.

Over the past two centuries, development of water resources transformed the San Joaquin River. In the late 1880s, settlers in the Central Valley drained large areas of valley floor lands and put these lands into agricultural production, supported by small and seasonal diversion dams on the river and a series of water conveyance and drainage canals. Hydroelectric project development in the upper portions of the San Joaquin River watershed harnessed power from the river and modified the natural flow patterns.

In 1944, Reclamation completed construction of Friant Dam on the San Joaquin River. With the completion of Friant-Kern Canal in 1951 and Madera Canal in 1945, Friant Dam diverted San Joaquin River water supplies to over 1 million acres of highly productive farmland along the eastern portion of the San Joaquin Valley. Operation of the dam ceased flow in some portions of the river and extirpated salmon runs in the San Joaquin River upstream from the confluence with the Merced River.

1.2.1 Stipulation of Settlement

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC) filed a lawsuit, known as *NRDC, et al., v. Kirk Rodgers, et al.*, challenging the renewal of long-term water service contracts between the United States and the Central Valley Project (CVP) Friant Division contractors. On September 13, 2006, after more than 18 years of litigation, the Settling Parties, including NRDC, Friant Water Users Authority (FWUA), and the U.S. Departments of the Interior and Commerce, agreed on the terms and conditions of a Settlement subsequently approved by the U.S. Eastern District Court of California (Court) on October 23, 2006. The San Joaquin River Restoration Settlement Act (Act), included in Public Law 111-11 and signed into law on March 30, 2009, authorizes and directs the Secretary of the Interior (Secretary) to implement the Settlement. The Settlement establishes two primary goals:

- **Restoration Goal –** To restore and maintain fish populations in "good condition" in the main stem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish
- **Water Management Goal –** To reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim and Restoration flows provided for in the Settlement

To achieve the Restoration Goal, the Settlement calls for releases of water from Friant Dam to the confluence of the Merced River (referred to as Interim and Restoration flows), a combination of channel and structural modifications along the San Joaquin River below Friant Dam, and reintroduction of Chinook salmon. Restoration Flows are specific volumes of water to be released from Friant Dam during different year types, according to Exhibit B of the Settlement; Interim Flows are experimental flows that began in 2009 and will continue until full Restoration Flows are initiated, with the purpose of collecting relevant data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture, and reuse. To achieve the Water Management Goal, the Settlement calls for recirculation, recapture, reuse, exchange or transfer of the Interim and Restoration flows to reduce or avoid impacts to water deliveries to all of the Friant Division long-term contractors caused by the Interim and Restoration flows. In addition, the Settlement establishes a Recovered Water Account (RWA) and program to make water available to all of the Friant Division long-term contractors who provide water to meet Interim or Restoration flows to reduce or avoid the impact of the Interim and Restoration flows on such contractors.

The Settlement and the Act authorize and direct specific physical and operational actions that could potentially directly or indirectly affect environmental conditions in the Central Valley. Areas potentially affected by Settlement actions include the San Joaquin River and associated flood bypass system, tributaries to the San Joaquin River, the Delta, and water service areas of the CVP and State Water Project (SWP), including the Friant Division. Settlement Paragraphs 11 through 16 describe physical and operational actions (see Table 1-1).

Table 1-1
Restoration and Water Management Framework in Key Settlement Paragraphs

Settlement Paragraph	Description of Constraint or Assumption
11	Identifies specific channel and structural improvements considered necessary to achieve the Restoration Goal. Includes a reach-by-reach list of improvements.
12	Acknowledges that additional channel or structural improvements not identified in Paragraph 11 may be needed to achieve the Restoration Goal.
13	Identifies specific volumes of water to be released from Friant Dam during different year-types (Restoration Flows), and provisional water supplies to meet the Restoration Flow targets as provided in Exhibit B of the Settlement. Stipulates the release of full Restoration Flows no later than January 1, 2014, subject to then-existing channel capacities.
14	Stipulates that spring-run and fall-run Chinook salmon be reintroduced to the San Joaquin River between Friant Dam and the confluence of the San Joaquin River with the Merced River no later than December 31, 2012, consistent with all applicable law and after commencement of sufficient flows and the issuance of all necessary permits. Assigns priority to wild spring-run Chinook salmon over fall-run Chinook salmon.
15	Specifies that Interim Flows begin no later than October 1, 2009, and continue until full Restoration Flows can begin, to collect relevant data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture, and reuse.
16	Requires that the Secretary of the Interior develop and implement a plan for recirculation, recapture, reuse, exchange, or transfer of the Interim and Restoration flows to reduce or avoid impacts to water deliveries for all Friant Division long-term contractors. This paragraph also calls for establishment of an RWA and program to make water available to the Friant Division long-term contractors who provide water to meet Interim or Restoration flows.

Key:
CEQA = California Environmental Quality Act
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Environmental Impact Report
RWA = Recovered Water Account

1.2.2 San Joaquin River Restoration Program

The SJRRP comprises several Federal and State of California (State) agencies responsible for implementing the Settlement. Implementing Agencies include: Reclamation, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), DWR, and California Department of Fish and Game (DFG). Exhibit C of the Settlement set forth milestone dates for the purposes of implementing the Settlement. The Implementing Agencies acknowledge that some of the implementation, including this project, is unavoidably behind schedule and have developed an Implementation Framework with a revised schedule (*Third Party Working Draft Framework for Implementation* (SJRRP 2012)). In addition, the Settlement stipulates that a Technical Advisory Committee be established, comprising six members appointed by NRDC and FWA. The Settlement also calls for a Restoration Administrator (RA) to be appointed by NRDC and FWA, to facilitate the Technical Advisory Committee and provide specific recommendations to the Secretary in coordination with the Technical Advisory Committee. The RA's duties are defined in the Settlement, and include making recommendations to the Secretary on the release of Interim and Restoration flows. The RA is also responsible for consulting with the Secretary on implementing actions under Paragraph 11 of the Settlement, and for identifying and recommending additional actions under Paragraph 12 of the Settlement. In addition, the RA is responsible for consulting with the Secretary on the reintroduction of Chinook salmon under Paragraph 14 of the Settlement. The Secretary will diligently pursue completion of project-specific actions in consultation with the RA.

Table 1-2 shows milestone dates recommended in the Settlement. The Implementing Agencies aim to achieve these milestones, as demonstrated by the release of Interim Flows beginning in October 2009; however, these dates may change, pending completion of compliance, coordination, consultation, data collection, and related efforts. Reclamation and DWR initiated the NEPA and CEQA processes in August 2007 to analyze implementation of the Settlement. Reclamation is the lead NEPA agency and DWR is the lead CEQA agency in preparing the Project EIS/R.

In addition, the Settlement stipulates that a Technical Advisory Committee be established, comprising six members appointed by NRDC and FWA. The Settlement also calls for a Restoration Administrator (RA) to be appointed by NRDC and FWA, to facilitate the Technical Advisory Committee and provide specific recommendations to the Secretary in coordination with the Technical Advisory Committee. The RA's duties are defined in the Settlement, and include making recommendations to the Secretary on the release of Interim and Restoration flows. The RA is also responsible for consulting with the Secretary on implementing actions under Paragraph 11 of the Settlement, and for identifying and recommending additional actions under Paragraph 12 of the Settlement. In addition, the RA is responsible for consulting with the Secretary on the reintroduction of Chinook salmon under Paragraph 14 of the Settlement. The Secretary will diligently pursue completion of project-specific actions in consultation with the RA.

Table 1-2
Key Settlement Milestones

Date	Milestone[1]	Status
October 2009	▪ Initiate Interim Flows and Monitoring Program	Completed
September 2010	▪ USFWS submits a completed permit application to NMFS for reintroduction of spring-run Chinook salmon	Completed
April 2012	▪ NMFS issues a decision on the permit application for reintroduction of spring-run Chinook salmon	Future
December 2012	▪ Reintroduce spring-run and fall-run Chinook salmon, if permitted by NMFS	Future
December 2013	▪ Complete Phase 1 improvements identified in the Settlement ▪ Secretary of the Interior, in consultation with NRDC and FWA, develops operational guidelines	Future
January 2014	▪ Initiate full Restoration Flows	Future
December 2016	▪ Complete Phase 2 improvements identified in the Settlement	Future
December 2024	▪ Secretary of Commerce reports to Congress on the progress made in reintroducing spring-run and fall-run Chinook salmon and discusses plans for future implementation of the Settlement	Future
December 2025	▪ Review and revise Restoration Flows, if necessary	Future
January – July 2026	▪ Any party to the Settlement may file a motion to request an increase, decrease, or material change in the quantity and/or timing of Restoration Flows	Future

Note:
[1] These milestones are set forth in the Settlement.
Key:
FWA = Friant Water Authority
NMFS = National Marine Fisheries Service
NRDC = Natural Resources Defense Council
Settlement = Stipulation of Settlement
USFWS = U.S. Fish and Wildlife Service

1.2.3 Overview of the Mendota Pool Bypass and Reach 2B Improvements

The Mendota Pool Bypass and Reach 2B Improvements Project (Project) includes the construction, operation, and maintenance of the Mendota Pool Bypass and improvements in the San Joaquin River channel in Reach 2B to convey at least 4,500 cubic feet per second (cfs). The Project area (Figure 1-1 and Figure 1-2) extends from approximately 0.3 miles above the Chowchilla Bypass Bifurcation Structure to approximately 1.0 mile below the Mendota Dam. It comprises the area that could be directly affected by the Project. The Project may also indirectly affect nearby portions of Reach 2A and Reach 3. The Project area is in Fresno and Madera counties, near the town of Mendota, California.

The Mendota Pool Bypass and Reach 2B improvements defined in the Settlement are (Settlement Paragraph 11(a)):

> *(1) Creation of a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cfs from Reach 2B downstream to Reach 3. This improvement requires construction of a structure capable of directing flow down the bypass and allowing the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary;*
>
> *(2) Modifications in channel capacity (incorporating new floodplain and related riparian habitat) to ensure conveyance of at least 4,500 cfs in Reach 2B between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel.*

Because the functions of these channels may be inter-related, the design, environmental compliance, and construction of the two are being addressed as one project. The Project shall be implemented consistent with the Settlement and the San Joaquin River Restoration Settlement Act, Public Law 111-11, with implementation dates clarified by the Implementation Framework (SJRRP 2012).

The Mendota Pool Bypass would include conveying at least 4,500 cfs around the Pool from Reach 2B to Reach 3 and a fish barrier to direct upmigrating adult salmon into the bypass. The bypass could be accomplished by constructing a new channel around Mendota Pool or by limiting Mendota Pool to areas outside of the San Joaquin River. This action would include the ability to divert 2,500 cfs to the Pool and may consist of a bifurcation structure in Reach 2B. The bifurcation structure would include a fish passage facility to enable up-migrating salmon to pass the structure and a fish screen to direct out-migrating fish into the bypass channel and minimize or avoid fish entrainment to the Pool.

Improvements to Reach 2B would include modifications to the San Joaquin River channel from the Chowchilla Bypass Bifurcation Structure to the new Mendota Pool Bypass to provide a capacity of at least 4,500 cfs with integrated floodplain habitat. The options under consideration include potential levee setbacks along Reach 2B to increase the channel and floodplain capacity and provide for floodplain habitat. Floodplain habitat is included along the Reach 2B portion of the Project as required by the Settlement; floodplain habitat is being considered along the Mendota Pool Bypass channel because Central Valley floodplains have been shown to be of value to rearing juvenile salmon as they migrate downstream (Jeffres 2008, Grosholz 2006, Sommer 2004, Sommer 2001). In addition, the SJRRP *Fisheries Management Plan* (SJRRP 2010) describes that sufficient floodplain habitat is an important feature for meeting salmon population targets.

Improvements included in the project could potentially be implemented in a phased approach to facilitate scheduling and funding. Phased implementation is discussed further in Section 3.4.14.

1.2.4 Scoping and Public Involvement Process

The Implementing Agencies conducted public and stakeholder outreach activities to engage and inform all interested parties of Project activities. Engaging those interested parties helped to inform the process for scoping the Project Alternatives, including development of this Project Description TM. Reclamation initiated the NEPA process by issuing a Notice of Intent (NOI) on July 13, 2009, and DWR initiated the CEQA process by issuing a Notice of Preparation (NOP) on the same day, to prepare a Project EIS/R and hold public scoping meetings. The Project EIS/R scoping comment period began the date the NOI was issued and ended on August 14, 2009. The Implementing Agencies convened two public meetings, one each in Fresno (July 28, 2009) and Firebaugh (July 29, 2009), to inform the public and interested stakeholders about the Project, and to solicit comments and input on the scope of the EIS/R. Reclamation and DWR received comments from 29 entities, including Federal and State agencies, local interest groups, local residents, farmers, landowners, public advocacy groups, and individuals. The comments received were summarized in a Public Scoping Report released February 2010 (SJRRP 2010c). The NEPA scoping process also serves as the scoping process for compliance with other Federal laws such as the National Historic Preservation Act, Section 106.

Public involvement and outreach activities have enabled the Implementing Agencies to involve stakeholders and incorporate public and stakeholder input into the development of major Project documents, including this Project Description TM. These activities seek to create an open and transparent process through which the general public, stakeholders, affected Third Parties, and other interested parties can track and participate in SJRRP activities, including the formulation of alternatives for this Project Description TM. Ongoing public outreach activities conducted in support of the Project include the following:

- Hosting Project-specific landowner meetings as well as participating in SJRRP Technical Feedback Meetings with subject-matter experts, Settling Parties, affected stakeholders, and the general public to obtain information and viewpoints from individual attendees; provide updates on the status of Project work products; keep the Technical Feedback Group up-to-date with the current status of the Project; gather feedback on Project documents; and discuss potential opportunities and constraints that may arise. The format of obtaining and disseminating information through the landowner meetings and Technical Feedback Group meetings is intended to be flexible to address the issues and documents at hand and to accommodate the needs of the SJRRP, Settling Parties, stakeholders, and the general public.
- Making available technical memoranda and other milestone Project documents to the general public, stakeholders, affected Third Parties, and other interested parties on the SJRRP Web site.

The lead agency must, whenever practicable, use a consensus-based management approach to the NEPA process, as required by 43 CFR 46.110. Consensus-based management "…involves outreach to persons, organizations or communities who may be interested in or affected by a proposed action with an assurance that their input will be given consideration by the Responsible Official in selecting a course of action" (43 CFR 46.110(a)). The Project Description TM was developed with a consensus-based management approach. The completed and ongoing activities conducted in support of the Project, as described above, constitute outreach performed in support of this approach.

Figure 1-1
Overview of the SJRRP Restoration Area and the Project Vicinity

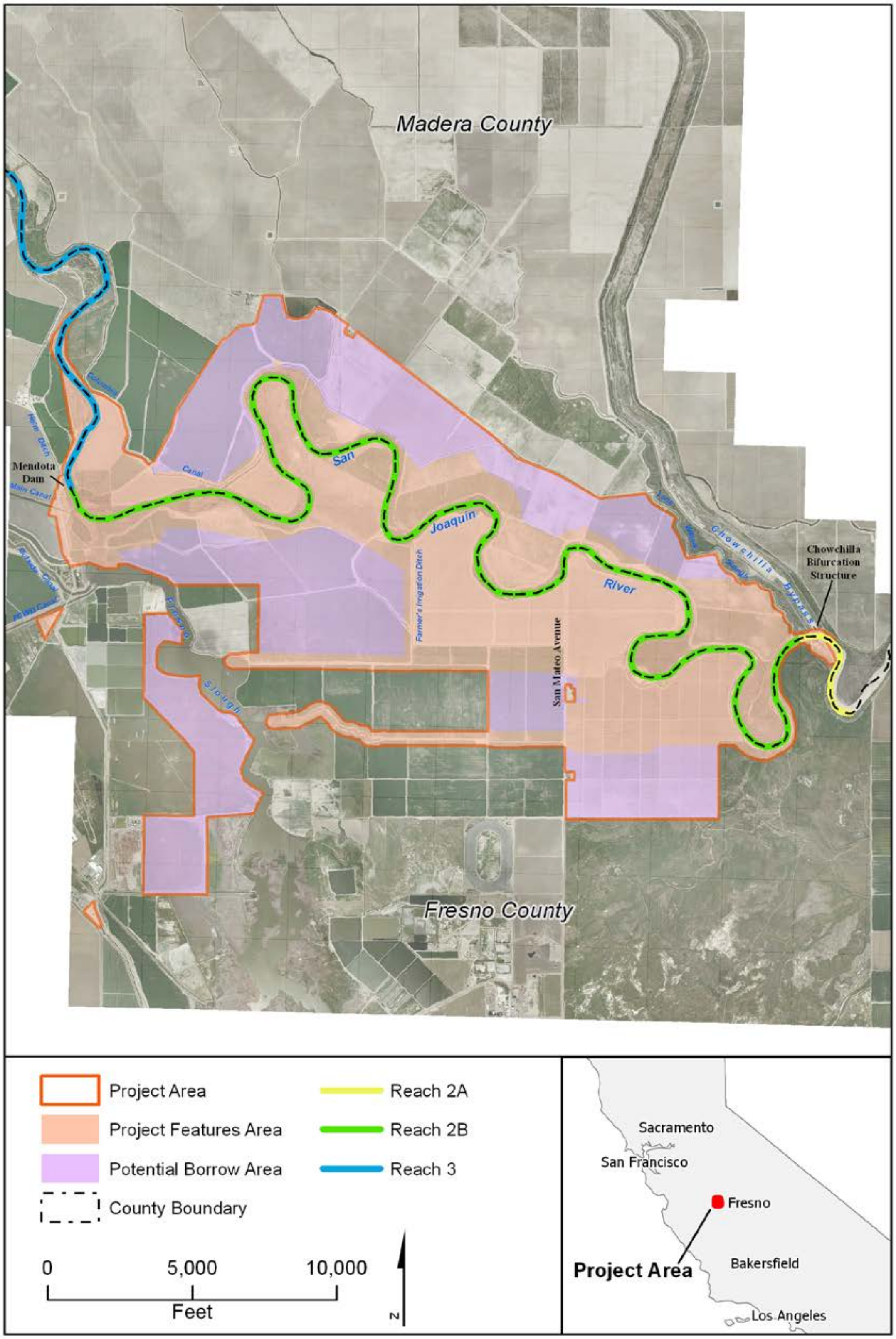


Figure 1-2
Mendota Pool Bypass and Reach 2B Channel Improvements Project Vicinity

1.3 Purpose and Uses of the Project EIS/R

The purpose of the Draft Project EIS/R will be to analyze the project-specific direct, indirect, and cumulative impacts of implementing the Project as directed by the Act, consistent with NEPA/CEQA requirements. The Draft Project EIS/R will serve as an informational document for decision makers, public agencies, non-government organizations, and the general public regarding the potential direct and indirect environmental consequences of implementing any of the alternatives.

The Draft Project EIS/R will not identify a preferred alternative for implementation. Consistent with CEQ Regulations, 40 CFR Part 46.425, and State CEQA Guidelines, the Final Project EIS/R will identify a preferred alternative for implementation (or alternatives, if more than one exists). The preferred alternative will be identified in the Final Project EIS/R based on the information presented in this Draft Project EIS/R, in light of any potential revisions made in response to comments received on the Draft Project EIS/R. After the Final Project EIS/R is published, Reclamation will prepare and adopt a Record of Decision, and DWR will prepare and adopt a Notice of Determination, to implement the preferred alternative.

1.3.1 National Environmental Policy Act

NEPA provides an interdisciplinary framework for Federal agencies to take environmental factors into account during a decision making process (42 United States Code (USC) 4321, 40 CFR 1500.1). NEPA requires an Environmental Impact Statement (EIS) whenever a proposed major Federal action (e.g., a proposal for legislation or an activity financed, assisted, conducted, or approved by a Federal agency with Federal agency control) significantly affects the quality of the human environment. Section 1508.14 of the CEQ Regulations defines the human environment to include “the natural and physical environment and the relationship of people with that environment.”

The EIS, in conjunction with other relevant material, is used by the Federal Government to plan actions and make decisions. Section 1502.1 of the CEQ Regulations states that an EIS primarily serves as an action-forcing device to infuse the policies and goals defined in NEPA into ongoing programs and actions of the Federal Government. As an informational document, an EIS provides a rigorous and objective evaluation of all reasonable alternatives; full and open disclosure of environmental consequences before agency action; an interdisciplinary approach to project evaluation; identification of measures to mitigate impacts; and an avenue for public and agency participation in decision making (40 CFR 1502.1). NEPA defines mitigation as avoiding, minimizing, rectifying, reducing, or compensating for significant effects of a proposed action (40 CFR 1508.20). NEPA also requires evaluating a proposed action and alternatives at an equal level of detail.

NEPA requires that a lead agency “include [in an EIS] appropriate mitigation measures not already included in the proposed action or alternatives” (40 CFR 1502.14(f)). An EIS must also include discussions of “means to mitigate adverse environmental impacts (if not fully covered under Section 1502.14(f)).” In preparing a Record of Decision under 40 CFR 1505.2, a lead agency must “[s]tate whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not. A monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation."

1.3.2 California Environmental Quality Act

The State CEQA Guidelines (14 CCR Section 15064(f)(1)) require that an Environmental Impact Report (EIR) be prepared whenever a project may result in a significant environmental impact. Section 15064(d) states that "in evaluating the significance of the environmental effect of a project, the lead agency shall consider direct physical changes in the environment which may be caused by the project and reasonably foreseeable indirect physical changes in the environment which may be caused by the project." An EIR is an informational document used to inform public agency decision makers and the general public of the significant environmental effects of a project, identify possible ways to mitigate or avoid the significant effects, and describe a range of reasonable alternatives to the project that could feasibly attain most of the basic objectives of the project while substantially lessening or avoiding any of the significant environmental impacts. When determining whether to approve a project, State and local public agencies are required by CEQA to consider the information presented in the EIR.

CEQA requires that State and local government agencies consider the potential environmental effects of projects over which they have discretionary authority before taking action on those projects (Public Resources Code (PRC) Section 21000 et seq.). CEQA also requires that each public agency avoid or mitigate to less-than-significant levels, wherever feasible, the significant environmental effects of projects it approves or implements. If a project would result in significant and unavoidable environmental impacts that cannot be feasibly mitigated to less-than-significant levels, the project can still be approved, but the lead agency's decision makers must issue a "statement of overriding considerations" explaining in writing the specific economic, social, or other considerations that they conclude, based on substantial evidence, make those significant effects acceptable.

Section 15126.6(a) of the State CEQA Guidelines also requires that an EIR describe and evaluate a reasonable range of alternatives that would feasibly attain most of the basic project objectives, and would avoid or substantially lessen any significant impact of the project, as proposed. A range of reasonable alternatives is analyzed to define issues and provide a clear basis for choice among options. CEQA requires that the lead agency consider alternatives that would avoid or reduce one or more of the significant impacts identified for a project in an EIR. The State CEQA Guidelines state that the range of alternatives required to be evaluated in an EIR is governed by the "rule of reason"; the EIR needs to describe and evaluate only those alternatives necessary to permit a reasonable choice and to foster informed decision making and informed public participation (Section 15126.6(f)). Consideration of alternatives focuses on those that can either eliminate significant adverse environmental impacts, or reduce them to less-than significant levels; alternatives considered in this context may include those that are more costly and those that could impede to some degree the attainment of all project objectives (Section 15126(b)). CEQA does not require alternatives to be evaluated in the same level of detail as the proposed project.

1.3.3 Type of Environmental Document

The Draft Project EIS/R, which this Project Description TM will become part of, will present project-level analyses of certain actions fully described in each alternative. Actions considered for evaluation but not included in the action alternatives (described in Attachment A, "Alternatives Evaluation") are not prohibited from future implementation, but would require separate analysis pursuant to NEPA and/or CEQA at a project level of detail.

Compliance and Permits Supported by the Project EIS/R

The Project EIS/R will support the needed permits, petitions, and similar compliance, coordination, and consultation efforts for the Project actions, as shown in Table 1-3 and described in Section 5.0.

Table 1-3
Compliance, Consultation, and Coordination to Be Supported by the Project EIS/R

Resource Applicable	Laws/Regulations/Permits	Regulating Agency/Agencies
All	San Joaquin River Restoration Settlement Act	Secretary of the Interior
Wetlands and Waters	Section 10 of the Rivers and Harbors Act – Individual or General Permit	U.S. Army Corps of Engineers
	Section 401 of the Clean Water Act – Water Quality Certification or Waiver	Regional Water Quality Control Board
	Section 402 of the Clean Water Act – National Pollutant Discharge Elimination System permit(s)	State Water Resources Control Board and Regional Water Quality Control Board
	Section 404 of the Clean Water Act – Individual or General Permit	U.S. Army Corps of Engineers
	Sections 1600 through 1607 of the California Fish and Game Code – Streambed Alteration Agreement	California Department of Fish and Game
Federally Listed Species	Section 7 of the Federal Endangered Species Act – Section 7 Consultation	U.S. Fish and Wildlife Service and National Marine Fisheries Service
	Section 10(j) of the Federal Endangered Species Act – Section 10 permit	National Marine Fisheries Service
Fish and Wildlife Resources	Magnuson-Stevens Fishery Conservation and Management Act	National Marine Fisheries Service
	Fish and Wildlife Coordination Act report	U.S. Fish and Wildlife Service
	Migratory Bird Treaty Act	U.S Fish and Wildlife Service
	Bald and Golden Eagle Protection Act	U.S Fish and Wildlife Service
Cultural Resources	National Historic Preservation Act – Section 106 Consultation	State Office of Historic Preservation

Table 1-3
Compliance, Consultation, and Coordination to Be Supported by the Project EIS/R

Resource Applicable	Laws/Regulations/Permits	Regulating Agency/Agencies
State-Listed Species/State Special-Status Species	Sections 2080.1 and 2081 of the California Endangered Species Act – Consistency Determination/Incidental Take Permit	California Department of Fish and Game
	California Native Plant Protection Act	California Department of Fish and Game
Levees and Floodways	Section 14 of the Rivers and Harbors Act (“Section 408”) – Permission	U.S. Army Corps of Engineers
	Central Valley Flood Protection Board Encroachment Permit and 33 Code of Federal Regulations 208.10 (U.S. Army Corps of Engineers review)	Central Valley Flood Protection Board and U.S. Army Corps of Engineers
Bridges	Section 9 of the Rivers and Harbors Act and General Bridge Act of 1946 permit	U.S Coast Guard
Water Quality	Porter-Cologne Water Quality Control Act and Basin Plan for the Sacramento River & San Joaquin River Basins	Regional Water Quality Control Board
Water Rights	California Water Code – Water Right Petitions (including petitions for changes to Water Right Permits 11885, 11886, and 11887)	State Water Resources Control Board
State Lands	Land Use Lease	State Lands Commission
Air Quality	Authority to Construct, Permit to Operate	San Joaquin Valley Air Pollution Control District Program
State-Owned Roadways	Encroachment Permit	California Department of Transportation
Surface Mining	California Surface Mining and Reclamation Act permit	California Surface Mining and Reclamation Act lead agencies and California Department of Conservation

1.4 Relationship to Other SJRRP NEPA and CEQA Documents

Several environmental documents have been prepared previously to facilitate early actions needed to implement the Settlement. These documents include the following:

- *Installation and Rehabilitation of Stream Gages on the San Joaquin River, Fresno, Madera, and Merced Counties, California Environmental Assessment* (EA)*/Finding of No Significant Impact* (FONSI). Reclamation. December 2008.
- *San Joaquin River Restoration Program Water Level Recorder Installation and Data Collection Notice of Exemption* (NOE). DWR. February 2009.
- *San Joaquin River Restoration Program Scour Chain Installation and Data Collection NOE*. DWR. February 2009.

- *Stream Gage Installation and Operation and Maintenance Project Initial Study* (IS)/*Mitigated Negative Declaration* (MND). DWR. March 2009.
- *San Joaquin River Restoration Program Stream Bed and Sand Sampling NOE*. DWR. April 2009.
- *Chowchilla Bifurcation Structure Gate Seal Installation NOE*. DWR. August 2009.
- *Interim Flows Project – Water Year 2010 Final EA/FONSI and IS/MND*. Reclamation and DWR. September 2009.
- *Draft San Joaquin River Restoration Program Geotechnical Investigation and Seepage Well Installation Project IS/MND*. DWR. October 2009
- *Interim Flows Project – Water Year 2011 Final Supplemental EA/FONSI*. Reclamation. September 2010.
- *Draft San Joaquin River Restoration Program PEIS/R*. April 2011.
- *Recirculation of Recaptured Water Year 2011 San Joaquin River Restoration Program Interim Flows Final EA*. May 2011.
- *Friant-Kern Canal Capacity Restoration Draft EA/FONSI*. June 2011
- *Interim Flows Project – Water Year 2012 Draft Supplemental EA/FONSI*. Reclamation. June 2011.

1.5 Purpose and Need for Action and Project Objectives

NEPA regulations require a statement of “the underlying purpose and need to which the agency is responding in proposing the alternatives, including the Proposed Action” (40 CFR 1502.13). The State of California (State) CEQA Guidelines require a clearly written statement of objectives, including the underlying purpose of a project (Guidelines Section 15124(b)).

The purpose of the Proposed Action is to implement portions of the Settlement consistent with the Act. The Act authorizes and directs the Secretary to implement the Settlement. Specifically, this Project is intended to implement Paragraphs 11(a)(1) and 11(a)(2) of the Settlement, which are authorized in Sec. 10004.(a)(1) of the Act.

The Settlement specifies the need, which requires modifications to Reach 2B and construction of a bypass around Mendota Pool in support of achieving the Restoration Goal (Settlement Paragraph 2):

> *… a goal of this Settlement is to restore and maintain fish populations in “good condition” in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish (the “Restoration Goal”).*

The objectives of the proposed action are identified in Paragraphs 11(a)(1) and 11(a)(2) of the Settlement:

Paragraph 11(a)(1)

> *Creation of a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cfs from Reach 2B downstream to Reach 3. This improvement requires construction of a structure capable of directing flow down the bypass and allowing the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary;*

Paragraph 11(a)(2)

> *Modifications in channel capacity (incorporating new floodplain and related riparian habitat) to ensure conveyance of at least 4,500 cfs in Reach 2B between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass Channel;*

The purpose and objectives respond to a need to provide increased capacity and floodplain and riparian habitat in Reach 2B, as well as fish passage and rearing habitat.

1.6 Responsibilities of Lead Agencies, Responsible Agency, and Implementing Agencies

Reclamation is the lead NEPA agency and DWR is the lead CEQA agency in preparing this Project Description TM. The actions identified in the Project Description TM include actions to be undertaken by Reclamation and DWR, and other implementing parties. The effects of these actions are to be identified in the Project EIS/R.

The Implementing Agencies include Reclamation, USFWS, NMFS, DWR, and DFG. The Settlement identifies the Secretary as the lead Federal entity responsible for implementation and USFWS as the lead Federal agency responsible for reintroduction of spring-run and fall-run Chinook salmon. The Settlement also identifies the Secretary of the U.S. Department of Commerce, through NMFS, as a necessary participant to allow for permitting the reintroduction of spring-run Chinook salmon. The Act authorizes and directs the Secretary to implement the Settlement and appropriates funds for implementation. Implementation of the Settlement also requires involvement of the State's Natural Resources Agency through DWR and DFG. Consistent with a Memorandum of Understanding (MOU) between the Settling Parties and the State, the California Natural Resources Agency will play a major role in funding and implementing actions called for in the Settlement and in the Act. DWR will assist in planning, designing, and constructing the physical improvements identified in the Settlement, including projects related to flood protection, levee relocation, and modifications to and maintenance of channel facilities. DFG will provide technical assistance on actions related to the release of Interim and Restoration flows and the reintroduction and monitoring of fish, and planning, designing, and constructing facilities to provide fish passage. SWRCB, as a State agency, may take a discretionary action, in the form of a water rights approval related to the relocation of diversions. Additional information on responsible agencies and permit requirements is provided in Section 5.0.

1.7 Project Study Area

1.7.1 Geographic Area Description

The study area for the Project, shown in Figure 1-2, (township 13S, range 15E) includes areas that may be affected directly or indirectly by implementing Project actions. The Project has two major components: Reach 2B and the Mendota Pool Bypass. Reach 2B generally includes the area from the San Joaquin River Control Structure near the Chowchilla Bypass downstream to Mendota Dam. Improvements in Reach 2B, which vary by Alternative, extend from the Chowchilla Bifurcation Structure on the upstream end to the head of the Mendota Pool Bypass channel or to Mendota Dam on the downstream end. However, Reach 2B improvements may also include areas just upstream of the Chowchilla Bifurcation Structure and may continue downstream of the head of the Mendota Pool Bypass or Mendota Dam, including the Pool area, as necessary to meet Project goals and objectives. The lateral extent of Reach 2B improvements, which varies by Alternative, includes lands to the north and south of the San Joaquin River in Reach 2B.

The Mendota Pool Bypass generally includes the area from the downstream end of the Reach 2B improvements to a tie-in location in Reach 3. Improvements for the Mendota Pool Bypass, which vary by Alternative, extend from the area south of Mowry Bridge over Fresno Slough to the area north of Mendota Dam where the Bypass ties into Reach 3. The Mendota Pool Bypass also includes areas adjacent to and on the west side of Mendota Pool and Fresno Slough and areas to the south of the Reach 2B improvements. Areas indirectly affected by this Project include the portions of Reach 3 to the downstream and Reach 2A to the upstream that are outside the study area.

The study area reflects current estimates of areas that may be affected by the Project Alternatives. In the Project EIS/R, the area where direct and indirect effects may occur differs according to resource area; therefore, the geographic range and environmental conditions that would be described in the Project EIS/R would vary by resource.

1.7.2 Description of Existing Conditions within the Study Area

At the upstream end of the Project, the Chowchilla Bifurcation Structure is used to control and route flood releases from Friant Dam and the upstream watershed into Reach 2B and the Chowchilla Bypass, a flood protection project on the San Joaquin River. Under no-flow conditions, plunge pools (approximately 7 feet deep and 10 feet deep, respectively) can be observed at the downstream base of the Chowchilla Bifurcation Structure in both the San Joaquin River and the Chowchilla Bypass.

Reach 2B ends on the downstream end at the Mendota Dam, which creates Mendota Pool (Pool). The Delta Mendota Canal terminates at the Pool, which distributes water deliveries from the Delta to the San Joaquin River Exchange Contractors (Exchange Contractors) via the Main Canal, Helm Ditch, Columbia Canal, Main Lift Canal, and Outside Canal. The Pool is shallow with little storage volume, and the pool elevation is maintained for the purposes of hydraulic head into Fresno Slough. The Pool does not contain additional storage above the operating elevation and, therefore, does not provide substantial flood control protection. During flood releases, the flash boards are removed at Mendota Dam allowing the backwatered Pool to become part of the flowing river.

Flood flows through Mendota Pool are released from Friant Dam, Pine Flat Dam, or both. Friant Dam flood control releases may be diverted into Reach 2B at the Chowchilla Bifurcation Structure, and Pine Flat Dam flood control releases may be diverted into Mendota Pool via the James Bypass and Fresno Slough. Pine Flat Dam flood control releases have priority over Friant Dam flood control releases, so depending on the available capacity in Reach 3, a portion or all of the flow from Reach 2A may be diverted into the Chowchilla Bypass. Pine Flat Dam flood control releases into Mendota Pool occur in wet years (approximately 1 in 5 years). Accordingly during wet years, flow in Reach 2B may be reduced during flood control releases from Pine Flat Dam.

Figure 1-3
Reach 2B Channel prior to Interim Flows (12/15/09)

The Project study area includes only one existing private crossing, a dip-crossing at San Mateo Avenue, consisting of a culvert to convey low flows and an earthen embankment supporting the roadbed, which is overtopped during higher flows.

The San Mateo Avenue crossing is the approximate limits of the backwater effects of the Pool. Downstream of San Mateo Avenue, the river channel is inundated as a result of the Pool water surface elevation. Upstream of the crossing, the channel is only wetted during Interim Flows or flood releases from Friant Dam. The Pool and associated river channel are drained approximately every two years to inspect and perform maintenance on Mendota Dam.

Several water diversions (including Lone Willow Slough and the Columbia Canal), canals, lift stations, and groundwater wells exist within the Project area. Additionally, electrical and gas distribution lines and water pipelines lie within the Project area.

Existing Land Use and Habitat

A narrow corridor of riparian and aquatic habitat exists along the river corridor, levees, and at Mendota Pool; otherwise, land use within and surrounding the Project area is primarily agriculture with the exception of the water management facilities at the Pool.

The Pool backwater supports perennial riparian vegetation, predominantly willow riparian and cottonwood riparian forest communities with emergent wetland communities. Upstream of San Mateo Avenue and prior to Interim Flows, the channel exhibited a sandy substrate with little to no in-channel vegetation. Existing vegetation along the banks of the channel in these areas consists predominantly of riparian scrub and willow scrub communities.

Existing Fish Population and Habitat Conditions

Prior to Interim Flows, Reach 2B upstream of San Mateo Avenue was dry except during flood flows (approximate frequency is every 5 years) consequently there are very limited in-channel habitat features. The Pool contains mostly introduced fishes and potentially a few native fish. The biannual dewatering of the Pool leaves the Pool site mostly dry, but some locations hold standing water during the several week period the Pool is drained in mid-winter.

The Reach 2B channel bed is composed of unconsolidated fine sand and there is little definition of the channel bed, which is typical for sand bed systems. No pool-bar structure or bed features occur which would typically be used in gravel bed or coarser systems to classify and evaluate fish habitat features (pools, riffles, runs) or conditions (instream cover, overhead cover, etc.).

Aquatic habitat in Reach 2B upstream of San Mateo Avenue is limited because there is a long history of the channel being dry prior to the start of Interim Flows. Riparian vegetation is limited to the levees along the channel banks. In the lower portion of Reach 2B, the channel is defined where vegetation has been established along the backwatered portion from the Pool between Mendota Dam and San Mateo Avenue. The Pool is bordered by emergent, wetland and riparian vegetation including mature cottonwood trees. Aquatic habitat in this section of river is affected by the backwatering of Mendota Dam and sedimentation in the Pool.

Existing Structures

Chowchilla Bifurcation Structure

The most upstream structure is the Chowchilla Bifurcation Structure (Figure 1-2 and Figure 1-4). This structure is used to route flood flows in excess of water supply demands down the Chowchilla Bypass. The structure has wingwalls bounding four gated bays on each channel. The bays are essentially 20-foot wide by 18-foot high box culverts containing a trash rack on the upstream side (Figure 1-5). The four bays discharge across a row of energy dissipaters (dragons teeth) then over a concrete slab that is bounded on the downstream end by a 2-foot high concrete weir. Immediately below the concrete weir is a row of rip rap sitting against the concrete weir and above the sand bed of Reach 2B

(Figure 1-6). Upstream and downstream of the structure, is the sand bed of Reach 2A and 2B, respectively.

Figure 1-4
View from downstream of the Chowchilla Bifurcation Structure in Reach 2B (12/15/09)

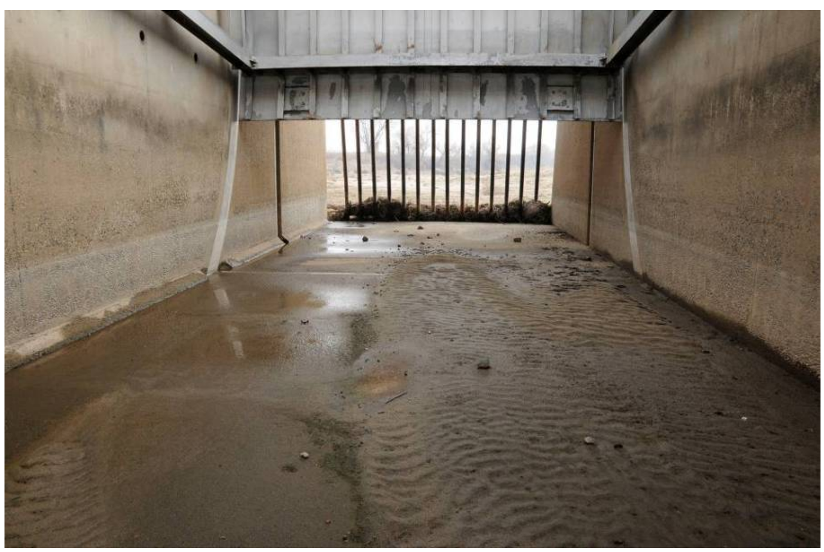


Figure 1-5
Inside of one of the bays at the Chowchilla Bifurcation Structure[1] (12/15/09)

[1] Ponded water shown in Figure 1-5 is the remains of the 2009 fall Interim Flows.

Figure 1-6
Concrete sill and bordering riprap along the downstream edge of the Chowchilla Bifurcation Structure in Reach 2B[2] (12/15/09)

San Mateo Avenue Crossing

The present crossing of Reach 2B is a dip crossing or low-water crossing (Figure 1-7, Figure 1-8). Flows less than approximately 150 cfs are routed through a culvert beneath the road. At flows above approximately 150 cfs, the road is inundated (Houk 2009). The north (Madera County) portion of the crossing is within public right-of-way, but the south (Fresno County) portion of the crossing is on private land, essentially rendering it a private river crossing.

[2] Ponded water shown in Figure 1-6 is the remains of the 2009 fall Interim Flows.

Figure 1-7
San Mateo Avenue Crossing of Reach 2B looking from north bank to south bank (12/15/09)

Figure 1-8
San Mateo Avenue crossing of Reach 2B showing single culvert beneath the road (12/15/09)

Mendota Dam and Mendota Pool

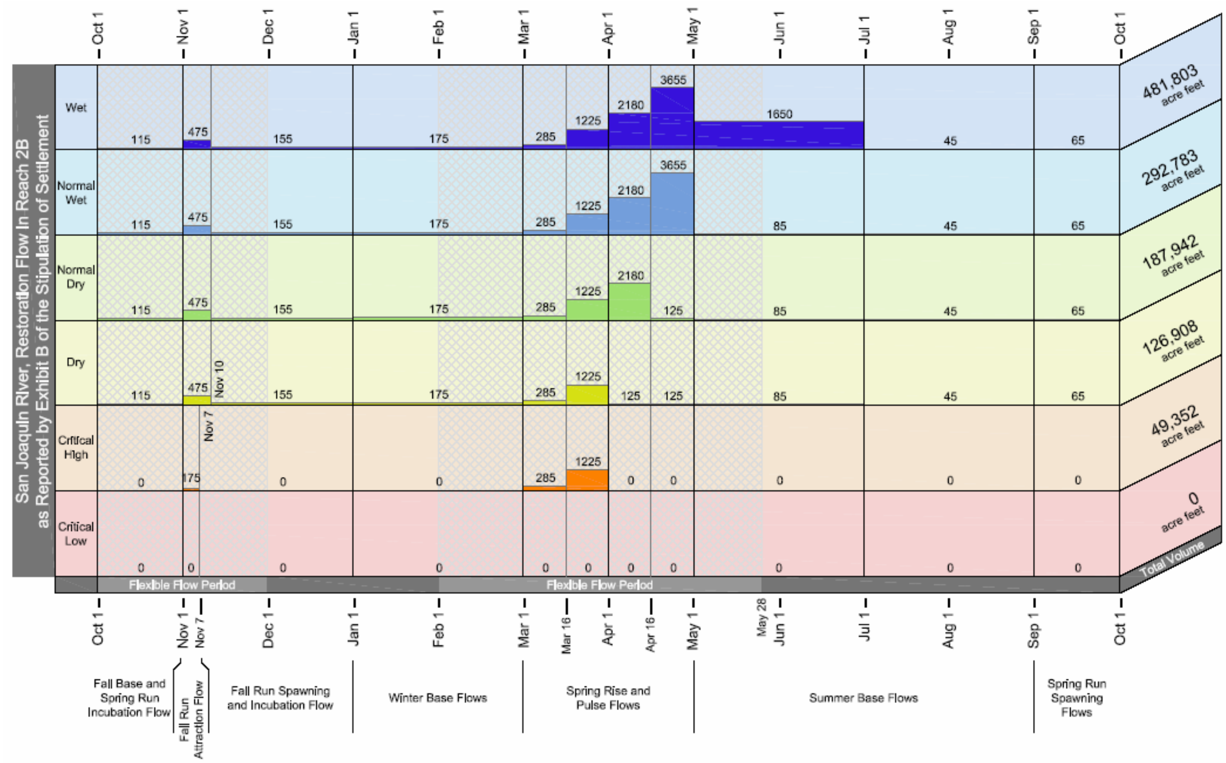
Mendota Dam (Figure 1-2 and Figure 1-9), at the downstream end of Reach 2B, forms a pool approximately 7 miles long to San Mateo Avenue. The downstream 2 to 3 miles of the channel is bordered by mature trees along the north bank. Typically, the Pool receives water from the Delta Mendota Canal which supplies water to the Helm Ditch, Main Canal, Outside Canal, Main Lift Canal, Fresno Slough, and Columbia Canal. The Pool is shallow and is drained about every two years for dam inspection and maintenance.

Figure 1-9
Downstream face of Mendota Dam (5/28/09)

1.7.3 Description of Local Hydrology

As part of the SJRRP, Restoration Flows will be released from Friant Dam based on water year type and other factors and conveyed to Reach 2B (see Figure 1-10). Flows conveyed into or diverted from Reach 2B and the Mendota Pool include:

- Restoration and Interim flows
- Exchange Contractor deliveries to Mendota Pool from the San Joaquin River
- Exchange Contractor deliveries to Mendota Pool from the Delta-Mendota Canal
- Millerton Lake flood releases
- Pine Flat Reservoir flood releases
- Diversions to Mendota Pool via groundwater pump-ins
- Diversions from Mendota Pool via the Columbia Canal, Mendota Dam (for Arroyo Canal in Reach 3), Helm Ditch, Main Canal, Outside Canal, Fresno County Waterworks District Canal, Fresno Slough, and Mowry pumps
- Diversions from the river via Lone Willow Slough and other pumps for riparian rights diversions



1 Hydrographs reflect assumptions about seepage losses and tributary inflows which are specified in the Settlement.
2 Reach 2B hydrographs are labeled as Reach 3 in Settlement Exhibit B.

Figure 1-10
Restoration Flow hydrographs by restoration year type (Reach 2B)

With the SJRRP and the Reach 2B Project, there are three basic flow scenarios involving Restoration Flows, flood flows, and water deliveries that will typically occur in Reach 2B:

- In critical-low to normal-wet water year types, Restoration Flows will proceed through Reach 2B and irrigation deliveries and diversions will occur in Mendota Pool with no interaction between the Restoration Flows in Reach 2B and Mendota Pool.
- In normal-wet to wet water year types, flood releases from Millerton Lake may be diverted from Reach 2B into the Chowchilla Bypass as well as to Mendota Pool where they can be used to fulfill water contracts or by legal water rights holders while alleviating pressure on the flood system. Some portion of these flows is anticipated to perform as Restoration Flows in Reach 2B, but the flood management agencies will have ultimate discretion in directing flood flows.
- In wet water year types, flood releases from Pine Flat Reservoir may be bypassed to the San Joaquin River via Fresno Slough and Mendota Pool. Due to capacity restrictions downstream of Reach 2B, the addition of these flows further restricts the amount of flow that can enter Reach 2B, and more San Joaquin River flows will be diverted into the Chowchilla Bypass to compensate. Some portion of the

San Joaquin River flows is anticipated to perform as Restoration Flows in Reach 2B, but the flood management agencies will have ultimate discretion in directing flood flows.

In addition to the above flow scenarios, the SJRRP has the ability to manage Restoration Flows shown in Figure 1-10 in order to meet the Program's goals and objectives. These management strategies include reshaping the flow block by moving it earlier in the schedule, later in the schedule, compressing the flow block, or extending it consistent with the provisions in the Settlement.

1.8 Organization of this Technical Memorandum

The content and format of this TM are intended to dovetail with the future Project EIS/R, which will meet the requirements of NEPA and CEQA. The TM is organized as shown below.

Executive Summary – summarizes Project purpose, study area, Alternatives, and stakeholder involvement. This section may be used as a stand-alone handout.

Section 1.0 Introduction – summarizes Project background and context, scope of this TM, Project purpose and need, Project study area, and TM organization.

Section 2.0 Alternatives Formulation Process – summarizes the process that was implemented to develop, evaluate, and select the Alternatives.

Section 3.0 Description of Alternatives – describes the Alternatives including the no-project/no-action alternative.

Section 4.0 Alternatives Considered and Eliminated from Further Consideration – describes options and alternatives that were considered throughout the alternatives formulation process but were eliminated from further consideration and the reasons for their elimination.

Section 5.0 Project Implementation – describes the State, Federal, and other agency actions (permits and approvals) required in order to implement the Project.

Section 6.0 Acknowledgments – provides a list of those who contributed to the document.

Section 7.0 References – provides a bibliography of sources cited throughout this TM.

2.0 Alternatives Formulation Process

As part of implementation of the Settlement, Reclamation and DWR began the NEPA/CEQA process on the site-specific projects, including the Mendota Pool Bypass and Reach 2B Improvements Project, by initiating preparation of an EIS/R. An early step in producing the EIS/R is the formulation of the Final Alternatives that will be evaluated by the EIS/R. This chapter presents an overview of the development of the action alternatives. Attachment A – Alternatives Evaluation provides an in depth discussion and analysis of the key steps in the development and refinement of options and alternatives considered from the beginning of the Project

2.1 Alternatives Development Process Overview

Alternatives development progressed through several stages before being presented here in the Project Description TM. The process began with the Initial Options TM (SJRRP 2010d) which presented initial options for meeting Project goals and objectives. Input from Program Work Groups, stakeholders, and the public was collected. Subsequently, the initial options were refined based on impact evaluations, additional engineering analyses (appraisal level design), additional data collection, screening criteria, and public input to produce the Initial Alternatives.

Initial Alternatives were evaluated (Attachment A) using a set of evaluation and screening criteria developed pursuant to NEPA and CEQA requirements, and developed in coordination with Project proponents, to produce the range of reasonable alternatives presented here.

Using information obtained through evaluation and refinement, the final set of bypass, channel, and structure options were combined to create the Final Alternatives (Project/Action Alternatives), which are the basis for the Project EIS/R Project Description (see Section 3.0). The Project Alternatives provide a range of approaches to meet the Project purpose and need, which will allow for an assessment of environmental effects. The preferred alternative, to be identified in the Final EIS/R, may draw together components from multiple Project Alternatives.

Following development of the first draft of the Project Alternatives, Reclamation conducted a Value Planning Study to identify options to improve performance or reduce costs including phased implementation. The Value Planning Study team members included independent experts in the fields of engineering and cost estimating, geomorphology, biology, and restoration ecology, as well those familiar with the operational constraints in the Project area. The Study resulted in design proposals and comments provided to the Project team for review and possible inclusion in the Project.

Opportunities for stakeholder involvement were integrated throughout the alternatives formulation process. Figure 2-1 presents a graphical view of the process.

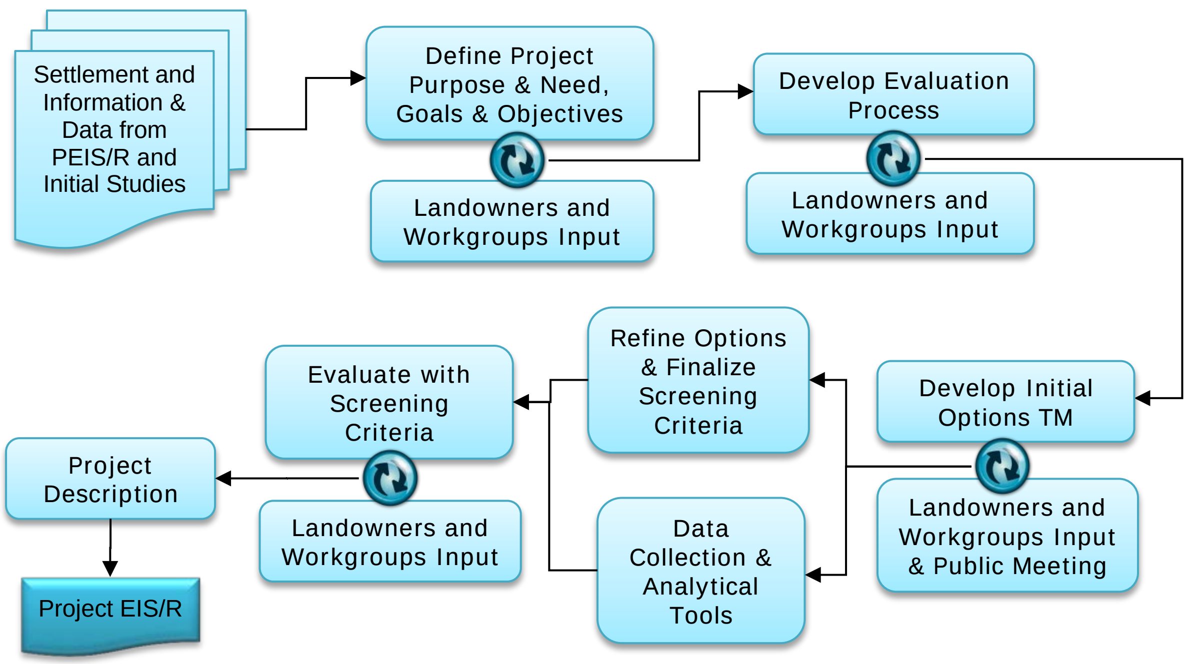


Figure 2-1
Alternatives Formulation Process

2.2 Stakeholder Involvement

The alternatives development provided the opportunity for early stakeholder involvement and input. Primary stakeholders include Federal, State, and local agencies, landowners, and the public. The following sections describe the level of involvement of the various stakeholder groups in the alternatives formulation.

2.2.1 Federal, State, & Local Agencies

Federal and State Implementing Agencies involved in the SJRRP have representatives in the Technical Work Groups and Subgroups. These groups provide support for the development, evaluation, and refinement of concepts. The following groups had input during the alternatives formulation:

Fisheries Management Workgroup:

- DWR presented the initial options for the Reach 2B floodplain and Mendota Pool Bypass alignment at the November 10, 2009 meeting.
- Refinement of initial options criteria and requirements related to fisheries were discussed during the December 11, 2009 Fisheries/Alternatives Subgroup.
- The design flow for fish screening was discussed on February 3, 2010.
- Further refinements to the floodplain and Mendota Pool bypass designs were presented and discussed on June 17, 2010, and passage requirements for non-salmonid native fish were also discussed.

- Passage at structures and passage design criteria were presented and discussed on August 19, 2010 and a recommendation was made to present to the Anadromous Fish Screen Program for feedback on fish screen designs.
- A special subgroup was convened twice, on October 27, 2010 and February 24, 2011, with members of the workgroup and other agency staff with expertise in fish passage structure design to discuss technical and engineering issues related to the design of the fish passage structures.
- A workshop was held on June 28, 2011
- Members of the workgroup participated in several calls with the Project team to discuss technical issues, approaches to resolving issues, and on-going analyses related to fisheries management.
- The workgroup was involved in the review and comment of some Project-specific documents: the Initial Options TM, Analytical Tools TM, and this TM.
- In addition, many calls and emails were exchanged with individuals in the workgroup to discuss specific issues.

Environmental Compliance and Permitting Workgroup:

- The Reach 2B consultant presented the initial options for the Reach 2B floodplain and Mendota Pool Bypass alignment at the December 1, 2009 meeting.
- The approach and use of analytical tools in the alternatives evaluation was presented and discussed at the meeting on May 18, 2010.
- DWR presented the Reach 2B draft borrow areas investigation plan at the meeting on February 15, 2011.
- The workgroup was involved in the review and comment of all Project-specific documents: the Initial Options TM, Environmental Data Needs TM, Analytical Tools TM, Environmental Survey Results TM, and this TM.
- In addition, the Project team has regularly attended the workgroup's meetings to provide Project updates and answer questions.

Engineering and Design Workgroup:

- Engineering and Design Workgroup members developed pre-appraisal level structural options descriptions that addressed channel and floodplain conveyance given the site boundary conditions and a range of potential floodplain and channel characteristics.
- Coordination with the workgroup has resulted in completion of an informal technical review by Reclamation's Technical Service Center in Denver and initiation of a Value Planning Study organized by Reclamation.
- In addition, the Project team has regularly attended the workgroup's weekly conference calls to provide Project updates and answer questions.

Water Management Workgroup:

- The Water Management Workgroup developed flow hydrographs for the purpose of evaluating site-specific alternatives under a range of potential flow schedules. Additionally, the group is coordinating with Reclamation and other stakeholders on Program operational guidelines.

Members of all the workgroups were invited to a presentation on the alternatives evaluation to provide input on the mechanism for evaluating the alternatives at a meeting on February 18, 2011.

Fresno and Madera counties:

- Representatives from DWR spoke on the phone (July 27, 2010) and met with the Madera County Road Department (October 5, 2010) to describe the purpose of the Project and its effects on the San Mateo Avenue crossing and Drive 10 ½. DWR solicited input on the use and need for the crossing, as well as desired improvements.
- A representative of DWR spoke on the phone with the Fresno County Road Maintenance Department on July 27, 2010 to describe the purpose of the Project and its effects on the San Mateo Avenue crossing. DWR solicited input on the use and need for the crossing, as well as desired improvements, but Fresno County did not desire to provide input because the crossing is not located within their right-of-way.

2.2.2 Landowners

Meetings are held periodically with the landowners and representatives who have a stake in the Project or are located along the channel in the Project area to provide updates on Project status and collect input on alternatives development.

- The Reach 2B floodplain pre-appraisal level themes and Mendota Pool Bypass alignments were presented by DWR at the November 17, 2009 meeting.
- Project status updates, overview of the publically available project-specific documents, concept refinement of the San Mateo Avenue crossing design and use of Little San Joaquin Slough, and the alternatives development process were presented and discussed, and comments were accepted at the May 27, 2010 meeting.
- Project status updates, overview of new publically available project-specific documents, California State Lands Commission preliminary findings, and DWR's land acquisitions process were presented and discussed, and comments were accepted at the March 24, 2011 meeting.
- The California State Lands Commission draft administrative maps for Reach 2B, a brief Program update, and a Reach 2B Project update were presented at the October 3, 2011 meeting.

- The Project effects on Mendota Pool and other operations, details of Project components, and effects on infrastructure using large-scale maps were presented at the November 14, 2011 workshop.
- Overview of borrow material needs and the status of geotechnical explorations was presented during the December 16, 2011 conference call.
- Project overview, status, and a brief review of the alternatives were presented to stakeholders associated with Fresno Slough at the May 31, 2012 meeting.
- In addition, many calls and emails were exchanged with individual landowners to discuss specific issues.

2.2.3 Public

Reclamation and DWR held two public scoping meetings in July of 2009 for the purpose of initiating the NEPA and CEQA public input processes on the Project. During the scoping meetings and throughout the public comment period, Reclamation and DWR accepted comments on the proposed Project regarding the range of alternatives, the environmental effects, and the mitigation measures to be considered in the EIS/R. Suggestions regarding the pre-appraisal level themes were documented in the Scoping Report and have been considered in this TM.

The SJRRP also organized and held several public outreach meetings in the form of Technical Feedback Groups. The Project participated in the April 28, 2010, Restoration Goal Technical Feedback Group meeting by providing an overview and discussion of the Initial Options TM and Analytical Tools TM and in the May 17, 2012, Restoration Goal Technical Feedback Group meeting by providing a status update on the Project and an overview of technical challenges the team worked on during alternatives formulation.

When they are released for public review, the public would also have the opportunity to comment on the Draft and Final EIS/R documents prepared for the Project. Public meetings would be held following the publication of these documents and a public comment period would be observed.

2.3 Initial Options Formulation

The initial options were formulated based existing information and data, preliminary engineering analyses and screening, as well as input from Program Work Groups, stakeholders, and the public. Individual and group landowner meetings were held to present and obtain input on the initial options presented. One of the guiding Project objectives and subsequent analyses pertains to flow conveyance. A one-dimensional hydraulic model was completed during the development of initial channel/floodplain options to examine the largest range of practical and feasible floodplain widths given a reasonable range of management and habitat restoration strategies.

The following sources of information were utilized in the initial options formulation:

- Public scoping comments

- SJRRP documents
- Pre-Settlement documents such as the *San Joaquin River Restoration Study Background Document* (McBain & Trush 2002)
- NMFS and DFG guidance on the restoration of salmonid passage (NMFS 2001 and DFG 1998)
- Preliminary pre-appraisal analyses prepared by DWR
- Technical expertise of the Implementing Agencies

Initial screening involved reviewing the options for consistency with the Settlement requirements and for technical feasibility. Any option deemed technically infeasible or beyond to the scope of the Settlement or contrary to its requirements were not carried forward for further consideration (see Section 4.0).

2.4 Alternatives Formulation

As part of implementation of the Settlement, Reclamation and DWR began the NEPA/CEQA process on the site-specific projects, including the Mendota Pool Bypass and Reach 2B Improvements Project, by initiating preparation of an EIS/R. An early step in developing the EIS/R is the formulation of the Final Alternatives that would be addressed by the document. The process diagram shown in Figure 2-2 depicts the steps in the formulation process.

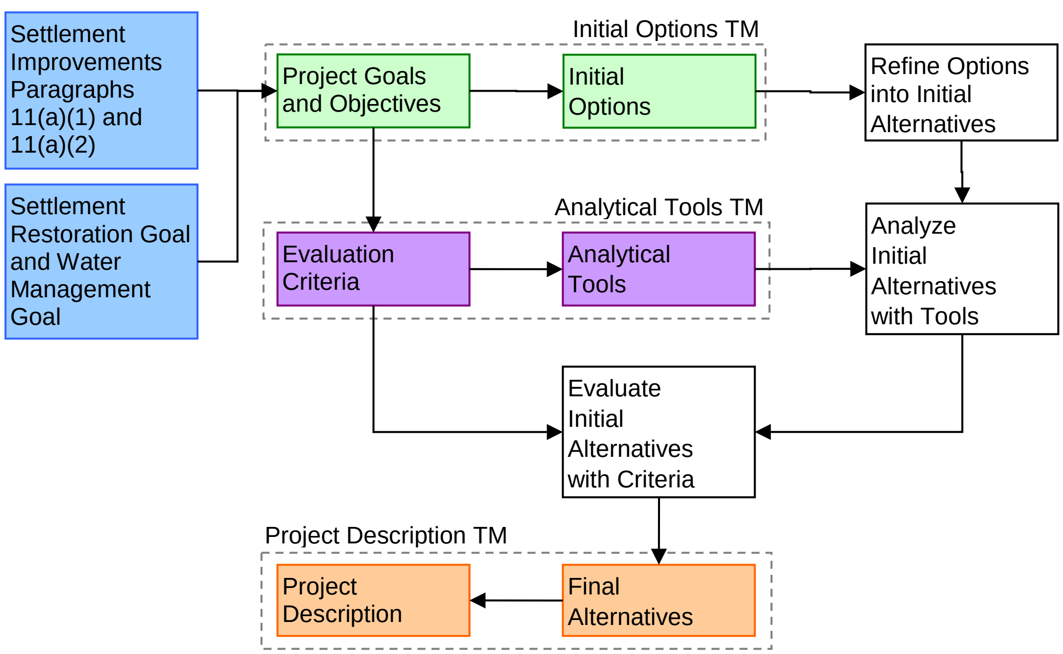


Figure 2-2
Alternatives Formulation Process Diagram

The initial guidance for developing the Project comes from language in the Settlement, specifically the Settlement's goals and the Settlement defined improvements. The Settlement goals are:

The Restoration Goal (Settlement Paragraph 2):

> *… a goal of this Settlement is to restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish (the "Restoration Goal").*

The Water Management Goal (Settlement Paragraph 2):

> *…a goal of this Settlement is to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in this Settlement (the "Water Management Goal").*

The Mendota Pool Bypass and Reach 2B improvements defined in the Settlement are (Settlement Paragraph 11(a)):

> *(1) Creation of a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cfs from Reach 2B downstream to Reach 3. This improvement requires construction of a structure capable of directing flow down the bypass and allowing the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary;*
>
> *(2) Modifications in channel capacity (incorporating new floodplain and related riparian habitat) to ensure conveyance of at least 4,500 cfs in Reach 2B between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel.*

Alternatives formulation builds on the Settlement goals and project-specific improvements and progresses through three stages: initial options, Initial Alternatives, and Final Alternatives.

- Initial options represent the preliminary concepts and the basic components for project implementation. They were developed based on existing information and data, studies undertaken for the PEIS/R process, pre-appraisal level analyses and screening, as well as input from Program Work Groups, stakeholders, and the public. The initial options are described in the Initial Options TM (SJRRP 2010d).
- The initial options were refined into Initial Alternatives based on additional concept refinement and engineering analyses, preliminary cost-benefit analyses, additional data collection, and input from the Program, Program Work Groups,

stakeholders, and the public. The Initial Alternatives represent a range of feasible implementation strategies incorporating appraisal-level design and analysis.

- The Initial Alternatives were evaluated based on the evaluation criteria and with the tools described in the Analytical Tools TM (SJRRP 2010e). Attachment A documents the methods and results of the evaluation and makes recommendations for Final Alternatives to include in the main body of the Project Description TM (see Section 3.0).

2.5 Summary of the Alternatives Evaluation Process

A set of evaluation criteria were proposed in the Analytical Tools TM with which to evaluate the Initial Alternatives on the basis of flow conveyance and operations, fish habitat and passage, habitat restoration, geomorphology and sediment, groundwater, land use, economics, and socioeconomics, and costs. The criteria were developed based on the Project goals and objectives as a means of determining whether the Initial Alternatives meet those goals and objectives. During the appraisal-level design, additional detail was developed for each component and structure, new and refined modeling of the river channel and floodplains was conducted, and new data from field surveys became available. The criteria were further refined based on the available data, analyses, and the level of design, and the criteria were grouped into various factors, categories, and finally implementation feasibility, benefits, and impacts perspectives.[3]

Data representing the performance of the Initial Alternatives according to each applicable criterion was generated and input into an evaluation matrix spreadsheet. The evaluation process leveraged concurrent data collection efforts, engineering analyses and modeling, as well as stakeholder and public input. Using the evaluation matrix, the Initial Alternatives were scored according to their performance at the factor, category, perspective, and overall levels allowing for an understanding of the Initial Alternatives with respect to the goals and objectives of the Project. Detailed information on the evaluation process is provided in Attachment A.

2.5.1 Summary of the Evaluation Criteria

Below is a summary of the evaluation criteria. The criteria are explained in-depth in Attachment A, Section 6.0.

Implementation/Technical Feasibility

Costs

- Capital improvement costs: The costs associated with designing and building the Initial Alternative in total dollars.

[3] Factors, categories, and perspectives are tiered groupings of the evaluation criteria. Factors are groupings of criteria, categories are groupings of factors, and perspectives are groupings of categories.

- Land costs: The estimated cost of land expected to be purchased for the Initial Alternative based on an average approximate value of $10,000 per acre.
- Operation and maintenance costs: The annual dollars required to operate and maintain the Initial Alternative.

Time to Build

- Time until action is functional: the number of months to construct and plant restoration vegetation for the Initial Alternative.

Objectives/Benefits Achievement

Fish Habitat and Passage

- Rearing habitat: total acres of floodplain with a depth greater than 1.0 feet at 2,500 cfs
- Shallow Water Habitat Quality: a rating based on the proportion of very shallow water habitat (less than 0.5 feet) to the amount of rearing habitat (greater than 1.0 feet)
- Artificial structures in the migratory path: number of structures that adult salmon would need to pass. Each drop structure, dam sill, fish passage facility (or bifurcation structure), and crossing is considered as an individual structure.
- Total number of steps at structures: the number of steps an adult salmon would need to jump or swim through. Each drop structure, dam sill, and fish passage facility step is considered as an individual step.
- Fish screens along the migratory path: the number of fish screens with large diversion rates (greater than 100 cfs) that juvenile salmon may encounter along the migratory path.
- Potential predation sites at structures: the number of potential predation sites that juvenile salmon may encounter along the migration path. Each drop structure, dam sill, fish passage facility (or bifurcation structure), fish screen outlet, and crossing is considered a potential predation site.

Habitat Restoration

- Wetlands and other waters of the U.S. area: the acreage of restored habitat with hydrophytic vegetation and on hydric soils.
- Sensitive vegetation alliance extent: the acreage of potential future sensitive vegetation alliances based on the Preliminary Planting Plans.
- Wildlife habitat extent: the acreage of potential future wildlife habitat types resulting from the restoration.
- Special status species habitat extent: the acreage of potential future habitat for special status wildlife species based on the wildlife habitat types.

Geomorphology

- Potential for lateral migration to impact levees: The estimated cost of providing erosion protection (revetment) on levees that may be impacted by lateral erosion.

Impacts

Groundwater

- Acres of land in which groundwater levels rise above 5-foot monitoring threshold: The acreage of land outside the proposed levee alignments that is anticipated to have shallow groundwater elevations above the 5-foot monitoring threshold and is thus subject to mitigation measures to prevent waterlogging.
- Acres of land in which groundwater levels rise above 7-foot monitoring threshold: The acreage of land outside the proposed levee alignments that is anticipated to have shallow groundwater elevations above the 7-foot monitoring threshold and is thus subject to mitigation measures to prevent waterlogging.

Land Use

- Acres of farmland removed from production: The total acres of alfalfa, almond, grapes, other row crops (grouped), palm, and pistachio that would be permanently removed from production due to the construction and long-term operation of the Initial Alternatives.

Socioeconomics and Economics

- Reduction in annual agricultural production values: The total production value based on unit production values and the acreage permanently removed from production due to the construction and long-term operation of the Initial Alternatives.

Environmental

- Wetland impacts: The estimated acreage of direct impacts to wetlands resulting from the Initial Alternatives.
- Sensitive vegetation alliance direct impacts: The estimated acreage of direct impacts to sensitive vegetation alliances resulting from the Initial Alternatives.
- Special status wildlife habitat impacts: The estimated acreage of direct impacts to special status wildlife habitat resulting from the Initial Alternatives.
- Historic properties potentially effected: The number of recorded historic properties identified within the extents of the Initial Alternatives.
- Buried deposits sensitivity: The highest buried deposits sensitivity within the extents of the Initial Alternatives based on the landform age scale.

2.5.2 Scoring Alternatives Data and Professional Judgment

Most of the data presented use objective measurements for each criterion, such as acres, dollars, or miles, based on appraisal-level designs for each alternative. Some of the criteria in the evaluation use qualitative assessments and rely on professional judgment to estimate results. Assumptions about current conditions and future effects of the alternatives are inherently involved at the current level of design. These assumptions have been based on information collected from similar projects and professional experience.

This page left blank intentionally.

3.0 Description of Alternatives

This chapter describes the Final Alternatives developed for the Project. Each of the Final Alternatives consist of a Floodplain Initial Alternative and a Bypass Initial Alternative as described in Attachment A. Final Alternatives are considered to comply with the terms of the Settlement, substantially meet the Project goals and objectives, and have benefits potentially offsetting their impacts. Final Alternatives will be assessed for environmental impacts to the various resource areas in the Project EIS/R and hereafter are called Alternatives. The preferred alternative, to be identified in the Final EIS/R, may draw together components from multiple Project Alternatives.

3.1 Alternatives Development

3.1.1 NEPA Requirements

This development of alternatives is being prepared by Reclamation as the Project proponent and Federal lead agency under NEPA. For the alternatives including the proposed action, NEPA requires that Federal government agencies shall (Sec. 1502.14):

(a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated.

(b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits.

(c) Include reasonable alternatives not within the jurisdiction of the lead agency.

(d) Include the alternative of no action.

(e) Identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.

(f) Include appropriate mitigation measures not already included in the proposed action or alternatives.

3.1.2 CEQA Requirements

This development of alternatives is being prepared by DWR as the Project proponent and State lead agency under CEQA. Section 15126.6 of the CEQA Guidelines requires that an EIR, "describe a range of reasonable alternatives to the project, or to the location of the project, which would feasibly attain most of the basic objectives of the project, but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives."

Additionally, Section 15126.6 of the Guidelines states:

- The specific alternative of "no project" shall also be evaluated along with its impact.
- An EIR need not consider every conceivable alternative to a project. Rather, it must consider a reasonable range of potentially feasible alternatives that will foster informed decision making and public participation. An EIR is not required to consider alternatives which are infeasible. . . . The range of potential alternatives to the proposed project shall include those that could feasibly accomplish most of the basic objectives of the project and could avoid or substantially lessen one or more of the significant effects.
- The EIR should briefly discuss the rationale for selecting the alternatives to be discussed. The EIR should also identify any alternatives that were considered by the lead agency but were rejected as infeasible during the scoping process and briefly explain the reasons underlying the lead agency's determination…Among the factors that may be used to eliminate alternatives from detailed consideration in an EIR are:

  (i) Failure to meet most of the basic project objectives,

  (ii) Infeasibility, or

  (iii) Inability to avoid significant environmental impacts.

Since this is a joint Federal-State Project, the EIS/R is being prepared compatibly with NEPA. To that end, the Alternatives are to be analyzed on an equal, non-preferential basis and at an equal level of detail (consistent with NEPA standards). The proposed project/preferred alternative will be identified in the Final EIR, with that selection to be informed through the CEQA process.

3.2 Overview of Alternatives

The Project Description TM presents a No-Action/No-Project and four action alternatives to implement the Project. Each action alternative includes the actions called for in the Settlement for the Mendota Pool Bypass and Reach 2B. Under the No-Action/No-Project alternative, the Project would not be implemented. Of the four action alternatives, there are two methods of bypassing Restoration Flows around Mendota Pool, two floodplain widths, and four ways to divert water into Mendota Pool.

Project alternatives include the following:

- No-Action/No-Project Alternative
- Compact Bypass with Narrow Floodplain and South Canal
- Compact Bypass with Wide Floodplain and Bifurcation Structure

- Fresno Slough Dam with Narrow Floodplain and Short Canal
- Fresno Slough Dam with Wide Floodplain and North Canal

3.3 No-Action/No-Project Alternative

The No-Action/No-Project Alternative[4] is required for the analysis of environmental effects under NEPA (the No-Action Alternative) and CEQA (the No-Project Alternative). Under this alternative, the Project would not be implemented. The No-Action Alternative is not consistent with the Settlement.

Existing conditions for the No-Project Alternative will be developed for each resource area based on the availability of historical data and recent observations.

Future conditions for the No-Action Alternative will be based on reasonably foreseeable actions that would occur without the Project, including projects that are currently authorized, funded, permitted, or highly likely to be implemented. The planning period for the future condition evaluation would vary depending on the resource area. The conditions under the No-Action Alternative are the conditions that are predicted to exist in the Project area during the planning period if the Project is not implemented

No-Action Conditions

If the Project were not implemented, the components described in the Alternatives would not be implemented; however, other components of the SJRRP would be implemented if they have completed appropriate environmental reviews and have been approved. Likely future conditions include the SJRRP components analyzed in the PEIS/R for the SJRRP, the Interim Flows analyzed in the Interim Flow Environmental Assessment (Reclamation 2010), and other reasonably foreseeable actions expected to occur in the Project study area. It is assumed for the No-Action condition that agriculture would continue and cropland would be the dominant cover type, consistent with the existing condition.

The No-Action Alternative generally assumes no channel or structural improvements would be made in Reach 2B, and Restoration Flows would be reduced to not exceed the existing Reach 2B capacity or rerouted/partially rerouted around Reach 2B. The following assumptions about No-Action will be evaluated in the resource sections of the Project EIS/R.

Fisheries

In the No-Action Alternative, the maximum channel conveyance would be limited to the existing capacity (approximately 810 cfs in Reach 2B, SJRRP 2011 – Appendix I: Underseepage Analysis). Fish passage improvements would not be provided at structures

[4] The No-Action Alternative was originally described in the Initial Options TM (SJRRP 2010d).

(Chowchilla Bifurcation Structure, San Mateo Avenue, and Mendota Dam). However, the remainder of the SJRRP would proceed, and salmon would be reintroduced into the San Joaquin River. Each spring during their outmigration, downstream migrating juveniles would be entrained in diversions from Mendota Pool and succumb to high rates of predation by non-native fish present in Mendota Pool. Adult salmon would be blocked on their upstream migration at Mendota Dam in all years except wet year types. Blocked adult salmon would be exposed to poaching in the river below Mendota Dam and poor water quality later in the year. There is no spawning substrate in Reach 3, downstream of the dam, so blocked adult fish would require alternative efforts to reach spawning grounds or would not spawn successfully.

Habitat

Under the No-Action Alternative, habitat conditions in the Project area may change to the extent that Interim and Restoration flows may recruit new vegetation in some areas. In this alternative, if Restoration Flows were to enter Reach 2B, the condition of the narrow strips of native riparian vegetation along the channel banks downstream of the San Mateo Avenue crossing would be maintained by the relatively stable water level held by Mendota Dam. Upstream of San Mateo Avenue, riparian vegetation may recruit along the wetted channel banks unless vegetation removal is employed.

Seepage

The No-Action Alternative would maintain the existing levee alignments and heights and maximum conveyance would continue to be limited to the existing capacity (approximately 810 cfs, SJRRP 2011 – Appendix I: Underseepage Analysis). If Restoration Flows enter the existing Reach 2B, there would probably be a minimal increase in seepage from the river channel but since capacity would remain unchanged, this may be similar to the seepage experienced during Interim Flows under existing conditions.

Land Use, Agriculture, Economics & Socioeconomics

Under No-Action conditions, future land use in the area is unlikely to change. Reach 2B is in the unincorporated areas of both Fresno and Madera Counties. The nearest incorporated cities are Firebaugh and Mendota, both in Fresno County. Population is expected to increase annually, compounded, by 1.8 percent and 2.5 percent in Fresno and Madera Counties, respectively, between 2000 and 2050 (CDF 2007). Most of that growth would likely occur in areas near the main cities in each of the counties. While population and economic projection data for specific unincorporated subareas of the counties are unavailable, neither agricultural nor non-agricultural activity is likely to expand substantially in the Mendota area.

If the Reach 2B Project is not implemented, future socioeconomic conditions in the pertinent Fresno and Madera County areas relative to conditions in other areas in the two counties would be expected to be similar. It is expected that the Reach 2B area would remain in agriculture and that most of the working population in the area would remain employed in agriculture and related industries.

Geomorphology

The No-Action Alternative would maintain the existing levee alignments and heights and maximum conveyance would continue to be limited to the existing capacity (approximately 810 cfs). If Restoration Flows enter the existing Reach 2B sand transport would likely increase; however, recent sediment continuity studies have predicted that sand inputs from Reach 2A under Restoration Flows will likely result in net deposition in the upper segment of Reach 2B and potentially down to the Mendota Pool. The No-Action Alternative would not likely change the existing geomorphic conditions in Reach 2B.

3.4 Elements Common to All Action Alternatives

All Alternatives would be designed to provide:

- Conveyance of at least 4,500 cfs in Reach 2B and the Mendota Pool Bypass channel
- Diversion and screening of up to 2,500 cfs from Reach 2B into Mendota Pool

Additionally, some constructed elements are also common to all Alternatives. Those elements are described below.

3.4.1 Fish Habitat and Passage

The amounts of fish habitat and the number of structures fish would need to pass vary among the Alternatives; however, some conditions and criteria are consistent across Alternatives and warrant discussion here.

One of the primary focuses of Alternatives is to provide floodplain and riparian habitat to provide benefit to migrating juvenile and adult salmonids and other native fishes. Floodplain and riparian habitats in the Alternatives would include a variety of native plant communities suited to the hydrology, soils, and climate of Reach 2B and the San Joaquin Valley (see additional discussion below under Habitat Restoration).

The Alternatives also include provision of fish passage at structures for salmonids and other native fish. These structures vary by alternative but overall include a culverted crossing at San Mateo Avenue, fish screens, fish passage facilities, grade control structures, bifurcation structures (under certain flows), and Mendota Dam. The designs for structures with fish passage components would be based on criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2001). Specifically, the alternatives would provide suitable hydraulic conditions for passage of up-migrating adult and juvenile salmonids, out-migrating juvenile salmonids, and inter-reach migration of other native fish between Reach 2A and Reach 3. Suitable hydraulic conditions include those conditions which the species is physically capable of passing and do not cause undue stress on the animal. The passage features would be designed to cause no physical harm to fish. The design criteria are structured around the life stages of the target anadromous species and the timing of the runs for upstream movement of adult fall and spring run Chinook and winter steelhead and the upstream and downstream movement of juvenile life stages spawned from these runs. Recommended criteria are based on a combination of swimming ability of the fish species as reported in scientific papers and criteria in agency design guidelines. Recommended design criteria to provide for successful fish passage (depth of flow, suitable velocity ranges and jump height) are provided in Table 3-1. The design criteria for a particular species would be met over the associated flow range (minimum flow to maximum flow).

All the Action Alternatives include facilities that fish would encounter or need to pass to migrate between the bypass and Reach 2A (from downstream to upstream). The Lone Willow Slough fish screen (see Section 3.4.8) is included in all alternatives, and each alternative includes other facilities specific to the alternative. Each structure represents a potential stressor for adult salmon and potential predation site for juvenile salmon. However, each structure would be designed to perform according to the fish passage design criteria. In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to accommodate channel structure variability, all of which may help to reduce stress and predation.

During construction, impacts to fish would be minimized by including some or all of the following measures:

- Temporary bypass facilities around construction areas that meet fish passage criteria
- Construction in the dry
- Phased construction that would allow passage to continue in the channel or in the completed portions of structures while other portions are built
- Fish rescue and relocation

Table 3-1
Fish Passage Design Criteria

Species	Life-stage	Migration Timeframe	Frequency	Minimum Flow	Maximum Flow	Maximum Velocity [1]	Minimum Water Depth [2]	Maximum Jump Height [3]	Minimum Pool Depth
			years	**cfs**	**cfs**	**fps**	**feet**	**feet**	**feet**
Chinook salmon	Adult	Spring and fall pulse	All years except CL	115 [4]	4,500	4.0	1.2	1.0	[5]
	Juvenile (upstream)	Late spring diminishing flows	All years except CL	125 [6]	n/a	1.0	1.0	0.5	[5]
	Juvenile (downstream)	Nov-May	All years except CL	85 [7]	n/a	n/a	1.0	n/a	[5]
Steelhead	Adult	Spring and fall pulse	All years except CL	115 [4]	4,500	4.0	1.2	1.0	[5]
	Juvenile (upstream)	Late spring diminishing flows	All years except CL	125 [6]	n/a	1.0	1.0	0.5	[5]
	Juvenile (downstream)	Nov-May	All years except CL	85 [7]	n/a	n/a	1.0	n/a	[5]
Sturgeon	Adult	Spring pulse	W and NW years	1,138 [8]	4,500	6.6	3.3	None – swim through	n/a
Lamprey	Adult	Spring pulse	All years except CL	125 [6]	4,500	[9]	[9]	[9]	n/a
Other native fish	Adult	Spring pulse	W, NW, and ND years	543 [10]	4,500	2.5	1.0	None – swim through	n/a

W = wet; NW = normal wet; ND = normal dry; CL = critical low

[1] Recommended velocities are for drop structures or structures with short longitudinal lengths. For structures with longer lengths (e.g., culverts and bifurcation structures under certain conditions), maximum velocities would be based on *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2001).

[2] Minimum water depth criteria based on 1.5 times body depth or 1 feet depth, whichever is greater.

[3] Maximum jump height criteria based on criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2001).

[4] Based on Exhibit B lowest flow in the fall spawning period (starts Oct 1) for the desired frequency; all Spring Pulse Flows are higher.

[5] Pool depths to be based on criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2001).

[6] Based on lowest flow within Exhibit B Spring Pulse Flow period for the desired frequency.

[7] Based on lowest flow within desired migration period for the desired frequency.

[8] Wet and normal wet years constitute 50% of years in the historical record. Based on an analysis of varying Restoration Flows management strategies (Reclamation 2010); flows with a 50% exceedance could range from 1,138 to 4,500 cfs.

[9] Lamprey designs to be based on criteria in *Best Management Practices for Pacific Lamprey* (USFWS 2010)

[10] Wet, normal wet, and normal dry years constitute 80% of years in the historical record. Based on an analysis of varying Restoration Flows management strategies (Reclamation 2010); flows with an 80% exceedance could range from 543 to 4,500 cfs.

3.4.2 Levees

The location, length, and height of the levees vary among the Alternatives; however, some design criteria and features would be consistent across all Alternatives and warrant discussion here.

Levees would be required along the Project area to contain Restoration Flows. While the height and footprint of the levees vary according to their location along the channel and the ground elevation, the capacity, freeboard, and cross-section would be consistent. Levees would be designed to maintain 3 feet of freeboard on the levees at 4,500 cfs. Levee design would be based on the USACE *Engineer Manual 1110-2-1913-Design and Construction of Levees* guidelines (USACE 2000a) and *Engineer Manual 1110-2-301 Guidelines for Landscape Planting and Vegetation Management at Floodwalls, Levees, & Embankment Dams* (USACE 2000b). The design includes seepage control measures, inspection trenches, maintenances roads, and drainage trenches to direct off-site drainage.

Levee alignments maintain a 300-foot buffer zone, where appropriate, between the levee and river channel to avoid impact to levees over time due to potential channel migration. In areas where a minimum 300-foot buffer zone between the main river channel and levee cannot be maintained, bank revetment would be incorporated in the design.

The levees would be designed to have sideslopes of 3 horizontal to 1 vertical (3H to 1V) on the waterside and landside. A maintenance road and surface drainage ditch would also be included. Surface drainage ditches would only be intended to capture and direct runoff; they are not intended to address groundwater seepage or through-levee seepage. Due to historical seepage and lack of geotechnical data, it was assumed for cost purposes that all of both new levees adjacent to potentially impacted lands (approximately 90 percent of the total levee length) would contain slurry walls[5]. By following the USACE standards, all levees would have an inspection trench. Additional data collection and analysis would be required to verify the groundwater conductivity rates of the *in situ* and borrow soils and to finalize the design of seepage control measures.

The levee alignments shown on the plan views of the alternatives may be adjusted during final design. Adjustments may be made for several reasons including to improve flow conditions on the floodplain, to improve habitat conditions on the floodplain, to reduce potential erosion, to accommodate adverse soil conditions, and to avoid existing infrastructure among others. The final levee alignments will be within the impact areas evaluated in this document.

---

[5] A slurry wall is a building technique to reinforce areas of soft earth that is near open water or a high groundwater table. The wall is constructed to act as a barrier to prevent water from flowing through it. Typical construction is to dig a trench to create a form for each wall, then the trench is filled with cement slurry, reinforcement is added to the trench (like rebar), then the trench is filled with concrete which displaces the slurry.

3.4.3 Seepage Control Measures

Seepage of river water through or under levees is a concern for levee integrity and adjacent land uses. Through-seepage, water that seeps laterally through the levee section, would be addressed through proper levee design and construction (e.g., selection of low porosity materials and proper compaction). Under-seepage, water that seeps laterally by travelling under the levee section, is primarily controlled by the native soils beneath the levee and seepage control measures would be included where native soils do not provide sufficient control. Seepage control measures would be included, as necessary, in the Project in areas where under-seepage is likely to affect adjacent land uses. Seepage control measures could include: slurry walls, tile drains, seepage wells, seepage berms, land acquisition (fee title or seepage easements) and other measures that can be implemented within the Project area.[6] While slurry walls were assumed for cost purposes, any of these control measures could be implemented.

3.4.4 Borrow

Borrow material would primarily be required for the construction of the levees, but it may also be utilized in the construction of other structures for foundation or backfill material. Levees may be constructed entirely of local borrow material, a mix of local and imported borrow material, or just imported borrow material. Borrow locations will be determined after a geotechnical exploration of the local borrow areas is complete; the exploration will determine the suitability of local soils for use as borrow material. Until the exploration can be complete, it is assumed that all levee fill will come from local borrow sites. Investigation and analysis of potential borrow sites is ongoing by DWR, and the borrow area information will be updated as new information becomes available. Topsoil from local borrow areas would be stockpiled for reuse at the borrow site or within the Project Area.

The locations of borrow areas are dependent on the locations of suitable materials. To the extent that suitable materials and the locations for floodplain grading coincide, borrow from those areas may be preferred. Borrow from within the Project Area will be designed to be compatible with native fish habitat and uses by either reconnecting to the river channel or by restoring to an appropriate elevation to prevent stranding.

It is estimated that up to 350 acres of land total will be needed for borrow areas. This includes borrow locations inside and outside the Project levees (identified as Potential Borrow Area on Figure 1-2). Borrow areas will avoid natural areas to the extent practicable.

[6] Tile drains are buried perforated pipes which intercept groundwater and redirect it to a discharge point. Because the drains have lower resistance to flow, the groundwater table can be kept artificially low in areas near the pipe. Seepage wells are groundwater wells that are used to pump and draw down the water table where seepage is occurring. Seepage berms are berms placed on the landside of a levee to add additional weight and width to the levee to counteract seepage.

3.4.5 Levee protection

Each Alternative generally provides a minimum 300-foot buffer between the existing channel and the proposed levee, where appropriate and feasible. For locations where the 300-foot buffer was not included, erosion protection for the levee in the form of revetment would be included. The revetment would be riprap material covered by soil and then planted to provide a vegetated surface. However, softer approaches, such as bioengineering or dense planting, may be considered during design depending on velocities and scour potential. Locations that require revetment include areas where the 300-foot buffer was not included due to the proximity of existing infrastructure, near the proposed structures, and along river bends less than 300 feet from the levee.

3.4.6 Removal of existing levees

Removal of portions of the existing levees is included and designed to expand the inundation area of the floodplain out to the proposed levees and improve connectivity between the river channel and proposed floodplain. The locations of existing levee removal are based upon the hydraulic performance of the channel and floodplain. In certain locations, however, highly desirable existing vegetation (native and sensitive vegetation communities that can serve as seed banks for future vegetation communities) can be found on the existing levees. Where hydraulic performance and connectivity of the floodplain would not be negatively affected, portions of the existing levees with highly desirable vegetation would remain in place.

3.4.7 Floodplain Grading

Floodplain grading would be included with all of the Alternatives. Floodplain grading would not involve wholesale recontouring of the entire floodplain, but would include any or all of the following at locations to be determined during design:

- Creating high-flow channels through the floodplain to increase the inundation extent at lower flows
- Connecting low-lying areas on the floodplain to the river to prevent stranding
- Removing high areas where flow connectivity would be impeded (e.g., farm road grades)
- Excavating floodplain benches adjacent to the river channel to increase the frequency of inundation
- Creating greater inundation depth diversity on the floodplain

Floodplain grading can provide benefits to salmon and other native fish by allowing inundation to occur at lower flows, by distributing suitable rearing habitats further into the floodplain, by connecting rearing habitat to primary production areas (shallow water habitat), and by providing escape routes during receding flows.

The Figure 3-1 provides an example of how various floodplain grading approaches can be used to expand inundation on the floodplain. The Existing Channel graphic shows an example of how inundation would occur without floodplain grading. The Lowered Floodplain example shows how floodplain benches, lowered areas to either side of the channel, could be used to inundate floodplain areas at lesser flows. This graphic also shows how lowered floodplains could affect inundation at moderate flows. The High Flow Channels graphic shows an example of how high flow channels, side channels that initiate at larger flows than the main channel, could be used to expand floodplain inundation.

3.4.8 Lone Willow Slough Fish Screen

Lone Willow Slough connects to the river at approximately RM 215.9 just downstream of the Chowchilla Bifurcation Structure. All Alternatives include construction of a fish screen at this diversion. During flood control releases from Friant Dam and when the Exchange Contractors are exercising their water rights on the San Joaquin River, in lieu of taking substitute water from the Delta Mendota Canal, up to 125 cfs of water may be diverted for irrigation from Reach 2B into the Lone Willow Slough. A screen would be necessary to prevent fish from entering the canal when flows are being diverted. The fish screen structure consists of a 15-foot by 21-foot concrete hollow box, with the river side of the box open to river flows and the back of the box fitted with a board guide to control diversion into the irrigation canal. The opening at the riverside includes an automated cleaner system, trash rack and a fish screen to prevent migrating fish from entering the intake. The screen would be designed to meet NMFS 2008 criteria.

3.4.9 Infrastructure for Fish Monitoring

The designs for control structures, fish passage facilities, and fish screens include security fences and gates, mounting hardware, and electrical supply in order to conduct fish monitoring activities. The fish monitoring activities themselves are not included in this Project.

3.4.10 Existing infrastructure relocations or floodproofing

Existing infrastructure (see Figure 3-2) such as groundwater wells, pumps, electrical and gas distribution lines, water pipelines, and canals are located in the Project area and would require relocation, retrofitting, or floodproofing to protect them from future Restoration Flows and increased floodplain area. The cost to perform the relocations, retrofits, and floodproofing would be included in the Project cost; the actual relocation, retrofit, or floodproofing work may be performed by others. As a result of the Project, some existing infrastructure may be unnecessary in the future (e.g., power lines that service pumps relocated to outside the project area). In these cases, infrastructure may be demolished or abandoned in place.

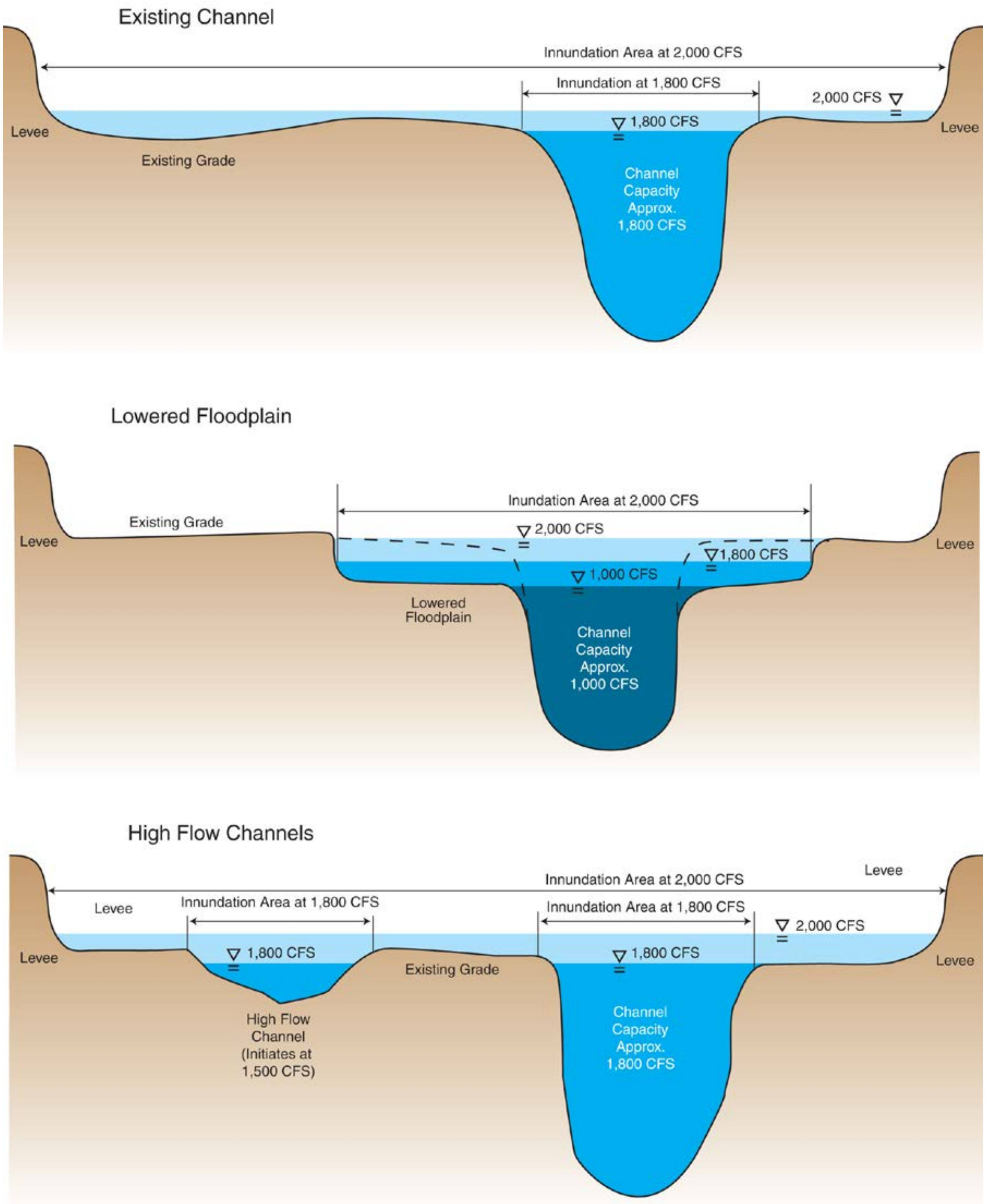


Figure 3-1
Example Floodplain Grading Approaches

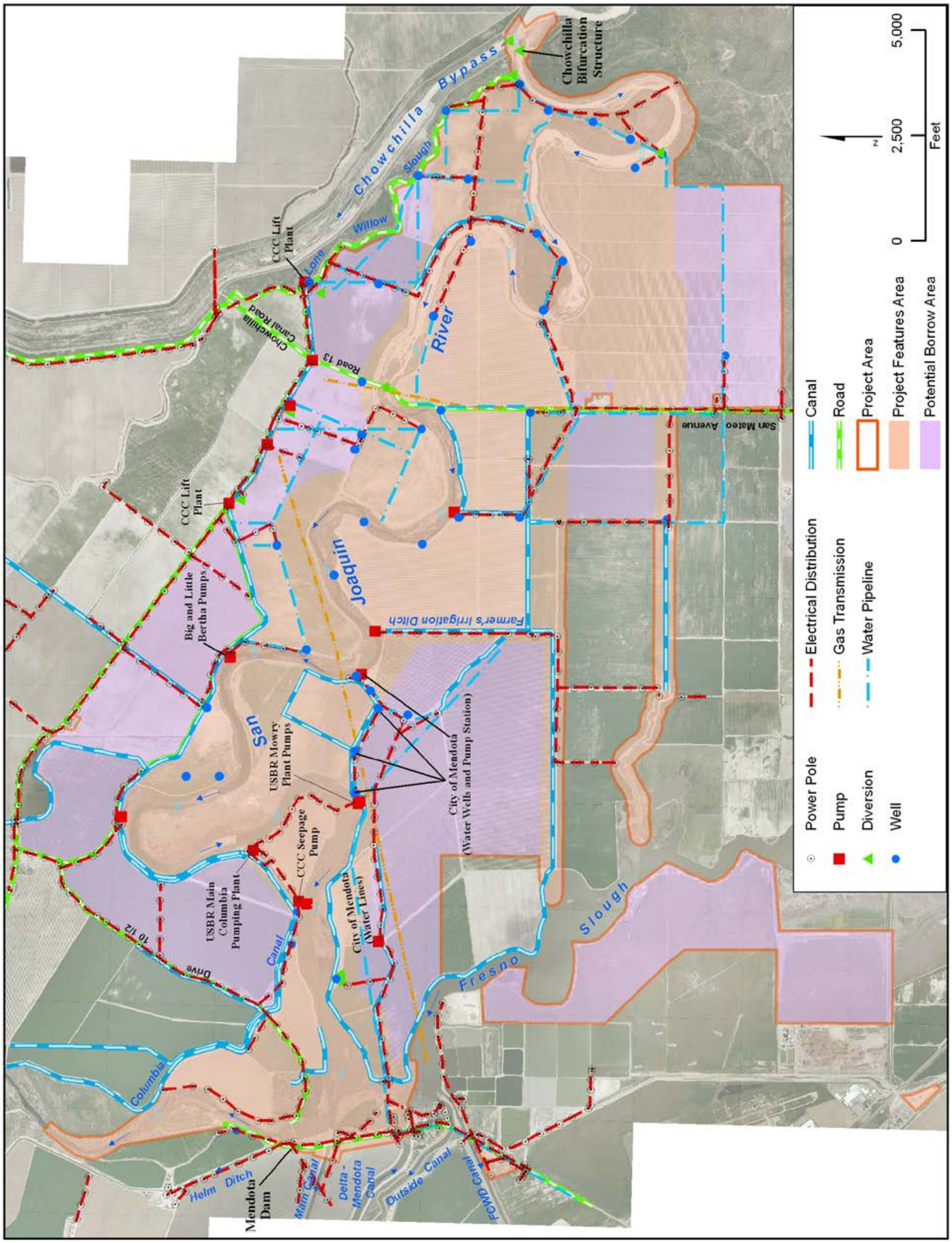


Figure 3-2
Existing Infrastructure in the Project Area

Electrical and Gas Distribution

The length of electrical and gas distribution line impacted by each Alternative was identified for possible relocation. Information from PG&E was available for portions of the area in shapefile format and was supplemented by field data. At the current level of design, it was assumed that the length of existing electrical and gas distribution line found within the Project area would need to be replaced. It is anticipated that some service could be discontinued in the future; the extent of discontinued and replaced service will be refined during the design phase.

Canals and Drains

The length of canals impacted by each Alternative was identified for possible relocation. On-farm canals and drains visible on the LiDAR imagery (Central Valley Floodplain Evaluation and Delineation (CVFED) 2009) and identified during on-site field meetings with landowners were quantified. At the current level of design, it is unknown how canals and drains outside the Project area would be reworked as a result of the impacted canals and drains. It is anticipated that some portions of canals and drains could be discontinued in the future; the extent of discontinued and replaced canals will be refined during the design phase. No subsurface drains were able to be quantified; however, some are believed to exist within the area.

Lift Pumps

The number of lift pumps impacted by each Alternative was identified for possible relocation. Lift pumps visible on the LiDAR imagery (CVFED 2009) or noted in the Calfish database (Pacific States Marine Fisheries Commission 2007) were assumed to require relocation to new facilities on the edge of the proposed levees. A pilot channel dug from the low flow river channel to the intake of the relocated pumps was also assumed. Locations in the Calfish database were confirmed using the LiDAR imagery when possible.

Groundwater Wells

The number of existing wells impacted by each Alternative was identified for possible floodproofing or relocation. Wells were identified within the area using aerial photography. It is recommended that the DWR wells database be consulted for an estimate of abandoned wells that have not been destroyed, so that these old wells would not be conduits for flood waters to the groundwater. A formal well canvas is recommended. Floodproofed wells would be provided with year-round vehicular access via a raised roadbed across the floodplain. The roadbed could include multiple culverts to support floodplain connectivity, depending on the length of the access road and its effect on floodplain flows.

Regulating Reservoirs

The number of irrigation regulating reservoirs was identified for possible relocation. Reservoirs were assumed to be a typical size, contain one lift pump, and half of the reservoir located below the surrounding grade and half above the surrounding grade.

Other Utilities

Other infrastructure was identified within the impacted areas. Other facilities include: high voltage transmission lines, gas lines, and water pipelines. High voltage transmission lines are assumed to be high enough to not be impacted. Gas lines are typically attached to bridges or buried below the river when crossing the river and were assumed not to require relocation. Water pipelines were quantified from existing maps and discussions with landowners. Water pipelines may be relocated or abandoned depending on their future use requirements. Mitigation would be required when crossing a service line (e.g., gas, water, electrical) with a levee depending on the depth of cover.

3.4.11 Construction Access

Access for vehicles carrying materials, equipment, and personnel to and from the construction area would be provided via several existing roadways in the Project vicinity (see Figure 3-3). Improvements may be required to upgrade roadways, pavements, and crossings for anticipated construction traffic and loads, provide adequate turning radii and site distances, and to control dust on non-paved roads. Anticipated improvements include:

- Eastside Drive – Approximately 0.6 miles of dirt road starting at Road 10 ½ will likely require overlaying, and the implementation of dust control measures. Measures could include the use of water trucks or dust palliative for dust control or gravel placement where necessary.
- Chowchilla Canal Road/Road 13 – Approximately 0.3 miles of road starting at Eastside Drive will likely require some overlaying and the implementation of dust control measures. Measures could include the use of water trucks or dust palliative for dust control or gravel placement where necessary.
- San Mateo Avenue – Approximately 0. 5 mile of gravel and 1.5 miles of oil-dirt road starting at the existing San Joaquin River levees will likely require some overlying and the implementation of dust control measures. Measures could include the use of water trucks or dust palliative for dust control or gravel placement where necessary.
- Bass Avenue Canal Crossings – These crossings may need additional bracing and shoring to ensure that they will be able to support the load of the construction equipment and activities. All the construction equipment on Bass Avenue will be within the legal loads (see note below). This crossing is on the Fresno County replacement list.
- Delta Mendota Canal Crossing – This crossing may need additional bracing and supports to ensure that it will be able to support the load of the construction equipment activities.

The above assumes that legal loads would be used on all roads, and once construction is completed, the roads would be returned to the same condition as they were prior to the Project.

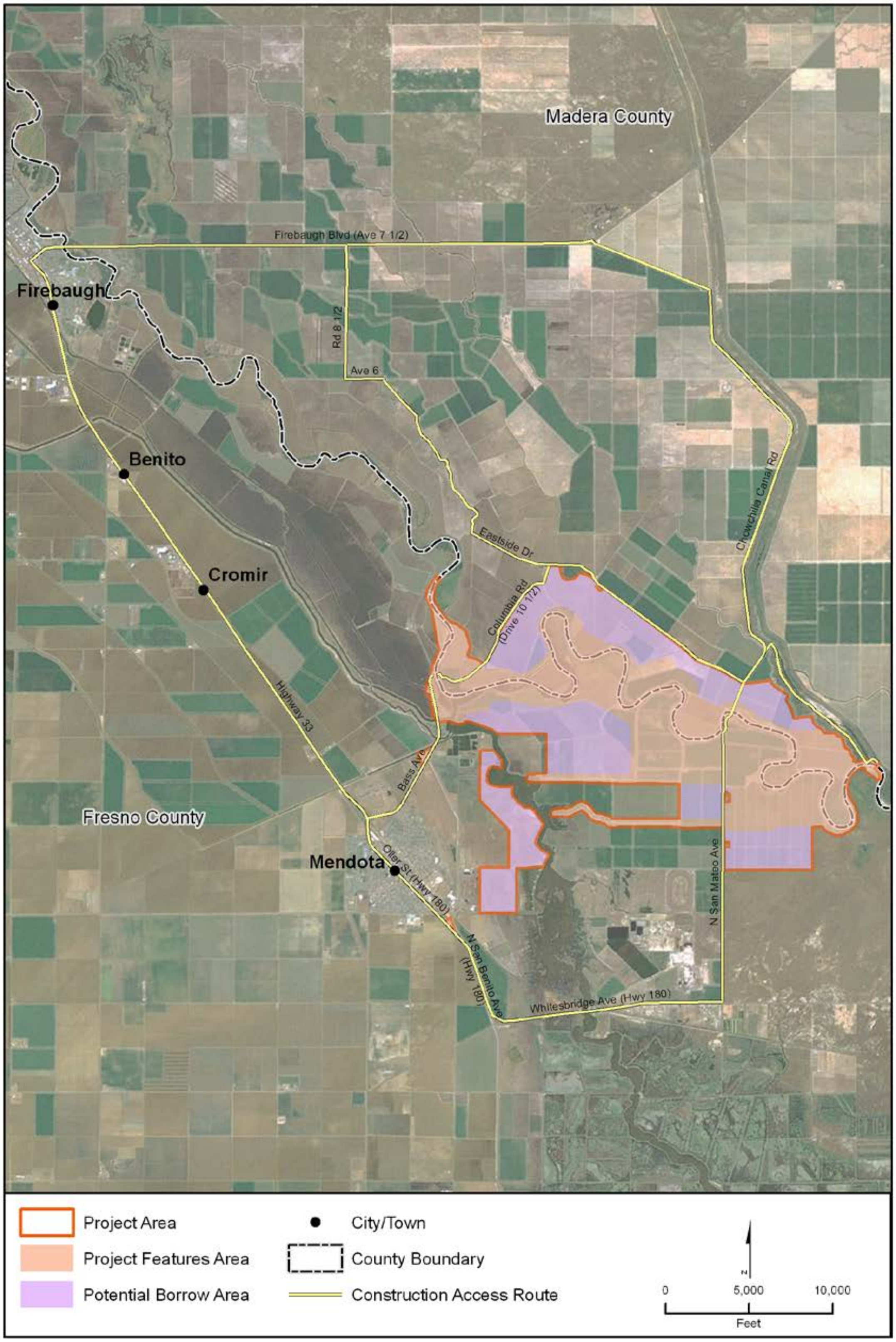


Figure 3-3
Construction Access Routes

3.4.12 Operations and Maintenance

The Project includes long-term operations and maintenance of the proposed facilities and features.

Maintenance

Levees will require maintenance for vegetation management, access roads, levee inspections, levee restoration, rodent control, minor structures, encroachment removal, levee patrolling during flood events, and equipment costs. Levee vegetation management includes equipment to drag the levee banks or aquatic-safe herbicide applications. Maintenance of access roads includes replacing gravel or scraping and filling of ruts to keep the roads in good condition. Levee restoration includes restoring areas with erosion or settlement problems or adding armor. Rodent control includes setting traps with bait and periodically checking the traps. Minor structures maintenance includes repair or replacement of gates, locks or fences. Encroachment removal involves removing illegally dumped materials.

Floodplain maintenance includes vegetation management for invasives, periodic floodplain and channel shaping to retain capacity and prevent fish stranding, and other floodplain maintenance activities such as debris removal.

San Mateo Avenue maintenance includes maintenance when flows overtop the road and annual maintenance to keep the crossing functional and ensure that it can meet fish passage requirements, these include cleaning the culverts of debris or sediment, clearing any debris from the roadway prior to opening after flows have receded, and repairing or replacing minor structures. Minor structures maintenance includes replacing gate locks, painting gates, replacing lost or damaged signage, and lubing gates.

Control structures and Fresno Slough Dam maintenance includes annual operating maintenance for control gates, lubing the fittings, greasing and inspecting the motors, replacing parts and equipment, and cleaning the trash rack. Work needed for the radial gates includes inspection of gates and seals and periodic replacement of seals. Work needed for the trash rake includes periodic repair or replacement of components, inspecting for operation, and greasing and inspecting the motors.

Fish screen maintenance is needed to ensure that the screen is functioning to NMFS standards at all times and capable of diverting the required flow. Fish screens maintenance includes removing the screens for cleaning, replacing screens when needed, periodic repair or replacement of brush cleaning system components, periodic repair or replacement of trash rake components, inspection for operation, greasing and inspecting motors.

Fish screen maintenance is needed to ensure that the barrier is functioning to NMFS standards at all times and capable of passing the required flow. Fish barrier maintenance includes periodic repair or replacement of screens and debris removal.

Fish screen maintenance is needed to ensure that the barrier is functioning to NMFS standards at all times. Fish passage facility maintenance includes removing sediment and debris from the facility, inspection of gates and seals and periodic replacement of seals, periodic repair or replacement of weir gates, periodic repair or replacement of supplementary water system components, inspection for operation, greasing and inspecting motors.

Water diversion canal maintenance includes sediment removal and channel re-shaping.

Mendota Dam maintenance includes periodic minor upstream sediment removal in order to operate the Short Canal only.

Maintenance Schedule

All maintenance activities, when possible, would be timed to minimize the impacts to fish. All activities would require environmental clearance to be completed prior to any annual maintenance or repairs that are not deemed an emergency. Access and safety concerns are the main driver for timing of the maintenance activities, but can be scheduled around fish migration. Ultimately, the schedule may be impacted by compliance with the clearance to conduct the work and timing of flows.

Maintenance of levees and floodplains for aquatic-safe herbicide treatment would occur sometime between spring and fall and would depend on the plant species that are being treated. Typically the herbicide would be administered prior to the plant going to seed and may need to be sprayed more than once. Disking for vegetation management usually occurs twice within the year; once in early spring after the rainfall season and then again in late summer prior to plants going to seed. Access road and levee restoration work would likely be done in the summer after the rainfall season, and timing and projects would be dependent on environmental clearance for small mammals, nesting birds or burrowing owls, and other wildlife species. Rodent control would likely be done by a pest control advisor and would likely be done in the spring through fall and not during the rainfall season. All levee and floodplain work can be impacted by the presence of nesting birds, so in some areas work may not begin until mid-summer (after June).

Timing of the maintenance of structures within the waterways would depend on the flow hydrograph and forecasted flows, but can typically be expected in the summer/fall after high spring flows have receded. Cleaning of the in-channel structures would typically occur when flows are low enough to allow crews and equipment to enter the river safely to access the structures. San Mateo Avenue may be cleared or repaired earlier for access as soon as flows recede and are not likely to increase for the remainder of the water year. If earlier, this work would only be for road access and would not be located in the channel itself.

Debris that collects on trash racks, screens, ladders, or other fish passage structures will need to be periodically removed but will likely be scheduled based on the operation permits for these structures. Annual maintenance cleaning would be expected after the fish migration, but will need to be timed when flows have receded.

Lubing and annual gate maintenance would likely be in the late summer or early fall prior to winter and spring flows to make sure the structures are operating properly and to provide time for repairs and ordering parts if needed. This will likely begin after the annual State budget is adopted and ordering of parts would be allowed.

For the Short Canal Option, the boards would be placed back into Mendota Dam. This could occur at any time, but would likely occur during the irrigation season. The fish passage structure at the dam would allow for fish passage when the boards are in-place.

Water diversion canals that require maintenance could be isolated from the river system by closing the headgates at the canals which will not impact fish migration.

Operations

There are no operations for levees or floodplains.

San Mateo Avenue operations include closing the gates to the crossing during high flows and reopening once flows have receded.

Control structures and Fresno Slough Dam operations include operating the motors for the control gates, inspecting and assessing the gates, adjusting the gates for various stages of flows, and running the automatic trash sweep.

Fish screens operations would occur every day when diversions are occurring. Operations include visually inspecting screens, verifying flow, clearing obstructions and debris, adjusting the baffles, permitting and regulatory compliance measures, estimating performance (i.e., velocity measurements), powering the screen, running the pumps for the sediment removal system, running automatic brush cleaning and trash rake motors, and running pumps for the fish diversion pipe. Operations also include methods to reduce predation of juvenile fish (e.g., noise systems to scatter predators, netting, and periodic draining of the screen return pipes).

Fish barrier operations would occur every day during salmon upmigration for spawning. Operations include visually inspecting screens, verifying flow, clearing obstructions and debris, installing and removing barrier screens, and permitting and regulatory compliance measures.

Fish passage facility operations would occur every day during fish migration. Operations include visually inspecting the facility, verifying flow, clearing obstructions and debris, adjusting the weirs, permitting and regulatory compliance measures, estimating performance (i.e., velocity measurements), powering mechanically controlled weirs.

There are no operations for the water diversion canal. Operation of the canal headworks is covered under control structures above.

Mendota Dam operations include placing and removing stop logs in order to operate the Short Canal (only applies to Fresno Slough Dam with Narrow Floodplain and Short Canal Alternative; see Section 3.8).

3.4.13 Land Acquisition

The approximate amount of additional lands to be acquired to accommodate the floodplain, levees, bypass channel, structures, and borrow was quantified based on parcel data in shapefile format from Fresno and Madera counties. Since portions of parcels outside the Project area may not be as easily utilized by the land owners, the entire parcels were considered, where appropriate, in the land acquisition costs for the Alternatives. The amount of land acquisition varies with each Alternative (approximately 2,450 to 3,300 acres).

3.4.14 Phased Implementation

The Project may utilize a phased approach to implementation or construction of the selected alternative. Phased implementation would involve building selected components of the Project in separate construction phases, allowing Project funding to be secured over time. For example, the bypass channel and bifurcation structure could be built in a first phase, levees and floodplain construction in a second phase, and fish screens and fish passage facilities in a third phase. Exact phasing would be developed during the detailed design phase of the selected alternative.

3.4.15 Monitoring and Management Plan

A Monitoring and Management Plan will be included in the Project EIS/R. Some components of the Project's Monitoring and Management Plan would be covered by the Program's *Physical Monitoring and Management Plan* (PEIS/R Appendix D.1, SJRRP 2011). The Project's monitoring activities are summarized here.

The Monitoring and Management Plan will provide guidelines for observing conditions as well as adjusting to changes in physical conditions within the Project area. The Monitoring and Management Plan will consist of multiple component plans, addressing physical conditions such as flow, groundwater seepage, channel capacity, and propagation of native vegetation, as well as addressing effectiveness monitoring of fish screens and fish passage at structures. Each component plan will identify objectives for the physical conditions within the Project area, and provides guidelines for the monitoring and management of those conditions. The component plans identify potential actions that could be taken to further enhance the achievement of the objectives. Finally, the Plan will include a description of monitoring activities which apply to one or more of the component plans. The component plans will include the following:

- **Flow –** To ensure compliance with the hydrograph releases in Exhibit B of the Settlement and any other applicable flow releases (e.g., Buffer Flows) (part of the Program's *Physical Monitoring and Management Plan*)

- **Seepage –** To reduce or avoid adverse or undesirable seepage impacts (part of the Program's *Physical Monitoring and Management Plan*)

- **Channel capacity** – To maintain flood conveyance capacity (part of the Program's *Physical Monitoring and Management Plan*)

- **Native vegetation** – To establish and maintain native riparian habitat (part of the Program's *Physical Monitoring and Management Plan*)

- **Passage and screening effectiveness** – To maintain effective fish passage and fish screening at structures and diversions

Monitoring Activities

Monitoring activities would include physical and nonphysical activities within the Project area. Monitoring activities, as they will be described in the Monitoring and Management Plan, are guidelines for monitoring and could change as part of implementation of the Project. These activities could include the following:

- **Flow monitoring** – Flow, cross sections, and surface water stage at six gaging stations, and at additional locations during high-flow events (part of the Program's *Physical Monitoring and Management Plan*)

- **Groundwater level monitoring** – Groundwater elevation in monitoring wells (part of the Program's *Physical Monitoring and Management Plan*)

- **Aerial and topographic surveys** – True color aerial photographs and topographic surveys to assess river stage, hydraulic roughness, river width, bed elevation, and vegetation conditions (part of the Program's *Physical Monitoring and Management Plan*)

- **Vegetation surveys** – Surveys of seed dispersal start and peak times, and native riparian vegetation establishment (part of the Program's *Physical Monitoring and Management Plan*)

- **Sediment mobilization monitoring** – Sediment mobilization, bar formation, and bank erosion through aerial and topographic surveys of areas with elevated erosion potential (part of the Program's *Physical Monitoring and Management Plan*)

- **Passage and screening effectiveness** – flow, cross-sections, water surface, and velocity measurements near and within structures that provide passage or screening. Fish counting devices and rotary screw traps to count and measure fish passage and fish size.

3.4.16 Conservation Strategy

As part of Project implementation, a comprehensive strategy for the conservation of listed and sensitive species and habitats has been prepared, and would be implemented in coordination with USFWS, NMFS, and DFG. The strategy's purpose is to serve as a tool built into the project description to minimize and avoid potential impacts to sensitive species and habitats. This Conservation Strategy guides development and implementation of specific conservation measures for project-level actions. The Conservation Strategy includes conservation goals and measures for species and communities (such as avoidance, minimization, monitoring, and management measures) consistent with adopted recovery plans, as described below. If avoidance and minimization measures are impractical or infeasible, then further consultation actions and mitigation measures will be pursued and developed in coordination with the appropriate regulatory agency.

To achieve the Restoration Goal, a number of actions that are proposed to be implemented may substantially alter not only the aquatic ecosystem of the San Joaquin River, but also the river's riparian and wetland ecosystems, and some adjacent upland ecosystems. Riparian, wetland, and upland ecosystems of the Central Valley, such as those along the San Joaquin River, provide habitat for a large number of species, including several Federally-listed and State-listed species. Therefore, the action alternatives include this Conservation Strategy, which would be implemented in a manner that is consistent with adopted conservation plans for sensitive species, and for wetland and riparian ecosystems of the Restoration Area.

The Conservation Strategy consists of management actions that would result in a net benefit for riparian and wetland habitats in the Project area, to avoid reducing the long-term viability of sensitive species, and to be consistent with adopted conservation plans. The goals of the strategy are described below:

- **Conserve riparian vegetation and waters of the United States, including wetlands –** It is anticipated that implementing the Project would result in a net increase in the acreage of riparian and wetland vegetation in the Project area. However, several project actions may disturb or eliminate riparian vegetation or waters of the United States (including wetlands). If impacts to waters of the United States (including wetlands), navigable waters, or the Federal levee system cannot be avoided, a USACE Section 404, Section 408, and/or Section 10 permit and Central Valley Regional Water Quality Control Board (RWQCB) Section 401 water quality certification would be obtained. Increased acreage of wetlands resulting from Interim and Restoration flows may be considered a means of replacing, restoring, or enhancing wetlands. However, the acreage, location, and methods of replacing, restoring, or enhancing wetlands would be determined during these permitting processes.
- **Control and manage invasive species –** Because of their adverse effects on aquatic and riparian ecosystems, the spread of invasive plant species as a result of Project would be controlled and managed. For each invasive plant species with known infestations, thresholds for management responses and specific management responses would be established and implemented (including species-specific control methods).
- **Conserve special-status species –** Populations of special-status species would benefit from restoring and sustaining riparian and wetland habitat, and controlling invasive species, as described previously. However, during construction-related activities, a variety of special-status species of upland, wetland, and riparian habitats could experience adverse effects. Therefore, this strategy includes measures to prevent or reduce impacts that could result from loss of habitat within project footprints or from impacts on adjacent habitat or species. In addition, this strategy includes coordination with appropriate regulatory agencies to provide mitigation or compensation, consistent with applicable conservation plans, to

avoid or minimize effects when actions would result in a net loss of habitat or other substantial adverse effects, if the implementation of avoidance and minimization measures is infeasible or impractical.

These measures address all potentially affected Federally-listed and/or State-listed species, and all other species identified by USFWS, NMFS, or DFG as candidates, sensitive, or special-status in local or regional plans, policies, or regulations. For individual actions under each of the Project Alternatives, the applicable, feasible measures would guide development of action-specific conservation strategies. Table 3-2 presents the Conservation Strategy.

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
VP	**Vernal pool habitats, fleshy (succulent) owl's clover, San Joaquin Valley Orcutt grass, hairy Orcutt grass, longhorn fairy shrimp, vernal pool fairy shrimp, and western spadefoot toad**	
VP-1. Avoid effects to species	a) If vernal pools or vernal pool species are anticipated within a project area, a qualified biologist will identify and map vernal pool and seasonal wetland habitat potentially suitable for listed vernal pool plants, invertebrates, and western spadefoot toad within the project footprint. b) Facility construction and other ground-disturbing activities will be sited to avoid core areas identified in the Vernal Pool Recovery Plan (USFWS 2005) because conservation of these areas is a high priority for recovering listed vernal pool species.	USFWS DFG
VP-2. Minimize effects to species	a) If vernal pools are present, a buffer around the microwatershed or a 250-foot-wide buffer, whichever is greater, will be established before ground-disturbing activities around the perimeter of vernal pools and seasonal wetlands that provide suitable habitat for vernal pool crustaceans or vernal pool plants. This buffer will remain until ground-disturbing activities in that area are completed. Suitable habitat and buffer areas will be clearly identified in the field by staking, flagging, or fencing. b) Appropriate fencing will be placed and maintained around all preserved vernal pool habitat buffers during ground-disturbing activities to prevent impacts from vehicles and other construction equipment. c) Worker awareness training and on-site biological monitoring will occur during ground-disturbing activities to ensure buffer areas are being maintained.	Lead Agency
VP-3. Compensate for temporary or permanent loss of habitat	a) If activities occur within the microwatershed or 250-foot-wide buffer for vernal pool habitat will be affected by the SJRRP, the project proponent will develop and implement a compensatory mitigation plan, consistent with the USACE and EPA April 10, 2008, Final Rule for Compensatory Mitigation for Losses of Aquatic Resources (33 CFR Parts 325 and 332 and 40 CFR Part 230) and other applicable regulations and rules at the time of implementation, that will result in no net loss of acreage, function, and value of affected vernal pool habitat. Unavoidable effects will be compensated through a combination of creation, preservation, and restoration of vernal pool habitat or purchase of credits at a mitigation bank approved by the applicable regulatory agency/agencies. b) Project effects and compensation will be determined in consideration of the Vernal Pool Recovery Plan goals for core areas, which call for 95 percent preservation for habitat in the Grasslands Ecological Area	USFWS DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	and Madera core areas, and 85 percent habitat preservation in the Fresno core area (USFWS 2005). c) Appropriate compensatory ratios for loss of habitat both in and out of core areas will be determined during coordination and consultation with USFWS and/or DFG, as appropriate. d) If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be and developed as part of the USFWS and/or DFG coordination and consultation process. The plan will include information on responsible parties for long-term management, holders of conservation easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations. Any impacts that result in a compensation purchase will require an endowment for land management in perpetuity before any project groundbreaking activities.	
CH	**Critical habitat**	
CH-1. Avoid and minimize effects to critical habitat	a) Designated critical habitats shall be identified and mapped. b) All SJRRP actions will be designed to avoid direct and indirect adverse modifications to these areas. c) Minimization measures, such as establishing and maintaining buffers around areas of designated critical habitat, shall be implemented if avoidance is not feasible.	USFWS
CH-2. Compensate for unavoidable adverse effects on Federally designated critical habitat	a) If critical habitat may be adversely modified by the implementation of SJRRP actions, the area to be modified will be evaluated by a qualified biologist to determine the potential magnitude of the project effects (i.e., description of primary constituent elements present and quantification of those affected) at a level of detail necessary to satisfy applicable environmental compliance and permitting requirements. b) Compensatory conservation measures developed through Section 7 consultation with USFWS will be implemented. If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in and developed as part of the USFWS consultation process. The plan will include information on responsible parties for long-term management, holders of conservation easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations. Any impacts that result in a compensation purchase require an endowment for land management in perpetuity before any project groundbreaking activities.	USFWS

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
CTS	**California tiger salamander**	
CTS-1. Avoid and minimize effects to species	a) If potential California tiger salamander habitat or species are anticipated within the project area, within 1 year before project construction activities, a qualified biologist shall identify and map potential California tiger salamander habitat (areas within 1.3 miles of known or potential California tiger salamander breeding habitat) within the project footprint. One week before ground-disturbing activities, a qualified biologist will survey for and flag the presence of ground squirrel and gopher burrow complexes. Where burrow complexes are present, a 250-foot-wide buffer shall be placed to avoid and minimize disturbance to the species. b) Facility construction and other ground-disturbing activities shall be sited to avoid areas of known California tiger salamander habitat and avoidance buffers. c) To eliminate an attraction to predators of the California tiger salamander, all food-related trash items such as wrappers, cans, bottles, and food scraps, must be disposed of in closed containers and removed at least once every day from the entire project site.	USFWS DFG
CTS-2. Minimize effects to species	a) Before and during construction activities, construction exclusion fencing will be installed just outside the work limit or around vernal pools where California tiger salamander may occur. This fencing shall be maintained throughout construction and will be removed at the conclusion of ground-disturbing activities. No vehicles will be allowed beyond the exclusion fencing. A USFWS-approved biological monitor shall be present on site, during intervals recommended by USFWS, to inspect the fencing. b) The biological monitor will be on site each day during any wetland restoration or construction, and during initial site grading or development of sites where California tiger salamanders have been found. c) Before the start of work each day, the biological monitor will check for animals under any equipment to be used that day, such as vehicles or stockpiles of items such as pipes. If California tiger salamanders are present, they will be allowed to leave on their own, before the initiation of construction activities for the day. To prevent inadvertent entrapment of California tiger salamanders during construction, all excavated, steep-walled holes or trenches more than 1 foot deep shall be covered, by plywood or similar materials, at the close of each working day or provided with one or more escape ramps constructed of earth fill or wooden planks. Before such holes or trenches are filled, they must be thoroughly inspected for trapped animals. d) Plastic monofilament netting (erosion control matting) or similar material shall not be used at the project site because California tiger salamanders may become entangled or trapped. Acceptable	USFWS

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	substitutes include coconut coir matting or tackified hydroseeding compounds. e) All ground-disturbing work shall occur during daylight hours. Clearing and grading will be conducted between April 15 and October 15, in coordination with USFWS and DFG, and depending on the level of rainfall and site conditions. f) Revegetation of project areas temporarily disturbed by construction activities will be conducted with locally occurring native plants.	
CTS-3. Compensate for temporary or permanent loss of habitat	a) If California tiger salamander, or areas within 1.3 miles of known or potential California tiger salamander breeding habitat, would be affected by the SJRRP, the project proponent will develop and implement a compensatory mitigation plan in coordination with USFWS and DFG, as appropriate. Unavoidable effects will be compensated through a combination of creation, preservation, and restoration of habitat or purchase of credits at a mitigation bank approved by the regulatory agencies. b) If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in and developed as part of the USFWS and/or DFG coordination and consultation process. The plan will include information on responsible parties for long-term management, holders of conservation easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations. Any impacts that result in a compensation purchase will require an endowment for land management in perpetuity before any project groundbreaking activities.	USFWS DFG
PALM	**Palmate-bracted bird's beak**	
PALM-1. Avoid and minimize effects to species	a) If palmate-bracted bird's beak is anticipated within the project area, a qualified botanist will identify and map the location of palmate-bracted bird's beak plants within the project footprint, within 1 year before the start of activities that may cause disturbance from either release of flows over 1,660 cfs or from ground-disturbing actions. b) A minimum 500-foot-wide buffer shall be placed around occurrences of palmate-bracted bird's beak during construction activities, consistent with recommendations in the Recovery Plan for Upland Species of the San Joaquin Valley, California (USFWS 1998). The 500-foot-wide buffer will be clearly identified in the field by staking, flagging, or fencing. Project activity will avoid buffer areas, and work awareness training and biological monitoring will be conducted to ensure that the buffer area is not encroached on and that effects are being avoided.	USFWS DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
PALM-2. Compensate for temporary or permanent loss of occupied habitat	a) A compensatory conservation plan shall be developed in coordination with USFWS and DFG, as appropriate. The conservation plan will require the project proponent to maintain viable plant populations in the Restoration Area and will identify compensatory measures for any populations affected. The conservation plan shall include monitoring and reporting requirements for populations to be preserved in or adjacent to construction areas, or populations to be protected or enhanced off site. b) If relocation efforts are part of the conservation plan, the plan will include details on the methods to be used: collection, relocation/transplant potential, storage, propagation, preparation of receptor site, installation, long-term protection and management, monitoring and reporting requirements, and remedial action responsibilities should the initial effort fail to meet compensation requirements. c) If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in the conservation plan and must occur with full endowment for management in perpetuity before groundbreaking. The plan will include information on responsible parties for long-term management, holders of conservation easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.	USFWS DFG
VELB	**Valley elderberry longhorn beetle**	
VELB-1. Avoid and minimize effects to species	a) If elderberry shrubs and valley elderberry longhorn beetle are anticipated within the project area, within 1 year before the commencement of ground-disturbing activities, a qualified biologist shall identify any elderberry shrubs in the project footprint. Qualified biologist(s) will survey potentially affected shrubs for valley elderberry longhorn beetle exit holes in stems greater than 1 inch in diameter. b) If elderberry shrubs are found on or adjacent to the construction project site, a 100-foot-wide avoidance buffer – measured from the dripline of the plant – will be established around all elderberry shrubs with stems greater than 1 inch in diameter at ground level and will be clearly identified in the field by staking, flagging, or fencing. No activities will occur within the buffer areas and worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented.	USFWS
VELB -2. Compensate for temporary or permanent loss of habitat	a) The project proponent will consult with USFWS to determine appropriate compensation ratios. Compensatory mitigation measures will be consistent with the Conservation Guidelines for Valley Elderberry Longhorn Beetle (USFWS 1999a), or current guidance. b) Compensatory mitigation for adverse effects may include	USFWS

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	transplanting elderberry shrubs during the dormant season (November 1 to February 15), if feasible, to an area protected in perpetuity, as well as required additional elderberry and associated native plantings and approved by USFWS. c) If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.	
BNLL	**Blunt-nosed leopard lizard**	
BNLL-1. Avoid and minimize effects to species	a) Three areas have been identified as having potential blunt-nosed leopard lizard habitat based on aerial maps. These areas include approximately 2,460 acres along the southwest side of the San Joaquin River in Reach 2, approximately 490 acres in a portion of the Eastside Bypass and adjacent lands near Reach 4A of the San Joaquin River, and approximately 2,938 acres encompassing the northern side of the Mariposa Bypass and parcels north of the Mariposa Bypass and west of the Eastside Bypass. Within 1 year before the commencement of the proposed project, focused site visits and habitat assessment will be conducted on these lands. Based on focused assessment, and discussions with the USFWS and DFG, protocol-level surveys may be conducted. If blunt-nosed leopard lizard are detected within or adjacent to the project site, measures that will avoid direct take of this species will be developed in cooperation with USFWS and DFG and implemented before ground disturbing activities. (DWR 2010).	USFWS DFG
BNLL-2. Compensate for temporary or permanent loss of habitat or species	a) Compensation for impacts to the species, if needed, will be determined in coordination with USFWS and DFG as appropriate.	USFWS DFG
PLANTS	**Other special-status plants**	
PLANTS-1. Avoid and minimize effects to special-status plants	a) Within 1 year before the commencement of ground-disturbing activities, habitat assessment surveys for the special-status plants listed in Table 1 of Appendix L of this Draft PEIS/R, “Biological Resources – Vegetation and Wildlife,” will be conducted by a qualified botanist, in accordance with the most recent USFWS and DFG guidelines and at the appropriate time of year when the target	USFWS DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	species would be in flower or otherwise clearly identifiable. b) Locations of special-status plant populations will be clearly identified in the field by staking, flagging, or fencing a minimum 100-foot-wide buffer around them before the commencement of activities that may cause disturbance. No activity shall occur within the buffer area, and worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented. c) Some special-status plant species are annual plants, meaning that a plant completes its entire life cycle in one growing season. Other special-status plant species are perennial plants that return year after year until they reach full maturity. Because of the differences in plant life histories, all general conservation measures will be developed on a case-by-case basis and will include strategies that are species- and site-specific to avoid impacts to special-status plants.	
PLANTS-2. Compensate for temporary or permanent loss of special-status plants	a) USFWS and/or DFG will be consulted to determine appropriate compensation measures for the loss of special-status plants, as appropriate. b) Appropriate mitigation measures may include the creation of off-site populations through seed collection or transplanting, preservation and enhancement of existing populations, restoration or creation of suitable habitat, or the purchase of credits at a regulatory-agency-approved mitigation bank. If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.	USFWS DFG
GGS	**Giant garter snake**	
GGS-1. Avoid and minimize loss of habitat for giant garter snake	a) If giant garter snake habitat is anticipated to be present within the project area, preconstruction surveys will be completed by a qualified biologist approved by USFWS and DFG within a 24-hour period before any ground disturbance of potential giant garter snake habitat. If construction activities stop on the project site for a period of 2 weeks or more, a new giant garter snake survey will be completed no more than 24 hours before the restart of construction activities. Avoidance of suitable giant garter snake habitat, as defined by USFWS (USFWS 1993) and DFG, will occur by demarcating and maintaining a 300-foot-wide buffer around these areas. b) For projects within potential giant garter snake habitat, all activity involving disturbance of potential giant garter snake habitat will be	Lead Agency USFWS DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	restricted to the period between May 1 and October 1, the active season for giant garter snakes. The construction site shall be re-inspected if a lapse in construction activity of 2 weeks or greater has occurred. c) Clearing will be confined to the minimal area necessary to facilitate construction activities. Giant garter snake habitat within or adjacent to the project will be flagged, staked, or fenced and designated as an Environmentally Sensitive Area. No activity shall occur within this area, and USFWS-approved worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented. Construction activities shall be minimized within 200 feet of the banks of giant garter snake habitat. Movement of heavy equipment will be confined to existing roadways to minimize habitat disturbance. d) Vegetation shall be hand-cleared in areas where giant garter snakes are suspected to occur. Exclusionary fencing with one-way exit funnels shall be installed at least 1 month before activities to allow the species to passively leave the area and to prevent reentry into work zones, per USFWS and/or DFG guidance. e) If a giant garter snake is found during construction activities, USFWS, DFG, and the project's biological monitor will immediately be notified. The biological monitor, or his/her assignee, will stop construction in the vicinity of the find and allow the snake to leave on its own. The monitor will remain in the area for the remainder of the work day to ensure the snake is not harmed. Escape routes for giant garter snake should be determined in advance of construction and snakes will be allowed to leave on their own. If a giant garter snake does not leave on its own within 1 working day, USFWS and DFG will be consulted. f) All construction-related holes shall be covered to prevent entrapment of individuals. Where applicable, construction areas shall be dewatered 2 weeks before the start of activities to allow giant garter snakes and their prey to move out of the area before any disturbance.	
GGS-2. Compensate for temporary or permanent loss of habitat	a) Temporarily affected giant garter snake aquatic habitat will be restored in accordance with criteria listed in the USFWS Mitigation Criteria for Restoration and/or Replacement of Giant Garter Snake Habitat (Appendix A to Programmatic Formal Consultation for U.S. Army Corps of Engineers 404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake Within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties, California (USFWS 1997)), or the most current criteria from USFWS or DFG. b) Permanent loss of giant garter snake habitat will be compensated at a ratio and in a manner consulted on with USFWS and DFG. Compensation may include preservation and enhancement of	USFWS DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	existing populations, restoration or creation of suitable habitat, or purchase of credits at a regulatory-agency-approved mitigation bank in sufficient quantity to compensate for the effect. Credit purchases, land preservation, or land enhancement to minimize effects to giant garter snakes should occur geographically close to the impact area. If off-site compensation is chosen, it shall include dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, and the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.	
WPT	**Western pond turtle**	
WPT-1. Avoid and minimize loss of individuals	a) A qualified biologist will conduct surveys in aquatic habitats to be dewatered and/or filled during project construction. Surveys will be conducted immediately after dewatering and before fill of aquatic habitat suitable for western pond turtles. If western pond turtles are found, the biologist will capture them and move them to nearby USFWS- and/or DFG-approved areas of suitable habitat that will not be disturbed by project construction.	DFG
EAGLE	**Bald eagle and golden eagle**	
EAGLE-1. Avoid and minimize effects to bald and golden eagles (as defined in the Bald and Golden Eagle Protection Act)	a) Surveys for bald and golden eagle nests will be conducted within 2 miles of any proposed project within areas supporting suitable nesting habitat and important eagle roost sites and foraging areas. These surveys will be conducted in accordance with the USFWS Protocol for Evaluating Bald Eagle Habitat and Populations in California and DFG Bald Eagle Breeding Survey Instructions or current guidance (USFWS Draft Project Design Criteria and Guidance for Bald and Golden Eagles). b) If an active eagle's nest is found, project disturbance will not occur within ½ mile of the active nest site during the breeding season (typically December 30 to July 1) or any project disturbance if it is shown to disturb the nesting birds. A no-disturbance buffer will be established around the nest site for construction activities in consultation with USFWS and DFG, and will depend on ecological factors, including topography, surrounding vegetation, nest height, and distance to foraging habitat, as well as the type and magnitude of disturbance. c) Project activity will not occur within the ½-mile-buffer areas, and worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being	USFWS DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	implemented.	
SWH	**Swainson's hawk**	
SWH-1. Avoid and minimize impacts to Swainson's Hawk	a) Preconstruction surveys for active Swainson's hawk nests will be conducted in and around all potential nest trees within 0.5 miles of project-related disturbance (including construction-related traffic).. b) If known or active nests are identified through preconstruction surveys or other means, a ½ mile no-disturbance buffer shall be established around all active nest sites if construction cannot be limited to occur outside the nesting season (February 15 through September 15). c) Worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented.	DFG
SWH-2. Compensate for loss of nest trees and foraging habitat	a) If foraging habitat for Swainson's hawk is removed in association with project implementation, foraging habitat compensation will occur in coordination with DFG. Foraging habitat mitigation may consist of planting and establishing alfalfa, row crops, pasture, or fallow fields. b) If potential nesting trees are to be removed during construction activities, removal will take place outside of Swainson's hawk nesting season, and the project proponent will develop a plan to replace known Swainson's hawk nest trees with a number of equivalent native trees that were previously determined to be impacts through consultation with DFG. Compensation shall include dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, and the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.	DFG
RAPTOR	**Other nesting raptors**	
RAPTOR-1. Avoid and minimize loss of individual raptors	a) Construction activity, including vegetation removal, will only occur outside the typical breeding season for raptors (September 1 to February 14), if raptors are determined to be present. b) Preconstruction surveys will be conducted by a qualified biologist in areas of suitable habitat to identify active nests in the project footprint. c) If active nests are located in the project footprint, a no-disturbance buffer will be established until a qualified biologist determines that the nest is no longer active. The size of the buffer shall be established by a qualified biologist in coordination with DFG based on the sensitivity of the resource, the type of disturbance activity, and nesting stage.	DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	No activity shall occur within the buffer area, and worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented.	
RAPTOR-2. Compensate for loss of nest trees	a) Native trees removed during project activities will be replaced with an appropriate number of native trees, in coordination with DFG.	DFG
MBTA	**Other birds protected by the Migratory Bird Treaty Act**	
MBTA-1. Avoid and minimize effects to species	a) Native nesting birds will be avoided by not conducting project activity, including vegetation removal, during the typical breeding season (February 1 to September 1), if species covered under the Migratory Bird Treaty Act and Fish and Game Code Sections 3503, 3503.5, and 3513 are determined to be present. b) An Avian Protection Plan shall be established in coordination with USFWS and DFG. Any overhead utility companies within the project area, whose lines, poles, or towers may be moved in association with the project, will also be consulted as part of the Avian Protection Plan.	USFWS DFG
BRO	**Burrowing owl**	
BRO-1. Avoid loss of species	a) Preconstruction surveys for burrowing owls will be conducted in areas supporting potentially suitable habitat and within 30 days before the start of construction activities. If ground-disturbing activities are delayed or suspended for more than 30 days after the preconstruction survey, the site should be resurveyed. b) Occupied burrows shall not be disturbed during the breeding season (February 1 through August 31). A minimum 160-foot-wide buffer shall be placed around occupied burrows during the nonbreeding season (September 1 through January 31), and a 250-foot-wide buffer shall be placed around occupied burrows during the breeding season. Ground-disturbing activities shall not occur within the designated buffers.	DFG
BRO-2. Minimize impacts to species	a) If a DFG-approved biologist can verify through noninvasive methods that owls have not begun egg-laying and incubation, or that juveniles from occupied burrows are foraging independently and are capable of independent survival, a plan shall be coordinated with DFG to offset burrow habitat and foraging areas on the project site if burrows and foraging areas are taken by SJRRP actions. b) If destruction of occupied burrows occurs, existing unsuitable burrows should be enhanced (enlarged or cleared of debris) or new burrows created. This should be done in consultation with DFG. c) Passive owl relocation techniques must be implemented. Owls should be excluded from burrows in the immediate impact zone within a 160-foot-wide buffer zone by installing one-way doors in burrow	DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	entrances. These doors shall be in place at least 48 hours before excavation to insure the owls have departed. d) The project area shall be monitored daily for 1 week to confirm owl departure from burrows before any ground-disturbing activities. e) Where possible, burrows should be excavated using hand tools and refilled to prevent reoccupation. Sections of flexible plastic pipe should be inserted into the tunnels during excavation to maintain an escape route for any animals inside the burrow.	
BAT	**Special-status bats**	
BAT-1. Avoid and minimize loss of species	a) If suitable roosting habitat for special-status bats will be affected by project construction (e.g., removal of buildings, modification of bridges), surveys for roosting bats on the project site will be conducted by a qualified biologist. The type of survey will depend on the condition of the potential roosting habitat and may include visual surveys or use of acoustic detectors. Visual surveys may consist of a daytime pedestrian survey for evidence of bat use (e.g., guano) and/or an evening emergence survey for the presence or absence of bats. The type of survey will depend on the condition of the potential roosting habitat. If no bat roosts are found, then no further study is required. b) If evidence of bat use is observed, the number and species of bats using the roost will be determined. Bat detectors may be used to supplement survey efforts. c) If roosts are determined to be present and must be removed, the bats will be excluded from the roosting site before the facility is removed. A mitigation program addressing compensation, exclusion methods, and roost removal procedures will be developed in consultation with DFG before implementation. Exclusion methods may include use of one-way doors at roost entrances (bats may leave, but not reenter), or sealing roost entrances when a site can be confirmed to contain no bats. Exclusion efforts may be restricted during periods of sensitive activity (e.g., during hibernation or while females in maternity colonies are nursing young).	DFG
BAT-2. Compensate for loss of habitat	a) The loss of each roost will be replaced, in consultation with DFG, and may include construction and installation of bat boxes suitable to the bat species and colony size excluded from the original roosting site. Roost replacement will be implemented before bats are excluded from the original roost sites. Once the replacement roosts are constructed and it is confirmed that bats are not present in the original roost sites, the structure may be removed.	DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
SJAS	**San Joaquin (Nelson's) antelope squirrel**	
SJAS-1. Avoid and minimize loss of individuals	a) A 50-foot-wide minimum buffer shall be maintained from all small mammal burrows of suitable size for San Joaquin antelope squirrel. b) If work is to occur within the 50-foot-wide buffer, a qualified, permitted biologist shall conduct focused visual surveys for San Joaquin antelope squirrel within a 500-foot-wide buffer of the work area. These surveys shall coincide with the squirrels' most active season, April 1 to September 30, and shall be conducted only when air temperatures are between 20º to 30º C (68º to 86º F). Surveys should be conducted using daytime line transects with 10- to 30-meter spacing. Focused live trapping may also be required, in coordination with DFG. If San Joaquin antelope squirrels are observed during surveys, no vegetation or soil disturbance will be allowed within 50 feet of occupied burrows or burrow systems until the individuals are determined to no longer be occupying the area, as determined by a qualified biologist. c) Focused surveys, which may involve live trapping, may be required, in coordination with DFG, as appropriate. Additional conservation measures may developed pending the results of surveys, and in consultation with DFG. d) Construction activities shall be conducted when they are least likely to affect the species (i.e., after the normal breeding season). This timing shall be coordinated with USFWS and DFG.	DFG
SJAS-2: Compensate for temporary or permanent loss of habitat or species	a) Compensation for impacts to the species, if needed, will be determined in coordination with DFG, as appropriate.	DFG
FKR	**Fresno kangaroo rat**	
FKR-1. Avoid and minimize effects to species	a) Preconstruction surveys will be conducted by a qualified biologist per USFWS and DFG survey methodology to determine if potential burrows for Fresno kangaroo rat are present in the project footprint. Surveys will be conducted within 30 days before ground-disturbing activities. The biologist will conduct burrow searches by systematically walking transects, which shall be adjusted based on vegetation height and topography, and in coordination with USFWS and DFG. Transects shall be used to identify the presence of kangaroo rat burrows. When burrows are found within 100 feet of the proposed project footprint, focused live trapping surveys shall be conducted by a qualified and permitted biologist, following a methodology approved in advance by USFWS and DFG. Additional conservation measures may be developed pending the results of	USFWS DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	surveys, and in consultation with USFWS and DFG. b) Construction activities shall be conducted when they are least likely to affect the species (i.e., after the normal breeding season). This timing shall be coordinated with USFWS and DFG.	
FKR-2. Avoid disturbance of designated critical habitat	a) Facility construction and modification and other restoration projects shall be sited to avoid primary constituent elements of designated critical habitat for Fresno kangaroo rat.	USFWS DFG
FKR-3: Compensate for temporary or permanent loss of habitat or species	a) Compensation for impacts to the species, if needed, will be determined in coordination with DFG and USFWS, as appropriate.	USFWS DFG
SJKF	**San Joaquin kit fox**	
SJKF-1. Avoid and minimize effects to species	a) A qualified biologist will conduct preconstruction surveys no less than 14 days and no more than 30 days before the commencement of activities to identify potential dens more than 5 inches in diameter. The project proponent shall implement USFWS' (1999b) Standardized Recommendations for Protection of San Joaquin Kit Fox Prior to or During Ground Disturbance. The project proponent will notify USFWS and DFG in writing of the results of the preconstruction survey within 30 days after these activities are completed. b) If dens are located within the proposed work area, and cannot be avoided during construction activities, a USFWS-approved biologist will determine if the dens are occupied. c) If occupied dens are present within the proposed work, their disturbance and destruction shall be avoided. Exclusion zones will be implemented following the latest USFWS procedures (currently USFWS 1999b). d) The project proponent will notify USFWS and DFG immediately if a natal or pupping den is found in the survey area. The project proponent will present the results of preactivity den searches within 5 days after these activities are completed and before the start of construction activities in the area. e) Construction activities shall be conducted when they are least likely to affect the species (i.e., after the normal breeding season). This timing shall be coordinated with USFWS and DFG.	USFWS DFG
SJKF-2. Compensate for loss of habitat	a) The project proponent, in coordination with USFWS and DFG, will determine if kit fox den removal is appropriate. If unoccupied dens need to be removed, the USFWS-approved biologist shall remove these dens by hand-excavating them in accordance with USFWS procedures (USFWS 1999b).	USFWS DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	b) Additional conservation measures will be coordinated with USFWS and DFG, and may include replacing dens, installing off-site artificial dens, acquiring compensation habitat, or other options to be determined. Compensation may include dedicating conservation easements, purchasing mitigation credits, or other off-site conservation measures, and the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations. c) The project proponent will present the results of den excavations to USFWS and DFG within 5 days after these activities are completed.	
PL	**Pacific lamprey**	
PL-1. Avoid and minimize effects to species	a) A qualified biologist will conduct preconstruction surveys as outlined in Attachment A of USFWS' Best Management Practices to Minimize Adverse Effects to Pacific Lamprey (Entosphenus tridentatus) (2010). b) Work in documented areas of Pacific lamprey presence will be timed to avoid in-channel work during typical lamprey spawning (March 1 to July 1). c) If temporary dewatering in documented areas of lamprey presence is required for instream channel work, salvage methods shall be implemented to capture and move ammocoetes to a safe area, in consultation with USFWS.	USFWS
RHSNC	**Riparian habitat and other sensitive natural communities**	
RHSNC-1. Avoid and minimize loss of riparian habitat and other sensitive natural communities	a) Biological surveys will be conducted to identify, map, and quantify riparian and other sensitive habitats in potential construction areas. b) Construction activities will be avoided in areas containing sensitive natural communities, as appropriate. c) If effects occur to riparian habitat, emergent wetland, or other sensitive natural communities associated with streams, the State lead agency will comply with Section 1602 of the California Fish and Game Code; compliance may include measures to protect fish and wildlife resources during the project.	DFG
RHSNC-2. Compensate for loss of riparian habitat and other sensitive natural communities	a) The Riparian Habitat Mitigation and Monitoring Plan for the SJRRP will be developed and implemented in coordination with DFG. Credits for increased acreage or improved ecological function or riparian and wetland habitats resulting from the implementation of SJRRP actions will be applied as compensatory mitigation before additional compensatory measures are required. b) If losses of other sensitive natural communities (e.g., recognized as sensitive by CNDDB, but not protected under other regulations or	DFG

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	policies) would not be offset by the benefits of the SJRRP, then additional compensation will be provided through creating, restoring, or preserving in perpetuity in-kind communities at a sufficient ratio for no net loss of habitat function or acreage. The appropriate ratio will be determined in consultation with USFWS or DFG, depending on agency jurisdiction.	
WUS	**Waters of the United States/waters of the State**	
WUS-1. Identify and quantify wetlands and other waters of the United States	a) Before SJRRP actions that may affect waters of the United States or waters of the State, Reclamation will map the distribution of wetlands (including vernal pools and other seasonal wetlands) in the Eastside and Mariposa bypasses. b) The project proponent will determine, based on the mapped distribution of these wetlands and hydraulic modeling and field observation, the acreage of effects, if any, on waters of the United States. c) If it is determined that vernal pools or other seasonal wetlands will be affected by the SJRRP, the project proponent will conduct a delineation of waters of the United States, and submit the delineation to USACE for verification. The delineation will be conducted according to methods established in the USACE Wetlands Delineation Manual (Environmental Laboratory 1987) and Arid West Supplement (Environmental Laboratory 2008). d) Construction and modification of road crossings, control structures, fish barriers, fish passages, and other structures will be designed to minimize effects on waters of the United States and waters of the State, and will employ BMPs to avoid indirect effects on water quality.	USACE
WUS-2. Obtain permits and compensate for any loss of wetlands and other waters of the United States/waters of the State	a) The project proponent, in coordination with USACE, will determine the acreage of effects on waters of the United States and waters of the State that will result from implementation of the SJRRP. b) The project proponent will adhere to a “no net loss” basis for the acreage of wetlands and other waters of the United States and waters of the State that will be removed and/or degraded. Wetland habitat will be restored, enhanced, and/or replaced at acreages and locations and by methods agreed on by USACE and the Central Valley RWQCB, as appropriate, depending on agency jurisdiction. c) The project proponent will obtain Section 404 and Section 401 permits and comply with all permit terms. The acreage, location, and methods for compensation will be determined during the Section 401 and Section 404 permitting processes. d) The compensation will be consistent with recommendations in the Fish and Wildlife Coordination Act Report (Appendix F of this Draft PEIS/R).	USACE

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
INV	**Invasive plants**	
INV-1. Implement the Invasive Vegetation Monitoring and Management Plan	a) Reclamation and the project lead agencies will implement the Invasive Vegetation Monitoring and Management Plan for the SJRRP (Appendix L of this Draft PEIS/R), which includes measures to monitor, control, and where possible eradicate, invasive plant infestations during flow releases and construction activities. b) The implementation of the Invasive Vegetation Monitoring and Management Plan (Appendix L of this Draft PEIS/R) will include monitoring procedures, thresholds for management responses, success criteria, and adaptive management measures for controlling invasive plant species. c) The control of invasive weeds and other recommended actions in the Invasive Vegetation Monitoring and Management Plan (Appendix L of this Draft PEIS/R) will be consistent with recommendations in the Fish and Wildlife Coordination Act Report (Appendix F of this Draft PEIS/R).	Lead Agency
CP	**Conservation plans**	
CP-1. Remain consistent with approved conservation plans	a) Facility siting and construction activities will be conducted in a manner consistent with the goals and strategies of adopted habitat conservation plans, natural community conservation plans, or other approved local, regional, or State habitat conservation plans to the extent feasible. Coordination shall occur with USFWS and/or DFG, as appropriate.	USFWS DFG
CP-2. Compensate effects consistent with approved conservation plans	a) The project proponent shall compensate effects consistent with applicable conservation plans and implement all applicable measures required by the plans.	USFWS DFG
GS	**Southern distinct population segment of North American green sturgeon**	
GS-1. Avoid and minimize loss of habitat and individuals	a) The SJRRP will be operated in such a way that actions within green sturgeon habitat shall be done in accordance with existing operating criteria of the CVP and SWP, and prevailing and relevant laws, regulations, BOs, and court orders in place when the action(s) are performed.	NMFS
CVS	**Central Valley steelhead**	
CVS-1. Avoid loss of habitat and risk of take of species	a) Impacts to habitat conditions (i.e., changes in flows potentially resulting in decreased flows in the tributaries, increases in temperature, increases in pollutant concentration, change in recirculation/recapture rates and methods, decrease in floodplain connectivity, removal of riparian vegetation, decreased in quality	NMFS

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	rearing habitat, etc.) must be analyzed in consultation with NMFS. b) The Hills Ferry Barrier will be operated and maintained to exclude Central Valley steelhead from the Restoration Area during construction activities and until suitable habitat conditions are restored. c) Maintenance of conservation measures will be conducted to the extent necessary to ensure that the overall long-term habitat effects of the project are positive. d) Before implementation of site-specific actions, the action agency shall conduct an education program for all agency and contracted employees relative to the Federally listed species that may be encountered within the study area of the action, and required practices for their avoidance and protection. A NMFS-appointed representative shall be identified to employees and contractors to ensure that questions regarding avoidance and protection measures are addressed in a timely manner. e) Disturbance of riparian vegetation will be avoided to the greatest extent practicable. f) A spill prevention plan will be prepared describing measures to be taken to minimize the risk of fluids or other materials used during construction (e.g., oils, transmission and hydraulic fluids, cement, fuel) from entering the San Joaquin River or contaminating riparian areas adjacent to the river itself. In addition to a spill prevention plan, a cleanup protocol will be developed before construction begins and shall be implemented in case of a spill. g) Stockpiling of materials, including portable equipment, vehicles and supplies, such as chemicals, shall be restricted to the designated construction staging areas, exclusive of any riparian and wetland areas. h) A qualified biological monitor will be present during all construction activities, including clearing, grubbing, pruning, and trimming of vegetation at each job site during construction initiation, midway through construction, and at the close of construction, to monitor implementation of conservation measures and water quality. i) The San Joaquin River channel shall be designed to decrease or eliminate predator holding habitat, in coordination with NMFS.	
CVS-2. Minimize loss of habitat and risk of take of species	a) In-channel construction activities that could affect designated critical habitat for Central Valley steelhead will be limited to the low-flow period between June 1 and October 1 to minimize potential for adversely affecting Federally listed anadromous salmonids during their emigration period. b) In-channel construction activities that could affect designated critical habitat for Central Valley steelhead will be limited to daylight hours during weekdays, leaving a nighttime and weekend period of passage for Federally listed fish species.	NMFS

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	c) Construction BMPs for off-channel staging, and storage of equipment and vehicles, will be implemented to minimize the risk of contaminating the waters of the San Joaquin River by spilled materials. BMPs will also include minimization of erosion and stormwater runoff, as appropriate. d) Riparian vegetation removed or damaged will be replaced at a ratio, coordinated with NMFS, within the immediate area of the disturbance to maintain habitat quality. e) If individuals of listed species are observed present within a project area, NMFS must be notified. NMFS personnel shall have access to construction sites during construction, and following completion, to evaluate species presence and condition and/or habitat conditions. f) If bank stabilization activities should be necessary, then such stabilization shall be constructed to minimize predator habitat, minimize erosion potential, and contain material suitable for supporting riparian vegetation.	
SRCS	**Central Valley spring-run Chinook salmon**	
SRCS-1. Avoid and minimize loss of habitat and individuals	a) The SJRRP will be operated in such a way that actions in the vicinity of spring-run Chinook salmon habitat shall be done in accordance with existing operating criteria of the CVP and SWP, and prevailing and relevant laws, regulations, BOs, and court orders in place at the time the actions are performed. b) SJRRP actions shall be performed in accordance with the Experimental Population 4(d) rule, as it is developed, and where applicable.	NMFS DFG
EFH	**Essential fish habitat (Pacific salmonids and starry flounder)**	
EFH-1. Avoid loss of habitat and risk of take of species	a) Impacts to habitat conditions (e.g., changes in flows potentially resulting in decreased flows in the tributaries, increases in temperature, increases in pollutant concentration, change in recirculation/recapture rates and methods, decrease in floodplain connectivity, removal of riparian vegetation, decreased in quality rearing habitat) must be analyzed in consultation with NMFS. b) The Hills Ferry Barrier will be operated and maintained to exclude Pacific salmonids from the Restoration Area during construction activities, and until suitable habitat conditions are restored. c) Maintenance of conservation measures will be conducted to the extent necessary to ensure that the overall long-term habitat effects of the project are positive. d) Before implementation of site-specific actions, the action agency shall conduct an education program for all agency and contracted employees relative to the Federally listed species that may be encountered within the study area of the action, and required practices for their avoidance and protection. A NMFS-appointed	NMFS

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	representative shall be identified to employees and contractors to ensure that questions regarding avoidance and protection measures are addressed in a timely manner. e) Disturbance of riparian vegetation will be avoided to the greatest extent practicable. f) A spill prevention plan will be prepared describing measures to be taken to minimize the risk of fluids or other materials used during construction (e.g., oils, transmission and hydraulic fluids, cement, fuel) from entering the San Joaquin River or contaminating riparian areas adjacent to the river itself. In addition to a spill prevention plan, a cleanup protocol will be developed before construction begins and shall be implemented in case of a spill. g) Stockpiling of materials, including portable equipment, vehicles and supplies, such as chemicals, shall be restricted to the designated construction staging areas, exclusive of any riparian and wetland areas. h) A qualified biological monitor will be present during all construction activities, including clearing, grubbing, pruning, and trimming of vegetation at each job site during construction initiation, midway through construction, and at the close of construction to monitor implementation of conservation measures and water quality. i) The bottom topography of the San Joaquin River channel will be designed to decrease or eliminate predator holding habitat.	
EFH-2. Minimize loss of habitat and risk of take from implementation of construction activities	a) In-channel construction activities that could affect habitat for will be limited to the low-flow period between June 1 and October 1 to minimize potential for adversely affecting Federally listed anadromous salmonids during their emigration period. b) In-channel construction activities that could affect habitat for starry flounder and Pacific salmonids will be limited to daylight hours during weekdays, leaving a nighttime and weekend period of passage for Federally listed fish species. c) Construction BMPs for off-channel staging and storage of equipment and vehicles will be implemented to minimize the risk of contaminating the waters of the San Joaquin River by spilled materials. BMPs will also include minimization of erosion and stormwater runoff, as appropriate. d) Riparian vegetation removed or damaged will be replaced at a ratio, coordinated with NMFS, within the immediate area of the disturbance to maintain habitat quality. e) If individuals of listed species are observed present within a project area, NMFS must be notified. NMFS personnel shall have access to construction sites during construction and following completion to evaluate species presence and condition and/or habitat conditions. f) If bank stabilization activities should be necessary, then such stabilization shall be constructed to minimize predator habitat,	

Table 3-2
Conservation Measures for Biological Resources That May Be Affected by Project Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Regulatory Agency
	minimize erosion potential, and contain material suitable for supporting riparian vegetation.	

3.5 Compact Bypass with Narrow Floodplain and South Canal

The Compact Bypass with Narrow Floodplain and South Canal includes:

- Building levees capable of conveying flows up to 4,500 cfs with 3 feet of freeboard
- Restoring floodplain habitat an average of approximately 3,000 feet wide to provide benefit to salmonids and other native fishes
- Construction of a new channel and structures capable of conveying up to 4,500 cfs of Restoration Flows around the Mendota Pool
- Construction of the South Canal and structures capable of conveying up to 2,500 cfs from Reach 2B to Mendota Pool
- Providing upstream and downstream fish passage for adult and juvenile salmonids and other native fishes between Reach 2A and Reach 3

This Alternative would construct a channel between Reach 2B and Reach 3, the Compact Bypass Channel, in order to bypass the Mendota Pool. Restoration Flows would enter Reach 2B, flow through the reach, then downstream to Reach 3 via the Compact Bypass Channel. A canal to convey San Joaquin River water deliveries to Mendota Pool, the South Canal, would be built. The San Joaquin River control structure at the Chowchilla Bypass would be removed, and a bifurcation structure would be built at the head of the South Canal to control flood diversions into the Chowchilla Bypass and water delivery diversions into Mendota Pool. Fish passage facilities and a fish screen would be built at the South Canal bifurcation structure to provide passage around the structure and prevent fish being entrained in the diversion. A fish barrier would be built in Reach 3 to direct up-migrating fish into the Compact Bypass Channel. A new crossing would be built at the San Mateo Avenue crossing. These features are described in further detail in the sections below.

See Figure 3-4 and Figure 3-5 for a plan view of the Alternative's features. In Section 3.6.8, Table 3-3, Table 3-4, and Table 3-5 list the quantities of levee construction, relocations, and land acquisition, costs, conditions, and features associated with this Alternative.

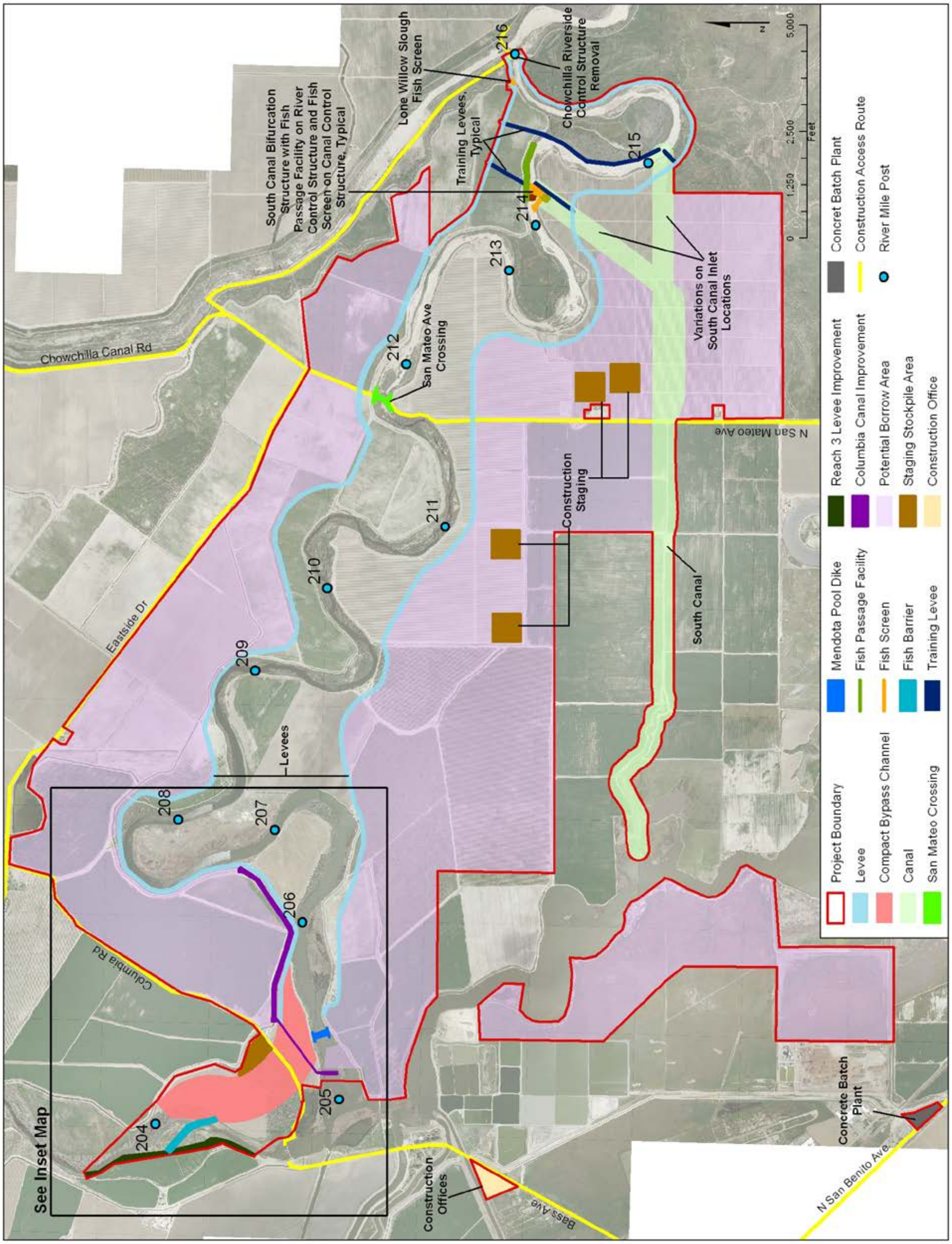


Figure 3-4
Plan View of Compact Bypass with Narrow Floodplain and South Canal

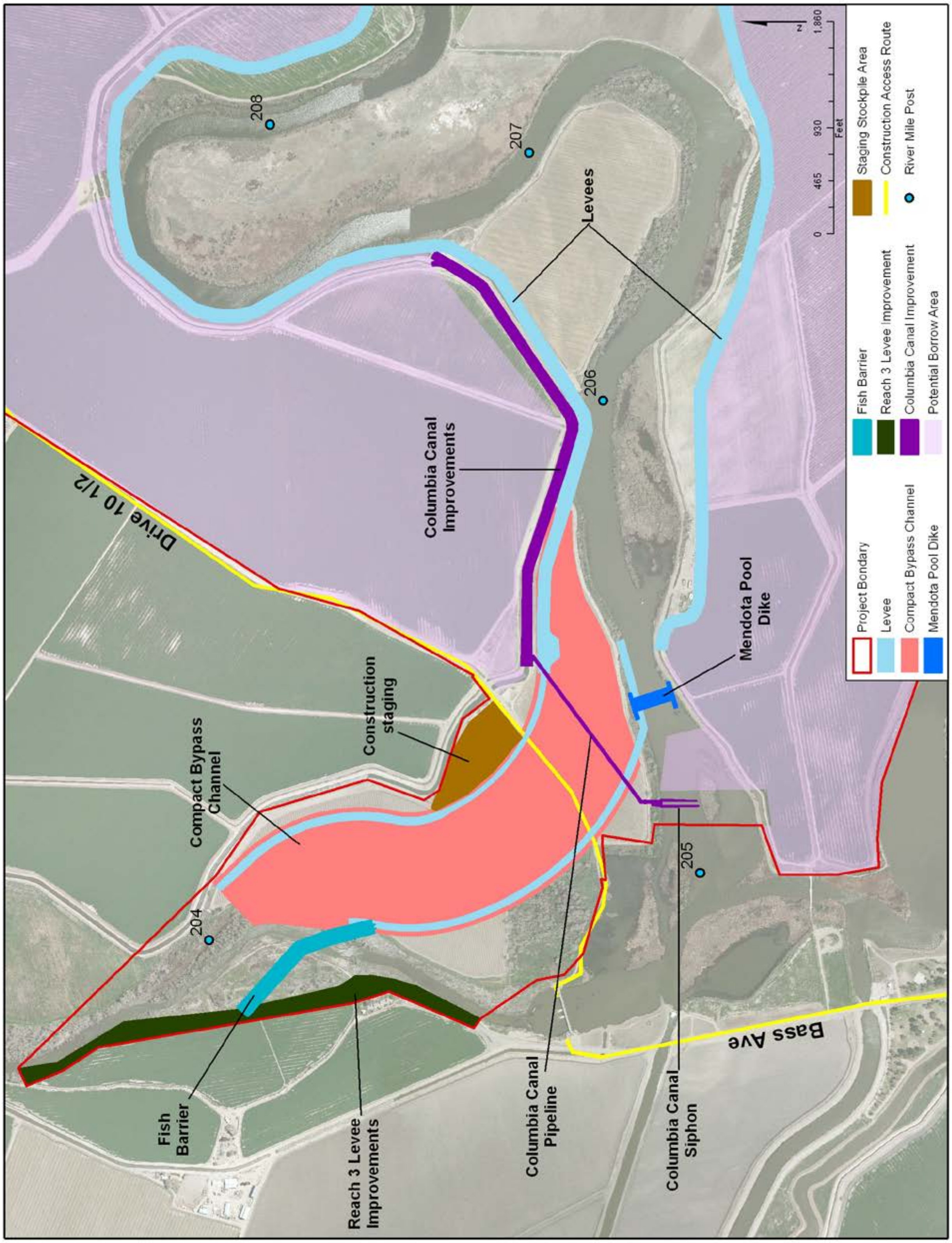


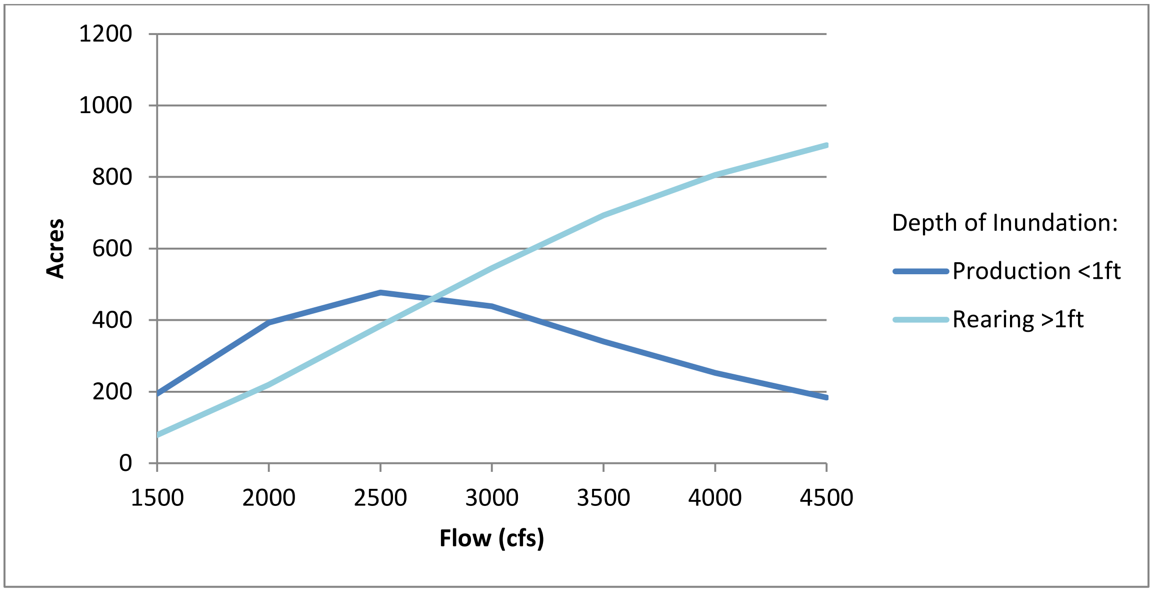
Figure 3-5
Inset Map of Compact Bypass with Narrow Floodplain and South Canal

3.5.1 Fish Habitat and Passage

The purpose of the floodplain would be to provide riparian and floodplain habitat and support the migration and seasonal rearing of salmonids and other native fishes in Reach 2B. The floodplain has an average width of approximately 3,000 feet and an inundated area of approximately 850 acres at 2,500 cfs.

This Alternative provides floodplain habitat resulting in approximately 450 acres of shallow water habitat for primary production[7] as well as approximately 400 acres of habitat that supports direct rearing[8] at 2,500 cfs. Approximately 55 percent of the floodplain in this Alternative would inundate less than 1 foot deep at 2,500 cfs. This Alternative also retains approximately 200 acres of shallow water habitat at flows up to 4,500 cfs. Source: Tetra Tech 2012

Figure 3-6 below presents conceptual inundation areas for primary production and rearing habitats as they vary by flow. Inundation acreages may change during the design process.



Source: Tetra Tech 2012

Figure 3-6
Potential Inundation Acreage by Flow for Compact Bypass with Narrow Floodplain and South Canal

In the Compact Bypass channel, floodplain benches with an approximate average width of 300 feet on each side the main flow portion of the bypass channel are included (see Section 3.6.3). Riparian and floodplain habitat would develop on the benches in the

---

[7] Primary production is defined as the production of organic compounds from atmospheric or aquatic carbon dioxide, principally through the process of photosynthesis. The organisms responsible for primary production are known as primary producers or autotrophs, and form the base of the food chain.

[8] Juvenile salmon direct rearing habitat is defined as areas with water greater than 1.0 feet deep at 2,300 cfs, a flow which will occur in approximately one out of every two years for a sustained period of at least 20 days in the period March 15 to May 15 (see further discussion in Attachment A Section 6.2.2). The modeled flow of 2,500 cfs is used as a surrogate for 2,300 cfs.

bypass channel to benefit migrating fish and promote a stable channel and sediment transport from Reach 2B to Reach 3.

This Alternative includes several facilities that fish would encounter or need to pass to migrate between Reach 3 and Reach 2B (from downstream to upstream):

- A fish barrier near the downstream end of the Compact Bypass
- Several (10 to 18) in-channel drop structures in the Compact Bypass
- The San Mateo Avenue crossing (this crossing is included in all Alternatives)
- Four fish screen return outlets from the South Canal fish screen
- A bifurcation control structure at the South Canal with fish passage facility
- A fish screen near the upstream end of the South Canal
- Fish screens at Lone Willow Slough, Big and Little Bertha pumps, and other smaller diversions (these screens are included in all Alternatives)

Each structure would be designed to perform according to the fish passage design criteria (see Section 3.4.1). In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to incorporate channel structure variability during detailed design, all of which may help to reduce stress and predation.

This Alternative includes a fish barrier at the downstream end of the bypass channel to keep fish from migrating into false migration pathways. Without the barrier, a false migration pathway up to the base of Mendota Dam would be available to fish in all years, and a false migration pathway into Mendota Pool and Fresno Slough (potentially into the King River system) would occur in about one in five years, when the boards are taken out of Mendota Dam to pass Pine Flat flood releases into Reach 3. However, with the barrier, which would be designed to accommodate flows up to 4,500 cfs, fish would not be able to migrate to Mendota Dam or enter Mendota Pool, but they would be guided into the bypass channel and Reach 2B.

3.5.2 Floodplain and Riparian Habitat

This Alternative includes passive riparian habitat restoration and farming in the floodplain. It is assumed that over time wetland communities (obligate, facultative-wet, and facultative species) would develop within the main channel and that a dense riparian scrubland would develop along the main river channel banks. Between the main river channel banks and the proposed levees, agricultural practices (e.g., annual crops, pasture, or floodplain-compatible permanent crops) would occur.[9] The Restoration Flows would be used to recruit new vegetation along the channel. This Alternative relies upon existing seed banks (upstream of the Project and on portions of existing Reach 2B levees to

[9] Rearing on floodplains with agricultural practices has been shown to provide faster salmon growth rates over in-channel rearing. (Sommer 2001)

remain) and Restoration Flows for vegetation recruitment. Invasive, non-native species would be removed from the channel and riparian areas during or following construction, and the Project would include long-term management for invasives.

Several native vegetation alliances may develop in the riparian areas, such as Saltgrass Flats, Sandbar Willow Thickets, California Mugwort Brush, Black Willow Thickets, Riparian Bank Herbs, California Bulrush Marsh, Button Willow Thickets, Oregon Ash Groves, Creeping Rye Grasslands, and Fremont Cottonwood Forests.

Maintenance and Invasive Species Control

Invasive, non-native species would be removed from the Project area during the construction phase. Long-term management of the Project would consist of removal of the most invasive non-native species within the reach such as giant reed grass (*Arundo donax*), perennial pepperweed (*Lepidium latifolium*) and poison hemlock (*Conium maculatum*). Long-term management would also include removal of other invasive species that are currently found in upstream reaches and may eventually colonize in the Project area such as red sesbania (*Sesbania punicea*), salt cedar (*Tamarix* species), and Chinese tallow (*Sapium sebiferum*). Invasives removal techniques may include mechanical removal, root excavation, hand pulling, mowing, disking, controlled burning, grazing, aquatic-safe herbicides, or a combination of techniques as appropriate.

While it is not anticipated that major management actions would be needed, the key objective of long-term management would be to monitor and identify any environmental issues that arise, and use adaptive management to determine what actions would be most appropriate to correct these issues.

The general management approach to the long-term maintenance of the floodplain areas would be to maintain quality habitat for each natural resource, on-going monitoring and maintenance of key environmental characteristics of the entire floodplain area within the reach. An adaptive management approach would be used to incorporate changes to management practices, including corrective actions as determined to be appropriate by the Bureau of Reclamation. Adaptive management includes those activities necessary to address the effects of climate change, fire, flood, or other natural events, force majeure, etc.

The expected long-term management needs and activities necessary to maintain any on-site mitigation sites would be: resource specific long-term maintenance activities and other general maintenance activities such as exotic species elimination, grazing management, clean-up and trash removal, infrastructure management such as gate, fence, road, culvert, signage and drainage-feature repair, and other maintenance activities necessary to maintain the riparian and floodplain habitat quality.

Existing Native Vegetation Protection

The existing native vegetation in the Project area designated to remain would be temporarily fenced with orange snow fencing (or equivalent) to prevent entry, driving, parking, or storing equipment or material within these areas during construction. Existing vegetation would be left in place or only minimally trimmed to facilitate access and work at the site. The existing soil is an ideal growing medium for all the desired native plants. In order to maximize plant growth and planting success, existing soil and topsoil would be preserved and disturbance during construction would be minimized to the maximum practicable extent.

3.5.3 Compact Bypass Channel

The bypass channel would convey 4,500 cfs around the Mendota Pool by constructing a channel just southwest of the existing Columbia Canal alignment. Once constructed, the bypass channel would become the new river channel. This Alternative includes excavating the bypass channel, constructing levees and in-channel structures, removing existing levees, relocating or modifying existing infrastructure, and acquiring land. The in-channel structures may include bifurcation control structures, grade control structures, fish screen(s), fish passage facility(ies), fish barrier(s), Columbia Canal Siphon, as well as the Drive 10 ½ realignment and are discussed in Section 3.6.5. The bypass channel and associated structures provide upstream and downstream passage of juvenile Chinook salmon and upstream passage of adult Chinook salmon, as well as passage for other native fishes, while isolating Mendota Pool from Restoration Flows.

The bypass channel would connect to Reach 3 approximately 0.6 miles downstream from Mendota Dam (approximately RM 204), bypass the Mendota Pool to the north, and connect to Reach 2B approximately 0.9 miles upstream from Mendota Dam (approximately RM 205.5). The bypass channel would have a total length of approximately 0.9 miles. A siphon under the bypass channel would be constructed to connect the Columbia Canal to the Mendota Pool.

The bypass channel would be a multi-stage channel designed to facilitate fish passage at low flows, channel stability at moderate flows, and contain high flows. The low-flow channel would be designed for a capacity of around 200 cfs and would have a topwidth of approximately 110 feet and a depth of approximately 2 feet. The main channel would be designed for a capacity of around 1,860 cfs (approximately the 2-year annual peak Restoration Flow in Reach 2B) and would have an average topwidth of approximately 320 feet and total depth of approximately 6 feet. The floodplain bench would be designed with a shallow cross-slope (approximately 1 percent slope) to allow variable floodplain depths at flows between 1,860 cfs and 4,500 cfs.

The channel, designed as an unlined earthen channel, would be approximately 4,800 feet long with a total corridor width of approximately 950 feet. The average slope of the channel between grade control structures would be approximately 0.0004 (approximately 2.1 feet/mile), while the total elevation drop would be approximately 12 feet including grade control structures. A series of grade-control structures would be included to achieve the necessary elevation change (see Section 3.6.5).

3.5.4 South Canal

The South Canal would deliver up to 2,500 cfs in water deliveries from the San Joaquin River to Mendota Pool (see Section 3.6.6). The South Canal could connect to the river at various locations, ideally on a straight section of the river or on the outside of bend. Two optional locations for the junction with the San Joaquin River are shown in Figure 3-4 at approximately RM 214.2 and RM 215. The South Canal would discharge into Fresno Slough via the Little San Joaquin Slough approximately 2.3 river miles south of Mendota Dam.

Water deliveries would be controlled at the upstream end of the South Canal by a bifurcation structure. The river control structure would have a fish passage facility for fish passage, and the canal control structure would have a fish screen to prevent entrainment. The control structures, fish screen, and fish passage facilities are discussed in Section 3.6.5.

The South Canal could be concrete-lined or unlined. The unlined design would include maintained grasses in the channel. Either design would have a trapezoidal cross-section. The lined South Canal would have a top-width of approximately 90 feet, a total corridor width of approximately 180 feet (including levees and maintenance roads), and 2H to 1V side slopes on the canal banks and levees. The unlined South Canal would have a top-width of approximately 270 feet, total corridor width of approximately 490 feet (including levees and maintenance roads), and 3H to 1V side slopes on the canal banks and levees.

Levee heights would be based on a flow of 2,500 cfs and 3 feet of freeboard. Seepage control measures and erosion protection would be included as necessary to minimize seepage impacts and reduce erosion and scour in the canal. However, seepage is assumed to not be an issue for a lined canal, so seepage control measures would not be provided for the lined canal.

The South Canal would cross San Mateo Avenue, so a bridge crossing would be provided to maintain access. The bridge would include concrete deck, reinforcing steel, piles, and pile extensions, railing, excavation, and backfill.

3.5.5 Structures

The structures described below would be required to provide the operational flexibility to divert water to the Mendota Pool, provide fish passage, allow maintenance access to Mendota Dam, prevent fish entrainment and straying, and provide controlled elevation drop between Reach 2B and Reach 3.

San Joaquin River Control Structure at Chowchilla Bypass Removal

The existing Chowchilla Bifurcation Structure consists of two control structures: one at the head of the Chowchilla Bypass and one across the San Joaquin River at RM 216. With the inclusion of a bifurcation structure at the head of the South Canal, a new control structure would be built across the San Joaquin River at the head of the canal. The new control structure would alleviate the need for the San Joaquin River control structure at the Chowchilla Bypass because all diversions into the Chowchilla Bypass could be controlled from the new control structure at the head of the South Canal. As part of this Alternative, the San Joaquin River control structure at the Chowchilla Bypass would be demolished.

South Canal Bifurcation Structure

A bifurcation structure would be constructed at the upstream end of the South Canal. The bifurcation structure consists of two control structures: one across the path of Restoration Flows (San Joaquin River) and one across the path of water deliveries to Mendota Pool (South Canal).

The control structure across the path of the Restoration Flows would be designed to accommodate up to 4,500 cfs and consists of six 20-foot wide bays for a structure length of approximately 138 feet. Conditions in this control structure would be designed to meet NMFS 2001 and NMFS 2008 fish passage criteria when flow conditions are amenable. The control structure across the path of the water deliveries would be designed to accommodate up to 2,500 cfs and consists of four 20-foot wide bays for a structure length of approximately 93 feet. Flow through each bay would be controlled by a gate (e.g., radial (Tainter) or inflatable Obermeyer). In the final design, the number and size of the gates may be modified. The size of the gates would be determined by the design maximum flow.

The Restoration Flow path structure includes a fish passage facility on the side of the structure, and the water deliveries flow path structure includes a fish screen upstream of the structure. Each control structure would be placed in the middle of the channel and has earthen embankments connecting the structure to the proposed levees. The connector embankments may include culverts, gates, weirs, inflatable bladder dams, or other features to improve flow and fish passage on the floodplain when water deliveries are not occurring. A 16-foot wide roadway and 20-foot wide maintenance/operations platform would be provided over each control structure.

South Canal Fish Passage Facility

The South Canal bifurcation structure would include a fish passage facility on the side of the control structure across the Restoration Flow path. The fish passage facility would be necessary to provide passage during Pool deliveries and for Restoration Flows where passage conditions through the control structure may not be ideal.

Passage Facility Design

The design of the fish passage facility would be based on criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008). The size and geometry of the fish passage facility would be dictated by the flow requirements for juvenile and adult fish in Table 3-1. Several types of fish passage facility may be considered in detailed design: vertical slot weir ladder design was included for its ability to accommodate a greater range of water depths (hydraulic head at the upstream and downstream ends), but the design may also consider ice-harbor, pool and chute, rock ramp fishway or other passage facility designs.

A roadway would need to be built over the fish passage facility to connect the maintenance road atop the river control structure with the levee road on the south side of the river. The roadway would be supported by the vertical concrete walls of the fish passage facility or other structural features.

Attraction Flows

The attraction flow magnitude will be 5 to 10 percent of the total flow through the control structure over the path of Restoration Flows. The Project requires conveyance of at least 4,500 cfs, so the attraction flow at the passage facility entrance could be as high as 450 cfs. The passage facility itself may have a design flow rate less than the maximum attraction flow. In this case, the balance of attraction flows would be provided at the passage facility entrance (downstream side) through supplementary water, described below.

Supplementary Water

Supplementary water is water already in the river and which is piped to the fish passage facility entrance to augment attraction flows. No additional water supply beyond what would be flowing in the river is required. The supplementary water allows the passage facility to operate under a wider range of river flows by supplying additional attraction flow when the need exceeds the design flow rate through the passage facility. Supplementary water would also be used to control the hydraulic head at the passage facility entrance.

Supplementary flow would be collected by a water delivery intake structure located upstream from the fish passage facility (see Figure 3-7). The intake structure would include an automated cleaning system, trash rack and a fish screen to prevent migrating fish from entering the intake. River water would enter the intake structure, and travel downriver through pipes to the passage facility entrance.

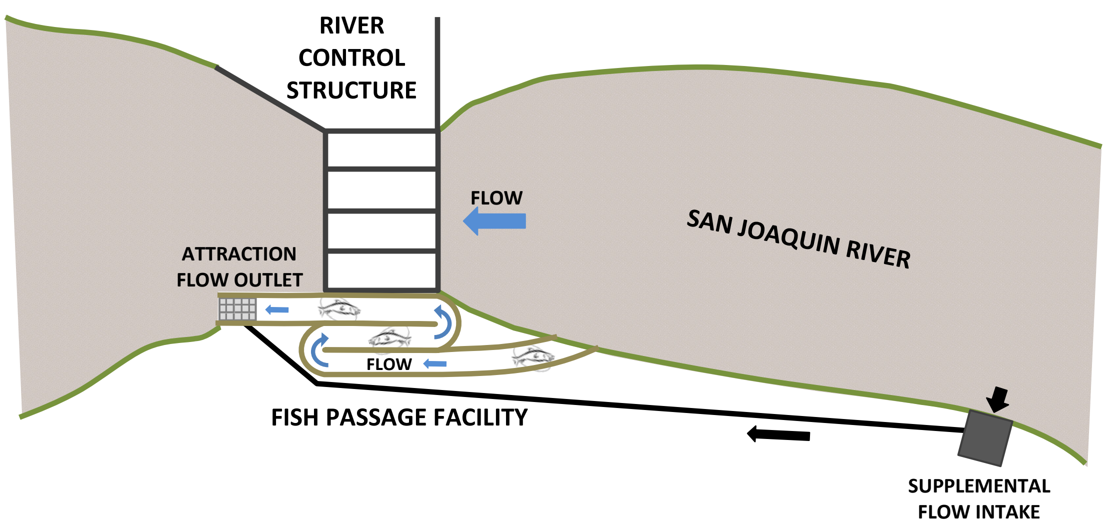


Figure 3-7
Supplementary flow system plan-view diagram

South Canal Fish Screen

A fish screen would be included at the head of the South Canal where Pool deliveries would be diverted from the river. The fish screen would be necessary to keep or return out-migrating juvenile salmon to the path of Restoration Flows during Pool deliveries.

The screen would be designed to pass flow up to 2,500 cfs. The type of fish screen could be a fixed flat plate in “V” configuration, vertical flat plate, inclined flat plate, cone, or cylindrical screens. Depending on the design type, the fish screen facility may include trash racks, stainless steel wedge wire fish screens, flow control baffle systems behind the screens, screen cleaning systems for the trashracks and screens, bypass flow control weirs, fish-friendly pumps, and/or fish bypass pressure pipelines. The trash racks would be installed at the entrance to the screen structures to protect screens from trash, logs, and other large debris.

Approach, sweeping, and bypass entrance velocities would be kept within established fish screen criteria (NMFS 2008). Flow through the fish screens may be controlled by baffles behind the fish screens. Cleaning of the screens would be accomplished using an automated brush system. Electric power would be needed for fish friendly pumps, if included, and screen cleaning systems. Operation of the fish screens would include methods to reduce predation of juvenile fish (e.g., noise systems to scatter predators, netting, and periodic draining of the screen return pipes).

Replacement of San Mateo Avenue Crossing

The San Mateo Avenue crossing is an existing river crossing located within a public right-of-way in Madera County and on private land in Fresno County at approximately RM 211.8. The crossing transitions from public right-of-way to private land at the center of the river. In order to maintain vehicular access, accommodate increased flow magnitudes associated with Restoration Flows, and provide fish passage, an improved crossing would be included with this Alternative. The crossing would accommodate the increased flows in the river by maintaining the required velocities for proper fish passage for flows up to 4,500 cfs. The crossing would be designed to meet NMFS 2001 and NMFS 2008 passage criteria. The crossing would be overtopped during some flows.

The proposed San Mateo Avenue crossing includes installing a low flow or dip crossing with multiple, counter-sunk concrete box culverts designed for highway loading. The structure includes armoring along the entrance and exit of the structure as well as along the channel banks in the immediate vicinity of the structure. The armoring would be necessary to protect the structure during overtopping flows. Culverts would be embedded below the existing channel bed. Grouted riprap would be placed in the culvert below the existing channel bed to prevent channel scour reaching the floor of the culvert and to create a roughened boundary layer for fish passage. Native bed material would be placed above the grouted riprap up to the existing channel bed elevation to provide passage conditions similar to that which exists in the adjacent natural stream.

Mendota Pool Dike

Adjacent to the head of the Compact Bypass, a dike across the existing river channel would be needed to prevent water in the Pool from flowing into the Compact Bypass. The dike would be of similar design as the levees in Section 3.4.2 including seepage control measures to prevent seepage from the Pool into the Compact Bypass. The dike would run from the proposed Reach 2B levee on the south side of the river, across the river, to proposed left-bank levee of the Compact Bypass. This structure would likely be regulated by DWR Division of Safety of Dams (DSOD).

Drive 10 ½
The Compact Bypass would cross existing Drive 10 ½, which provides access to the east side of Mendota Dam. With this Alternative, the road would end at east side of the bypass channel and would not continue to Mendota Dam.

Mendota Dam Fish Barrier
A fish exclusion barrier would be included in Reach 3 near the downstream end of the Compact Bypass to prevent adult fish from migrating beyond the bypass channel up to the base of Mendota Dam, which during most flows out of Mendota Pool, would be a dead end for fish passage. This would lead to delays in adult salmon migration or potentially death. Although out-migrating fish would not be expected to be present downstream from Mendota Dam, the fish barrier would allow juveniles to pass the structure.

The exclusion barrier design would be a high-flow picket barrier, which is a flow-through structure of closely spaced bars (i.e., pickets) that prevent adult fish from traveling upstream in the river to Mendota Dam at flows up to a combined discharge of 4,500 cfs (Mendota Dam and the Compact Bypass). The design accounts for a range of flow options from routing the entire 4,500-cfs flow through the structure (flood flows from the James Bypass), to routing a 600-cfs irrigation delivery through the structure with up to 3,900 cfs being routed down the Compact Bypass, to routing no flow through the structure with up to 4,500 cfs down the Compact Bypass.

The total length of the structure would be approximately 1,410 feet, with 260 feet across the main channel and 1,150 feet across the overbanks. The base of the structure would consist of a concrete sill connected to concrete piles, which extend into clay layers. The structure would be approximately 20 feet high in the main channel and 9 feet high in the overbanks. Riprap would be placed 2 feet thick at the entrance and exit of the sill to prevent erosion. The fish barrier meets the average through-velocity criteria of 1.0 fps in *Anadromous Salmonid Passage Facility Design* (NMFS 2008).

In order to meet velocity criteria for the structure, some floodplain grading between the existing Reach 3 levees would be required to provide even flow-through conditions. In addition, approximately 4,200 linear feet of improvements to the Reach 3 left-bank levee are included to ensure that backwater conditions at the structure do not affect adjacent property. The improved Reach 3 levee would have the same alignment as the existing levee.

Grade Control Structures
A series of several (10 to 18), approximately 0.5-ft high grade-control structures would be included within the bypass channel to achieve the necessary elevation change between Reach 2B and Reach 3. The grade control could be provided by structures such as sheet pile weirs or constructed rock riffles.

Rock riffles have benefits for native fish migration, but they present construction challenges in the sandy substrate of the Reach 2B and Reach 3 area. The flow over constructed rock riffles may reduce the disorienting effects on juveniles from rapidly changing hydraulics otherwise created at weir structures, and they are more favorable to sturgeon, which do not jump. Constructed rock riffles may be less favorable to predators which can hold in the quiescent pools below weir structures. However, placing rock in sandy substrate requires engineered foundation materials (layers of rock in gradually decreasing sizes) to prevent undermining the structure. Further analysis during design will determine which type of drop structure will be selected.

Sheet pile weirs would be constructed with capped and anchored sheet piles. Caps on the sheet piles would be used to avoid injuring fish and can be surfaced with natural materials (i.e., grouted rock) to emulate natural conditions which fish may be exposed to in non-manmade portions of the San Joaquin River.

Each drop structure would extend across the main channel and key into the overbanks a distance of approximately 50 feet to protect against flanking, resulting in a total structure width of about 420 feet.

Vegetated revetment would be included along both channel banks within the portion of the bypass containing the grade control structures to provide additional protection against flanking. It is assumed that the revetment would consist of buried riprap covered with topsoil, erosion control fabric, and native woody vegetation, so that fish would experience natural channel banks. Native woody vegetation directly upstream, downstream, and adjacent to the drop structures would provide shading and opportunities for juveniles to hide from predators.

3.5.6 Water Deliveries

This Alternative includes the South Canal for making up to 2,500 cfs in water deliveries from the San Joaquin River to Mendota Pool. Water deliveries to the Pool would include diversion of Friant Dam releases that are meant to satisfy the Exchange Contract as well as diversion of San Joaquin River flood flows if there is demand in Mendota Pool.

3.5.7 Construction Considerations

The total construction timeline for this Alternative is currently estimated to range approximately from 102 to 132 months (8.5 to 11 years); opportunities to shorten the overall schedule through construction efficiencies will be studied during the detailed design process.

Flow in the San Joaquin River, operations at the existing Mendota Dam, and operation of the existing Columbia Canal must be maintained during construction. It is anticipated that the majority of the Compact Bypass channel can be constructed without interruption to the San Joaquin River flow or the Columbia Canal.

The construction of the control structure across the existing river channel would require removable cofferdams in three phases to facilitate the construction without blocking the flow. If flow is present in the river during the construction period, flow will be diverted around the work area via a temporary diversion pipe or canal and fish passage will be provided. Cofferdams include two rows of braced sheet piling filled with dirt for stability and seepage control. The total height of the cofferdam is assumed to be 24 feet of which

12 feet would be above the channel bed. The control structures to be constructed on dry land (e.g., head of the South Canal) would not require cofferdams.

Stone slope protection (riprap) would be provided on the upstream and downstream slopes of the control structure embankment including some portions of the side slopes of the channel itself to prevent scouring. Riprap would be placed on bedding over geotextile fabric.

Construction of the fish screen and return/bypass fish pipes would take place in the dry using conventional construction methods and must be coordinated with construction of the water delivery canal. The exception to this is the outlet for the fish return pipes, which would require a cofferdam. All fish facility structures and pipes with surfaces exposed to fish require additional attention to surface-smoothness.

For construction of the control structures and fish passage facilities, a minimum flow must be maintained during construction; the amount or range of flows has not yet been identified. For construction at the bifurcation, it was assumed that construction would first be done away from the fish passage facility. A sheet pile cofferdam would be provided for the river control structure and/or the canal control structure and the water diverted away from the construction. Additional sheet piling would be provided to divert flows through the new bifurcation structure while the fish passage facility is constructed.

It was assumed that nuisance water will be in the San Mateo Avenue Crossing construction site and that installation of coffer dams would be required around portions of the work. Since a portion of the existing crossing is private (not a public road), it was assumed that access could be closed during construction. Construction would be timed (July 1 to November 1) so that the lesser Restoration Flows (5 to 195 cfs) can be routed around the structure during construction. At high flows water would flow over the structure, in addition to through the proposed culverts. To protect the structure during high flows, the proposed fill would be enclosed in concrete and cutoff walls and riprap would be included to prevent damage to the structure during over topping flows.

3.5.8 Summary

The following tables summarize the levees, relocations, land acquisition, costs, benefits, and impacts associated with the Compact Alignment Bypass with Narrow Floodplain and South Canal Alternative based on design, field, and evaluation criteria data prepared for the Alternatives Evaluation. This data is preliminary for this TM and may be updated during the development of the Project EIS/R.

Table 3-3
Compact Bypass with Narrow Floodplain and South Canal Levees, Relocations, and Land Acquisition

		Left Levee		Right Levee
Levee Length		8.7 miles		7.1 miles
Average Levee Height		5.8 feet		5.4 feet
Fill Volume		345,200 cubic yards		269,700 cubic yards
Relocations				
Electrical Distribution	43,500 feet		Barn/Shed	1
Gas Transmission	10,000 feet		Facility	1
Water Pipeline	31,000 feet		Groundwater Well	26
Canal	32,500 feet		Lift Pump	10
Culvert	1		Power Pole	144
Diversion	3		Dwelling	2
Land Acquisition[1]				
Total	2,700 acres			

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 3-4
Compact Bypass with Narrow Floodplain and South Canal Costs

Categories	Factors	Criteria	Units of Measure	Quantity
Costs[1]	Upfront Costs	Capital Improvement Costs	dollars	$487,640,000
		Land Costs	dollars	$29,690,000
		Subtotal	dollars	$517,330,000
	Long-Term Costs	O&M	dollars/year	$1,746,000
Time to Build	Timeline	Maximum Construction Time[2]	months	132

[1] Costs were developed by DWR for the appraisal-level designs evaluated in Attachment A – Alternatives Evaluation.
[2] Construction timeline does not include the time that would also be needed to complete the NEPA and CEQA documentation process, obtain permits, appraise and acquire land, and perform pre-construction surveys.

Table 3-5
Compact Bypass with Narrow Floodplain and South Canal
Conditions and Features within the Project Boundary

Categories	Factors	Criteria	Units of Measure	Quantity
Existing Environmental Conditions	Special Status Vegetation and Waters	Wetlands	acres	239.8
		Marsh	acres	43.9
		Riparian wetland	acres	140.5
		Wet meadow	acres	55.4
		Other Waters	acres	443.7
		Sensitive Vegetation Alliances		
		Alkali heath marsh	acres	0.2
		Arrow weed thickets	acres	0.4
		Black willow thickets	acres	124.9
		Blue elderberry stands	acres	75.4
		Button willow thickets	acres	1.0
		California bulrush marsh	acres	16.9
		California rose briar patches	acres	11.1
		Creeping rye grass turfs	acres	6.2
		Fremont cottonwood forest	acres	68.3
		Oregon ash groves	acres	6.9
		Pale spike rush marshes	acres	1.6
		Red willow thicket	acres	0.6
		Salt grass flats	acres	1.4
		Silver bush lupine scrub	acres	2.0
		Spinescale scrub	acres	0.1
		Tar plant fields	acres	33.5
		Yerba mansa meadows	acres	0.8
	Special Status Wildlife	Special status wildlife habitats		
		Blunt-nosed leopard lizard	acres	17.4
		Fresno kangaroo rat	acres	17.4
		Giant garter snake	acres	364.9
		Greater sandhill crane	acres	669.8
		San Joaquin kit fox	acres	201.6
		Swainson's hawk	acres	441.4
		Valley elderberry longhorn beetle	acres	75.4
		Valley elderberry longhorn beetle	number of elderberry shrubs	112
	Cultural and Historical Resources	Historic Properties	number of listed properties[1]	3
		Maximum Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

Table 3-5
Compact Bypass with Narrow Floodplain and South Canal
Conditions and Features within the Project Boundary

Categories	Factors	Criteria	Units of Measure	Quantity
Existing Socioeconomics and Economics Conditions	Crop Acreage	Total Farmland in Production	acres	1066.9
		Alfalfa	acres	46.5
		Almond	acres	341.6
		Cotton	acres	7.0
		Grapes	acres	242.4
		Other Row Crop	acres	166.1
		Palm	acres	9.7
		Pistachio	acres	253.7
Project Fish Habitat & Passage Conditions	Floodplain Characteristics	Primary production (<1.0 feet inundation at 2,500 cfs)	acres	477
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	385
	Passage Conditions for Adult Chinook Salmon	Artificial structures across migratory path	number of structures	20
		Maximum number of steps at structures	number of jumps	43
	Passage Conditions for Juvenile Chinook Salmon	New fish screens along migratory path	number of screens	3
		Potential predation sites	number of artificial structures	21

[1] The number of listed properties is based on records from NRHP National Register of Historic Places, California Register of Historical Resources, Office for Historic Preservation Historic Property Directory, California State Historical Landmarks listing, California Inventory of Historic Resources, California Points of Historical Interest listing, the Caltrans State and Local Bridge Survey, and historical maps, including GLO Plat Maps. No previously recorded National Register or California Register eligible resources were identified in the records search.

3.6 Compact Bypass with Wide Floodplain and Bifurcation Structure

The Compact Bypass with Wide Floodplain and Bifurcation Structure includes:

- Building levees capable of conveying flows up to 4,500 cfs with 3 feet of freeboard
- Restoring floodplain habitat an average of approximately 4,200 feet wide to provide benefit to salmonids and other native fishes
- Construction of a new channel and structures capable of conveying up to 4,500 cfs of Restoration Flows around the Mendota Pool
- Construction of structures capable of conveying up to 2,500 cfs from Reach 2B to Mendota Pool
- Providing upstream and downstream fish passage for adult and juvenile salmonids and other native fishes between Reach 2A and Reach 3

This Alternative would construct a channel between Reach 2B and Reach 3, the Compact Bypass Channel, in order to bypass the Mendota Pool. Restoration Flows would enter Reach 2B at the Chowchilla Bifurcation Structure, flow through Reach 2B, then downstream to Reach 3 via the Compact Bypass Channel. The existing Chowchilla Bifurcation Structure would continue to divert San Joaquin River flows into the Chowchilla Bypass during flood operations, and a fish passage facility and control structure modifications would be included at the San Joaquin River control structure at the Chowchilla Bypass to provide fish passage. A bifurcation structure would be built at the head of the Compact Bypass Channel to control diversions into Mendota Pool. Fish passage facilities and a fish screen would be built at the Compact Bypass bifurcation structure to provide passage around the structure and prevent fish being entrained in the diversion. A fish barrier would be built in Reach 3 to direct up-migrating fish into the Compact Bypass Channel. A new crossing would be built at the San Mateo Avenue crossing. These features are described in further detail in the sections below.

See Figure 3-8 and Figure 3-9 for a plan view of the Alternative's features. In Section 3.7.7, Table 3-6, Table 3-7, and Table 3-8 list the quantities of levee construction, relocations, and land acquisition, costs, conditions, and features associated with this Alternative.

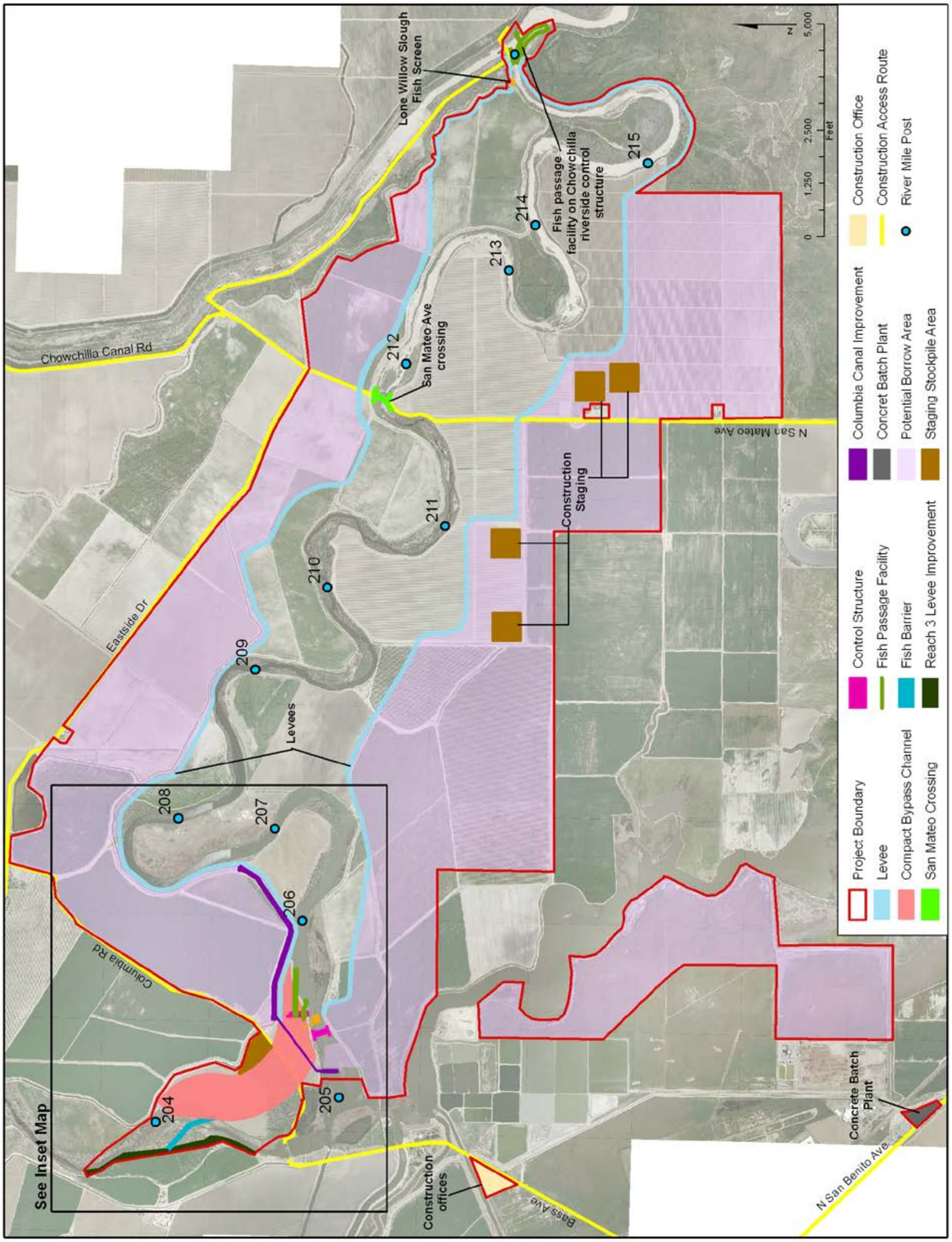


Figure 3-8
Plan View of Compact Bypass with Wide Floodplain and Bifurcation Structure

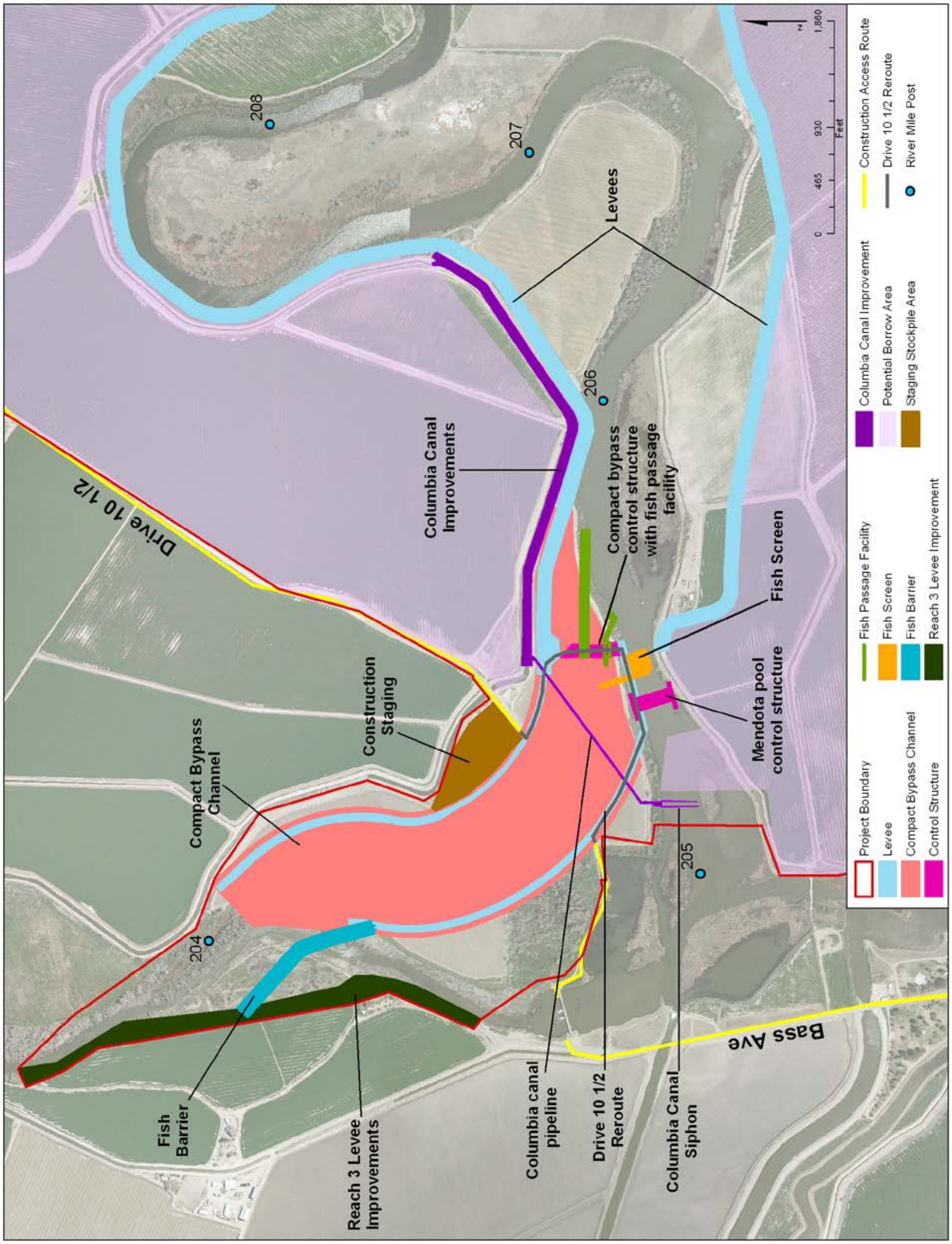
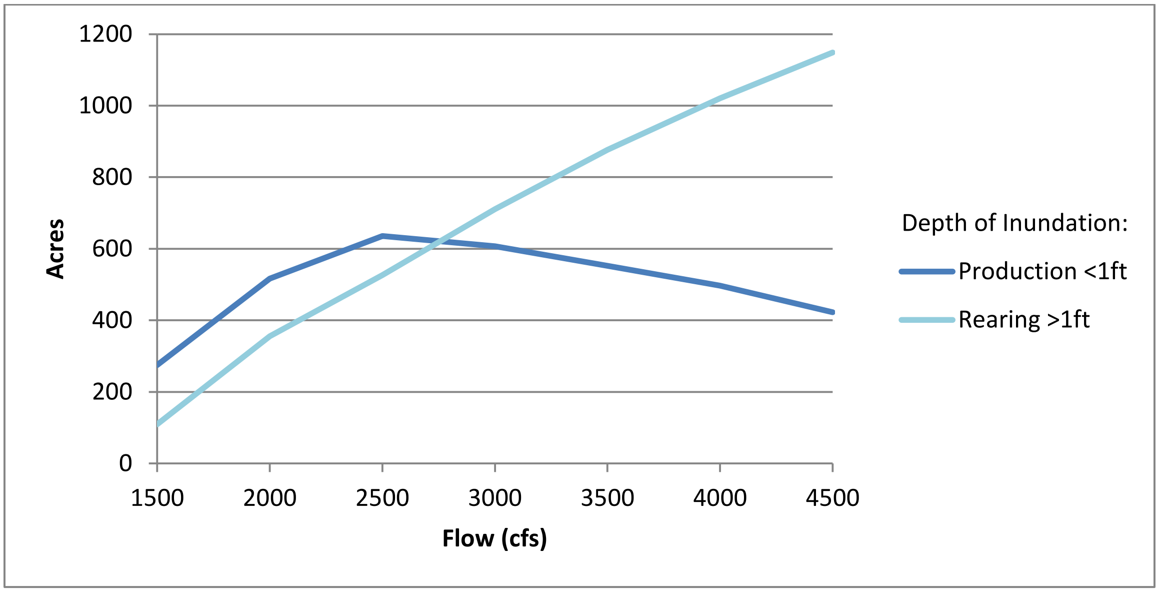


Figure 3-9
Inset Map of Compact Bypass with Wide Floodplain and Bifurcation Structure

3.6.1 Fish Habitat and Passage

The purpose of the floodplain would be to provide riparian and floodplain habitat and support the migration and seasonal rearing of salmonids and other native fishes in Reach 2B. The floodplain has an average width of approximately 4,200 feet and an inundated area of approximately 1,150 acres at 2,500 cfs.

This Alternative provides floodplain habitat resulting in approximately 650 acres of shallow water habitat for primary production as well as approximately 500 acres of habitat that supports direct rearing at 2,500 cfs. Approximately 55 percent of the floodplain in this Alternative would inundate less than 1 foot deep at 2,500 cfs. This Alternative also retains approximately 400 acres of shallow water habitat at flows up to 4,500 cfs. Figure 3-10 below presents conceptual inundation areas for primary production and rearing habitats as they vary by flow. Inundation acreages may change during the design process.



Source: Tetra Tech 2012

Figure 3-10
Potential Inundation Acreage by Flow for Compact Bypass with Wide Floodplain and Bifurcation Structure

In the Compact Bypass channel, floodplain benches with an approximate average width of 300 feet on each side the main flow portion of the bypass channel are included (see Section 3.7.3 Compact Bypass Channel). Riparian and floodplain habitat would develop on the benches in the bypass channel to benefit migrating fish and promote a stable channel and sediment transport from Reach 2B to Reach 3.

This Alternative includes several facilities that fish would encounter or need to pass to migrate between Reach 3 and Reach 2B (from downstream to upstream):

- A fish barrier near the downstream end of the Compact Bypass

- Several (10 to 18) in-channel drop structures in the Compact Bypass
- The San Mateo Avenue crossing (this crossing is included in all Alternatives)
- Four fish screen return outlets from the Compact Bypass bifurcation structure fish screen
- A bifurcation control structure at the upstream end of the Compact Bypass with fish passage facility
- A fish screen near the upstream end of the Compact Bypass
- Fish screens at Lone Willow Slough, Big and Little Bertha pumps, and other smaller diversions (these screens are included in all Alternatives)
- The San Joaquin River control structure at the Chowchilla Bypass with a fish passage facility

Each structure would be designed to perform according to the fish passage design criteria (see Section 3.4.1). In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to incorporate channel structure variability during detailed design, all of which may help to reduce stress and predation.

This Alternative includes a fish barrier at the downstream end of the bypass channel to keep fish from migrating into false migration pathways. Without the barrier, a false migration pathway up to the base of Mendota Dam would be available to fish in all years, and a false migration pathway into Mendota Pool and Fresno Slough (potentially into the King River system) would occur in about one in five years, when the boards are taken out of Mendota Dam to pass Pine Flat flood releases into Reach 3. However, with the barrier, which would be designed to accommodate flows up to 4,500 cfs, fish would not be able to migrate to Mendota Dam or enter Mendota Pool, but they would be guided into the bypass channel and Reach 2B.

3.6.2 Floodplain and Riparian Habitat

This Alternative includes active riparian and floodplain habitat restoration. It is assumed that wetland communities (obligate, facultative-wet, and facultative species) would develop within the main channel, that a dense riparian scrubland would develop along the main river channel banks, and that bands of other habitat types (wetland, scrub, grassland, and forest) would develop at higher elevations along the channel corridor. The wetland, floodplain, and riparian areas would be planted following construction and then irrigated and managed as necessary during the establishment period. Invasive, non-native species would be removed from the Project area during or following construction, and the Project would include long-term management for invasives.

Several native vegetation alliances could be incorporated into the floodplain and habitat planting design. The grass-dominated vegetation alliances, which produce the maximum food benefits for salmon, could be more than twice as large as those that would develop with the narrow floodplain alternatives. All of the elevated areas of the meander loops could be maintained or restored to Saltgrass Flats. The adjacent existing wetland areas within the loops could be preserved or enhanced by additional wetland species plantings and removal of numerous invasive species. The lower lying portions of the reach could be planted with the Button Willow Thicket vegetation alliance. Because of the wide floodplain and the slowly moving water, the extent of this vegetation alliance could almost quadruple compared to what might develop in the narrow floodplain alternatives. The extent of Black Willow Thicket and California Mugwort Brush could also increase over what might develop in the narrow floodplain alternatives. Additional restoration work could focus on the re-establishment of the Riparian Bank Herbs, California Bulrush Marsh, Oregon Ash Groves, Creeping Rye Grasslands, and Fremont Cottonwood Forests. Because of the fast growth and its soft and brittle wood, the cottonwood is considered to be a good source of large woody debris and organic matter within the riverine channel. The riverside levee banks would be planted with native grass species such as those in the Creeping Rye Grassland alliance. Since creeping wild rye (*Leymus triticoides*) is a facultative wetland species that thrives in the upper parts of riparian areas, the extent of Creeping Rye Grassland could more than double compared to the narrow floodplain alternatives.

This Alternative would provide potential habitat for greater sandhill crane and Swainson's hawk. The larger floodplains provide increasingly more potential habitat.

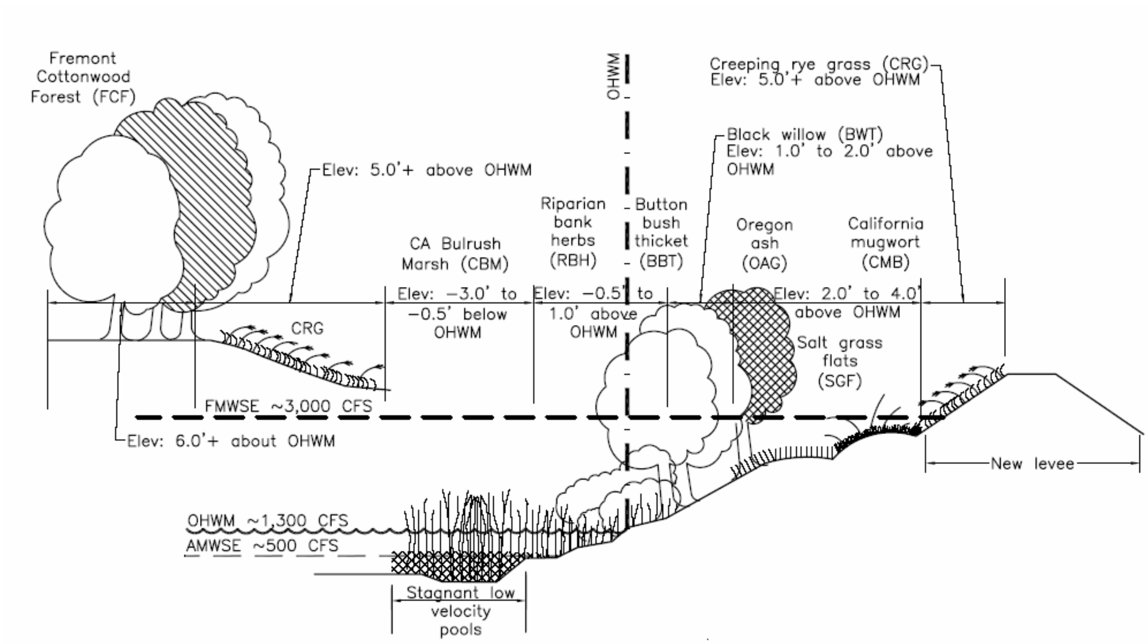


Figure 3-11
Typical distribution of vegetation alliances along a restored Reach 2B riparian bank section

Maintenance and Invasive Species Control

Invasive, non-native species would be removed from the Project area during the installation, plant establishment and maintenance periods. Maintenance and invasives species control would be conducted as described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.2.

Temporary Irrigation System and Water Supply

Since all of the proposed plantings are wetland species or borderline wetland species, they would need regular overhead irrigation (typically April through October) during their establishment period (three to five years depending on rainfall conditions and the plants' growth rates and vigor). The amount of water needed is estimated to be approximately 2.4 feet per acre per year. They would be irrigated with an extensive temporary surface mounted irrigation system that would provide water for the plants several times a week during the hot months of the year. The irrigation distribution piping would be installed aboveground and anchored to the ground with rebar soil staples so that it would not be damaged during high flows that would be regularly inundating the floodplain. The sprinkler heads would be installed on four-foot high, braced standpipes so that their irrigation stream would not be blocked or diverted by growing vegetation. The irrigation system would be disassembled and removed at the end of the establishment period.

The Program would pursue options for irrigation water supply, including groundwater wells or water pumped from the river with portable, skid-mounted, diesel- or gas-powered pumps and stored in tanks. Additionally, purchases from willing sellers may be required to withdraw water from the river or other nearby water sources (e.g., Mendota Pool). If water is pumped from the river, the amount of water diverted will be controlled so that river water temperatures do not increase and passage for salmonids is not impaired. The diversion from the river would also be screened to prevent entraining juvenile salmonids.

Existing Native Vegetation Protection

Existing native vegetation protection would be conducted as described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.2.

Maintenance and Monitoring

The key maintenance and monitoring activities include close monitoring of the installed plants for drought stress and overwatering, removal of competitive, invasive, non-native species, replacement of diseased and dead plants, irrigation system maintenance, and removal of trash and debris.

Close monitoring of the installed plants for both drought stress and overwatering would be performed because the proposed plants are native wetland species that can be quickly damaged by lack of irrigation.

For irrigation system maintenance, the system would be used intensively each year on a biweekly to daily basis during the hot part of the growing season. The landscape contractor would be required to regularly check the integrity of the system and make sure that none of the sprinkler heads are clogged or damaged.

Removal of trash and debris from the restoration areas on both sides of the river would be performed on an as-needed basis for the duration of the entire monitoring period.

3.6.3 Compact Bypass Channel

The Compact Bypass channel is the same as described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.3.

3.6.4 Structures

The structures described below would be required to provide the operational flexibility to divert water to the Mendota Pool, provide fish passage, allow maintenance access to Mendota Dam, prevent fish entrainment and straying, and provide controlled elevation drop between Reach 2B and Reach 3.

San Joaquin River Control Structure at the Chowchilla Bypass Fish Passage Facility

The San Joaquin River control structure at the Chowchilla Bypass would not be passable by up-migrating salmon and native fish for all flows and flow splits between the river and the Chowchilla Bypass. The undershot gates, sill across the downstream side of the structure, and trash rack on the upstream side contribute to upstream passage difficulties at high, low, and all flows, respectively. It was determined that a fish passage facility would be required for upmigrating salmon and other natives fish to swim into Reach 2A from Reach 2B under most conditions. The fish passage facility is the same as described for the South Canal in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

San Joaquin River Control Structure at the Chowchilla Bypass Modifications

In addition to the passage facility, the San Joaquin River control structure at the Chowchilla Bypass would be modified to improve fish passage through the control structure itself or to improve operations of the passage facility. Fish passage through the modified river control structure may meet passage criteria only for certain flows, so the fish passage facility described above would still be required.

Improvements to the river control structure could include removing the trash racks, replacing one or more radial gates with over-shot gates (e.g. inflatable Obermeyer weir gates), notching or removal of the baffle wall or weir, removing the dragon’s teeth, and replacing or modifying the scour protection. Improvements would be designed to meet NMFS 2001 and NMFS 2008 passage criteria when flow conditions are amenable. Improvements would not affect the ability of the structure to divert flood water into the Chowchilla Bypass.

Replacement of San Mateo Avenue Crossing

The existing river crossing at San Mateo Avenue would be replaced with a new culverted crossing. The crossing is the same as described in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5

Compact Bypass Bifurcation Structure

A bifurcation structure would be constructed at the upstream end of the Compact Bypass. The bifurcation structure consists of two control structures: one across the path of Restoration Flows (Compact Bypass) and one across the path of water deliveries to Mendota Pool (San Joaquin River). Since this structure will be retaining the Pool, it would likely be regulated by DSOD. The Compact Bypass bifurcation structure is the same as described for the South Canal in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Compact Bypass Fish Passage Facility

The Compact Bypass control structure across the Restoration Flow path includes a fish passage facility. The fish passage facility would be necessary to provide passage during Pool deliveries and for Restoration Flows where passage conditions in the control structure may not be ideal. The design of the fish passage facility is the same as that presented for the South Canal in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Drive 10 ½ Crossing

The Compact Alignment Bypass would cross existing Drive 10 ½, which provides access for the operations and maintenance of Mendota Dam. To continue the current level of access, the road would be rerouted along the bypass channel levees and cross the head of the bypass channel at the proposed Compact Bypass bifurcation structure. A road deck would also be provided over the fish passage facility adjacent to the bifurcation structure. The road would be designed for HS-20 loading (e.g., sufficient to allow transport of a 25-ton maintenance crane to Mendota Dam).

Compact Bypass Fish Screen

A fish screen would be included adjacent to the head of the Compact Bypass where Pool deliveries would be diverted from the river. The fish screen would be necessary to keep or return out-migrating juvenile salmon to the path of Restoration Flows during Pool deliveries. The Compact Bypass fish screen is the same as described for the South Canal in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Mendota Dam Fish Barrier

A fish exclusion barrier would be included in Reach 3 near the downstream end of the Compact Bypass to prevent adult fish from migrating beyond the bypass channel up to the base of Mendota Dam. The fish barrier is the same as described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Grade Control Structures

A series of several (10 to 18), approximately 0.5-ft high grade-control structures would be included within the bypass channel to achieve the necessary elevation change between Reach 2B and Reach 3. The drop structures are the same as described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

3.6.5 Water Deliveries

This Alternative includes a diversion at the head of the Compact Bypass for making up to 2,500 cfs in water deliveries from the San Joaquin River to Mendota Pool. This diversion would directly deliver water from the river to Mendota Pool without the need for a canal. Water deliveries to the Pool would include diversion of Friant Dam releases that are meant to satisfy the Exchange Contract as well as diversion of San Joaquin River flood flows if there is demand in Mendota Pool.

3.6.6 Construction Considerations

The total construction timeline for this Alternative is currently estimated to range approximately from 106 to 157 months (9 to 13 years); opportunities to shorten the overall schedule through construction efficiencies will be studied during the detailed design process.

The construction considerations are the same as described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.7.

3.6.7 Summary

The following tables summarize the levees, relocations, land acquisition, costs, benefits, and impacts associated with the Compact Alignment Bypass with Narrow Floodplain and Bifurcation Structure Alternative based on design, field, and evaluation criteria data prepared for the Alternatives Evaluation. This data is preliminary for this TM and may be updated during the development of the Project EIS/R.

Table 3-6
Compact Bypass with Wide Floodplain and Bifurcation Structure
Levees, Relocations, and Land Acquisition

<table>
<tr><th colspan="2"></th><th colspan="2">Left Levee</th><th>Right Levee</th></tr>
<tr><td colspan="2">Levee Length</td><td colspan="2">8.1 miles</td><td>6.8 miles</td></tr>
<tr><td colspan="2">Average Levee Height</td><td colspan="2">5.6 feet</td><td>4.7 feet</td></tr>
<tr><td colspan="2">Fill Volume</td><td colspan="2">328,600 cubic yards</td><td>226,900 cubic yards</td></tr>
<tr><th colspan="5">Relocations</th></tr>
<tr><td>Electrical Distribution</td><td>48,500 feet</td><td colspan="2">Barn/Shed</td><td>1</td></tr>
<tr><td>Gas Transmission</td><td>11,000 feet</td><td colspan="2">Facility</td><td>1</td></tr>
<tr><td>Water Pipeline</td><td>41,000 feet</td><td colspan="2">Groundwater Well</td><td>32</td></tr>
<tr><td>Canal</td><td>31,500 feet</td><td colspan="2">Lift Pump</td><td>10</td></tr>
<tr><td>Culvert</td><td>1</td><td colspan="2">Power Pole</td><td>162</td></tr>
<tr><td>Diversion</td><td>3</td><td colspan="2">Dwelling</td><td>2</td></tr>
<tr><th colspan="5">Land Acquisition[1]</th></tr>
<tr><td>Total</td><td colspan="4">2,900 acres</td></tr>
</table>

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 3-7
Compact Bypass with Wide Floodplain and Bifurcation Structure Costs

Categories	Factors	Criteria	Units of Measure	Quantity
Costs[1]	Upfront Costs	Capital Improvement Costs	dollars	$446,280,000
		Land Costs	dollars	$33,700,000
		Subtotal	dollars	$479,980,000
	Long-Term Costs	O&M	dollars/year	$1,241,000
Time to Build	Timeline	Maximum Construction Time[2]	months	157

[1] Costs were developed by DWR for the appraisal-level designs evaluated in Attachment A – Alternatives Evaluation.
[2] Construction timeline does not include the time that would also be needed to complete the NEPA and CEQA documentation process, obtain permits, appraise and acquire land, and perform pre-construction surveys.

Table 3-8
Compact Bypass with Wide Floodplain and Bifurcation Structure
Conditions and Features within the Project Boundary

Categories	Factors	Criteria	Units of Measure	Quantity
Existing Environmental Conditions	Special Status Vegetation and Waters	Wetlands	acres	236.2
		Marsh	acres	40.3
		Riparian wetland	acres	143.7
		Wet meadow	acres	52.2
		Other Waters	acres	437.2
		Sensitive Vegetation Alliances		
		Alkali heath marsh	acres	0.2
		Arrow weed thickets	acres	0.4
		Black willow thickets	acres	124.9
		Blue elderberry stands	acres	75.4
		Button willow thickets	acres	1.2
		California bulrush marsh	acres	12.8
		California rose briar patches	acres	11.3
		Creeping rye grass turfs	acres	6.1
		Fremont cottonwood forest	acres	68.5
		Oregon ash groves	acres	7.0
		Red willow thickets	acres	0.6
		Salt grass flats	acres	1.4
		Silver bush lupine scrub	acres	4.1
		Spinescale scrub	acres	0.1
		Tar plant fields	acres	34.9
		Yerba mansa meadows	acres	0.8
	Special Status Wildlife	Special status wildlife habitats		
		Blunt-nosed leopard lizard	acres	15.4
		Fresno kangaroo rat	acres	15.4
		Giant garter snake	acres	348.3
		Greater sandhill crane	acres	635.3
		San Joaquin kit fox	acres	197.8
		Swainson's hawk	acres	443.9
		Valley elderberry longhorn beetle	acres	75.4
		Valley elderberry longhorn beetle	number of elderberry shrubs	113
	Cultural and Historical Resources	Historic Properties	number of listed properties[1]	3
		Maximum Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

Table 3-8
Compact Bypass with Wide Floodplain and Bifurcation Structure
Conditions and Features within the Project Boundary

Categories	Factors	Criteria	Units of Measure	Quantity
Existing Socioeconomics and Economics Conditions	Crop Acreage	Total Farmland in Production	acres	1302.1
		Alfalfa	acres	55.2
		Almond	acres	512.0
		Cotton	acres	7.0
		Grapes	acres	175.6
		Other Row Crop	acres	102.5
		Palm	acres	9.7
		Pistachio	acres	440.1
Project Fish Habitat & Passage Conditions	Floodplain Characteristics	Primary production (<1.0 feet inundation at 2,500 cfs)	acres	636
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	527
	Passage Conditions for Adult Chinook Salmon	Artificial structures across migratory path	number of structures	21
		Maximum number of steps at structures	number of jumps	67
	Passage Conditions for Juvenile Chinook Salmon	New fish screens along migratory path	number of screens	4
		Potential predation sites	number of artificial structures	22

[1] The number of listed properties is based on records from NRHP National Register of Historic Places, California Register of Historical Resources, Office for Historic Preservation Historic Property Directory, California State Historical Landmarks listing, California Inventory of Historic Resources, California Points of Historical Interest listing, the Caltrans State and Local Bridge Survey, and historical maps, including GLO Plat Maps. No previously recorded National Register or California Register eligible resources were identified in the records search.

3.7 Fresno Slough Dam with Narrow Floodplain and Short Canal

The Fresno Slough Dam with Narrow Floodplain and Short Canal includes:

- Building levees capable of conveying flows up to 4,500 cfs with 3 feet of freeboard
- Restoring floodplain habitat an average of approximately 3,000 feet wide to provide benefit to salmonids and other native fishes
- Construction of a dam capable of containing Mendota Pool within Fresno Slough so that 4,500 cfs of Restoration Flows can be conveyed around the Mendota Pool
- Construction of the Short Canal and structures capable of conveying up to 2,500 cfs from Reach 2B to Mendota Pool
- Providing upstream and downstream fish passage for adult and juvenile salmonids and other native fishes between Reach 2A and Reach 3

This Alternative would build a dam across Fresno Slough, the Fresno Slough Dam, to contain the Mendota Pool, and it would utilize the existing river channel in order to bypass the Mendota Pool. Restoration Flows would enter Reach 2B at the Chowchilla Bifurcation Structure, flow through Reach 2B, then downstream to Reach 3 over the sill at Mendota Dam. Mendota Pool would be contained south of the Fresno Slough Dam. The existing Chowchilla Bifurcation Structure would continue to divert San Joaquin River flows into the Chowchilla Bypass during flood operations, and a fish passage facility and control structure modifications would be included at the San Joaquin River control structure at the Chowchilla Bypass to provide fish passage. A canal to convey San Joaquin River water deliveries to Mendota Pool, the Short Canal, would be built adjacent to the Fresno Slough Dam. The Mendota Dam along with a control structure built at the head of the Short Canal would be used to control diversions into Mendota Pool through the Short Canal. Fish passage facilities at Mendota Dam and a fish screen on the Short Canal would be built to provide passage around Mendota Dam and prevent fish from being entrained in the diversion. A fish barrier would be built downstream of the Fresno Slough Dam to keep up-migrating fish in Reach 2B. A new crossing would be built at the San Mateo Avenue crossing. These features are described in further detail in the sections below.

See Figure 3-12 and Figure 3-13 for a plan view of the Alternative's features. In Section 3.8.8, Table 3-9, Table 3-10, and Table 3-11 list the quantities of levee construction, relocations, and land acquisition, costs, conditions, and features associated with this Alternative.

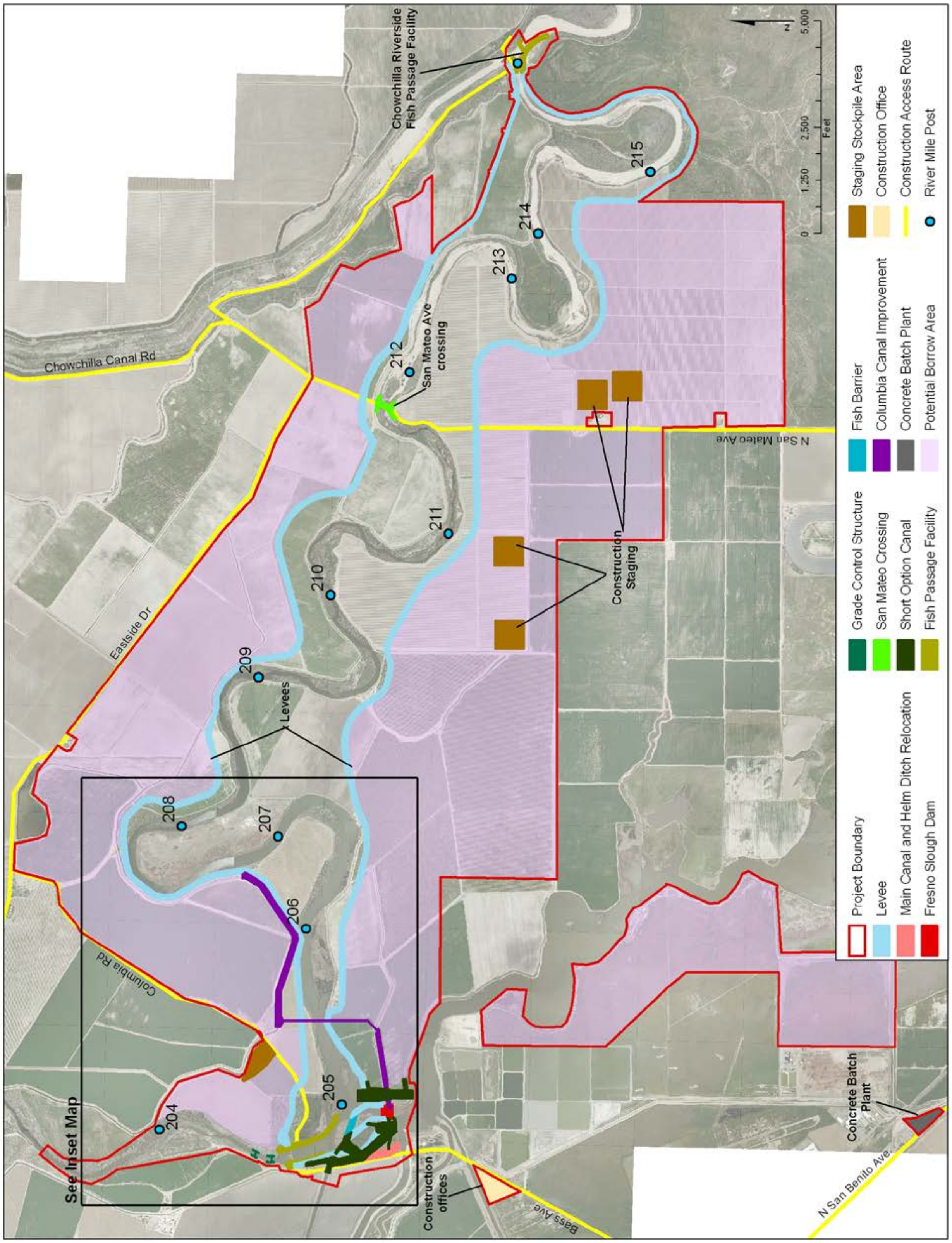


Figure 3-12
Plan View of Fresno Slough Dam with Narrow Floodplain and Short Canal

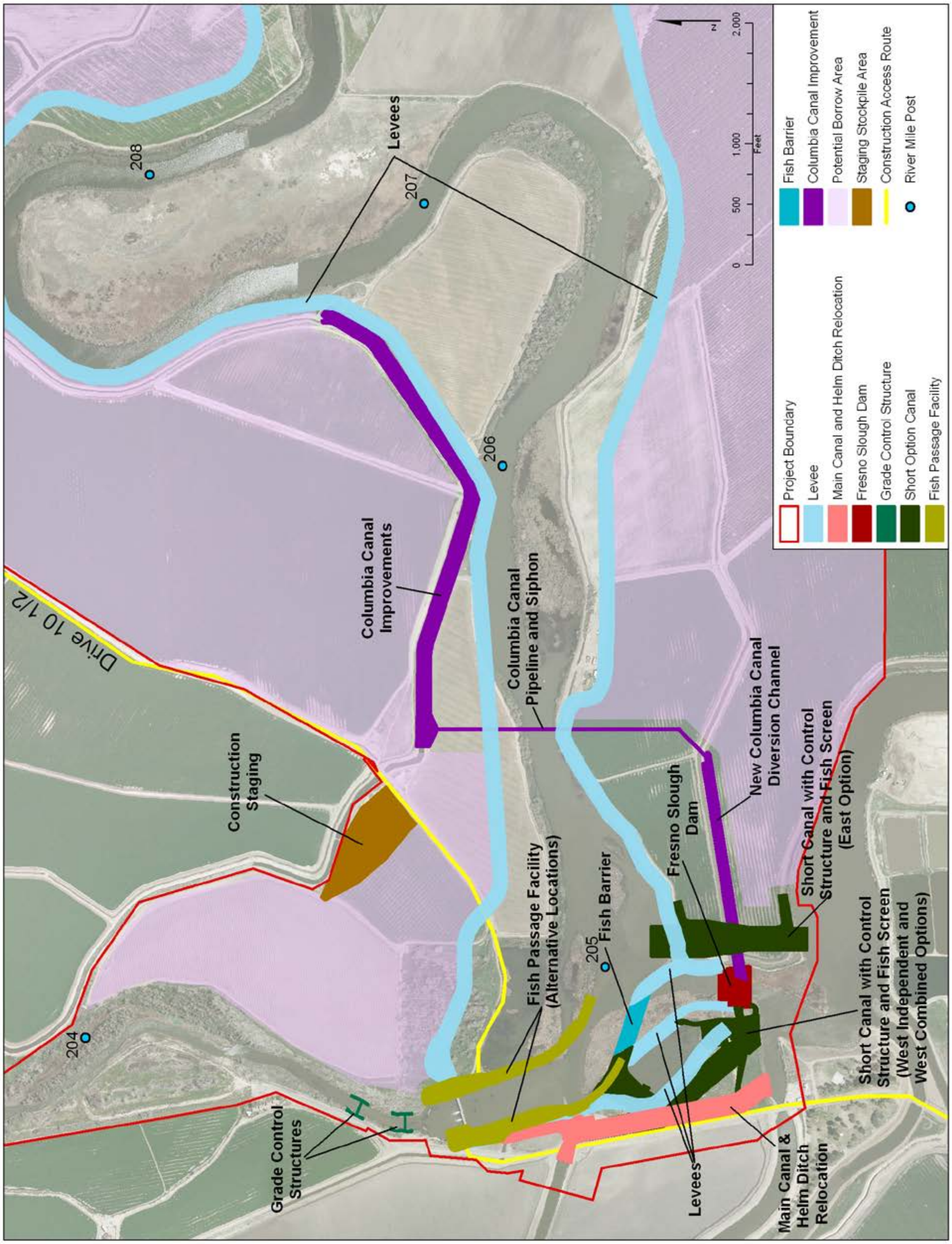


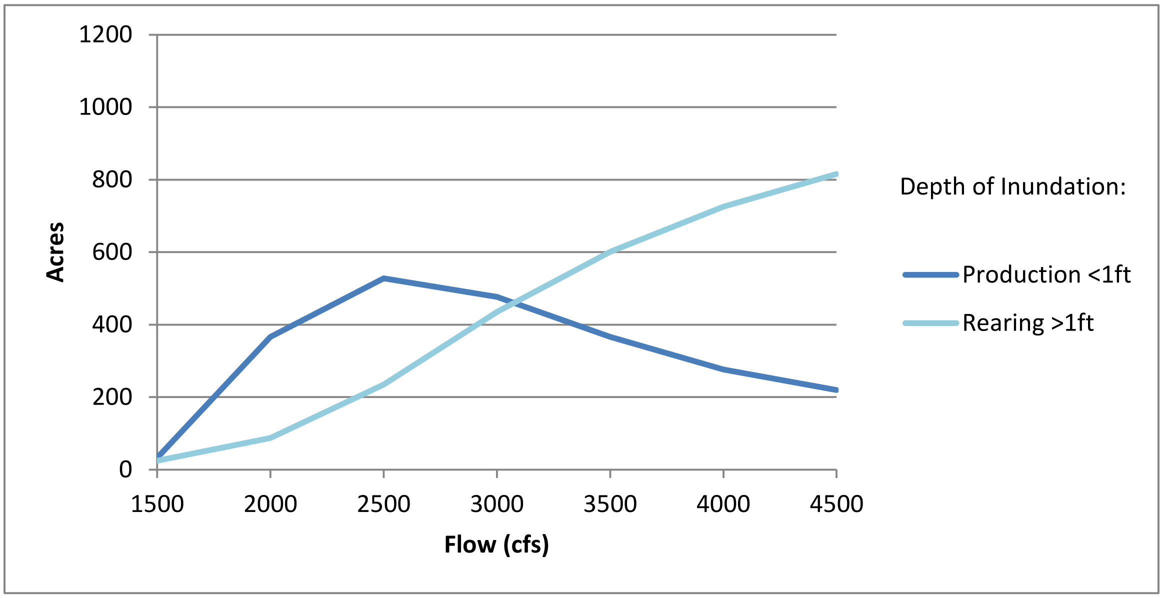
Figure 3-13
Inset Map of Fresno Slough Dam with Narrow Floodplain and Short Canal

3.7.1 Fish Habitat and Passage

The purpose of the floodplain would be to provide riparian and floodplain habitat and support the migration and seasonal rearing of salmonids and other native fishes in Reach 2B. The floodplain has an average width of approximately 3,000 feet and an inundated area of approximately 750 acres at 2,500 cfs.

This Alternative provides floodplain habitat resulting in approximately 500 acres of shallow water habitat for primary production as well as approximately 250 acres of habitat that supports direct rearing at 2,500 cfs. For this Alternative, approximately 65 percent of the floodplain would inundate less than 1 foot deep at 2,500 cfs. This Alternative also retains approximately 200 acres of shallow water habitat at flows up to 4,500 cfs. Source: Tetra Tech 2012

Figure 3-14 below presents conceptual inundation areas for primary production and rearing habitats as they vary by flow. Inundation acreages may change during the design process.



Source: Tetra Tech 2012

Figure 3-14
Potential Inundation Acreage by Flow for Fresno Slough Dam with Narrow Floodplain and Short Canal

This Alternative includes several facilities that fish would encounter or need to pass to migrate between Reach 3 and Reach 2B (from downstream to upstream):

- An estimated two to four in-channel drop structures below Mendota Dam
- The sill of Mendota Dam (when boards are out) or a fish passage facility at Mendota Dam (when boards are in)
- Four fish screen return outlets from the Short Canal fish screen
- A fish barrier north of the Fresno Slough Dam
- A fish screen near the upstream end of the Short Canal
- The San Mateo Avenue crossing (this crossing is included in all Alternatives)

- Fish screens at Lone Willow Slough, Big and Little Bertha pumps, and other smaller diversions (these screens are included in all Alternatives)
- A bifurcation control structure at the Chowchilla Bypass with fish passage facility

Each structure would be designed to perform according to the fish passage design criteria (see Section 3.4.1). In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to incorporate channel structure variability during detailed design, all of which may help to reduce stress and predation.

3.7.2 Floodplain and Riparian Habitat

Floodplain and riparian habitat would be included in this Alternative as described for the Compact Bypass with Wide Floodplain and Bifurcation Structure Alternative in Section 3.7.2.

3.7.3 Short Canal

The Short Canal would deliver up to 2,500 cfs in water deliveries from the San Joaquin River to Mendota Pool (see Section 3.8.6). The Short Canal could connect to the river either on the east or west side of the Fresno Slough Dam. Additionally, the west-side configuration could be combined with the Main Canal and Helm Ditch Relocations or be constructed independent of those relocations. The Short Canal would discharge into Fresno Slough approximately 0.8 river miles south of Mendota Dam.

Water deliveries would be controlled by a control structure at the north end of the Short Canal and Mendota Dam. The canal control structure would have a fish screen to prevent entrainment and Mendota Dam would be retrofitted with fish passage facilities. The control structures, fish screen, and fish passage facilities are discussed in Section 3.8.4.

The Short Canal would be concrete-lined with a trapezoidal cross-section. The Short Canal would have a top-width of approximately 70 feet, a total corridor width of approximately 180 feet (including levees and maintenance roads), and 2H to 1V side slopes on the canal banks and 3H to 1V side slopes on the levees. Levee heights would be based on a flow of 2,500 cfs and 3 feet of freeboard.

3.7.4 Structures

The structures described below would be required to provide the operational flexibility to divert water to the Mendota Pool, provide fish passage, prevent fish entrainment and straying, and provide controlled elevation drop between Reach 2B and Reach 3.

Chowchilla Bifurcation Structure Fish Passage Facility

The Chowchilla Bifurcation Structure fish passage facility is the same as that in the Compact Bypass with Wide Floodplain and Bifurcation Structure Alternative in Section 3.7.4.

San Joaquin River control structure at the Chowchilla Bypass Modifications

The San Joaquin River control structure at the Chowchilla Bypass modifications are the same as those in the Compact Bypass with Wide Floodplain and Bifurcation Structure Alternative in Section 3.7.4.

Replacement of San Mateo Avenue Crossing

The existing river crossing at San Mateo Avenue would be replaced with a new culverted crossing. The crossing is the same as described in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5

Short Canal Control Structure

A control structure would be constructed at the upstream end of the Short Canal. The control structure would be across the path of water deliveries to Mendota Pool. Since this structure will be retaining the Pool, it would likely be regulated by DSOD. The Short Canal control structure is the same as the control structure across the path of water deliveries described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Short Canal Fish Screen

A fish screen would be included at the head of the Short Canal where Pool deliveries would be diverted from the river. The fish screen would be necessary to keep or return out-migrating juvenile salmon to the path of Restoration Flows during Pool deliveries. The Short Canal fish screen is the same as described for the South Canal in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Fresno Slough Dam

The Fresno Slough Dam would be constructed approximately 0.5 miles south of the Mendota Dam, in the existing Fresno Slough. In addition, the dam structure would be located just south of the existing Mowry Bridge that crosses the Fresno Slough. The dam would serve to limit the extent of Mendota Pool so it no longer occupies portions of the San Joaquin River. This pool would feed the five existing irrigation canals (Main Canal, Helm Ditch, Columbia Canal, Outside Canal, and Main Lift Canal). A screened water diversion canal would enable water deliveries from the San Joaquin River to the Mendota Pool. Since inputs into the Mendota Pool would be screened, Fresno Slough Dam does not require provisions for fish passage. Since this structure will be retaining the Pool, it would likely be regulated by DSOD.

The dam structure would be designed to accommodate a maximum water elevation of 156 feet. This water elevation corresponds to a pool depth of 16 feet above the top of the concrete floor.

The Fresno Slough Dam would have a reinforced concrete spillway. The spillway would not require the support of piles. The spillway would include a concrete cutoff wall at the upstream end of the spillway to limit the hydrostatic uplift pressures and reduce the effects of scour. Baffle blocks and riprap would be included at the downstream end the concrete spillway to limit the effects of scour and erosion.

Directly adjacent to the upstream and downstream ends of the concrete dam structure, a total of four concrete retaining walls form the walls of the spillway, and retain the sides of the earthen embankment portion of the dam. The spillway structure would be comprised of multiple gates, which serve to control the flow of water from the Mendota Pool to the San Joaquin River.

Over the dam, a concrete roadway, concrete maintenance platform, and a hoist operation platform span the full width of the structure. A series of vertical stoplog slots would be included in the concrete abutment walls. The stoplog slots allow the placement of stoplogs directly upstream of the gates, to facilitate local dewatering of the gates for maintenance operations.

Some excavation of existing channel sediments upstream of the dam will be required to improve flow conditions through the dam during Kings River floods.

Fresno Slough Dam Fish Barrier

A fish exclusion barrier would be included north of the Fresno Slough Dam to prevent adult fish from migrating into Fresno Slough during Kings River flood releases through the Fresno Slough Dam. Levees would be constructed to delineate a channel between the Fresno Slough Dam and the fish barrier, and sediments in the San Joaquin River would be excavated to allow proper structure placement and acceptable sweeping velocities.

The design of the fish barrier is the same as the Mendota Dam fish barrier described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Mendota Dam Modifications

This Alternative includes using the San Joaquin River channel as a means of bypassing Mendota Pool. Since the Mendota Dam crosses the San Joaquin River, the structure will need to be modified to provide run-of-the-river conditions during Restoration Flows. The concrete portions of structure of Mendota Dam would remain in place, and the flash boards currently used to close the bays and back up water would be removed during non-water delivery operations using the Short Canal. The sill of the dam may be notched in one or more bays to improve fish passage conditions, and the notch would be designed to accommodate flash boards similar to the current bays. When the Short Canal is in operation, the flash boards would be placed in the notch(es) and bays to back up water for water deliveries.

Mendota Dam Fish Passage Facilities

Fish passage facilities are provided at Mendota Dam for two conditions: when the boards are out and when the boards are in. Most of the time, the flash boards at Mendota Dam will be out, and Restoration Flows will pass unimpeded over the sill at Mendota Dam. When water deliveries from the river to Mendota Pool are occurring, the flash boards at Mendota Dam will be installed to create an impoundment. Due to the variation in conditions, different fish passage facilities are required for each condition.

Boards-Out Conditions (no water deliveries occurring)
Passage for boards-out conditions could be accomplished with either grade-control structures, dam notching, a fish passage facility, or a combination of these.

A series of approximately 0.5-feet high grade control structures could be installed downstream of Mendota Dam to increase the water surface elevation during low flows of around 100 cfs to allow fish passage over the sill when the boards are out at Mendota Dam. The structures would be located several hundred feet apart. Each structure would raise the water surface incrementally on the downstream side of the dam so that salmonids would be able to migrate over the sill. Other aspects of the grade control structures are the same as those described for those in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

The sill of the dam could also be notched to provide suitable low flow passage conditions when the boards are out. Notching the dam would involve removing portions of the existing concrete sill and potentially reinforcing the remaining concrete. The notch(es) would be designed to accommodate flash boards so that water delivery operations could occur. Notching could be utilized in combination with the grade control structures to reduce the overall number of structures needed to incrementally raise the water surface on the downstream side of the dam.

Alternatively, a fish passage facility could be installed at Mendota Dam to provide passage when the boards are out. The boards-out fish passage facility could be combined with the boards-in fish passage facility (described below) by including multiple entrances and exits on the facility. Otherwise, an independent fish passage facility for boards-out conditions could be constructed. The design of the boards-out fish passage facility is the same as described for the South Canal fish passage facility in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Boards-In Conditions (during water deliveries)
For the Short Canal to operate, the boards at Mendota Dam would be replaced to raise the water surface in the river and back up water into the Mendota Pool. A proposed fish passage facility enables fish to pass over Mendota Dam when the boards are in. The passage facility transitions from the minimum San Joaquin River water surface elevation in Reach 3 (occurring during low flow/base flow conditions) to the normal pool water surface elevation above Mendota Dam. The boards-in fish passage facility could be combined with the boards-out fish passage facility (described above) by including multiple entrances and exits on the facility. Otherwise, an independent fish passage facility for boards-in conditions would be constructed. The design of the boards-in fish passage facility is the same as described for the South Canal fish passage facility in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Main Canal and Helm Ditch Relocations
The Fresno Slough Dam requires the headworks of the Central California Irrigation District's (CCID) Main Canal and Helm Ditch to be reconfigured to divert water from the upstream (south) side of the Fresno Slough Dam. This would allow the District to

continue to receive their water supply from the Delta Mendota Canal and flows from the Fresno Slough without requiring screening of those diversions.

To provide water to the CCID's Main Canal and Helm Ditch, an inlet canal is proposed that would take water from the upstream side of the proposed Fresno Slough Dam, run north adjacent to the west side of the San Joaquin River, and connect to the Main Canal and Helm Ditch just west of their current intakes. This canal would be capable of conveying the full flow of both the Main Canal and the Helm Ditch combined (1550 cfs).

The inlet canal would be designed to pass the design flow at anticipated low water levels in the Pool, but it would still provide 2 feet of freeboard at the anticipated high water level. The water elevation in the inlet canal would essentially float with the Mendota Pool. A bridge over the inlet canal would be required to maintain access to Mowry Bridge and the future Fresno Slough Dam. Currently, there is a 20-inch drinking water pipeline for the City of Mendota that crosses the Mowry Bridge. This pipeline would need to be modified so that it crosses the proposed inlet canal on the proposed bridge.

The inlet canal would be concrete lined in locations where erosion is likely to be a concern (i.e., at bends and transitions), and riprap would be placed at the transition from the Pool to the inlet channel.

A concrete control structure would control the water from the inlet canal. It would function to control flows to both the Main Canal and the Helm Ditch. Controlling the flow to the Main Canal would be accomplished with control gates Upstream of the gates on the eastern wall, a pipeline would deliver water to the relocated head of the Helm Ditch. The concrete pipe, equipped with a canal gate, would serve to control the flow rate as well as shutoff point. It is assumed that existing headworks and telemetry for both the Main Canal and Helm Ditch would be removed from the site, and new telemetry would be installed.

The upstream side of the Main Canal structure would have a cutoff wall to prevent undermining the structure. Downstream of the control structure, the Main Canal would transition both vertically and horizontally into the existing Main Canal alignment and cross-section. The extension of Helm Ditch would be designed to match the cross-section of the existing Helm Ditch downstream.

3.7.5 Removal of River Sediments

This Alternative would make use of the existing river channel from the Chowchilla Bifurcation Structure (approximately RM 216) down to Mendota Dam (approximately RM 204.6) in order to convey Restoration Flows. Since a portion of this river segment is currently impounded by Mendota Dam, sediment has filled in the pre-Mendota Dam channel. This Alternative assumes that the sediment would be excavated from portions of the former Pool impoundment area to establish a new equilibrium channel slope. The cost of removing sediment over an estimated channel cross-section, equilibrium slope, and length is included in the cost of this Alternative. If sediments meet on-site disposal criteria, they may be used to backfill soil borrow areas or to grade low areas on the floodplain.

3.7.6 Water Deliveries

This Alternative includes the Short Canal for making up to 2,500 cfs in water deliveries from the San Joaquin River to Mendota Pool. Water deliveries to the Pool would include diversion of Friant Dam releases that are meant to satisfy the Exchange Contract as well as diversion of San Joaquin River flood flows if there is demand in Mendota Pool

When water deliveries need to occur, the normal pool elevation in Mendota Pool may be higher than the water surface in the river at Fresno Slough Dam. In order for the Short Canal to be able to deliver water into Mendota Pool, the flash boards of Mendota Dam would be installed, and the water surface in the river would be raised until water could flow from the river south into Mendota Pool via the Short Canal. A fish screen would be included at the Short Canal, and fish passage facilities would be included at Mendota Dam when the boards are in and the diversion is operating.

3.7.7 Construction Considerations

The total construction timeline for this Alternative is currently estimated to range approximately from 91 to 133 months (7.5 to 11 years); opportunities to shorten the overall schedule through construction efficiencies will be studied during the detailed design process.

Soil improvements to mitigate for possible liquefiable soils may be required.

Construction of the Fresno Slough Dam must not interrupt water deliveries. To accomplish this, the construction of the dam would require removable cofferdams in three phases to facilitate the construction without blocking the flow. If flow is present in the slough during the construction period, flow will be diverted around the work area via a temporary diversion pipe or canal and fish passage will be provided.

Construction of the fish screen and return/bypass fish pipes would take place in the dry using conventional construction methods and must be coordinated with construction of the water delivery canal. The exception to this is the outlet for the fish return pipes, which would require a cofferdam. All fish facility structures and pipes with surfaces exposed to fish require additional attention to surface-smoothness.

For construction of the control structures and fish passage facilities, a minimum flow must be maintained during construction; the amount or range of flows has not yet been identified. For construction at the bifurcation, it was assumed that construction would first be done away from the fish passage facility. A sheet pile cofferdam would be provided for the river control structure and/or the canal control structure and the water diverted away from the construction. Additional sheet piling would be provided to divert flows through the new bifurcation structure while the fish passage facility is constructed.

3.7.8 Summary

The following tables summarize the levees, relocations, land acquisition, costs, benefits, and impacts associated with the Fresno Slough Dam with Narrow Floodplain and Short Canal Alternative based on design, field, and evaluation criteria data prepared for the

Alternatives Evaluation. This data is preliminary for this TM and may be updated during the development of the Project EIS/R.

Table 3-9
Fresno Slough Dam with Narrow Floodplain and Short Canal
Levees, Relocations, and Land Acquisition

		Left Levee		Right Levee
Levee Length		7.7 miles		6.9 miles
Average Levee Height		5.6 feet		5.2 feet
Fill Volume		317,500 cubic yards		224,500 cubic yards
Relocations				
Electrical Distribution	48,000 feet	Barn/Shed		1
Gas Transmission	9,000 feet	Facility		1
Water Pipeline	33,000 feet	Groundwater Well		25
Canal	32,500 feet	Lift Pump		10
Culvert	1	Power Pole		166
Diversion	3	Dwelling		2
Land Acquisition[1]				
Total	2,450 acres			

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 3-10
Fresno Slough Dam with Narrow Floodplain and Short Canal Costs

Categories	Factors	Criteria	Units of Measure	Quantity
Costs[1]	Upfront Costs	Capital Improvement Costs	dollars	$465,470,000
		Land Costs	dollars	$24,700,000
		Subtotal	dollars	$490,170,000
	Long-Term Costs	O&M	dollars/year	$1,100,000
Time to Build	Timeline	Maximum Construction Time[2]	months	133

[1] Costs were developed by DWR for the appraisal-level designs evaluated in Attachment A – Alternatives Evaluation.
[2] Construction timeline does not include the time that would also be needed to complete the NEPA and CEQA documentation process, obtain permits, appraise and acquire land, and perform pre-construction surveys.

Table 3-11
Fresno Slough Dam with Narrow Floodplain and Short Canal
Conditions and Features within the Project Boundary

Categories	Factors	Criteria	Units of Measure	Quantity
Existing Environmental Conditions	Special Status Vegetation and Waters	Wetlands	acres	215.8
		Marsh	acres	61.7
		Riparian wetland	acres	101.9
		Wet meadow	acres	52.2
		Other Waters	acres	469.9
		Sensitive Vegetation Alliances		
		Alkali heath marsh	acres	0.7
		Arrow weed thickets	acres	0.4
		Black willow thickets	acres	120.0
		Blue elderberry stands	acres	75.4
		Button willow thickets	acres	1.6
		California bulrush marsh	acres	24.8
		California rose briar patches	acres	13.0
		Creeping rye grass turfs	acres	6.1
		Fremont cottonwood forest	acres	45.3
		Oregon ash groves	acres	7.0
		Red willow thickets	acres	0.6
		Salt grass flats	acres	1.7
		Silver bush lupine scrub	acres	4.1
		Spinescale scrub	acres	0.7
		Tar plant fields	acres	35.4
		Valley oak woodland	Acres	0.2
		Yerba mansa meadows	acres	0.8
	Special Status Wildlife	Special status wildlife habitats		
		Blunt-nosed leopard lizard	acres	15.4
		Fresno kangaroo rat	acres	15.4
		Giant garter snake	acres	436.0
		Greater sandhill crane	acres	539.9
		San Joaquin kit fox	acres	185.6
		Swainson's hawk	acres	366.3
		Valley elderberry longhorn beetle	acres	75.4
		Valley elderberry longhorn beetle	number of elderberry shrubs	113
	Cultural and Historical Resources	Historic Properties	number of listed properties[1]	4
		Maximum Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

Table 3-11
Fresno Slough Dam with Narrow Floodplain and Short Canal
Conditions and Features within the Project Boundary

Categories	Factors	Criteria	Units of Measure	Quantity
Existing Socioeconomics and Economics Conditions	Crop Acreage	Total Farmland in Production	acres	795.7
		Alfalfa	acres	21.5
		Almond	acres	339.7
		Cotton	acres	13.4
		Grapes	acres	92.8
		Other Row Crop	acres	65.0
		Palm	acres	9.7
		Pistachio	acres	253.6
Project Fish Habitat & Passage Conditions	Floodplain Characteristics	Primary production (<1.0 feet inundation at 2,500 cfs)	acres	528
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	235
	Passage Conditions for Adult Chinook Salmon	Artificial structures across migratory path	number of structures	13
		Maximum number of steps at structures	number of jumps	59
	Passage Conditions for Juvenile Chinook Salmon	New fish screens along migratory path	number of screens	3
		Potential predation sites	number of artificial structures	14

[1] The number of listed properties is based on records from NRHP National Register of Historic Places, California Register of Historical Resources, Office for Historic Preservation Historic Property Directory, California State Historical Landmarks listing, California Inventory of Historic Resources, California Points of Historical Interest listing, the Caltrans State and Local Bridge Survey, and historical maps, including GLO Plat Maps. No previously recorded National Register or California Register eligible resources were identified in the records search.

3.8 Fresno Slough Dam with Wide Floodplain and North Canal

The Fresno Slough Dam with Wide Floodplain and North Canal includes:

- Building levees capable of conveying flows up to 4,500 cfs with 3 feet of freeboard
- Restoring floodplain habitat an average of approximately 4,200 feet wide to provide benefit to salmonids and other native fishes
- Construction of a dam capable of containing Mendota Pool within Fresno Slough so that 4,500 cfs of Restoration Flows can be conveyed around the Mendota Pool
- Construction of the North Canal and structures capable of conveying up to 2,500 cfs from Reach 2B to Mendota Pool
- Providing upstream and downstream fish passage for adult and juvenile salmonids and other native fishes between Reach 2A and Reach 3

This Alternative would build a dam across Fresno Slough, the Fresno Slough Dam, to contain the Mendota Pool, and it would utilize the existing river channel in order to bypass the Mendota Pool. Restoration Flows would enter Reach 2B, flow through the reach, then downstream to Reach 3 over the sill at Mendota Dam. Mendota Pool would be contained south of the Fresno Slough Dam. A canal to convey San Joaquin River water deliveries to Mendota Pool, the North Canal, would be built. The San Joaquin River control structure at the Chowchilla Bypass would be removed, and a bifurcation structure would be built at the head of the North Canal to control flood diversions into the Chowchilla Bypass and water delivery diversions into Mendota Pool. Fish passage facilities and a fish screen would be built at the North Canal bifurcation structure to provide passage around the structure and prevent fish being entrained in the diversion. A fish barrier would be built downstream of the Fresno Slough Dam to keep up-migrating fish in Reach 2B. A new crossing would be built at the San Mateo Avenue crossing. These features are described in further detail in the sections below.

See Figure 3-15 and Figure 3-16 for a plan view of the Alternative's features. In Section 3.9.8, Table 3-12, Table 3-13, and Table 3-14 list the quantities of levee construction, relocations, and land acquisition, costs, conditions, and features associated with this Alternative.

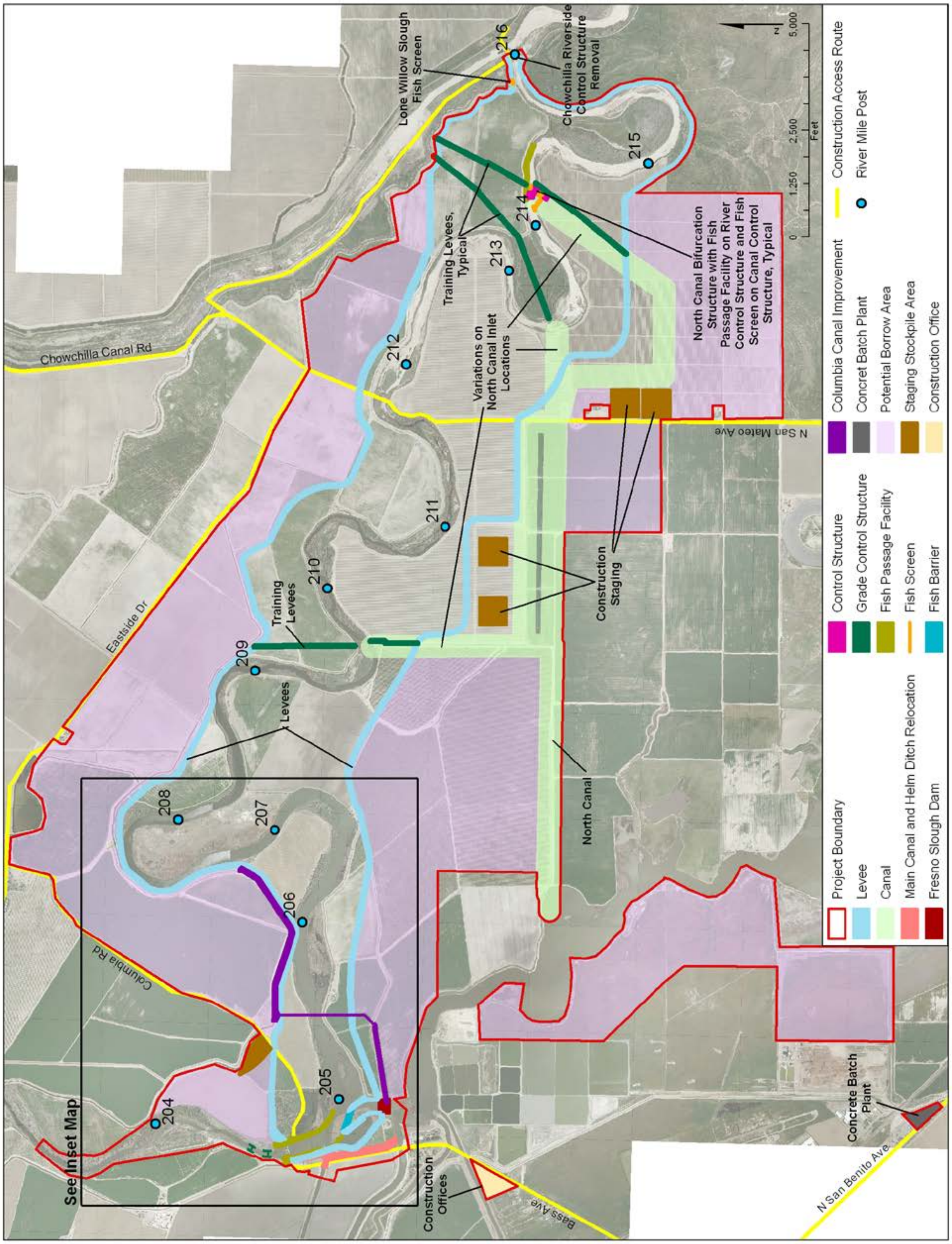


Figure 3-15
Plan View of Fresno Slough Dam with Wide Floodplain and North Canal

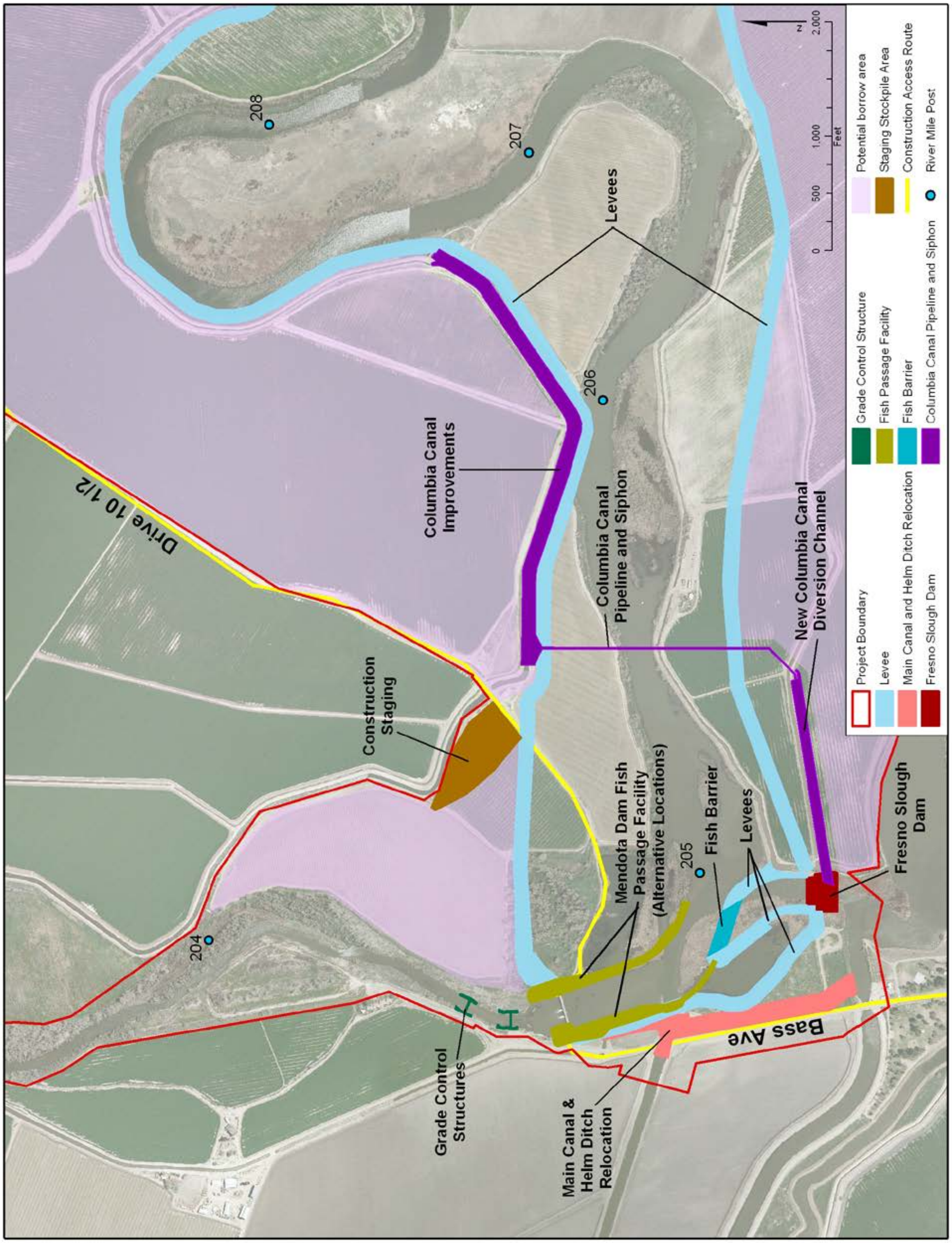


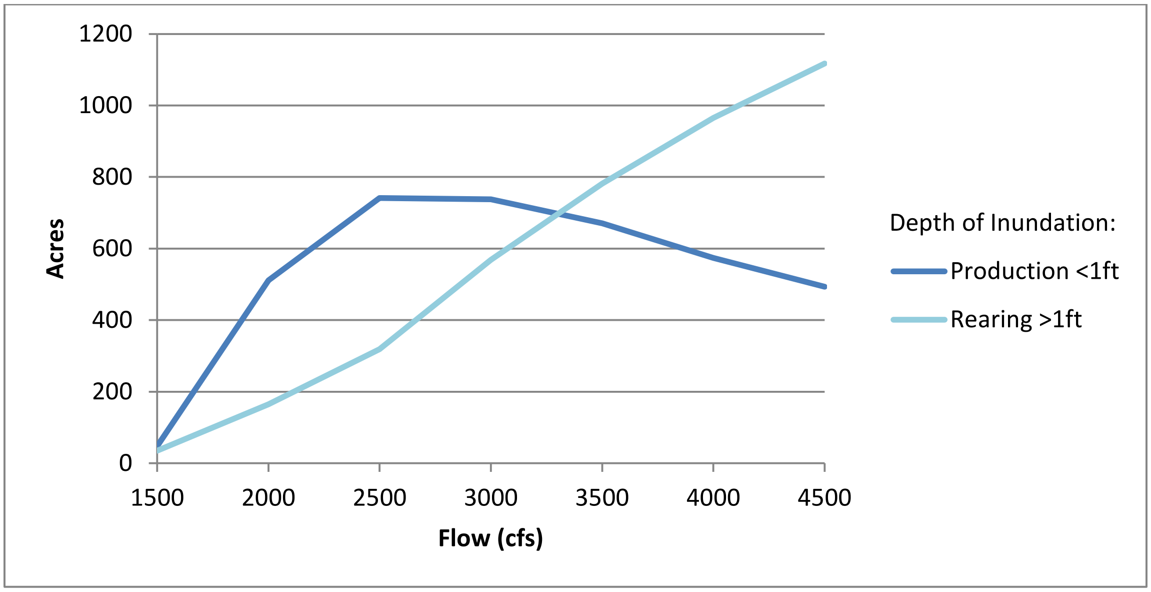
Figure 3-16
Inset Map of Fresno Slough Dam with Wide Floodplain and North Canal

3.8.1 Fish Habitat and Passage

The purpose of the floodplain would be to provide riparian and floodplain habitat and support the migration and seasonal rearing of salmonids and other native fishes in Reach 2B. The floodplain has an average width of approximately 4,200 feet and an inundated area of approximately 1,050 acres at 2,500 cfs.

This Alternative provides floodplain habitat resulting in approximately 750 acres of shallow water habitat for primary production as well as approximately 300 acres of habitat that supports direct rearing at 2,500 cfs. Approximately 70 percent of the floodplain in this Alternative would inundate less than 1 foot deep at 2,500 cfs. This Alternative also retains approximately 500 acres of shallow water habitat at flows up to 4,500 cfs. Source: Tetra Tech 2012

Figure 3-17 below presents conceptual inundation areas for primary production and rearing habitats as they vary by flow. Inundation acreages may change during the design process.



Source: Tetra Tech 2012

Figure 3-17
Potential Inundation Acreage by Flow for Fresno Slough Dam with Wide Floodplain and North Canal

This Alternative includes several facilities that fish would encounter or need to pass to migrate between Reach 3 and Reach 2B (from downstream to upstream):

- An estimated two to four in-channel drop structures below Mendota Dam
- The sill of Mendota Dam
- A fish barrier north of the Fresno Slough Dam
- The San Mateo Avenue crossing (this crossing is included in all Alternatives)
- Four fish screen return outlets from the North Canal fish screen
- A bifurcation control structure at the North Canal with fish passage facility
- A fish screen near the upstream end of the North Canal

- Fish screens at Lone Willow Slough, Big and Little Bertha pumps, and other smaller diversions (these screens are included in all Alternatives)

Each structure represents a potential stressor for adult salmon and potential predation site for juvenile salmon. However, each structure would be designed to perform according to the fish passage design criteria (see Section 3.4.1). In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to incorporate channel structure variability during detailed design, all of which may help to reduce stress and predation.

3.8.2 Floodplain and Riparian Habitat

Floodplain and riparian habitat restoration actions similar to those described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.2.would be included in this Alternative.

3.8.3 North Canal

The North Canal would deliver up to 2,500 cfs in water deliveries from the San Joaquin River to Mendota Pool (see Section 3.9.6). The North Canal could connect to the river at various locations, ideally on a straight section of the river or on the outside of bend. Three optional locations for the junction with the San Joaquin River are shown in Figure 3-4 at approximately RM 209.8, RM 213.4, and RM 214.2. The North Canal would discharge into Fresno Slough approximately 1.8 river miles south of Mendota Dam.

Other aspects of the North Canal are the same as those described for the South Canal in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.4.

3.8.4 Structures

The structures described below would be required to provide the operational flexibility to divert water to the Mendota Pool, provide fish passage, prevent fish entrainment and straying, and provide controlled elevation drop between Reach 2B and Reach 3.

San Joaquin River control structure at the Chowchilla Bypass Removal

The Chowchilla Bifurcation Structure consists of two control structures: one at the head of the Chowchilla Bypass and one across the San Joaquin River at RM 216. With the inclusion of a bifurcation structure at the head of the North Canal, a new control structure would be built across the San Joaquin River at the head of the canal. The new control structure would alleviate the need for the San Joaquin River control structure at the Chowchilla Bypass because all diversions into the Chowchilla Bypass could be controlled from the new control structure at the head of the North Canal. As part of this Alternative, the San Joaquin River control structure at the Chowchilla Bypass would be demolished.

North Canal Bifurcation Structure

A bifurcation structure would be constructed at the upstream end of the North Canal. The bifurcation structure consists of two control structures: one across the path of Restoration Flows (San Joaquin River) and one across the path of water deliveries to Mendota Pool

(North Canal). The North Canal bifurcation structure is the same as described for the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

North Canal Fish Passage Facility

The North Canal bifurcation structure would include a fish passage facility on the side of the control structure across the Restoration Flow path. The fish passage facility would be necessary to provide passage during Pool deliveries and for Restoration Flows where passage conditions through the control structure may not be ideal. The design of the fish passage facility is the same as that presented for the South Canal fish passage facility in Section 3.6.5.

North Canal Fish Screen

A fish screen would be included at the head of the North Canal where Pool deliveries would be diverted from the river. The fish screen would be necessary to keep or return out-migrating juvenile salmon to the path of Restoration Flows during Pool deliveries. The North Canal fish screen is the same as described for the South Canal in the Compact Bypass with Narrow Floodplain and South Canal Alternative in Section 3.6.5.

Removal of San Mateo Avenue Crossing

The San Mateo Avenue crossing is an existing river crossing located within a public right-of-way in Madera County and on private land in Fresno County at approximately RM 211.8. The crossing transitions from public right-of-way to private land at the center of the river. The crossing consists of a low flow or dip crossing with a single culvert. As part of this Alternative, the culvert and road embankments would be demolished, and no river crossing would be provided at this location.

Fresno Slough Dam

The Fresno Slough Dam is the same as that described in the Fresno Slough Dam with Narrow Floodplain and Short Canal Alternative in Section 3.8.4.

Fresno Slough Dam Fish Barrier

The Fresno Slough Dam fish barrier is the same as that described in the Fresno Slough Dam with Narrow Floodplain and Short Canal Alternative in Section 3.8.4.

Mendota Dam Fish Passage Facilities

The Mendota Dam fish passage facilities are the same as described for the boards-out condition in the Fresno Slough Dam with Narrow Floodplain and Short Canal Alternative in Section 3.8.4

Main Canal and Helm Ditch Relocations

The Main Canal and Helm Ditch relocations are the same as described in the Fresno Slough Dam with Narrow Floodplain and Short Canal Alternative in Section 3.8.4.

3.8.5 Removal of River Sediments

The removal of river sediment is the same as described in the Fresno Slough Dam with Narrow Floodplain and Short Canal Alternative in Section 3.8.5

3.8.6 Water Deliveries

This Alternative includes the North Canal for making up to 2,500 cfs in water deliveries from the San Joaquin River to Mendota Pool. Water deliveries to the Pool would include diversion of Friant Dam releases that are meant to satisfy the Exchange Contract as well as diversion of San Joaquin River flood flows if there is demand in Mendota Pool.

3.8.7 Construction Considerations

The total construction timeline for this Alternative is currently estimated to range approximately from 97 to 158 months (8 to 13 years); opportunities to shorten the overall schedule through construction efficiencies will be studied during the detailed design process.

The construction considerations are the same as described for the Fresno Slough Dam with Narrow Floodplain and Short Canal Alternative in Section 3.8.7.

3.8.8 Summary

The following tables summarize the levees, relocations, land acquisition, costs, benefits, and impacts associated with the Fresno Slough Dam with Wide Floodplain and North Canal Alternative based on design, field, and evaluation criteria data prepared for the Alternatives Evaluation. This data is preliminary for this TM and may be updated during the development of the Project EIS/R.

Table 3-12
Fresno Slough Dam with Wide Floodplain and North Canal
Levees, Relocations, and Land Acquisition

		Left Levee		**Right Levee**
Levee Length		7.2 miles		6.6 miles
Average Levee Height		5.2 feet		4.2 feet
Fill Volume		272,000 cubic yards		188,250 cubic yards
Relocations				
Electrical Distribution	68,000 feet	Barn/Shed		1
Gas Transmission	11,500 feet	Facility		1
Water Pipeline	50,000 feet	Groundwater Well		32
Canal	56,000 feet	Lift Pump		10
Culvert	1	Power Pole		239
Diversion	3	Dwelling		2
Land Acquisition[1]				
Total	3,300 acres			

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 3-13
Fresno Slough Dam with Wide Floodplain and North Canal Costs

Categories	Factors	Criteria	Units of Measure	Quantity
Costs[1]	Upfront Costs	Capital Improvement Costs	dollars	$469,500,000
		Land Costs	dollars	$35,890,000
		Subtotal	dollars	$505,390,000
	Long-Term Costs	O&M	dollars/year	$1,387,000
Time to Build	Timeline	Maximum Construction Time[2]	months	158

[1] Costs were developed by DWR for the appraisal-level designs evaluated in Attachment A – Alternatives Evaluation.
[2] Construction timeline does not include the time that would also be needed to complete the NEPA and CEQA documentation process, obtain permits, appraise and acquire land, and perform pre-construction surveys.

Table 3-14
Fresno Slough Dam with Wide Floodplain and North Canal
Conditions and Features within the Project Boundary

Categories	Factors	Criteria	Units of Measure	Quantity
Existing Environmental Conditions	Special Status Vegetation and Waters	Wetlands	acres	218.7
		Marsh	acres	60.5
		Riparian wetland	acres	106.0
		Wet meadow	acres	52.2
		Other Waters	acres	476.7
		Sensitive Vegetation Alliances		
		Alkali heath marsh	acres	0.7
		Arrow weed thickets	acres	0.4
		Black willow thickets	acres	119.8
		Blue elderberry stands	acres	75.4
		Button willow thickets	acres	1.4
		California bulrush marsh	acres	23.6
		California rose briar patches	acres	12.5
		Creeping rye grass turfs	acres	6.1
		Fremont cottonwood forest	acres	52.5
		Oregon ash groves	acres	6.9
		Red willow thickets	acres	0.6
		Salt grass flats	acres	1.7
		Silver bush lupine scrub	acres	2.0
		Spinescale scrub	acres	0.7
		Tar plant fields	acres	33.9
		Valley oak woodland	Acres	0.2
		Yerba mansa meadows	acres	0.8
	Special Status Wildlife	Special status wildlife habitats		
		Blunt-nosed leopard lizard	acres	15.2
		Fresno kangaroo rat	acres	15.2
		Giant garter snake	acres	438.9
		Greater sandhill crane	acres	740.4
		San Joaquin kit fox	acres	179.4
		Swainson's hawk	acres	393.5
		Valley elderberry longhorn beetle	acres	75.4
		Valley elderberry longhorn beetle	number of elderberry shrubs	112
	Cultural and Historical Resources	Historic Properties	number of listed properties[1]	4
		Maximum Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

Table 3-14
Fresno Slough Dam with Wide Floodplain and North Canal
Conditions and Features within the Project Boundary

Categories	Factors	Criteria	Units of Measure	Quantity
Existing Socioeconomics and Economics Conditions	Crop Acreage	Total Farmland in Production	acres	1620.0
		Alfalfa	acres	48.3
		Almond	acres	557.7
		Cotton	acres	13.4
		Grapes	acres	271.3
		Other Row Crop	acres	200.9
		Palm	acres	9.7
		Pistachio	acres	518.6
Project Fish Habitat & Passage Conditions	Floodplain Characteristics	Primary production (<1.0 feet inundation at 2,500 cfs)	acres	741
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	319
	Passage Conditions for Adult Chinook Salmon	Artificial structures across migratory path	number of structures	13
		Maximum number of steps at structures	number of jumps	36
	Passage Conditions for Juvenile Chinook Salmon	New fish screens along migratory path	number of screens	3
		Potential predation sites	number of artificial structures	14

[1] The number of listed properties is based on records from NRHP National Register of Historic Places, California Register of Historical Resources, Office for Historic Preservation Historic Property Directory, California State Historical Landmarks listing, California Inventory of Historic Resources, California Points of Historical Interest listing, the Caltrans State and Local Bridge Survey, and historical maps, including GLO Plat Maps. No previously recorded National Register or California Register eligible resources were identified in the records search.

3.9 Alternatives Comparison Tables

The tables below combine the summary tables from Sections 0, 3.7.7, 3.8.8, and 3.9.8 in order to allow easy cross-comparison of the Alternatives.

Table 3-15
Levees, Relocations, and Land Acquisition

Levees	**Compact Bypass with Narrow Floodplain and South Canal**	**Compact Bypass with Wide Floodplain and Bifurcation Structure**	**Fresno Slough Dam with Narrow Floodplain and Short Canal**	**Fresno Slough Dam with Wide Floodplain and North Canal**
Left Levee Length	8.7 miles	8.1 miles	7.7 miles	7.2 miles
Left Average Levee Height	5.8 feet	5.6 feet	5.6 feet	5.2 feet
Left Fill Volume	345,200 cubic yards	328,600 cubic yards	317,500 cubic yards	272,000 cubic yards
Right Levee Length	7.1 miles	6.8 miles	6.9 miles	6.6 miles
Right Average Levee Height	5.4 feet	4.7 feet	5.2 feet	4.2 feet
Right Fill Volume	269,700 cubic yards	226,900 cubic yards	224,500 cubic yards	188,250 cubic yards
Relocations				
Electrical Distribution	43,500 feet	48,500 feet	48,000 feet	68,000 feet
Gas Transmission	10,000 feet	11,000 feet	9,000 feet	11,500 feet
Water Pipeline	31,000 feet	41,000 feet	33,000 feet	50,000 feet
Canal	32,500 feet	31,500 feet	32,500 feet	56,000 feet
Culvert	1	1	1	1
Diversion	3	3	3	3
Barn/Shed	1	1	1	1
Facility	1	1	1	1
Groundwater Well	26	32	25	32
Lift Pump	10	10	10	10
Power Pole	144	162	166	239
Dwelling	2	2	2	2
Land Acquisition[1]				
Total	2,700 acres	2,900 acres	2,450 acres	3,300 acres

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 3-16
Costs

Categories	Factors	Criteria	Units of Measure	Compact Bypass with Narrow Floodplain and South Canal	Compact Bypass with Wide Floodplain and Bifurcation Structure	Fresno Slough Dam with Narrow Floodplain and Short Canal	Fresno Slough Dam with Wide Floodplain and North Canal
Costs[1]	Upfront Costs	Capital Improvement Costs	dollars	$487,640,000	$446,280,000	$465,470,000	$469,500,000
		Land Costs	dollars	$29,690,000	$33,700,000	$24,700,000	$35,890,000
		Subtotal	dollars	$517,330,000	$479,980,000	$490,170,000	$505,390,000
	Long-Term Costs	O&M	dollars/year	$1,746,000	$1,241,000	$1,100,000	$1,387,000
Time to Build	Timeline	Maximum Construction Time[2]	months	132	157	133	158

[1] Costs were developed by DWR for the appraisal-level designs evaluated in Attachment A – Alternatives Evaluation.
[2] Construction timeline does not include the time that would also be needed to complete the NEPA and CEQA documentation process, obtain permits, appraise and acquire land, and perform pre-construction surveys.

Table 3-17
Conditions and Features within the Project Boundaries

Categories	Factors	Criteria	Units of Measure	Compact Bypass with Narrow Floodplain and South Canal	Compact Bypass with Wide Floodplain and Bifurcation Structure	Fresno Slough Dam with Narrow Floodplain and Short Canal	Fresno Slough Dam with Wide Floodplain and North Canal
Existing Environmental Conditions	Special Status Vegetation and Waters	Wetlands	acres	239.8	236.2	215.8	218.7
		Marsh	acres	43.9	40.3	61.7	60.5
		Riparian wetland	acres	140.5	143.7	101.9	106.0
		Wet meadow	acres	55.4	52.2	52.2	52.2
		Other Waters	acres	443.7	437.2	469.9	476.7
		Sensitive Vegetation Alliances					
		Alkali heath marsh	acres	0.2	0.2	0.7	0.7
		Arrow weed thickets	acres	0.4	0.4	0.4	0.4
		Black willow thickets	acres	124.9	124.9	120.0	119.8
		Blue elderberry stands	acres	75.4	75.4	75.4	75.4
		Button willow thickets	acres	1.0	1.2	1.6	1.4
		California bulrush marsh	acres	16.9	12.8	24.8	23.6
		California rose briar patches	acres	11.1	11.3	13.0	12.5
		Creeping rye grass turfs	acres	6.2	6.1	6.1	6.1
		Fremont cottonwood forest	acres	68.3	68.5	45.3	52.5
		Oregon ash groves	acres	6.9	7.0	7.0	6.9
		Pale spike rush marshes	acres	1.6	--	--	--
		Red willow thickets	acres	0.6	0.6	0.6	0.6
		Salt grass flats	acres	1.4	1.4	1.7	1.7
		Silver bush lupine scrub	acres	2.0	4.1	4.1	2.0
		Spinescale scrub	acres	0.1	0.1	0.7	0.7
		Tar plant fields	acres	33.5	34.9	35.4	33.9
		Valley oak woodland	acres	--	--	0.2	0.2
		Yerba mansa meadows	acres	0.8	0.8	0.8	0.8

Table 3-17
Conditions and Features within the Project Boundaries

Categories	Factors	Criteria	Units of Measure	Compact Bypass with Narrow Floodplain and South Canal	Compact Bypass with Wide Floodplain and Bifurcation Structure	Fresno Slough Dam with Narrow Floodplain and Short Canal	Fresno Slough Dam with Wide Floodplain and North Canal
Existing Environmental Conditions	Special Status Wildlife	Special status wildlife habitats					
		Blunt-nosed leopard lizard	acres	17.4	15.4	15.4	15.2
		Fresno kangaroo rat	acres	108.8	111.2	111.2	106.5
		Giant garter snake	acres	364.9	348.3	436.0	438.9
		Greater sandhill crane	acres	669.8	635.3	539.9	740.4
		San Joaquin kit fox	acres	201.6	197.8	185.6	179.4
		Swainson's hawk	acres	441.4	443.9	366.3	393.5
		Valley elderberry longhorn beetle	acres	75.4	75.4	75.4	75.4
		Valley elderberry longhorn beetle	number of elderberry shrubs	112	113	113	112
	Cultural and Historical Resources	Historic Properties	number of listed properties[1]	3	3	4	4
		Maximum Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4	4	4	4

Table 3-17
Conditions and Features within the Project Boundaries

Categories	Factors	Criteria	Units of Measure	Compact Bypass with Narrow Floodplain and South Canal	Compact Bypass with Wide Floodplain and Bifurcation Structure	Fresno Slough Dam with Narrow Floodplain and Short Canal	Fresno Slough Dam with Wide Floodplain and North Canal
Existing Socioeconomics and Economics Conditions	Crop Acreage	Total Farmland in Production	acres	1066.9	1302.1	795.7	1620.0
		Alfalfa	acres	46.5	55.2	21.5	48.3
		Almond	acres	341.6	512.0	339.7	557.7
		Cotton	acres	7.0	7.0	13.4	13.4
		Grapes	acres	242.4	175.6	92.8	271.3
		Other Row Crop	acres	166.1	102.5	65.0	200.9
		Palm	acres	9.7	9.7	9.7	9.7
		Pistachio	acres	253.7	440.1	253.6	518.6
Project Fish Habitat & Passage Conditions	Floodplain Characteristics	Primary production (<1.0 feet inundation at 2,500 cfs)	acres	477	636	528	741
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	385	527	235	319
	Passage Conditions for Adult Chinook Salmon	Artificial structures across migratory path	number of structures	20	21	13	13
		Maximum number of steps at structures	number of jumps	43	67	59	36
	Passage Conditions for Juvenile Chinook Salmon	New fish screens along migratory path	number of screens	3	4	3	3
		Potential predation sites	number of artificial structures	21	22	14	14

[1] The number of listed properties is based on records from NRHP National Register of Historic Places, California Register of Historical Resources, Office for Historic Preservation Historic Property Directory, California State Historical Landmarks listing, California Inventory of Historic Resources, California Points of Historical Interest listing, the Caltrans State and Local Bridge Survey, and historical maps, including GLO Plat Maps. No previously recorded National Register or California Register eligible resources were identified in the records search.

4.0 Alternatives Considered and Eliminated from Further Consideration

Formulation of a range of Project Alternatives for inclusion in this Project Description TM began with a review of Settlement provisions for achieving the Restoration and Water Management goals and the Settlement provisions for the Reach 2B and Mendota Pool Bypass components. This was followed by preparing the purpose, need, and objectives; developing criteria for including actions in the Project Alternatives; defining planning and implementation constraints; and identifying related projects and opportunities associated with achieving the purpose and need. These steps were applied to actions identified in Settlement provisions and to comments received during the public scoping process to identify a range of alternatives to be addressed. As a result of this process, several potential actions were eliminated from consideration and the reasonable range of Initial Alternatives was identified. This process and the alternatives eliminated from consideration are described in the Alternatives Evaluation TM (Attachment A).

4.1 Pre-Initial Options Analysis

Pre-initial options analysis included concepts suggested during the Project scoping meetings and other concepts suggested within the Project team.

Some actions suggested during the scoping process and considered by the Project Team were retained for inclusion in the Project initial options, while others were not retained for inclusion because they would not meet the Project purposes, needs, goals, and objectives. The suggested actions, and associated screening information, are summarized below.

- Mitigation for flood impacts: No alterations to flood management operations or to the service level of existing flood control facilities (such as design capacity and levee stability) are included in the Project. Mitigation of flood risks not generated by the Project is unwarranted. Local flooding conditions would be improved through increased capacity within the channel and floodplain and improved levees. Alterations to existing flood control facilities (such as the Chowchilla Bifurcation Structure) would provide at least the same level of service as the existing features and would require no changes to operations.
- Evaluation and redesign of the Columbia-Mowry Distribution System including facility access, O&M, pumps, pipelines, and power: Modifications to existing canals, pumps, pipelines, access, and power are limited to those relocations necessary to construct the Project. The Project will not include evaluation or redesign of system components outside of those potentially impacted by the Project.

- No interruption of water deliveries: The Project goals and objectives include diverting water deliveries up to 2,500 cfs within Reach 2B from the San Joaquin River to the Mendota Pool; however, the availability of the contracted water amounts from any particular source is outside the Project purpose.
- Acquire land to support recreation, tourism, flora, fauna, and groundwater recharge: The purpose of the Project does not include independently supporting recreation, tourism, flora (other than riparian habitat), fauna (other than salmon and other native fishes), or groundwater recharge, so land would not be acquired solely for these purposes. However, opportunities may exist to support these functions in conjunction with or incidental to implementation of the Project, and land acquired to meet the Project purposes, needs, goals, and objectives may also benefit recreation, tourism, flora, fauna, and groundwater recharge.
- Shortening channel distance to reduce levee length and reduce maintenance costs: Shortening of the river channel or the bypass alignments is currently not considered due to the considerable negative effects to habitat, geomorphology, and sediment continuity in the reach that would result from shortening, or straightening, the channel.
- Installing a cutoff channel before the river bends just downstream of the Chowchilla Bifurcation Structure to reduce flooding toward Hwy 180: No alterations to flood management operations are included in the Project, and mitigation for flood risks not generated by the Project are unwarranted. Local flooding conditions could be improved through increased capacity within the channel and floodplain and improved levees.
- Installing a wall across the river in Reach 3 just below Mendota Dam and diverting water to Mendota Pool: This action would not meet the purpose and need of the Settlement as it would not provide a bypass around the Pool.
- Allow salmon in the Pool and Chowchilla Bypass: The extent to which fish would be screened out of the Chowchilla Bypass was not considered as part of this action. Fish screening upstream of Reach 2B diversions to Mendota Pool was included because of high predation risks for juvenile salmon in the Pool due to populations of non-native predators.
- Include provisions to allow for Mendota Dam maintenance: Maintenance of Mendota Dam as it relates to operating the Project is included (e.g., removing sediment to operate the Short Canal); however, general maintenance of the structure and it’s equipment are beyond the purpose, need, and scope of the Project.
- Avoid bifurcation of future flows: The Settlement requires Restoration Flows in Reach 2B and in downstream reaches, but it does not require flood conveyance in Reach 2B, and diversion of flood flows into the Chowchilla Bypass is required to meet existing flood operation guidelines. The flexibility to divert flows away from the Bypass and to the Pool is also required to meet potential Exchange Contract water deliveries; however, Restoration Flows are required in the Mendota Pool Bypass and downstream reaches.

- Fish screens in the Pool: This action would not meet the purpose and need of the Settlement as it would not provide a bypass around the Pool. In addition, the maintenance, cost and reliability of fish screens for all Pool connections would be prohibitively expensive and would not perform as well as other alternatives.
- Evaluate all alternatives that avoid impacts to wetlands: The extent of impact to existing wetlands was considered in the alternatives evaluation process.
- Avoid dredging or filling in waters of the United States: Filling in waters of the United States would be minimized to the extent possible and was considered in the alternatives evaluation process.
- Address effects of the Project on Milburn Pond: The Project does not affect Milburn Pond.
- Do not reintroduce salmon in order to protect existing riparian habitat: Existing riparian habitat was considered in the alternatives evaluation process. Not reintroducing salmon would be contrary to the Settlement.

Some additional options exist that were not part of the scoping process, but were also considered by the Project Team and not retained for inclusion in the Project initial options because they would not meet the Project purposes, needs, goals, and objectives. These include the following:

- Construction of levees to withstand a 200-year flood: Eliminated because existing levees in the Project area are not part of the Lower San Joaquin River Flood Control Project.

4.2 Pre-Evaluation Screening

During the concept refinement phase of the Project, some of the initial options were revised, refined, or eliminated from further consideration. The concepts considered and eliminated from further consideration prior to the alternatives evaluation are described below. Many concepts were refined or revised during appraisal-level design before moving into the alternatives evaluation; those refinements are described in Attachment A, Section 5.2.

4.2.1 Bottomless Arch Culverts

Bottomless arch culverts were considered in the Initial Options TM as a potential method of improving the crossing at San Mateo Avenue. However, based upon further consideration it was decided that bottomless arch culverts would be too difficult to implement in the sand bed channel of Reach 2B because the culverts would require substantial undercut for foundation work, the culverts would potentially require a concrete floor to stabilize the structures during high flows, and could have an unacceptable failure rate. In addition, less expensive and equally beneficial options are available (i.e., concrete box culverts).

4.2.2 Corrugated Metal Pipe Culverts

Corrugated metal pipe culverts were considered in the Initial Options TM as a potential method of improving the crossing at San Mateo Avenue. However, based upon further consideration it was decided that corrugated metal pipe culverts would be difficult to design for the fish passage requirements and they may have a shortened lifespan due to the corrosive nature of the soils in the Project area.

4.2.3 Bridge

A bridge was considered in the Initial Options TM as a potential type of crossing for the San Mateo Avenue crossing. However, based upon further consideration it was found that both a box culvert crossing and a bridge crossing are capable of meeting the fish passage requirements, but the bridge is significantly more expensive. Therefore, the bridge crossing was eliminated from further consideration.

4.2.4 Floodplain Vegetation Types

In the Initial Options TM, several floodplain vegetation types were considered: fully grassed floodplain, forested riparian fringe along the river with a grassed floodplain, and fully forested floodplain. Based upon further review during concept refinement, the floodplain vegetation concept used in the hydraulics modeling was revised to a mosaic type floodplain habitat including a forested riparian fringe along the river and a mixture of grasslands, scrub, and trees on the floodplain. The mosaic floodplain habitat was more typically found along the river historically and can be found in other parts of the San Joaquin Valley today.

4.2.5 Floodplain Recontouring

As part of the Initial Options development, recontouring of the entire floodplain to allow inundation of large areas at lower flows was considered. Based upon further review during concept refinement, this concept provided less or similar benefit as the select floodplain grading included in the Project Alternatives. Wholesale recontouring would not increase the habitat diversity on the floodplain and thus would not provide increased benefits to fish. However, it would require excavation of much larger quantities of material and thus would increase costs. Wholesale recontouring also has the potential to decrease the area of inundation and cause erosion along the channel. Wholesale floodplain recontouring was therefore eliminated from further consideration.

4.2.6 Older Levee Setbacks

During concept refinement, the levee alignments presented in the Initial Options TM were refined and revised and one alignment was eliminated: Initial Option FP-1. Initial Option FP-1 was found to not sufficiently meet the Settlement requirements to provide floodplain and riparian habitat in Reach 2B. The other levee alignments were modified to account for property lines, field lines, infrastructure, flow and sediment continuity purposes, and to add a minimum 300-foot buffer, where appropriate, between the channel and levee to protect the levee from lateral channel migration and erosion.

4.2.7 Mendota Dam Removal

The Fisheries Management Workgroup asked the Project to consider removing Mendota Dam as part of the Fresno Slough Dam Initial Alternative. Based upon further consideration and analysis, it was decided that the Project would not remove the dam because it provides a grade control point between Reach 3 and Reach 2B. Without the dam, the channel base level would be lowered and incision could migrate upstream through Reach 2B (Tetra Tech 2011a). This could jeopardize passage conditions at the structures in the Project area such as at San Mateo Avenue and Chowchilla Bifurcation Structure where channel grades would potentially be lowered by up to approximately 4.7 feet and 1.9 feet, respectively, effectively relocating the grade-control point. Lowering the base-level would also eliminate overbank flow during all but the highest flows (Tetra Tech 2011a). Furthermore, structural stability of existing and proposed structures could be compromised by the decreased bed elevations and resulting scour.

4.2.8 Channel Grading from Reach 3 to Chowchilla Bifurcation Structure

The Technical Advisory Committee requested that the Project consider not constructing grade control structures in the Mendota Pool Bypass channel and that the channel be graded from the confluence with Reach 3 at an appropriate slope. Based upon further analysis, it was found that grading the channel at the equilibrium slope starting at the confluence with Reach 3 would lower the entire Mendota Pool Bypass Channel and Reach 2B channel up to approximately 14.3 feet and 11.7 feet, respectively, and that the new base elevation would require excavation (or result in erosion) all the way up to the Chowchilla Bifurcation Structure, which would serve as a grade control point. Furthermore, it was found that this would leave the Reach 2B channel elevation approximately up to 5.3 feet below the floor elevation of the Chowchilla Bifurcation Structure potentially undermining the structure and presenting a fish passage barrier as well as disconnecting the channel from its floodplain throughout Reach 2B (Tetra Tech 2011b). Based upon the necessary structural improvements at the Chowchilla Bifurcation Structure to prevent failure, the fish passage impacts, the significant decrease in floodplain inundation area and frequency, the surplus of cut material for the bypass channel, and water quality/stability concerns from eroding channel bed and banks, this concept was eliminated from further consideration.

4.2.9 Floating Picket Weir

A floating picket weir was considered in the Initial Options TM as a potential method of providing a fish exclusion barrier at the downstream end of the Mendota Pool Bypass Channel to direct fish into the Bypass. Based upon further consideration, this option was eliminated due to the magnitude of flows expected to be seen at the barrier location and this type of weir not being appropriate for such high flows.

4.2.10 Behavioral Barrier

Behavioral fish barriers were investigated during the appraisal-level design as a means of providing an exclusion/directional barrier at the downstream end of the Mendota Pool Bypass Channel to direct upmigrating adult salmon into the bypass channel and away from the base of Mendota Dam. A system to reroute irrigation flows from Mendota Dam to downstream of the barrier would be included with this concept, leaving slack water between the end of the bypass channel and the Dam. Behavioral barrier systems are a developing technology, but two main types of barriers have been implemented on other rivers: electric barriers and acoustic barriers. Both types of barriers have significant draw-backs for implementation in the Project.

Electric barriers generate an electric current through the water across a channel in order to deter fish. Based on existing and previous installations, electric barriers were found to present potential unavoidable electric shock hazards for fish (target and non-target species), other animals, people, and watercraft. Often target fish species either made it past the barrier or were killed. Velocities and depths need to be consistent for the barrier to be effective; something that has proven difficult on reaches with moveable beds and those with variable flows. Velocities also need to be sufficient to sweep stunned fish out of the barrier, which may be difficult in the low slope, low velocity Reach 3. Some programs are considering replacing their electric barriers with different technologies. For all these reasons, the electric barrier is not recommended.

Acoustic barriers use a sound signal contained in a bubble curtain of air to deter fish; acoustic barriers may also incorporate the use of strobes and lights to deter fish. There are few existing installations of acoustic barriers, but they have been found to be most effective on juvenile fish with minimal effectiveness on adult fish. Effectiveness has also been found to decrease with increasing flows. Acoustic barrier technology is not capable of functioning during high flows such as flood releases from Pine Flat routed down Fresno Slough into Reach 3 (typically at 4,500 cfs or reach capacity). These high flows occur on an average annual frequency of 1 in 5 years, typically in wet years. Since the purpose of the Mendota Pool Bypass Barrier is to direct adult migrating salmon into the bypass at all flows, including flood flows, the acoustic barrier is not recommended.

4.2.11 Velocity Barrier

Based on design and hydraulic analyses, a velocity barrier at the downstream end of the Mendota Pool Bypass Channel was eliminated from further consideration because the resulting barrier would be higher than Mendota Dam, would increase the elevation in Mendota Pool between 4 and 5 feet, and would necessitate improvements to all levees on Mendota Pool and Fresno Slough.

4.2.12 Other Types of Fish Screens

During the appraisal-level design several types of fish screens were reviewed for their applicability to the Project for screening fish from the 2,500 cfs diversion to Mendota Pool. The following screen design types were eliminated from further consideration due to design constraints. Horizontal flat plate screens (patented by Farmers Irrigation District, OR) were eliminated because they are intended for use with smaller diversions (less than 100 cfs); there are no physical model studies or field applications demonstrating that this design is capable of handling larger diversions. Travelling screens were eliminated because maintenance is a significant problem, and there are no known field applications for diversions of the Project’s size. Box screens were eliminated because, while they can be sized for larger applications, they function very similarly to cylindrical screens which were considered further. Pump screens were eliminated because they are only applicable to very small diversions (less than 10 cfs).

4.2.13 Pump Diversion to Mendota Pool

All the proposed Alternatives divert water to Mendota Pool via gravity. During the appraisal-level design, a pump diversion was also considered and preliminary costs were developed. The pump diversion was eliminated from further consideration because the capital improvement costs are nearly four times the cost of the gravity diversions. In addition, the pump diversion would rely on Mendota Dam or another barrier to form a backwatered pool, so the pump diversion would not be able to eliminate the need for a fish passage structure.

4.3 Initial Alternatives Screening

Two Floodplain Initial Alternatives and two Bypass Initial Alternatives were included in the Project Description based on their comparatively better performance in the alternatives evaluation. The included alternatives were FP-2 (now called the Narrow Floodplain), FP-4 (now called the Wide Floodplain), Compact Bypass, and Fresno Slough Dam. The results of the alternatives evaluation and the Initial Alternatives recommended for elimination are described in Section 8.0 of Attachment A.

Three Initial Alternatives were eliminated from consideration based on the evaluation results: FP-1, FP-5, and the Settlement Alignment. These Initial Alternatives were eliminated because they perform relatively poorly when compared to the other Initial Alternatives. The remaining Initial Alternatives (FP-2, FP-3, FP-4, Compact Alignment, and Fresno Slough Dam) provide a better balance between benefits and impacts.

FP-1 would result in a confined channel system with high velocities and scour along the corridor requiring expensive bank revetment. Vegetation could be difficult to establish, and water depths would often be too deep to provide effective floodplain rearing and primary production benefits. Based on the results of the evaluation, FP-1 performs poorly for several reasons:

- Relatively low amounts of rearing habitat
- Poor quality shallow water habitat
- Relatively high capital improvement costs
- Relatively low amounts of restoration area
- Relatively greater risk of channel instability
- Relatively larger nuisance seepage impacts

FP-5 would result in large areas too shallow and dry to provide effective floodplain rearing and primary production benefits. Based on the results of the evaluation, FP-5 performs poorly for several reasons:

- Poor quality shallow water habitat
- Relatively high restoration and land costs
- Relatively greater land removed from production
- Limited additional fish habitat and passage benefits for the added costs
- Potential for fish strandings

The Settlement Alignment provides less habitat than the Compact Alignment but with higher costs and larger land requirements. Based on the results of the evaluation, the Settlement Alignment performs poorly for several reasons:

- No additional shallow water or rearing habitat
- Relatively high capital improvement costs
- Relatively less restoration area
- Relatively greater risk of channel instability
- Relatively greater land removed from production

One option was recommended for elimination from consideration based on the evaluation results: Bend 10 Columbia Canal Relocation. This option was recommended for elimination because it performs relatively poorly when compared to the Bend 10 levee revetment, which provides a better balance between benefits and impacts.

Based on the results of the evaluation, the Bend 10 Columbia Canal Relocation option performs poorly for several reasons:

- Additional land acquisition is required
- More land removed from production
- Relatively greater environmental impacts

5.0 Project Implementation

The purpose of this section is to identify permits and approvals required for implementation of the Project. Table 5-1 provides planning information for the permitting process, including the recommended prerequisites for application, the estimated time for processing, and the estimated fee. Federal, State, and local actions are described in the sections below in reference to their application to the Project and the permit purpose and requirements. In general, all Federal and State actions (permit issuance) will require a signed Record of Decision/Notice of Determination. Additional information on permit acquisition procedures, submittal package requirements, critical issues, timing, and permit fees is discussed in detail in the Regulatory Compliance TM (SJRRP 2010b).

Table 5-1
Summary of Permits and Approvals Required for the Project

Agency and Associated Permit or Approval	Recommended Prerequisites for Submittal[1]	Estimated Processing Time[2]	Anticipated Fees	Lead Agency for Submittal
Federal				
USACE Clean Water Act Section 404 Individual Permit Rivers and Harbors Act Section 10 Permit Rivers and Harbors Act Section 14 Permit (Section 408)	<u>Section 404 and Section 10</u> • Application • Biological Assessment for submittal to USFWS/NMFS • Section 401 Water Quality Certification permit or application • Draft NEPA document • Section 106 compliance documentation • Wetland delineation • Alternatives analysis • Mitigation and Monitoring Plan <u>Section 408</u> • Written request for approval of the Federal flood control project modification • Technical analyses and demonstration of adequate design • Description and maps of lands, easements, and right-of-way owned by the Federal project and required for the modification • Discussion of residual risk • Administrative record of decisions related to the Project proposal • Justification to construct in the floodplain • Demonstration of environmental protection compliance	8 months	$100 for Individual permit is waived for governmental agencies (none)	Reclamation
USFWS/NMFS Endangered Species Act Section 7 Consultation Magnuson-Stevens Fisheries Conservation and Management Act	• Ongoing technical assistance (pre-consultation) • Biological Assessment • EFH Assessment	135 days	None	Reclamation

Table 5-1
Summary of Permits and Approvals Required for the Project

Agency and Associated Permit or Approval	Recommended Prerequisites for Submittal[1]	Estimated Processing Time[2]	Anticipated Fees	Lead Agency for Submittal
USFWS/NMFS Fish and Wildlife Coordination Act Report	• Ongoing informal technical consultation • Biological impact assessments (as addressed in TM 2.3 Environmental Field Survey Report)	N/A	None	USFWS/NMFS
SHPO/ACHP National Historic Preservation Act, Section 106	• Cultural Resources Survey and Evaluation Report (if mitigation is necessary to resolve adverse effects to historic properties, then additional reports would be required for SHPO consultation that detail the results of these efforts)	18 months	None	Reclamation
U.S. Coast Guard General Bridge Act and Rivers and Harbors Act Section 9	• Bridge design • Fish and Game Code Section 1602 Notification or Alteration Agreement • CWA Section 404 permit or application • Draft NEPA Document • Section 401 Water Quality Certification application • Biological Assessment for submittal to USFWS/NMFS or Biological Opinion	3 months	None	Reclamation
State				
CVRWQCB Clean Water Act Section 401 Water Quality Certification	• Application • Fish and Game Code Section 1602 Notification or Alteration Agreement • CWA Section 404 permit or application • Draft CEQA Document • Mitigation and Monitoring Plan	2 months	$500 or more	Reclamation/ DWR
SWRCB/ CVRWQCB Clean Water Act Section 402 Construction General Permit	• Permit Registration Documents • Design drawings (for SWPPP)	1 to 2 weeks	Up to $3,192	Reclamation/ DWR

Table 5-1
Summary of Permits and Approvals Required for the Project

Agency and Associated Permit or Approval	Recommended Prerequisites for Submittal[1]	Estimated Processing Time[2]	Anticipated Fees	Lead Agency for Submittal
DFG California Endangered Species Act Section 2080.1 Consistency Determination 2081 Incidental Take Statement	• Informal technical consultation • Biological Opinion, if requesting a consistency determination • Biological document for 2081 Permit, if requesting incidental take statement	30 days for consistency determination, if appropriate 6 months for incidental take statement	None	DWR
DFG Fish and Game Code Section 1602 Streambed Alteration Agreement	• Application • Section 401 Water Quality Certification permit or application • CWA Section 404 permit or application • Final CEQA Document and Mitigation Plan	3 months	Up to $4,482.75	DWR
CVFPB California Code of Regulations, Title 23: Encroachment Permit	• Application • Section 401 Water Quality Certification permit or application • CWA Section 404 permit or application • Draft CEQA Document and Mitigation Plan • Fish and Game Code Section 1602 Notification or Alteration Agreement • Biological Assessment for submittal to USFWS/NMFS or Biological Opinion	2 months	None	DWR
SWRCB Amended water right	• Application • Draft (possibly Final) CEQA Document	3 months	$200 or more	Reclamation/ DWR
State Lands Commission Land Use Lease	• Application • Draft CEQA Document • Property ownership determination	4 to 5 months	$25 application fee and possible leasing fees	Reclamation/ DWR

Table 5-1
Summary of Permits and Approvals Required for the Project

Agency and Associated Permit or Approval	Recommended Prerequisites for Submittal[1]	Estimated Processing Time[2]	Anticipated Fees	Lead Agency for Submittal
Local				
SJVAPCD Air Impact Analysis Regulation VIII Dust Control Plan Federal Clean Air Act	• AIA Application • AIA Monitoring and Reporting Schedule • AIA Fee Deferral Schedule • Dust Control Plan • Dust Control Training Course • Pre-application meeting (encouraged) • List of construction equipment that may require Portable Equipment Registration	1.5 months for Dust Control Plan and Air Impact Analysis	$700 for Air Impact Analysis application[3] $350 to process Dust Control Plan $177 for Portable Equipment Registration	Reclamation/ DWR
Fresno/Madera Counties SMARA	• Permit application • Reclamation plan	3 months	Varies	DWR
Fresno/Madera Counties Williamson Act Contracts	• Copy of applicable contracts	2 months	None	DWR

[1] Items listed are the items recommended for submittal of the specified application, not for approval. Several permits require additional items for permit approval (e.g., signed Record of Decision/Notice of Determination). Requirements for approval are discussed within the corresponding section of the document.

[2] Anticipated processing time is estimated based on the period from verified submission of completed application documents to permit issuance.

[3] The $700 filing fee has been paid as part of the AIA submittal for the SJRRP.

ACHP = Advisory Council on Historic Preservation
AIA = Air Impact Assessment
DFG = California Department of Fish and Game
CEQA = California Environmental Quality Act of 1970
CVFPB = Central Valley Flood Protection Board
CVRWQCB = Central Valley Regional Water Quality Control Board
CWA = Clean Water Act
DWR = California Department of Water Resources
EFH = essential fish habitat
NEPA = National Environmental Policy Act of 1969
NMFS = National Marine Fisheries Service
SHPO = State Historic Preservation Officer
SJVAPCD = San Joaquin Valley Air Pollution Control District
SJRRP = San Joaquin River Restoration Program
SMARA = Surface Mining and Reclamation Act of 1975
SWPPP – storm water pollution prevention plan
SWRCB = State Water Resources Control Board
USACE = U.S. Army Corps of Engineers
USFWS = U.S. Fish and Wildlife Service

5.1 Federal Actions

5.1.1 U.S. Army Corps of Engineers Regulations

Application to Proposed Action

The proposed action would result in fill and/or dredge of jurisdictional waters of the United States, including wetlands, especially within the San Joaquin River during any in-river construction activities (e.g., levee removal and construction of the San Mateo Avenue crossing) and at other locations, including Fresno Slough and Little San Joaquin Slough. As a result, this Project will require authorization from USACE pursuant to Section 404 of the Clean Water Act (CWA).

In addition to affecting waters of the United States, the proposed action would also result in construction in, over, or under; excavation of material from; or deposition of material into "navigable waters," such as the San Joaquin River. As a result, the Project will require authorization from USACE pursuant to Section 10 of the Rivers and Harbors Act (RHA) (33 USC 403) for the construction of certain elements of the Project.

Additionally, since the Project would alter a Federal flood control project by potentially relocating or modifying an existing Federal project levee, USACE approval under Section 14 of the RHA (33 USC 408, referred to as Section 408) or under Section 208.10 (33 CFR 208.10) is required prior to proceeding with the Project.

Permit Purpose and Requirements

CWA Section 404 establishes a program to regulate the discharge of dredged material or placement of fill material into waters of the United States, including wetlands. Waters of the United States include surface waters such as navigable waters and their tributaries, all interstate waters and their tributaries, natural lakes, all wetlands adjacent to other waters, and all impoundments of these waters. Activities that require a permit under Section 404 include, but are not limited to, placing fill or riprap, grading, mechanized land clearing, and dredging in waters of the United States. Any activity that results in the deposit of dredged or fill material within the ordinary high-water mark of waters of the United States usually requires a permit, even if the area is dry when the activity takes place.

The USACE Regulatory Branch issues several types of Section 404 permits. Those most applicable to the proposed action are Nationwide Permits (NWPs) and Individual Permits. Projects with only minimal adverse effects (i.e., fills of less than 0.5 acre of nontidal waters of the United States) can typically be authorized under USACE's NWP program to expedite the environmental compliance process, provided the Project satisfies the terms and conditions of the particular NWP. Since the proposed Project would have more than minimal impacts, it would require an Individual Permit.

The CWA and guidelines outlined in a Memorandum of Agreement (MOA) between the U.S. EPA and USACE dated November 15, 1989, set forth a goal of restoring and maintaining existing aquatic resources. This MOA directs USACE to strive to avoid adverse impacts and offset unavoidable adverse impacts to existing aquatic resources, and for wetlands, to strive to achieve a goal of no overall net loss of values and functions. The

MOA also noted the value of other waters of the United States, including streams, rivers, and lakes. Under the guidelines, all jurisdictional waters of the United States are afforded protection and requirements are outlined for practicable mitigation based on values and functions of the aquatic resources that will be affected.

U.S. EPA develops regulations with which USACE must comply and reviews the permits issued by USACE. Section 404(c) of the CWA authorizes U.S. EPA to veto a USACE decision to issue a permit if a proposed action “will have an unacceptable effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas.”

Section 10 of the RHA (33 USC 403) requires authorization from USACE for any work in navigable waters including the construction of any structure over, in, and under navigable waters of the United States. In addition, authorization is required for excavation/dredging or deposition of material or any obstruction or alteration in a navigable water. Navigable waters are those subject to the ebb and flow of the tide and those that are currently used, have been used in the past, or may be susceptible to use to transport interstate or foreign commerce (55 CFR 329.4). They include coastal and inland waters, lakes, rivers, and streams that are navigable, and the territorial seas. Structures or work outside the limits defined for navigable waters would require a Section 10 permit if the structure or work affects the course, location, condition, or capacity of the water body.

Section 208.10 (33 CFR 208.10) provides regulations regarding encroachments on Federal flood control structures and facilities that are constructed for local flood protection. Minor, low impact modifications of Federal flood control projects which do not adversely affect the function of the protective system can be approved by the USACE under Section 208.10. These modifications cannot change the authorized geometry or the hydraulic capacity of the Federal project. Small alterations are typically approved under a Central Valley Flood Protection Board (CVFPB) Encroachment Permit (see Section 4.5) and are reviewed and approved by the USACE in accordance with Section 208.10.

Major alterations to a Federal flood control project, including alterations to channels and levees that change the Federal project’s authorized geometry or the hydraulic capacity, would require a Section 408 permit. Section 408 requires authorization from USACE for the alteration of any sea wall, bulkhead, jetty, dike, levee, wharf, pier, or other work built by a Federal agency for the preservation and improvement of any of its navigable waters or to prevent floods. The types of alterations or modifications that require Section 408 approval include degradations, raisings, and realignments to the flood protection system or any modification where engineering analysis indicates that the system performance is adversely impacted. To receive authorization, the applicant must establish that the proposed alteration will not be injurious to the public interest and will not impair the usefulness of such work.

The USACE would initiate formal actions under Section 408 and Section 208.10 at the request of the CVFPB. The USACE is also consulted prior to initiating formal actions.

5.1.2 Federal Endangered Species Act

Application to Proposed Action

Several species that are Federally listed as threatened or endangered potentially occur in the Project area. As described in the TM on Existing Environmental Conditions for the Project, implementation of the proposed action may result in adverse effects to these species or their habitat. Because the action is proposed by a Federal agency and requires Federal permits and approvals, and because Project implementation could adversely affect Federally listed species, Section 7 consultation with USFWS and NMFS is required. The lead agency will prepare a Biological Assessment to obtain concurrence or a Biological Opinion (with incidental take statements, as necessary) from USFWS and NMFS for the proposed action.

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), NMFS regulates essential fish habitat (EFH). Since the proposed action may have adverse effects to EFH, the lead agency will need to consult with NMFS under the MSFCMA along with the Section 7 consultation.

Permit Purpose and Requirements

The ESA of 1973, as amended (16 USC 1531 et seq.), is a mechanism for the protection and recovery of species threatened with extinction and includes, but is not limited to, the following:

- a process to list species in danger of becoming extinct (Section 4)
- a prohibition on "take" of threatened and endangered species (Section 9)
- processes for exemption from Section 9 take prohibitions when take is incidental to, and not the purpose of, otherwise lawful activities (Section 7 and Section 10)

The ESA is administered by USFWS and NMFS. USFWS is responsible for protection of birds, terrestrial, and resident (nonanadromous) freshwater species. NMFS is responsible for protection of marine species and anadromous fish.

Section 9 of the ESA prohibits "take" (i.e., harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct) of any threatened or endangered species. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.

Section 7 of the ESA outlines procedures for Federal interagency cooperation to conserve Federally listed species and designated critical habitat. ESA mandates that all Federal agencies participate in the conservation and recovery of listed threatened and endangered species and that each agency ensure that any action it authorizes, funds, or carries out does not jeopardize the continued existence of a listed species or its critical habitat. Critical habitat is identified as specific areas that have the physical and biological features that are essential to the conservation of a listed species, and that may require special management considerations for protection. Section 7 outlines the required consultation procedures that provide Federal agencies with a mechanism for "incidental take," provided the "taking" will not jeopardize the continued existence of any listed species, or destroy or adversely modify critical habitat. Depending upon the anticipated level of impact to Federally listed species, the Federal lead agency and the USFWS and/or NMFS will engage in different levels of consultation:

- If the Federal lead agency finds that the Project would have "no effect" on listed species, no formal consultation is initiated with USFWS or NMFS
- If the Federal lead agency finds that the Project is "not likely to adversely affect" listed species, informal consultation with USFWS and/or NMFS would be initiated by the Federal lead agency to determine appropriate avoidance and minimization measures (e.g., best management practices [BMPs]) for the Project. The desired outcome of informal consultation is a letter of concurrence from USFWS and/or NMFS with the findings presented by the Federal lead agency
- If the Federal lead agency finds that the Project is "likely to adversely affect" a listed species, formal consultation is initiated with USFWS and/or NMFS. After determining whether the Project would jeopardize the continued existence of a listed species, the USFWS and/or NMFS would render either a jeopardy or nonjeopardy determination. The desired outcome of formal consultation is a signed nonjeopardy Biological Opinion, issued by USFWS and/or NMFS, stating the acceptable level of impact to listed species, the conservation measures for the species, and the agreed upon mitigation ratios for anticipated impacts. A signed Biological Opinion would include a statement authorizing take of species that may occur as incidental to an otherwise legal activity (i.e., incidental take statement) and is issued on the basis of information provided to USFWS or NMFS by a lead agency, often in the form of a Biological Assessment, prepared by either the Federal lead agency or the applicant

The MSFCMA, also known as the Sustainable Fisheries Act (16 USC Section 1801 et seq.), requires NMFS and the eight regional Fishery Management Councils to minimize, to the extent practicable, adverse effects to EFH. EFH is defined as the waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (50 CFR 600 et seq.). The EFH provisions of the MSFCMA are designed to protect fisheries habitat from being lost due to disturbance and degradation. NMFS and the regional Fishery Management Councils identify and describe EFH for each of the commercially managed marine and anadromous fish species in published fishery management plans.

The MSFCMA requires all Federal agencies to consult with NMFS (under the stewardship of the Secretary of Commerce) on activities or proposed activities that are authorized, funded, or undertaken by that agency that may adversely affect EFH. NMFS must then provide conservation recommendations to conserve and reduce impacts to EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH. Federal agencies are required to respond to EFH Conservation Recommendations.

Guidelines from the MSFCMA direct NMFS to use a coordinated process to evaluate projects that may affect EFH under Section 305(b) of the MSFCMA (16 USC

Section 1855[b]; 50 CFR 600 et seq.). EFH consultation would be included with the Section 7 consultation (16 USC Section 1536).

5.1.3 Fish and Wildlife Coordination Act

Application to Proposed Action

The Fish and Wildlife Coordination Act (FWCA) requires Federal agencies to consult with USFWS, NMFS, and DFG before undertaking or approving water projects that would control or modify surface water. Because the proposed action would affect surface waters, the lead agency must conduct consultation pursuant to the FWCA.

Purpose and Requirements

Coordination under FWCA is intended to promote conservation of fish and wildlife habitats by preventing their loss or damage and to provide for development and improvement of fish and wildlife habitats in connection with water projects. Federal agencies undertaking water projects are required to fully consider recommendations made by USFWS, NMFS, and DFG in project reports and include measures in project plans to reduce impacts on fish and wildlife habitat. Documentation of compliance with FWCA is a separate analysis of habitats of concern to USFWS and DFG and does not replace the analysis required by Section 7 of the Federal ESA. The process will, however, help to ensure that impacts to species protected under the Migratory Bird Treaty Act and the Bald Eagle Protection Act (see Section 6.1.1 and 6.1.2) are considered and avoided as required by law.

5.1.4 National Historic Preservation Act, Section 106

Application to Proposed Action

The proposed action may affect properties that are listed or eligible for listing on the National Register of Historic Places (NRHP) (16 U.S.C. 470 as amended).

Purpose and Requirements

Section 106 of the National Historic Preservation Act (NHPA) and implementing regulations at 36 CFR Part 800 require Federal agencies to take into account the effects of their undertakings on cultural resources (which include archaeological and architectural resources, and traditional cultural properties) that are listed on, are eligible for listing on, or are potentially eligible for listing on the NRHP. During this process, the Federal agency is usually required to consult with the State Historic Preservation Officer (SHPO) and in some instances the Advisory Council on Historic Preservation (ACHP), an independent Federal agency that advises the President and Congress on national historic preservation policy and administers the NHPA’s Section 106 review process. Section 101 of the NHPA establishes the responsibilities of the SHPO, which include consulting with Federal agencies regarding undertakings that may affect historic properties. The NHPA also requires that, in carrying out the requirements of Section 106, each federal agency must consult with any Indian tribe that attaches religious and cultural significance to historic properties that may be affected by the agency’s undertakings.

5.1.5 Rivers and Harbors Act Section 9 and General Bridge Act of 1946

Application to Proposed Action

The General Bridge Act of 1946, as amended, and Section 9 of the RHA, as amended, require that the location and plans of bridges and causeways across the navigable waters of the United States be submitted to and approved by the Secretary of Transportation prior to construction. The proposed Project will likely require the construction of a bridge at the intersection of San Mateo Avenue and the San Joaquin River; therefore, the lead agency will need to apply for a bridge permit.

Permit Purpose and Requirements

The purpose of regulating bridge construction under the General Bridge Act and Section 9 of the RHA is to preserve the public right of navigation and to prevent interference with interstate and foreign commerce. The authority to issue bridge permits was delegated by the Secretary of Transportation to the Commandant, U.S. Coast Guard, by Department of Transportation Order 1100.1 dated 31 March 1967 (49 CFR 1.46(c)). Project information and details about the proposed bridge must be submitted to the Commandant for approval prior to the construction of a bridge over navigable waters.

5.2 State Actions

5.2.1 Clean Water Act Section 401

Application to Proposed Action

The proposed action will result in fill and/or dredging of jurisdictional waters of the State, including wetlands, particularly in the San Joaquin River and nearby channels such as the Fresno Slough and Little San Joaquin Slough. As a result, a Section 401 Water Quality Certification will be required for these actions.

Permit Purpose and Requirements

Under Section 401 of the CWA, an applicant for a Section 404 permit must obtain a certificate from the USEPA or their delegated authority (in California, the SWRCB is delegated by EPA to administer the 401 Program) stating that proposed fill is consistent with the State’s water quality standards and criteria. In California, the authority to grant water quality certification is delegated by the State Water Resources Control Board (SWRCB) to the nine Regional Water Quality Control Boards (RWQCBs). Due to its location, the Project falls under jurisdiction of the Central Valley Regional Water Quality Control Board (CVRWQCB); therefore, the lead agency will consult with the CVRWQCB to obtain a Section 401 Water Quality Certification.

5.2.2 Clean Water Act Section 402

Application to Proposed Action

The proposed action would result in discharges of waste into waters of the State, which include “any surface water or ground water, including saline waters, within the boundaries of the State." An NPDES permit will be required for construction-related discharges to surface waters.

Permit Purpose and Requirements

Dischargers whose projects disturb 1 or more acres of soil or whose projects disturb less than 1 acre but are part of a larger common plan of development that in total disturbs 1 or more acres, are required to obtain coverage under the General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activity (Construction General Permit, 2009-0009-DWQ). Construction activity subject to this permit includes clearing, grading, and disturbances to the ground such as stockpiling or excavation, but does not include regular maintenance activities performed to restore the original line, grade, or capacity of the facility. In California, the authority to regulate compliance with CWA Section 402 requirements is shared between the SWRCB and the nine RWQCBs. Most enforcement responsibilities are delegated to the RWQCBs; therefore, the lead agency will coordinate with the CVRWQCB to ensure compliance.

To acquire a Construction General Permit, applicants must submit Permit Registration Documents (PRDs), including an NOI Form to discharge stormwater, a Storm Water Pollution Prevention Plan (SWPPP), and other documents. The SWPPP must be prepared by a Qualified SWPPP Developer and must list BMPs the discharger will use to protect stormwater runoff. Implementation of these BMPs must be overseen by a Qualified SWPPP Practitioner.

Compliance with the General Permit also requires on-site visual monitoring of stormwater and non–stormwater discharges and the submission of annual reports throughout the duration of the Project. Depending on the risk level of the Project, additional effluent monitoring or bioassessment sampling may be required. Once the Project is complete, the applicant must submit a Notice of Termination to be approved by the RWQCB.

5.2.3 California Endangered Species Act

Application to Proposed Action

Several State-listed threatened or endangered species potentially occur in the Project area and particularly near the San Joaquin River and in adjacent waterways such as the Fresno Slough, Little San Joaquin Slough, and the Mendota Pool. Implementation of the proposed action may result in adverse effects to these species or their habitat. For species listed as "Fully Protected," DFG cannot issue take authorization and requires the Project proponent to completely avoid these species.

Permit Purpose and Requirements

CESA (Fish and Game Code Section 2050 et seq.) generally parallels the main provisions of the Federal ESA and is administered by DFG. Under CESA, the term "endangered species" is defined as a species of plant, fish, or wildlife that is "in serious danger of becoming extinct throughout all, or a significant portion of, its range" and is limited to species or subspecies native to California.

CESA establishes a petitioning process for the listing of threatened or endangered species. The California Fish and Game Commission is required to adopt regulations for this process and establish criteria for determining whether a species is endangered or threatened. The California Code of Regulations, Title 14, Section 670.1(a) sets forth the required contents for such a petition. CESA prohibits the "taking" of listed species except as otherwise provided in State law. Unlike its Federal counterpart, CESA applies the take prohibitions to species petitioned for listing (State candidates). Section 86 of the Fish and Game Code defines "take" as to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill."

Sections 2080 and 2081 of the Fish and Game Code cover the "take" of State threatened and endangered species. One of two CESA-compliance processes is generally followed when take of a State-listed species may occur, the Section 2080.1 consistency determination or Section 2081 incidental take permit processes. If all listed species potentially affected by the proposed action are protected under both the Federal ESA and CESA, the California legislation encourages cooperative and simultaneous consultation between USFWS and DFG to coordinate the Federal ESA Section 7 process (see Section 5.1.2) and the CESA process so that consistent and compatible findings result. In this circumstance, authorization for take under CESA would be provided by a Section 2080.1 consistency determination. Section 2080.1 allows an applicant who has obtained a Federal incidental take statement through Section 7 consultation to request that DFG issue a consistency determination stating that the Federal document is "consistent" with CESA. A Section 2081 incidental take permit is required if agreement cannot be reached about consistency, for example if the Biological Opinion allows for incidental take of a fully protected species or if the project may affect a species that is only listed by the State.

5.2.4 California Fish and Game Code Section 1602

Application to Proposed Action

The proposed action will substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of a river, stream, or lake or use materials from a streambed. As a result, a notification of Streambed Alteration Agreement pursuant to Section 1600 et seq. of the Fish and Game Code must be submitted for this Project.

Permit Purpose and Requirements

DFG's Lake and Streambed Alteration Program (Fish and Game Code Section 1600 et. seq.) requires any person, State or local governmental agency, or any public utility who proposes a project that will substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake or use materials from a streambed to notify DFG.

Notification is generally required for any project that will take place in or in the vicinity of a river, stream, lake, or their tributaries. This includes rivers or streams that flow at least periodically or permanently through a bed or channel with banks and support fish or other aquatic life, and watercourses having a surface or subsurface flow that supports or has supported riparian vegetation.

After DFG determines that the Project will need a Lake or Streambed Alteration Agreement, Project activities within jurisdictional waters may not begin until a Lake or Streambed Alteration Agreement is developed and the Project described in that agreement is reviewed under CEQA. By working with DFG to develop a draft Lake or Streambed Alteration Agreement, the Project applicant can modify the Project features to avoid or lessen potential impacts on fish and wildlife resources. This would simplify CEQA review of the Project and expedite the issuance of a final agreement.

5.2.5 California Code of Regulations, Title 23

Application to Proposed Action

A permit is required for any project or plan of work that is: (1) within Federal flood control project levees and within a CVFPB easement, (2) or may have an effect on the flood control functions of project levees, (3) or is within a CVFPB designated floodway, (4) or is within regulated Central Valley streams listed in Table 8.1 in Title 23 of the California Code of Regulations. The San Joaquin River is listed in Table 8.1 and the proposed action could have an effect on the flood control functions of project levees just east and north of the Chowchilla Bifurcation Structure or downstream project levees. Therefore, an encroachment permit from the CVFPB (formerly known as the Reclamation Board) will likely be required for the proposed action. Approval by local reclamation districts may also be necessary.

Permit Purpose and Requirements

The CVFPB issues encroachment permits to maintain the integrity and safety of flood control project levees and floodways that were constructed according to the flood control plans adopted by the CVFPB or the California Legislature.

The CVFPB has jurisdiction over the levee section, the waterward area between project levees, a 10-foot-wide strip adjacent to the landward levee toe, within 30 feet of the top of the banks of unleveed project channels, and within designated floodways adopted by the CVFPB. Activities outside of these limits that could adversely affect the flood control project also fall under the jurisdiction of the CVFPB.

5.2.6 California Water Rights

Application to Proposed Action

The SJRRP is coordinating with the SWRCB to amend water rights at the Program level; however, those negotiations do not require action on the Project level. Most or all of the water rights present within the Project area are not under jurisdiction of the SWRCB because they are pre-1914 or riparian water rights. Therefore, it is unlikely that the Project will require coordination with the SWRCB. If water rights under the jurisdiction of the SWRCB are present, and if the Project required that the diversion point for the water rights be changed, it is possible that those water rights would have to be amended.

Permit Purpose and Requirements

A water right is a legally protected right, granted by law, to take possession of water and put it to beneficial use. Under the California Water Code, SWRCB is responsible for allocating surface water rights and permitting the diversion and use of water throughout the State. Through its Division of Water Rights, SWRCB issues permits to divert water for new appropriations or to change existing water rights. SWRCB attaches conditions to these permits to ensure that the water user prevents waste, conserves water, does not infringe on the rights of others, and puts the State's water resources to the most beneficial

An applicant, permittee, or licensee who wishes to change the point of diversion, place of use, or purpose of use from that specified in an existing permit or license must petition SWRCB to amend a water right. When considering a petition for a water right amendment, SWRCB considers the same factors as those it considers when a water user applies for a new permit, such as waste prevention, water conservation, infringement on the rights of others, and public trust values.

5.2.7 State Lands Commission Land Use Lease

Application to Proposed Action

The proposed action may directly affect lands, such as the San Joaquin River, under the jurisdiction of the SLC. The proposed action will therefore likely require a State lands lease agreement.

Permit Purpose and Requirements

The SLC was given authority and responsibility to manage and protect the important natural and cultural resources on certain public lands within the State and public's rights to access these lands. The public lands under the SLC's jurisdiction are of two distinct types—sovereign and school lands. Sovereign lands encompass approximately 4 million acres. These lands include the beds of California's naturally navigable rivers, lakes, and streams, as well as the State's tidal and submerged lands along the coastline.

5.3 Local Actions

5.3.1 San Joaquin Valley Air Pollution Control District Regulations

Application to Proposed Action

The Federal Clean Air Act (CAA) establishes national ambient air quality standards. Under the CAA, the U.S. EPA is responsible for setting and enforcing the Federal ambient air quality standards for atmospheric pollutants. Most regulatory responsibilities under the CAA are delegated to State, regional, or local government bodies. For the Project, the SJVAPCD has the authority to issue permits an ensure compliance with air quality regulations.

Any Federal agency providing financial assistance, issuing a license or permit, or approving or supporting in any way a proposed project located in a nonattainment or maintenance area for a criteria air pollutant is required to issue a conformity analysis. The conformity analysis must certify that the Federally permitted project is consistent with the State Implementation Plan (SIP) developed pursuant to the CAA. A conformity analysis is required unless the proposed action's emissions are below the Federally established *de* *minimis* emissions thresholds, and the proposed action's emissions do not reach the level of 10 percent or more of the regional emissions budget for any given pollutant in the nonattainment area. This is also applicable to short-term, construction-related emissions, and therefore applies to the Project.

The SJVAPCD is required by the California Clean Air Act (CCAA) to develop "indirect source" control programs in their attainment plans. The SJVAPCD committed to reducing PM_{10} and nitrous oxides emissions from indirect sources in the 2003 PM_{10} Plan and the 2004 Extreme Ozone Attainment Demonstration Plan. The SJVAPCD's Governing Board adopted District Rule 9510 as a result of this commitment. To comply with this rule, the Project will have to submit an Air Impact Assessment (AIA) to the SJVAPCD.

Since the Project will not require the construction or operation of a major stationary source that is adding new emissions units or modifying existing emissions units, the Project will not require Construction or Operation Permits from the SJVAPCD. However, if the Project requires the use of equipment (i.e., a generator) with an internal combustion engine with a rated brake horsepower greater than 50 horsepower that will operate less than six months at one location, a Portable Equipment Certification from SJVAPCD will be necessary.

Finally, because the proposed action would likely involve the construction of a nonresidential development of more than 5 acres of disturbed surface area and could involve moving, depositing, or relocating more than 2,500 cubic yards per day of bulk materials on at least 3 days, a Dust Control Plan is required by SJVAPCD.

Permit Purpose and Requirements

The CAA requires areas with unhealthy levels of ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and inhalable particulate matter to develop SIPs to comply with the national ambient air quality standards (42 USC §7410 et seq.). Federal agencies must conform to SIPs, meaning they must ensure that Federally supported activities will not cause or contribute to a new violation, increase the severity of an existing violation, or delay timely attainment of any standard in any area (42 USC §7506(c)(1)(B)).

A Federal action conforms with the applicable SIP if: (1) the total of direct and indirect emissions from the action are compliant and consistent with the requirements of the SIP, and (2) one of a list of enumerated, pollutant-specific requirements are satisfied (such as accounting for the Federal action's projected emission of any criteria pollutant in the SIP, or offsetting ozone or nitrogen dioxide emissions within the nonattainment area) (42 CFR §93.158(a)). Ultimately, a conformity analysis may require revising the SIP, implementing mitigation measures to bring the Federal action's emissions levels down, or altering the Project to reduce emissions to levels within the budgets established by the SIP for specific pollutants.

In accordance with SJVAPCD Rule 9510 Indirect Source Review (ISR), applicants must mitigate project impacts through the incorporation of on-site emission reducing design elements and/or the payment of fees that would be used to fund off-site emissions reduction projects. Applicants subject to the rule must submit an AIA application to the SJVFCD no later than when applying for final discretionary approval, and must pay any applicable off-site mitigation fees before issuance of the first grading/building permit.

In accordance with SJVAPCD Rule 2020 – Exemptions – emissions units that qualify and are registered as Portable Equipment do not require Construction and Operating Permits. If the Project requires the use of an internal combustion engine with a rated brake horsepower greater than 50 horsepower to operate for less than six months, it must be registered as Portable Equipment to be exempt from requirements under Rule 4702 – Internal Combustion Engines.

In accordance with SJVAPCD Rule 8021 – Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities, the owner or operator of a construction project is required to submit a Dust Control Plan to SJVAPCD if at any time the project would involve:

- residential developments of 10 or more acres of disturbed surface area;
- nonresidential developments of 5 or more acres of disturbed surface area; or
- moving, depositing, or relocating of more than 2,500 cubic yards per day of bulk materials on at least three days of the project

A Dust Control Plan identifies the fugitive dust sources at the construction site and describes all of the dust control measures to be implemented before, during, and after any dust-generating activity for the duration of the project. SJVAPCD will review and make a determination on the Dust Control Plan. Construction activities shall not commence until the Dust Control Plan has been approved or conditionally approved.

At least one key individual representing the owner or operator, or any person who prepares a Dust Control Plan, must complete a Dust Control Training Course presented by SJVAPCD. SJVAPCD will be contacted to determine when courses are offered. For those who need to submit a Dust Control Plan but have not had the course, SJVAPCD will accept the Dust Control Plan with the contingency that the individual sign up for the next scheduled course.

Regardless of whether an SJVAPCD-approved Dust Control Plan is in place, the owner or operator is required to comply with all requirements of the applicable rules under Regulation VIII and SJVAPCD's Rules and Regulations at all times.

5.3.2 Surface Mining and Reclamation Act of 1975

Application to Proposed Action

The requirements of the Surface Mining and Reclamation Act of 1975 (SMARA) apply to anyone, including government agencies, engaged in surface mining operations in California (including those on Federally managed lands) that disturb more than one acre or remove more than 1,000 cubic yards of material. This includes, but is not limited to, prospecting and exploratory activities, dredging and quarrying, streambed skimming, borrow pitting, and the stockpiling of mined materials.

SMARA does not typically apply to on-site excavation and on-site earthmoving activities that are an integral and necessary part of a construction project and that are undertaken to prepare a site for construction of structures, landscaping or other land improvements, including the related excavation, grading, compaction or the creation of fills, road cuts and embankments. This is true whether or not surplus materials are exported from the site so long as required permits are approved by public agencies, the county's approval included consideration of the on-site excavation and on-site earthmoving activities pursuant to CEQA, the project is consistent with the general plan or zoning of the site, and surplus materials are not exported from the site until actual construction work has commenced and cease when construction activities have terminated. However, the SMARA process may be required, as determined by the county, for earth-moving projects that exceed 1,000 cubic yards if greater than 80 percent of the material is disposed of offsite.

Permit Purpose and Requirements

The SMARA (Public Resources Code, Sections 2710-2796) provides a comprehensive surface mining and reclamation policy with the regulation of surface mining operations to assure that adverse environmental impacts are minimized and mined lands are reclaimed to a usable condition. SMARA also encourages the production, conservation, and protection of the State's mineral resources. On a State level, the Department of Conservation's Office of Mine Reclamation and the State Mining and Geology Board are jointly charged with ensuring proper administration of the SMARA's requirements.

City and county lead agencies adopt ordinances for land use permitting and reclamation procedures that provide the regulatory framework under which local mining and reclamation activities are conducted. SMARA lead agencies review applications for permits and/or reclamation plans (or amendments thereto), submit reclamation plans and financial assurances to the State for technical review and comment prior to approval, annually review financial assurances, annually inspect mining operations for compliance, and take enforcement actions where necessary.

Financial assurances are required to ensure compliance with elements of the reclamation plan, including but not limited to revegetation and landscaping requirements, restoration of aquatic or wildlife habitat, restoration of water bodies and water quality, slope stability and erosion and drainage control, disposal of hazardous materials, and other measures, if necessary.

5.3.3 Williamson Act

Application to Proposed Action

Land within the Project area may be under a Williamson Act contract.

Permit Purpose and Requirements

The California Land Conservation Act (Government Code §51200 et seq.) of 1965, commonly known as the Williamson Act, provides a tax incentive for the voluntary enrollment of agricultural and open space lands in contracts between local government and landowners. The contract restricts the land to agricultural and open space uses and compatible uses defined in state law and local ordinances. Local government establishes an agricultural preserve defining the boundary within which a city or county will enter into contracts with landowners. Local governments calculate the property tax assessment based on the actual land use instead of the potential land value assuming full development.

Williamson Act contracts are for 10 years and longer. The contract is renewed automatically each year, maintaining a constant, 10-year contract, unless the landowner or local government files to initiate nonrenewal. Should that occur, the Williamson Act would terminate 9 years after the filing of a notice of nonrenewal. Only a landowner can petition for a contract cancellation. Tentative contract cancellations can be approved only by a local government. The cancellation fee typically must be paid by the landowner.

California Government Code (§51290–51295) outlines the procedure for locating a public use on Williamson Act contracted land, which may apply to the Project and is described in the following section.

5.4 Applicable Laws, Policies, and Plans Not Requiring Specific Permit or Approval

5.4.1 Federal

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA), first enacted in 1918, implements domestically a series of treaties between the United States and Great Britain (on behalf of Canada), Mexico, Japan, and the former Soviet Union that provide for international migratory bird protection. The MBTA authorizes the Secretary of the Interior to regulate the taking of migratory birds; the act provides that it shall be unlawful, except as permitted by regulations, "to pursue, take, or kill any migratory bird, or any part, nest or egg of any such bird…" (USC Title 16, Section 703). This prohibition includes both direct and indirect acts, although harassment and habitat modification are not included unless they result in direct loss of birds, nests, or eggs. The current list of species protected by MBTA includes several hundred species and essentially includes all native birds. The act offers no statutory or regulatory mechanism for obtaining an incidental take permit for the loss of nongame migratory birds.

Bald and Golden Eagle Protection Act

The Bald Eagle Protection Act (16 USC 668 668d, 54 Stat. 250) as amended, provides protection for the bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) by prohibiting the taking, possession, and commerce of such birds, their nests, eggs, or feathers unless expressly authorized by permit pursuant to Federal regulations.

Executive Order 11990 (Wetlands Policy)

Executive Order 11990 is an overall wetlands policy for all agencies that manage Federal lands, sponsor Federal projects, or provide Federal funds to State or local projects. The order requires Federal agencies to follow avoidance, mitigation, and preservation procedures with public input before they propose new construction in wetlands. Executive Order 11990 can restrict the sale of Federal land containing wetlands; however, it does not apply to Federal discretionary authority for non-Federal projects (other than funding) on non-Federal land.

Before implementing an action that is located in a wetland or may affect a wetland, Federal agencies must demonstrate that there is no practical alternative and that the proposed action includes all practical measures to minimize harm to the wetlands. To demonstrate compliance with Executive Order 11990, Reclamation must make such a demonstration if appropriate, provide the opportunity for early public review, and disclose its findings in the Project EIS/R and/or subsequent NEPA documents.

Projects requiring compliance with Executive Order 11990 (except USACE projects) are likely to require a permit under CWA Section 404. The assessment of effects of the proposed action on wetlands should be closely coordinated with the Section 404 process.

Executive Order 11988 (Flood Hazard Policy)

Executive Order 11988 is a flood hazard policy for all Federal agencies that manage Federal lands, sponsor Federal projects, or provide Federal funds to State or local projects. It requires that all Federal agencies take necessary action to reduce the risk of flood loss; restore and preserve the natural and beneficial values served by floodplains; and minimize the impacts of floods on human safety, health, and welfare. Specifically, Executive Order 11988 dictates that all Federal agencies avoid construction or management practices that would adversely affect floodplains unless that agency finds that there is no practical alternative and the proposed action has been designed or modified to minimize harm to or within the floodplain.

Before implementing a proposed action, Federal agencies are required to determine whether the action would occur in a floodplain. This determination must be made according to a floodplain map provided by the Department of Housing and Urban Development or, if available, a more detailed map of an area. If the Federal agency proposes an action in a floodplain, it must consider alternatives to avoid adverse effects and incompatible development in the floodplain. If the agency finds that the only practicable alternative requires that the project be sited in a floodplain, it must:

- design or modify its action to minimize potential harm to or within the floodplain
- prepare and circulate a notice, not to exceed three pages in length, that includes:
  - reasons why the action is proposed to be located in a floodplain
  - a statement indicating whether the action conforms to applicable State or local floodplain protection standards
  - a list of alternatives considered

The agency should send the notice to the State Clearinghouse.

To demonstrate compliance, Reclamation must conduct this determination and consider alternatives as appropriate, provide an opportunity for early public review by those who may be affected, and disclose its findings in the NEPA documentation.

Executive Order 12898 (Environmental Justice Policy)

Executive Order 12898 requires Federal agencies to identify and address disproportionately high and adverse human health and environmental effects of Federal programs, policies, and activities on minority and low-income populations. These effects are to be considered in terms of both their frequency and magnitude. Executive Order 12898 requirements apply to all Federal actions that are located on Federal lands, sponsored by a Federal agency, or funded with Federal monies and may affect minority or low-income populations. This executive order was incorporated into California State Government through California Government Code, Section 65040.12, which codified a definition of environmental justice and established the Governor's Office of Planning and Research as the coordinating agency in state government for environmental justice programs.

To demonstrate compliance with Executive Order 12898, the lead agency must show that it has considered the effects of the proposed action on minority and low-income populations and must design the proposed action to ensure that the action does not result, either directly or indirectly, in discrimination on the basis of race, color, or national origin.

There is no single analytical approach to environmental justice analysis, but the approach chosen should be designed to incorporate any unique circumstances of the community potentially affected by a proposed project. The use of multiple approaches in this analysis is encouraged to ensure the accuracy and completeness of findings. In all cases, the agency must undertake specific outreach to any identified minority and low-income populations. This outreach is to be specifically targeted to allow environmental justice populations to fully participate in the public involvement process. The agency must also provide an opportunity for early public review by those who may be affected, and must include a description of the specific outreach undertaken and all findings in the Project EIS/R. If a proposed Federal action will not result in significant adverse impacts on minority and low-income populations, the Project EIS/R must describe how Executive Order 12898 was addressed during the NEPA process.

Executive Order 13112 (Invasive Species)

Executive Order 13112 requires Federal agencies to perform measures to minimize the spread of invasive species and to reintroduce native species where possible. This order applies to "actions [that] may affect the status of invasive species" (§2). Federal agencies must pursue the duties mandated under the order in consultation with the Invasive Species Council (§2(b)). The order also requires agencies to formulate their own Invasive Species Management Plan (ISMP) (§5). Restoration activities and planning will be integrated with Reclamation's ISMP. The following list will be key species to be evaluated and have been observed in the Project area:

- tree tobacco (*Nicotiana glauca*)

- giant reed grass (*Arundo donax*)
- tamarisk (*Tamarix sp.*)
- perennial pepperweed (*Lepidium latifolium*)
- yellow star thistle (*Centaurea solstitialis*)
- Italian thistle (*Carduus pycnocephalus*)
- ripgut brome (*Bromus diandrus*)
- Bermuda grass (*Cynodon dactylon*)
- prickly lettuce (*Lactuca s*erriola)
- Russian knapweed (*Rhaponticum repens*)
- rabbitsfoot grass (*Polypogon monspeliensis*)

Executive Order 13186 (Migratory Birds)

Executive Order 13186 directs Federal agencies to take certain actions to further implement the MBTA and outlines the responsibilities of Federal agencies to protect migratory birds. Specifically, this order directs Federal agencies with direct activities that will likely result in the take of migratory birds, to develop and implement an MOU with the USFWS that shall promote the conservation of migratory bird populations, with emphasis on species of concern. Reclamation has not finalized the MOU required in this order pending Department of Interior guidance. Reclamation has begun implementing the conservation measures set forth in this order, however, as appropriate and applicable.

Birds protected under the MBTA include all common songbirds, waterfowl, shorebirds, hawks, owls, eagles, ravens, crows, native doves and pigeons, swifts, martins, swallows, and others, including their body parts (feathers, plumes, etc.), nests, and eggs. A complete list of protected species is found at 50 CFR 10.13. Project activities that are most likely to result in take of migratory birds include, but are not limited to, clearing or grubbing of migratory bird nesting habitat during the nesting season when eggs or young are likely to be present. Efforts will be made to remove nesting habitat or inactive nests of migratory birds outside of the bird breeding season, and such activities will occur in coordination with the USFWS office with local jurisdiction.

Executive Order 13007 (Indian Sacred Sites)

Executive Order 13007 requires Federal land management agencies to "accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and avoid adversely affecting the physical integrity of such sacred sites." Additionally, the order requires Federal agencies to provide notice of proposed actions or land management policies that may restrict future access to or ceremonial use of, or adversely affect the physical integrity of, sacred sites. If an Indian sacred site is encountered within the Project area, measures will be implemented to prevent any restriction of access or effect on the site's physical integrity.

Indian Trust Assets

All Federal agencies have a responsibility to protect Indian Trust Assets. Indian Trust Assets are legal interests in assets held in trust by the Federal government for Native

American tribes or individuals. Assets may be owned property, physical assets, intangible property rights, a lease, or the right to use something and typically include lands, minerals, water rights, hunting and fishing rights, natural resources, money, and claims. If Indian Trust Assets may be affected by the proposed action, mitigation or compensation measures are to be identified so that no net loss is incurred by the Native American beneficial owners of the asset.

Farmland Protection Policy Act

The Farmland Protection Policy Act requires that a Federal agency examine the potential impacts of a proposed action on prime and unique farmland, as defined by the Natural Resources Conservation Service (NRCS), and if the action would adversely affect farmland preservation, consider alternatives to lessen the adverse effects. As a Federal agency preparing an EIS, Reclamation is required to include in its analysis a farmland assessment designed to minimize adverse impacts on prime and unique farmlands and provide for mitigation as appropriate. Compliance with the Farmland Protection Policy Act could include early consultation and coordination with NRCS.

Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (25 USC Sections 3001 to 3013) sets provisions for the removal and inadvertent discovery of human remains and other cultural items on Federal and tribal lands. The Native American Graves Protection and Repatriation Act clarifies the ownership of human remains and sets forth a process for repatriation of human remains and associated funerary objects and sacred religious objects to the Native American tribes or tribes likely to be lineal descendants or culturally affiliated with the discovered remains or objects.

5.4.2 State

California Native Plant Protection Act

Sections 1900 1913 of the Fish and Game Code (California Native Plant Protection Act of 1977) establish criteria for the preservation, protection, and enhancement of endangered or rare native plants of the State. The California Native Plant Protection Act protects endangered and rare species, subspecies, and varieties of wild plants native to California. This act requires all State agencies to use their authority to carry out programs to conserve endangered and rare native plants. Provisions of the California Native Plant Protection Act prohibit the taking of listed plants from the wild and require notification of the DFG at least 10 days in advance of any change in land use. This allows the DFG to salvage listed plant species that would otherwise be destroyed. The project sponsor is required to conduct botanical inventories and consult with the DFG during project planning to comply with the provisions of this act and sections of CEQA that apply to rare or endangered plants.

California Native Plant Society Species Designations

The California Native Plant Society (CNPS) is a statewide nonprofit organization that seeks to increase understanding of California's native flora and to preserve this rich resource for future generations. CNPS has developed and maintains lists of vascular plants of special concern in California. CNPS-listed species have no formal legal protection, but the values and importance of these lists are widely recognized. CNPS List 1 and 2 species are considered rare plants pursuant to Section 15380 of CEQA, and it is recommended that they be fully considered while preparing environmental documents relating to CEQA.

Porter-Cologne Water Quality Control Act

Under the Porter-Cologne Water Quality Control Act, the RWQCBs have jurisdiction over State water quality permitting activities. The Porter-Cologne Water Quality Control Act specifies water quality provisions and discharge requirements for regulating the discharge of waste that could affect the quality of waters of the State. Under the act, the SWRCB has the ultimate authority over State water rights and water quality policy. However, the appropriate RWQCB is tasked with setting waste discharge requirements for projects and for updating basin plans (water quality control plans) for protected waters of the State. Waters of the State are defined as "any surface water or groundwater, including saline waters, within the boundaries of the State (Water Code section 13050(e)) which include all waters within the State's boundaries, whether private or public, including waters in both natural and artificial channels."

Under the act, RWQCB must prepare and periodically update water quality control basin plans. Each basin plan sets forth water quality standards for surface water and groundwater, as well as actions to control nonpoint and point sources of pollution to achieve and maintain these standards. Projects that affect wetlands or waters must meet RWQCB waste discharge requirements, which may be issued in addition to a water quality certification under Section 401 of the CWA.

California Register of Historical Resources

Public Resources Code Section 5024.1 establishes the California Register of Historical Resources (CRHR). The register lists all properties considered to be significant historical resources in the State. The CRHR includes all properties listed or determined eligible for listing on the NRHP, including properties evaluated under Section 106. The criteria for listing are similar as those of the NRHP. CEQA (Public Resources Code) Section 21084.1 requires a finding of significance for substantial adverse changes to historical resources and defines the term "historical resources." CEQA Section 21083.2 and CEQA Guidelines Section 15064.5(c) provide further definitions and guidance for archaeological sites and their treatment. The lead agency is required to follow the established guidelines during the CEQA process.

California Native American Graves Protection and Repatriation Act

The California Native American Graves Protection and Repatriation Act (California Health & Safety Code Section 8010 et seq.) establishes a State repatriation policy intent that is consistent with and facilitates implementation of the Federal Native American Graves Protection and Repatriation Act. The act strives to ensure that all California Indian human remains and cultural items are treated with dignity and respect, and states an intent for the State to provide mechanisms for aiding California Indian tribes, including non-Federally recognized tribes.

5.4.3 Local

The counties of Fresno and Madera, and their respective public works departments, will require compliance with local plans and ordinances, such as County general plans, zoning ordinances, grading plan, and various use permits. Specifically, although neither county has ordinances requiring tree protection, both counties have provided voluntary guidelines for the protection of oaks and heritage trees.

This page left blank intentionally.

6.0 Acknowledgments

The preparers would like to acknowledge the input and participation of Bureau of Reclamation and other SJRRP staff, third-party consultants, resource agency staff, and others. A partial list of these participants includes:

Michelle Banonis	Reclamation	Bob Mussetter	Tetra Tech
Lisa Fotherby	Reclamation	Nick Hindman	USFWS
Alicia Gasdick	Reclamation	Zac Jackson	USFWS
Elaina Gordon	Reclamation	Becky Lorig	USFWS
Blair Greimann	Reclamation	Carl Mesick	USFWS
Katrina Harrison	Reclamation	Donnie Ratcliff	USFWS
Jeremy Lorberau	Reclamation	Stephanie Rickabaugh	USFWS
David Mooney	Reclamation	Kim Webb	USFWS
Erin Rice	Reclamation	Michelle Workman	USFWS
Karen Dulik	DWR	Larry Brown	USGS
David Encinas	DWR	Steven Phillips	USGS
Greg Farley	DWR	George Heise	DFG
Alexis Phillips-Dowell	DWR	Dale Stanton	DFG
Paul Romero	DWR	Leslie Mirise	NMFS
Susan Cundiff	Tetra Tech	Erin Strange	NMFS
Chad Morris	Tetra Tech	Steve Thomas	NMFS

This page left blank intentionally.

7.0 References

Barbour 2007. Barbour, M.G., T. Keeler-Wolf, and A. Schoenherr. *Terrestrial Vegetation of California*. Third Edition.

CDF 2007. California Department of Finance. *Population Projections for California and Its Counties 2000-2050 by Age, Gender and Race/Ethnicity*. Sacramento. July.

CVFED 2009. Central Valley Floodplain Evaluation and Delineation and San Joaquin River Restoration Program LiDAR data and aerial imagery. Produced for California Department of Water Resources. April 9.

DFG 1998. California Department of Fish and Game. *California Salmonid Stream Habitat Restoration Manual, Third Edition.* January.

DWR 2009a. California Department of Water Resources. *Chowchilla Bifurcation Structure Gate Seal Installation Notice of Exemption*. August.

DWR 2009b. California Department of Water Resources. *Draft San Joaquin River Restoration Program Geotechnical Investigation and Seepage Well Installation Project Initial Study/Mitigated Negative Declaration*. October.

DWR 2009c. California Department of Water Resources. *San Joaquin River Restoration Program Scour Chain Installation and Data Collection Notice of Exemption*. February.

DWR 2009d. California Department of Water Resources. *San Joaquin River Restoration Program Stream Bed and Sand Sampling Notice of Exemption*. April.

DWR 2009e. California Department of Water Resources. *San Joaquin River Restoration Program Stream Gage Installation and Operation and Maintenance Project Initial Study/Mitigated Negative Declaration*. March.

DWR 2009f. California Department of Water Resources. *San Joaquin River Restoration Program Water Level Recorder Installation and Data Collection Notice of Exemption*. February.

Grosholz 2006. Grosholz, Edwin and E. Gallo 2006. *The influence of flood cycle and fish predation on invertebrate production on a restored California floodplain*. Hydrobiologia. (2006) 568: 91-109.

Houk, 2009. Randy Houk. Personal communication with the Reach 2B team during a site visit. December 15.

Jeffres 2008. Jeffres, Carson A., J.J. Opperman and P. B. Moyle. Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California River. *Environmental Biology of Fishes*. Vol. 83, No. 4. Pages 449-458.

McBain & Trush 2002. *San Joaquin River Restoration Study Background Report*. Prepared by Friant Water Users Authority, Lindsay, California, and Natural Resources Defense Council, San Francisco, California. December.

NMFS 2001. National Marine Fisheries Service, Southwest Region. *Guidelines for Salmonid Passage at Stream Crossings*. September.

NMFS 2008. National Marine Fisheries Service, Northwest Region. *Anadromous Salmonid Passage Facility Design*. February.

Pacific States Marine Fisheries Commission 2007. CalFish Passage Assessment Database. Downloaded from www.calfish.org.

Reclamation 2006. U.S. Bureau of Reclamation. *Water Resources Technical Publication, Fish Protection at Water Diversions, a Guide for Planning and Designing Fish Exclusion Facilities*. April.

Reclamation 2008. U.S. Bureau of Reclamation. *Installation and Rehabilitation of Stream Gages on the San Joaquin River, Fresno, Madera, and Merced Counties, California Environmental Assessment/Finding of No Significant Impact*. December.

Reclamation 2010. U.S. Bureau of Reclamation. *Water Year 2011 Interim Flows Project Supplemental Environmental Assessment and Finding of No Significant Impact*. September.

Reclamation and DWR 2009. U.S. Bureau of Reclamation and California Department of Water Resources. *San Joaquin River Restoration Program Water Year 2010 Interim Flows Project, Environmental Assessment and Finding of No Significant Impact/Initial Study and Mitigated Negative Declaration*. October.

SJRRP 2010a. San Joaquin River Restoration Program. *Draft Mendota Pool Bypass and Reach 2B Improvements Project Technical Memorandum on Environmental Field Survey Results*. November.

SJRRP 2010b. San Joaquin River Restoration Program. *First Administrative Draft Mendota Pool Bypass and Reach 2B Project Technical Memorandum on Regulatory Compliance*. December.

SJRRP 2010c. San Joaquin River Restoration Program. *Mendota Pool Bypass and Reach 2B Improvements Project Public Scoping Report*. February.

SJRRP 2010d. San Joaquin River Restoration Program. *Mendota Pool Bypass and Reach 2B Improvements Project Technical Memorandum on Initial Options*. April.

SJRRP 2010e. San Joaquin River Restoration Program. *Mendota Pool Bypass and Reach 2B Improvements Project Technical Memorandum on Selection and Use of Analytical Tools*. October.

SJRRP 2011. San Joaquin River Restoration Program. *Draft San Joaquin River Restoration Program PEIS/R.* April.

SJRRP 2012. San Joaquin River Restoration Program. *Third Party Working Draft Framework for Implementation*. June 19.

Sommer 2001. Sommer, T.R., M.L. Nobriga, W.C. Harrell, W. Batham and W.J. Kimmerer. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. *Canadian Journal of Fisheries and Aquatic Sciences*. Volume 58. Pages 325–333

Sommer 2004. Sommer, T. R., W.C. Harrell, A.M. Solger, B. Tom and W. Kimmerer. Effects of flow variation on channel and floodplain biota and habitats of the Sacramento River, California, USA. *Aquatic Conservation-Marine and Freshwater Ecosystems.* Volume 14. Pages 247–261.

Tetra Tech 2011a. *Fresno Slough Dam Alternative - Elimination of Mendota Dam Option*. September 22.

Tetra Tech 2011b. *Mendota Pool Bypass Final Alternatives - Mendota Bypass Channel with no Grade-control Option*. November 16.

Tetra Tech 2012. *Reach 2B Floodplain Alternatives Supplemental Analysis*. January 9.

USACE 2000a. U.S. Army Corps of Engineers. *Engineer Manual 1110-2-1313 Design and Construction of Levees*. April 30.

USACE 2000b. U.S. Army Corps of Engineers. *Engineer Manual 1110-2-301 Guidelines for Landscape Planting and Vegetation Management at Floodwalls, Levees, & Embankment Dams*. January 1.

This page left blank intentionally.

Mendota Pool Bypass and Reach 2B Improvements Project

Project Description Technical Memorandum
Attachment A – Initial Alternatives Evaluation

SAN JOAQUIN RIVER
RESTORATION PROGRAM

October 2012

Table of Contents

Tables

Figures

Attachments

List of Abbreviations and Acronyms

2D	two-dimensional
Act	San Joaquin River Restoration Settlement Act
CCC	Columbia Canal Company
CCID	Central California Irrigation District
CDFG	California Department of Fish and Game
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	cubic feet per second
CVFED	Central Valley Floodplain Evaluation and Delineation
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
DOE	California Department of Water Resources, Division of Engineering
DWR	California Department of Water Resources
EIS/R	Environmental Impact Statement/Environmental Impact Report
ESA	Endangered Species Act
FAF	floodplain activation flow
FMWG	SJRRP Fisheries Management Work Group
Flood Control Project	Lower San Joaquin River Flood Control Project
Flood Operation Manual	Flood Control Project's Operation and Maintenance Manual for Levee, Irrigation and Drainage Structures, Channels and Miscellaneous Facilities
fps	feet per second
ft^2	square feet
FSRAF	floodplain salmonid rearing activation flow
Levee District	Lower San Joaquin Levee District
NAVD88	North American Vertical Datum 1988
NEPA	National Environmental Policy Act
NGVD29	National Geodetic Vertical Datum 1929
NMFS	National Marine Fisheries Service
NRDC	Natural Resources Defense Council

OHV	off-highway vehicle
OHWM	ordinary high water mark
O&M	operations and maintenance
PEIS/R	Program Environmental Impact Statement/ Environmental Impact Report
Pool	Mendota Pool
Project	Mendota Pool Bypass and Reach 2B Improvements Project
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Restoration Area	the San Joaquin River Restoration area from Friant Dam to the Merced River confluence
RM	river mile
Secretary	Secretary of the U.S. Department of the Interior
Settlement	Stipulation of Settlement
SJRRP	San Joaquin River Restoration Program
SSJVIC	South San Joaquin Valley Information Center
State	State of California
SWP	State Water Project
TM	Technical Memorandum
USACE	U.S. Army Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Definitions

For the purposes of the discussion in this technical memorandum, the following terms are defined.

The Project – The Project refers to the portion of Reach 2B that will convey Restoration Flows, the Mendota Pool Bypass, and all facilities related to implementation.

Reach 2B – Reach 2B refers either to the existing San Joaquin River between the Chowchilla Bifurcation Structure and the Mendota Dam or to the future portion of that reach which will contain Restoration Flows. Reach 2B does not include the Mendota Pool Bypass.

Mendota Pool Bypass – Refers to the portion of the Project (channels, structures, and other facilities) that will enable conveyance of Restoration Flows around the Mendota Pool.

Pre-appraisal level themes – Pre-appraisal level themes are concepts used in an iterative process of modeling coupled with public outreach and concept refinement. Themes were refined and presented as initial options in the Initial Options Technical Memorandum (TM) (SJRRP 2010e).

Initial Options – Initial options represent building blocks for future development of project alternatives. Initial options were prepared for each project component and presented in the Initial Options TM as a "menu" of preliminary ideas to meet the project goals for each component. The initial options were further refined into Initial Alternatives by subsequent data collection, analysis and analytical tools.

Initial Alternatives – Initial Alternatives are refined versions of the initial options and were used to conduct the alternatives evaluation presented here. The evaluation assesses the effects of the Initial Alternatives in several key resource areas (costs, schedule, fish habitat and passage, habitat restoration, geomorphology, economics, socioeconomics, land use, and threatened and endangered plants and wildlife). Initial Alternatives present a range of alternatives for each major component of the Project, both the Reach 2B improvements and the Mendota Pool Bypass.

Final Alternatives – The Final Alternatives are those Floodplain Initial Alternatives and Bypass Initial Alternatives that were selected following the alternatives evaluation and paired to form a whole (complete) project alternative. They are presented in the Project Description TM, which will feed into the Environmental Impact Statement/Environmental Impact Report (EIS/R). Final Alternatives are of a sufficient detail to evaluate benefits and impacts, including project costs, land acquisition, and mitigation needs. Each Final Alternative for the Project includes actions for both the Mendota Pool Bypass and the Reach 2B improvements.

This Draft Technical Memorandum (TM) was prepared by the San Joaquin River Restoration Program (SJRRP) Team as a draft document in support of preparing an Environmental Impact Statement/Environmental Impact Report (EIS/R) for the Mendota Pool Bypass and Reach 2B Improvements Project (Project). The purpose for circulating this document at this time is to facilitate early coordination regarding initial approaches currently under consideration by the SJRRP Team with the Settling Parties, Third Parties, other stakeholders, and interested members of the public. Therefore, the content of this document may not necessarily be included in the Project EIS/R. While the SJRRP Team is not requesting formal comments on this document, comments received will be considered to the extent possible.

This page left blank intentionally.

1.0 Introduction

This Project Description Technical Memorandum (TM) Attachment A documents the process for formulating and evaluating a broad range of Initial Alternatives to arrive at a reasonable range of complete alternatives. The alternatives will be evaluated further in the Project EIS/R for the Mendota Pool Bypass and Reach 2B Improvements Project (Project), a component of Phase 1 of the overall San Joaquin River Restoration Program (SJRRP). The SJRRP was established in late 2006 to implement the Stipulation of Settlement (Settlement) in *Natural Resources Defense Council (NRDC), et al,. v. Kirk Rodgers, et al*.

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation), as the Federal lead agency under the National Environmental Policy Act (NEPA), and the California Department of Water Resources (DWR), as the State lead agency under the California Environmental Quality Act (CEQA), prepared this TM as an initial step in preparation of an Environmental Impact Statement/ Environmental Impact Report (EIS/R) for the Project. Federal authorization for implementing the Settlement is provided in the San Joaquin River Restoration Settlement Act (Act) (Public Law 111-11).

1.1 Purpose of this Attachment

This Attachment is intended to:

- Document the alternatives formulation and evaluation process for the Project consistent with NEPA and CEQA requirements
- Describe Project goals and objectives and opportunities and constraints
- Examine a reasonable range of alternatives to identify those that could meet the Settlement goals for the Project
- Obtain input and feedback from the Implementing Agencies, Technical Work Groups, landowners, and other stakeholders involved in the Project

1.2 Summary of the Alternatives Formulation Process

As part of implementation of the Settlement, Reclamation and DWR began the NEPA/CEQA process on the site-specific projects, including the Mendota Pool Bypass and Reach 2B Improvements Project, by initiating preparation of an EIS/R. An early step in developing the EIS/R is the formulation of the project alternatives that would be addressed by the document. The process diagram shown in Figure 1-1 depicts the steps in the formulation process.

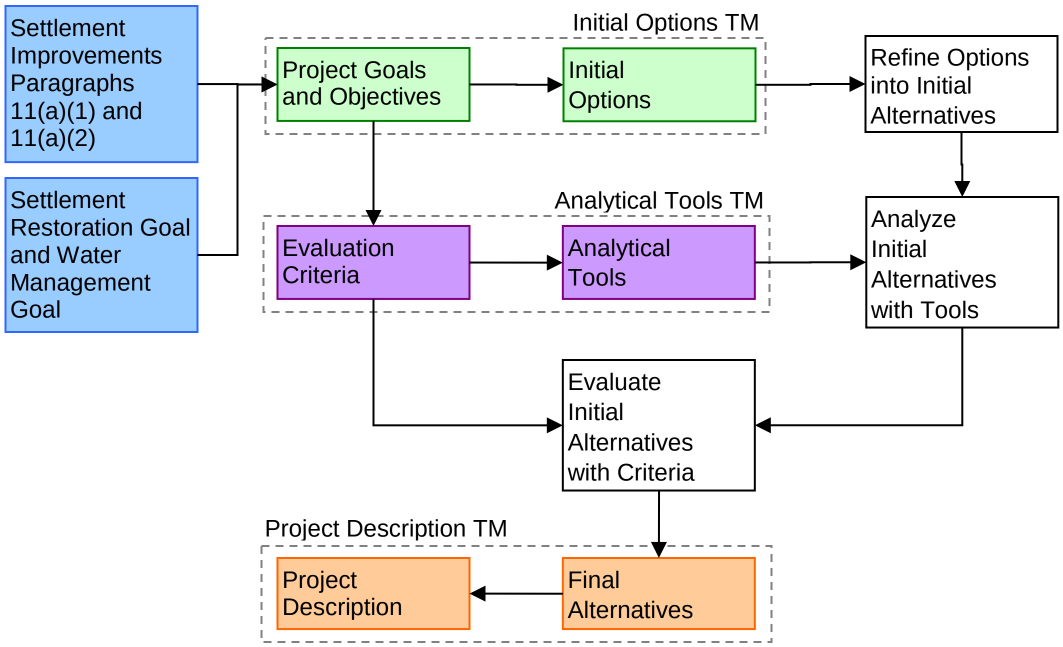


Figure 1-1.
Alternatives Formulation Process Diagram

The initial guidance for developing the Project comes from language in the Settlement, specifically the Settlement's goals and the Settlement defined improvements. The Settlement goals are:

The Restoration Goal (Settlement Paragraph 2):

> *… a goal of this Settlement is to restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish (the "Restoration Goal").*

The Water Management Goal (Settlement Paragraph 2):

> *…a goal of this Settlement is to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in this Settlement (the "Water Management Goal").*

The Mendota Pool Bypass and Reach 2B improvements defined in the Settlement are (Settlement Paragraph 11(a)):

> *(1) Creation of a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cfs from Reach 2B downstream to Reach 3. This improvement requires construction of a structure capable of directing flow down the bypass and allowing the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary;*
>
> *(2) Modifications in channel capacity (incorporating new floodplain and related riparian habitat) to ensure conveyance of at least 4,500 cfs in Reach 2B between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel.*

Alternatives formulation builds on the Settlement goals and project-specific improvements and progresses through three stages: initial options, Initial Alternatives, and Final Alternatives. Initial options represent the preliminary concepts and the basic components for project implementation. They were developed based on existing information and data, studies undertaken for the PEIS/R process, pre-appraisal level analyses and screening, as well as input from Program Work Groups, stakeholders, and the public. The initial options are described in the Initial Options TM (SJRRP 2010e). Subsequently, the initial options were refined into Initial Alternatives based on additional concept refinement and engineering analyses, preliminary cost-benefit analyses, additional data collection, and input from the Program, Program Work Groups, stakeholders, and the public. The Initial Alternatives represent a range of feasible implementation strategies incorporating appraisal-level design and analysis. The Initial Alternatives were evaluated based on the evaluation criteria and with the tools described in the Analytical Tools TM (SJRRP 2010f). This attachment documents the methods and results of the evaluation and makes recommendations for Final Alternatives to include in the main body of the Project Description TM.

1.3 Initial Alternatives Evaluation Process and Methods

The following steps outline the evaluation process. At this time only steps 1 through 4 were implemented. Step 5 was not conducted because it was found to not be necessary in order to arrive at a reasonable range of alternatives.

Step 1: Refine Evaluation Criteria

- Identify criteria with meaningful, quantifiable results given stage of design and available field data
- Identify criteria that are applicable to all alternatives, thereby providing a means of comparing alternatives
- Group criteria into relevant factors, then group factors into relevant categories, then finally group categories into relevant perspectives so that alternatives can be compared at these different aggregated levels

Step 2: Develop Project Data

- Using current level of design, field data, and appropriate assumptions, determine raw data for each criterion for each alternative

Step 3: Normalize Scores

- Score each criterion on a range of 0 to 10, with 10 awarded to the alternative with the most desirable outcome. A score is normalized relative to the range of data values among the alternatives.
- For criteria where high values of raw data indicate positive outcomes (i.e., benefits), the larger raw data values produce higher normalized scores, and smaller raw data values produce lower normalized scores.
- For criteria where high values of raw data indicate negative outcomes (i.e., costs, impacts), the larger raw data values produce lower normalized scores, and smaller raw data values produce higher normalized scores.
- Normalized scores are displayed on a qualitative scale of low, medium, and high.

Step 4: Alternatives Comparison (without weighting)

- Calculate the average score to obtain the overall score for the subsequent aggregated levels (i.e., the factor level score is the average of the criteria scores under that factor; the category level score is the average of the factor scores under that category; the perspective level score is the average of the category scores under that perspective).
- Aggregated scores are displayed on a qualitative scale of low, medium, and high.

Step 5: Alternatives Comparison (with weighting)

- Using professional judgment, determine weights (i.e., fractions of 1, summing to 1 within a given level) for each criterion, factor, category, and perspective such that more important or influential items are assigned higher weights
- Calculate the weighted average score to obtain the overall score for the subsequent aggregated levels (i.e., weighted average of criteria scores is the overall factor score; weighted average of factor is category; weighted average of category is perspective)

1.4 Organization of this Attachment

The content and format of this attachment are intended to dovetail with the future Project EIS/R. The attachment is organized as shown below.

Section 1.0 Introduction – summarizes the alternatives formulation process and describes the Project purpose and Settlement goals/improvements and the organization of this attachment.

Section 2.0 Opportunities and Constraints – provides an analysis of opportunities that exist outside the Project purpose and constraints within the study area.

Section 3.0 Goals and Objectives – presents the Project goals and objectives organized according to the overarching project purposes.

Section 4.0 Pre-Initial Options Analysis – describes decision making involved in the development of the initial options.

Section 5.0 Initial Options Refinement – describes the decision making and analysis involved in refining the initial options into Initial Alternatives.

Section 6.0 Initial Alternatives Evaluation Criteria – describes the criteria used in the alternatives evaluation.

Section 7.0 Initial Alternatives Descriptions – describes the Initial Alternatives for each component of the Project.

Section 8.0 Initial Alternatives Evaluation Results – describes the results of the evaluation, compares the Initial Alternatives based on the results, and recommends Final Alternatives as the reasonable range of alternatives to be evaluated in the Project EIS/R.

Section 9.0 Acknowledgments – provides a list of those who contributed to the document.

Section 10.0 References – provides a bibliography of sources cited throughout this attachment.

This page left blank intentionally.

2.0 Opportunities and Constraints

Implementation of the Project may provide opportunities for improvements beyond the scope of the project purpose. These opportunities may be incorporated or accommodated in the Project incidentally or as a part of project alternatives. While incorporation of the opportunities into the Project is not required, some opportunities may provide broad-scale benefits to the terrestrial and aquatic ecosystem of the San Joaquin River or to the CVP and SWP water supplies and flood management and may be considered for inclusion to the extent that they do not negatively affect the ability of the Project to meet the Project purpose, goals, and objectives.

In addition, some constraints on the planning process would limit the ability to implement certain Project options and future alternatives. In general, constraints limit the range or extent of options being considered, and in some cases, limitations set by constraints may be used as a basis for development of evaluation criteria to be used during alternatives formulation to examine the extent to which certain options meet Project goals and objectives.

2.1 Opportunities

2.1.1 Habitat Improvement for Other Native and Special Status Species

The restoration of the San Joaquin River for the purposes of reintroduction of Chinook salmon to reaches between the Merced River and Friant Dam may incorporate restoration of native floodplain and in-channel habitats. Restoration of these habitats is one of the Project purposes and is likely to benefit other native and potentially special status terrestrial and aquatic species such as Swainson's hawk (*Buteo swainsoni*), greater sandhill crane (*Grus canadensis tabida*), etc. Benefits to other native species would be realized through the re-introduction of perennial base flows as well as seasonal high flows in the River, which in turn would promote the establishment of indigenous riparian vegetation. Well-established native plant communities in the floodplain would support rich and diverse native flora, including potentially, special status plant species, would effectively prevent invasive vegetation encroachment, and would provide foraging habitat and shelter for native wildlife species.

Specific opportunities include the following:

- Restoring river-floodplain connectivity and longitudinal connectivity of riparian vegetation near the channel (without major breaks in the distribution of woody vegetation except where natural conditions prevent establishment of native trees or shrubs) that can provide cover and habitat for a variety of wildlife species
- Creating or maintaining a combination of diverse habitats required by selected wildlife species, such as species that depend on concurrence of aquatic, wetland

or riparian, and upland habitats to meet various life stage requirements (e.g., western pond turtle, Swainson's hawk)

- Enhancing landscape connectivity between the river corridor and adjacent areas of ecological significance (e.g., wildlife refuges and other protected lands, biodiversity "hotspots," adjacent sloughs or tributary channels with existing riparian habitat, wildlife movement corridors, and private natural preserves such as the Mendota Wildlife Area)
- Protecting, restoring, or enhancing special status vegetation alliances and plant species

2.1.2 Open Space & Mitigation

Opportunities for open space and wetlands/waters and habitat/species mitigation for Project-related impacts are available in the areas south of the proposed Mendota Pool Bypass. It is expected that agricultural land between the Mendota Pool Bypass configuration and the existing river would not support production in the future condition due to lack of drainage. These lands may be acquired as part of the project due to the impacts to agricultural utility, and therefore, may be available for open space conservation and mitigation. Some of these lands have been fallowed in anticipation of the acquisition.

Open space and mitigation may also be available in the two river bends (west and east loops) near the upstream end of the Project. These areas are occasionally used for cattle grazing but are substantially non-native grasslands. Potential exists for habitat improvements to be incorporated in these areas that may provide some mitigation credit for the Project.

The property along the south bank at the upstream end of the Project currently exhibits natural topography, is connected to the river corridor, and management of this land is virtually unchanged since pre-Friant Dam times. It is believed that high quality, native species habitat is extensive on this property, which appears to extend in similar fashion south to Alkali Sink Ecological Reserve. Significant mitigation and conservation opportunities are available on this parcel, and the potential to include this parcel with the Project could be explored further.

Finally, opportunities for open space and mitigation may be available on portions of parcels that may be acquired for the Project but are outside of the area required to build the Project. For example, a whole parcel may be purchased for the Project even though the full extents are not required to build the project. This may occur when the property which remains outside the Project extents has limited use or value for agricultural production.

2.1.3 Recreation

Existing water-related recreational opportunities on the Reach 2B segment of the San Joaquin River are limited because the upper half of the River reach was dry most years prior to Interim Flows, and even the downstream inundation associated with the Pool water is drained bi-annually for several weeks. Moreover, areas immediately adjacent to the riverbed are privately owned, and public access is limited.

Currently, the nearest vehicular access to the riverbed is San Mateo Avenue. The primary nearby water-related recreational opportunities are outside the immediate Reach 2B channel area at Mendota Pool, approximately four miles from the San Mateo Avenue crossing, which offers angling.

Future recreational activities along Reach 2B would be similarly limited if the Project were not implemented. While population in the Project area and vicinity would likely increase at rates common for the west side of the San Joaquin Valley, any increased recreational demands would be directed to nearby recreational venues, including Mendota Pool and San Luis Reservoir (approximately 40 miles to the northwest).

Implementation of the Reach 2B Project may offer some expansion in recreational opportunities. However, it would be necessary to consider these opportunities relative to the Restoration Goal (Settlement Paragraph 2):

> *… a goal of this Settlement is to restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish (the "Restoration Goal").*

Habitat restoration goals for Reach 2B may be found in Section 3.4 of this document. Consequently, if implementation of the Project would provide greater public access to Reach 2B, it is expected that appropriate restrictions on fishing and other activities in and near the water that could endanger salmon or result in trespassing on private lands would be implemented.

2.1.4 Water Quality

Implementation of the Project has the potential to improve water quality to the extent that native aquatic, riparian, and floodplain vegetation may remove and uptake some pollutants dissolved in San Joaquin River flows. Greater water quality improvements may be realized through nutrient cycling and pollutant uptake following sediment deposition during high flow events where floodplains are inundated. However, because Millerton Lake has good water quality and there are minimal agricultural return flows upstream of Reach 2B, water quality is expected to be good in the Reach 2B and, therefore, will not likely need improvement.

2.1.5 Education

If implementation of the Project would provide greater public access to Reach 2B, the Project could also incorporate opportunities for education for students, land owners, restoration specialists, recreational enthusiasts, and the general public. River processes, native wildlife and habitats, water management, and ecological restoration are all topics that could be incorporated into education campaigns involving interpretive signage, trails, and field trips as appropriate.

2.1.6 Flood System

The Lower San Joaquin River Flood Control Project (Flood Control Project), authorized by Congress in 1944 to protect irrigated agricultural lands and associated developments, is operated and maintained by the Lower San Joaquin Levee District (Levee District) under the Flood Control Project's Operation and Maintenance Manual for Levee, Irrigation and Drainage Structures, Channels and Miscellaneous Facilities (Flood Operation Manual). The Project offers some opportunity for improving the flood system and flood operations within the San Joaquin River Reach 2B. The current channel capacity of 2,500 cfs would be increased to at least 4,500 cfs. Although not analyzed as part of this TM, the increased conveyance may provide opportunities for improving flood operations during certain flood scenarios. The ability to accommodate higher flows during flood releases is dependent on the downstream capacity of the system. Currently, the Project will not alter the Flood Operations Manual.

2.2 Constraints

2.2.1 Settlement and Act Requirements

The Settlement requirements and conditions of the Act place legal constraints on the Project. Specifically, Settlement Paragraphs 11(a)(1) and 11(a)(2) require:

> *[Paragraph 11(a)] (1) Creation of a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cfs from Reach 2B downstream to Reach 3. This improvement requires construction of a structure capable of directing flow down the bypass and allowing the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary;*

> *[Paragraph 11(a)] (2) Modifications in channel capacity (incorporating new floodplain and related riparian habitat) to ensure conveyance of at least 4,500 cfs in Reach 2B between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel.*

2.2.2 Other Legal and Regulatory Compliance

The Project must comply with various Federal, State, and local laws, regulations, executive orders, and policies. The alternatives developed for the Project must demonstrate compliance with applicable regulatory requirements as part of the NEPA/CEQA process. Additionally, regulatory compliance is needed to obtain the many permits and approvals that would be required prior to project construction. Many of the laws and regulations, such as the Clean Air Act and the Clean Water Act, set thresholds or standards for certain types of impacts associated with a project. Consideration of these thresholds early in the alternatives formulation process is important in order to avoid adverse environmental effects, project delays, and costly mitigation. Table 2-1 presents a brief list of applicable laws, regulations, executive orders, and policies that the Project must comply with. These regulatory requirements would be considered throughout the alternatives formulation process and would be updated as the options are further refined.

Table 2-1
Laws, Regulations, Executive Orders, and Policies

Federal	State
▪ Bald and Golden Eagle Protection Act	▪ California Clean Air Act
▪ Clean Air Act	▪ California Code of Regulations Title 23: Central Valley Flood Protection Board
▪ Clean Water Act, Sections 401, 402, 404	▪ California Endangered Species Act
▪ Endangered Species Act, Section 7	▪ California Environmental Quality Act
▪ Executive Order 11988, Flood Hazard Policy	▪ California Fish and Game Code, Section 1602
▪ Executive Order 11990, Protection of Wetlands	▪ California Land Conservation Act (Williamson Act)
▪ Executive Order 12898, Environmental Justice Policy	▪ California Native American Graves Protection and Repatriation Act
▪ Executive Order 13007, Indian Sacred Sites	▪ California Native Plant Protection Act
▪ Executive Order 13112, Invasive Species	▪ California Native Plant Society Species Designations
▪ Executive Order 13186, Migratory Birds	▪ California Office of Historic Preservation
▪ Farmland Protection Policy Act	▪ California Register of Historic Resources
▪ Fish and Wildlife Coordination Act	▪ California Water Rights
▪ Indian Trust Assets (U.S. Department of the Interior Departmental Manual Part 512)	▪ Environmental Justice Public Resources Code 65040.12(e)
▪ National Environmental Policy Act	▪ Porter-Cologne Water Quality Control Act
▪ National Historic Preservation Act, Section 106	▪ Public Resources Code 6501-6509 Lease of Public Lands under State Lands Commission
▪ Native American Graves Protection and Repatriation Act	▪ Surface Mining and Reclamation Act
▪ Magnuson-Stevens Fishery Conservation and Management Act	**Local**
▪ Migratory Bird Treaty Act	▪ Fresno County Code 13.08 Private Improvements within Road Rights-of-Way
▪ Rivers and Harbors Act, Section 9, (33 USC 401), Section 10 (33 USC 403) and 14 (33 USC 408)	▪ Madera County Code Section 14.50 Grading Permit and Section 17.32 Road Encroachment Permit
	▪ San Joaquin Valley Air Pollution Control District Rule 2010 – Authority to Construct/Permit to Operate

2.2.3 Operations for Flood Releases and Water Deliveries

The Project will consider three different conditions under which releases are or would be made from Friant Dam: Restoration Flows, flood releases, and water deliveries. While the Project is primarily focused on building the reach for conveyance of the Restoration Flows, the factors and conditions surrounding the management of flood releases and water deliveries to Mendota Pool are constraints on the available Project options, particularly for structures. The PEIS/R includes information on the Program approach to flood operations and water deliveries (SJRRP 2011a).

The Exchange Contract (Reclamation 1967) defines that a maximum of 2,316 cfs may be required to be delivered to the Pool from Friant via Reach 2B, and also defines to varying extents maximum monthly flow magnitudes and volumes that may be requested for delivery. To date, water deliveries to the Pool have never been made via releases from Friant and the San Joaquin River; in addition, current planning models do not anticipate any future occurrence of a Friant delivery. Due to the lack of precedent and predictive cases, the timing of these delivery requests and the delivery duration are unknown, and it is also unknown what coincident flow may be available to meet Restoration Flows. Therefore, the alternatives for the Mendota Pool Bypass Bifurcation Structure would need to incorporate the flexibility to divert a range of flows to the Mendota Pool Bypass, the Pool, or both. The structure may also need to incorporate fish screens that would function under a variety of flow ranges and splits to screen fish from the Pool.

Flood operations are managed from a risk perspective for the purposes of protecting public health and safety and property. The specific flood operations in Reach 2B are dependent on flow entering the Pool from Fresno Slough, as well as the flow at the Chowchilla Bifurcation Structure. The O&M manual recommends flood operations based on flow rates in Reach 2B for varying flow magnitudes in Fresno Slough and the Chowchilla Bifurcation Structure (Reclamation Board 1969). The levee districts have the latitude to operate facilities in the manner that will best protect public health and safety and property. Since the project specific EIS/Rs establish the improvements that would safely convey the Restoration Flows in the various reaches, it is assumed that conveyance of Restoration Flows coincident with flood flows are not in conflict, and the system can be managed in a manner that will protect public health and safety and property while also maintaining the flexibility to provide some level of flow in the principal migration pathways (i.e., Mendota Pool Bypass). However, future agreements and/or changes in the Flood Operation Manual would be necessary to provide for this type of management. These agreements and/or possible changes to the Flood Operation Manual are outside of the scope of this Project and would likely undergo separate review and approval, if executed. For the purposes of this evaluation it is understood that protection of public health and safety and property takes precedence and certain conditions may arise where ensuring ideal flows and pathways for fish migration may not be obtainable.

As part of development of the Initial Alternatives, the following order of priorities for flow management was considered.

- 1st Priority: Flood operations for the protection of public health and safety and property.
- 2nd Priority: Water deliveries to the Exchange Contractors.
- 3rd Priority: Restoration Flows.
- 4th Priority: Flood releases to meet water supply delivery contracts.

Under this management prioritization, several specific scenarios may occur, but in general, it is assumed that:

- Flood releases from Friant may be routed through the Mendota Pool Bypass pending other flood operations considerations (e.g., Fresno Slough contributions) or they may be routed through both the Mendota Pool Bypass and the Pool
- Water deliveries may reduce Restoration Flows in the Mendota Pool Bypass to a maximum of 2,000 cfs, given the 4,500 cfs total reach capacity and the 2,500 cfs delivery, but otherwise do not restrict Restoration Flows in the reach

2.2.4 Fish Passage

The following is a summary of operational and site constraints that may limit the ability of the Project to meet the project goals and objectives pertaining to fish passage in the channel and at structures under Restoration and flood flows:

1. Flow routing, particularly during flood and Pool delivery scenarios will affect the range and types of options presented. Since the reach will be conveying flow for three purposes (floods, water deliveries, and fish), the various structure operational scenarios need to be understood such that new structures and modifications of existing structures can be configured to provide adequate conditions for fish over the widest range of potential flow routing scenarios. Channel and habitat connectivity should be considered during flood flows analysis in order to support meeting fishery restoration objectives.

2. Low flow conditions (100-350 cfs releases at Friant Dam) may preclude passage up or downstream for native fish in the channel due to upsteam uses, losses to groundwater, and the limited depth of flow in the wide and sandy channel of Reach 2B. These flows can occur in any water year type in the summer following spring pulse flows and in the winter following fall pulse flows, so they may only have limited effect on fish passage. Reach 2B prior to Interim Flows had very poor aquatic habitat to support fish. The channel is wide, with little morphological development. Substrate is homogenous and aquatic habitat features are limited to minor bars and shallow depressions. The rate of development of riparian vegetation may be a key in improving channel conditions. Encouraging the establishment of a low flow channel in a sand bed without benefit of riparian vegetation may be a challenge. Recreational activities in Reach 2B upstream of San Mateo Avenue crossing may preclude re-establishment of riparian vegetation and a functional channel and floodplain (see Section 2.2.11).

3. The number of existing and proposed structures in Reach 2B could become a factor in the success of migrating native fish completing their life cycle. While potential structures will be designed to meet NMFS and DFG criteria for passage, and existing structures may be modified to meet these criteria, the structures will not be a natural system. The channel, floodplain, and structures need to be designed to allow river connectivity and passage flows to be sustained over the structures for a sufficient period of time to provide for fish to pass over all the structures on their upstream movements into Reach 2A and for downstream passage of juveniles into Reach 3. The structures also need to be designed to minimize the effects of predation and localized hydraulic changes on fish.

4. Routing of flood flows should consider effects to the native fish populations with the understanding that the foremost priority during flood operations will be for the protection of public health and safety and property (see Section 2.2.3). Flood routing decisions are not made by the SJRRP, but are carried out by other entities, including the Central Valley Flood Protection Board and the Levee District.

2.2.5 Special Status Species

There are known occurrences and the potential for occurrences of special status plant and wildlife species native to the San Joaquin River corridor and specifically the area in and adjacent to the Project. Impacts to species and their habitats are regulated through Federal programs via the Endangered Species Act (ESA) and through State programs via the California Endangered Species Act (CESA). By law, those responsible for the Project must incorporate assessment, coordination, permitting, and avoidance, minimization, and mitigation for impacts to special status species and their regulated habitats.

2.2.6 Cultural and Historical Resources

Project has the potential to affect cultural and historical resources within the Project area due to proposed grading, construction of structures, land use change, and possible increased extent and depth of flooding. An assessment of the presence of cultural and historic resources would be addressed in a separate TM. Impacts to cultural and historical resources within the area of potential effect of the Project must be avoided, minimized, or mitigated, as applicable.

2.2.7 Land Use/Agriculture and Socioeconomic/Environmental Justice

Land Use/Agriculture

Implementation of the Project would have a direct affect on landowners and land uses proximate to Reach 2B. The land proximate to Reach 2B is primarily in agricultural production with permanent (high value) crops. The land is within the water service areas of Columbia Canal Company, (one of the San Joaquin River Exchange Contractors), the Aliso Water District, and the Farmers Water District. Much of the agricultural land is planted in permanent crops, including almonds, pistachios, palms, and wine grapes (Houk 2009). Annual crops are primarily corn and silage (in support of the local dairy industry) alfalfa, and melons. None of the affected land is typically used to grow vegetables.

Socioeconomic/Environmental Justice Issues

Environmental justice is defined as the potential for a project to disproportionately affect disadvantaged populations including low income and minority populations. The potential for the Reach 2B Project to affect these groups would be associated with economic impacts, as few people live in the affected Project area. Because the riverbed, prior to Interim Flows, was partially dry and public access is very limited, little potential exists for the Project to affect subsistence fishing activity by disadvantaged populations.

Data from the 2000 Census of Population and Housing show that agriculture and agriculture-related industries provide most of the household employment in the area.

Construction, implementation, and maintenance of the Reach 2B Project have the potential to adversely affect agricultural land proximate to the River because of the land acquisition that would be required to construct both levee setbacks for the purposes of increasing channel capacity and creating habitat to support anadromous fisheries. The number of acres affected would vary by alternative. The loss of agricultural production land may adversely affect the socioeconomic and environmental justice characteristics of the affected area. Any reduction in agricultural land use can be expected to affect not only agricultural production itself, but also the many industries which support and are supported by production agriculture. Construction-related activities and purchases of goods and services in the project area would at least partially offset the reductions in agricultural economic activity. The economic areas most likely to be affected include the incorporated cities of Firebaugh and Mendota, both in Fresno County, and unincorporated areas in both Fresno and Madera Counties.

2.2.8 Seepage

The Project design criteria will address any seepage effects on adjacent agricultural lands due to the increased flow frequency, quantity, and duration in the River channel and floodplain under the Restoration Flows. Seepage is a concern for levee stability and because it can cause damage to agricultural crops through increased root zone groundwater saturation and/or increased soil salinity which may decrease yield or cause die-off of crops, thus affecting lands outside of the direct Project footprint. An analysis of the potential for seepage and the monitoring and action thresholds for the Project area has been developed in the Draft Seepage Management Plan (SJRRP, 2009c), and further development of this plan is expected.

2.2.9 River Crossings

One river crossing exists in Reach 2B at San Mateo Avenue. This crossing is a low water crossing with a Madera County public right-of-way to the centerline of the river on the north side and no right-of-way south of the centerline in Fresno County (Fresno County public right-of-way picks up approximately 3,600 feet south of the river). In addition, a future crossing at Road 10 ½ is anticipated over the bypass channel (Settlement and Compact Alignments). Historically, access across the river at San Mateo Avenue could occur during most times because the channel flowed infrequently. With the introduction of the Restoration Flows, access may become limited because the Restoration Flows could overtop the roadway surface more frequently.

The need to maintain the San Mateo Avenue crossing, if needed and appropriate, provide the Road 10 ½ crossing, and limit overtopping flows at both will constrain the type of crossing design as well as affect the construction and maintenance costs. Coordination with landowners and Counties was conducted to help determine access needs (times of year, equipment types, etc.) and crossing frequency. The crossings also have the potential to affect fish passage, sediment transport, and geomorphic processes.

2.2.10 Geomorphology

The geomorphic constraints for this project include channel base elevations, longitudinal slope, and the imposed flow and sediment supply regimes. Channel base elevations at the up and downstream ends of the Project are fixed because the Project must tie into channel elevations of Reach 2A and 3. Actual slope of the channel is dependent on channel length or sinuosity. In the case of the proposed Mendota Pool Bypass Settlement and Compact alignment options, the length of the river channel would be shortened over the current length. This in turn increases the slope of the bed profile between the two bypass tie-in locations. Increases in slope effectively increase the sediment transport capacity of the reach, which may result in erosion and degradation.

To maintain long-term stability, the incoming sediment supply must be transported through the Project reach maintaining sediment continuity. The incoming sediment load is a boundary condition, and Project constraint, defined by the future flows and sediment transport from the upstream reaches. To maintain stability during discrete events (particularly at structures), the transient sediment regime during individual high and low flow events must also be understood.

Rivers are dynamic systems that change over time and space due to imposed environmental conditions. Meander migration is a natural process of a rivers lateral movement across valley floors. It is a result of erosion on the outer bank of meander bends and deposition on the inner bars forming floodplain surfaces. Migration is a complex process not fully understood involving various types of movement. As a river channel migrates, ideally, it maintains its general shape (width, depth and slope) or "dynamic equilibrium".

Meander migration may not be a desirable physical process to reestablish. However, some form of erosion and deposition is expected in rivers and stream systems. The wider the floodplain alternative, the more natural lateral migration processes in river alignment may be accommodated. As the corridor width of the options decreases, the river channel is constrained to its current location, and the need for engineered structures to restrict migration increases.

2.2.11 Recreation

Prior to Interim Flows, recreational activities occurring on the site primarily consisted of operating off-highway vehicles (OHVs) in areas upstream of the San Mateo Avenue crossing. OHV use in the river corridor post-restoration is potentially a significant site constraint during low flows. With the fine sand bed that exists in the river channel, vegetation is the only means of stabilizing the low flow channel, and establishment of vegetation would be greatly hindered by OHV use, which would continuously remove emerging vegetation and prevent establishment of successional vegetation (see Figure 2-1). The prevention of the establishment of vegetation has strong implications for geomorphic processes as well as for providing appropriate fish habitat. Prevention of unauthorized vehicular access to the restoration area would be key to encouraging the establishment of vegetation, wildlife habitats, and geomorphic stability.

Figure 2-1
Aerial view of Reach 2B showing OHV tracks

2.2.12 Illegal Dumping

Illegal dumping is occurring at the San Mateo Avenue crossing, which is the primary public access point to the river in Reach 2B. Large areas on both the upstream and downstream sides of this crossing are affected by the dumping of trash, furniture, appliances, and other items. This material has the potential to not only affect the operation and maintenance of existing and proposed structures (by clogging or fouling San Mateo Avenue culverts, Mendota Pool Bypass Bifurcation Structure, etc.), but could also have a large effect on water and habitat quality. Additionally, the costs associated with characterizing, removing, and disposing of any contaminated material are potentially significant. The effects on structures and water and habitat quality have repercussions for the ability of the reach to support fish uses. The material should be removed and measures to prevent additional dumping should be incorporated into the Project.

2.2.13 Sand Mining

Evidence of sand mining is apparent within Reach 2B between the Chowchilla Bifurcation Structure and San Mateo Avenue. This results in the presence of deep, unnatural pools in the river channel and large stockpiles of sand adjacent to the river corridor. Sand mining may have adverse effects on riparian vegetation, native and special status species, channel geomorphology, and seepage. It is recommended that these operations be discontinued and that the Project include measures to prevent future mining operations within the Project area. Sand mining does not refer to future sediment management or maintenance dredging that may occur as part of the Project, which would be conducted according to the Sediment Management Plan.

3.0 Goals and Objectives

Project goals and objectives provide a comprehensive vision for meeting the project purpose. Goals denote broad statements of intent that provide focus or vision for planning. The project goals provide a basis upon which specific objectives are formed. The objectives are intended to be well grounded, rooted in the project realities, and measurable to the extent possible so the project would have a quantitative means of evaluating project success. It should be noted that some biological objectives may not be quantifiable. Goals and objectives are presented for the following categories: flow conveyance, water supply, fish habitat and passage, habitat restoration, seepage, and geomorphology.

Many of the goals and objectives are interrelated. For example, flow conveyance will be necessary to support fish passage and habitat restoration. While goals and objectives are organized by resource area, it should be understood that the Project should meet all the goals and objectives.

The goals and objectives presented below were assembled from studies and documents prepared specifically for the SJRRP as well as non-SJRRP scientific and guidance documents representing the best available knowledge on the resource areas.

3.1 Flow Conveyance

Flow conveyance goals and objectives refer to the capacity of the channel, bypass, and structures to accommodate the range of Restoration Flows and flood releases. Restoration releases from Friant Dam are shown in Figure 3-1, and associated Restoration Flows expected in Reach 2 are shown in Figure 3-2.

Flow Conveyance Goal

Improve flow conveyance within Reach 2B between the Chowchilla Bifurcation Structure and the Mendota Pool Bypass to accommodate at least 4,500 cfs (Settlement Paragraph 11(a)(2)), and provide at least 4,500 cfs of flow conveyance in the proposed Mendota Pool Bypass (Settlement Paragraph 11(a)(1)).

Objectives

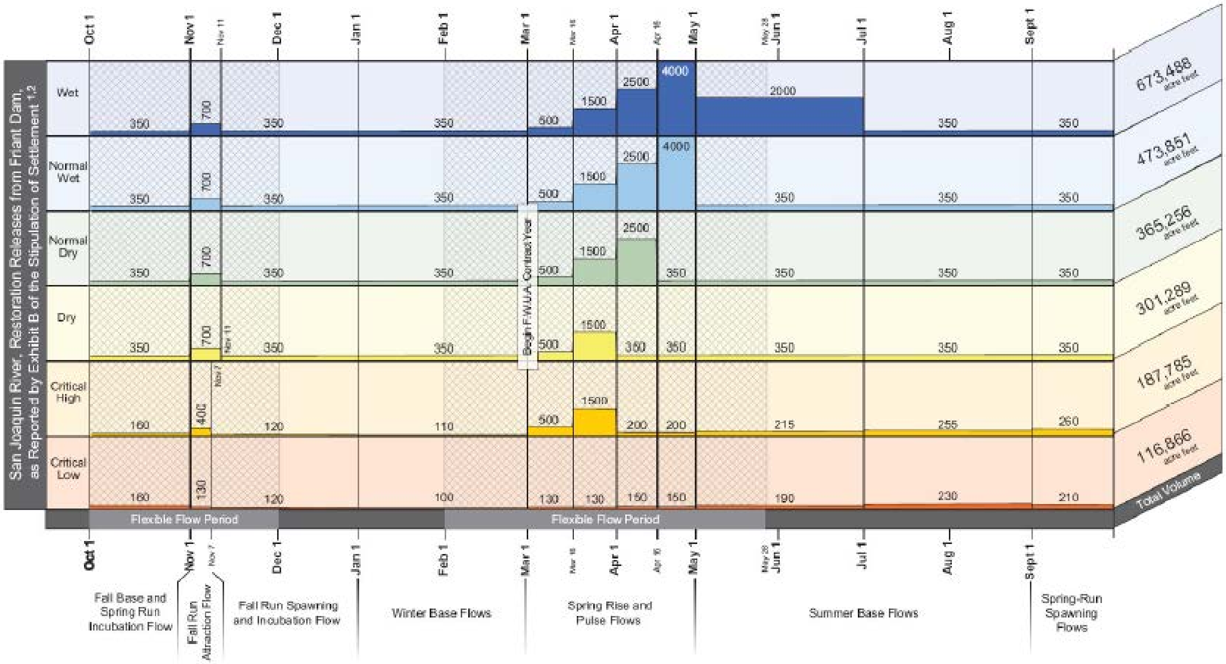
1. The entire Project channel/floodplain reach shall convey the full range of flows, up to at least 4,500 cfs.

2. Construct a bypass channel around Mendota Pool to convey the full range of flows, up to at least 4,500 cfs, to Reach 3.

3. The proposed San Mateo Avenue and Road 10 ½ crossings, if built, shall be designed to convey the full range of flows, up to at least 4,500 cfs.

4. The proposed Mendota Pool Bifurcation structure shall divert the full range of flows (up to 4,500 cfs) into the Mendota Pool Bypass channel.

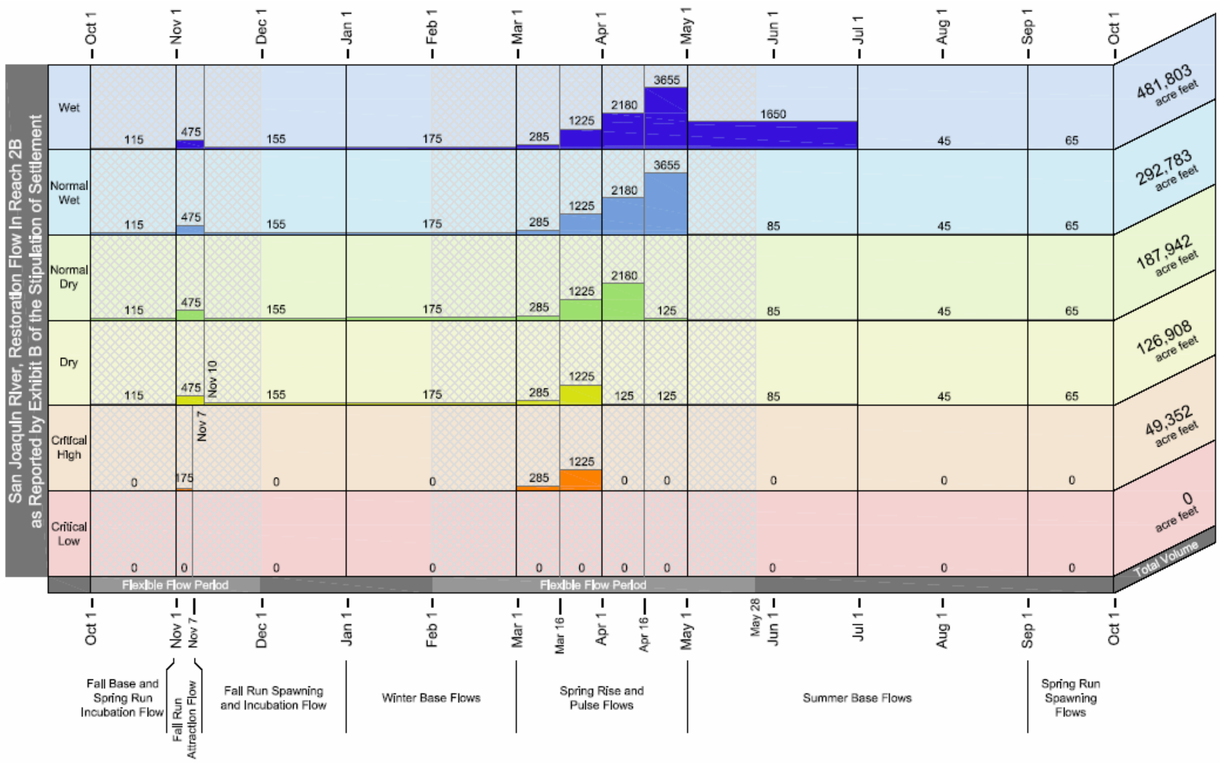
5. The proposed Mendota Pool Bifurcation Structure shall prevent, to the extent practicable, water loss below the normal pool elevations to maintain the Pool elevation under proposed conditions. The Pool currently operates at a water surface elevation of about 152.7 feet (NGVD29) or 155.0 feet (NAVD88).



Source: SJRRP 2008

Figure 3-1

Restoration Flow hydrographs by restoration year type (Friant releases)



1 Hydrographs reflect assumptions about seepage losses and tributary inflows which are specified in the Settlement.
2 Reach 2B hydrographs are labeled as Reach 3 in Settlement Exhibit B.

Figure 3-2
Restoration Flow hydrographs by restoration year type (Reach 2B)

3.2 Water Supply

Water supply goals and objectives refer to provisions of the Project which will enable the continued ability to deliver contract water from Friant Dam to Mendota Pool via the San Joaquin River. Provisions for sufficient capacity outside the Project area and provisions for securing the water required by the contract are beyond the purpose of this Project.

Water Supply Goal

Accommodate water deliveries and flood releases to Mendota Pool at the Mendota Pool Bypass Bifurcation Structure (Settlement Paragraph 11(a)(1)).

Objectives

1. Under certain flood operation scenarios, it may be preferred to direct all or a portion of flood releases (see Section 2.2.3 for a summary of flood operations constraints) into the Pool. Should all flood flows be required in the Pool, the Mendota Pool Bypass Bifurcation Structure may require the flexibility to prevent or limit flows into the Mendota Pool Bypass.

2. The Mendota Pool Bypass Bifurcation Structure shall be capable of providing up to a 2,500 cfs delivery to the Pool when directed by the Secretary. During these delivery

flows, the structure shall have the flexibility to convey a range of flows (100-2,000 cfs) above the delivery flow through the Mendota Pool Bypass.

3.3 Fish Habitat and Passage

Restoration of aquatic habitat and fish passage for the purposes of establishing fish populations involves several interrelated processes:

- Determining the correct habitat components to include in the system
- Understanding how those components would function with the hydrology and geomorphology of the system
- Understanding how the flow routing and river conditions would interact to restore the hydrologic connectivity

Fisheries goals for the Restoration of the San Joaquin River are derived from the Restoration Goal in the Settlement (Settlement Paragraph 2):

> *… a goal of this Settlement is to restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish (the "Restoration Goal").*

Priority is given to spring-run Chinook salmon populations, while fall-run Chinook populations are also included in the SJRRP fisheries goal (SJRRP 2010c). In this regard, an important component of the SJRRP is to convey flows for fish passage and migration from Reach 1 to Reach 5. Reach 1 contains all of the spawning and incubation habitat, and nearly all of the year-round rearing habitat for spring-run Chinook salmon (SJRRP 2010c). Reaches 2 through 5 (as well as the remainder of the San Joaquin River from the Merced River confluence to the Delta) would support fry to juvenile rearing during the outmigration life stages for spring- and fall-run salmon. Rearing during the outmigration life stage is described by the term "transient rearing." A second component of the Project is to provide suitable habitat and passage conditions for upstream migrating adults.

SJRRP fisheries goals and objectives are presented in Chapter 3 of the *Fisheries Management Plan* (SJRRP 2010c). Fishery restoration and management goals are applied throughout the Restoration Area – i.e., the San Joaquin River from confluence with the Merced River to Friant Dam. Individual reaches have different goals since the reaches are not all similar in habitat function and have somewhat different issues regarding flow conveyance and fish passage. Therefore not all restoration and management goals are applicable to all reaches.

The *Fisheries Management Plan* divides goals into Population Goals and Habitat Goals. Goal statements are general statements identifying the elements necessary to restore the fish populations and habitat in the entire San Joaquin River Restoration Project Area. Each Population or Habitat Goal in the *Fisheries Management Plan* is supported by a series of more detailed Objectives that in some cases provide a target restoration condition for the fish population or the habitat condition once the project is implemented and operating.

3.3.1 Fish Habitat Goals and Objectives

The following fish habitat goals and objectives apply to Reach 2B. The goals correspond to those found in the Fisheries Management Plan for the Restoration Area and for individual reaches (Table 3-1).

Fish Habitat Goal 1

Provide functional rearing habitat for juvenile salmon for the purposes of transient rearing during outmigration.

Objectives

1. Create habitat conditions (suitable depth, velocity, and temperature) for juvenile foraging during winter and spring.

2. Minimize fish and bird predation at structures.

3. Create habitat conditions (suitable depth, velocity, and temperature) that support successful outmigration.

4. Include seasonally inundated floodplain with suitable habitat conditions for juvenile salmon.

5. Minimize population losses to diversions within Reach 2B.

Fish Habitat Goal 2

Provide habitat to facilitate upstream migration of adult Chinook salmon.

Objectives

1. Provide opportunities for resting/refuge pools at appropriate intervals throughout Reach 2B.

2. Improve habitat conditions (suitable depth and velocity) that support successful upmigration.

Fish Habitat Goal 3

Provide habitat to support native fishes other than salmon.

Objectives

1. Create habitat conditions to support fish species historically native to Reach 2B

2. Modify channel to enhance existing habitat for native fishes at the restoration low flow condition.

3. Provide connectivity within the river system to support native fish movements

Fish Habitat Goal 4

Restore in-channel vegetative communities in support of the establishment of an anadromous fishery.

Objectives

1. Increase, to the extent practicable, freshwater marsh, perennial and seasonal wetlands in the river corridor for the purposes of enhancing slow velocity habitat conditions for fish.

2. Promote the development of shaded aquatic riverine habitat (e.g. by including woody riparian species such as sandbar willow (*Salix exigua*) and buttonbush (*Cephalanthus occidentalis*)).

3. Include sources for instream woody material at the August and February mean water surface elevations to support suitable habitat for juvenile stages of desired fish species.

3.3.2 Fish Passage Goals and Objectives

The following fish passage goals and objectives are applicable to Reach 2B.

Fish Passage Goal 1

Provide flow routing and appropriate fish passage conditions at each of these instream structures and potential future structures:

- Chowchilla Bifurcation Structure
- San Mateo Avenue crossing
- Road 10 ½ crossing (as applicable)
- Mendota Pool Bypass Bifurcation Structure (as applicable)
- Mendota Pool Bypass Fish Screen
- Mendota Pool Bypass Fish Barrier (as applicable)
- Mendota Pool Bypass Drop Structures (as applicable)
- Mendota Dam (as applicable)

Objectives

1. Develop preferred fish migration routes based on triggers for the range of Restoration Flows, flood releases, and water deliveries along with the associated flow routing.

2. Protect migrating juveniles from entering the Mendota Pool for the range of Restoration Flows.

3. Direct upstream migrating adults out of Reach 3 and into the Mendota Pool Bypass at the confluence with Reach 3.

4. Ensure up and downstream fish passage during migration flows through each bifurcation structure, the grade control structures in the Mendota Pool Bypass, and the

San Mateo Avenue and Road 10 ½ crossings in terms of appropriate timing and duration, minimum flow depth, maximum velocity, and entrance and exit conditions.

Table 3-1
Restoration Area Habitat Goals and Compatible Reach 2B Habitat Goals

Fish Management Plan Habitat Goal	Applicability	Compatible Reach 2B Habitat Goals
Restore a flow regime that (1) maximizes the duration and downstream extent of suitable rearing and outmigration temperatures for Chinook salmon and other native fishes, and (2) provides year-round river habitat connectivity throughout the Restoration Area.	Restoration Area	▪ Provide functional rearing habitat for juvenile salmon for the purposes of transient rearing during outmigration.
Provide adequate flows and necessary structural modifications to ensure adult and juvenile passage during the migration periods of both spring-run and fall-run Chinook salmon.	Restoration Area	▪ Provide functional rearing habitat for juvenile salmon for the purposes of transient rearing during outmigration. ▪ Provide habitat to facilitate upstream migration of adult Chinook salmon.
Provide suitable habitat for Chinook salmon holding, rearing, and outmigration during a variety of water year types, enabling an expression of a variety of life history strategies. Suitable habitat will encompass appropriate holding habitat, spawning areas, and seasonal rearing habitat.	Restoration Area	▪ Provide functional rearing habitat for juvenile salmon for the purposes of transient rearing during outmigration.
Provide water-quality conditions suitable for Chinook salmon and other native fishes completing their life cycle without lethal or sublethal effects.	Restoration Area	▪ Provide functional rearing habitat for juvenile salmon for the purposes of transient rearing during outmigration and suitable conditions for upstream migration of adults.
Reduce predation losses in all reaches by reducing the extent and suitability of habitat for nonnative predatory fish.	Restoration Area	▪ Provide habitat to support native fishes other than salmon and design fish passage structures to minimize habitat supporting non-native predatory species.
Restore habitat complexity, functional floodplains, and diverse riparian forests that provide habitat for spawning and rearing by native resident species during winter and spring.	Restoration Area	▪ Provide functional rearing habitat for juvenile salmon for the purposes of transient rearing during outmigration and to support other native species.
Goal A: Provide flows sufficient to ensure habitat connectivity and allow for unimpeded upstream passage and outmigration	Reaches 2-4	▪ Provide flow routing, fish screens, and fish passage at current structures and potential future structures as appropriate. ▪ Provide flow routing and fish passage in the river channel.
Goal D: Minimize juvenile entrainment losses	Reaches 1-5	▪ Provide flow routing and fish passage at current structures and design potential future structures to minimize impediments to migration.
Goal F: Eliminate fish passage barriers and minimize migration delays	Reaches 1-5	▪ Provide flow routing and fish passage at current structures and potential future structures. ▪ Provide flow routing and fish passage in the river channel.

Table 3-1
Restoration Area Habitat Goals and Compatible Reach 2B Habitat Goals

Fish Management Plan Habitat Goal	Applicability	Compatible Reach 2B Habitat Goals
Goal G: Provide suitable water temperatures for upstream passage, spawning, egg incubation, rearing, smoltification, and outmigration to the extent achievable considering hydrologic, climatic, and physical channel characteristics	Reaches 2-5	▪ Provide functional rearing habitat for juvenile salmon for the purposes of transient rearing during outmigration. ▪ Provide habitat to facilitate upstream migration of adult Chinook salmon.
Goal Q: Ensure suitable quantity and quality of floodplain and riparian habitat to provide habitat and food resources for Chinook salmon and other fishes	Restoration Area	▪ Provide functional rearing habitat for juvenile salmon for the purposes of transient rearing during outmigration.. ▪ Provide habitat to facilitate upstream migration of adult Chinook salmon. ▪ Provide habitat to support native fishes other than salmon.

Fish Passage Goal 2

Provide flow routing and fish passage in the river channel for upstream migrating adults and emigrating juveniles.

Objectives

1. Encourage the development of channel geometry to provide minimum depth of at least 12 inches through the river thalweg over at least 10 percent of the cross section width during low flow conditions occurring in the migration season.

3.4 Habitat Restoration

Habitat restoration of Reach 2B of the San Joaquin River would focus on incorporating riparian and floodplain habitat communities (Settlement Paragraph 11(a)(2)) in support of restoring and maintaining a fish population in “good condition” (Settlement Paragraph 2). Adjacent upland habitat communities are also considered important for the long-term health and diversity of the in-stream, riparian, and floodplain communities. Habitat Restoration would consider the natural community structure, function, and capacity for change, within the constraints of flow regulation and other water and land management activities. To the extent feasible, efforts would focus on restoring channel and floodplain processes of water, sediment, and organic matter cycling in the reach. Physical reconstruction would be required to initiate these changes. The altered dynamics would promote ecosystem processes that create and maintain riparian habitats suitable for well-distributed, viable populations of native fish, plants and animals.

The key principles for this project begin with restoration of ecosystem processes wherever possible, and restructuring of the new stream channel and floodplain geometry to function under the proposed flow regime. The aim of improving geomorphic function is to benefit long-term ecosystem processes that support native riparian habitats and aquatic species and that promote development of a dynamic, self-sustaining ecosystem to the greatest extent possible.

Habitat Restoration Goal

Encourage the establishment and growth of riparian and floodplain vegetation and habitat complexes and maintain existing vegetation, to the extent practicable.

Objectives

1. Preserve, to the extent practicable, any remaining patches of functional native vegetation for the purposes of maintaining habitat in Reach 2B while new vegetation becomes established, minimizing short-term project impacts, and supplying propagules for natural vegetation recruitment.

2. Restore floodplain habitat by increasing the acreage of riparian woodland, forest and scrub for the purposes of providing multiple benefits to the riparian ecosystem, such as filtering of nutrients and fine sediment, stabilizing channel banks, shading the river channel, and others.

3. Include, to the extent practicable, a native vegetative buffer (e.g. upland habitats like valley oak woodland and elderberry savanna) on riparian and floodplain habitats to protect water quality and the health of the adjacent riparian vegetation alliances from chemical drift and other potential external impacts to the health of the fish population.

4. Reduce the acreage and distribution of invasive, non-native species (e.g. giant reed-grass (*Arundo donax*), scarlet wisteria (*Sesbania punicea*), castor bean (*Ricinus communis*), and poison hemlock (*Conium maculatum*)) in order to diminish their range, lessen their competition with native plants, avoid alterations to riparian habitat value and ecosystem function, and protect fish and wildlife.

5. Restore a riparian corridor with improved ecological functioning, increased longitudinal connectivity, increased average width of riparian vegetation on both sides of the river, and larger, contiguous patches of woody riparian vegetation and instream woody material.

3.5 Seepage

Seepage goals and objectives are included to address the prevention of damage or losses to agricultural land outside the Project area. Increased water levels in the Project area as a result of Restoration Flows may have a negative effect on the production value of adjacent lands due to the corresponding increase in water table. These effects would be assessed and addressed as part of the Project according to the goals and objectives. The recommended objectives should be treated as preliminary recommendations, recognizing they would very likely be revised as more is learned about the local seepage needs and additional groundwater modeling, water level, and other data are analyzed to better quantify thresholds.

Seepage Goal

The Program Environmental Impact Statement/Environmental Impact Report (PEIS/R) states that an objective of the SJRRP is to reduce or avoid adverse or undesirable groundwater seepage impacts (SJRRP 2011a). The SJRRP *Draft Seepage Management Plan* (SJRRP 2011b) describes the monitoring and operating guidelines for the reduction or avoidance of potential seepage-related effects.

Objectives

1. During the growing season, avoid impacts to crops from water logging by conforming to the minimum depth to water thresholds developed in the *Draft Seepage Management Plan* (SJRRP 2011b).

2. Avoid impacts to crops from salinity by conforming to the maximum soil salinity concentration developed in the *Draft Seepage Management Plan* (SJRRP 2011b).

3. Prevent any significant levee stability issues from standing water, boils, or piping that may compromise the short- or long-term stability of the levees.

3.6 Geomorphology

Geomorphology goals and objectives are aimed at balancing the available water and sediment loads with the channel planform, slope, cross sectional dimensions, and vegetation. The dynamic nature of a river system includes both the physical processes and the attributes (or form) that the target aquatic species depend on.

The focus of the goals and objectives is to utilize geomorphic processes and develop a plan for long-term (including individual flow events and changes over time) channel, floodplain, levee, and structure stability based upon current and future socio-economic, physical, and biological constraints. An understanding of the fluvial geomorphic processes in the Project area will also inform the potential of the Project to meet the Fish Habitat and Passage and Habitat Restoration goals and objectives.

Geomorphology Goal 1

Provide for long-term stability of required riverine structures, such as diversions, levees and any bed and bank stabilization measures.

Objectives

1. Minimize erosion and scour problems, and associated maintenance and cost requirements for management agencies.

2. Minimize the risk of potential structural failure due to uncertainties inherent in hydrologic and geomorphic sciences and practices.

Geomorphology Goal 2

Reestablish a functioning river morphology which, to the extent possible, promotes long-term stability of the river system and which supports fish habitat and passage goals by utilizing hydro-geomorphic processes in conjunction with Restoration Flows.

Objectives

1. Establish the optimum channel and floodplain configuration (morphology) that is consistent with the future flow and sediment supply regimes.
2. Incorporate vegetation to the extent possible to protect channel banks, while maintaining the channel and floodplain capacity requirements.
3. Provide geomorphic features that support fish management goals for migrating and transient rearing habitats (e.g. side channels, bars, woody debris).
4. Enable the establishment and maintenance of diverse bed features (e.g. pools) and channel structure (e.g. large woody debris) through natural processes.
5. Promote the establishment of a single-thread, low-flow channel to provide for fish passage through natural processes.
6. Promote for periodic inundation of floodplain surfaces at the proper frequency for fish access and transient rearing.

This page left blank intentionally.

4.0 Pre-Initial Options Analysis

Pre-initial options analysis included concepts suggested during the Project scoping meetings and other concepts suggested within the Project team (SJRRP 2010d).

Some actions suggested during the scoping process and considered by the Project Team were not retained for inclusion in the Project initial options because they would not meet the project purposes, needs, goals, and objectives. These actions, and associated screening information, are summarized below.

- Mitigation for flood impacts: No alterations to flood management operations are included in the Project, and mitigation for flood impacts not associated with the Project are unwarranted. Local flooding conditions would be improved through increased capacity within the channel and floodplain and improved levees.
- Evaluation and redesign of the Columbia-Mowry Distribution System including facility access, O&M, pumps, pipelines, and power: Modifications to existing canals, pumps, pipelines, access, and power are limited to those relocations necessary to construct the Project. The Project will not include evaluation or redesign of system components outside of those potentially impacted by the Project.
- No interruption of water deliveries: The Project goals and objectives do include accommodating water deliveries up to 2,500 cfs within Reach 2B; however, the ability of Reclamation to perform in delivering the contracted water amounts is outside the Project purpose.
- Acquire land to support recreation, tourism, flora, fauna, and groundwater recharge: The purpose of the Project does not include independently supporting recreation, tourism, flora (other than riparian habitat), fauna (other than salmon), or groundwater recharge, so land would not be acquired solely for these purposes. However, opportunities may exist to support these functions in conjunction with or incidental to implementation of the Project, and land acquired to meet the Project purposes, needs, goals, and objectives may also benefit recreation, tourism, flora, fauna, and groundwater recharge.
- Shortening channel distance to reduce levee length and reduce maintenance costs: Shortening of the river channel or the bypass alignments is currently not considered due to the considerable negative effects to habitat, geomorphology, and sediment continuity in the reach that would result from shortening, or straightening, the channel.
- Installing a cutoff channel before the river bends just downstream of the Chowchilla Bifurcation Structure to reduce flooding toward Hwy 180: No alterations to flood management operations are included in the Project, and mitigation for flood impacts not associated with the Project are unwarranted.

Local flooding conditions could be improved through increased capacity within the channel and floodplain and improved levees.

- Installing a wall across the river in Reach 3 just below Mendota Dam and diverting water to Mendota Pool: This action would not meet the purpose and need of the Settlement as it would not provide a bypass around the Pool.
- Allow salmon in the Pool and Chowchilla Bypass: The extent to which fish would be screened out of the Pool and Chowchilla Bypass has not been determined at this time. Fish screening, and any benefits that may be provided under future conditions, would be considered in the alternatives evaluation process.
- Include provisions to allow for Mendota Dam maintenance: Construction of the Bypass places maintenance of Mendota Dam outside the purpose, need, and scope of this project.
- Avoid bifurcation of future flows: The Settlement requires Restoration Flows in Reach 2B and in downstream reaches, but it does not require flood conveyance in Reach 2B, and diversion of flood flows into the Chowchilla Bypass is required to meet existing flood operation guidelines. The flexibility to divert flows away from the Bypass and to the Pool is also required to meet potential Exchange Contract water deliveries; however, Restoration Flows are required in the Mendota Pool Bypass and downstream reaches.
- Fish screens in the Pool: This action would not meet the purpose and need of the Settlement as it would not provide a bypass around the Pool. In addition, the maintenance, cost and reliability of fish screens for all Pool connections would be problematic.
- Evaluate all alternatives that avoid impacts to wetlands: The extent to which initial options impact existing wetlands has not been determined at this time. Extent of impact to existing wetlands would be considered in the alternatives evaluation process.
- Avoid dredging or filling in waters of the United States: Filling in waters of the United States would be minimized to the extent possible and would be considered in the alternatives evaluation process.
- Address effects of the Project on Milburn Pond: Addressing the effects of the Project on Milburn Pond is outside of the purpose, need, and scope of this project.
- Do not reintroduce salmon in order to protect existing riparian habitat: Existing riparian habitat would be considered in the alternatives evaluation process. Not reintroducing salmon would be contrary to the Settlement.

Some additional options exist that were not part of the scoping process, but were also considered by the Project Team and not retained for inclusion in the Project initial options because they would not meet the project purposes, needs, goals, and objectives. These include the following:

- Construction of levees to withstand a 200-year flood: Eliminated because existing levees in the Project area are not part of the Lower San Joaquin River Flood Control Project.

5.0 Initial Options Refinement

During the concept refinement phase of the Project, some of the initial options were revised, refined, or eliminated from further consideration.

5.1 Pre-Evaluation Screening

The concepts considered and eliminated from further consideration prior to the alternatives evaluation are described below.

5.1.1 Bottomless Arch Culverts

Bottomless arch culverts were considered in the Initial Options TM as a potential method of improving the crossing at San Mateo Avenue. However, based upon further consideration it was decided that bottomless arch culverts would be too difficult to implement in the sand bed channel of Reach 2B because the culverts would require substantial undercut for foundation work, the culverts would potentially require a concrete floor to stabilize the structures during high flows, and could have an unacceptable failure rate. In addition, less expensive and equally beneficial options are available (i.e., concrete box culverts).

5.1.2 Corrugated Metal Pipe Culverts

Corrugated metal pipe culverts were considered in the Initial Options TM as a potential method of improving the crossing at San Mateo Avenue. However, based upon further consideration it was decided that corrugated metal pipe culverts would be difficult to design for the fish passage requirements and they may have a shortened lifespan due to the corrosive nature of the soils in the Project area.

5.1.3 Bridge

A bridge was considered in the Initial Options TM as a potential type of crossing for the San Mateo Avenue crossing. However, based upon further consideration it was found that both a box culvert crossing and a bridge crossing are capable of meeting the fish passage requirements, but the bridge is significantly more expensive. Therefore, the bridge crossing was eliminated from further consideration.

5.1.4 San Mateo Avenue Crossing Removal

The Project considered removing the San Mateo Avenue crossing as a means of simplifying fish passage in Reach 2B; however, based upon further review, it was found that Madera County has a public right-of-way to the centerline of the river on the north side, and they would like to maintain access on all their rights-of-way for the landowners. Therefore, the Project has not proposed to remove this crossing.

5.1.5 Floodplain Vegetation Types

In the Initial Options TM, several floodplain vegetation types were considered: fully grassed floodplain, forested riparian fringe along the river with a grassed floodplain, and fully forested floodplain. Based upon further review during concept refinement, the floodplain vegetation concept used in the hydraulics modeling was revised to a mosaic type floodplain habitat including a forested riparian fringe along the river and a mixture of grasslands, scrub, and trees on the floodplain. The mosaic floodplain habitat was more typically found along the river historically and can be found in other parts of the San Joaquin Valley today. The preliminary planting plans also present mosaic floodplain habitats but with forested vegetation where inundation depths and soils are appropriate for tree species. The concept used for the hydraulic modeling and that presented in the preliminary planting plans are considered to be comparable in terms of roughness.

5.1.6 Floodplain Recontouring

As part of the Initial Options development, recontouring of the entire floodplain to allow inundation of large areas at lower flows was considered. Based upon further review during concept refinement, this concept provided less or similar benefit as the select floodplain grading included in the Project alternatives. Wholesale recontouring would not increase the habitat diversity on the floodplain and thus would not provide increased benefits to fish. However, it would require excavation of much larger quantities of material and thus would increase costs. Wholesale recontouring also has the potential to decrease the area of inundation and cause erosion along the channel. Wholesale floodplain recontouring was therefore eliminated from further consideration.

5.1.7 Older Levee Setbacks

During concept refinement, the levee alignments presented in the Initial Options TM were refined and revised and one alignment was eliminated: Initial Option FP-1. Initial Option FP-1 was found to not sufficiently meet the Settlement requirements to provide floodplain and riparian habitat in Reach 2B. The other levee alignments were modified to account for property lines, field lines, infrastructure, flow and sediment continuity purposes, and to add a minimum 300-foot buffer, where appropriate, between the channel and levee to protect the levee from lateral channel migration and erosion.

5.1.8 Mendota Dam Removal

The Fisheries Management Workgroup asked the Project to consider removing Mendota Dam as part of the Fresno Slough Dam Initial Alternative. Based upon further consideration and analysis, it was decided that the Project would not remove the dam because it provides a grade control point between Reach 3 and Reach 2B. Without the dam, the channel base level would be lowered and incision could migrate upstream through Reach 2B. This could jeopardize passage conditions at the structures in the project area such as at San Mateo Avenue and Chowchilla Bifurcation Structure where channel grades would potentially be lowered by up to approximately 4.7 feet and 1.9 feet, respectively, effectively relocating the grade-control point. Lowering the base-level would also eliminate overbank flow during all but the highest flows (Tetra Tech 2011a). Furthermore, structural stability of existing and proposed structures could be compromised by the decreased bed elevations and resulting scour.

5.1.9 Channel Grading from Reach 3 to Chowchilla Bifurcation Structure

The Technical Advisory Committee requested that the Project consider not constructing grade control structures in the Mendota Pool Bypass channel and that the channel be graded from the confluence with Reach 3 at an appropriate slope. Based upon further analysis, it was found that grading the channel at the equilibrium slope starting at the confluence with Reach 3 would lower the entire Mendota Pool Bypass Channel and Reach 2B channel up to approximately 14.3 feet and 11.7 feet, respectively, and that the new base elevation would require excavation (or result in erosion) all the way up to the Chowchilla Bifurcation Structure, which would serve as a grade control point. Furthermore, it was found that this would leave the Reach 2B channel elevation approximately up to 5.3 feet below the floor elevation of the Chowchilla Bifurcation Structure potentially undermining the structure and presenting a fish passage barrier as well as disconnecting the channel from its floodplain throughout Reach 2B (Tetra Tech 2011a). Based upon the necessary structural improvements at the Chowchilla Bifurcation Structure to prevent failure, the fish passage impacts, the significant decrease in floodplain inundation area and frequency, the surplus of cut material for the bypass channel, and water quality/stability concerns from eroding channel bed and banks, this concept was eliminated from further consideration.

5.1.10 Floating Picket Weir

A floating picket weir was considered in the Initial Options TM as a potential method of providing a fish exclusion barrier at the downstream end of the Mendota Pool Bypass Channel to direct fish into the Bypass. Based upon further consideration, this option was eliminated due to the magnitude of flows expected to be seen at the barrier location and this type of weir not being appropriate for such high flows.

5.1.11 Behavioral Barrier

Behavioral fish barriers were investigated during the appraisal-level design as a means of providing an exclusion/directional barrier at the downstream end of the Mendota Pool Bypass Channel to direct upmigrating adult salmon into the bypass channel and away from the base of Mendota Dam. A system to reroute irrigation flows from Mendota Dam to downstream of the barrier would be included with this concept, leaving slack water between the end of the bypass channel and the Dam. Behavioral barrier systems are a developing technology, but two main types of barriers have been implemented on other rivers: electric barriers and acoustic barriers. Both types of barriers have significant draw-backs for implementation in the Project.

Electric barriers generate an electric current through the water across a channel in order to deter fish. Based on existing and previous installations, electric barriers were found to present potential unavoidable electric shock hazards for fish (target and non-target species), other animals, people, and watercraft. Often target fish species either made it past the barrier or were killed. Velocities and depths need to be consistent for the barrier to be effective; something that has proven difficult on reaches with moveable beds and those with variable flows. Velocities also need to be sufficient to sweep stunned fish out of the barrier, which may be difficult in the low slope, low velocity Reach 3. Some programs are considering replacing their electric barriers with different technologies. For all these reasons, the electric barrier is not recommended.

Acoustic barriers use a sound signal contained in a bubble curtain of air to deter fish; acoustic barriers may also incorporate the use of strobes and lights to deter fish. There are few existing installations of acoustic barriers, but they have been found to be most effective on juvenile fish with minimal effectiveness on adult fish. Effectiveness has also been found to decrease with increasing flows. Acoustic barrier technology is not capable of functioning during high flows such as flood releases from Pine Flat routed down Fresno Slough into Reach 3 (typically at 4,500 cfs or reach capacity). These high flows occur on an average annual frequency of 1 in 5 years, typically in wet years. Since the purpose of the Mendota Pool Bypass Barrier is to direct adult migrating salmon into the bypass at all flows, including flood flows, the acoustic barrier is not recommended.

5.1.12 Velocity Barrier

Based on design and hydraulic analyses, a velocity barrier at the downstream end of the Mendota Pool Bypass Channel was eliminated from further consideration because the resulting barrier would be higher than Mendota Dam, would increase the elevation in Mendota Pool between 4 and 5 feet, and would necessitate improvements to all levees on Mendota Pool and Fresno Slough.

5.1.13 Other Types of Fish Screens

During the appraisal-level design several types of fish screens were reviewed for their applicability to the Project for screening fish from the 2,500 cfs diversion to Mendota Pool. The following screen design types were eliminated from further consideration due to design constraints. Horizontal flat plate screens (patented by Farmers Irrigation District, OR) were eliminated because they are intended for use with smaller diversions (less than 100 cfs); there are no physical model studies or field applications demonstrating that this design is capable of handling larger diversions. Travelling screens were eliminated because maintenance is a significant problem, and there are no known field applications for diversions of the Project’s size. Box screens were eliminated because, while they can be sized for larger applications, they function very similarly to cylindrical screens which were considered further. Pump screens were eliminated because they are only applicable to very small diversions (less than 10 cfs). Rotary drum screens were also reviewed but would not provide increased benefits (on-canal installation) and would have higher costs than the selected design (fixed flat plate in “V” configuration). Other fish screen types that may be considered further include: vertical flat plate, inclined flat plate, cone, and cylindrical screens.

5.1.14 Pump Diversion to Mendota Pool

All the proposed alternatives divert water to Mendota Pool via gravity. During the appraisal-level design, a pump diversion was also considered and preliminary costs were developed. The pump diversion was eliminated from further consideration because the capital improvement costs are nearly four times the cost of the gravity diversions. In addition, the pump diversion would rely on Mendota Dam or another barrier to form a backwatered pool, so the pump diversion would not be able to eliminate the need for a fish passage structure.

5.2 Other Refinements

Many concepts were refined or revised during appraisal-level design before moving into the alternatives evaluation; those refinements are described below.

5.2.1 Levee Alignments

During the concept refinement, a minimum 300-foot buffer between the channel and levee to protect the levee from lateral channel migration and erosion was included on all levee alignments. However, at Bend 10 (approximately RM 209), the river channel and existing right bank levee are located directly adjacent to the Columbia Canal. Providing the 300-foot buffer on this bend would require relocating the Columbia Canal. As an alternative, the Project considered building the new levee along the existing right bank levee alignment and providing revetment along the bend to protect the levee. Revetment is not desirable from a habitat and fisheries perspective. A preliminary cost comparison was prepared to compare the construction and land acquisition costs for the 300-foot buffer versus the revetment on Bend 10. Based on the preliminary cost comparison, it was decided that both bank protection methods at Bend 10 would be evaluated as options in the alternatives evaluation (see Section 7.4.1).

5.2.2 Floodplain Grading

During concept refinement, the inclusion of floodplain grading was considered as a means of providing greater variety of inundation depths on the floodplain as well as more inundation at lower flows. Several iterations of grading were analyzed: 1-2 feet of excavation to create 3-4-foot water depths on the floodplain during most floodplain inundation flows, then approximately 1 foot of excavation on certain inside bends to create 3-4 water depths on the floodplain, and finally approximately 1 foot of excavation to provide high-flow channels and connectivity across certain bends in the floodplain. In the first two iterations of grading, the analysis showed that the additional capacity generated in the excavated areas reduced the area of floodplain inundation and did not increase the variety of inundation depths on the floodplain. The loss of floodplain inundation acreage led to the iterative decrease in the quantity of grading until the high-flow channel concept was selected for inclusion in the design. The high-flow channels do not significantly affect inundation acreages or the variety of inundation depths, but they may provide other fisheries benefits such as juvenile rearing and food production as well as inundation at lower flows.

5.2.3 Removal of Existing Levees

Removal of existing levees is necessary to expand the inundation area of the floodplain out to the proposed levees. Rather than remove existing levees in their entirety, a preliminary plan to selectively preserve some levees was developed based upon the locations of highly desirable existing vegetation (native and sensitive vegetation communities that can serve as seed banks for future vegetation communities) as well as hydraulic performance of the channel and floodplain. Where levee removal was necessary to allow inundation of the floodplain and floodplain connectivity for fish movement, vegetation and levee preservation was not included in the design.

5.2.4 Placement of Structures

During concept refinement, the placement of the bifurcation control structures at the head of the Mendota Pool Bypass Channel was refined. For the Settlement alignment of the bypass (see description in Section 7.2.2), the Mendota Pool control structure was relocated downstream of the confluence with Reach 2B so that unfarmable land to the south of the confluence could be incorporated as floodplain.

5.2.5 Operational Flexibility

During concept refinement, it was decided that the structure designs and fish routing needed to function with full operational flexibility. Meaning that fish passage facilities were selected and designed based on their ability to fully function and route fish through the Mendota Pool Bypass facilities during both of the following operational scenarios:

- Zero to 4,500 cfs through the Mendota Pool Bypass facilities with no diversion to Mendota Pool
- Zero to 2,500 cfs into the Mendota Pool and the remainder of Reach 2B flows through the Mendota Pool Bypass facilities simultaneously

Not all types of fish passage facilities are capable of operating under such variable flow and hydraulic head conditions, and the flexibility required necessarily limited the types of facilities and structures that are feasible for the project.

5.2.6 Fish Passage Design Criteria

The Project team worked in conjunction with the Fisheries Management Workgroup and other experts at the fisheries agencies to develop criteria for fish passage that were used to design structures and analyze passage conditions in the channel and at structures during the concept refinement phase. The design criteria are structured around the life stages of the target anadromous species and the timing of the runs for upstream movement of adult fall and spring run Chinook and winter steelhead and the upstream and downstream movement of juvenile life stages spawned from these runs. Recommended criteria are based on a combination of swimming ability of the fish species as reported in scientific papers and criteria in agency design guidelines. Recommended design criteria to provide for successful fish passage (depth of flow, suitable velocity ranges and jump height) are provided in Table 5-1. The design criteria for a particular species would be met over the associated flow range (minimum flow to maximum flow).

Table 5-1.
Fish Design Criteria

Species	Life-stage	Migration Timeframe	Frequency	Minimum Flow	Maximum Flow	Maximum Velocity [1]	Minimum Water Depth [2]	Maximum Jump Height [3]	Minimum Pool Depth
			years	**cfs**	**cfs**	**fps**	**feet**	**feet**	**feet**
Chinook salmon	Adult	Spring and fall pulse	All years except CL	115 [4]	4,500	4.0	1.2	1.0	[5]
	Juvenile (upstream)	Late spring diminishing flows	All years except CL	125 [6]	n/a	1.0	1.0	0.5	[5]
	Juvenile (downstream)	Nov-May	All years except CL	85 [7]	n/a	n/a	1.0	n/a	[5]
Steelhead	Adult	Spring and fall pulse	All years except CL	115 [4]	4,500	4.0	1.2	1.0	[5]
Sturgeon	Adult	Spring pulse	W and NW years	1,138 [8]	4,500	6.6	3.3	None – swim through	n/a
Lamprey	Adult	Spring pulse	All years except CL	125 [6]	4,500	[9]	[9]	[9]	n/a
Other native fish	Adult	Spring pulse	W, NW, and ND years	543 [10]	4,500	2.5	1.0	None – swim through	n/a

W = wet; NW = normal wet; ND = normal dry; CL = critical low

[1] Recommended velocities are for drop structures or structures with short longitudinal lengths. For structures with longer lengths (e.g., culverts and bifurcation structures under certain conditions), maximum velocities would be based on *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2001).

[2] Minimum water depth criteria based on 1.5 times body depth or 1 feet depth, whichever is greater.

[3] Maximum jump height criteria based on criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2001).

[4] Based on Exhibit B lowest flow in the fall spawning period (starts Oct 1) for the desired frequency; all Spring Pulse Flows are higher.

[5] Pool depths to be based on criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2001).

[6] Based on lowest flow within Exhibit B Spring Pulse Flow period for the desired frequency.

[7] Based on lowest flow within desired migration period for the desired frequency.

[8] Wet and normal wet years constitute 50% of years in the historical record. Based on an analysis of varying Restoration Flows management strategies (Reclamation 2010); flows with a 50% exceedance could range from 1,138 to 4,500 cfs.

[9] Lamprey designs to be based on criteria in *Best Management Practices for Pacific Lamprey* (USFWS 2010)

[10] Wet, normal wet, and normal dry years constitute 80% of years in the historical record. Based on an analysis of varying Restoration Flows management strategies (Reclamation 2010); flows with an 80% exceedance could range from 543 to 4,500 cfs.

5.2.7 Columbia Canal Relocation Facilities

The Bypass Initial Alternatives will require modification and relocation of portions of the conveyance facilities for the Columbia Canal Company (CCC). Currently, irrigation water is diverted into an inlet channel approximately 6,000 feet upstream from the Mendota Dam, which backwaters Mendota Pool and the inlet channel, where it is pumped by Reclamation's Main Columbia Pumping Plant. Approximately 125 cfs of irrigation water is diverted to the west Columbia Canal and 125 cfs into a concrete lined ditch to the east. The location and level of impact to the CCC facilities depends on the Bypass Initial Alternative. Generally, either the alternative cuts across the CCC or disconnects it from the Mendota Pool.

The Settlement Alignment Initial Alternative will sever portions of the Columbia Canal south of the Settlement Alignment from the remainder of the canal system. This necessitates relocating a portion of the canal and installing siphons to pass irrigation flow, from the existing USBR Main Columbia Pumping Plant, beneath the bypass channel to the irrigation canals. The pre-appraisal designs include installing two siphons to allow irrigation flows to pass beneath the upstream and downstream ends of the Settlement Alignment. This would allow the use of the existing canal to the south of the bypass channel to continue to convey irrigation water. This design was revised for appraisal design by including a double barrel siphon on the upstream end of the bypass channel, and a realigned canal just north of the bypass channel. It was determined that agricultural lands to the south between the bypass channel and river would likely no longer receive irrigation deliveries from the CCC, making the two siphon design more costly and inefficient. The future detailed design phase may consider including pumps and pressurized pipes to convey water from Mendota Pool to the CCC as a means of avoiding sediment build-up in the siphons and to mitigate for possible fluctuations in the Pool water surface level.

The Compact Alignment Initial Alternative will prevent the use of the existing CCC inlet channel and Pumping Plant. The pre-appraisal and appraisal designs are essentially the same. The Pumping Plant will be relocated to the Mendota Pool about 1800 feet upstream of the Dam. Water will be pumped under the bypass channel via pipe and into the Columbia Canal. Water will be diverted to the east or west into irrigation canals using a new outlet structure. The outlet structure and the canal to the east will need to be raised to allow water to be diverted in both directions. The inlet location for the appraisal design was moved approximately 800 feet southeast from the pre-appraisal location due to the original location being a shallow area of the river.

The Fresno Slough Dam Initial Alternative will prevent the use of the existing CCC inlet channel and Pumping Plant. For this alternative, four different designs were developed to account for the different Reach 2B Floodplain Initial Alternatives and water delivery canal options. All four designs were basically the same, but the layouts are slightly different to account for the levees and water delivery canals. In general, a new pump station would be located on Mendota Pool as created by the proposed Fresno Slough Dam, and irrigation water would initially be diverted to canals on the south side of the river. The water would travel by gravity in the canal, then into pipeline siphons under the river, and then be pumped again into the Columbia Canal where it is diverted to the west or east. The easterly portion of the Columbia Canal would need to be raised and modifications would be made to various sections of existing canals to allow the majority of the canals to be gravity fed.

5.2.8 Fresno Slough Dam Height

During concept refinement it was decided that the proposed height of the Fresno Slough Dam would be the same height as the existing Mendota Dam and not the height of the proposed Mendota Dam, which is being considered as part of a separate project for the Mendota Wildlife Refuges. Using the existing Mendota Dam height is consistent with the other Bypass Initial Alternatives (Settlement and Compact alignments), neither of which would raise the height of Mendota Dam.

5.2.9 Picket Barriers

In addition to the review and exclusion of behavioral barriers and velocity barriers described in Sections 5.1.10 and 5.1.12, hydraulic analyses were performed on several picket barrier concepts during concept refinement:

- Picket barrier across the Reach 3 channel designed for 600 cfs through the structure (from Mendota Dam) and 4,500 cfs in the downstream channel
- Picket barrier across the Reach 3 channel designed for 4,500 cfs through the structure (from Mendota Dam) and 4,500 cfs in the downstream channel
- Picket barrier across the Reach 3 channel and floodplain designed for 4,500 cfs through the structure (from Mendota Dam) and 4,500 cfs in the downstream channel

The skew angle of the structure to the direction of flow was also refined, concepts for the alignments of extension levees were developed, and preliminary costs for levee improvements along Reach 3 between the Mendota Dam and the barrier were developed. The picket barrier across the channel and floodplain (third option) was selected for evaluation because it does not restrict the flow width or floodplain processes.

5.2.10 Infrastructure Relocations and Floodproofing

During concept refinement it was decided that relocation of the three City of Mendota wells located on the south side of the river would not be included in the costs of floodplain alternatives where the wells are inside the levee alignments. These wells are deep, and were difficult to drill and site when installed, so relocation of these wells could result in significant costs. The design of the Initial Alternatives includes costs to raise the wells and construct an access road across the floodplain.

5.2.11 Seepage Mitigation

At the time of the appraisal-level design there was minimal geotechnical information available to determine the potential location, extents, and duration of nuisance seepage resulting from the Restoration Flows. In addition, the CVHM-SJR model results were not available. A preliminary, cross-section based groundwater model was developed to determine the approximate extent of nuisance seepage. As a result, the design of the Initial Alternatives assumes that slurry walls will be installed along the entire length of the proposed levees, except along lands not sensitive to increased groundwater elevations (e.g. natural ground and grazing lands). It is expected that the type, length, and design of seepage mitigation measures will be refined once geotechnical data and the CVHM-SJR model results become available.

This page left blank intentionally.

6.0 Initial Alternatives Evaluation Criteria

The criteria described below were determined for each of the Initial Alternatives described in Section 7.0. Criteria for the Floodplain Initial Alternatives and Bypass Initial Alternatives (including applicable structures) were determined independently so that the Floodplain Initial Alternatives could be scored amongst themselves and likewise for the Bypass Initial Alternatives. The intent was to allow any Floodplain Initial Alternative to be combined with any Bypass Initial Alternative during development of the Final Alternatives without the need to evaluate all possible combinations. For the purposes of the evaluation, the location of the junction between the Floodplain Initial Alternatives and the Bypass Initial Alternatives needed to be the same for all Initial Alternatives to allow the independent scoring. The Floodplain Initial Alternatives extend from the Chowchilla Bifurcation Structure downstream to the location of the head of the Settlement Alignment Bypass, and the Bypass Initial Alternatives extend from the location of the head of the Settlement Alignment Bypass downstream to their respective tie-in locations in Reach 3.

6.1 Implementation/Technical Feasibility

The sections below describe the criteria chosen to represent the range of implementation and technical feasibility of the Initial Alternatives.

6.1.1 Costs

Capital Improvement Costs

Capital improvement costs include the costs to procure and manage contractors, buy and haul materials, do earthwork, build structures (including concrete, metal, valves, equipment, plumbing, electrical, power, and communications work), and stabilize and revegetate (plant and irrigate) the Project. Capital improvement costs do not include land acquisition, mitigation, or operations, repair, and maintenance costs.

Construction costs are the combined cost of contractor payments and construction inspection/administration. Contractor payments were estimated by itemizing the contract bid items and applying current labor and materials rates to develop the costs for each bid item.

Costs were based on 2007 labor, equipment, and material rates, estimated time for equipment, and the quantity estimates using Reclamation Cost Estimating guidelines. Unit costs were also developed by Provost and Pritchard Engineering, Tetra Tech, and DWR (equipment costs based on 2007 Caltrans rates). Final costs were subject to rounding and contingencies as outlined in the USBR March 1989 “Cost Estimating Handbook.”

Land Costs

Data from the ASFMRA was reviewed with information on the number of acres of each crop that will be permanently removed from production. The average land cost was found to be somewhat less than $10,000 per acre, so a more conservative estimate of $10,000 per acre (independent of crop type) was chosen for the appraisal-level design and alternatives evaluation. The purpose of selecting the land cost was solely to provide a consistent value to evaluate the relative acquisition costs associated with the various Initial Alternatives. It is not meant to represent land values that will be determined as part of the real estate appraisal process in a later phase of the Project

Operation and Maintenance Costs

Operation and maintenance costs include annual power costs, annual equipment maintenance cost, including periodic replacement, annual structure maintenance costs, and annual vegetation management maintenance costs. More specifically, levee maintenance includes vegetation management, access roads, levee inspections, levee restoration, rodent control, minor structures, encroachment removal, levee patrolling during flood events, and equipment costs. Floodplain maintenance includes vegetation management for invasives and periodic floodplain and channel shaping to retain capacity. There are no operating costs for levees or floodplains.

San Mateo Avenue maintenance includes post-overtopping flow and annual maintenance to keep the crossing functional, which includes cleaning debris or sediment from culverts, clearing debris from the roadway after flows have receded, and repairing or replacing minor structures. The crossing is assumed to be equipped with manually locking gates to prevent traffic crossing during overtopping flows. Operations costs assume the road would be closed once a year, in the late fall, and open in the late spring.

Bifurcation Structure maintenance includes annual operating maintenance for radial gates, lubing the fittings, replacing seals, greasing and inspecting the motors, and cleaning the trash rack. Operating costs include operating the motors for the radial gates, inspection and assessment of the gates, and adjusting the gates for various stages of flows.

Fish ladder maintenance and operations costs include periodic monitoring of the fish ladder for debris and minor cleaning.

Fish screen maintenance includes pre and post operating maintenance for screens (periodically removing, cleaning, and replacing screens), brush cleaning system (periodic repair or parts replacement, inspections, and grease motor), and trash rack (periodic repair or parts replacement, inspections, and grease motor). Screen operations assume daily operations during juvenile migration periods during Pool deliveries. Operations costs include visual inspection, flow verification, clearing obstructions and debris, adjusting the baffles, permitting and regulatory compliance, velocity measurements, performance estimate, and power.

Fish barrier operations assume daily operations during adult migration period. Operations costs include visual inspection, flow verification, and clearing obstructions and debris.

Seasonal operations include installation and removal of the barrier and permitting and regulatory compliance.

Water delivery canals are either an unlined earthen channel or concrete lined. Maintenance costs of the unlined earthen channel include sediment removal and channel re-shaping. Maintenance costs of the concrete lined channel include sediment removal. There are no operating costs for the water delivery canal.

Fresno Slough Dam maintenance costs include annual operating maintenance for radial gates, lubing the fittings, replacing seals, greasing and inspecting the motors, and repair of miscellaneous equipment. Operating costs include operating the motors for the gates, motor for the automatic trash sweep, and annual permitting fees.

Costs were based on 2007 labor, equipment, and material rates, estimated time for equipment, and the quantity estimates using Reclamation Cost Estimating guidelines. Unit costs were also developed by Provost and Pritchard Engineering, Tetra Tech, and DWR (equipment costs based on 2007 Caltrans rates). Final costs were subject to rounding and contingencies as outlined in the USBR March 1989 “Cost Estimating Handbook.” Additional costs were estimated for environmental permitting for work to be completed as previously discussed. This was calculated to be a bulk sum of salary and overhead.

Evaluation Criteria

- Capital improvement costs: The costs associated with designing and building the Initial Alternative in total dollars.
- Land costs: The estimated cost of land expected to be purchased for the Initial Alternative based on an average approximate value of $10,000 per acre.
- Operation and maintenance costs: The annual dollars required to operate and maintain the Initial Alternative.

Criteria initially identified but not evaluated

Other criteria were initially identified in the Analyitical Tools TM (SJRRP 2010f) for evaluating the costs of the Project. These criteria were removed for the reasons described below.

- The Project was considered to be too early in the process for thoughtful and reasonable development of mitigation needs, ratios, assessment of potential ways to meet mitigation and monitoring requirements. Mitigation costs were, therefore, removed from the evaluation. However, because mitigation would likely be proportional to environmental effects the relative differences in likely mitigation alternatives are captured in the environmental effects criteria for the purpose of comparison.

6.1.2 Time to Build

Construction

Labor and equipment time and hourly rates and construction quantities were estimated for each activity and sub-activity during construction. Activity schedules are based on finish-start logic with no overlap in sub-activities. Main activities are scheduled based on finish-start logic with a negative 50% lag between each main activity and the subsequent main activity. Labor and equipment rates include 15% markup. Production rates are based on 8 hour shifts. Schedule based on an average of 21 working days per month (252 working days per year).

Evaluation Criteria

- Time until action is functional: the number of months to construct and plant restoration vegetation for the Initial Alternative.

Criteria initially identified but not evaluated

Other criteria were initially identified in the Analyitical Tools TM (SJRRP 2010f) for evaluating the costs of the Project. These criteria were removed for the reasons described below.

- Design costs are included as a percent contingency in the capital improvement costs, but the design timeline was not estimated, so this criterion was removed from the evaluation.
- Permitting timelines are assumed to be independent of which alternative is selected, so this criterion was removed from the evaluation.

6.2 Objectives/Benefits Achievement

The sections below describe the criteria chosen to represent the range of objectives and benefits achievement offered by the Initial Alternatives.

6.2.1 Flow Conveyance

Since all Initial Alternatives have the ability to convey up to 4,500 cfs along the path of Restoration Flows and to divert up to 2,500 cfs to the Mendota Pool, this criterion was not a differentiator and was removed from the evaluation.

6.2.2 Fish Habitat and Passage

The discussion below provides background information and documentation of the approach used in evaluating fish habitat and passage. Fish habitat in the three Bypass Initial Alternatives is evaluated separately from that associated with the Floodplain Initial Alternatives.

Floodplain Fish Habitat

The assessment of floodplain habitat in California is founded in the concept of the floodplain activation flow (FAF) (Williams 2009 and Opperman 2010). The FAF is considered the minimum flood pulse necessary to trigger or “activate” floodplain ecological processes within an alluvial system. The flow, which allows hydraulic connectivity between the river and floodplain, must occur for a suitable duration and occur with a great enough frequency to assure that ecological benefits are meaningful. The FAF is defined as the river stage that is exceeded in at least two out of three years and sustained for at least seven days from mid-March to mid-May (Williams 2009).

As defined, the FAF has a season that is based on work conducted on the Sacramento River, and it is likely appropriate for the San Joaquin River as well. While the FAF, as defined, may function for sediment delivery, water recharge, and seed dispersal, it is not sustained for a sufficient period of time to provide a meaningful support of juvenile salmon rearing; however, even short-term floodplain inundation can provide some benefits for salmon. In order to function for fish habitat and increase juvenile growth rates, the flows would need to be a sustained for longer than seven days and/or provide repeat inundation periods during the mid-March to mid-May period.

Dramatic differences have been shown in growth rates of juvenile Chinook salmon reared on vegetated floodplains versus those reared in the channel downstream of those floodplains over a period of 54 days (Jeffres 2008 and as cited in Opperman 2010). The juvenile salmon outmigration on the San Joaquin River is anticipated to occur between about March 15 to May 15. Reach 2B is not adjacent to, or near any spawning habitat, so juveniles using this reach would likely be migrating downstream toward the ocean, which is a life history stage referred to as transient rearing and also described as a "grow as you go" life stage. For this outmigration period, an inundated floodplain could provide additional valuable transient rearing habitat.

Furthermore, based on an analysis of potential future Restoration Flow management strategies, it appears that flows with a 2 out of 3 year recurrence interval, as described by the FAF, would not inundate much of the Reach 2B floodplain. The flows at this annual frequency generally remain in the channel. Geomorphologically speaking, flows that recur on a 2 of 3 year basis are often described as the "channel forming flow", and it is not expected that a flow of this frequency would inundate the floodplain. Therefore, a less-frequent flow, which would inundate the floodplain, with a longer duration was developed to support the evaluation of fish habitat.

Floodplain Salmonid Rearing Activation Flow

For the purpose of this evaluation, a Floodplain Salmonid Rearing Activation Flow (FSRAF) was defined based on the characteristics of functional floodplain for juvenile salmonid rearing. The FSRAF is assumed to be the minimum flow needed to support floodplain rearing habitat for juvenile salmonids in Reach 2B and is established as the flow that is sustained for 20 days between March 15 and May 15 and has a frequency of 1 out of 2 years. The FSRAF for Reach 2B inundates the floodplain directly connected to the main channel. For Reach 2B, the FSRAF is estimated as 2,300 cfs based on a frequency-duration analysis of potential future Restoration Flow management strategies

(SJRRP 2010a)[1]. The FSRAF should not be interpreted as a recommendation for managing flows in the San Joaquin River; it is the flow that creates sufficient floodplain habitat in Reach 2B for a sufficiently long duration to provide a benefit for rearing young salmon.

The evaluation of the Floodplain Initial Alternatives assumes that the hydrologic criteria of the FSRAF are achievable in Reach 2B under the Restoration Flows. While specific hydrographs of the Restoration Flows are not defined at this time, a framework study was completed that incorporates the management of the volume of water reserved for the Restoration Flows (SJRRP 2010a). The actual flows will be recommended by the Restoration Administer with input from the Technical Advisory Committee. Actual flows cannot be predicted with any degree of certainty at this time because the Restoration Administrator must also consider reservoir conditions and precipitation updates and predictions as well as a variety of goals and purposes before flows are set, including the consideration of the value of channel forming flows, riparian recruitment flows, and fish flows not only in Reach 2B but also in other reaches of the river. Given the uncertainty surrounding actual flow conditions, the evaluation of the Floodplain Initial Alternatives focused on floodplain inundation (modeled depths and velocities and area of inundation) for steady state flows of 2,000, 2,500, 3,000 and 4,500 cfs, and the 2,500 cfs inundation was used as surrogate for the 2,300 cfs FSRAF.

The Floodplain Initial Alternatives were evaluated based upon their potential to support juvenile salmon transient rearing with the assumption that this habitat would also provide habitat for other native fishes. The timing, in early spring, for salmon rearing habitat and native fish spawning is similar as native fishes tend to spawn earlier in the year when water temperatures are relatively cool. In contrast, floodplain inundation late in the spring or early summer is not as favorable to salmon and native fishes when conditions are more in line with the time period and temperature for the reproduction of non-native fish (Crain 2004). Therefore, the March 15 to May 15 inundation period is the preferred time frame for floodplain inundation within Reach 2B.

Shallow Water Habitat Quality

Juvenile salmon rearing habitat is evaluated for direct rearing which is defined as areas with water greater than 1.0 feet deep. This is habitat that juvenile salmon occupy and use as they forage on the floodplain. Primary production[2] occurs in water that is less than a foot deep. This is habitat that salmon do not directly occupy but does produce algae, zooplankton and aquatic macroinvertebrates or other larval fishes that then become food

---

[1] This was done for the daily flow record from March 1, 1922 to February 29, 2008. Each year, only the time period of March 15 – May 15 was assessed. A 20-day running window was applied to the data set, and the minimum (sustained) flow was counted as the flow value for that entire 20-day window. The maximum of these sustained flows each year was then ranked, and the flow that was exceeded in one half of all years was identified to find the flow that occurs in approximately one out of two years with duration of 20 days between March 15 and May 15.

[2] Primary production in aquatic systems refers to the production of bacteria, diatoms and algae or other vegetation components that then drive the production of invertebrates that become food for fish on the floodplain or in the river.

for salmon on the remainder of the floodplain or in the main channel. While floodplain areas with depths less than 1.0 feet may provide some resources used by salmon, extensive areas of very shallow water (less than 0.5 feet deep) do not provide direct benefit to rearing salmon since these areas would be isolated from the flowing deeper waters used by salmon. However, a floodplain that does not have enough shallow water may not provide sufficient primary production to support salmon.

Large expanses of very shallow water habitat would not provide a lot of value to fish using the floodplains. The very shallow water habitats would have low velocities resulting in limited mixing with water adjacent to the rearing habitat. Food resources produced in these areas would not contribute to overall productivity in the river. As the flood levels recede, much of this habitat, especially on the south side of the channel where it is so prevalent, would disconnect from the rearing habitat and the channel.

Guidelines are not forthcoming in the literature regarding the ideal proportion of shallow to deep water because all floodplain waters are typically considered “shallow water habitat” in the literature. However, logic implies that large expanses of water less than 0.5 feet deep would result in very little of the shallow water area exchanging food resources with the rearing habitat on the floodplain because of the limited interaction between the extensive very shallow water and the rearing habitat on the floodplain. Given the physical limitation of transport from shallow water to the deeper floodplain areas or the channel, an optimal width of very shallow floodplain is probably somewhere around 100-200 feet.

All the Floodplain Initial Alternatives provide some shallow water habitat at flows of 2,300 cfs, but because of the extensive areas of shallow water on the wider floodplain alternatives, much of this habitat is physically distant from rearing habitat and would not benefit the rearing habitat. A method for evaluating the quality of the shallow water habitat was needed to differentiate the relative benefits or lack of benefits associated with each Initial Alternative. A rating system based on the proportion of very shallow water habitat (less than 0.5 feet) to rearing habitat (greater than 1.0 feet) was developed based on literature reviews and professional knowledge. The evaluation does not consider the amount of floodplain habitat between 0.5 and 1.0 feet because this area would be transitional between the very shallow water and rearing habitats. The evaluation considers that too little very shallow water prevents development of sufficient levels of primary production to support fish using the floodplain rearing habitat. In contrast, too much very shallow water habitat results in large areas of primary production that are functionally isolated from the floodplain rearing areas and thus are of minimal benefit to salmon. Since inundation depth is inversely related to floodplain width, a balance between the quantities of these two habitats is needed to provide suitable conditions for juvenile salmon in Reach 2B. The rating system is outlined in Table 6-1.

Table 6-1
Shallow Water Habitat Quality Rating Scale

Rating	Ratio of Very Shallow Water Habitat (less than 0.5 feet) to Rearing Habitat (greater than 1.0 feet)
Poor	Less than 0.20
Fair	0.21-0.30
Good	0.31 - 0.40
Fair	0.41 - 0.50
Poor	Greater than 0.50

Floodplain Modeling

For the purposes of the evaluation, the location of the junction between the Floodplain Initial Alternatives and the Bypass Initial Alternatives needed to be the same for all Initial Alternatives to allow the independent scoring. The Floodplain Initial Alternatives extend from the Chowchilla Bifurcation Structure downstream to the location of the head of the Settlement Alignment Bypass, and the Bypass Initial Alternatives extend from the location of the head of the Settlement Alignment Bypass downstream to their respective tie-in locations in Reach 3. The river channel and each Floodplain Initial Alternative and each Bypass Initial Alternative were modeled in HEC-RAS and SRH-2D. The water depth results (from HEC-RAS) and velocity results (from SRH-2D) were output into GIS to calculate the acreages of various depth and velocity ranges associated with each alternative. Specifically, FP-1, FP-2, FP-3, FP-4, and FP-5 were modeled in HEC-RAS at flows of 1,000, 1,500, 2,000, 2,500, 3,000 and 4,500 cfs, and FP-1, FP-3, FP-4, and FP-5 were modeled in SRH-2D at flows of 2,000, 3,000, and 4,500 cfs. The results were also processed graphically to produce “heat maps” of the depth and velocity ranges. Additional processing included overlaying the areas with velocities less than 0.1 fps on the depth maps. However, the velocity results did not substantially differentiate the Initial Floodplain Alternatives, and after a close examination of the data, the velocity data was not used further in the evaluation.

Some of the HEC-RAS model runs show inundation occurring in areas disconnected from the river channel. This is an artifact of the HEC-RAS model, and most of these areas were associated with the lower modeled flows. To eliminate this “noise” from the analysis, and knowing that the channel begins to overbank at about 1,800 cfs along the eastern portion of Reach 2B and around 1,200 cfs along the western portion, the fish habitat evaluation only used modeling results for flows greater than 2,000 cfs. Further review of the flows resulted in the FSRAF concept, so Initial Alternatives were evaluated by comparing the amount of acres for 2,500 cfs.

In addition, comparison of inundation maps and velocity maps sometimes shows that slightly different areas of the floodplain are subjected to flows. This is an artifact of the different modeling routines in the HEC-RAS and SRH-2D models; the differences were reviewed and considered minor.

Fish Passage Conditions

Evaluation of passage conditions assumes that all designs meet the fish passage design criteria developed for the preparation of the appraisal-level designs (see Section 5.2.6) and fish screening criteria established in NMFS 2008.

Upstream passage conditions for adult salmon and downstream passage conditions for juvenile salmonids were evaluated separately. Where upstream-migrating fish encounter artificial structures, passage is via fish ladders, so the total number structures and the total number of steps that a fish must pass was used to evaluate upstream fish passage.

Downstream fish passage conditions for juvenile salmonids is evaluated by tallying the number of fish screens that juvenile fish would pass or move through and the number of potential predation sites at structures (including bifurcation structures, ladders, and fish screen outlets). All structures tend to increase predation risk to juveniles because they may provide atypical riverine conditions, create unfavorable localized hydraulic conditions, and create habitat that can be used by predatory fish to feed. Although design measures and management strategies can be used to alleviate some of the predation risk, it may be that predation cannot be fully eliminated.

Evaluation Criteria

Evaluation criteria associated with fish habitat and passage and the approach to quantifying the criteria are described below.

Floodplain Characteristics

- Rearing habitat: total acres of floodplain with a depth greater than 1.0 feet at 2,500 cfs
- Shallow Water Habitat Quality: a rating based on the proportion of very shallow water habitat (less than 0.5 feet) to the amount of rearing habitat (greater than 1.0 feet)

Passage Conditions for Adult Chinook Salmon

- Artificial structures in the migratory path: number of structures that adult salmon would need to pass. Each drop structure, dam sill, fish ladder (or bifurcation structure), and crossing is considered as an individual structure.
- Total number of steps at structures: the number of steps an adult salmon would need to jump or swim through. Each drop structure, dam sill, and fish ladder step is considered as an individual step.

Passage Conditions for Juvenile Chinook Salmon

- Fish screens along the migratory path: the number of fish screens with large diversion rates (greater than 100 cfs) that juvenile salmon may encounter along the migratory path.
- Potential predation sites at structures: the number of potential predation sites that juvenile salmon may encounter along the migration path. Each drop structure, dam sill, fish ladder (or bifurcation structure), fish screen system, and crossing is considered a potential predation site.

Criteria initially identified but not evaluated

Several other criteria were initially identified in the Analytical Tools TM (SJRRP 2010f) for evaluating fish habitat and passage in the Project. These addressed the amount of habitat in the main channel, frequency of pools and bars, main channel width, average pool depth, floodplain habitat features, length of banks with bordering riparian vegetation, and floodplain connectivity. These criteria were removed for the reasons described below.

- The main channel habitat does not vary significantly between the different Floodplain Initial Alternatives, so this analysis would not produce information with which to compare alternatives and was removed from the evaluation.
- No modifications to the main channel are proposed, so the average channel width and depth does not vary amongst alternatives and these criteria were removed from the evaluation.
- Two-dimensional (2D) modeling completed in advance of the evaluation was conducted on a limited basis and was not available to evaluate the Initial Alternatives on the basis of in-channel habitat favored by native vs. non-native fishes (pools and bars). While the model results did provide some useful results for velocities on the floodplains, the overall assessment of areas of low to moderate velocities did not provide a tool that discriminated between the alternatives.
- In-channel velocities, which vary somewhat dependent on water depth and, therefore, floodplain width, were found to not limit fish passage within the reach, so this criteria was removed from the evaluation.
- There was no tool available to evaluate floodplain habitat features that favor native over non-native fishes. These features also do not exist on some of the wider floodplain options, which would occupy land now in agricultural production outside of the existing levees.
- Since all banks are proposed to be planted with riparian vegetation, the length of banks with bordering riparian vegetation is a function of channel length only, which does not vary with the Floodplain Initial Alternatives, so this criterion was removed from the evaluation.
- While the concept of floodplain connectivity would be of interest, the ability to measure or develop a mechanism to evaluate this was not successful. Connectivity was originally conceptualized as the ratio of total floodplain area to channel length (in acres per foot of channel). This varies by both flow magnitude and floodplain width such that at low flows, very little of the channel may be “connected” while at higher flows, almost all of it is connected. Since this is more a function of the capacity of the channel and has little to do with the floodplain itself, this assessment tool was also removed from the evaluation.
- For water temperature during migration, air temperature, wind speed, and vegetative cover were found to have an effect on water temperature. However, water depth on the floodplain, which is a function of width, was found to be far less significant. Since all the Floodplain Initial Alternatives include planting the

floodplain with woody riparian and floodplain vegetation, and the Project has no effect on air temperature and wind speed, the alternatives were found to not have varying effects on water temperature, so this criterion was removed from the evaluation.

6.2.3 Habitat Restoration

The discussion below provides background information and documentation of the approach used in evaluating habitat restoration. Restored habitat in the three Bypass Initial Alternatives is evaluated separately from that associated with the Floodplain Initial Alternatives.

Vegetation

The evaluation assumes the riverbank and areas between the levees would be planted following construction and then irrigated and managed as necessary during the establishment and monitoring periods. This assumption is included in all alternatives in the evaluation in order to compare their restoration potentials. Conceptual planting layouts utilizing native plant wetland and riparian vegetation alliances were developed for each alternative. Individual alliances were distributed along the river based on:

- Observations of existing vegetation alliances distribution in relationship to the pre-interim flows
- The water demand of dominant species in the vegetation alliance
- Wetland status of the dominant species in the vegetation alliance
- Potential flooding depth/water surface elevation
- Potential flooding duration
- Water velocities during high water events
- Existing soil types
- Levee maintenance requirements

Sensitive Vegetation Alliance Extent

The future sensitive vegetation alliance[3] extent is based on the extent of vegetation communities shown on the Preliminary Planting Plans, and it represents the projected vegetation cover acreage within the floodplain corridor by plant community. The floodplain corridor is the area associated with each of the Initial Alternatives and confined by the levees. The acreages were calculated in GIS.

---

[3] For the purpose of this document, special status vegetation alliances are defined as natural communities that are of limited distribution statewide or within a county or region and are often vulnerable to environmental impacts of projects. These natural communities may or may not contain special status species or their habitat. The current version of the List of California Vegetation Alliances (CDFG 2009) indicates vegetation alliances of high inventory priority as globally or State ranked 1-3 (critically imperiled, imperiled, and vulnerable) for conservation status. Most types of wetlands and riparian communities are considered special status vegetation alliances due to their limited distribution in California. These high-priority vegetation alliances often contain special-status plants.

Wetlands and Other Waters of the United States Area

All vegetation communities proposed in the Preliminary Planting Plans are wetland (hydrophytic) vegetation alliances. It is assumed that Restoration Flows will provide sufficiently frequent inundation of the floodplain to support wetland hydrology. Therefore, the extent of future wetlands is based on the extent of hydric soils in the project area. The area of hydric soils is assumed to be the extent of future jurisdictional wetlands and other waters of the U.S. in the near-term, post-restoration because the other two criteria for a wetland, hydrophytic vegetation and wetland hydrology, will be provided by the Project and the SJRRP. The area of hydric soils was calculated in GIS using the National Resource Conservation Service's GIS-based soils maps and the lists of hydric soils for Fresno and Madera counties.

Wildlife

Vegetation restoration has the potential to support various wildlife species native to the area. The following discusses the criteria used to evaluate potential wildlife use.

Wildlife Habitat Extent

Following construction and revegetation, the Project would provide potential habitat for special-status species. To determine the types of habitat that would be present, a crosswalk (Table 6-2) was created between the sensitive vegetation alliances used in the Preliminary Planting Plans and the existing wildlife habitat types present within the Project area.

Table 6-2.
Wildlife habitat crosswalk

Sensitive Vegetation Alliances	Wildlife Habitat Type
California bulrush marsh	Fresh emergent wetland
Riparian bank forbs and herbs	Fresh emergent wetland
Buttonbush willow thickets	Riparian scrub
Black willow thickets	Willow scrub
Sandbar willow thickets	Willow scrub
Oregon ash groves	Valley foothill riparian
Salt grass flats	Wet herbaceous
California mugwort brush	Riparian scrub
Fremont cottonwood forest	Valley foothill riparian
Creeping rye grass turfs	Wet herbaceous

Special Status Species Habitat Extent

Existing habitats in the project area have been assessed for suitability for special-status species. This knowledge of wildlife usage in the project area was then used to predict the species' habitat that would be available following revegetation. Species-specific habitat layers were created based on wildlife habitat types provided by the Preliminary Planting Plans and wildlife usage assumptions outlined in Section 6.3.4. The species-specific habitat layers were then used to calculate acres of habitat potentially provided by each Initial Alternative.

Evaluation Criteria

- Wetlands and other waters of the U.S. area: the acreage of restored habitat with hydrophytic vegetation and on hydric soils.
- Sensitive vegetation alliance extent: the acreage of potential future sensitive vegetation alliances based on the Preliminary Planting Plans.
- Wildlife habitat extent: the acreage of potential future wildlife habitat types resulting from the restoration.
- Special status species habitat extent: the acreage of potential future habitat for special status wildlife species based on the wildlife habitat types.

Criteria initially identified but not evaluated

Other criteria were initially identified in the Analyitical Tools TM (SJRRP 2010f) for evaluating the costs of the Project. These criteria were removed for the reasons described below.

- Special status plant species extent was removed from the evaluation because field surveys of listed plants could not be completed prior to the evaluation.
- Invasive species establishment potential is not considered to vary significantly amongst the alternatives, so this criterion was removed from the evaluation.
- Floodplain vegetation species diversity is a difficult metric to predict at this stage of the Project. All the Initial Alternatives propose ten sensitive vegetation alliances to restore vegetation on the floodplain. While greater species diversity within those alliances may rely on larger patches to support listed plants, design details and modeling during the appraisal level design are not capable of predicting how diverse vegetation alliances may be. Additionally, the amount, extent, and location of diversity is difficult to quantify. Based on these reasons, this criterion was removed from the evaluation.
- Total shaded riverine aquatic habitat area: There are no changes proposed to the river channel, and all Initial Alternatives include similar planting strategies, resulting the same areas of shaded riverine habitat in all Initial Alternatives; therefore, this criterion was removed from the evaluation.

6.2.4 Geomorphology

The discussion below provides background information and documentation of the approach used in evaluating channel geomorphology. Geomorphology in the three Bypass Initial Alternatives is evaluated separately from that associated with the Floodplain Initial Alternatives.

Analyses of channel vertical stability, lateral migration potential, and overall channel stability were completed using 2008 LiDAR data, bed-material transport capacity rating curves, hydraulics from HEC-RAS, flow records from the SJRRP CalSim model, bed material gradations, historical aerial photographs, previous levee and bank erosion risk studies, bedload transport modeling, and bank energy indices (Tetra Tech 2011b). As described below, neither the analyses of channel vertical stability nor overall channel stability showed that these criteria would be differentiators for the alternatives and were, therefore, eliminated.

Lateral Migration Potential

The analysis of the lateral migration potential reviewed previous levee and bank erosion risk studies and updated those analyses with the Restoration Flows to calculate the bank energy index associated with the Initial Alternatives. Based on the bank energy index, the existing vegetative cover, and the proximity of the channel to the proposed levee, the erosion hazard potential of the various channel banks was qualitatively assessed. Typical erosion protection concepts and costs were developed and weighted based on the qualitative hazard potential. The weighted costs for each bank section were summed to obtain the total estimated erosion protection cost for each Initial Alternative.

Evaluation Criteria

Evaluation criteria associated with geomorphology and the approach to quantifying the criteria are described below.

- Potential for lateral migration to impact levees: The estimated cost of providing erosion protection (revetment) on levees that may be impacted by lateral erosion.

Criteria initially identified but not evaluated

Other criteria were initially identified in the Analyitical Tools TM (SJRRP 2010f) for evaluating the costs of the Project. These criteria were removed for the reasons described below.

- Channel vertical stability: The analysis showed no significant differences in vertical channel stability (channel degradation or aggradation) are anticipated among the various Floodplain and Bypass Initial Alternatives, so this criterion was eliminated from the evaluation.
- Potential to reach a future stable channel configuration in dynamic equilibrium: This analysis is expected to show no significant differences in future stable channel cross-section or equilibrium slope for the various Floodplain and Bypass Initial Alternatives, so this criterion was eliminated from the evaluation.

6.3 Preliminary Impact Assessment

The sections below describe the criteria chosen to represent the range of impacts associated with the Initial Alternatives.

6.3.1 Groundwater

The discussion below provides background information and documentation of the approach used in evaluating seepage impacts. Seepage impacts in the three Bypass Initial

Alternatives are evaluated separately from that associated with the Floodplain Initial Alternatives.

Seepage Impacts

Cross-sectional seepage modeling developed in MODFLOW-SURFACT was used to estimate the potential for water levels to exceed the monitoring threshold at distances within one mile of the river. Output from the cross-sectional seepage modeling was exported to GIS and used to delineate the approximate areas where monitoring thresholds may be exceeded. Acreages of shallow groundwater were also estimated. The analysis is intended to provide a relative comparison between Initial Alternatives; it is not intended or capable of being compared to baseline conditions.

Evaluation Criteria

- Acres of land in which groundwater levels rise above 5-foot monitoring threshold: The acreage of land outside the proposed levee alignments that is anticipated to have shallow groundwater elevations above the 5-foot monitoring threshold and is thus subject to mitigation measures to prevent waterlogging.
- Acres of land in which groundwater levels rise above 7-foot monitoring threshold: The acreage of land outside the proposed levee alignments that is anticipated to have shallow groundwater elevations above the 7-foot monitoring threshold and is thus subject to mitigation measures to prevent waterlogging.

6.3.2 Land Use

The discussion below provides background information and documentation of the approach used in evaluating land use impacts. Land use impacts in the three Bypass Initial Alternatives is evaluated separately from that associated with the Floodplain Initial Alternatives.

Crop Acreage

Land use impacts focus exclusively on agricultural uses in the project area. Agricultural impacts are based on the amount of active cropland that would be taken out of production under the Initial Alternatives and crop data from field surveys and communications with landowners. Only alfalfa, almond, grapes, other row crops (grouped), palm, and pistachio production were considered.

Evaluation Criteria

- Acres of farmland removed from production: The total acres of alfalfa, almond, grapes, other row crops (grouped), palm, and pistachio that would be removed from production due to the construction of the Initial Alternatives.

6.3.3 Socioeconomics and Economics

The discussion below provides background information and documentation of the approach used in evaluating socioeconomics and economics impacts. Socioeconomics and economics impacts in the three Bypass Initial Alternatives are evaluated separately from that associated with the Floodplain Initial Alternatives.

Agricultural Economic Impacts

Agricultural economic impacts are based on the annual value of crop production that would be lost with taking land out of production (in acres) multiplied by representative crop production values ($/acre). Representative crop production values are based on historical estimates as presented in county agricultural commissioner reports for Fresno and Madera counties. Historical data between 2004 and 2008 were evaluated. Historical data were first adjusted to 2010 dollars using the consumer price index and then normalized to develop average annual values per acre for different types of crops grown in the project area. Representative per-acre production values used in the analysis are:

- Almonds (Fresno County): $5,020/acre
- Almond (Madera County): $4,121/acre
- Grapes (Fresno County): $3,975/acre (using a weighted average for raisin, table, and wine grape production values)
- Pistachio (Fresno County): $6,037/acre
- Palm (Fresno and Madera Counties): $52,769/acre (using miscellaneous nursery crop production for all counties that report acres and values in the agricultural commissioner reports)
- Grazing (Fresno County): $8.74/acre
- Vacant land (Fresno County): $8.74/acre (assumed to be comparable to grazing land values)
- Vacant land (Madera County): $12.88/acre (assumed to be comparable to grazing land values)
- Non-Agricultural (Fresno and Madera Counties): $0/acre (it is assumed that no agricultural production occurs on these lands)

The regional economic impacts (i.e., output, employment, and income) associated with changes in agricultural production have not been quantified as part of the alternatives evaluation; this analysis will occur as part of the EIS/R process using regional economic models. Based on declines in crop production values, there would be an ancillary decline in regional economic activity and associated benefits in the project area.

The regional economic impacts (i.e., output, employment, and income) associated with construction and operations, maintenance, and repair activities have not been quantified as part of the alternatives evaluation; this analysis will occur as part of the EIS/R process. Based on anticipated expenditures in the project area, there would be an ancillary increase in regional economic activity and benefits in the project area.

The fiscal impacts of the project on local municipalities have not been quantified as part of the alternatives evaluation; this evaluation will occur as part of the EIS/R process.

The financial impacts to local landowners have not been quantified as part of the alternatives evaluation; this evaluation will occur as part of the EIS/R process. It is anticipated that landowner impacts will be negligible assuming that they are compensated at fair market value for their properties.

Evaluation Criteria

- Reduction in annual agricultural production values: The total production value based on unit production values and the acreage removed from production due to the construction of the Initial Alternatives.

6.3.4 Environmental

The discussion below provides background information and documentation of the approach used in the preliminary environmental impacts evaluation. Environmental impacts in the three Bypass Initial Alternatives are evaluated separately from that associated with the Floodplain Initial Alternatives.

Special Status Vegetation

Wetlands

Data on field delineated wetlands was not available for the alternatives evaluation. The National Wetlands Inventory maps were used as a basis for calculating impacts to wetlands in the project area.

To calculate the direct impact of Project activities, including grading, levee construction, and the placement of fill, a direct impact layer was created for each Initial Alternative to map all areas where direct impacts are anticipated. Each Initial Alternative's impact layer was overlain with the National Wetlands Inventory layer to calculate the area of direct impact to potential wetlands, represented by the intersection of the two layers. Direct impacts to potential wetlands will result in the loss of that habitat.

Sensitive Vegetation Alliances

The Environmental Field Survey TM (SJRRP 2010b) documents the mapped sensitive vegetation alliances occurring with the project area. These mapped alliances were used to calculate direct impacts to sensitive vegetation alliances from the Initial Alternatives.

To calculate the direct impact of Project activities, including grading, levee construction, and the placement of fill, a direct impact layer was created for each Initial Alternative to map all areas where direct impacts are anticipated. Each Initial Alternative's impact layer was overlain with the sensitive vegetation alliances layer to calculate the area of direct impact to sensitive vegetation alliances, represented by the intersection of the two layers. Direct impacts to sensitive vegetation alliances will result in the loss of that habitat.

Special Status Wildlife

The Environmental Field Survey TM (SJRRP 2010b) provides an assessment of the State or Federally listed wildlife species that are likely to occur in the Project area and are, therefore, likely to be impacted by the Project. Based on the information presented in the Environmental Field Survey TM, the following nine listed wildlife species were selected for inclusion in this alternatives analysis:

- Blunt-nosed leopard lizard (*Gambelia sila*), Federally and State listed as endangered, and CDFG Fully Protected

- Fresno kangaroo rat (*Dipodomys nitratoides exilis*), Federally and State listed as endangered
- Giant garter snake (*Thamnophis gigas*), Federally and State listed as threatened
- Greater sandhill crane (*Grus canadensis tabida*), State listed as threatened, CDFG Fully Protected, and protected under the Migratory Bird Treaty Act
- Longhorn fairy shrimp (*Branchinecta longiantenna*), Federally listed as endangered
- San Joaquin kit fox (*Vulpes macrotis mutica*), Federally and State listed as endangered
- Swainson's hawk (*Buteo swainsoni*), State listed as threatened and protected under the Migratory Bird Treaty Act
- Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), Federally listed as threatened
- Vernal pool fairy shrimp (*Branchinecta lynchi*), Federally listed as threatened

To quantify impacts to these species and allow for comparison between alternatives, impacts are defined in terms of acres[4] of potential habitat lost or altered for each species. The following sections describe how potential habitat was defined and how impacts were calculated.

Species Habitat Layers

Habitat layers were created for each species to estimate the location and area of potential habitat present within the Project area under existing conditions. Each species-specific habitat layer is based on the wildlife habitat types layer[5], which identifies the wildlife habitat types present in the project area. The wildlife habitat types layer is a product of the wildlife habitat assessment and habitat mapping effort described in the Environmental Field Survey TM (SJRRP 2010b). The wildlife habitat types layer was adapted to create species-specific layers according to the rules outlined below. These rules are based on assumptions developed from available data about species' use of specific wildlife habitat types.

- Blunt-nosed Leopard Lizard: Suitable upland habitat types, including annual grassland and elderberry savannah, within the southeastern portion of the study area are designated as habitat for the blunt-nosed leopard lizard.
- Fairy Shrimp: Longhorn fairy shrimp and vernal pool fairy shrimp have similar habitat requirements; therefore, a single habitat layer was created to estimate potential impacts to both species and they are addressed collectively as "fairy shrimp". Because access allowing a more informed assessment has not been

[4] Impacts to listed wildlife are discussed in terms of acres except for the valley elderberry longhorn beetle for which impacts are typically discussed in terms of the number of individual elderberry shrubs lost. Both the acreage and the number of shrubs are provided the summary tables in Section 7.0.

[5] The valley elderberry longhorn beetle is an exception because the habitat layer for this species was created using a combination of point data and vegetation mapping of elderberry stands.

available, all potential seasonal wetland is designated as habitat for these species. Per USFWS guidance (USFWS 1996), any direct impact within 250 feet of a discrete unit of potential seasonal wetland habitat was considered to impact the entire unit. Additionally, any direct impact to a discrete unit of potential seasonal wetland was considered to directly impact the entire unit.

- Fresno Kangaroo Rat: For Fresno kangaroo rat, habitat was defined as annual grassland and elderberry savannah within the southeast portion of the study area.
- Giant Garter Snake: Habitat for the giant garter snake includes the following habitat categories, aquatic, upland and wetland. Aquatic habitat is defined as all lacustrine habitat within the Project area, which has been present during the snake's active period in the San Joaquin River west of the San Mateo Road crossing (the Mendota Pool). Per USFWS guidance (USFWS 2005), suitable upland habitat within 200 feet of the lacustrine habitat was designated as upland habitat for this species, including the following habitat types: annual grassland, barren, riparian scrub, river wash, valley foothill riparian, wet herbaceous, and willow scrub. All fresh emergent wetland within the 200-foot buffer is defined as wetland habitat for this species.
- Greater Sandhill Crane: Winter foraging habitat for the greater sandhill crane is defined as all annual grassland, fresh emergent wetland, irrigated hayfield, cropland, irrigated row and field crop, pasture, and wet herbaceous habitat within the project area.
- San Joaquin Kit Fox: Habitat for the San Joaquin kit fox is defined as all annual grassland, elderberry savannah, barren, and pasture habitat within the project area.
- Swainson's Hawk: Swainson's hawk habitat includes two categories, foraging and nesting. Foraging habitat is defined as all annual grassland, barren, elderberry savannah, irrigated hayfield, wet herbaceous, and pasture habitat within the project area. All valley foothill riparian habitat is considered nesting habitat. Additionally, nesting habitat is expanded to include up to approximately 0.5 acres centered on observed nesting sites as recorded in the California Natural Diversity Database (CDFG 2010), regardless of the wildlife habitat type designation assigned to the vegetation at that location.
- Valley Elderberry Longhorn Beetle: Habitat for valley elderberry longhorn beetle is quantified in terms of elderberry shrubs (*Sambucus spp.*); therefore, the habitat layer for this species was created through a different process than that of other species evaluated. To create a habitat layer for valley elderberry longhorn beetle, point data mapping the location of known elderberry shrubs created in 2002 (ESRP 2006) was combined with elderberry stands mapped in 2010 during special-status vegetation alliance surveys completed for the Project. All points that overlapped with mapped elderberry stands were excluded to avoid double counting. Impacts are typically discussed in terms of individual shrubs, so the approximate number of shrubs was calculated by estimating the density of shrubs and multiplying by the acreage. For the purposes of this analysis only, the density of elderberry shrubs within the Project area was estimated to be 42 shrubs per acre in the riparian zone and 9 shrubs per acre in areas of elderberry savannah. Impacts

were also quantified in terms of acres for the evaluation in order to sum all habitat impacts.

Impact Calculations

The anticipated impacts of the Project alternatives were calculated in GIS using the species habitat layers described above.

To calculate the direct impact of Project activities, including grading, levee construction, and the placement of fill, a direct impact layer was created for each alternative to map all areas where direct impacts are anticipated. Each alternative's impact layer was overlain with each species habitat layer to calculate the area of direct impact to potential habitat, represented by the intersection of the two layers. Direct impacts to potential species habitat will result in the loss of that habitat and, therefore, a potential direct impact to listed wildlife species.

In addition to direct impacts that occur at the time of construction, the Project may also result in indirect impacts to listed wildlife species as a result of habitat change that occurs over time due to changes in hydrology. New hydrologic patterns may alter the existing vegetation present within the Project area which may cause new habitat types to gradually replace existing habitats, and existing farmland within the project area will be planted with native riparian and floodplain habitats appropriate for the new hydrologic regime. All habitat areas anticipated to be altered due to changes in hydrology are considered to be indirectly impacted. Although indirect impacts are anticipated for the Project, the acreage of indirect impacts was not calculated for the alternatives evaluation.

Cultural and Historical Resources

The following sections describe the assessment of the potential for cultural and historic resources to be impacted by the Initial Alternatives. Limited surface investigations for cultural and historic resources have been completed based on access availability; however, some areas could not be investigated due to access restrictions, and no subsurface investigations have been completed.

Historic properties

Record searches were conducted through the South San Joaquin Valley Information Center (SSJVIC). The information center staff accessed the records for the Mendota, Firebaugh, and Tranquility (USGS) 7.5-minute quadrangles, including a one-mile radius around the project extent. The following references were also reviewed:

- NRHP National Register of Historic Places
- California Register of Historical Resources
- Office for Historic Preservation Historic Property Directory
- California State Historical Landmarks listing
- California Inventory of Historic Resources
- California Points of Historical Interest listing
- The Caltrans State and Local Bridge Survey

- Historical maps, including GLO Plat Maps

The number of previously recorded sites was used to evaluate alternatives. No previously recorded National Register or California Register eligible resources were identified in the records search.

Buried deposits sensitivity
Landform age classes can be associated with a qualitative sensitivity for buried deposits (Byrd 2009). Each sensitivity class was assigned a numerical rating for the purposes of the alternatives evaluation (see Table 6-3). Landform age classes mapped by Fresno and Madera counties were overlain with the extents of the Initial Alternatives, and the highest sensitivity class within the extent of each Initial Alternative was noted.

Table 6-3.
Buried deposits sensitivity according to landform age class

Sensitivity Class	Landform	Map Symbol	Rating
Low to High	Historical to Modern Fans, Floodplains, Artificial Fill, and Cuts; Water	Hm	5[1]
Very Low	Pre Pleistocene through Latest Pleistocene Hillslopes, Fans, and Floodplains	pP, pQ, OP	1
Low	Early Holocene Fans and Floodplains	LtP, EH	2
Moderate	Middle Holocene Fans and Floodplains	MH	3
High	Late Holocene Fans and Floodplains	LH	4
Very High	Latest Holocene Fans and Floodplains	LtH	5

Based on Byrd 2009.
[1] Assumed high sensitivity to be conservative.

Evaluation Criteria

- Wetland impacts: The estimated acreage of direct impacts to wetlands resulting from the Initial Alternatives.
- Sensitive vegetation alliance direct impacts: The estimated acreage of direct impacts to sensitive vegetation alliances resulting from the Initial Alternatives.
- Special status wildlife habitat impacts: The estimated acreage of direct impacts to special status wildlife habitat resulting from the Initial Alternatives.
- Historic properties potentially effected: The number of recorded historic properties identified within the extents of the Initial Alternatives.
- Buried deposits sensitivity: The highest buried deposits sensitivity within the extents of the Initial Alternatives based on the landform age scale.

6.4 Scoring Alternatives Data and Professional Judgment

Most of the data presented use objective measurements for each criterion, such as acres, dollars, or miles, based on appraisal-level designs for each alternative. Some of the criteria in the evaluation use qualitative assessments and rely on professional judgment to estimate results. Assumptions about current conditions and future effects of the alternatives are inherently involved at the current level of design. These assumptions have been based on information collected from similar projects and professional experience.

7.0 Initial Alternatives Descriptions

This chapter describes the Initial Alternatives developed for the Project. Initial Alternatives are presented for each the floodplain and bypass components individually. Following the alternatives evaluation, an Initial Alternative for each component will be combined together to form the Final Alternatives, which are complete Project alternatives that will be evaluated in the Project EIS/R. For example, a Floodplain Initial Alternative will be combined with a Bypass Initial Alternative to form a Final Alternative. Factors that will influence the selection of Initial Alternatives include whether they comply with the terms of the Settlement, whether they substantially meet the Project goals and objectives, and whether their benefits are seen to offset their impacts. Final Alternatives will then be assessed for environmental impacts to the various resource areas in the Project EIS/R.

7.1 Floodplain Initial Alternatives

The Floodplain Initial Alternatives include:

- Building levees capable of conveying flows up to 4,500 cfs
- Restoring floodplain habitat to provide benefit to salmonids and other native fishes

in the portion of Reach 2B between the Chowchilla Bifurcation Structure (approximately RM 216) and the head of the Settlement Alignment Bypass Initial Alternative (approximately RM 207.7). (Additional floodplain area downstream of the head of the Settlement Alignment Bypass Initial Alternative associated with the Compact Alignment Bypass Initial Alternative and the Fresno Slough Dam Initial Alternative is considered part of those Initial Alternatives and is discussed is Sections 7.2.3 and 7.2.4, respectively). See Figure 7-1.

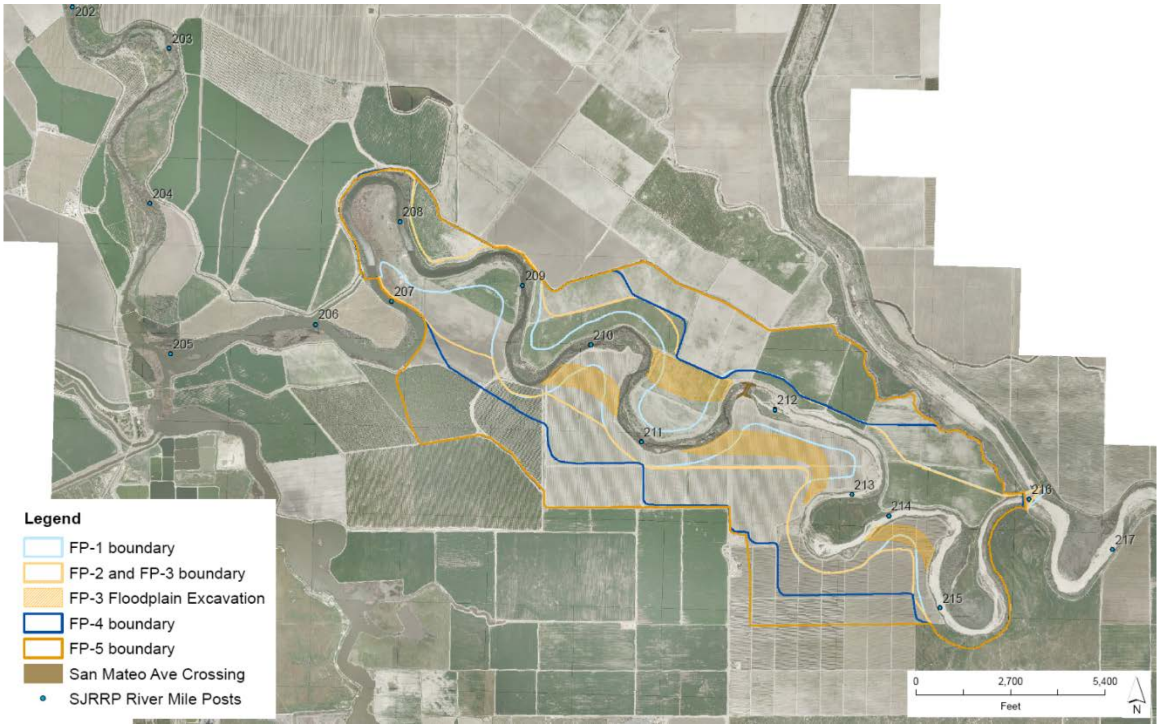


Figure 7-1.
Levee Alignments for Floodplain Initial Alternatives

The purpose of the floodplain is to provide riparian and floodplain habitat and support the migration and transient rearing of salmonids and other native fishes in Reach 2B. Five alternative levee alignments (FP-1 through FP-5) with varying widths and varying amounts of floodplain grading will increase the habitat and capacity in Reach 2B. Elements of the designs include:

- Fish habitat and passage
- Floodplain and riparian habitat restoration
- Construction of new levees
- Removal or partial removal of existing levees
- Floodplain grading
- Retrofit the San Joaquin control structure at the Chowchilla Bifurcation Structure with a fish ladder
- Existing infrastructure relocations or floodproofing
- Replacement of San Mateo Avenue crossing
- Levee protection
- Lone Willow Slough fish screen
- Land acquisition

7.1.1 Elements Common to All Floodplain Initial Alternatives

The following sections describe the elements that are common to all Floodplain Initial Alternatives.

Fish Habitat and Passage

One of the primary focuses of the Floodplain Initial Alternatives is to provide floodplain and riparian habitat in support of migrating juvenile and adult salmonids and other native fishes. Floodplain and riparian habitats included in the Floodplain Initial Alternatives are a variety of native plant communities suited to the hydrology, soils, and climate of Reach 2B and the San Joaquin Valley (see additional discussion below under Habitat Restoration). Vegetation communities that provide the greatest benefits for juvenile salmonids (annual grassland communities; Jeffres 2008) were preferred wherever those communities were also supported by the hydrology of the Restoration Flows. Based on the floodplain modeling, inundation depths less than 1.0 foot represent 28-53% of total floodplain area, and depths less than 0.5 feet represent 12-25% of total floodplain area, depending on the Floodplain Initial Alternative.

The Floodplain Initial Alternatives also include provision of fish passage through structures for salmonids and other native fish. These structures include a culverted crossing at San Mateo Avenue, fish screens, fish passage facilities, grade control structures, bifurcation structures (under certain flows), and Mendota Dam. The designs for structures with fish passage components would be based on criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008) and *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2001). Specifically, the alternatives will provide suitable hydraulic conditions for passage of up-migrating adult and juvenile salmonids, out-migrating juvenile salmonids, and inter-reach migration of other native fish between Reach 2A and Reach 3. Suitable hydraulic conditions include those conditions which the species is physically capable of passing and do not cause undue stress on the animal. The passage features are designed to cause no physical harm. See Fish Passage Design Criteria in Section 5.2.6.

The Floodplain Initial Alternatives include three facilities that fish would encounter or need to pass to migrate between Bypass Initial Alternatives and Reach 2A (from downstream to upstream): San Mateo Avenue crossing, Lone Willow Slough fish screen, and the Chowchilla Bifurcation Structure with fish ladder. Each structure represents a potential stressor for adult salmon and potential predation site for juvenile salmon. However, each structure is designed to perform according to the fish passage design criteria. In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to accommodate channel structure variability. All of which may help to reduce stress and predation.

Habitat Restoration

For the evaluation, it is assumed that active riparian and floodplain habitat restoration would occur in the Floodplain and Bypass Initial Alternatives. It is assumed that native plant wetland vegetation alliances consisting primarily of obligate, facultative-wet, and facultative species, similar to species historically present, will thrive within the main channel. Eventually, a mosaic of riparian habitat types will develop along the main river channel banks consisting of cottonwood forests, willow scrublands, riparian wetlands, herbaceous meadows with sedges, rushes and grasses, and occasional groves of Oregon ash (Figure 7-2).

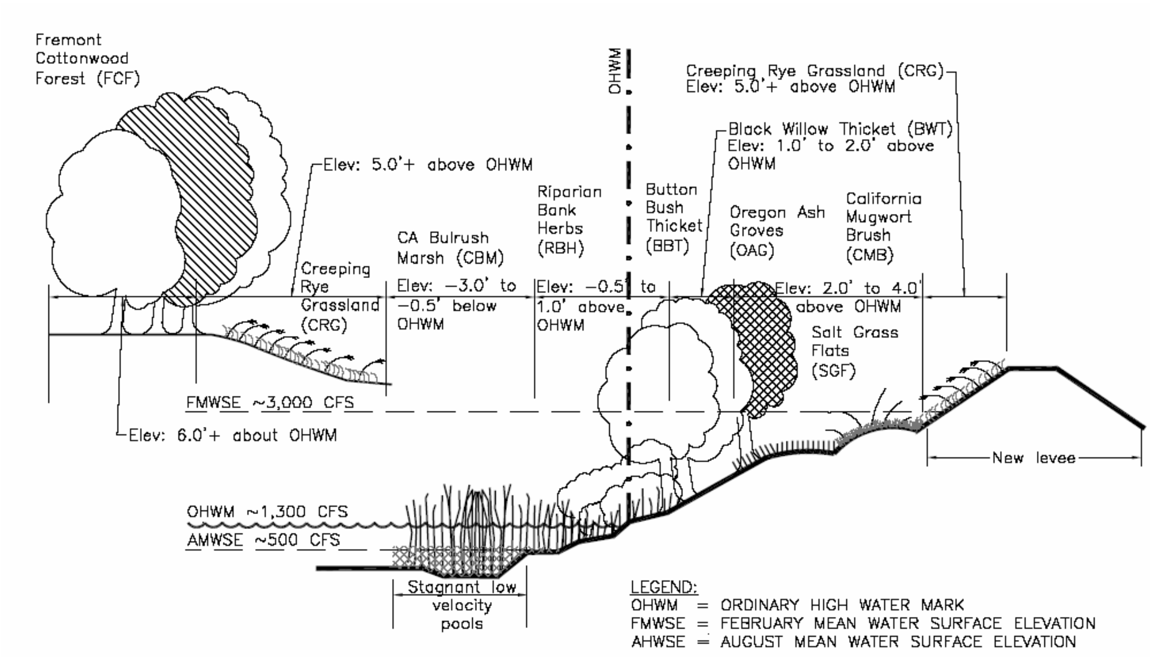


Figure 7-2.
Typical distribution of vegetation alliances along a Reach 2B riparian bank section

Vegetation Alliance Descriptions and Assumptions for their Location

Native vegetation alliances that were observed and described during plant community mapping surveys performed for the Environmental Field Surveys TM (SJRRP 2010b) are anticipated to be included in a restoration design.

The following vegetation alliances are likely candidates for the ecological restoration of the San Joaquin River channel. They are listed in order of their distance from the ordinary high water mark (OHWM); alliances requiring location near the OHWM are listed first, alliances preferring locations higher up on the floodplain are listed later.

- California Bulrush Marsh
- Riparian Bank Herbs
- Button Willow Thickets (*Cephalanthus occidentalis* alliance)
- Black willow thickets (*Salix gooddingii* alliance)
- Oregon ash groves (*Fraxinus latifolia* forest alliance)
- Saltgrass Flats (*Distichlis spicata* grassland alliance)
- California Mugwort Brush

- Creeping Wildrye Grassland (*Leymus triticoides* herbaceous alliance)
- Fremont cottonwood forest (*Populus fremontii* alliance)
- Other Vegetation Alliances

Maintenance & Invasive Species Control

Invasive, non-native species would be removed from the project area during the installation, plant establishment and maintenance periods. Long-term management of the project would consist of removal of the most invasive non-native species within the reach such as giant reed grass (*Arundo donax*), perennial pepperweed (*Lepidium latifolium*) and poison hemlock (*Conium maculatum*). Long-term management would also include removal of other invasive species that are currently found in upstream reaches and may eventually colonize in the project area such as red sesbania (*Sesbania punicea*), salt cedar (*Tamarix* species), and Chinese tallow (*Sapium sebiferum*). Invasives removal techniques may include mechanical removal, root excavation, hand pulling, mowing, disking, controlled burning, grazing, aquatic-safe herbicides, or a combination of techniques as appropriate.

While it is not anticipated that major management actions will be needed, the key objective of long-term management would be to monitor and identify any environmental issues that arise, and use adaptive management to determine what actions would be most appropriate to correct these issues.

The general management approach to the long-term maintenance of the floodplain areas will be to maintain quality habitat for each natural resource, on-going monitoring and maintenance of key environmental characteristics of the entire floodplain area within the reach. An adaptive management approach will be used to incorporate changes to management practices, including corrective actions as determined to be appropriate by the Bureau of Reclamation. Adaptive management includes those activities necessary to address the effects of climate change, fire, flood, or other natural events, force majeure, etc.

The expected long-term management needs and activities necessary to maintain any on-site mitigation sites would be: resource specific long-term maintenance activities and other general maintenance activities such as exotic species elimination, grazing management, clean-up and trash removal, infrastructure management such as gate, fence, road, culvert, signage and drainage-feature repair, and other maintenance activities necessary to maintain the riparian floodplain habitat quality.

Temporary Irrigation System and Water Supply

Since all of the anticipated plantings are wetland species or borderline wetland species, they would need regular overhead irrigation (typically April through October) during their establishment period (three to five years depending on rainfall conditions and the plants growth rates and vigor). The amount of water needed is estimated to be approximately 2.4 feet per acre per year. They will be irrigated with an extensive temporary surface mounted irrigation system that would provide water for the plants several times a week during the hot months of the year. The irrigation distribution piping would be installed aboveground and anchored to the ground with rebar soil staples so that it would not damaged during high flows that would be regularly inundating the floodplain. The sprinkler heads will be installed on four-foot high, braced standpipes so that their irrigation stream is not blocked or diverted by growing vegetation. The irrigation system will be disassembled and removed at the end of the establishment period.

The irrigation water supply could include groundwater wells or water pumped from the river with portable, skid mounted, diesel- or gas-powered pumps and stored in tanks. Additionally, purchases from willing sellers may be required to withdrawal water from the river or other nearby water sources (e.g., Mendota Pool).

Existing Native Vegetation Protection

The existing native vegetation in the project area designated to remain will be temporarily fenced with orange snow fencing (or equivalent) to prevent entry, driving, parking, or storing equipment or material within these areas during construction. Existing vegetation would be left in place or only minimally trimmed to facilitate access and work at the site. The existing soil is an ideal growing medium for all the desired native plants. In order to maximize plant growth and planting success, existing soil and topsoil would be preserved and disturbance during construction will be minimized to the maximum practicable extent.

Maintenance and Monitoring

The key maintenance and monitoring activities include close monitoring of installed plants for drought stress and overwatering, removal of competitive, invasive, non-native species, replacement of diseased and dead plants, irrigation system maintenance, and removal of trash and debris.

Wildlife

As associates of the anticipated vegetation alliances, wildlife habitats and wildlands will develop. The Floodplain Initial Alternatives would provide potential habitat for greater sandhill crane and Swainson's hawk. The larger floodplains provide increasingly more potential habitat.

Levees

New levees (FP-1 through FP-5) would be constructed to create varying corridor widths, ranging from just outside of the existing levee alignment, to a corridor width of approximately 5,600 feet (Figure 7-1). The levee alignments for FP-2 and FP-3 are the same; however, FP-3 includes floodplain grading (see discussion in Section 7.1.4).

While the length, height, and footprint of the levees vary, the capacity, freeboard, and cross-section are common to all the Floodplain Initial Alternatives. Levees will be designed to maintain 3 feet of freeboard on the levees at 4,500 cfs. Levee design is based on the Corps of Engineers and USACE *Engineer Manual 1110-2-1913-Design and Construction of Levees* guidelines (USACE 2000) and includes slurry walls to reduce seepage, inspection trenches, maintenances roads, and drainage trenches to direct off-site drainage.

Levee alignments maintain a 300-foot buffer zone, where appropriate, between the levee and river channel to avoid impact to levees over time due to potential channel migration. In areas where a minimum 300-foot buffer zone between the main river channel and levee cannot be maintained, bank revetment is incorporated in the design in accordance with DWR Division of Engineering (DOE) guidelines.

The levees would be designed to have sideslopes of 3 horizontal to 1 vertical (3H to 1V) on the waterside and landside. A maintenance road and surface drainage ditch would also be included. Surface drainage ditches would only be intended to capture and direct runoff; they are not intended to address nuisance seepage. Due to historical seepage and lack of geotechnical data, it was assumed for cost purposes that all of both new levees adjacent to potentially impacted lands (approximately 90 percent of the total levee length) would contain slurry walls. By following the USACE standards, all levees without a slurry wall will have an inspection trench. Levees that include a slurry wall would also have an inspection trench. Additional data collection and analysis will be required to verify the groundwater conductivity rates of the *in situ* and borrow soils and to finalize the seepage control measures.

The levee costs are based on the assumptions that suitable earthen fill materials will be available within 1 mile of the levee locations and that some modification to soils may be required to meet permeability requirements. Once the borrow source for the levees is identified, import and hauling costs may be updated.

Removal of existing levees

All Floodplain Initial Alternatives include removal of portions of the existing levees. Levee removal is designed to expand the inundation area of the floodplain out to the proposed levees and improve connectivity between the river channel and proposed floodplain. The locations of existing levee removal are based upon the hydraulic performance of the channel and floodplain. In certain locations, however, highly desirable existing vegetation (native and sensitive vegetation communities that can serve as seed banks for future vegetation communities) can be found on the existing levees. Where hydraulic performance and connectivity of the floodplain would not be negatively affected, portions of the existing levees with highly desirable vegetation would remain in place.

Existing infrastructure relocations or floodproofing

Existing infrastructure such as groundwater wells, pumps, electrical and gas distribution lines, water pipelines, and canals are located in the Project area and will require relocation or floodproofing to protect them from future Restoration Flows and increased floodplain area in the Reach 2B corridor. The quantity and extent of relocations varies with each Floodplain Initial Alternative. The cost to perform the relocations and floodproofing is included in the Project cost; the actual relocation or floodproofing work may be performed by others.

Electrical and Gas Distribution

The length of electrical distribution line impacted by each Floodplain Initial Alternative was identified for possible relocation. Information from PG&E was available for portions of the area in shapefile format and was supplemented by field data. At the current level of design, it was assumed that the same length of electrical and gas distribution line will need to be replaced.

Canals and Drains

The length of canals impacted by each Floodplain Initial Alternative was identified for possible relocation. On-farm canals and drains visible on the LiDAR imagery (Central Valley Floodplain Evaluation and Delineation (CVFED) 2009) and identified during on-site field meetings with landowners were quantified. At the current level of design, it is unknown how canals and drains outside the project area will be reworked as a result of the impacted canals and drains. To account for the costs of reworking canals and drains, it was assumed that the same length of canals and drains impacted will need to be replaced. A typical canal cross-section and 2007 unit costs were used to estimate the costs of relocation. No subsurface drains were able to be quantified; however, some are believed to exist within the area.

Lift Pumps

The number of lift pumps impacted by each Floodplain Initial Alternative was identified for possible relocation. Lift pumps visible on the LiDAR imagery (CVFED 2009) or noted in the Calfish database (Pacific States Marine Fisheries Commission 2007) were assumed to require relocation to new facilities on the edge of the proposed levees. A pilot channel dug from the low flow river channel to the intake of the relocated pumps was also assumed. Locations in the Calfish database were confirmed using the LiDAR imagery when possible.

Groundwater Wells

The number of wells impacted by each Floodplain Initial Alternative was identified for possible floodproofing or relocations. Wells were identified within the area using aerial photography. It is recommended that the DWR wells database be consulted for an estimate of abandoned wells that have not been destroyed, so that these old wells are not conduits for flood waters to the groundwater. A formal well canvas is recommended. Floodproofed wells would be provided with year-round vehicular access via a raised roadbed across the floodplain. The roadbed could include multiple culverts to support floodplain connectivity, depending on the length of the access road and its effect on floodplain flows.

Other Utilities

Other infrastructure was identified within the impacted areas. However, costs were not developed for this infrastructure at this time. Other facilities include: high voltage transmission lines, gas lines, and water pipelines. High voltage transmission lines are assumed to be high enough to not be impacted. Gas lines are typically attached to bridges or buried below the river when crossing the river and were assumed not to require relocation. As such, no costs for gas line relocation or replacement would be involved, but there could be mitigation required when crossing a gas line with a levee depending on the depth of cover. Water pipelines were quantified from existing maps and discussions with landowners. It was assumed that pipelines will be abandoned in place and no cost is involved. Depending on the improvements and grading to be done in the floodplains, there may in fact be a cost for the removal of at least some of the pipelines.

Replacement of San Mateo Avenue crossing

The San Mateo Avenue crossing is located at approximately RM 211.8, upstream of all the Bypass Initial Alternatives, and consequently within the Floodplain Initial Alternatives area. All Floodplain Initial Alternatives include replacement of the San Mateo Avenue crossing with a box culvert design (see discussion in Section 7.3.3).

Levee protection

Each Floodplain Initial Alternative generally provides a minimum 300-foot buffer between the existing channel and the proposed levee, where possible. For locations where the 300-foot buffer was not included, erosion protection for the levee in the form of revetment would be included. The revetment would be riprap material covered by soil and then planted to provide a vegetated surface. Locations that require revetment include areas where the 300-foot buffer was not included due to the proximity of existing infrastructure, near the proposed structures, and along river bends less than 300 feet from the levee.

Lone Willow Slough Fish Screen

Lone Willow Slough connects to the river at approximately RM 215.9 just downstream of the Chowchilla Bifurcation Structure. All Floodplain Initial Alternatives include construction of a fish screen at this diversion (see discussion in Section 7.3.2).

Land Acquisition

The approximate amount of additional lands to be acquired to accommodate the floodplain, levees, and structures was quantified based on parcel data in shapefile format from Fresno and Madera counties. Since portions of parcels outside the project area may not be as easily utilized by the land owners, the entire parcels were considered in the land acquisition costs for the Floodplain Initial Alternatives.

Construction Considerations

It was assumed that nuisance water will be in the San Mateo Avenue Crossing construction site and that installation of coffer dams will be required around portions of the work. Since a portion of the existing crossing is private (not a public road), it was assumed that access could be closed during construction. Construction will be timed (July 1 to November 1) so that the lesser Restoration Flows (5 to 195 cfs) can be routed around the structure during construction. At high flows water will flow over the structure, in addition to through the proposed culverts. To protect the structure during high flows, the proposed fill will be enclosed in concrete and cutoff walls and riprap are included to prevent damage to the structure during over topping flows.

It was assumed that installation of coffer dams will be required around portions of the Chowchilla Fish Ladder. In addition, portions of the existing Chowchilla control structure will need to be demolished (portion of the roadway, and wing wall) in order to construct the fish ladder.

7.1.2 FP-1

Floodplain Initial Alternative FP-1 represents the narrowest floodplain in the range of Initial Alternatives with an average floodplain width of approximately 2,340 feet. Floodplain Initial Alternative FP-1 provides the least floodplain acreage, but also requires the least amount of land acquisition. Table 7-1 lists the quantities of levee construction, relocations, and land acquisition included in this Initial Alternative. Table 7-2, Table 7-3, and Table 7-4 for the costs, benefits, and impacts data used in the evaluation.

Fish Habitat and Passage

Floodplain Initial Alternative FP-1 provides the least amount of floodplain and the least amount of rearing habitat of all the alternatives at the FSRAF (2,500 cfs as described in Section 6.2.2). The limited floodplain width results in low acreages of very shallow water habitat and as flows increase above 3,000 cfs very shallow water habitat is progressively diminished down to insignificant levels (approximately 5 acres at 4,500 cfs) because the entire floodplain is inundated and flows are up against the levees. There are no up or downstream fish passage issues associated with this alternative.

Habitat Restoration

FP-1 is the narrowest Floodplain Initial Alternative. The constricted conditions will result in the deepest inundation depths and poor quality floodplain. The extent of the anticipated vegetation alliances in this alternative is limited by the narrow corridor. The grass-dominated alliances, which produce the maximum food benefits for salmon, would be located primarily in the upstream, widest part of the reach where two large meander loops and a portion of an existing orchard north of them will be enclosed by the proposed levees. The higher, flat parts of the meander loops would likely be dominated by Saltgrass Flats. The adjacent existing wetland areas within the loops could be preserved or enhanced by additional wetland species plantings and invasive species removal. The middle and lower portions of the reach under this Initial Alternative would primarily maintain the existing vegetation. Additional restoration work could focus on the re-establishment of the Sandbar Willow Thicket, Black Willow Thicket, Oregon Ash Groves and Riparian Bank Herbs. Because of the requirement that there be no woody species on the levees, the riverside levee banks could be planted with plants from the California Mugwort Brush and Creeping Rye Grassland. Low-lying areas outside of the main river channel, with stagnant or slowly moving water that may be quite deep during high flows could be planted with Buttonbush Thicket or California Bulrush Marsh.

Table 7-1.
FP-1 Levees, Relocations, and Land Acquisition

	Left Levee		Right Levee
Levee Length	7.7 miles		5.9 miles
Average Levee Height	5.8 feet		6.3 feet
Fill Volume	350,000 cubic yards		270,000 cubic yards
Relocations			
Electrical Distribution	20,272 feet	Facility	1
Gas Transmission	5,029 feet	Groundwater Well	19
Water Pipeline	15,976 feet	Lift Pump	5
Canal	26,668 feet	Power Pole	68
Confluence	1	Monitoring Well	-
Culvert	1	Regulating Reservoir	-
Diversion	1	Abandoned Well	-
Barn/Shed	-		
Land Acquisition[1]			
Total	1,076 acres		

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 7-2.
FP-1 Implementation/Technical Feasibility Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-1
Costs	Upfront Costs	Capital Improvement Costs	dollars	$194,430,000
		Land Costs	dollars	$15,300,000
		Subtotal	dollars	$209,730,000
	Long-Term Costs	O&M	dollars/year	$606,000
Time to Build	Timeline	Construction	months	40

Table 7-3.
FP-1 Objectives/Benefits Achievement Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-1
Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	1
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	373
	Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	2
		Total number of steps at structures	number of jumps	12
	Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	1
		Potential predation sites	number of artificial structures	3
Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	451.3
		Sensitive vegetation alliance extent	acres	817.0
		Button willow thickets	acres	36.8
		California bulrush marsh	acres	46.9
		California mugwort brush	acres	96.4
		Creeping rye grass turfs	acres	49.3
		Riparian banks forbes and herbs	acres	89.5
		Salt grass flats	acres	148.0
		Fremont cottonwood forest	acres	14.6
		Oregon ash groves	acres	35.7
		Sandbar willow thickets	acres	124.9
		Black willow thickets	acres	97.9
		Exist. sensitive vegetation alliance preservation	acres	76.9
	Wildlife	Wildlife habitat extent	acres	740.1
		Freshwater emergent wetland	acres	136.4
		Riparian scrub	acres	133.2
		Valley foothill riparian	acres	50.3
		Wet herbaceous	acres	197.4
		Willow scrub	acres	222.8
		Special-status species habitat extent	acres	581.4
		Greater sandhill crane	acres	333.8
		Swainson's hawk	acres	247.6
		Net change in wildland extent	acres	395.6
Geomorphology	Channel Stability	Potential to for lateral migration to impact levees (estimated erosion protection cost)	dollars	$1,935,000

Table 7-4.
FP-1 Impacts Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-1
Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	490
		Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	580
Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	400.5
		Alfalfa	acres	0.0
		Almond	acres	213.0
		Grapes	acres	64.6
		Other Row Crop	acres	0.0
		Palm	acres	9.7
		Pistachio	acres	113.3
	Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	$2,339,259
Environmental	Special Status Vegetation	Wetland Impacts	acres	66.4
		Freshwater Emergent Wetland	acres	0.0
		Freshwater Forested/Shrub Wetland	acres	41.3
		Riverine	acres	25.1
		Sensitive Vegetation Alliance Direct Impacts	acres	48.0
		Alkali heath marsh	acres	0.0
		Arrow weed thickets	acres	0.1
		Black willow thickets	acres	19.9
		Blue elderberry stands	acres	16.3
		Button willow thickets	acres	0.1
		California bulrush marsh	acres	0.5
		California rose briar patches	acres	4.4
		Creeping rye grass turfs	acres	0.2
		Fremont cottonwood forest	acres	3.6
		Oregon ash groves	acres	0.9
		Pale spike rush marshes	acres	0.0
		Salt grass flats	acres	0.9
		Silver bush lupine scrub	acres	0.0
		Spinescale scrub	acres	0.0
		Tar plant fields	acres	1.0
		Yerba mansa meadows	acres	0.0
	Special Status Wildlife	Special status wildlife habitat impacts	acres	220.9
		Blunt-nosed leopard lizard	acres	11.5
		Fairy shrimp	acres	2.3
		Fresno kangaroo rat	acres	21.4
		Giant garter snake	acres	35.0
		Greater sandhill crane	acres	56.0
		San Joaquin kit fox	acres	30.4
		Swainson's hawk	acres	48.0
		Valley elderberry longhorn beetle	acres	16.3
		Valley elderberry longhorn beetle	number of elderberry shrubs	270
	Cultural and Historical Resources	Historic Properties Potentially Effected	number of listed properties	3
		Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

7.1.3 FP-2

Floodplain Initial Alternative FP-2 is the second narrowest floodplain in the range of Initial Alternatives with an average floodplain width of approximately 3,070 feet. Table 7-5 lists the quantities of levee construction, relocations, and land acquisition included in this Initial Alternative. See Table 7-6, Table 7-7, Table 7-8 for the costs, benefits, and impacts data used in the evaluation.

Fish Habitat and Passage

Floodplain Initial Alternative FP-2 provides a moderate amount of floodplain habitat resulting in sufficient acres of the very shallow water habitat for primary production as well as sufficient acres of habitat that supporting direct rearing at the FSRAF. FP-2 also retains very shallow water habitat at flows up to 4,500 cfs. There are no up or downstream fish passage issues associated with this alternative.

Habitat Restoration

Floodplain Initial Alternative FP-2 includes a somewhat wider floodplain than FP-1. This alternative incorporates larger areas of land between the meander loops and provides a good quality floodplain with slightly larger area of protected existing habitat. The extent of the anticipated vegetation alliances in this alternative is sufficient to support beneficial salmonid habitat. The grass-dominated vegetation alliances, which produce the maximum food benefits for salmon, would likely be well distributed along the reach, with the largest segments of grasslands in the upstream portion of the reach. The higher, flat parts of all of the meander loop areas would likely be dominated by Saltgrass Flats. The adjacent existing wetland areas within the loops could be preserved or enhanced by additional wetland species plantings and removal of numerous invasive species. In addition to the Saltgrass Flats, the middle and lower portions of the reach under this alternative could include predominantly Sandbar Willow Thickets, California Mugwort Brush, and Black Willow Thickets. Additional restoration work could focus on the re-establishment of the Riparian Bank Herbs, California Bulrush Marsh, Button Willow Thickets, Oregon Ash Groves, Creeping Rye Grasslands, and Fremont Cottonwood Forests. The riverside of the proposed levee banks could be planted with plant species from the California Mugwort Brush and Creeping Rye Grassland alliances. Low-lying areas outside of the main river channel, with stagnant or slowly moving water that may be deep during high flows could be planted with Buttonbush Thicket or California Bulrush Marsh. This alternative could include a considerably larger area of the Fremont Cottonwood Forest than FP-1. The Fremont Cottonwood Forest is considered one of the most important riparian plant communities in California because of the height of the cottonwood trees and the “gallery forest” effect, with several stories of branches above the riparian plain which provide habitat for the largest diversity of bird species in California (Barbour 2007). Additionally, because of the fast growth and its soft and brittle wood, the cottonwood is considered to be a good source of large woody debris and organic matter within the riverine channel.

Table 7-5.
FP-2 Levees, Relocations, and Land Acquisition

<table>
<tr><th colspan="2"></th><th colspan="2">Left Levee</th><th>Right Levee</th></tr>
<tr><td colspan="2">Levee Length</td><td colspan="2">6.3 miles</td><td>4.9 miles</td></tr>
<tr><td colspan="2">Average Levee Height</td><td colspan="2">5.5 feet</td><td>5.0 feet</td></tr>
<tr><td colspan="2">Fill Volume</td><td colspan="2">230,000 cubic yards</td><td>160,000 cubic yards</td></tr>
<tr><th colspan="5">Relocations</th></tr>
<tr><td>Electrical Distribution</td><td>21,409 feet</td><td colspan="2">Facility</td><td>1</td></tr>
<tr><td>Gas Transmission</td><td>7,613 feet</td><td colspan="2">Groundwater Well</td><td>19</td></tr>
<tr><td>Water Pipeline</td><td>22,569 feet</td><td colspan="2">Lift Pump</td><td>5</td></tr>
<tr><td>Canal</td><td>27,191 feet</td><td colspan="2">Power Pole</td><td>72</td></tr>
<tr><td>Confluence</td><td>1</td><td colspan="2">Monitoring Well</td><td>-</td></tr>
<tr><td>Culvert</td><td>1</td><td colspan="2">Regulating Reservoir</td><td>-</td></tr>
<tr><td>Diversion</td><td>1</td><td colspan="2">Abandoned Well</td><td>-</td></tr>
<tr><td>Barn/Shed</td><td>-</td><td colspan="2"></td><td></td></tr>
<tr><th colspan="5">Land Acquisition[1]</th></tr>
<tr><td>Total</td><td colspan="4">1,465 acres</td></tr>
</table>

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 7-6.
FP-2 Implementation/Technical Feasibility Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-2
Costs	Upfront Costs	Capital Improvement Costs	dollars	$192,480,000
		Land Costs	dollars	$19,800,000
		Subtotal	dollars	$212,280,000
	Long-Term Costs	O&M	dollars/year	$646,000
Time to Build	Timeline	Construction	months	40

Table 7-7.
FP-2 Objectives/Benefits Achievement Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-2
Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	3
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	482
	Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	2
		Total number of steps at structures	number of jumps	12
	Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	1
		Potential predation sites	number of artificial structures	3
Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	518.3
		Sensitive vegetation alliance extent	acres	1208.1
		Button willow thickets	acres	70.9
		California bulrush marsh	acres	72.2
		California mugwort brush	acres	117.8
		Creeping rye grass turfs	acres	46.6
		Riparian banks forbes and herbs	acres	90.9
		Salt grass flats	acres	248.4
		Fremont cottonwood forest	acres	38.9
		Oregon ash groves	acres	67.2
		Sandbar willow thickets	acres	261.9
		Black willow thickets	acres	114.5
		Exist. sensitive vegetation alliance preservation	acres	78.7
	Wildlife	Wildlife habitat extent	acres	1129.4
		Freshwater emergent wetland	acres	163.2
		Riparian scrub	acres	188.7
		Valley foothill riparian	acres	106.1
		Wet herbaceous	acres	295.1
		Willow scrub	acres	376.4
		Special-status species habitat extent	acres	859.4
		Greater sandhill crane	acres	458.2
		Swainson's hawk	acres	401.2
		Net change in wildland extent	acres	756.3
Geomorphology	Channel Stability	Potential to for lateral migration to impact levees (estimated erosion protection cost)	dollars	$1,123,000

Table 7-8.
FP-2 Impacts Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-2
Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	330
		Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	390
Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	658.7
		Alfalfa	acres	0.0
		Almond	acres	340.4
		Grapes	acres	76.1
		Other Row Crop	acres	0.0
		Palm	acres	9.7
		Pistachio	acres	232.5
	Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	$3,630,735
Environmental	Special Status Vegetation	Wetland Impacts	acres	64.6
		Freshwater Emergent Wetland	acres	0.0
		Freshwater Forested/Shrub Wetland	acres	40.4
		Riverine	acres	24.1
		Sensitive Vegetation Alliance Direct Impacts	acres	48.2
		Alkali heath marsh	acres	0.0
		Arrow weed thickets	acres	0.2
		Black willow thickets	acres	18.5
		Blue elderberry stands	acres	16.4
		Button willow thickets	acres	0.1
		California bulrush marsh	acres	0.6
		California rose briar patches	acres	4.4
		Creeping rye grass turfs	acres	0.0
		Fremont cottonwood forest	acres	3.0
		Oregon ash groves	acres	0.9
		Pale spike rush marshes	acres	0.0
		Salt grass flats	acres	0.9
		Silver bush lupine scrub	acres	0.0
		Spinescale scrub	acres	0.0
		Tar plant fields	acres	3.1
		Yerba mansa meadows	acres	0.0
	Special Status Wildlife	Special status wildlife habitat impacts	acres	202.0
		Blunt-nosed leopard lizard	acres	11.1
		Fairy shrimp	acres	2.3
		Fresno kangaroo rat	acres	21.0
		Giant garter snake	acres	37.2
		Greater sandhill crane	acres	52.2
		San Joaquin kit fox	acres	24.1
		Swainson's hawk	acres	37.7
		Valley elderberry longhorn beetle	acres	16.4
		Valley elderberry longhorn beetle	number of elderberry shrubs	273
	Cultural and Historical Resources	Historic Properties Potentially Effected	number of listed properties	3
		Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

7.1.4 FP-3

Floodplain Initial Alternative FP-3 has the same levee alignments as Floodplain Initial Alternative FP-2 (average floodplain width of approximately 3,070 feet) but includes grading on the floodplain to establish greater heterogeneity of water depths on the floodplain. A variety of floodplain depths potentially provides more habitat appropriate for rearing salmonids. Table 7-9 lists the quantities of levee construction, relocations, and land acquisition included in this Initial Alternative. See Table 7-10, Table 7-11, and Table 7-12 for the costs, benefits, and impacts data used in the evaluation.

While a conceptual grading plan was developed during concept refinement that focused on providing more floodplain connectivity and greater floodplain depths, the quantity and location of floodplain grading should be refined during the next Project stages as an avoidance measure for existing vegetation and habitat.

Fish Habitat and Passage

Floodplain Initial Alternative FP-3 provides a moderate amount of floodplain habitat resulting in sufficient acres of shallow water habitat for primary production as well as sufficient acres of habitat supporting direct rearing at the FSRAF. FP-3 also retains shallow water habitat at flows up to 4,500 cfs. In addition, grading areas for this alternative increase the amount of floodplain habitat available at lower flows. There are no up or downstream fish passage issues associated with this alternative.

Habitat Restoration

Floodplain Initial Alternative FP-3 includes the same floodplain acreage as FP-2. The main difference between this alternative and FP-2 is several high flow channels shorting the meander loops. The anticipated vegetation alliances in this alternative could be enriched by additional riparian bank herb communities along the high flow channels. The grass-dominated vegetation alliances, which produce the maximum food benefits for salmon, could be well distributed but their areal extent is slightly lower than in FP-2. The higher, flat parts of all of the meander loop areas would likely be dominated by Saltgrass Flats. The adjacent existing wetland areas within the loops could be preserved or enhanced by additional wetland species plantings and removal of numerous invasive species. In addition to the Saltgrass Flats, the middle and lower portions of the reach under this alternative could include predominantly Sandbar Willow Thickets, California Mugwort Brush and Black Willow Thickets. Additional restoration work could focus on the re-establishment of the Riparian Bank Herbs, California Bulrush Marsh, Button Willow Thickets, Oregon Ash Groves, Creeping Rye Grasslands, and Fremont Cottonwood Forests. The riverside of the proposed levee banks could be planted with plant species from the California Mugwort Brush and Creeping Rye Grassland alliances. Low-lying areas outside of the main river channel, with stagnant or slowly moving water that may be deep during high flows could be planted with Buttonbush Thicket or California Bulrush Marsh.

Table 7-9.
FP-3 Levees, Relocations, and Land Acquisition

		Left Levee	Right Levee
Levee Length		6.3 miles	4.9 miles
Average Levee Height		5.5 feet	5.0 feet
Fill Volume		230,000 cubic yards	160,000 cubic yards
Relocations			
Electrical Distribution	21,409 feet	Facility	1
Gas Transmission	7,613 feet	Groundwater Well	19
Water Pipeline	22,569 feet	Lift Pump	5
Canal	27,191 feet	Power Pole	72
Confluence	1	Monitoring Well	-
Culvert	1	Regulating Reservoir	-
Diversion	1	Abandoned Well	-
Barn/Shed	-		
Land Acquisition[1]			
Total	1,465 acres		

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 7-10.
FP-3 Implementation/Technical Feasibility Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-3
Costs	Upfront Costs	Capital Improvement Costs	dollars	$194,780,000
		Land Costs	dollars	$19,800,000
		Subtotal	dollars	$214,580,000
	Long-Term Costs	O&M	dollars/year	$646,000
Time to Build	Timeline	Construction	months	40

Table 7-11.
FP-3 Objectives/Benefits Achievement Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-3
Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	3
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	481
	Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	2
		Total number of steps at structures	number of jumps	12
	Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	1
		Potential predation sites	number of artificial structures	3
Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	518.3
		Sensitive vegetation alliance extent	acres	1208.7
		Button willow thickets	acres	43.0
		California bulrush marsh	acres	72.2
		California mugwort brush	acres	114.5
		Creeping rye grass turfs	acres	47.1
		Riparian banks forbes and herbs	acres	117.1
		Salt grass flats	acres	218.8
		Fremont cottonwood forest	acres	38.6
		Oregon ash groves	acres	61.8
		Sandbar willow thickets	acres	277.0
		Black willow thickets	acres	140.8
		Exist. sensitive vegetation alliance preservation	acres	77.6
	Wildlife	Wildlife habitat extent	acres	1131.1
		Freshwater emergent wetland	acres	189.4
		Riparian scrub	acres	298.4
		Valley foothill riparian	acres	100.4
		Wet herbaceous	acres	265.9
		Willow scrub	acres	277.0
		Special-status species habitat extent	acres	821.6
		Greater sandhill crane	acres	455.3
		Swainson's hawk	acres	366.3
		Net change in wildland extent	acres	756.9
Geomorphology	Channel Stability	Potential to for lateral migration to impact levees (estimated erosion protection cost)	dollars	$1,123,000

Table 7-12.
FP-3 Impacts Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-3
Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	330
		Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	390
Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	658.7
		Alfalfa	acres	0.0
		Almond	acres	340.4
		Grapes	acres	76.1
		Other Row Crop	acres	0.0
		Palm	acres	9.7
		Pistachio	acres	232.5
	Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	$3,630,735
Environmental	Special Status Vegetation	Wetland Impacts	acres	66.8
		Freshwater Emergent Wetland	acres	0.0
		Freshwater Forested/Shrub Wetland	acres	40.6
		Riverine	acres	26.2
		Sensitive Vegetation Alliance Direct Impacts	acres	50.0
		Alkali heath marsh	acres	0.0
		Arrow weed thickets	acres	0.2
		Black willow thickets	acres	19.1
		Blue elderberry stands	acres	16.6
		Button willow thickets	acres	0.2
		California bulrush marsh	acres	0.6
		California rose briar patches	acres	4.6
		Creeping rye grass turfs	acres	0.0
		Fremont cottonwood forest	acres	3.1
		Oregon ash groves	acres	1.5
		Pale spike rush marshes	acres	0.0
		Salt grass flats	acres	0.9
		Silver bush lupine scrub	acres	0.0
		Spinescale scrub	acres	0.0
		Tar plant fields	acres	3.1
		Yerba mansa meadows	acres	0.0
	Special Status Wildlife	Special status wildlife habitat impacts	acres	204.5
		Blunt-nosed leopard lizard	acres	11.1
		Fairy shrimp	acres	2.3
		Fresno kangaroo rat	acres	21.0
		Giant garter snake	acres	39.1
		Greater sandhill crane	acres	52.2
		San Joaquin kit fox	acres	24.1
		Swainson's hawk	acres	38.2
		Valley elderberry longhorn beetle	acres	16.6
		Valley elderberry longhorn beetle	number of elderberry shrubs	285
	Cultural and Historical Resources	Historic Properties Potentially Effected	number of listed properties	3
		Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

7.1.5 FP-4

Floodplain Initial Alternative FP-4 represents the second widest floodplain in the range of Initial Alternatives with an average floodplain width of approximately 4,200 feet. Table 7-13 lists the quantities of levee construction, relocations, and land acquisition included in this Initial Alternative. See Table 7-14, Table 7-15, Table 7-16 for the costs, benefits, and impacts data used in the evaluation.

Fish Habitat and Passage

Floodplain Initial Alternative FP-4 provides sufficient rearing habitat on the floodplain, but at 2,500 cfs, there are about equal acres of shallow water habitat and direct rearing habitat, and about half of the shallow water habitat is very shallow water habitat (less than 0.5 feet deep). This results in fair quality shallow water habitat. As flows increase above 2,500 cfs, the proportion of shallow water habitat decreases; at 3,000 cfs it is about 25% of the amount of rearing habitat; at 4,000 cfs it is about 10% of rearing habitat. There are no up or downstream fish passage issues associated with this alternative.

Habitat Restoration

Floodplain Initial Alternative FP-4 is the second largest alternative. Because of the areal extent of the floodplain, the inundation depth will be relatively shallow and the quality of the floodplain average. The grass-dominated vegetation alliances, which produce the maximum food benefits for salmon, could be more than twice as large as those in FP-2 and FP-3. All of the elevated areas of the meander loops would likely be dominated by Saltgrass Flats. The existing wetland areas within the loops could be preserved or enhanced by additional wetland species plantings and removal of numerous invasive species. The lower lying portions of the reach in this alternative could be planted with the Button Willow Thicket vegetation alliance. Because of the wide floodplain and the slowly moving water, the extent of this vegetation alliance could almost quadruple compared to alternatives FP-2 and FP-3. The extent of black willow thicket and California mugwort brush could increase considerably also. The riverside levee banks could be planted with plant species from the California Mugwort Brush and Creeping Rye Grassland. Since creeping wild rye (*Leymus triticoides*) is a facultative wetland species that thrives in the upper parts of riparian areas, the extent of Creeping Rye Grassland could more than double compared to FP-2 and FP-3 because FP-4 has shallower inundation depths.

Table 7-13.
FP-4 Levees, Relocations, and Land Acquisition

		Left Levee	Right Levee
Levee Length		6.0 miles	4.6 miles
Average Levee Height		5.3 feet	4.1 feet
Fill Volume		230,000 cubic yards	120,000 cubic yards
Relocations			
Electrical Distribution	28,482 feet	Facility	1
Gas Transmission	10,441 feet	Groundwater Well	26
Water Pipeline	30,320 feet	Lift Pump	6
Canal	28,839 feet	Power Pole	99
Confluence	0	Monitoring Well	1
Culvert	1	Regulating Reservoir	-
Diversion	2	Abandoned Well	-
Barn/Shed	-		
Land Acquisition[1]			
Total	2,011 acres		

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 7-14.
FP-4 Implementation/Technical Feasibility Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-4
Costs	Upfront Costs	Capital Improvement Costs	dollars	$218,110,000
		Land Costs	dollars	$27,300,000
		Subtotal	dollars	$245,410,000
	Long-Term Costs	O&M	dollars/year	$721,000
Time to Build	Timeline	Construction	months	45

Table 7-15.
FP-4 Objectives/Benefits Achievement Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-4
Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	2
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	585
	Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	2
		Total number of steps at structures	number of jumps	12
	Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	1
		Potential predation sites	number of artificial structures	3
Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	751.6
		Sensitive vegetation alliance extent	acres	1752.2
		Button willow thickets	acres	167.2
		California bulrush marsh	acres	72.2
		California mugwort brush	acres	163.0
		Creeping rye grass turfs	acres	97.6
		Riparian banks forbes and herbs	acres	89.0
		Salt grass flats	acres	483.3
		Fremont cottonwood forest	acres	51.1
		Oregon ash groves	acres	63.5
		Sandbar willow thickets	acres	318.7
		Black willow thickets	acres	169.1
		Exist. sensitive vegetation alliance preservation	acres	77.5
	Wildlife	Wildlife habitat extent	acres	1674.7
		Freshwater emergent wetland	acres	161.2
		Riparian scrub	acres	330.1
		Valley foothill riparian	acres	114.6
		Wet herbaceous	acres	580.9
		Willow scrub	acres	487.9
		Special-status species habitat extent	acres	1437.6
		Greater sandhill crane	acres	742.1
		Swainson's hawk	acres	695.5
		Net change in wildland extent	acres	1299.9
Geomorphology	Channel Stability	Potential to for lateral migration to impact levees (estimated erosion protection cost)	dollars	$315,000

1 **Table 7-16.**
2 **FP-4 Impacts Evaluation Data**

Categories	Factors	Criteria	Units of Measure	FP-4
Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	300
		Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	360
Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	1,159.2
		Alfalfa	acres	0.0
		Almond	acres	544.7
		Grapes	acres	169.6
		Other Row Crop	acres	0.0
		Palm	acres	9.7
		Pistachio	acres	435.2
	Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	$6,084,658
Environmental	Special Status Vegetation	Wetland Impacts	acres	62.9
		Freshwater Emergent Wetland	acres	0.0
		Freshwater Forested/Shrub Wetland	acres	40.1
		Riverine	acres	22.8
		Sensitive Vegetation Alliance Direct Impacts	acres	48.6
		Alkali heath marsh	acres	0.0
		Arrow weed thickets	acres	0.2
		Black willow thickets	acres	18.1
		Blue elderberry stands	acres	16.3
		Button willow thickets	acres	0.1
		California bulrush marsh	acres	1.0
		California rose briar patches	acres	4.4
		Creeping rye grass turfs	acres	0.0
		Fremont cottonwood forest	acres	3.8
		Oregon ash groves	acres	0.8
		Pale spike rush marshes	acres	0.0
		Salt grass flats	acres	0.9
		Silver bush lupine scrub	acres	0.0
		Spinescale scrub	acres	0.0
		Tar plant fields	acres	2.9
		Yerba mansa meadows	acres	0.0
	Special Status Wildlife	Special status wildlife habitat impacts	acres	199.6
		Blunt-nosed leopard lizard	acres	10.9
		Fairy shrimp	acres	2.3
		Fresno kangaroo rat	acres	20.8
		Giant garter snake	acres	38.9
		Greater sandhill crane	acres	48.4
		San Joaquin kit fox	acres	24.2
		Swainson's hawk	acres	37.9
		Valley elderberry longhorn beetle	acres	16.3
		Valley elderberry longhorn beetle	number of elderberry shrubs	270
	Cultural and Historical Resources	Historic Properties Potentially Effected	number of listed properties	3
		Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

7.1.6 FP-5

Floodplain Initial Alternative FP-5 represents the widest floodplain in the range of Initial Alternatives with an average floodplain width of approximately 5,600 feet. Floodplain Initial Alternative FP-5 provides the most floodplain acreage, but also requires the most amount of land acquisition. Table 7-17 lists the quantities of levee construction, relocations, and land acquisition included in this Initial Alternative. See Table 7-18, Table 7-19, and Table 7-20 for the costs, benefits, and impacts data used in the evaluation.

Fish Habitat and Passage

Floodplain Initial Alternative FP-5 provides more shallow water habitat than direct rearing habitat at flows of about 2,500 cfs, and about half of the shallow water habitat is very shallow water habitat (less than 0.5 feet deep). As flows increase above 2,500 cfs, the proportion of shallow water habitat decreases; at 3,000 cfs it is nearly 80% of the amount of rearing habitat; at 4,000 cfs it is about 40% of rearing habitat. In both higher flow cases, very shallow water habitat makes up a significantly proportion (40-60%) of the total shallow water habitat. There are no up or downstream fish passage issues associated with this alternative.

Based on a review of the floodplain modeling, an additional negative feature of FP-5 is the potential to strand fish. The land adjacent to the Reach 2B slopes away from the channel and towards the proposed levee; hence, when FP-5 floods up, water would flow overland toward the levee. This would not be a problem during flood up but it becomes a problem during flow recession. As flows recede, inundated areas adjacent to the levee become disconnected from the channel (between 3,500 and 3,000 cfs). Fish could become stranded in the disconnected floodplain areas. While there is some stranding potential in all the alternatives, there is a much higher potential for it to occur in FP-5 because of the extensive levee set back. Grading could be used to connect low-lying areas to the main channel to provide escape routes, but the long distance between levee and channel in FP-5 would likely result in slower velocities and higher siltation in the potential escape routes, and the grading would likely require periodic maintainenance.

Habitat Restoration

Floodplain Initial Alternative FP-5 is the largest alternative. Because of the areal extent of the floodplain, the inundation depth would be very shallow and the quality of the floodplain poor. The grass-dominated vegetation alliances, which produce the maximum food benefits for salmon, would however be very large. All of the higher areas of the meander loops would likely be dominated by Saltgrass Flats. The existing wetland areas within the loops could be preserved or enhanced by additional wetland species plantings and removal of numerous invasive species. The lower lying portions of the reach in this alternative could be planted with Button Willow Thicket and California Bulrush Marsh. The Black Willow Thicket and California Mugwort Brush could be the next largest vegetation alliances. The riverside of the proposed levee banks could be planted with plant species from the California Mugwort Brush and Creeping Rye Grassland. Since creeping wildrye (*Leymus triticoides*) is a facultative wetland species that thrives in the upper parts of riparian areas, the extent of Creeping Rye Grassland could almost double compared to FP-4 because of the shallower inundation depths. This alternative could include a very large Fremont Cottonwood Forest area that would be almost four times as large as the area of this vegetation alliance in FP-4.

Table 7-17.
FP-5 Levees, Relocations, and Land Acquisition

	Left Levee	Right Levee
Levee Length	6.4 miles	4.6 miles
Average Levee Height	5.5 feet	3.9 feet
Fill Volume	250,000 cubic yards	120,000 cubic yards

Relocations			
Electrical Distribution	46,148 feet	Facility	1
Gas Transmission	13,568 feet	Groundwater Well	36
Water Pipeline	54,558 feet	Lift Pump	8
Canal	40,922 feet	Power Pole	170
Confluence	0	Monitoring Well	2
Culvert	1	Regulating Reservoir	3
Diversion	2	Abandoned Well	2
Barn/Shed	-		

Land Acquisition[1]	
Total	2,699 acres

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 7-18.
FP-5 Implementation/Technical Feasibility Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-5
Costs	Upfront Costs	Capital Improvement Costs	dollars	$266,900,000
		Land Costs	dollars	$36,300,000
		Subtotal	dollars	$303,200,000
	Long-Term Costs	O&M	dollars/year	$846,000
Time to Build	Timeline	Construction	months	52

Table 7-19.
FP-5 Objectives/Benefits Achievement Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-5
Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	1
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	762
	Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	2
		Total number of steps at structures	number of jumps	12
	Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	1
		Potential predation sites	number of artificial structures	3
Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	980.4
		Sensitive vegetation alliance extent	acres	2432.5
		Button willow thickets	acres	240.4
		California bulrush marsh	acres	76.5
		California mugwort brush	acres	201.3
		Creeping rye grass turfs	acres	182.4
		Riparian banks forbes and herbs	acres	86.4
		Salt grass flats	acres	578.0
		Fremont cottonwood forest	acres	198.9
		Oregon ash groves	acres	118.3
		Sandbar willow thickets	acres	423.8
		Black willow thickets	acres	249.1
		Exist. sensitive vegetation alliance preservation	acres	77.3
	Wildlife	Wildlife habitat extent	acres	2355.2
		Freshwater emergent wetland	acres	163.0
		Riparian scrub	acres	446.1
		Valley foothill riparian	acres	326.5
		Wet herbaceous	acres	746.7
		Willow scrub	acres	672.9
		Special-status species habitat extent	acres	1982.9
		Greater sandhill crane	acres	909.7
		Swainson's hawk	acres	1073.2
		Net change in wildland extent	acres	1979.0
Geomorphology	Channel Stability	Potential to for lateral migration to impact levees (estimated erosion protection cost)	dollars	$130,000

Table 7-20.
FP-5 Impacts Evaluation Data

Categories	Factors	Criteria	Units of Measure	FP-5
Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	230
		Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	320
Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	1,797.1
		Alfalfa	acres	0.0
		Almond	acres	982.0
		Grapes	acres	287.8
		Other Row Crop	acres	0.0
		Palm	acres	9.7
		Pistachio	acres	517.6
	Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	$8,988,212
Environmental	Special Status Vegetation	Wetland Impacts	acres	64.2
		Freshwater Emergent Wetland	acres	0.0
		Freshwater Forested/Shrub Wetland	acres	40.2
		Riverine	acres	24.0
		Sensitive Vegetation Alliance Direct Impacts	acres	49.3
		Alkali heath marsh	acres	0.0
		Arrow weed thickets	acres	0.2
		Black willow thickets	acres	18.0
		Blue elderberry stands	acres	16.3
		Button willow thickets	acres	0.1
		California bulrush marsh	acres	0.9
		California rose briar patches	acres	4.4
		Creeping rye grass turfs	acres	0.1
		Fremont cottonwood forest	acres	4.2
		Oregon ash groves	acres	0.8
		Pale spike rush marshes	acres	0.0
		Salt grass flats	acres	0.9
		Silver bush lupine scrub	acres	0.0
		Spinescale scrub	acres	0.0
		Tar plant fields	acres	3.2
		Yerba mansa meadows	acres	0.0
	Special Status Wildlife	Special status wildlife habitat impacts	acres	200.2
		Blunt-nosed leopard lizard	acres	11.3
		Fairy shrimp	acres	2.3
		Fresno kangaroo rat	acres	21.2
		Giant garter snake	acres	39.8
		Greater sandhill crane	acres	46.1
		San Joaquin kit fox	acres	24.6
		Swainson's hawk	acres	38.6
		Valley elderberry longhorn beetle	acres	16.3
		Valley elderberry longhorn beetle	number of elderberry shrubs	271
	Cultural and Historical Resources	Historic Properties Potentially Effected	number of listed properties	3
		Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

7.2 Bypass Initial Alternatives

The Bypass Initial Alternatives include construction of channels and structures capable of conveying 4,500 cfs of Restoration Flows around the Mendota Pool and providing fish passage for salmonids and other native fishes between Reach 2A and Reach 3. The bypass will provide upstream and downstream passage of juvenile Chinook salmon and upstream passage of adult Chinook salmon, as well as passage for other native fishes, while isolating Mendota Pool from Restoration Flows.

There were two general approaches used for the bypass. The first involves excavating a channel around the existing Mendota Pool (see Settlement Alignment in Section 7.2.2 and Compact Alignment in Section 7.2.3). The second approach involves relocating the Mendota Pool into Fresno Slough and using the old San Joaquin River channel to convey Restoration Flows (see Fresno Slough Dam in Section 7.2.4). Design elements common to each Bypass Initial Alternative include:

- Construction of new levees
- Removal or partial removal of existing levees
- Existing infrastructure relocations or floodproofing
- Construction of a bifurcation or control structure with fish screen and ladder
- Floodplain and riparian habitat restoration
- Columbia Canal relocation and siphon
- Land acquisition

Additional design elements for the Settlement and Compact alignments include:

- Excavation of a channel
- Construction of a downstream fish barrier
- Construction of in-channel grade control structures

Additional design elements for the Fresno Slough Dam include:

- Removal of river sediments
- Construction of a dam on Fresno Slough
- Construction of a water diversion canal
- Relocation of portions of the Main Canal and Helm Ditch

7.2.1 Elements Common to All Bypass Initial Alternatives

The following sections describe the elements that are common to all Bypass Initial Alternatives.

Habitat Restoration

For the evaluation, it is assumed that active riparian and floodplain habitat restoration would occur in the Floodplain and Bypass Initial Alternatives similar to the habitat restoration presented for the Initial Floodplain Alternatives.

Levees

New levees will be constructed along the bypass channel and to connect the bypass channel to the Floodplain Initial Alternatives (extension levees). Proposed levee alignments take into account land parcel boundaries, the 300-foot buffer zone, and appropriate hydraulic and geomorphic transitions between the Floodplain Initial Alternatives and the Bypass Initial Alternatives. The design would be the same as for the Initial Floodplain Alternatives levees.

Removal of existing levees

All Bypass Initial Alternatives include removal of portions of the existing levees similar to that presented for the Initial Floodplain Alternatives.

Existing infrastructure relocations or floodproofing

Existing infrastructure such as groundwater wells, pumps, electrical and gas distribution lines, water pipelines, and canals are located in the Project area and will require relocation or floodproofing to protect them from future Restoration Flows and construction of the bypass channel and associated levees and structures. The quantity and extent of relocations varies with each Bypass Initial Alternative. See discussion under the Initial Floodplain Alternatives for more information.

7.2.2 Settlement Alignment

Bypass Initial Alternative Settlement Alignment will convey 4,500 cfs around the Mendota Pool consistent with the location and layout of the channel as described in exhibits created during the negotiation of the Settlement. This Initial Alternative includes excavating the bypass channel, constructing levees and in-channel structures, relocating or modifying existing infrastructure, and acquiring land. The in-channel structures: bifurcation control structures, grade control structures, fish screen, fish ladder, fish barrier, Columbia Canal Siphon, as well as the Road 10 ½ realignment are discussed in Section 7.3.

The bypass channel connects to Reach 3 approximately 1.4 miles downstream from Mendota Dam (approximately RM 203.2), bypasses the Mendota Pool to the north, and connects to Reach 2B approximately 3.1 miles upstream from Mendota Dam (approximately RM 207.7). The bypass channel has a total length of approximately 1.9 miles. A siphon under the bypass channel would be constructed to connect the Columbia Canal to the Mendota Pool, and portions of the Canal would be relocated north of the bypass channel.

Table 7-21 lists the quantities of levee construction, relocations, and land acquisition included in this Initial Alternative. See Table 7-22, Table 7-23, and Table 7-24 for the costs, benefits, and impacts data used in the evaluation.

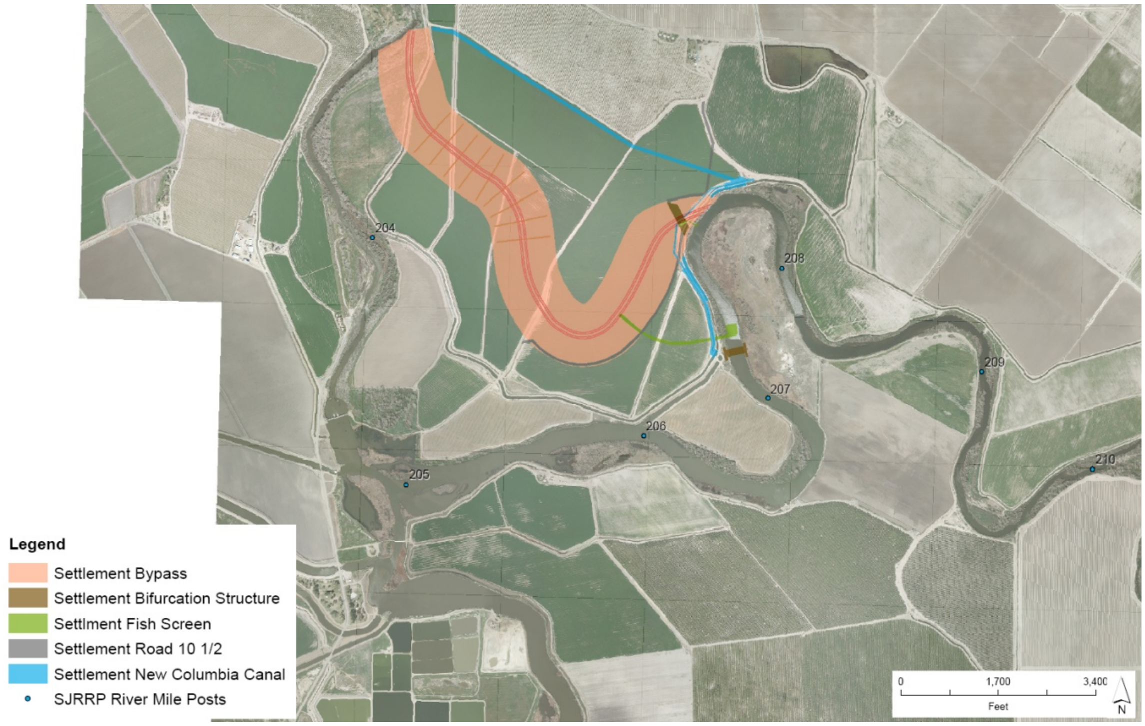


Figure 7-3.
Plan View of Settlement Alignment

Fish Habitat and Passage

The Bypass Initial Alternative Settlement Alignment includes provision of fish passage for salmonids and other native fish. Specifically, the alternative will provide suitable hydraulic conditions for passage of up-migrating adult salmonids, up- and out-migrating juvenile salmonids, and inter-reach migration of other native fish between Reach 2B and Reach 3. Suitable hydraulic conditions include those conditions which fish are physically capable of passing and do not cause undue stress on the animal (see Fish Passage Design Criteria in Section 5.2.6). The passage features are designed to cause no physical harm and to direct fish into connected migration pathways.

The Settlement Alignment includes floodplain and riparian habitat along and directly adjacent to the bypass channel to benefit migrating fish and promote a stable channel and reasonable sediment transport from Reach 2B to Reach 3.

The Settlement Alignment also includes several facilities that fish would encounter or need to pass to migrate between Reach 3 and Reach 2B (from downstream to upstream): a fish barrier, nine in-channel drop structures, four fish screen return/bypass outlets, a bifurcation control structure with fish ladder, and a fish screen. Each structure represents a potential stressor for adult salmon and potential predation site for juvenile salmon. However, each structure is designed to perform according to the fish passage design criteria. In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to incorporate channel structure variability during detailed design. All of which may help to reduce stress and predation.

The Settlement Alignment includes a fish barrier at the downstream end of the bypass channel to keep fish from migrating into false migration pathways. Without the barrier, a false migration pathway up to the base of Mendota Dam would be available to fish in all years, and a false migration pathway into Mendota Pool and Fresno Slough (potentially into the King River system) would occur in about one in five years, when the boards are taken out of Mendota Dam to pass Pine Flat flood releases into Reach 3. However, with the barrier, which is designed to accommodate flows up to 4,500 cfs, fish would not be able to migrate to Mendota Dam or enter Mendota Pool, but they would be guided into the bypass channel and Reach 2B.

Channel

The bypass channel would be a multi-stage channel designed to facilitate fish passage at low flows, channel stability at moderate flows, and contain high flows. The low-flow channel would be designed for a capacity of around 200 cfs and would have a topwidth of approximately 110 feet and a depth of approximately 2 feet. The main channel would be designed for a capacity of around 1,860 cfs (approximately the 2-year annual peak Restoration Flow in Reach 2B) and would have an average topwidth of approximately 320 feet and total depth of approximately 6 feet. The floodplain bench would be designed with a shallow cross-slope (approximately 1 percent slope) to allow variable floodplain depths at flows between 1,860 cfs and 4,500 cfs.

The channel, designed as an unlined earthen channel, will be approximately 9,800 feet long with a total corridor width of approximately 950 feet and will connect to the river at the downstream end at approximately RM 203.2 and connect at the upstream end at approximately RM 207.7. The average slope of the channel would be approximately 0.0004 (approximately 2.1 feet/mile), while the total elevation drop would be approximately 12 feet. A series of grade-control structures are included to achieve the necessary elevation change (see Section 7.3.9). Costs assume that the grade control structures would be constructed with capped and anchored sheet piles. Each grade-control structure will extend across the main channel and key into the overbanks to protect against flanking. Revetment and plantings are included around the structures to further reduce the potential of flanking.

Land Acquisition

Approximately 710 acres of additional lands will need to be acquired to accommodate the bypass channel, levees and structures. The bypass channel and associated facilities will be constructed within several parcels. Once severed, these lands may not be as easily utilized by the land owners and the entire parcels were considered in the land acquisition costs for this alternative.

Table 7-21.
Settlement Alignment Levees, Relocations, and Land Acquisition

		Left Levee	Right Levee
Levee Length		1.6 miles	1.6 miles
Average Levee Height		5.4 feet	5.1 feet
Fill Volume		60,000 cubic yards	56,100 cubic yards
Relocations			
Electrical Distribution	1,537 feet	Facility	-
Gas Transmission	-	Groundwater Well	-
Water Pipeline	-	Lift Pump	2
Canal	4,860 feet	Power Pole	-
Confluence	1	Monitoring Well	-
Culvert	-	Regulating Reservoir	1
Diversion	-	Abandoned Well	-
Barn/Shed	-		
Land Acquisition[1]			
Total	710 acres		

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 7-22.
Settlement Alignment Implementation/Technical Feasibility Evaluation Data

Categories	Factors	Criteria	Units of Measure	Settlement Alignment Bypass
Costs	Upfront Costs	Capital Improvement Costs	dollars	$225,370,000
		Land Costs	dollars	$13,000,000
		Subtotal	dollars	$238,370,000
	Long-Term Costs	O&M	dollars/year	$500,000
Time to Build	Timeline	Construction	months	59

Table 7-23.
Settlement Alignment Objectives/Benefits Achievement Evaluation Data

Categories	Factors	Criteria	Units of Measure	Settlement Alignment Bypass
Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	1
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	58
	Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	10
		Total number of steps at structures	number of jumps	21
	Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	1
		Potential predation sites	number of artificial structures	11
Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	55.6
		Sensitive vegetation alliance extent	acres	141.5
		Button willow thickets	acres	0.0
		California bulrush marsh	acres	0.0
		California mugwort brush	acres	18.5
		Creeping rye grass turfs	acres	20.0
		Riparian banks forbes and herbs	acres	61.1
		Salt grass flats	acres	15.2
		Fremont cottonwood forest	acres	0.0
		Oregon ash groves	acres	0.0
		Sandbar willow thickets	acres	13.7
		Black willow thickets	acres	13.0
		Exist. sensitive vegetation alliance preservation	acres	0.0
	Wildlife	Wildlife habitat extent	acres	141.5
		Freshwater emergent wetland	acres	61.1
		Riparian scrub	acres	18.5
		Valley foothill riparian	acres	0.0
		Wet herbaceous	acres	35.2
		Willow scrub	acres	26.7
		Special-status species habitat extent	acres	131.5
		Greater sandhill crane	acres	96.3
		Swainson's hawk	acres	35.2
		Net change in wildland extent	acres	188.1
Geomorphology	Channel Stability	Potential to for lateral migration to impact levees (estimated erosion protection cost)	dollars	$8,455,000

Table 7-24.
Settlement Alignment Impacts Evaluation Data

Categories	Factors	Criteria	Units of Measure	Settlement Alignment
Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	Not estimated
		Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	Not estimated
Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	717.8
		Alfalfa	acres	190.2
		Almond	acres	250.3
		Grapes	acres	0.0
		Other Row Crop	acres	277.3
		Palm	acres	0.0
		Pistachio	acres	0.0
	Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	$1,528,896
Environmental	Special Status Vegetation	Wetland Impacts	acres	15.5
		Freshwater Emergent Wetland	acres	0.0
		Freshwater Forested/Shrub Wetland	acres	11.8
		Riverine	acres	3.7
		Sensitive Vegetation Alliance Direct Impacts	acres	9.7
		Alkali heath marsh	acres	0.0
		Arrow weed thickets	acres	0.0
		Black willow thickets	acres	0.7
		Blue elderberry stands	acres	0.0
		Button willow thickets	acres	0.0
		California bulrush marsh	acres	0.2
		California rose briar patches	acres	0.0
		Creeping rye grass turfs	acres	0.0
		Fremont cottonwood forest	acres	8.8
		Oregon ash groves	acres	0.0
		Pale spike rush marshes	acres	0.0
		Salt grass flats	acres	0.0
		Silver bush lupine scrub	acres	0.0
		Spinescale scrub	acres	0.0
		Tar plant fields	acres	0.0
		Yerba mansa meadows	acres	0.0
	Special Status Wildlife	Special status wildlife habitat impacts	acres	186.9
		Blunt-nosed leopard lizard	acres	0.0
		Fairy shrimp	acres	0.0
		Fresno kangaroo rat	acres	0.0
		Giant garter snake	acres	3.4
		Greater sandhill crane	acres	120.9
		San Joaquin kit fox	acres	0.0
		Swainson's hawk	acres	62.6
		Valley elderberry longhorn beetle	acres	0.0
		Valley elderberry longhorn beetle	number of elderberry shrubs	0
	Cultural and	Historic Properties Potentially Effected	number of listed properties	0

Categories	Factors	Criteria	Units of Measure	Settlement Alignment
	Historical Resources	Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	1

7.2.3 Compact Alignment

Bypass Initial Alternative Compact Alignment will convey 4,500 cfs around the Mendota Pool by constructing a channel just south of the Columbia Canal. This Initial Alternative includes excavating the bypass channel, constructing levees and in-channel structures, removing existing levees, relocating or modifying existing infrastructure, and acquiring land. The in-channel structures: bifurcation control structures, grade control structures, fish screen, fish ladder, fish barrier, Columbia Canal Siphon, as well as the Road 10 ½ realignment are discussed in Section 7.3.

The bypass channel connects to Reach 3 approximately 0.6 miles downstream from Mendota Dam (approximately RM 204), bypasses the Mendota Pool to the north, and connects to Reach 2B approximately 0.9 miles upstream from Mendota Dam (approximately RM 205.5). The bypass channel has a total length of approximately 0.9 miles and is approximately 1.9 miles downstream of the Floodplain Initial Alternatives necessitating extension levees to connect the two. A siphon under the bypass channel would be constructed to connect the Columbia Canal to the Mendota Pool.

Table 7-26 lists the quantities of levee construction, relocations, and land acquisition included in this Initial Alternative. See Table 7-26, Table 7-27, Table 7-28 for a summary of the costs, benefits, and impacts data used in the evaluation.

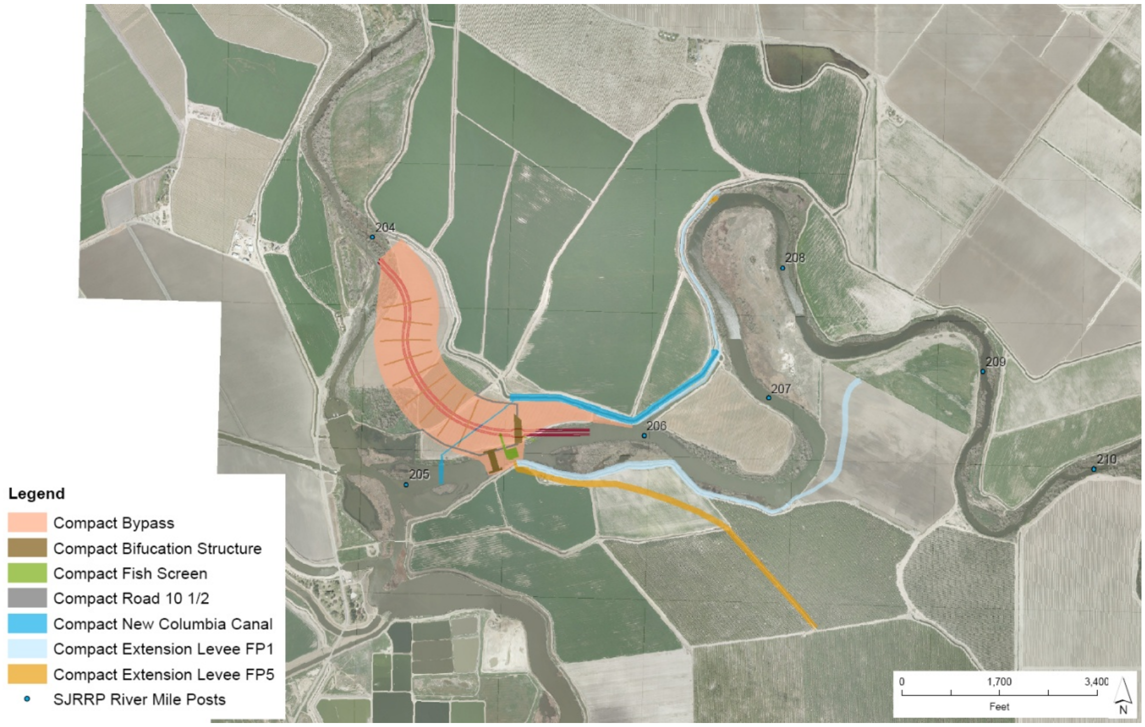


Figure 7-4.
Plan View of Compact Alignment

Fish Habitat and Passage

The Bypass Initial Alternative Compact Alignment includes provision of fish passage for salmonids and other native fish. Specifically, the alternative will provide suitable hydraulic conditions for passage of up-migrating adult salmonids, up- and out-migrating juvenile salmonids, and inter-reach migration of other native fish between Reach 2B and Reach 3. Suitable hydraulic conditions include those conditions which fish are physically capable of passing and do not cause undue stress on the animal (see Fish Passage Design Criteria in Section 5.2.6). The passage features are designed to cause no physical harm and to direct fish into connected migration pathways.

The Compact Alignment includes floodplain and riparian habitat along the extension levees and directly adjacent to bypass channel to benefit migrating fish and promote a stable channel and reasonable sediment transport from Reach 2B to Reach 3. However, due to the hydraulics, location, and elevation at the head of the bypass, this alternative reduces the water surface elevation in the river as compared to the Settlement Alignment causing a reduction in inundation acreage upstream of the bypass into the Floodplain Initial Alternatives area.[6] The additional rearing habitat provided along the extension

[6] The head of the Settlement Alignment was selected as the downstream endpoint of the Floodplain Initial Alternatives, so the hydraulic modeling utilized the hydraulic conditions at the head of the Settlement Bypass as the downstream boundary conditions for the Floodplain Initial Alternatives. The Compact

levees does not offset the loss of rearing habitat in the floodplains caused by the reduction in inundation. The reduction in inundation acreage is accounted for as negative rearing habitat acreage associated with this Initial Alternative.

The Compact Alignment also includes several facilities that fish would encounter or need to pass to migrate between Reach 3 and Reach 2B (from downstream to upstream): a fish barrier, nine in-channel drop structures, four fish screen return/bypass outlets, a bifurcation control structure with fish ladder, and a fish screen. Each structure represents a potential stressor for adult salmon and potential predation site for juvenile salmon. However, each structure is designed to perform according to the fish passage design criteria. In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to incorporate channel structure variability during detailed design. All of which may help to reduce stress and predation.

The Compact Alignment includes a fish barrier at the downstream end of the bypass channel to keep fish from migrating into false migration pathways. Without the barrier, a false migration pathway up to the base of Mendota Dam would be available to fish in all years, and a false migration pathway into Mendota Pool and Fresno Slough (potentially into the King River system) would occur in about one in five years, when the boards are taken out of Mendota Dam to pass Pine Flat flood releases into Reach 3. However, with the barrier, which is designed to accommodate flows up to 4,500 cfs, fish would not be able to migrate to Mendota Dam or enter Mendota Pool, but they would be guided into the bypass channel and Reach 2B.

Channel

The bypass channel would be a multi-stage channel designed to facilitate fish passage at low flows, channel stability at moderate flows, and contain high flows. The low-flow channel would be designed for a capacity of around 200 cfs and would have a topwidth of approximately 110 feet and a depth of approximately 2 feet. The main channel would be designed for a capacity of around 1,860 cfs (approximately the 2-year annual peak Restoration Flow in Reach 2B) and would have an average topwidth of approximately 320 feet and total depth of approximately 6 feet. The floodplain bench would be designed with a shallow cross-slope (approximately 1 percent slope) to allow variable floodplain depths at flows between 1,860 cfs and 4,500 cfs.

The channel, designed as an unlined earthen channel, would be approximately 4,800 feet long with a total corridor width of approximately 950 feet and will connect to the river at the downstream end near approximately RM 204 and connect at the upstream end near approximately RM 205.5. The average slope of the channel would be approximately 0.0004 (approximately 2.1 feet/mile), while the total elevation drop would be

Bypass provides different boundary conditions for the Floodplain, so the acreages presented in the tables need to compensate for those differences.

approximately 12 feet. A series of grade-control structures are included to achieve the necessary elevation change (see Section 7.3.9). Costs assume that the grade control structures would be constructed with capped and anchored sheet piles. Each grade-control structure will extend across the main channel and key into the overbanks to protect against flanking. Revetment and plantings are included around the structures to further reduce the potential of flanking.

Land Acquisition

Approximately 240 acres of additional lands will need to be acquired to accommodate the bypass channel, levees, and structures. Approximately 282 and 262 acres of additional lands will need to be acquired to accommodate the extension levees and floodplain in the area connecting the Compact Alignment to the Floodplain Initial Alternatives FP-1 and FP-5, respectively. The area includes the channel and floodplain between the existing levees. The area for the FP-1 extension levees and floodplain is larger than that for FP-5, even though FP-5 has a greater setback distance, because a larger portion of land on the downstream end of Reach 2B near RM 207.5 was included in Floodplain Initial Alternative FP-5.

Table 7-25.
Compact Alignment Levees, Relocations, and Land Acquisition

	Left Levee	Right Levee
Levee Length		
Bypass Channel	0.9 miles	1.1 miles
FP-1 Extension Levees	1.5 miles	1.1 miles
FP-5 Extension Levees	1.2 miles	1.1 miles
Average Levee Height		
Bypass Channel	7.0 feet	7.0 feet
FP-1 Extension Levees	6.0 feet	5.2 feet
FP-5 Extension Levees	5.7 feet	5.0 feet
Fill Volume		
Bypass Channel	51,100 cubic yards	70,500 cubic yards
FP-1 Extension Levees	64,100 cubic yards	39,200 cubic yards
FP-5 Extension Levees	47,500 cubic yards	36,400 cubic yards

Relocations

Electrical Distribution	6,683 feet	Facility	-
Gas Transmission	-	Groundwater Well	2
Water Pipeline	1,254 feet	Lift Pump	4
Canal	7,205 feet	Power Pole	-
Confluence	-	Monitoring Well	-
Culvert	-	Regulating Reservoir	-
Diversion	-	Abandoned Well	-
Barn/Shed	-		

Land Acquisition[1]

Total	522 acres (bypass channel with FP-1 extension levees) 502 acres (bypass channel with FP-5 extension levees)

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 7-26.
Compact Alignment Implementation/Technical Feasibility Evaluation Data

Categories	Factors	Criteria	Units of Measure	Compact Alignment Bypass[1]
Costs	Upfront Costs	Capital Improvement Costs	dollars	$234,970,000
		Land Costs	dollars	$7,000,000
		Subtotal	dollars	$241,970,000
	Long-Term Costs	O&M	dollars/year	$540,000
Time to Build	Timeline	Construction	months	59

[1] Table shows the worst case (highest costs, least benefits, most impacts) between the bypass channel with FP-1 extension levees and bypass channel with FP-5 extension levees.

Table 7-27.
Compact Alignment Objectives/Benefits Achievement Evaluation Data

Categories	Factors	Criteria	Units of Measure	Compact Alignment Bypass[1]
Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	1
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	-91
	Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	10
		Total number of steps at structures	number of jumps	21
	Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	1
		Potential predation sites	number of artificial structures	11
Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	97.8
		Sensitive vegetation alliance extent	acres	218.0
		Button willow thickets	acres	0.0
		California bulrush marsh	acres	68.5
		California mugwort brush	acres	18.0
		Creeping rye grass turfs	acres	19.1
		Riparian banks forbes and herbs	acres	42.4
		Salt grass flats	acres	23.2
		Fremont cottonwood forest	acres	0.0
		Oregon ash groves	acres	0.0
		Sandbar willow thickets	acres	1.0
		Black willow thickets	acres	16.8
		Exist. sensitive vegetation alliance preservation	acres	15.7
	Wildlife	Wildlife habitat extent	acres	202.1
		Freshwater emergent wetland	acres	110.8
		Riparian scrub	acres	18.0
		Valley foothill riparian	acres	0.0
		Wet herbaceous	acres	43.9
		Willow scrub	acres	17.6
		Special-status species habitat extent	acres	210.4
		Greater sandhill crane	acres	162.0
		Swainson's hawk	acres	43.9
		Net change in wildland extent	acres	155.9
Geomorphology	Channel Stability	Potential to for lateral migration to impact levees (estimated erosion protection cost)	dollars	$7,824,000

[1] Table shows the worst case (highest costs, least benefits, most impacts) between the bypass channel with FP-1 extension levees and bypass channel with FP-5 extension levees.

Table 7-28.
Compact Alignment Impacts Evaluation Data

Categories	Factors	Criteria	Units of Measure	Compact Alignment[1]
Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	Not estimated
		Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	Not estimated
Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	158.3
		Alfalfa	acres	41.2
		Almond	acres	24.7
		Grapes	acres	0.0
		Other Row Crop	acres	92.4
		Palm	acres	0.0
		Pistachio	acres	0.0
	Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	$265,460
Environmental	Special Status Vegetation	Wetland Impacts	acres	24.2
		Freshwater Emergent Wetland	acres	0.0
		Freshwater Forested/Shrub Wetland	acres	9.4
		Riverine	acres	14.9
		Sensitive Vegetation Alliance Direct Impacts	acres	22.8
		Alkali heath marsh	acres	0.1
		Arrow weed thickets	acres	0.0
		Black willow thickets	acres	11.6
		Blue elderberry stands	acres	0.0
		Button willow thickets	acres	0.0
		California bulrush marsh	acres	0.2
		California rose briar patches	acres	1.0
		Creeping rye grass turfs	acres	0.6
		Fremont cottonwood forest	acres	8.9
		Oregon ash groves	acres	0.1
		Pale spike rush marshes	acres	0.0
		Salt grass flats	acres	0.0
		Silver bush lupine scrub	acres	0.0
		Spinescale scrub	acres	0.0
		Tar plant fields	acres	0.2
		Yerba mansa meadows	acres	0.1
	Special Status Wildlife	Special status wildlife habitat impacts	acres	156.9
		Blunt-nosed leopard lizard	acres	0.0
		Fairy shrimp	acres	0.0
		Fresno kangaroo rat	acres	0.0
		Giant garter snake	acres	18.3
		Greater sandhill crane	acres	101.3
		San Joaquin kit fox	acres	0.0
		Swainson's hawk	acres	37.4
		Valley elderberry longhorn beetle	acres	0.0
		Valley elderberry longhorn beetle	number of elderberry shrubs	0
	Cultural and Historical Resources	Historic Properties Potentially Effected	number of listed properties	1
		Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

[1] Table shows the worst case (highest costs, least benefits, most impacts) between the bypass channel with FP-1 extension levees and bypass channel with FP-5 extension levees.

7.2.4 Fresno Slough Dam

Bypass Initial Alternative Fresno Slough Dam would convey 4,500 cfs around the Mendota Pool by constructing a dam across Fresno Slough which would contain Mendota Pool and using the existing river channel to convey Restoration Flows. This Initial Alternative includes removing a portion of river sediments currently stored behind Mendota Dam, constructing a dam on Fresno Slough, constructing a water delivery canal, constructing levees, removing existing levees, relocating or modifying existing infrastructure, and acquiring land. The in-channel structures: dam, bifurcation control structures, fish screen, fish ladder, Columbia Canal Siphon, and Main Canal and Helm Ditch relocations are discussed in Section 7.3.

The Fresno Slough Dam would be located approximately 0.5 miles south of the existing Mendota Dam. Mendota Dam (approximately RM 204.6) is approximately 3.1 miles downstream of the Floodplain Initial Alternatives (approximately RM 207.7) necessitating extension levees along the river to connect the two. Three optional alignments of the water delivery canal to divert water from the San Joaquin River into Mendota Pool were investigated. The North and South Canal alignments would connect to the river upstream of San Mateo Avenue and discharge water to Fresno Slough south of Mendota Dam. The South Canal would discharge via the Little San Joaquin Slough. The Short Canal option would be located directly east of the Fresno Slough Dam. Portions of the Main Canal and Helm Ditch would be relocated to connect them the Mendota Pool, and a siphon under the river would be constructed to connect the Columbia Canal.

Table 7-29 lists the quantities of levee construction, relocations, and land acquisition included in this Initial Alternative. See Table 7-30, Table 7-31, Table 7-32 for a summary of the costs, benefits, and impacts data used in the evaluation.

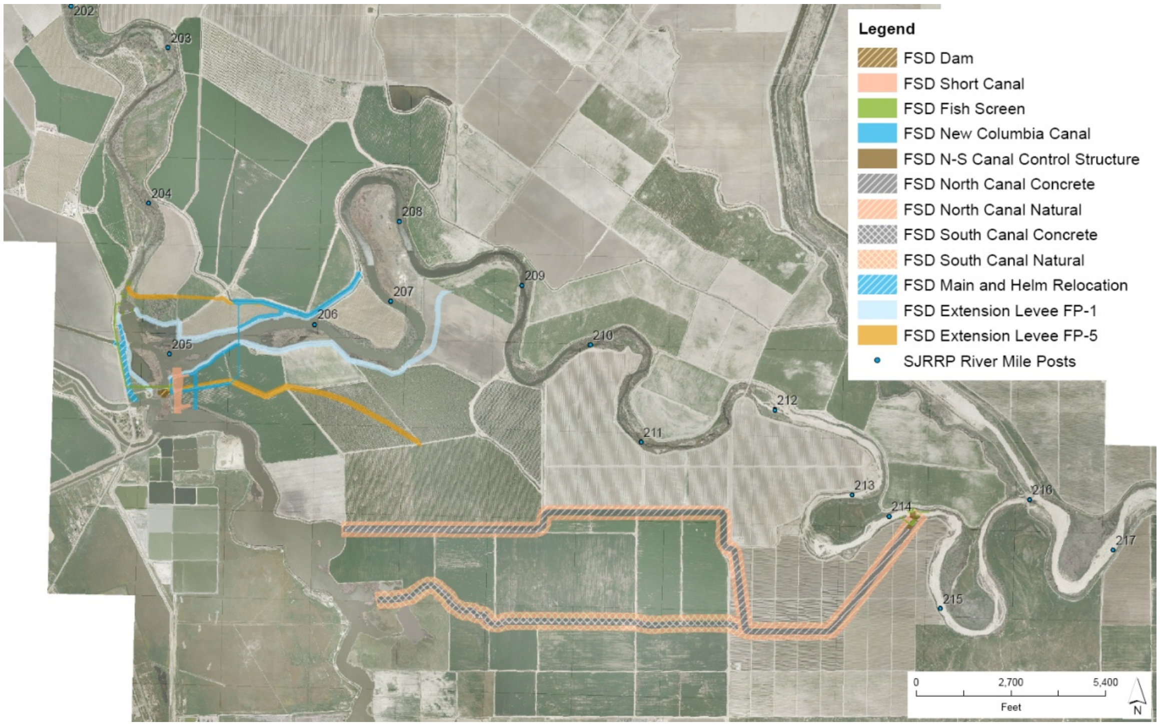


Figure 7-5.
Plan View of Fresno Slough Dam

Fish Habitat and Passage

The Bypass Initial Alternative Fresno Slough Dam includes provision of fish passage for salmonids and other native fish. Specifically, the alternative will provide suitable hydraulic conditions for passage of up-migrating adult salmonids, up- and out-migrating juvenile salmonids, and inter-reach migration of other native fish between Reach 2B and Reach 3. Suitable hydraulic conditions include those conditions which fish are physically capable of passing and do not cause undue stress on the animal (see Fish Passage Design Criteria in Section 5.2.6). The passage features are designed to cause no physical harm and to direct fish into connected migration pathways.

The Fresno Slough Dam includes floodplain and riparian habitat along the extension levees and river channel to benefit migrating fish and promote a stable channel and reasonable sediment transport from Reach 2B to Reach 3. However, due to the hydraulics, location, and elevation of the sill of Mendota Dam, this alternative reduces the water surface elevation in the river causing a reduction in inundation acreage upstream of the Dam into the Floodplain Initial Alternatives area. The additional rearing habitat provided along the extension levees more than offsets the loss of rearing habitat in the floodplains caused by the reduction in inundation area, this Initial Alternative provides additional acreage of rearing habitat.

The Fresno Slough Dam also includes several facilities that fish would encounter or need to pass to migrate between Reach 3 and Reach 2B (from downstream to upstream): two in-channel drop structures below Mendota Dam, the sill of Mendota Dam (when boards are out) or a fish ladder at Mendota Dam (when boards are in; Short Canal only), four fish screen return/bypass outlets, a fish screen, and a bifurcation control structure with fish ladder (North and South Canals only). Each structure represents a potential stressor for adult salmon and potential predation site for juvenile salmon. However, each structure is designed to perform according to the fish passage design criteria. In addition, the channel and floodplain incorporate riparian plantings to provide cover, woody material, and velocity variability, while the design footprint allows sufficient space to incorporate channel structure variability during detailed design. All of which may help to reduce stress and predation.

The Fresno Slough Dam includes a fish barrier to keep fish from migrating into false migration pathways. False migration pathways will not be available to fish in most years. The only false migration pathway would occur when Pine Flat Reservoir flood releases are coming down the James Bypass into Fresno Slough. During these conditions the gates of Fresno Slough Dam would be open to pass those flows into Reach 3. When the dam gates are open, the barrier would prevent fish from migrating into Fresno Slough and potentially into the King River system were they would be lost to the San Joaquin River. Flood flows in the James Bypass occur in about one in five years.

Removal of River Sediments

The Fresno Slough Dam would make use of the existing river channel from the end of the Floodplain Initial Alternatives (approximately RM 207.7) down to Mendota Dam (approximately RM 204.6) in order to convey Restoration Flows. Since this portion of the river is currently impounded by Mendota Dam, sediment has filled in the pre-Mendota Dam channel. If left in place once Fresno Slough Dam is implemented, the sediment is expected to erode and establish a new equilibrium slope. The cost of removing sediment for an estimated channel cross-section, equilibrium slope, and length is included in the cost of this Bypass Initial Alternative.

Water Delivery Canal

The Fresno Slough Dam includes three optional canals for delivering up to 2,500 cfs in water deliveries from the San Joaquin River into Mendota Pool: North Canal, South Canal, and Short Canal. The North and South Canal alignments connect to the river at approximately RM 214.2, upstream of San Mateo Avenue, and discharge water to Fresno Slough at locations approximately 1.8 and 2.3 river miles south of Mendota Dam, respectively. The South Canal discharges via the Little San Joaquin Slough. The Short Canal option would be located directly east of the Fresno Slough Dam. See additional discussion in Section 7.4.2.

Land Acquisition

Approximately 36 acres of additional lands will need to be acquired to accommodate the dam and other structures. Approximately 340 and 420 acres of additional lands (including the channel and floodplain between the existing levees) will need to be acquired to accommodate the extension levees and floodplain in the area between Mendota Dam and the Floodplain Initial Alternatives FP-1 and FP-5, respectively.

Table 7-29.
Fresno Slough Dam Levees, Relocations, and Land Acquisition

	Left Levee	Right Levee
Levee Length		
FP-1 Extension Levees	1.4 miles	2.0 miles
FP-5 Extension Levees	1.2 miles	2.5 miles
Average Levee Height		
FP-1 Extension Levees	5.8 feet	5.6 feet
FP-5 Extension Levees	4.5 feet	3.5 feet
Fill Volume		
FP-1 Extension Levees	87,500 cubic yards	64,500 cubic yards
FP-5 Extension Levees	42,000 cubic yards	68,250 cubic yards

Relocations			
Electrical Distribution	6,700 feet (FP-1) 12,500 feet (FP-5)	Facility	-
Gas Transmission	-	Groundwater Well	2 (FP-1 & FP-5)
Water Pipeline	-	Lift Pump	-
Canal	7,200 feet (FP-1) 12,000 feet (FP-5)	Power Pole	-
Confluence	-	Monitoring Well	-
Culvert	-	Regulating Reservoir	-
Diversion	-	Abandoned Well	-
Barn/Shed	-		

Land Acquisition[1]	
Total	376 acres (structures with FP-1 extension levees) 456 acres (structures with FP-5 extension levees)

Note: This table does not include levee construction, relocations, and land acquisition for the water delivery canals. See Section 7.4.2 and Table 7-34.
[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

Table 7-30.
Fresno Slough Dam Implementation/Technical Feasibility Evaluation Data

Categories	Factors	Criteria	Units of Measure	Fresno Slough Dam[1]
Costs	Upfront Costs	Capital Improvement Costs	dollars	$375,990,000
		Land Costs	dollars	$8,890,000
		Subtotal	dollars	$384,880,000
	Long-Term Costs	O&M	dollars/year	$666,000
Time to Build	Timeline	Construction	months	65

[1] Table shows the worst case (highest costs, least benefits, most impacts) between the structures with FP-1 extension levees and structures with FP-5 extension levees plus the worst case between the water delivery canals.

Table 7-31.
Fresno Slough Dam Objectives/Benefits Achievement Evaluation Data

Categories	Factors	Criteria	Units of Measure	Fresno Slough Dam[1]
Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	1
		Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	39
	Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	4
		Total number of steps at structures	number of jumps	16
	Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	1
		Potential predation sites	number of artificial structures	5
Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	101.8
		Sensitive vegetation alliance extent	acres	251.2
		Button willow thickets	acres	2.1
		California bulrush marsh	acres	0.0
		California mugwort brush	acres	16.2
		Creeping rye grass turfs	acres	27.8
		Riparian banks forbes and herbs	acres	41.4
		Salt grass flats	acres	50.5
		Fremont cottonwood forest	acres	0.0
		Oregon ash groves	acres	0.0
		Sandbar willow thickets	acres	23.1
		Black willow thickets	acres	72.0
		Exist. sensitive vegetation alliance preservation	acres	20.3
	Wildlife	Wildlife habitat extent	acres	230.9
		Freshwater emergent wetland	acres	41.4
		Riparian scrub	acres	16.2
		Valley foothill riparian	acres	0.0
		Wet herbaceous	acres	78.3
		Willow scrub	acres	95.1
		Special-status species habitat extent	acres	197.9
		Greater sandhill crane	acres	119.6
		Swainson's hawk	acres	78.3
		Net change in wildland extent	acres	72.6
Geomorphology	Channel Stability	Potential to for lateral migration to impact levees (estimated erosion protection cost)	dollars	$2,306,000

[1] Table shows the worst case (highest costs, least benefits, most impacts) between the structures with FP-1 extension levees and structures with FP-5 extension levees plus the worst case between the water delivery canals.

Table 7-32.
Fresno Slough Dam Impacts Evaluation Data

Categories	Factors	Criteria	Units of Measure	Fresno Slough Dam[1]
Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	Not estimated
		Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	Not estimated
Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	389.1
		Alfalfa	acres	68.7
		Almond	acres	81.9
		Grapes	acres	83.5
		Other Row Crop	acres	167.5
		Palm	acres	0.0
		Pistachio	acres	5.4
	Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	$1,023,146
Environmental	Special Status Vegetation	Wetland Impacts	acres	30.4
		Freshwater Emergent Wetland	acres	7.6
		Freshwater Forested/Shrub Wetland	acres	10.0
		Riverine	acres	12.8
		Sensitive Vegetation Alliance Direct Impacts	acres	22.4
		Alkali heath marsh	acres	0.4
		Arrow weed thickets	acres	0.1
		Black willow thickets	acres	8.9
		Blue elderberry stands	acres	0.3
		Button willow thickets	acres	0.3
		California bulrush marsh	acres	3.7
		California rose briar patches	acres	2.5
		Creeping rye grass turfs	acres	0.7
		Fremont cottonwood forest	acres	4.6
		Oregon ash groves	acres	0.1
		Pale spike rush marshes	acres	1.3
		Salt grass flats	acres	0.3
		Silver bush lupine scrub	acres	0.0
		Spinescale scrub	acres	0.4
		Tar plant fields	acres	0.7
		Yerba mansa meadows	acres	0.1
	Special Status Wildlife	Special status wildlife habitat impacts	acres	220.0
		Blunt-nosed leopard lizard	acres	0.0
		Fairy shrimp	acres	0.0
		Fresno kangaroo rat	acres	0.0
		Giant garter snake	acres	44.9
		Greater sandhill crane	acres	127.0
		San Joaquin kit fox	acres	12.4
		Swainson's hawk	acres	35.4
		Valley elderberry longhorn beetle	acres	0.3
		Valley elderberry longhorn beetle	number of elderberry shrubs	15
	Cultural and Historical Resources	Historic Properties Potentially Effected	number of listed properties	2
		Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	4

[1] Table shows the worst case (highest costs, least benefits, most impacts) between the structures with FP-1 extension levees and structures with FP-5 extension levees plus the worst case between the water delivery canals.

7.3 Structures Included in the Initial Alternatives

More detailed discussion of the structures included in the Initial Alternatives is provided in the following sections. The structures are generally listed from upstream to downstream.

7.3.1 Chowchilla Bifurcation Structure Fish Passage Retrofit

The San Joaquin control structure at the Chowchilla Bifurcation Structure will not be passable to up-migrating salmon for all flows and flow splits between the river and the Chowchilla Bypass. The undershot gates, sill across the downstream side of the structure, and trash rack on the upstream side contribute to upstream passage difficulties at high, low, and all flows, respectively. It was determined that a fish passage facility would be required for upmigrating salmon to swim into Reach 2A from Reach 2B under most conditions. Appraisal-level design was completed for a fish ladder retrofitted to the side of the San Joaquin control structure.

Ladder Design

The design of the fish ladder was based on criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008). The size and geometry of the fish ladder was dictated by the flow requirements for juvenile and adult fish. A vertical slot weir ladder design was selected for its ability to accommodate a greater range of water depths (hydraulic head at the upstream and downstream ends), when compared to an 'ice-harbor' or 'pool and chute' ladder design. The pool dimensions would be governed by the maximum anticipated ladder flow magnitudes.

At the ladder upstream exit, a minimum horizontal weir elevation was selected to accommodate up to 9.6 feet of total headwater depth fluctuation. The exit weir is vertically adjustable to control river flow into the ladder. This weir elevation may be controlled either manually or automatically, depending on the level of ladder automation selected in a future design phase.

The downstream entrance port of the fish ladder includes a self-sealing mechanically operated vertical slide gate. The purpose of this gate is to control ladder entrance flow and account for variations in the tailwater depth during ladder operation. This slide gate may be either manually or automatically operated, depending on the level of ladder automation selected in a future design phase.

A roadway will need to be built over the fish ladder to connect the maintenance road atop the San Joaquin control structure with the levee road on the south side of the river. The roadway would be supported by the vertical concrete walls of the fish ladder. The design may need to be revised to match the size and design and of the Chowchilla Bifurcation Structure.

Portions of the existing San Joaquin control structure, such as the left bank wing wall and a portion of the roadway will need to be demolished before installing the fish ladder.

The design flow through the ladder would be based on the fish criteria, and supplementary water may be used to meet attraction flow requirements. The layout and alignment of the ladder and auxiliary features is preliminary and may be updated in a future design phase.

7.3.2 Lone Willow Slough Fish Screen

Lone Willow Slough connects to the river at approximately RM 215.9 just downstream of the Chowchilla Bifurcation Structure. During high flows, up to 125 cfs of water may be diverted for irrigation from Reach 2B into the Lone Willow Slough. A screen is necessary to prevent fish from entering the canal when flows are being diverted. The fish screen structure consists of a concrete hollow box, with the river side of the box open to river flows and the back of the box fitted with a board guide to control diversion into the irrigation canal. The opening at the riverside includes an automated cleaner system, trash rack and a fish screen to prevent migrating fish from entering the intake. The screen would be designed to meet NMFS 2008 criteria.

7.3.3 San Mateo Avenue Crossing

The San Mateo Avenue crossing is an existing river crossing located within a public right-of-way in Madera County and on private land in Fresno County at approximately RM 211.8. The crossing transitions from public right-of-way to private land at the center of the river. In order to maintain vehicular access and accommodate increased flow magnitudes, durations, and frequencies associated with Restoration Flows, an improved crossing is included with all Floodplain Initial Alternatives. The crossing will accommodate the increased flows in the river by maintaining the required velocities for proper fish passage for flows up to 4,500 cfs. The crossing would be designed to meet NMFS 2001 and NMFS 2008 passage criteria.

The proposed San Mateo Avenue crossing includes installing a low flow or dip crossing with multiple concrete box culverts designed for highway loading. The structure includes armoring along the entrance and exit of the structure as well as along the channel banks in the immediate vicinity of the structure. The armoring is necessary to protect the structure during overtopping flows (greater than approximately 1,500 cfs). Culverts would be embedded below the existing channel bed. Grouted riprap would be placed in the culvert below the existing channel bed to prevent channel scour reaching the floor of the culvert and to create a roughened boundary layer for fish passage. Native bed material would be placed above the grouted riprap up to the existing channel bed to provide passage conditions similar to that which exists in the adjacent natural stream.

7.3.4 Mendota Pool Bypass Bifurcation Structure

Bifurcation structures would be constructed at the upstream ends of the Settlement Alignment, Compact Alignment, North Canal, and South Canal. Each bifurcation structure consists of two control structures: one across the path of Restoration Flows (bypass channel for the Settlement and Compact alignments and the river for the North and South canals) and one across the path of water deliveries to Mendota Pool (the river for the Settlement and Compact alignments and the water delivery canal for the North and South Canals). The Short Canal has one control structure of similar design.

Structures across the path of the Restoration Flows need to accommodate up to 4,500 cfs and consist of multiple bays. Conditions in this control structure would be designed to meet NMFS 2001 and NMFS 2008 passage criteria when flow conditions are amenable. Those across the path of the water deliveries need to accommodate up to 2,500 cfs and also consist of multiple bays. Flow through each bay can be controlled by a radial (Tainter) gate. The gate size would be determined during final design and is based on the design maximum flow.

The Restoration Flow path structures include a fish ladder on the right bank side of the structure (see Section 7.3.5), and the water deliveries flow path structures include a fish screen upstream of the structure (see Section 7.3.7). Each control structure is placed in the middle of the channel and has earthen embankments connecting the structure to the levees. A roadway and maintenance/operations platform are provided over each control structure.

7.3.5 Mendota Pool Bypass Fish Ladder

Each Mendota Pool Bypass control structure across the Restoration Flow path has a fish ladder on the right bank side of the structure. The fish ladder is necessary to provide passage during pool deliveries and for Restoration Flows where passage conditions in the control structure may not be ideal. The design of the fish ladder is the same as that presented for the Chowchilla Bifurcation Structure retrofit in Section 7.3.1.

7.3.6 Drive 10 ½ Crossing

The Settlement and Compact alignments will cross existing Drive 10 ½, which provides access to the east side of Mendota Dam. The road could be rerouted along the bypass channel levees and cross the bypass channel at the proposed Mendota Pool Bypass bifurcation structure. A road deck would also be provided over the fish ladder adjacent to the bifurcation structure.

7.3.7 Mendota Pool Bypass Fish Screen

Each control structure across the water deliveries path has a fish screen upstream of the structure. The fish screen is necessary to return out-migrating juvenile salmon to the path of Restoration Flows during pool deliveries.

The screen is designed to pass flow up to 2,500 cfs. The fish screen is arranged in four sets of V-shaped configurations. The fish screen facility includes trash racks, stainless steel wedge wire fish screens, flow control baffle systems behind the screens, screen cleaning systems for the trashracks and screens, bypass flow control weirs, fish-friendly pumps, and fish bypass pressure pipelines. The trash racks are installed at the entrance to the screen structures to protect screens from trash, logs, and other large debris.

Approach, sweeping, and bypass entrance velocities would be kept within established fish screen criteria (NMFS 2008). Flow through the fish screens may be controlled by baffles behind the fish screens. Cleaning of the screens would be accomplished using an automated brush system. Electric power would be needed for fish friendly pumps, if included, and screen cleaning systems. Operation of the fish screens would include methods to reduce predation of juvenile fish (e.g., noise systems to scatter predators, netting, and periodic draining of the screen return pipes).

General arrangement and features were configured based on guidelines presented in *Fish Protection at Water Diversions* (Reclamation 2006). The design shows the outlet of the fish return pipes ending and flowing into the main channel of the Mendota Pool Bypass Channel or river, depending on the Initial Alternative, followed by a section of riprap leading to the low flow channel. Future detailed design will confirm that the outlet structure is appropriate and meets applicable fish criteria.

7.3.8 Mendota Dam Fish Barrier

Fish exclusion barriers are included in Reach 3 near the downstream ends of the Settlement and Compact alignments to prevent fish from migrating beyond the bypass channel up to the base of Mendota Dam, which during most flows out of Mendota Pool, would be a dead end for fish passage. This would lead to delays in adult salmon migration or potentially death. Although out-migrating fish are not expected to be present downstream from Mendota Dam, the fish barrier would allow juveniles to pass the structure.

The exclusion barrier design is a high-flow picket barrier, which is a flow-through structure of closely spaced bars (i.e., pickets) that prevent adult fish from traveling upstream in the river to Mendota Dam at flows up to a combined discharge of 4,500 cfs. The design accounts for a range of flow options from routing the entire 4,500-cfs flow through the structure (flood flows from the James Bypass), to routing a 600-cfs irrigation delivery through the structure with up to 3,900 cfs being routed down the Mendota Pool Bypass Channel, to routing no flow through the structure with up to 4,500 cfs down the Mendota Pool Bypass Channel.

For both the Settlement and Compact alignments, the structure will be across the main channel and across the overbanks. The base of the structure will consist of a concrete sill connected to concrete piles, which extend into clay layers. The structure will be approximately 20 feet high in the main channel and 9 feet high in the overbanks. Riprap will be placed 2 feet thick at the entrance and exit of the sill to prevent erosion.

Due to challenging river geometry at the outlet of the Settlement Alignment, the average velocity through the structure does not meet the 1.0 fps criteria in *Anadromous Salmonid Passage Facility Design* (NMFS 2008). The calculated velocity is 1.6 fps. The Compact Alignment fish barrier, however, does meet the NMFS criteria.

7.3.9 Mendota Pool Bypass Channel Grade Control Structures

For the Settlement and Compact alignments, a series of nine, approximately 1.0-ft high grade-control structures are included within the channel to achieve the necessary elevation change between Reach 2B and Reach 3. Costs assume that the grade control structures would be constructed with capped and anchored sheet piles. Each 1.0-foot high drop will extend across the main channel and key into the overbanks to protect against flanking. Revetment is included along both channel banks within the portion of the bypass containing the grade control structures to provide additional protection against flanking. It is assumed that the revetment will consist of buried riprap covered with topsoil, erosion control fabric, and native vegetation.

7.3.10 Fresno Slough Dam

The Fresno Slough Dam will be constructed approximately 0.5 miles south of the Mendota Dam, in the existing Fresno Slough. In addition, the dam structure will be located just south of the existing Mowry Bridge that crosses the Fresno Slough. The dam will serve to limit the extent of Mendota Pool so it no longer occupies portions of the San Joaquin River. This pool will feed the five existing irrigation canals (Main Canal, Helm Ditch, Columbia Canal, Outside Canal, and Main Lift Canal). A screened water diversion canal would enable water deliveries from the San Joaquin River to the Mendota Pool. Since inputs into the Mendota Pool will be screened, Fresno Slough Dam does not require provisions for fish passage.

The dam structure was preliminarily designed to accommodate a maximum water elevation of 156.0 feet. This water elevation corresponds to a pool depth of 16.0 feet above the top of the concrete floor.

The Fresno Slough Dam consists of a reinforced concrete spillway with a top elevation of 140.0 feet. The spillway does not require the support of piles. The spillway includes a concrete cutoff wall at the upstream end of the spillway to limit the hydrostatic uplift pressures and reduces the effects of scour. Baffle blocks and riprap are included at the downstream end of the concrete spillway to limit the effects of scour and erosion.

Directly adjacent to the upstream and downstream ends of the concrete dam structure, a total of four concrete retaining walls form the walls of the spillway, and retain the sides of the earthen embankment portion of the dam. The spillway structure is comprised of multiple gates, which serve to control the flow of water from the Mendota Pool to the San Joaquin River.

Over the dam, a concrete roadway, concrete maintenance platform, and a hoist operation platform span the full width of the structure. A series of vertical stoplog slots would be included in the concrete abutment walls. The stoplog slots allow the placement of stoplogs directly upstream of the gates, to facilitate local dewatering of the gates for maintenance operations.

Some excavation of existing channel sediments upstream of the dam will be required to improve flow conditions through the dam during Kings River floods.

7.3.11 Mendota Dam Fish Passage Facilities

Boards-Out Conditions

For the Fresno Slough Dam, two sharp crested weirs downstream of Mendota Dam will increase the water surface elevation during low flows around 100 cfs to allow fish passage over the top of sill when the boards are out at Mendota Dam. The weirs are located about 400 feet apart. Each drop structure will raise the water surface about 0.6 feet upstream of the structure.

The weirs could be formed of vinyl or aluminum sheet piles. The sheet piles will be anchored into earthen layers beyond the channel bed for lateral and foundation support. Riprap will be built along the riverbank upstream and downstream of each of the structures to protect the channel from erosion. It is assumed that the revetment will consist of buried riprap covered with topsoil, erosion control fabric, and native vegetation.

Boards-In Conditions

For the Short Canal option on the Fresno Slough Dam, the boards at Mendota Dam would be replaced to backwater the Mendota Pool. A proposed fish ladder enables fish to pass over Mendota Dam when the boards are in. The ladder transitions from a minimum San Joaquin River water surface elevation Reach 3 (occurring during low flow/base flow conditions) to the normal pool water surface elevation above Mendota Dam. Design of the ladder follows the general guidelines in the *Anadromous Salmonid Passage Facility Design* (NMFS 2008). A vertical slot configuration was selected because this configuration has been used successfully to facilitate the upstream migration of salmon and steelhead (NMFS 2008).

The design of the fish ladder is the same as that presented for the Chowchilla Bifurcation Structure retrofit in Section 7.3.1.

7.3.12 Main Canal and Helm Ditch Relocations

The Fresno Slough Dam requires the headworks of the Central California Irrigation District's (CCID) Main Canal and Helm Ditch to be reconfigured to divert water from the upstream (south) side of the Fresno Slough Dam. This will allow the District to continue to receive their water supply from the Delta Mendota Canal and flows from the Fresno Slough without requiring screening of those diversions.

To provide water to the CCID's Main Canal and Helm Ditch, an inlet canal is proposed that will take water from the upstream side of the proposed Fresno Slough Dam, run north adjacent to the west side of the San Joaquin River, and connect to the Main Canal and Helm Ditch just west of their current intakes. This canal will be capable of conveying the full flow of both the Main Canal and the Helm Ditch combined (1550 cfs).

The inlet canal would be designed to pass the design flow at anticipated low water levels in the Pool, but it would still provide 2 feet of freeboard at the anticipated high water level. The water elevation in the inlet canal would essentially float with the Mendota Pool. A bridge over the inlet canal would be required to maintain access to Mowry Bridge and the future Fresno Slough Dam. Currently, there is a 20-inch drinking water pipeline for the City of Mendota that crosses the Mowry Bridge. This pipeline would need to be modified so that it crosses the proposed inlet canal on the proposed bridge.

The inlet canal would be concrete lined in locations where erosion is likely to be a concern (i.e., at bends and transitions), and riprap would be placed at the transition from the Pool to the inlet channel.

A concrete control structure would control the water from the inlet canal. It would function to control flows to both the Main Canal and the Helm Ditch. Controlling the flow to the Main Canal would be accomplished with control gates Upstream of the gates on the eastern wall, a pipeline would deliver water to the relocated head of the Helm Ditch. The concrete pipe, equipped with a canal gate, would serve to control the flow rate as well as shutoff point. It is assumed that existing headworks and telemetry for both the Main Canal and Helm Ditch would be removed from the site, and new telemetry would be installed.

The upstream side of the Main Canal structure would have a cutoff wall to prevent undermining the structure. Downstream of the control structure, the Main Canal would transition both vertically and horizontally into the existing Main Canal alignment and cross-section. The extension of Helm Ditch would be designed to match the cross-section of the existing Helm Ditch downstream.

7.4 Project Options

7.4.1 Bend 10 Revetment or Columbia Canal Relocation

At Bend 10 (approximately RM 209), the channel runs along the right-bank levee, and the Columbia Canal is located adjacent on the north side of the levee. For the Floodplain Initial Alternatives, levee alignments were typically placed with a minimum 300-foot buffer between the channel and the levee. Due to the proximity, the portion of the Columbia Canal along Bend 10 would need to be relocated in order to accommodate the 300-foot buffer. If the Columbia Canal is not relocated and the buffer is not included, the levee will require revetment to protect it from erosion. To examine the range of benefits and impacts, the revetment and the Columbia Canal relocation were both analyzed as project options. Either option can be combined with the Floodplain Initial Alternatives.

The revetment design assumes an average waterside slope of 1.5H to 1V, average riprap thickness of 3 feet, a 6-foot riparian bench, 1-foot of rock slope protection and 7.5 feet of launch rock (the rock placed along the bank below the mean water surface elevation).

Land Acquisition

Approximately 18 acres of additional lands will need to be acquired to accommodate the Columbia Canal relocation. No additional lands are required for the revetment option.

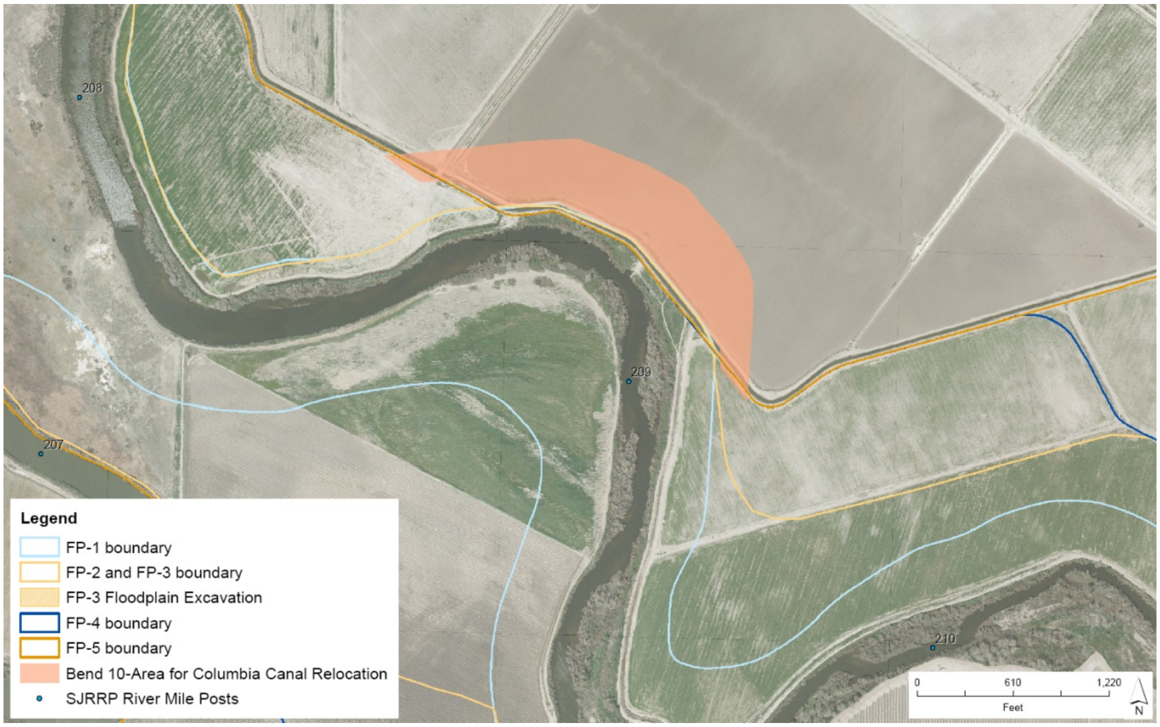


Figure 7-6.
Bend 10 Levee Alignment

Table 7-33.
Bend 10 Options

	Revetment	Columbia Canal Relocation
Revetment/Levee Length	2,752 feet	2,934 feet
Canal Relocations	-	2,500 feet
Pump Relocations	2	2
Land Acquisition	-	18 acres

7.4.2 Water Delivery Canal Options

The Fresno Slough Dam includes three optional canals for delivering up to 2,500 cfs in water deliveries from the San Joaquin River into Mendota Pool: North Canal, South Canal, and Short Canal. The North and South Canal alignments connect to the river at approximately RM 214.2, upstream of San Mateo Avenue, and discharge water to Fresno Slough at locations approximately 1.8 and 2.3 river miles south of Mendota Dam, respectively. The South Canal discharges via the Little San Joaquin Slough. The Short Canal option would be located directly east of the Fresno Slough Dam. Any of the options can be combined with the Fresno Slough Dam.

In addition, the North and South canals could be combined with the Settlement and Compact alignments; in this case the water diversion point would be relocated from the head of the bypass channel to the head of the water delivery canal.

North and South Canals

Water deliveries would be controlled at the upstream ends of the North and South canals by a bifurcation structure of similar design to those used for the Settlement and Compact alignments. The river control structure would have a fish ladder for fish passage, and the canal control structure would have a fish screen to prevent entrainment. The control structures, fish screen, and fish ladders are discussed in Section 7.3.

The North and South canals can be concrete-lined or unlined. The current unlined design assumes maintained grasses. All canals will have a trapezoidal cross-section. The lined North and South canals have a top-width of approximately 88 feet, a total corridor width of approximately 175 feet (including levees and maintenance roads), and 2H to 1V side slopes on the canal and levees. The unlined North and South canals have top-widths of approximately 235 and 270 feet, respectively, total corridor widths of approximately 435 and 490 feet (including levees and maintenance roads), respectively, and 3H to 1V side slopes on the canal and levees.

Levee heights are based on a flow of 2,500 cfs and three feet of freeboard. Seepage control measures and erosion protection would be included as necessary to minimize seepage impacts and reduce erosion and scour in the canal. However, seepage is assumed not be an issue for a lined canal, so seepage control measures would be not provided for the lined canal.

The North and South canals will cross San Mateo Avenue, so bridge crossings are assumed. The costs include a concrete deck, reinforcing steel, piles, and pile extensions, railing, excavation, and backfill; however, design details are yet to be refined.

Current costs are based on the assumptions that suitable earthen fill materials will be available within 1 mile of the levee locations and that some modification to soils will be required to meet permeability requirements. Once the borrow source for the levees is identified, import and hauling costs may be updated.

Short Canal

For the Short Canal, Mendota Dam will function as the river control structure during water deliveries to the Pool, so only the canal control structure will be constructed. Here, Mendota Dam will be equipped with fish passage facilities, and again, the canal control structure will have a fish screen. The control structures, fish screen, and fish ladders are discussed in Section 7.3.

The Short Canal would deliver up to 2,500 cfs in water deliveries from the San Joaquin River to Mendota Pool. The Short Canal would discharge into Fresno Slough approximately 0.8 river miles south of Mendota Dam.

The Short Canal would be concrete-lined with a trapezoidal cross-section. The Short Canal would have a top-width of approximately 70 feet, a total corridor width of approximately 180 feet (including levees and maintenance roads), and 2H to 1V side slopes on the canal banks and 3H to 1V side slopes on the levees. Levee heights would be based on a flow of 2,500 cfs and two feet of freeboard.

Land Acquisition

Approximately 82, 205, 82, 199, and 8 acres of additional lands will need to be acquired to accommodate the North Canal (lined and unlined), South Canal (lined and unlined), and Short Canal, respectively.

Construction Considerations

Construction of the North and South canals will need to be coordinated with construction of the Floodplain Initial Alternatives levees because depending on the alternative, levees may be shared.

Construction of the fish screen and return/bypass fish pipes will take place in the dry using conventional construction methods and must be coordinated with construction of the water delivery canal. The exception to this is the outlet for the fish return pipes, which will require a cofferdam. All fish facility structures and pipes with surfaces exposed to fish require additional attention to surface-smoothness.

For construction of the control structures and fish ladders, a minimum flow must be maintained during construction; the amount or range of flows has not yet been identified. For construction at the bifurcation, it was assumed that construction would first be done away from the fish ladder. A sheet pile cofferdam would be provided for the river control structure and/or the canal control structure and the water diverted away from the construction. Additional sheet piling will be provided to divert flows through the new bifurcation structure while the fish ladder is constructed.

Table 7-34.
Fresno Slough Dam Levees, Relocations, and Land Acquisition

	Left Levee	Right Levee
Levee Length		
North Canal (lined and unlined)	4.0 miles	4.0 miles
South Canal (lined and unlined)	3.3 miles	3.3 miles
Short Canal	0.2 miles	0.2 miles
Average Levee Height		
North Canal (lined)	3.9 feet	3.9 feet
North Canal (unlined)	3.0 feet	3.0 feet
South Canal (lined)	4.3 feet	4.3 feet
South Canal (unlined)	3.1 feet	3.1 feet
Short Canal	6.3 feet	6.3 feet
Fill Volume		
North Canal (lined)	147,800 cubic yards	147,800 cubic yards
North Canal (unlined)	140,700 cubic yards	140,700 cubic yards
South Canal (lined)	154,900 cubic yards	154,900 cubic yards
South Canal (unlined)	109,900 cubic yards	109,900 cubic yards
Short Canal	8,800 cubic yards	8,800 cubic yards

Relocations			
Electrical Distribution	6,300 feet (North Canal) 4,000 feet (South Canal)	Facility	-
Gas Transmission	1,100 feet (North Canal) 500 feet (South Canal)	Groundwater Well	2 (North & South canals)
Water Pipeline	3,800 feet (North Canal) 1,400 feet (South Canal)	Lift Pump	2 (South Canal)
Canal	11,900 feet (North Canal) 4,300 feet (South Canal)	Power Pole	-
Confluence	-	Monitoring Well	-
Culvert	-	Regulating Reservoir	-
Diversion	-	Abandoned Well	-
Barn/Shed	1,200 ft^2 (North Canal) 2,200 ft^2 (South Canal)		

Land Acquisition[1]	
Total	82 acres (North Canal lined), 205 acres (North Canal unlined) 82 acres (South Canal lined), 199 acres(South Canal unlined) 8 acres (Short Canal)

[1] Land acquisition total includes areas that may be State of California sovereign lands or public trust lands.

7.4.3 7,000 cfs Capacity

Floodplain and Bypass Initial Alternatives were designed for conveyance of up to 4,500 cfs in Restoration Flows from Reach 2A downstream to Reach 3 and diversion of up to 2,500 cfs to Mendota Pool. In order to make irrigation deliveries, Restoration Flows over 2,000 cfs may be reduced because the total flow is capped at the 4,500 cfs capacity. The 7,000 cfs capacity option can be included with any of the Final Alternatives.

If the SJRRP wants to convey Restoration Flows up to 4,500 cfs while simultaneously making irrigation deliveries up to 2,500 cfs to the Pool, the capacity in Reach 2B at some locations would need to be increased to 7,000 cfs. This will require modifications to the appraisal-level designs and costs for the levees, structures, and other elements. The total length of the Project that will need to convey 7,000 cfs depends on the Bypass Initial Alternative. For the Settlement Alignment, 8 river miles of the Project would need to handle 7,000 cfs. For the Compact Alignment, it is 10 river miles. For the Fresno Slough Dam with the North or South canal, only 2 river miles would need to handle 7,000 cfs, but for the Fresno Slough Dam with the Short Canal, it is 10.5 river miles.

This page left blank intentionally.

8.0 Initial Alternatives Evaluation Results

Results of the alternatives evaluation can be found summarized in the evaluation matrix and supporting data provided in Attachment B. The evaluation matrix is structured such that evaluation criteria are grouped into factors, factors are grouped into categories, and categories are grouped into perspectives. Each alternative's score is also grouped at these levels so that the interplay between various resource areas and perspectives can be better understood. The discussion in this chapter refers to the various levels of the evaluation, and it is useful to refer to the matrix while reading these sections. A summary of the results of the evaluation is provided in Figure 8-1; higher bars indicate higher scores and more preferable alternatives.

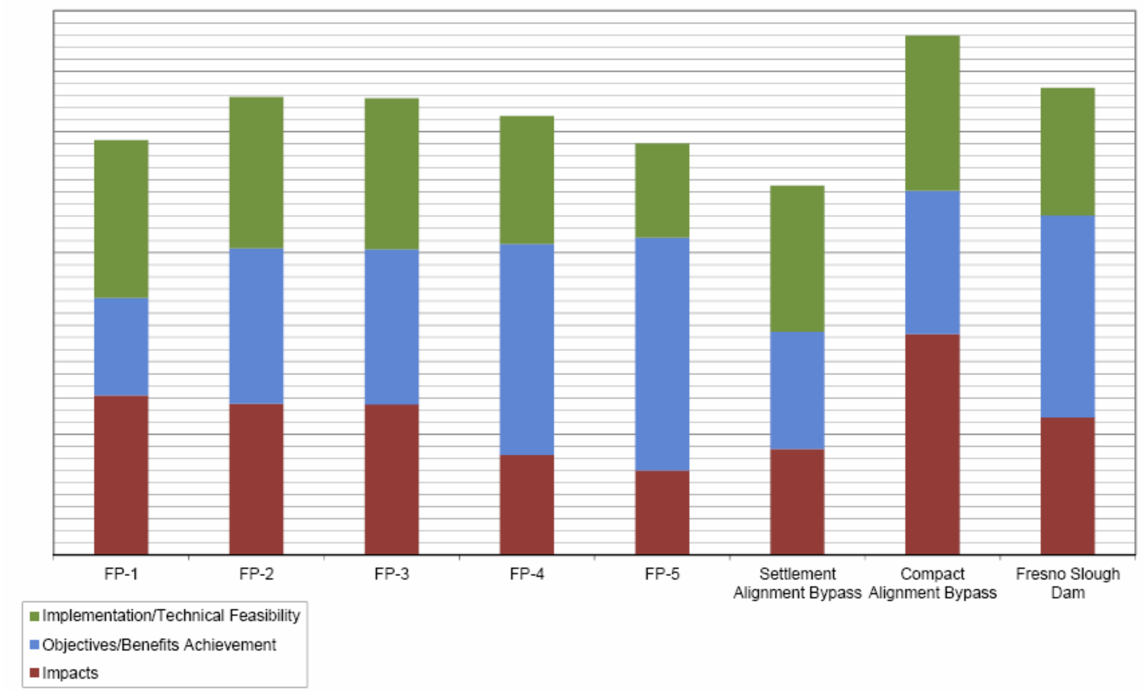


Figure 8-1
Summary of Evaluation Results

8.1 Evaluation by Settlement Goals and Settlement Defined Improvements

The initial guidance used in the development of the Project came from language in the Settlement, specifically the Settlement's goals and the defined improvements. The Settlement goals are:

The Restoration Goal (Settlement Paragraph 2):

> *… a goal of this Settlement is to restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish (the "Restoration Goal").*

The Water Management Goal (Settlement Paragraph 2):

> *…a goal of this Settlement is to reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in this Settlement (the "Water Management Goal").*

The Mendota Pool Bypass and Reach 2B improvements defined in the Settlement are (Settlement Paragraph 11(a)):

> *(1) Creation of a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cfs from Reach 2B downstream to Reach 3. This improvement requires construction of a structure capable of directing flow down the bypass and allowing the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary;*

> *(2) Modifications in channel capacity (incorporating new floodplain and related riparian habitat) to ensure conveyance of at least 4,500 cfs in Reach 2B between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel.*

The Initial Alternatives are designed such that one Floodplain Initial Alternative is paired with one Bypass Initial Alternative to create a complete Project Alternative. All paired combinations of the Initial Alternatives will work towards meeting the Settlement Restoration Goal by providing suitable passage conditions for adult and juvenile salmonids and transient rearing habitat for juvenile salmonids, two key components for supporting a fish population in "good condition" (SJRRP 2010c). The Project has limited to no effect on meeting the Water Management Goal.

All paired combinations of the Initial Alternatives meet the requirements of the project-specific improvements in Settlement Paragraphs 11(a)(1) and 11(a)(2) by:

- Bypassing the Mendota Pool
- Designing for conveyance of at least 4,500 cfs in the Mendota Pool Bypass
- Designing in-channel and levee structures that allow the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary
- Designing for channel and floodplain capacity of at least 4,500 cfs in Reach 2B between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel

- Incorporating new floodplain and related riparian habitat between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel

8.2 Evaluation by Initial Alternative

The sections below discuss the results of the alternatives evaluation for each Initial Alternative.

8.2.1 FP-1

FP-1 has relatively the lowest cost, particularly land costs and restoration costs, and one of the shortest construction timelines. FP-1 provides the least amount of floodplain and the least amount of rearing habitat of all the alternatives. The limited floodplain width results in low acreages of very shallow water habitat and may not provide sufficient levels of productivity. There are no up or downstream fish passage issues associated with this alternative. FP-1 has the least amount of restoration area for vegetation and wildlife and is more likely to have channel stability issues. FP-1 has the most acreage of potential nuisance seepage because the relatively narrower floodplain results in greater water depths and increased hydraulic gradients through the levees. FP-1 requires the least amount of land to be removed from production. FP-1 has relatively slightly more environmental impacts due to proposed levees impacting more existing habitat because they are located nearer the river channel, resulting in a longer overall levee length.

8.2.2 FP-2

FP-2 has relatively moderate costs, particularly capital improvement costs, and one of the shortest construction timelines. FP-2 provides a moderate amount of floodplain habitat resulting in sufficient acres of the very shallow water habitat for primary production as well as sufficient acres of habitat that supporting direct rearing. There are no up or downstream fish passage issues associated with this alternative. FP-2 has relatively moderate amounts of restoration area for vegetation and wildlife and is equally likely to have channel stability issues as not. FP-2 has relatively moderate acreage of potential nuisance seepage. FP-2 requires relatively moderate amounts of land to be removed from production. FP-2 has relatively moderate environmental impacts.

8.2.3 FP-3

FP-3 has relatively moderate costs and one of the shortest construction timelines. FP-3 provides a moderate amount of floodplain habitat resulting in sufficient acres of shallow water habitat for primary production as well as sufficient acres of habitat supporting direct rearing. In addition, grading areas for this alternative increase the amount of floodplain habitat available at lower flows. There are no up or downstream fish passage issues associated with this alternative. FP-3 has relatively moderate amounts of restoration area for vegetation and wildlife and is equally likely to have channel stability issues as not. FP-3 has relatively moderate acreage of potential nuisance seepage. FP-3 requires relatively moderate amounts of land to be removed from production. FP-3 has relatively slightly more environmental impacts due to the grading area impacting existing habitats.

8.2.4 FP-4

FP-4 has relatively somewhat higher costs and somewhat longer construction timelines. FP-4 provides sufficient rearing habitat on the floodplain, but at flows of around 2,000 to 2,500 cfs, there are about equal acres of shallow water habitat and direct rearing habitat, and about half of the shallow water habitat is less than 0.5 feet deep. This results in fair quality shallow water habitat. There are no up or downstream fish passage issues associated with this alternative. FP-4 has relatively greater amounts of restoration area for vegetation and wildlife and is relatively somewhat less likely to have channel stability issues. FP-4 has relatively lower acreage of potential nuisance seepage. FP-4 requires relatively higher amounts of land to be removed from production. FP-4 has relatively moderate environmental impacts.

8.2.5 FP-5

FP-5 has relatively the highest costs and longest construction timelines. FP-5 provides more shallow water habitat than direct rearing habitat at flows of about 2,500 cfs, and about half of the shallow water habitat is less than 0.5 feet deep. There are no up or downstream fish passage issues associated with this alternative. FP-5 has the greatest amounts of restoration area for vegetation and wildlife and is relatively the least likely to have channel stability issues. FP-5 has relatively the least acreage of potential nuisance seepage because the relatively wider floodplain results in lowest water depths and decreased hydraulic gradients through the levees. FP-5 requires relatively the most amount of land to be removed from production. FP-5 has relatively moderate environmental impacts.

8.2.6 Settlement Alignment

Compared to the other Bypass Initial Alternatives, the Settlement Alignment has relatively moderate costs and construction timelines. The Settlement Alignment has relatively fewer fish habitat and passage benefits including minimal additional shallow water or rearing habitat and relatively more structures, steps, and potential predation sites. The Settlement Alignment has the least amounts of restoration area for vegetation and wildlife and is relatively the most likely to have channel stability issues both because it shortens the overall length of the river. The Settlement Alignment requires relatively the most amount of land to be removed from production. The Settlement Alignment has relatively the least environmental impacts.

8.2.7 Compact Alignment

Compared to the other Bypass Initial Alternatives, the Compact Alignment has relatively the lowest costs, particularly land costs, and relatively moderate construction timelines. The Compact Alignment has relatively fewer fish habitat and passage benefits including minimal additional shallow water, a reduction in overall rearing habitat, and relatively more structures, steps, and potential predation sites. The Compact Alignment has relatively moderate amounts of restoration area for vegetation and wildlife and is equally likely to have channel stability issues as not. The Compact Alignment requires relatively the least amount of land to be removed from production. The Compact Alignment has relatively moderate environmental impacts.

8.2.8 Fresno Slough Dam

Compared to the other Bypass Initial Alternatives, the Fresno Slough Dam has relatively the highest costs, particularly capital improvement costs, and relatively longer construction timelines. Fresno Slough Dam has relatively greater fish habitat and passage benefits including additional rearing habitat and relatively fewer structures, steps, and potential predation sites. Fresno Slough Dam has relatively moderate amounts of restoration area for vegetation and wildlife and is least likely to have channel stability issues. Fresno Slough Dam requires relatively moderate amounts of land to be removed from production. Fresno Slough Dam has relatively the most environmental impacts.

8.3 Comparisons of Initial Alternatives

The following sections provide comparative discussions of the Initial Alternatives for selected criteria, the three perspective levels, and overall.

8.3.1 Based on Fish Habitat and Passage Criteria

In the evaluation of Initial Alternatives based on fish habitat and passage, FP-2 and FP-3 score the best and FP-1 scores the worst, but FP-4 and FP-5 score nearly as well as FP-2 and FP-3 (see Table 8-1). This is primarily related to the relative amounts of the shallow water habitat in each Floodplain Initial Alternative. FP-2 and FP-3 have the best ratings for proportion of very shallow water habitat relative to rearing habitat, and FP-1 and FP-5 have the worst ratings. This is because FP-1 has very limited areas shallow water habitat and FP-5 is so wide that a large proportion of the floodplain is very shallow. FP-2 and FP-3 have the same floodplain width, with FP-3 providing some additional inundation at moderate flows from grading the floodplain. FP-4 functions intermediate to FP-2/FP-3, and FP-5 but large areas of shallow water occur at modeled flows of 2,500 cfs. In combination with the extensive shallow water at the inundation Index Flow and the much higher potential for fish stranding, FP-5 does not function for fish as well as FP-2, FP-3, or FP-4. The Floodplain Initial Alternatives perform equivalently under the passage criteria.

For the Bypass Initial Alternatives, Fresno Slough Dam scores the best and the Settlement and Compact alignments score equally and less than the Fresno Slough Dam. Fresno Slough Dam has a number of criteria contributing to its higher score, including: the higher amount of rearing habitat and the fewer number of structures, steps, and potential predation sites. While the Settlement Alignment provides no additional shallow water or rearing habitat, the Compact Alignment lowers the water level upstream thus reducing the quantity of rearing habitat in the Floodplain Initial Alternatives. The Settlement and Compact alignments perform equivalently under the passage criteria.

For the project options, the objectives and benefits achievement criteria do not apply to the Bend 10 options. While the Short Canal scores the best of the water delivery canals for Fresno Slough Dam, and the remaining options score equivalently.

Table 8-1.
Initial Alternative Rankings for Fish Habitat and Passage Criteria

Rank	Floodplain Alternative	Bypass Alternative	Bend 10 Options	Water Delivery Canal Options
1st	FP-2 and FP-3	Fresno Slough Dam	n/a	Short Canal
2nd		Settlement Alignment Compact Alignment		Lined North Canal, Unlined North Canal, Lined South Canal, Unlined South Canal
3rd	FP-4			
4th	FP-5			
5th	FP-1			

8.3.2 Based on Costs

In the evaluation of Initial Alternatives based on costs, three separate cost items (capital improvements, land, and operation and maintenance (O&M) costs) were analyzed. For the Floodplain Initial Alternatives, FP-1, FP-2, and FP-3 score similarly well in all three costs criteria (see Table 8-2). FP-2 has the lowest capital improvement costs, FP-1 the lowest land and O&M costs. FP-5 costs are highest of the Floodplain Initial Alternatives for all three costs criteria. This is strongly influenced by the amount of restoration area in each Floodplain Initial Alternative and the cost of planting. FP-4 and FP-5 are the cheapest to construct infrastructure-wise, but the revegetation costs out-weigh this and result in higher overall costs. Likewise, FP-1 is the most expensive to construct infrastructure-wise, but it has the least revegetation costs and results in a cheaper overall alternative.

For the Bypass Initial Alternatives, the Settlement Alignment has the lowest capital improvement costs, while the Compact Alignment's capital improvement costs are similar but slightly more. The Compact Alignment has the lowest land costs, and the Settlement Alignment has the lowest O&M costs.

For the project options, the Bend 10 levee revetment is significantly more expensive than the Columbia Canal Relocation. The Short Canal is the least expensive water delivery canal option for the Fresno Slough Dam. If an alternative diversion point for the Settlement or Compact alignments is desired, then lined South Canal would be the least expensive option.

Table 8-2.
Initial Alternative Rankings for Costs Criteria

Rank	Floodplain Alternative	Bypass Alternative	Bend 10 Options	Water Delivery Canal Options
1st	FP-1	Compact Alignment	Levee Revetment	Short Canal
2nd	FP-2 and FP-3	Settlement Alignment	Columbia Canal Relocation	Lined South Canal
3rd		Fresno Slough Dam		Lined North Canal
4th	FP-4			Unlined South Canal
5th	FP-5			Unlined North Canal

8.3.3 Based on Implementation/Technical Feasibility Perspective

The evaluation of the Initial Alternatives at the implementation and technical feasibility perspective is similar to the discussion in Section 8.3.2 for costs with the addition of construction timeline being considered.

For the Floodplain Initial Alternatives, FP-1 scores the best and FP-5 scores the worst at this perspective level, but FP-2 and FP-3 score nearly as well as FP-1 (see Table 8-3). This is strongly influenced by the amount of restoration area in each Floodplain Initial Alternative and the cost of planting. FP-4 and FP-5 are the cheapest to construct infrastructure-wise, but the revegetation costs out-weigh this and result in higher overall costs. Conversely, FP-1 is the most expensive to construct infrastructure-wise, but it has the least revegetation costs and results in a cheaper overall alternative.

For the Bypass Initial Alternatives, the Compact Alignment scores the best and Fresno Slough Dam scores the worst. For the project options, the Bend 10 levee revetment scores the better, and the Short Canal scores the best of the water delivery canals for Fresno Slough Dam. If an alternative diversion point for the Settlement or Compact alignments is desired, then the lined South Canal scores the best of the available options.

Table 8-3.
Initial Alternative Rankings for Implementation/Technical Feasibility Perspective

Rank	Floodplain Alternative	Bypass Alternative	Bend 10 Options	Water Delivery Canal Options
1st	FP-1	Compact Alignment	Levee Revetment	Short Canal
2nd	FP-2 and FP-3	Settlement Alignment	Columbia Canal Relocation	Lined South Canal
3rd		Fresno Slough Dam		Lined North Canal
4th	FP-4			Unlined South Canal
5th	FP-5			Unlined North Canal

8.3.4 Based on Objectives/Benefits Achievement Perspective

Under the evaluation of the Initial Alternatives at the objectives and benefits achievement perspective for the Floodplain Initial Alternatives, FP-5 scores the best and FP-1 scores the worst, but FP-4 scores nearly as well as FP-5 (see Table 8-4). This is primarily related to the amount of restoration area (vegetation and wildlife) in each Floodplain Initial Alternative. FP-4 and FP-5 have the most restoration area thus providing the most overall benefits. Conversely, FP-1 has the least restoration area and thus provides the least overall benefits. Additionally, the wider floodplain with FP-4 and FP-5 significantly reduces the risk of channel instability thus contributing to the benefits of these Initial Alternatives, while FP-1 is more likely to have channel stability issues, which reduces the relative benefits.

For the Bypass Initial Alternatives, Fresno Slough Dam scores the best and the Settlement Alignment scores the worst. This is primarily related to the amount of restoration area and the length of the river channel. The restoration area for the Settlement Alignment is limited to the bypass channel corridor, which also shortens the river's length, so it has relatively smaller restoration area and less benefits. While Fresno Slough Dam has the longest river length and incorporates floodplain habitat along that length, providing more restoration area and greater benefits.

For the project options, the objectives and benefits achievement criteria do not apply to the Bend 10 options. While the Short Canal scores the best of the water delivery canals for Fresno Slough Dam, and the remaining options score equivalently.

Table 8-4.
Initial Alternative Rankings for Objectives/Benefits Achievement Perspective

Rank	Floodplain Alternative	Bypass Alternative	Bend 10 Options	Water Delivery Canal Options
1st	FP-5	Fresno Slough Dam	n/a	Short Canal
2nd	FP-4	Compact Alignment		Lined North Canal, Unlined North Canal, Lined South Canal, Unlined South Canal
3rd	FP-2 and FP-3	Settlement Alignment		
4th				
5th	FP-1			

8.3.5 Based on Impacts Perspective

Under the evaluation of the Initial Alternatives at the impacts perspective for the Floodplain Initial Alternatives, FP-1 scores the best and FP-5 scores the worst, but FP-2 and FP-3 score nearly as well as FP-1 (see Table 8-5). This is primarily related to the amount of land required by each Floodplain Initial Alternative. FP-5 has the largest area and takes the most land of the Initial Alternatives thus causing the largest impact to agriculture and land use. Conversely, FP-1 has the smallest area, takes the least amount of land of the Initial Alternatives, and causes less impact to agriculture.

For the Bypass Initial Alternatives, the Compact Alignment scores the best and the Settlement Alignment scores the worst. This is primarily related to the amount of land required by each Bypass Initial Alternative. The Settlement Alignment results in additional land outside the bypass channel corridor being inaccessible or unusable for agricultural purposes, so it has the largest land acquisition area and takes the most land of the Initial Alternatives thus causing more impacts to agriculture and land use. Conversely, the Compact Alignment has the smallest area, takes the least amount of land of the Initial Alternatives, and causes less impact to agriculture.

For the project options, the Bend 10 levee revetment scores the better because it does not require additional land. The Short Canal scores the best of the water delivery canals for Fresno Slough Dam. If an alternative diversion point for the Settlement or Compact alignments is desired, then the lined South Canal scores the best of the available options.

Table 8-5.
Initial Alternative Rankings for Impacts Perspective

Rank	Floodplain Alternative	Bypass Alternative	Bend 10 Options	Water Delivery Canal Options
1st	FP-1	Compact Alignment	Levee Revetment	Short Canal
2nd	FP-2 and FP-3	Fresno Slough Dam	Columbia Canal Relocation	Lined South Canal
3rd		Settlement Alignment		Lined North Canal
4th	FP-4			Unlined North Canal
5th	FP-5			Unlined South Canal

8.3.6 Based on All Criteria

Comparisons of the Initial Alternatives based on all the criteria can be viewed by looking at the total score at each of the four evaluation levels (criteria, factor, category, and perspective). Essentially, the perspectives have equal weight in the total or overall score at the perspective level, the categories have equal weight in the total or overall score at the category level, the factors have equal weight in the total or overall score at the factor level, and the criteria have equal weight in the total or overall score at the criteria level.

FP-2, FP-3, and FP-4 rank at the top at the factor, category, and perspective levels, and FP-1 consistently ranks at or near the bottom. FP-5 ranks at or near the bottom at all but the criteria level, where it ranks first. The Compact Alignment, Fresno Slough Dam, and the Settlement Alignment consistently rank first, second, and third, respectively. Table 8-6 shows the resulting rankings of the Initial Alternatives according to their total scores.

Table 8-6.
Overall Initial Alternative Rankings

	Perspective Level		Category Level	
Rank	**Floodplain Alternative**	**Bypass Alternative**	**Floodplain Alternative**	**Bypass Alternative**
1st	FP-2	Compact Alignment	FP-2	Compact Alignment
2nd	FP-3	Fresno Slough Dam	FP-3	Fresno Slough Dam
3rd	FP-4	Settlement Alignment	FP-4	Settlement Alignment
4th	FP-1		FP-1	
5th	FP-5		FP-5	
	Factor Level		**Criteria Level**	
Rank	**Floodplain Alternative**	**Bypass Alternative**	**Floodplain Alternative**	**Bypass Alternative**
1st	FP-2	Compact Alignment	FP-5	Compact Alignment
2nd	FP-3	Fresno Slough Dam	FP-4	Fresno Slough Dam
3rd	FP-4	Settlement Alignment	FP-2	Settlement Alignment
4th	FP-5		FP-3	
5th	FP-1		FP-1	

8.4 Recommended Alternatives for Inclusion in the EIS/R Project Description

Two Floodplain Initial Alternatives and two Bypass Initial Alternatives are recommended for inclusion in the Project Description based on their comparatively better performance in the alternatives evaluation. The recommended alternatives are FP-2, FP-4, Compact Alignment, and Fresno Slough Dam.

8.4.1 Alternatives Eliminated

Three Initial Alternatives are recommended for elimination from consideration based on the evaluation results: FP-1, FP-5, and the Settlement Alignment. These Initial Alternatives are recommended for elimination because they perform relatively poorly when compared to the other Initial Alternatives, or they provide no additional comprehensive benefit with increased cost. The remaining Initial Alternatives (FP-2, FP-3, FP-4, Compact Alignment, and Fresno Slough Dam) provide a better balance between benefits and impacts.

FP-1 would result in a confined channel system with high velocities and scour along the corridor requiring expensive bank revetment. Vegetation could be difficult to establish, and water depths would often be too deep to provide effective floodplain rearing and primary production benefits. Based on the results of the evaluation, FP-1 performs poorly for several reasons:

- Relatively low amounts of rearing habitat
- Poor quality shallow water habitat
- Relatively high capital improvement costs
- Relatively low amounts of restoration area
- Relatively greater risk of channel instability
- Relatively larger nuisance seepage impacts

FP-5 would result in large areas too shallow and dry to provide effective floodplain rearing and primary production benefits. Based on the results of the evaluation, FP-5 performs poorly for several reasons:

- Poor quality shallow water habitat
- Relatively high restoration and land costs
- Relatively greater land removed from production
- Limited additional fish habitat and passage benefits for the added costs
- Potential for fish strandings

The Settlement Alignment provides less habitat than the Compact Alignment but with higher costs and larger land requirements. Based on the results of the evaluation, the Settlement Alignment performs poorly for several reasons:

- Minimal additional shallow water or rearing habitat
- Relatively high capital improvement costs
- Relatively less restoration area
- Relatively greater risk of channel instability
- Relatively greater land removed from production

In addition, for design and river geometry reasons, a fish barrier at the downstream end of the Settlement Alignment would not be able to meet NMFS criteria.

One option is recommended for elimination from consideration based on the evaluation results: Bend 10 Columbia Canal Relocation. This option is recommended for elimination because it performs relatively poorly when compared to the Bend 10 levee revetment, which provides a better balance between benefits and impacts.

Based on the results of the evaluation, the Bend 10 Columbia Canal Relocation option performs poorly for several reasons:

- Additional land acquisition is required
- More land removed from production
- Relatively greater environmental impacts

8.4.2 Alternatives Modified to Reduce Impacts

No specific modifications to reduce impacts are recommended at this time but in general, reduction of impacts was a consideration in the concept refinement phase (development of Initial Alternatives). Mitigation measures for avoiding, reducing, compensating for, or minimizing impacts may be developed during the Project EIR/S environmental impact assessments.

8.5 Recommended Additional Analysis or Study

The items listed below are recommended additional analysis or study of the designs that may be completed if necessary to inform the Project EIS/R assessments.

- Selective removal of levees may be refined during the Project EIS/R development to further refine avoidance of existing vegetation and habitat.
- Based on input from the TAC regarding the frequency and magnitude of future hydrology in the San Joaquin River system, the quantity and location of floodplain grading may be refined during the Project EIS/R development as an avoidance measure for existing vegetation and habitat and to increase the frequency and acreage of floodplain inundation. However, this must be balanced with the geomorphic analysis concerning channel stability and sediment transport.
- Analysis and design of other types of fish ladders or fish ways may be completed to better understand the flows, velocities, depths, and hydraulic jump heights associated with various flow split and delivery operations and whether passage can be further improved and potential predation sites can be reduced.
- Analysis and design of other types of fish screens may be completed with the goal of reducing stress on juvenile salmonids, increasing successful downstream migration, or reducing potential predation sites.

9.0 Acknowledgments

The preparers would like to acknowledge the input and participation of Bureau of Reclamation and other SJRRP staff, third-party consultants, resource agency staff, and others. A partial list of these participants includes:

Michelle Banonis	Reclamation
Lisa Fotherby	Reclamation
Alicia Gasdick	Reclamation
Elaina Gordon	Reclamation
Blair Greimann	Reclamation
Katrina Harrison	Reclamation
Jeremy Lorberau	Reclamation
David Mooney	Reclamation
Erin Rice	Reclamation
Karen Dulik	DWR
David Encinas	DWR
Greg Farley	DWR
Alexis Phillips-Dowell	DWR
Paul Romero	DWR
Susan Cundiff	Tetra Tech
Chad Morris	Tetra Tech
Bob Mussetter	Tetra Tech
Nick Hindman	USFWS
Zac Jackson	USFWS
Becky Lorig	USFWS
Carl Mesick	USFWS
Donnie Ratcliff	USFWS
Stephanie Rickabaugh	USFWS
Michelle Workman	USFWS
Larry Brown	USGS
Steven Phillips	USGS
George Heise	CDFG
Dale Stanton	CDFG
Leslie Mirise	NMFS
Erin Strange	NMFS
Steve Thomas	NMFS

This page left blank intentionally.

10.0 References

Barbour 2007. Barbour, M.G., T. Keeler-Wolf, and A. Schoenherr. *Terrestrial Vegetation of California*. Third Edition.

Byrd 2009. Byrd, B. F., S. Wee, and J. Costello, Far Western Anthropological Research Group, Inc., Davis, California. *Cultural Resources Sensitivity Study and Research Design for the San Joaquin River Restoration Program, Fresno, Madera, Merced, and Stanislaus Counties, California*. Prepared for U.S. Bureau of Reclamation, Sacramento, California.

CDFG 1998. California Department of Fish and Game. *California Salmonid Stream Habitat Restoration Manual, Third Edition.* January.

CDFG 2009. California Department of Fish and Game, Biogeographic Data Branch Vegetation Classification and Mapping Program. *List of California Vegetation Alliances*. December.

CDFG 2010. California Department of Fish and Game. *Special Animals* (List). Biogeographic Data Branch: California Natural Diversity Database. Updated July 2009. Available from web site, http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/SPAnimals.pdf.

Crain 2004. Crain, P.K., K. Whitener, and P.B. Moyle. *Use of a Restored Central California Floodplain by Larvae of Native and Alien Fishes*. American Fisheries Society Symposium.

CVFED 2009. Central Valley Floodplain Evaluation and Delineation and San Joaquin River Restoration Program LiDAR data and aerial imagery. Produced for California Department of Water Resources. April 9.

ESRP 2006. Endangered Species Recovery Program, California State University, Stanislaus, Fresno, California. *Valley Elderberry Longhorn Beetle Surveys, San Joaquin River, 2004-2005*. November 6.

Houk 2009. Randy Houk. Personal communication with Susan Hootkins and Duane Paul, ENTRIX. December 9.

Jeffres 2008. Jeffres, Carson A., J.J. Opperman and P. B. Moyle. Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California River. *Environmental Biology of Fishes*. Vol. 83, No. 4. Pages 449-458.

NMFS 2001. National Marine Fisheries Service, Southwest Region. *Guidelines for Salmonid Passage at Stream Crossings*. September.

NMFS 2008. National Marine Fisheries Service, Northwest Region. *Anadromous Salmonid Passage Facility Design*. February. Retrieved from: http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/Fish_Passage_Design.pdf

Opperman, 2010. Opperman, J.J., R. Luster, B.A. McKenney, M. Roberts, and A.W. Meadows. Ecological functional floodplains: connectivity, flow regime, and scale. *Journal of the American Water Resources Association.* April.

Pacific States Marine Fisheries Commission 2007. CalFish Passage Assessment Database. Downloaded from www.calfish.org.

Reclamation 1967. United States Department of the Interior, Bureau of Reclamation, Central Valley Project, California, Second Amended Contract for Exchange of Waters. Contract I1r-1144, Second Amendatory. September 15, 1967, revised December 6.

Reclamation 2006. U.S. Bureau of Reclamation. *Water Resources Technical Publication, Fish Protection at Water Diversions, a Guide for Planning and Designing Fish Exclusion Facilities*. April.

Reclamation Board 1969. Lower San Joaquin River Flood Control Project, *Operation and Maintenance Manual for San Joaquin River and Chowchilla Canal Bypass Automatic Control Structures and Appurtenances*, Part III.

SJRRP 2008. San Joaquin River Restoration Program. *Draft Technical Memorandum, Operation Guidelines for Implementing Restoration Flows*. April.

SJRRP 2010a. San Joaquin River Restoration Program. *Draft Daily Flow Time Series*. June 16.

SJRRP 2010b. San Joaquin River Restoration Program. *Draft Mendota Pool Bypass and Reach 2B Improvements Project Technical Memorandum on Environmental Field Survey Results.* November.

SJRRP 2010c. San Joaquin River Restoration Program. *Fisheries Management Plan: A Framework for Adaptive Management in the San Joaquin River Restoration Program*. November.

SJRRP 2010d. San Joaquin River Restoration Program. *Mendota Pool Bypass and Reach 2B Improvements Project Public Scoping Report*. February.

SJRRP 2010e. San Joaquin River Restoration Program. *Mendota Pool Bypass and Reach 2B Improvements Project Technical Memorandum on Initial Options*. April.

SJRRP 2010f. San Joaquin River Restoration Program. *Mendota Pool Bypass and Reach 2B Improvements Project Technical Memorandum on Selection and Use of Analytical Tools*. October.

SJRRP 2011a. San Joaquin River Restoration Program. *Draft San Joaquin River Restoration Program PEIS/R*. April.

SJRRP 2011b. San Joaquin River Restoration Program. *Draft Seepage Management Plan.* March 28.

Tetra Tech 2011a. Tetra Tech d.b.a. Mussetter Engineering, Inc. *Draft Potential Effects of Eliminating the Mendota Bypass Channel Grade-Control Structures and Mendota Dam*. Prepared for California Department of Water Resources. March 29.

Tetra Tech 2011b. Tetra Tech d.b.a. Mussetter Engineering, Inc. *Geomorphic Analysis for the San Joaquin River Reach 2B Alternative Evaluation*. Prepared for California Department of Water Resources. January 26.

USACE 2000. U.S. Army Corps of Engineers (USACE). *Engineer Manual 1110-2-1313 Design and Construction of Levees*. April 30.

USFWS 1996. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Service Office, Sacramento, California. *Programmatic Formal Endangered Species Act Consultation on Issuance of 404 Permits for Projects with Relatively Small Effects on Listed Vernal Pool Crustaceans Within the Jurisdiction of the Sacramento Field Office, California*. February 28.

USFWS 2005. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Service Office, Sacramento, California. *Programmatic Biological Opinion on the Effects of Small Highway Projects on the Threatened Giant Garter Snake in Butte, Colusa, Glenn, Sacramento, San Joaquin, Solano, Sutter, Yolo, Yuba Counties, California*. January 24.

USFWS 2010. U.S. Fish and Wildlife Service. *Best Management Practices for Pacific Lamprey*. April.

Williams 2009. Williams, P.B., E. Andrews, J.J. Opperman, S. Bozkurt, and P.B. Moyle. Quantifying activated floodplains on a lowland regulated river: its application to floodplain restoration in the Sacramento Valley. *San Francisco Estuary & Watershed Science*. September.

This page left blank intentionally.

Mendota Pool Bypass and Reach 2B Improvements Project

Project Description Technical Memorandum
Attachment B – Evaluation Matrix

SAN JOAQUIN RIVER
RESTORATION PROGRAM

October 2012

Perspective	Categories	Factors	Criteria	Units of Measure	P or N*	FP-1	FP-2	FP-3	FP-4	FP-5	Settlement Alignment Bypass	Compact Alignment Bypass	Fresno Slough Dam
						Initial Alternatives							
						Floodplain Initial Alternatives					Mendota Pool Bypass Initial Alternatives		
A.	Implementation/Technical Feasibility												
	Costs	Upfront Costs	Capital Improvement Costs	dollars	N	$194,430,000	$192,480,000	$194,780,000	$218,110,000	$266,900,000	$225,370,000	$234,970,000	$375,990,000
			Land Costs	dollars	N	$15,300,000	$19,800,000	$19,800,000	$27,300,000	$36,300,000	$13,000,000	$7,000,000	$8,890,000
			Subtotal	dollars	N	$209,730,000	$212,280,000	$214,580,000	$245,410,000	$303,200,000	$238,370,000	$241,970,000	$384,880,000
		Long-Term Costs	O&M	dollars/year	N	$606,000	$646,000	$646,000	$721,000	$846,000	$500,000	$540,000	$666,000
	Time to Build	Timeline	Time until action is functional	months	N	40	40	40	45	52	59	59	65
B.	Objectives/Benefits Achievement												
	Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	rating: 1 (poor), 3 (good)	P	1	3	3	2	1	1	1	1
			Rearing habitat (>1.0 feet inundation at 2,500 cfs)	acres	P	373	482	481	585	762	58	-91	39
		Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	number of structures	N	2	2	2	2	2	10	10	4
			Total number of steps at structures	number of jumps	N	12	12	12	12	12	21	21	16
		Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	number of screens	N	1	1	1	1	1	1	1	1
			Potential predation sites at structures	number of artificial structures	N	3	3	3	3	3	11	11	5
	Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	acres of hydric soils	P	451.3	518.3	518.3	751.6	980.4	55.6	97.8	101.8
			Sensitive vegetation alliance extent	acres	P	817.0	1208.1	1208.7	1752.2	2432.5	141.5	218.0	251.2
			Button willow thickets	acres	P	36.8	70.9	43.0	167.2	240.4	0.0	0.0	0.0
			California bulrush marsh	acres	P	46.9	72.2	72.2	72.2	76.5	0.0	68.5	0.0
			California mugwort brush	acres	P	96.4	117.8	114.5	163.0	201.3	18.5	18.0	16.2
			Creeping rye grass turfs	acres	P	49.3	46.6	47.1	97.6	182.4	20.0	19.1	27.8
			Riparian banks forbes and herbs	acres	P	89.5	90.9	117.1	89.0	86.4	61.1	42.4	41.4
			Salt grass flats	acres	P	148.0	248.4	218.8	483.3	578.0	15.2	23.2	50.5
			Fremont cottonwood forest	acres	P	14.6	38.9	38.6	51.1	198.9	0.0	0.0	0.0
			Oregon ash groves	acres	P	35.7	67.2	61.8	63.5	118.3	0.0	0.0	0.0
			Sandbar willow thickets	acres	P	124.9	261.9	277.0	318.7	423.8	13.7	1.0	23.1
			Black willow thickets	acres	P	97.9	114.5	140.8	169.1	249.1	13.0	16.8	72.0
			Exist. sensitive vegetation alliance preservation	acres	P	76.9	78.7	77.6	77.5	77.3	0.0	15.7	20.3
		Wildlife	Wildlife habitat extent	acres	P	740.1	1129.4	1131.1	1674.7	2355.2	141.5	202.1	230.9
			Freshwater emergent wetland	acres	P	136.4	163.2	189.4	161.2	163.0	61.1	110.8	41.4
			Riparian scrub	acres	P	133.2	188.7	298.4	330.1	446.1	18.5	18.0	16.2
			Valley foothill riparian	acres	P	50.3	106.1	100.4	114.6	326.5	0.0	0.0	0.0
			Wet herbaceous	acres	P	197.4	295.1	265.9	580.9	746.7	35.2	43.9	78.3
			Willow scrub	acres	P	222.8	376.4	277.0	487.9	672.9	26.7	17.6	95.1
			Special-status species habitat extent	acres	P	581.4	859.4	821.6	1437.6	1982.9	131.5	210.4	197.9
			Greater sandhill crane	acres	P	333.8	458.2	455.3	742.1	909.7	96.3	162.0	119.6
			Swainson's hawk	acres	P	247.6	401.2	366.3	695.5	1073.2	35.2	43.9	78.3
			Net change in wildland extent	acres	P	395.6	756.3	756.9	1299.9	1979.0	188.1	155.9	72.6
	Geomorphology	Channel Stability	Potential for lateral migration to impact levees (estimated erosion protection cost)	dollars	N	$1,935,000	$1,123,000	$1,123,000	$315,000	$130,000	$8,455,000	$7,824,000	$2,306,000
C.	Impacts												
	Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	acres	N	490	330	330	300	230	0	0	0
			Acres of land in which groundwater levels rise above 7-foot monitoring threshold	acres	N	580	390	390	360	320	0	0	0
	Socioeconomics and Economics	Crop Acreage	Total Farmland Removed from Production	acres	N	400.5	658.7	658.7	1,159.2	1,797.1	717.8	158.3	389.1
			Alfalfa	acres	N	0.0	0.0	0.0	0.0	0.0	190.2	41.2	68.7
			Almond	acres	N	213.0	340.4	340.4	544.7	982.0	250.3	24.7	81.9
			Grapes	acres	N	64.6	76.1	76.1	169.6	287.8	0.0	0.0	83.5
			Other Row Crop	acres	N	0.0	0.0	0.0	0.0	0.0	277.3	92.4	167.5
			Palm	acres	N	9.7	9.7	9.7	9.7	9.7	0.0	0.0	0.0
			Pistachio	acres	N	113.3	232.5	232.5	435.2	517.6	0.0	0.0	5.4
		Agricultural Economic Impacts	Reduction in annual agricultural production values	dollars	N	$2,339,259	$3,630,735	$3,630,735	$6,084,658	$8,988,212	$1,528,896	$265,460	$1,023,146
	Environmental	Special Status Vegetation	Wetland Impacts	acres	N	66.4	64.6	66.8	62.9	64.2	15.5	24.2	30.4
			Freshwater Emergent Wetland	acres	N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6
			Freshwater Forested/Shrub Wetland	acres	N	41.3	40.4	40.6	40.1	40.2	11.8	9.4	10.0
			Riverine	acres	N	25.1	24.1	26.2	22.8	24.0	3.7	14.9	12.8
			Sensitive Vegetation Alliance Direct Impacts	acres	N	48.0	48.2	50.0	48.6	49.3	9.7	22.8	22.4
			Alkali heath marsh	acres	N	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4
			Arrow weed thickets	acres	N	0.1	0.2	0.2	0.2	0.2	0.0	0.0	0.1
			Black willow thickets	acres	N	19.9	18.5	19.1	18.1	18.0	0.7	11.6	8.9
			Blue elderberry stands	acres	N	16.3	16.4	16.6	16.3	16.3	0.0	0.0	0.3
			Button willow thickets	acres	N	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.3
			California bulrush marsh	acres	N	0.5	0.6	0.6	1.0	0.9	0.2	0.2	3.7
			California rose briar patches	acres	N	4.4	4.4	4.6	4.4	4.4	0.0	1.0	2.5
			Creeping rye grass turfs	acres	N	0.2	0.0	0.0	0.0	0.1	0.0	0.6	0.7
			Fremont cottonwood forest	acres	N	3.6	3.0	3.1	3.8	4.2	8.8	8.9	4.6
			Oregon ash groves	acres	N	0.9	0.9	1.5	0.8	0.8	0.0	0.1	0.1
			Pale spike rush marshes	acres	N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
			Salt grass flats	acres	N	0.9	0.9	0.9	0.9	0.9	0.0	0.0	0.3
			Silver bush lupine scrub	acres	N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Spinescale scrub	acres	N	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
			Tar plant fields	acres	N	1.0	3.1	3.1	2.9	3.2	0.0	0.2	0.7
			Yerba mansa meadows	acres	N	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
		Special Status Wildlife	Special status wildlife habitat impacts	acres	N	211.1	192.1	194.7	189.7	190.4	186.9	156.9	220.0
			Blunt-nosed leopard lizard	acres	N	11.5	11.1	11.1	10.9	11.3	0.0	0.0	0.0
			Fairy shrimp	acres	N	2.3	2.3	2.3	2.3	2.3	0.0	0.0	0.0
			Fresno kangaroo rat	acres	N	11.5	11.1	11.1	10.9	11.3	0.0	0.0	0.0
			Giant garter snake	acres	N	35.0	37.2	39.1	38.9	39.8	3.4	18.3	44.9
			Greater sandhill crane	acres	N	56.0	52.2	52.2	48.4	46.1	120.9	101.3	127.0
			San Joaquin kit fox	acres	N	30.4	24.1	24.1	24.2	24.6	0.0	0.0	12.4
			Swainson's hawk	acres	N	48.0	37.7	38.2	37.9	38.6	62.6	37.4	35.4
			Valley elderberry longhorn beetle	acres	N	16.3	16.4	16.6	16.3	16.3	0.0	0.0	0.3
			Valley elderberry longhorn beetle	number of elderberry shrubs	N	270	273	285	270	271	0	0	15
		Cultural and Historical Resources	Historic Properties Potentially Effected	number of listed properties	N	3	3	3	3	3	0	1	2
			Buried Deposits Sensitivity	ranking: 1 (very low)-5 (very high)	N	4	4	4	4	4	1	4	4

Initial Alternatives

Floodplain Initial Alternatives

Perspective	Categories	Factors	Criteria	P or N[1]	FP-1				FP-2				FP-3			
					Criteria Level	Factor Level	Category Level	Perspective Level	Criteria Level	Factor Level	Category Level	Perspective Level	Criteria Level	Factor Level	Category Level	Perspective Level
A.	Implementation/Technical Feasibility															
	Costs	Upfront Costs	Capital Improvement Costs	N	med	med	med	med	med	med	med	med	med	med	med	med
			Land Costs	N	med				med				med			
		Long-Term Costs	O&M	N	med	med			med	med			med	med		
	Time to Build	Timeline	Time until action is functional	N	med	med	med		med	med	med		med	med	med	
B.	Objectives/Benefits Achievement															
	Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	P	low	low	low	low	high	med	med	med	high	med	med	med
			Rearing habitat (>1.0 feet inundation at 2,500 cfs)	P	med				med				med			
		Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	N	low	low			low	low			low	low		
			Total number of steps at structures	N	low				low				low			
		Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	N	low	low			low	low			low	low		
			Potential predation sites at structures	N	low				low				low			
	Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	P	med	med	med		med	med	med		med	med	med	
			Sensitive vegetation alliance extent	P	low				high				med			
		Wildlife	Wildlife habitat extent	P	med	med			med	med			med	med		
			Special-status species habitat extent	P	med				med				med			
			Net change in wildland extent	P	med				med				med			
	Geomorphology	Channel Stability	Potential for lateral migration to impact levees (estimated erosion protection cost)	N	low	low	low		med	med	med		med	med	med	
C.	Impacts															
	Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	N	low	low	low	med	med	med	med	med	med	med	med	med
			Acres of land in which groundwater levels rise above 7-foot monitoring threshold	N	low				med				med			
	Land Use	Crop Acreage	Total Farmland Removed from Production	N	med	med	med		med	med	med		med	med	med	
	Socioeconomics and Economics	Agricultural Economic Impacts	Change in annual agricultural production values	N	med	med	med		med	med	med		med	med	med	
	Environmental	Special Status Vegetation	Wetland Impacts	N	low	med	low		med	med	med		low	low	low	
			Sensitive Vegetation Alliance Direct Impacts	N	med				med				low			
		Special Status Wildlife	Special status wildlife habitat impacts	N	low	low			med	med			med	med		
		Cultural and Historical Resources	Historic Properties Potentially Effected	N	low	low			low	low			low	low		
			Buried Deposits Sensitivity	N	low				low				low			
TOTAL[2]					**low**	**low**	**med**	**low**	**med**	**med**	**high**	**med**	**med**	**med**	**high**	**med**

Perspective	Categories	Factors	Criteria	P or N[1]	FP-4				FP-5			
					Criteria Level	Factor Level	Category Level	Perspective Level	Criteria Level	Factor Level	Category Level	Perspective Level
A.	Implementation/Technical Feasibility											
	Costs	Upfront Costs	Capital Improvement Costs	N	med	med	med	med	low	low	low	low
			Land Costs	N	low				low			
		Long-Term Costs	O&M	N	med	med			low	low		
	Time to Build	Timeline	Time until action is functional	N	low	low	low		low	low	low	
B.	Objectives/Benefits Achievement											
	Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	P	med	med	med	high	low	med	med	high
			Rearing habitat (>1.0 feet inundation at 2,500 cfs)	P	med				high			
		Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	N	low	low			low	low		
			Total number of steps at structures	N	low				low			
		Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	N	low	low			low	low		
			Potential predation sites at structures	N	low				low			
	Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	P	high	high	high		high	high	high	
			Sensitive vegetation alliance extent	P	med				med			
		Wildlife	Wildlife habitat extent	P	high	high			high	high		
			Special-status species habitat extent	P	high				high			
			Net change in wildland extent	P	high				high			
	Geomorphology	Channel Stability	Potential for lateral migration to impact levees (estimated erosion protection cost)	N	high	high	high		high	high	high	
C.	Impacts											
	Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	N	med	med	med	low	high	med	med	low
			Acres of land in which groundwater levels rise above 7-foot monitoring threshold	N	med				med			
	Land Use	Crop Acreage	Total Farmland Removed from Production	N	low	low	low		low	low	low	
	Socioeconomics and Economics	Agricultural Economic Impacts	Change in annual agricultural production values	N	low	low	low		low	low	low	
	Environmental	Special Status Vegetation	Wetland Impacts	N	high	high	med		med	med	med	
			Sensitive Vegetation Alliance Direct Impacts	N	med				med			
		Special Status Wildlife	Special status wildlife habitat impacts	N	med	med			med	med		
		Cultural and Historical Resources	Historic Properties Potentially Effected	N	low	low			low	low		
			Buried Deposits Sensitivity	N	low				low			
TOTAL[2]					**med**	**med**	**med**	**med**	**med**	**med**	**low**	**low**

Mendota Pool Bypass Initial Alternatives

Perspective	Categories	Factors	Criteria	P or N[1]	Settlement Alignment Bypass				Compact Alignment Bypass				Fresno Slough Dam			
					Criteria Level	Factor Level	Category Level	Perspective Level	Criteria Level	Factor Level	Category Level	Perspective Level	Criteria Level	Factor Level	Category Level	Perspective Level
A.	Implementation/Technical Feasibility															
	Costs	Upfront Costs	Capital Improvement Costs	N	med	med	med	med	med	high	med	med	low	med	low	low
			Land Costs	N	low				med				med			
		Long-Term Costs	O&M	N	med	med			med	med			low	low		
	Time to Build	Timeline	Time until action is functional	N	med	med	med		med	med	med		low	low	low	
B.	Objectives/Benefits Achievement															
	Fish Habitat & Passage	Floodplain Characteristics	Shallow Water Habitat Quality	P	low	med	med	med	low	low	low	med	low	med	high	high
			Rearing habitat (>1.0 feet inundation at 2,500 cfs)	P	med				low				med			
		Passage Conditions for Adult Chinook Salmon	Artificial structures in migratory path	N	med	med			med	med			high	high		
			Total number of steps at structures	N	med				med				high			
		Passage Conditions for Juvenile Chinook Salmon	Fish Screens along migratory path	N	low	med			low	med			low	high		
			Potential predation sites at structures	N	med				med				high			
	Habitat Restoration	Vegetation	Wetlands and other waters of the U.S area	P	low	low	low		med	med	med		med	med	med	
			Sensitive vegetation alliance extent	P	low				med				med			
		Wildlife	Wildlife habitat extent	P	low	med			med	high			med	med		
			Special-status species habitat extent	P	low				med				med			
			Net change in wildland extent	P	med				med				low			
	Geomorphology	Channel Stability	Potential for lateral migration to impact levees (estimated erosion protection cost)	N	med	med	med		med	med	med		high	high	high	
C.	Impacts															
	Groundwater	Seepage Impacts	Acres of land in which groundwater levels rise above 5-foot monitoring threshold	N				med				high				med
			Acres of land in which groundwater levels rise above 7-foot monitoring threshold	N												
	Land Use	Crop Acreage	Total Farmland Removed from Production	N	low	low	low		high	high	high		med	med	med	
	Socioeconomics and Economics	Agricultural Economic Impacts	Change in annual agricultural production values	N	med	med	med		high	high	high		med	med	med	
	Environmental	Special Status Vegetation	Wetland Impacts	N	high	high	high		med	med	med		low	med	low	
			Sensitive Vegetation Alliance Direct Impacts	N	high				med				med			
		Special Status Wildlife	Special status wildlife habitat impacts	N	med	med			high	high			low	low		
		Cultural and Historical Resources	Historic Properties Potentially Effected	N	high	high			med	med			low	med		
			Buried Deposits Sensitivity	N	high				med				med			
TOTAL[2]					**med**	**low**	**low**	**low**	**high**	**high**	**med**	**high**	**med**	**med**	**med**	**med**

Notes:

[1] P or N refers to whether higher raw data values constitute positive or negative outcomes. If P, then high raw data values get normalized to high scores. If N, then high raw data values get normalized to low scores

[2] Totals reflect all criteria, factors, categories, and perspectives. Totals are rated according to their distribution amongst all the totals at a particular level for a particular set of alternatives.

Blank cells indicate no data available or criteria ia not applicable to that set of alternatives.

Summary of Total Scores