# Mendota Pool Bypass and Reach 2B Improvements Project

## Final
## Environmental Impact Statement/Report

## Part VI – Appendices to the Response to Comments

SAN JOAQUIN RIVER
RESTORATION PROGRAM

Final
July 2016

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## Final
## Environmental Impact Statement/Report

## Mendota Pool Entrainment: Fish Screen Assessment Technical Memorandum

SAN JOAQUIN RIVER
RESTORATION PROGRAM

Final
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# Mendota Pool Entrainment: Fish Screen Assessment

## Technical Memorandum

SAN JOAQUIN RIVER RESTORATION PROGRAM

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

U.S. Department of the Interior
Bureau of Reclamation

July 2016

## Mission Statements

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

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

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# Abbreviations and Acronyms

| | |
|---|---|
| CALSIM | California Statewide Integrated Model |
| CCC | Columbia Canal Company |
| CCID | Central California Irrigation District |
| cfs | cubic feet per second |
| CVP | Central Valley Project |
| Delta | Sacramento–San Joaquin Delta |
| DMC | Delta–Mendota Canal |
| DFW | California Department of Fish and Wildlife |
| DWR | California Department of Water Resources |
| ESA | Endangered Species Act |
| FCWD | Firebaugh Canal Water District |
| LSJLD | Lower San Joaquin Levee District |
| NMFS | National Marine Fisheries Service |
| NRDC | Natural Resources Defense Council |
| Reclamation | U.S. Department of the Interior, Bureau of Reclamation |
| RWA | SJRRP Reclaimed Water Account |
| Secretary | U.S. Secretary of the Interior |
| Settlement | Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.* |
| SJFMWG | San Joaquin Fish Management Work Group |
| SJREC | San Joaquin River Exchange Contractors |
| SJRRP | San Joaquin River Restoration Program |
| SLCC | San Luis Canal Company |
| SWP | State Water Project |
| TAF | thousand acre–feet |
| USFWS | U.S. Fish and Wildlife Service |
| WY | water year |

# 1.0 Statement of Purpose

Consistent with the Stipulation of Settlement in *NRDC, et al., v. Rodgers, et al.,* (Settlement), the Bureau of Reclamation (Reclamation) is working to implement the channel and structural improvements in the San Joaquin River called for in Paragraph 11(a) of the Settlement. Specifically, Paragraph 11(a)(1) of the Settlement requires the following: 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. However, the Settlement does not require a screen at the planned Mendota Pool Bypass. There may be a need to install a fish screen to protect juvenile salmon migrating downstream from entrainment (a fisheries term for the incidental trapping of fish in waters being diverted for irrigation or similar purposes) at Mendota Pool.

This study was conducted to determine the degree of benefit a screen would provide to the San Joaquin River Restoration Program (SJRRP). The fish screen would be designed to direct fish into the new Mendota Pool Bypass channel and minimize or avoid fish passage from Reach 2B to Mendota Pool.

This analysis assumes that juvenile fish swim along with flows, and therefore split in proportion to flows at junctions. The frequency and volume of water that would be passed into Mendota Pool in a daily operations model scenario was used to estimate the likelihood of juvenile Chinook salmon entering Mendota Pool, where the many water management structures and predators are likely to cause high mortality. Only the entrainment of juvenile fall–run and spring–run Chinook salmon was analyzed, though some of the results would be applicable to other fish species with additional analysis.

# 2.0 Background

Water districts and landowners in the Restoration Area have expressed concerns regarding potential Endangered Species Act (ESA) enforcement as a result of unscreened diversions causing take of listed fish that would not be present in the system absent SJRRP Restoration Flows. Additionally, the San Joaquin Fish Management Work Group has identified entrainment as a high priority limiting factor (SJFMWG 2009). The potential effectiveness of small screens on juvenile salmon and other fishes has been uncertain, however. The Mendota Pool Bypass and Reach 2B Channel Improvements Project will soon require a decision on whether screening Mendota Pool is necessary, and thus should be part of the ongoing design efforts.

This analysis of fish entrainment is pertinent to the Reach 2B Channel Improvements Project. This action would be located just upstream of Mendota Pool and includes the creation of a bypass channel and structure that could selectively route flow either into or around Mendota Pool.

There are two primary scenarios where water from the San Joaquin River would flow into Mendota Pool after construction of the Mendota Pool Bypass. One is when flood flows are released from Friant Dam, either to improve the storage potential of Millerton Lake to retain floods, or when the reservoir is spilling water. Under this condition, water is diverted into Mendota Pool to be utilized by San Joaquin River Exchange Contractors (SJREC). The second scenario occurs when water is released from Friant Dam with the express purpose of supplying water to the SJREC in fulfillment of the Second Amended Contract for the Exchange of Waters.

This analysis uses a daily flow model combining historical hydrology with future river conditions (and associated SJRRP Flows). It uses only one scenario of flow and flood operation deemed to be the most likely, and uses a more complex pattern of juvenile salmon emigration (i.e. fish movement out of the river system) than was employed for a previous draft analysis of the need for a fish screen (SJRRP 2009). It also adds an analysis of entrainment of juvenile steelhead trout.

## 2.1 Program Background

In 1988, a coalition of environmental groups led by the Natural Resources Defense Council (NRDC) filed a lawsuit challenging the renewal of long–term water service contracts between the United States and the Central Valley Project, Friant Division contractors, *NRDC, et al., v. Kirk Rodgers, et al.*, Case No. CIV S–88–1658 LKK/GGH. On September 13, 2006, after more than 18 years of litigation, NRDC, Friant Water Authority, and the U.S. Departments of the Interior and Commerce agreed on terms and conditions for a Settlement. The Settlement established two goals:

- **Restoration –** 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.

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

The Settlement establishes a framework for accomplishing the Restoration and Water Management goals that will require environmental compliance, design, construction, and monitoring of projects over a multiple–year period. To achieve the Restoration Goal, the Settlement calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and reintroduction of Chinook salmon. To achieve the Water Management Goal, the Settlement calls for downstream recapture of Interim and Restoration flows and recirculation of that water to reduce or avoid water supply impacts to the Friant Division long–term contractors resulting from the release of Interim and Restoration flows. In addition, the Settlement establishes a Recovered Water Account (RWA) and allows for the delivery of surplus water supplies to the Friant Division long–term contractors during wet hydrologic conditions.

The SJRRP is the program established to implement the Settlement. Implementing agencies responsible for managing and implementing the SJRRP are Reclamation, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), the California Department of Water Resources (DWR), and California Department of Fish and Wildlife (DFW). The Settlement Act, included in Public Law 111–11, the Omnibus Public Lands Management Act of 2009, authorizes and directs the Secretary of the Interior to implement the terms and conditions of the Settlement.

## 2.2 Description of Flow Routing and River Features

The Restoration Area extends from Friant Dam downstream the San Joaquin River and associated channels to the confluence with the Merced River. The San Joaquin River is divided up into five reaches, numbered 1 at the upstream end just below Friant Dam, to 5 just before the confluence with the Merced River. This analysis deals with the upper part of the Restoration Area, from Friant Dam to Mendota Pool — which sits at the transition between Reach 2 and Reach 3. Reaches are further subdivided into sections labeled “A”, “B”, etc. Mendota Pool is the site of the Reach 2B Channel Improvements Project, which includes a bypass channel that would route flows around Mendota Pool and spans from Reach 2B to Reach 3.

Mendota Pool is the small reservoir created by Mendota Dam and has both a San Joaquin River arm and a Fresno Slough arm. The San Joaquin arm of Mendota Pool is the portion of Reach 2B that extends east from Mendota Dam upstream to the San Mateo Road crossing. The Fresno Slough arm of Mendota Pool, also known as the James Bypass, extends several miles south of the San Joaquin River. The pool serves as a distribution point for irrigation water supplies delivered by the Delta–Mendota Canal and for refuge water supply deliveries to the Mendota Wildlife Area.

Mendota Pool delivers water to the San Joaquin River Exchange Contractors (SJREC), other Central Valley Project (CVP) contractors, Settlement contractors, wildlife refuges and management areas, and State Water Project (SWP) contractors. Water delivered to Mendota Pool from the Delta–Mendota Canal (DMC) is withdrawn at seven canal or pump locations in the pool, leaving a portion of water to be discharged down the San Joaquin River for delivery to the Arroyo Canal downstream from Mendota Dam.

The following describes the pertinent elements of the Restoration Area now that Restoration Flows have begun. When elements of flow routing or operations will be changed by the Reach

2B Channel Improvements Project, it is so noted. The analysis for fish entrainment at Mendota Pool assumes the Reach 2B Channel Improvements Project is complete.

### 2.2.1 Friant Dam & Millerton Lake

Friant Dam impounds Millerton Lake. Flows from Millerton Lake are routed through the Madera and Friant–Kern canals to provide water for the Friant Division long–term contractors. Millerton Lake is operated as an annual reservoir — all water supplies available in a given year are allocated with the expectation of delivery. Prior to the start of SJRRP Flows, average annual Friant Dam releases had a baseflow of 40 to 250 cfs (McBain and Trush, 2002). Restoration Flows augment this historical average in all water year types except Critical–Low water years. Restoration Flows range from an additional 100 cfs to 4,000 cfs depending on the time of year, water availability, and schedule established by the Restoration Administrator. During flood conditions, releases from Millerton Lake are sent down the San Joaquin River or flood bypasses to preserve life and property, with guidance provided in the Operation Manual (Reclamation Board, 1969).

### 2.2.2 Reach 1

Reach 1 is 42 miles long, from just below Friant Dam to approximately Gravelly Ford. The current maximum average flow through Reach 1 is 8,000 cfs (Reclamation Board, 1969; Mussetter, 2002). Flows within Reach 1 are predominantly influenced by releases from Friant Dam, along with diversions and seepage losses. River releases in Reach 1 are made to comply with Holding Contract requirements (relatively small prior water rights holders along the channel) and for SJRRP Restoration Flows. Streamflow of at least 5 cfs must be maintained past the last diversion near Gravelly Ford for the Holding Contract requirements. Restoration Flows often substantially increase the flows at the end of Reach 1 at Gravelly Ford, the degree to which ranges widely depending on time of year and water year type (Restoration Flow Guidelines, 2013). Reach 1 serves as the predominant spawning and holding habitat for salmon.

### 2.2.3 Reach 2A

Reach 2A stretches 9 from near Gravelly Ford to the Chowchilla Bifurcation Structure. The Army Corps of Engineers recommended flow capacity of Reach 2A is 8,000 cfs (McBain and Trush, 2002). Reach 2A is typified by the accumulation of sand caused in part by backwater effects of the Chowchilla Bypass Bifurcation Structure and by a lower gradient relative to Reach 1, and thus has high infiltration losses. Reach 2A was typically dry before Restoration Flows were initiated.

### 2.2.4 Chowchilla Bypass & Chowchilla Bifurcation Structure

The Chowchilla Bypass extends from the Chowchilla Bypass Bifurcation Structure to the Eastside Bypass at the confluence of the Fresno River. The Chowchilla Bypass Bifurcation Structure at the head of Reach 2B regulates the flow split between the San Joaquin River and Chowchilla Bypass. The design channel capacity of the Chowchilla Bypass is 5,500 cfs (Reclamation Board, 1969). The bypass is constructed in highly permeable soils, and much of the initial flows infiltrate and recharge groundwater. The structure is operated according to the Lower San Joaquin Flood Control Project Operations Manual (Reclamation Board, 1969).

The current operation of the bifurcation structure routes the first 1,300 cfs to Mendota Pool via Reach 2B (SJRRMC, 2007). Other operational guidance suggests 1,120 cfs (California Department of Water Resources), 1,400 cfs (CalSim), or 1,500 cfs (Musseter 2002). The subsequent 5,500 cfs (1,500 to 7,000 cfs of total flow) is routed into the Chowchilla Bypass, with the next increment of 1,000 cfs (7,000 cfs to 8,000 cfs total flow) being directed again into Reach 2B (Mussetter, 2002; McBain and Trush, 2002). The structure is typically operated to provide as steady flow as possible into Reach 2B when Mendota Pool is taking water through irrigation demand (Mussetter, 2002; McBain and Trush, 2002).

Flood flows may enter Mendota Pool from either the Kings River via the James Bypass and Fresno Slough or the San Joaquin River. The design capacity of Reach 3 below Mendota Pool is 4,500 cfs (Reclamation Board, 1969). Therefore, to minimize damage to life and property, flows into Reach 2B would be proportionally reduced when the combined volume from the James Bypass and San Joaquin River minus the uptake at Mendota Pool exceed 4,500 cfs.

Should flows exceed 8,000 cfs at the Chowchilla Bifurcation Structure or 10,000 cfs total between the San Joaquin River and the Kings River, the Lower San Joaquin Levee District is to operate the bifurcation structure *"at their own discretion with the objective of minimizing damage to the flood control project and protected area."* (Reclamation Board, 1969).

#### 2.2.4.1 Post Construction Operations

With the completion of the Reach 2B Channel Improvements Project and other independent projects to improve channel capacity in Reaches 3, 4, and 5, Restoration Flows will be routed to Reach 2B and through the newly built Mendota Pool Bypass. In flood flow situations, the Lower San Joaquin Levee District (LSJLD) will continue to operate in accordance with the flood control manual and to minimize loss of life and property. When just the San Joaquin River is in flood, the LSJLD could choose to route flood flows through the Chowchilla Bypass, or through Reach 2B of the San Joaquin River (and either through the Mendota Pool Bypass or into Mendota Pool). If James Bypass is contributing flood flows, flood flows from the San Joaquin River would generally be routed into the Chowchilla Bypass. Flows in excess of 10,000 cfs (or less depending on James Bypass flows) would be handled "*at their own discretion*" as before.

### 2.2.5 Reach 2B

Reach 2B is a sandy channel extending 11 miles from Chowchilla Bifurcation Structure into Mendota Pool. Reach 2B ends at Mendota Dam, and Mendota Pool backs water up the San Joaquin River to San Mateo Road. Significant seepage has been observed at flows above 1,300 cfs (SJRRMC 2007). Flow in Reach 2B is set by the Chowchilla Bifurcation Structure as described above.

#### 2.2.5.1 Post Construction Operations

With the completion of the Reach 2B Channel Improvements Project, the capacity of Reach 2B will be increased to 4,500 cfs (SJRRP, 2011). The Mendota Bifurcation Structure would be placed in the lower half of Reach 2B just upstream of Mendota Pool.

### 2.2.6 Mendota Pool

Mendota Pool acts as a forebay amid the San Joaquin River channel — the primary function of which is to distribute water from the DMC and San Joaquin River to local diversion points. There are three main inlets to Mendota Pool: Reach 2B of the San Joaquin River, Fresno Slough/James Bypass, and the DMC There are multiple outlets, including: Main Canal, Outside Canal, Firebaugh Canal, Helm Ditch, Columbia Canal Company's Canal, Mowry Canal, and the downstream San Joaquin River (SJRRMC, 2003) (Figure 2–1). Up to 700 cfs of water from

Mendota Pool is discharged from the dam into the San Joaquin River for delivery to the Arroyo Canal, located about 23 miles downstream of the dam.

Flows into Mendota Pool are supplemented from the DMC, and also with deliveries from the Fresno Slough/James Bypass and San Joaquin River during occasional flood releases from Friant and Pine Flat Dams. Except in floods and during Exchange Contractor releases from Friant Dam as occurred in 2014 and 2015, the DMC is the primary source of water to Mendota Pool. Mendota Pool delivers water to the SJREC, other CVP contractors, wildlife refuges and management areas, and SWP contractors. Mendota Pool provides no long–term storage for water supply operations or flood management. The pool averages about 400 feet wide, is generally less than 10 feet deep, and has a total capacity of about 3,000 acre–feet. Mendota Dam, which impounds the pool, is owned and operated by the Central California Irrigation District. Manual gates and flashboards are opened or removed during periods of high flow to reduce seepage impacts on land surrounding Mendota Pool.

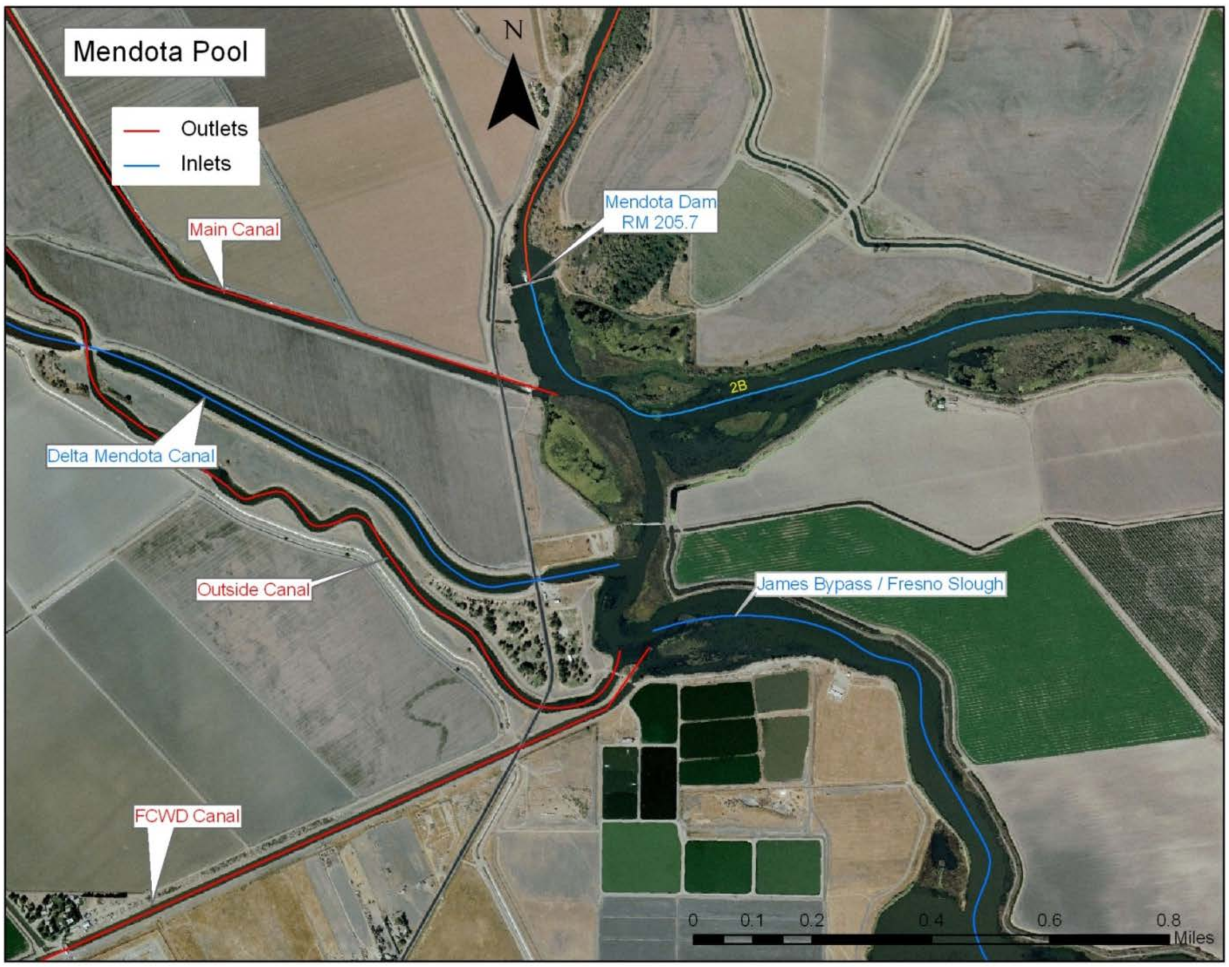



**Figure 2-1. Mendota Pool Schematic Prior to Completion of Mendota Pool Bypass**

#### 2.2.6.1 Post Construction Operations

With the completion of the Reach 2B Channel Improvements Project, Mendota Pool will then be one of two routes for water into Reach 3. Restoration Flows would be intentionally diverted around Mendota Pool. San Joaquin River flood flows would be routed into Mendota Pool, but only to the extent that irrigator demand could utilize such flows; otherwise flood flows would be routed through the Mendota Pool Bypass. Flows for delivery to the Arroyo Canal, located 23 miles downstream, would be released from Mendota Dam if the water source was Mendota Pool (and its associated outlet canals and pumps), or would primarily be routed through the Mendota Pool Bypass if the source was San Joaquin River water (either flood flows or Exchange Contractor Releases). Arroyo Canal deliveries from flood flows or Exchange Contractor releases could also be routed through Mendota Pool.

### 2.2.7 Mendota Pool Bypass and Mendota Bifurcation Structure

As specified in the Settlement, Paragraph 11(a)(1), "a bypass channel will be created 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." The Mendota Pool Bypass will be the principal conveyer of Restoration Flows. The existing river channel, from the future Mendota Bifurcation Structure to Mendota Pool, will be retained and will have a channel capacity of 2,500 cfs.

During future floods, up to 2,500 cfs of flood deliveries may be made to Mendota Pool for Exchange Contractor use, with the remainder going through the Mendota Pool Bypass (also known as the Compact Bypass) or Chowchilla Bypass, at the discretion of the operator. Less than 2,500 cfs will be routed to Mendota Pool, with the remainder flowing through the bypass, if the combined flow into Mendota Pool from James Bypass and Reach 2B exceed the demand for water. This is discussed in section 3.4. In addition, San Joaquin River water for San Luis Canal Company (SLCC) would be routed through the Mendota Pool Bypass during flood flows.

The many diversion canals at Mendota Pool make it a source of fish entrainment. The potential Mendota Pool Fish Screen, the subject of this analysis, would be located at the Mendota Bifurcation Structure and would screen the channel entrance to Mendota Pool. The screen would require that a minimum fraction of flow be routed to the Mendota Pool Bypass to allow emigrating juvenile and other fish to escape the screen.

### 2.2.8 James Bypass

Fresno Slough delivers flood water from the Kings River to Mendota Pool via James Bypass; it generally only flows during floods. Flows from the Kings River are regulated by Pine Flat Dam releases and the Crescent Weir, which are operated by the Kings River Conservation District. The discharge to James Bypass from Pine Flat Dam on the Kings River ranges from 0 to 5,000 cfs (Reclamation, 1969), with 4,750 cfs the general operating limit. These flood flows are conveyed through the James Bypass to Mendota Pool and from there, through Reach 3. Some of James Bypass flood water is able to be collected in Mendota Pool; with the remainder continuing to flow downstream when it exceeds the demand for water at Mendota Pool.

### 2.2.9 Delta–Mendota Canal

The DMC carries water from the Jones Pumping Plant in the Sacramento–San Joaquin Delta along the west side of the San Joaquin Valley to its terminus at Mendota Pool. It is used by the Delta Division, West San Joaquin Division, San Felipe Division, wildlife refuges, and the Exchange Contractors and other Settlement contractors. This is the main supply to Mendota Pool. The DMC typically conveys on the order of 2,500 to 2,800 cfs to Mendota Pool during the peak irrigation season (McBain and Trush, 2002).

### 2.2.10 Exchange Contractors Canals

There are multiple canals draining Mendota Pool, the largest ones including Main and Outside Canals. These irrigation canals provide water to the SJREC. Through an Exchange Contract, Reclamation provides a substitute water supply via the DMC to the Exchange Contractors (Central California Irrigation District (CCID), Columbia Canal Company (CCC), Firebaugh Canal Water District (FCWD), and the San Luis Canal Company (SLCC)), in exchange for the use of waters of the San Joaquin River within the Friant Division. Three of these Exchange Contractors draw upon Mendota Pool, with SLCC maintaining a canal at Arroyo Canal downstream. When water is available at Mendota Pool from the San Joaquin River or Kings River (occurrences typically associated with wet conditions), the water is used to offset the need to provide the Exchange Contractors with water from the DMC. The Exchange Contractors can also call upon water from Millerton Lake under certain circumstances as occurred in 2014 and 2015.

### 2.2.11 Reach 3

Reach 3 flows 23 miles along a sandy channel from Mendota Dam to Sack Dam, past the town of Firebaugh. The design capacity of Reach 3 is 4,500 cfs, though anecdotal observations suggest that flooding of Firebaugh is likely at flows of only 4,000 cfs.

# 3.0 Methods

This analysis considers a future state after completion of the Reach 2B Channel Improvements Project and Mendota Pool Bypass. This scenario also assumes improvements to channel capacity facilitated by seepage mitigation, setback levees, the Mendota Pool Bypass, and associated structures. It does assume that Friant Dam, Chowchilla Bypass, and Mendota Pool operations follow similar logic as they do at present or as required in the 1969 Operations Manual. The scenario does not include Buffer Flows (supplemental flows augmenting Restoration Flows), groundwater banking, Unreleased Restoration Flows, or Recapture & Recirculation programs.

This modeling effort is an update of a draft analysis conducted in 2009 using CALSIM and monthly flow data (SJRRP, 2009). Instead of being restricted to CALSIM's monthly time–steps, the San Joaquin Basin was modeled in CADSWES Riverware software for this present study. The same 82–year historical basin runoff record (i.e. inflow into Millerton Lake) that is utilized by CALSIM served as the basis for the daily flow modeling in Riverware (Vandegrift, 2012). Daily flow data from Riverware were then manipulated in a Microsoft Excel Spreadsheet, which took into account additional operational steps that would be present once the Mendota Pool Bypass is constructed and serves as a quality assurance step for the SJRRP Daily Flow Model output.

Additionally, five synthetic years with deliveries to the SJREC from Millerton Lake to satisfy the Exchange Contract were added into the Excel flow record. These 5 years simulate a future of greater delta pumping constraints or climate change. The modeling is based upon the best available data. However, the only instances of deliveries to the SJREC from Millerton Lake occurred in 2014 and 2015, and as such there is a lack of sufficient hydrology data to apply in the model to account for SJREC deliveries. Therefore, five synthetic years were generated in order to provide an understanding of how fish entrainment would be affected by these deliveries (See Section 3.3).

The final step was to analyze the impact to emigrating juvenile Chinook salmon (*Oncorhynchus tshawytscha)* and juvenile steelhead trout (*Oncorhynchus mykiss)*. This was accomplished by multiplying the ratio of flow volume leaving Reach 2A that is diverted into Mendota Pool by the fraction of fish population that emigrates in a given month. Two emigration timing curves were developed for Chinook salmon, one for spring–run and another for fall–run. An additional timing curve was developed for Steelhead. The methodology is discussed in more detail below (Section 3.5)

## 3.1 Flow Analysis

The basis for the analysis of flows was a model of future operating conditions run in Riverware software. This SJRRP Daily Flow Model used CALSIM model rules of operation and incorporated many of the planned structures associated with the SJRRP. This model used as its basis of climatology the actual record of precipitation in the basin, from water years 1922 to 2003, and synthesized a future condition under which Restoration Flows were fully operational and unconstrained by channel conveyance.

The SJRRP Daily Flow Model output was then analyzed in an Excel spreadsheet. Flood flows were confirmed based on the model data, spurious hours-long flood flows (which the model improperly characterized because of the time lag of water as it flows downstream) were omitted (see Table 3-1 below for more information on what constitutes a spurious flood flow), and additional operational constraints were placed on the model output and mass–balanced, to accurately portray Reach 3 channel capacity, the Mendota Pool Control Structure design flow, and Exchange Contractor demand.

The SJRRP Daily Flow Model output was refined as follows:

- Limiting combined flows into Mendota Pool from James Bypass and San Joaquin River to 4,500 cfs, based on Reach 3 design capacity of 4,500 cfs
- Limiting flood flows past the planned Mendota Bifurcation Structure to Mendota Pool to 2,500 cfs, based on the design capacity of Reach 2B and the Exchange Contract
- Limiting flood flows past the planned Mendota Bifurcation Structure to Mendota Pool to the demonstrated average SJREC demand at Mendota Pool by month based on Delta-Mendota Canal operations (1975–2012)
- Synthetically adding in five deliveries to the SJREC from Millerton Lake to satisfy the Exchange Contract in Critical–High and Critical–Low water year types, as occurred in 2014 and 2015 (see Section 3.3)
- The fraction of SJREC flows for Arroyo Canal were routed through the Mendota Pool Bypass, as the easiest operational path (although Arroyo Canal flows could also be routed through Mendota Pool)

## 3.2 Adjustment of Flood Flow Frequency

A quality control check of the SJRRP Daily Flow Model output revealed that it depicted significantly more instances of flood releases than in the historic record of Friant Dam operations. Consequently, more water was being routed into Mendota Pool than expected. Consultation with Todd Vandegrift, Reclamation Technical Service Center, who generated the model output, confirmed the model's logic was immediately releasing water once a threshold of reservoir inflow was exceeded yet before the most concurrent runoff forecast was consulted. Many of these instances occurred in February and March, were short in duration, and were modest in volume. In many cases the model's logic, which was applied in daily time–steps, ceased flood releases shortly after initiation after a new monthly water supply forecast had been received in the time–step model. There were other instances that appear as flood releases in the model output that are reasonably avoided in real–world practice. For example, advancing a Restoration Flow pulse in the schedule may remove the need for flood release as it could draw down the reservoir level and attain the required amount of storage. In addition, flood control operators anticipate future forecasts and would avoid short-duration and small volume flood pulses by not applying strict thresholds as done in the model. There are additional unmodeled factors that would contribute to lessening the frequency of flood flows, such as the daily availability of low cost water (e.g. RWA water or "Section 215" water) prior to flood releases.

The model's logic is highly deterministic and strict, and does not consider flood control operator judgement in regards to flood flows or the coordination process that precedes flow scheduling. Therefore, a set of criteria were developed to omit these small flood flows in the model output (Table 3–1). For simplicity, these omissions were not mass–balanced across the flow record; however, they were checked to determine that their omission would not cause the reservoir to spill at a later date.  Since the reservoir does not spill later than expected, the omission of these small flood flow volumes is not significant and does not necessitate performing a mass balance.

**Table 3-1. Criteria for Omission of Flood Release in Daily Flow Model Output**

| **Trigger for Omission** | **Additional Criteria for all instances** |
|---|---|
| When flood release is less than 100 cfs or 2 TAF in total volume | Omission of flood release must not result in reservoir spill at a later date, and<br><br>Any adjustment of Restoration Flow Schedule to minimize flood release must conform to SJRRP Restoration Flow Guidelines |
| When a small flood flow is released atop a large Restoration Flow (e.g. 300 cfs flood flow atop 4000 cfs Restoration Flow) | |
| When adjustment of a planned Restoration Flow schedule would remove need for flood release | |
| When flood release is the result of elevations above a threshold days before a new monthly water supply forecasts | |

Omission of these small modeled flood flows resulted in the average annual frequency of flood flows being reduced from 6.2% to 5.4% of days, and the average annual volume of flood flows being reduced from 9.2% to 8.6% of the total annual runoff. The principal effect of these omissions was upon the February and March hydrographs, and involves four Water Year Types — Normal–Wet, Normal–Dry, Dry, and Critical–High. This adjustment provides a more realistic analysis, and the analysis of a fish screen then proceeded with this modified model output. Unfortunately, daily observed operations data is not available for the full 1922-2003 record. A future analysis could use a reduced period of record and observed data, but herein a longer dataset was desired to capture a broader range of hydrology.

## 3.3 Exchange Contractor Flows

In 2014 and 2015, releases from Friant Dam were required to meet the conditions of the Exchange Contract for the first time. These releases were unprecedented in the record and were originally not part of the SJRRP Daily Flow Model. To account for this, synthetic SJREC deliveries were added to the flow record: a 270 thousand acre–feet (TAF) release for the SJREC in Critical–Low water years (1 in the 82–year record) and a 65 TAF release during Critical–High years (4 in the 82–year record). Critical-High and Critical-Low water year types were selected because these were the water year types for 2014 and 2015 when the only deliveries to SJREC from Millerton Lake have occurred in the record (i.e., historical occurrence of two years since the dam was built).  The five synthetic years (an additional three years over the historical record), which is based on the occurrence of Critical-High and Critical-Low water years in the historical record, account for a future of greater delta pumping constraints and/or climate change. The timing and pattern was derived from the actual SJREC releases in 2014 and 2015. Losses between Friant Dam and Mendota Pool were not accounted for, but this made no difference to the analysis since no other water was present in Reach 2 during SJREC releases. These deliveries were not mass–balanced — in other words, the commensurate amount of water was not subtracted from Millerton Lake which would have impacted how the model operated. This mass–balancing was omitted for practicality reasons. The primary effect of this omission is that flood flows will be slightly over–predicted over the 82–year model run, especially in the subsequent year after a synthetic SJREC delivery. If the reservoir has a substantial spill on subsequent years, or if the subsequent years after an Exchange Contractor delivery are so dry as to not have flood releases, the consequences of the lack of mass–balancing are diminished.

Exchange Contractor releases were scheduled in the adjusted SJRRP Daily Flow Model to begin on May 15 on Critical–Low water years and July 15 on Critical–High water years. This mimics the schedule that was actually used in 2014 (May 15$^{th}$ for a 270 TAF release from Friant Dam) and 2015 (July 15 for a 65 TAF release from Friant Dam). It should be noted that 2014 was a Critical–High year, but had a larger release than the subsequent 2015 Critical–Low year. These volumes are intentionally large so that they produce a liberal estimate of SJREC deliveries and a corresponding conservative estimate of fish entrainment. In fact, there may not be adequate stored water in Millerton Lake to fill such deliveries.

## 3.4 Mendota Pool Demand

Modeled flood flows into Mendota Pool were capped by the predicted water demand of the SJREC. When supply exceeded demand, surplus San Joaquin River water was routed through the Mendota Pool Bypass. This test assumed water from James Bypass would be used first to satisfy Mendota Pool demand, with water from the San Joaquin River second; thus, if James Bypass water fully saturated demand, no water from the San Joaquin River would be routed to Mendota Pool. To develop a demand curve, a record of SJREC operations from 1975 to 2012 was utilized. Demand at Arroyo Canal (i.e. SLCC) based on a 1999-2014 record was removed from the SJREC total to determine the draw at Mendota Pool. Arroyo Canal consists of approximately 20% of SJREC's demand. The average monthly demand over the 1975-2012 period was selected. Demand by month is depicted in Figure 3–2. Demand was treated as a block throughout the month (i.e. not ramped up or down by day).

## 3.5 Salmon Emigration and Timing

The underlying assumption throughout this report is that the percentage of flow diverted to Mendota Pool is proportional to the fraction of fish population diverted to the pool. This approach has been utilized successfully in estimating salmon entrainment on Idaho's Lemhi River (Walters et al 2012). The multiple small points of entrainment on the Lemhi River are different than the single large point of entrainment analyzed here. It is acknowledged that this is a simplified assumption that is adopted for modeling efficiency and based on the lack of an available salmon emigration model. Factors such as sweeping velocity, head differential, and other hydraulic parameters will affect fish movement at bifurcations. Modeling these parameters would require significantly longer than the time available to do this analysis.

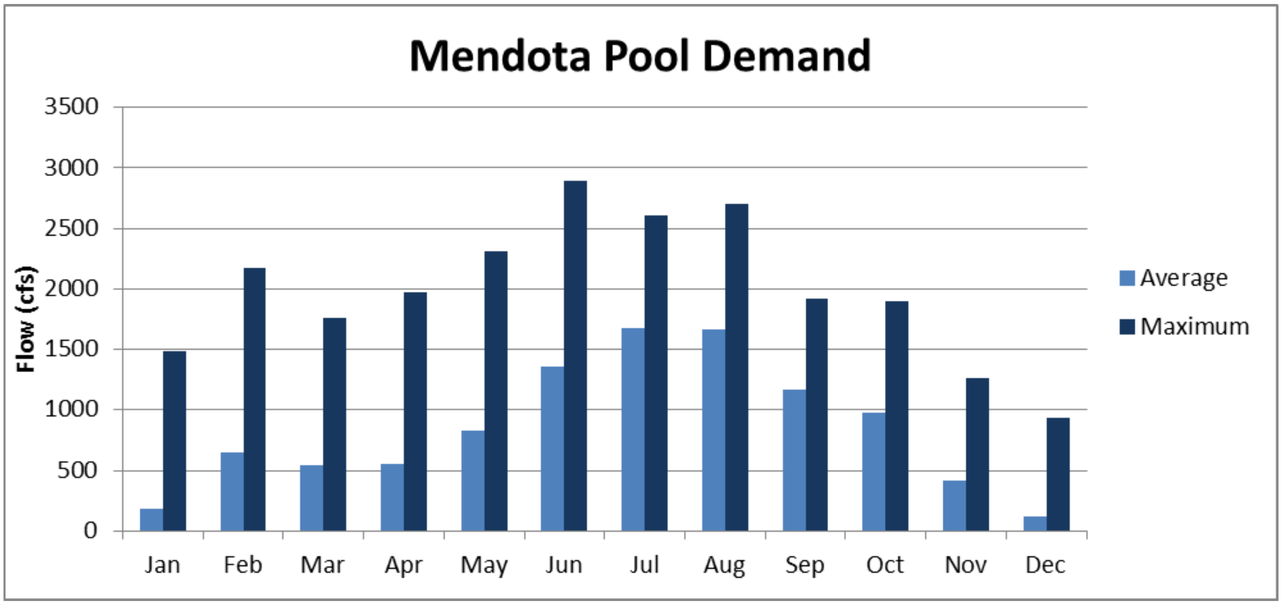



**Figure 3-1. Mendota Pool Demand Curve Used to Limit Flood Flows to Mendota Pool**

The previous Mendota Pool Fish Screen Analysis, a draft 2009 report conducted by SJRRP, used a basic presence/absence model, where juvenile salmon were present January through June, and absent otherwise. The current analysis is improved in that it does not assume that fish are evenly distributed temporally during all months that fish are present.

To generate a more detailed pattern of emigration for Chinook salmon, emigration timing from the SJRRP Minimum Floodplain Habitat Area report were utilized (SJRRP 2012), as there is not enough fish migration data available on the San Joaquin River, and none of it is at flows representative of future Restoration Flows. Figure 5 and Figure 8 of that report provide "pulse emigration" curves for fall–run and spring–run Chinook salmon respectively. These pulse emigration curves paired capture data with flow to determine the likelihood of fish emigration should there be a pulse in flow, thereby removing the bias that flow has upon fish movement. This correction for flow produces an independent variable of emigration, thereby making the curve of emigration timing suitable for this analysis.

Fall–run curves in the Minimum Floodplain Habitat Area report were generated from catch data on the Stanislaus River, roughly 100 miles north of the San Joaquin River. Spring–run curves were generated from catch data on the Feather River (200 miles north of the San Joaquin) and adjusted using a capture efficiency model from the Stanislaus. This approach was tested on the Mokelumne River, adjacent to the Stanislaus, and found to be a valid approach in correcting for geographic distance (SJRRP 2012). Both fall–run and spring–run emigration curves derived from the Minimum Floodplain Habitat Area report also incorporated adjustment to SJR river mile 234, just below the downstream limit of the spawning areas. This is approximately 28 miles upstream of Mendota Pool. The Stanislaus and Feather River data were used as they represent the nearest most complete dataset currently available.

The daily data from these two pulse emigration curves were then smoothed with a 30–day moving average filter to generate monthly emigration curves (Figure 3–2).

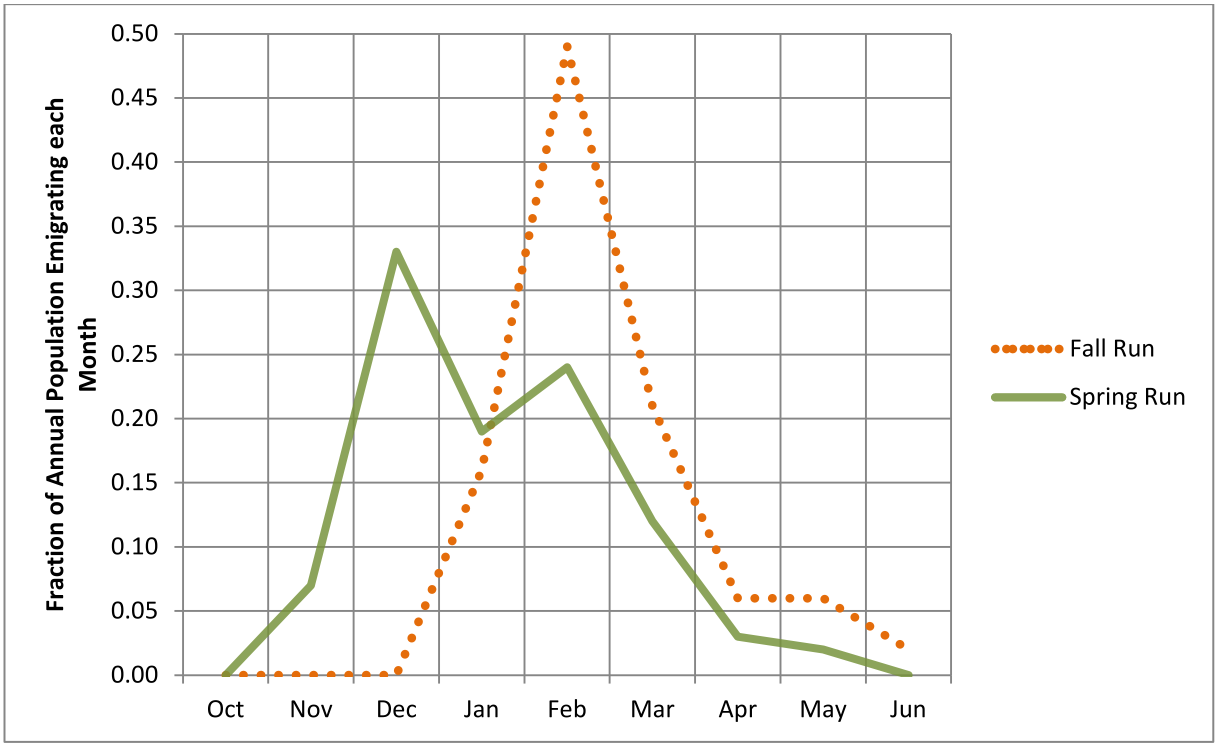



**Figure 3-2. Initial Pulse Emigration Curves (SJRRP 2012) from Minimum Floodplain Habitat Area report, after smoothing**

While there is currently no spring–run capture data from the San Joaquin River, there are two years of fall–run data from which to test this hypothetical emigration curve. In 2014, capture was conducted February 26 through May 8th, in 2014 (2393 captures), and February 14 through May 13, 2015 (625 captures). In both years, fry were captured immediately upon the start of the capture period, indicating that juveniles were present in mid–February. Additionally, flows were nearly constant during both periods, removing any effect of flow velocity upon a pulse emigration strategy. A monthly summary of data is presented in Table 3-2.

**Table 3-2. Capture data of fall–run Chinook salmon in the San Joaquin River.**

| | Fraction of Captures 2014 | Fraction of Captures 2015 |
|---|---|---|
| February (partial) | .08 | .24 |
| March | .38 | .56 |
| April | .47 | .16 |
| May (partial) | .07 | .04 |

Consulting with professional fisheries biologists (Portz pers. comm.) indicated that 2014 capture data was more representative of what is expected in the future for fall–run salmon due to the larger sample size and more normal water temperatures. Compared to the initial model (Figure

3–2), San Joaquin River capture data peaks later in the year. This difference is in line with recent observational trends (including a later onset of upstream migration of adults). Based on this capture data, the location of fish captures (which were upstream of SJR river mile 234), and professional judgment, the initial fall–run pulse emigration model was substantially modified by translating the curve back (delaying by 24 days) and adjusting the skewness of the curve (subtracting a combined 26% of the population from February and March, and adding it to the curve in April). Additionally, the June and July emigrants were curtailed due to the expected lethality of water temperatures during those months. This implies a peak fall–run emigration of April 4th with 95 percent of the population emigrating from February 1 through May 31. These modifications of the fall–run emigration pattern more closely follow the 2014 capture data in Table 3–2. The 2014 capture data however, does not cover the entire emigration period. Thus, it was used only to adjust the previously developed emigration curves, and not as the basis for an emigration curve.

Adjustment of the spring–run curves had no local capture data to rely upon, so the initial curve (Figure 3–2) was adjusted more modestly. The curve was translated back in the season to the same degree as indicated by the fall–run capture data (delaying by 24 days) (Portz pers.comm.) and the bimodal peaks of the curve were mellowed by moving 8% of the population (area under the curve) from the January peak to February, March and April. This results in a more bell-shaped (i.e. Gaussian) curve for spring–run salmon. Though there is biological significance to this bimodal structure (i.e. early and late emigration strategies), the intent was to reduce the influence of this characteristic because of the uncertainty in the precise timing. The subsequent analysis then becomes less sensitive to errors in the fish emigration curves. Figure 3–3 and Table 3–3 represent the adjusted juvenile Chinook salmon emigration models used for this analysis.

The emigration pattern presented in Figure 3–3 is generalized for Reach 1 and 2a where the majority of fry are expected to be found. As the fry mature, they are expected to disperse downstream into Reach 2B and Mendota Pool. It is recognized that the precise pattern of emigration may shift slightly later in the season for a given point lower in the river; however, this minor variance was not accounted for in the analysis. The influence of such a shift is within the uncertainty of the model, therefore no attempt was made to fine–tune a relatively coarse assumption.

Many assumptions went into the creation of the fish emigration curves. Please see Section 5.5 for a sensitivity analysis on different fish emigration curves.

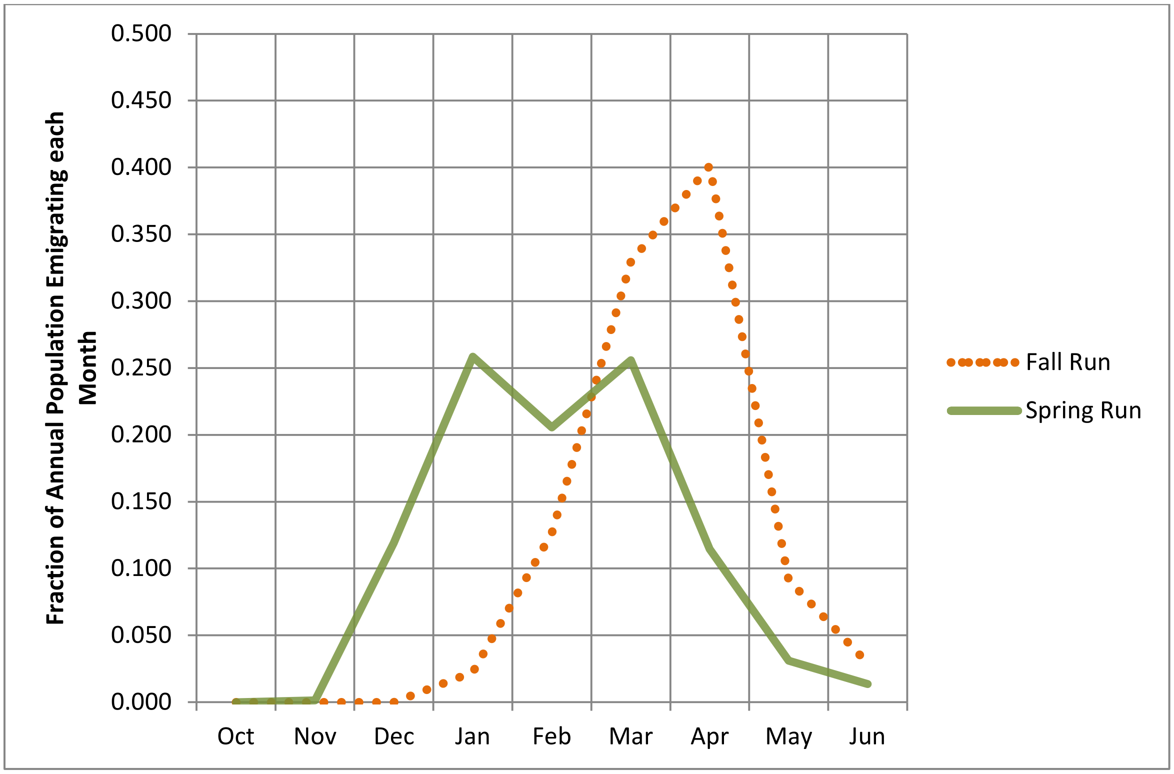



**Figure 3-3. Model of Fraction of Emigrating Salmon Population by Month used in this analysis**

**Table 3-3. Table of Fraction of Emigrating Salmon Population by Month**

| | Fall–run Emigration Pattern | Spring–run Emigration Pattern |
|---|---|---|
| October | 0.00 | 0.00 |
| November | 0.00 | 0.00 |
| December | 0.00 | 0.12 |
| January | 0.02 | 0.26 |
| February | 0.13 | 0.21 |
| March | 0.33 | 0.26 |
| April | 0.40 | 0.11 |
| May | 0.09 | 0.03 |
| June | 0.03 | 0.01 |

## 3.6 Steelhead Trout Emigration and Timing

The development of emigration curves for steelhead proceeded in a similar fashion to Chinook salmon. The analysis started with Mokelumne River steelhead capture data from 2011-2014 (reference). Multiple trap efficiency tests (approximately 10/year) were conducted for each Rotary Screw Trap (RST) from December-June on the Mokelumne River. Standard mark-recapture ratios were used as measurements of trap efficiency. Between 2011-2014, trap efficiencies ranged from 0.2% to 22.7% and averaged 7.4%. Mokelumne River Fish Hatchery and naturally produced Chinook salmon were used for the trap efficiency tests. This raw data, which is adjusted for trap efficiency, is shown in Table 3-5 below.

This raw data was first smoothed, and then compressed by 24 days to reduce the emigration period, as expected on the San Joaquin River due to higher temperatures (D. Portz, pers. Comm.). As with the salmon analysis above, the intent was to reduce the influence of sharp peaks in the data because of the uncertainty in the precise timing. The resulting analysis then becomes less sensitive to errors in the fish emigration curves.

1) The data was smoothed by first creating a smooth distribution of the average fraction of captures (column 4 of Table 3-4) into 6 day increments (5 periods per month). For example, the 4% of average captures found in February was assumed to occur with 0.2% in the first 6 days of February, 0.4% in the next 6 days, 0.7% in the next 6 days, 1.1% in the next 6, and finally 1.7% in the last section of February. This distribution was roughly linearly interpolated from the average fraction in Table 3-5 below, assuming a more Gaussian distribution of fish migration. It is shown in Column 4 of Table 3-6 below.
2) Secondly, the data was further smoothed by calculating a running average. For example, the adjusted % of capture assumed in the first 6 days of March was the sum of the % from the last 2 periods of February plus the first 3 periods of March. This is shown in Column 5 of Table 3-5 below.
3) Thirdly, the smoothed data was shifted or compressed, eliminating any expected fraction of steelhead in late January or early February. This was done to account for temperature differences between the Mokulumne and the San Joaquin Rivers in discussion with fisheries biologists (D. Portz pers. Comm.). Figure 3-4 below shows the compression.

For comparison, Figure 3-5 below shows the original average fraction of steelhead captured from the Mokelumne River compared to the smoothed, compressed dataset used for this analysis. The overall effect is a compressed fish emigration curve. The San Joaquin River curve used for the rest of this analysis demonstrates a higher peak than the data from the Mokelumne as a result of the distribution step, step 1 above.

**Table 3-4. Capture data of Steelhead in the Mokelumne River.**

| | Fraction of Captures 2011 | Fraction of Captures 2013 | Fraction of Captures 2014 | Average Fraction |
|---|---|---|---|---|
| February | .006 | .060 | .053 | .040 |
| March | .012 | .232 | .228 | .157 |
| April | .113 | .322 | .402 | .279 |
| May | .510 | .364 | .217 | .364 |
| June | .359 | .020 | .101 | .160 |
| Total Individuals for the Year | 337 | 354 | 189 | — |

**Table 3-5. Smoothing of Capture data of Steelhead in the Mokelumne River.**

| Month | Period in Month | Average 2011-2014 Mokelumne River Fraction Captured | Distributed Steelhead Fraction Captured | Smoothed Fraction Using running average | Smoothed Fraction Steelhead Captured by Month |
|---|---|---|---|---|---|
| Feb | 2 | 0.041 | 0.002 | 0.003 | 0.044 |
| | 2.2 | | 0.004 | 0.005 | |
| | 2.4 | | 0.007 | 0.008 | |
| | 2.6 | | 0.011 | 0.012 | |
| | 2.8 | | 0.017 | 0.017 | |
| Mar | 3 | 0.157 | 0.022 | 0.021 | 0.157 |
| | 3.2 | | 0.026 | 0.026 | |
| | 3.4 | | 0.031 | 0.031 | |
| | 3.6 | | 0.036 | 0.036 | |
| | 3.8 | | 0.042 | 0.042 | |
| Apr | 4 | 0.279 | 0.047 | 0.047 | 0.277 |
| | 4.2 | | 0.052 | 0.051 | |
| | 4.4 | | 0.056 | 0.056 | |
| | 4.6 | | 0.06 | 0.060 | |
| | 4.8 | | 0.064 | 0.063 | |
| May | 5 | 0.364 | 0.067 | 0.067 | 0.351 |
| | 5.2 | | 0.07 | 0.070 | |
| | 5.4 | | 0.073 | 0.073 | |
| | 5.6 | | 0.076 | 0.073 | |
| | 5.8 | | 0.078 | 0.069 | |
| Jun | 6 | 0.159 | 0.067 | 0.060 | 0.166 |
| | 6.2 | | 0.05 | 0.047 | |
| | 6.4 | | 0.028 | 0.032 | |
| | 6.6 | | 0.014 | 0.018 | |
| | 6.8 | | 0 | 0.008 | |

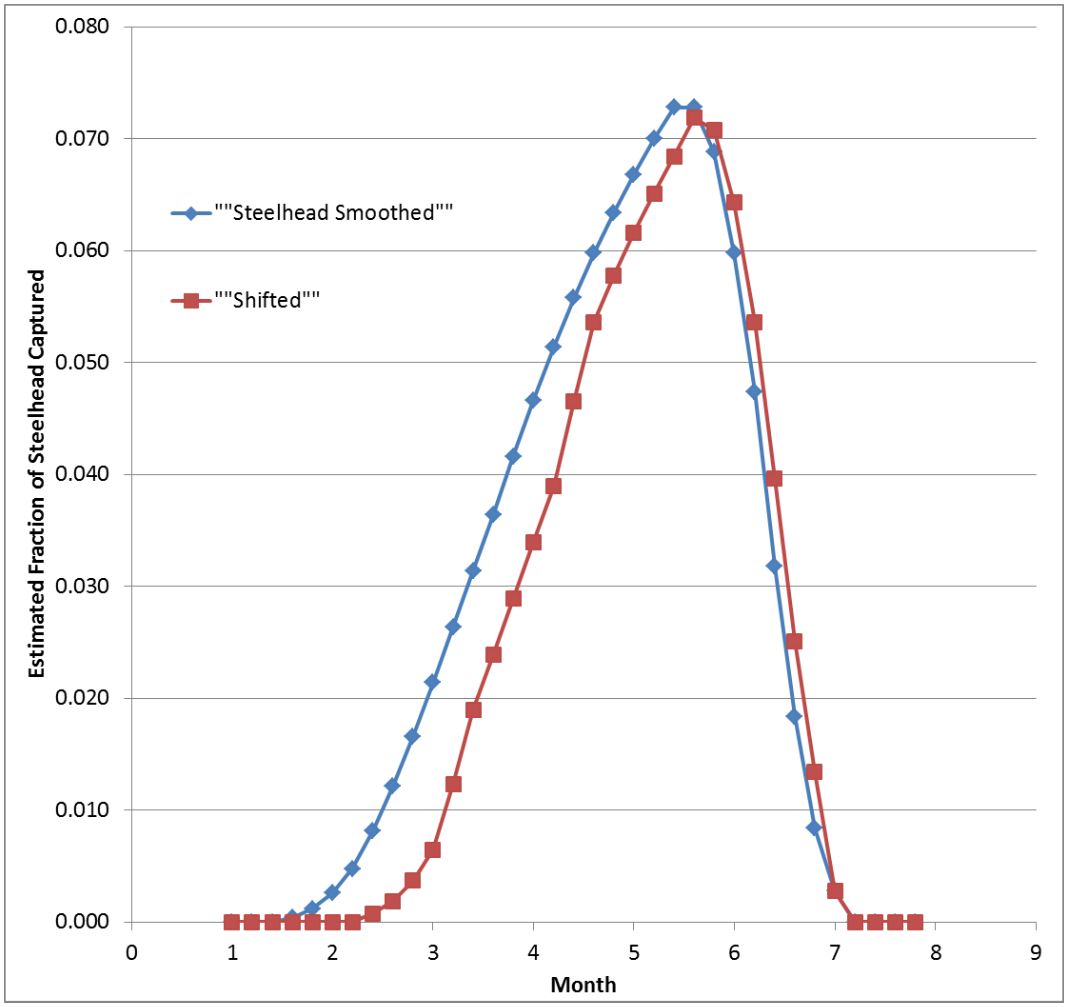



**Figure 3-4. Smoothed Mokelumne River Data shifted / compressed to account for San Joaquin River temperature differences**

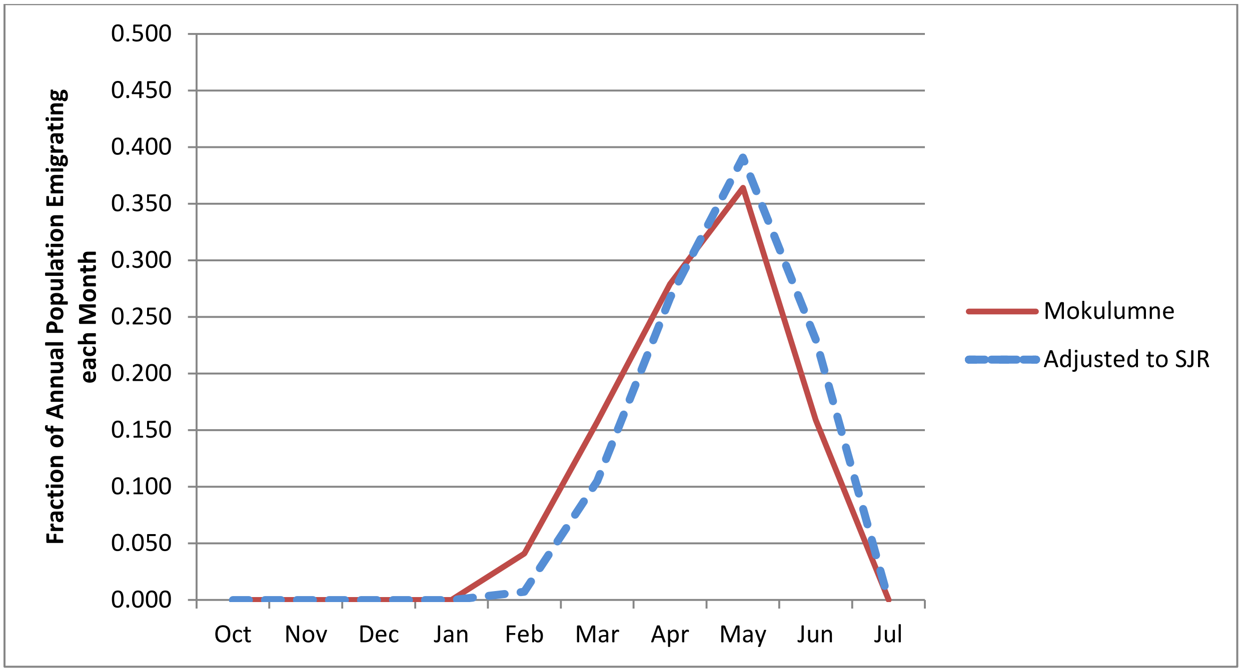



**Figure 3-5. Monthly Distribution of Steelhead from Mokelumne River Data and then Adjusted to San Joaquin River curve used in this analysis.**

# 4.0 Results

## 4.1 Results Summary

Modeling results show that flows into Mendota Pool are primarily dictated by when Friant Dam is releasing flood flows, and to a smaller degree by releases to meet the Exchange Contract. The relative proportion of volume flowing into Mendota Pool as compared to other flowpaths leaving Reach 1 (i.e. the Chowchilla Bypass and the Mendota Pool Bypass) was combined with a model of juvenile fish emigration to determine the proportion of juvenile fish that would likely be entrained into Mendota Pool. This showed that flood flows, particularly precautionary flood flows during February and March, result in the majority of juvenile salmon entrainment. The effect upon spring–run Chinook salmon is roughly equivalent to the effect upon fall–run Chinook salmon, with an annual average of 3.47% of the juvenile fall-run population and 3.96% of the spring-run juvenile fish population predicted by this analysis to be entrained in Mendota Pool. All water year types contribute substantively to this aggregate entrainment, from Wet to Critical–Low. For steelhead, the average annual entrainment of the juvenile fish population predicted is 2.68%, with between 0.4 and 5.1% entrainment predicted in all water year types except Critical Low. As the steelhead emigration window extends into June, it overlaps with the Exchange Contractor releases that can occur in Critical Low and Critical High water years. Critical Low years have substantial entrainment percentages, as there are no Restoration Flows in Critical-Low water years, so any fish emigrating would be doing so in the water supply released from Friant Dam for the exchange contractors to Mendota Pool.

## 4.2 Frequency of Flows

Figure 4–1 below depicts the frequency of days where San Joaquin River water flows into Mendota Pool. Flows into Mendota Pool are dominated by two modes: 1) flood flows released by Friant Dam, and 2) delivery of water to Exchange Contractors from Friant Dam. The former can be further divided into: 1a) precautionary releases to increase reservoir capacity in order to attenuate expected runoff, and 1b) mandatory releases due to reservoir at or near capacity.

The greatest likelihood of flows into Mendota Pool occurs in February and July, where 18% and 12% of days respectively have significant flows into the pool. Figure 4–2 depicts the same information broken out by Water Year Type (See Appendix A for Water Year Type definitions). Here the preponderance of flood flows during the Exchange Contractor deliveries during May through September dominate the frequency, but only during Critical–High and Critical–Low water year types. Because Critical–High and Critical–Low water year types are relatively uncommon, their overall impact to the 82–year record is diminished. There were 16 wet years, 24 Normal–Wet years, 25 Normal–Dry years, 12 Dry years, 4 Critical–High years, and 1 Critical–Low year in the analysis set.

Note that flood flows tend to be bimodal, with early season flood flows in February and March, consisting mostly of precautionary releases, and late season mandatory flood flows in June through August. This pattern is most pronounced in Wet year types. The frequency of flows into Mendota Pool during Critical–High and Critical–Low years is the result of water releases for Exchange Contractors.

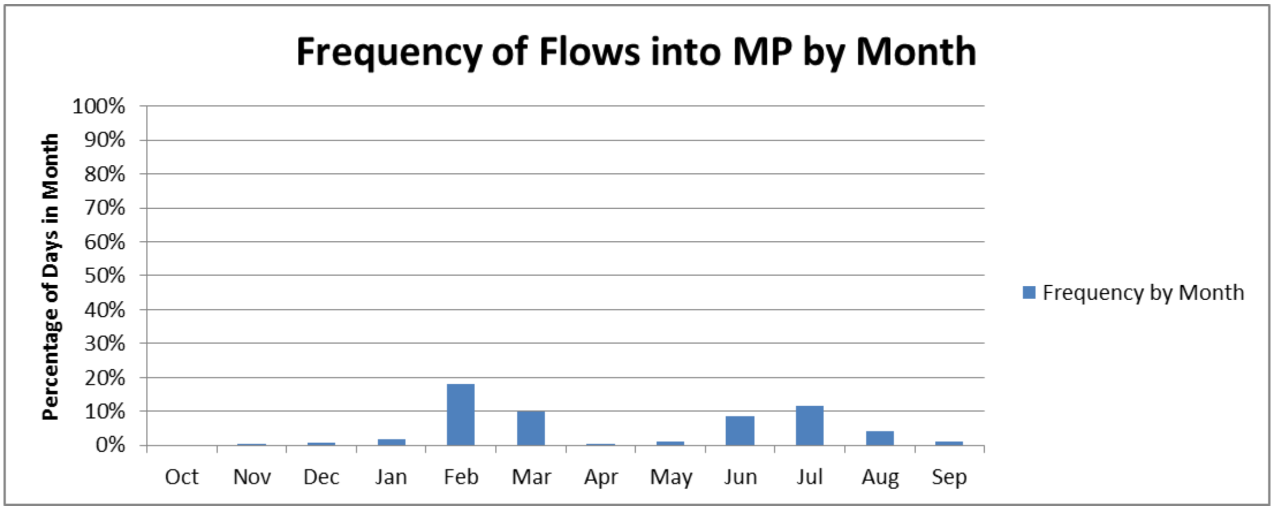



**Figure 4-1. Frequency of Days with Flows into Mendota Pool**

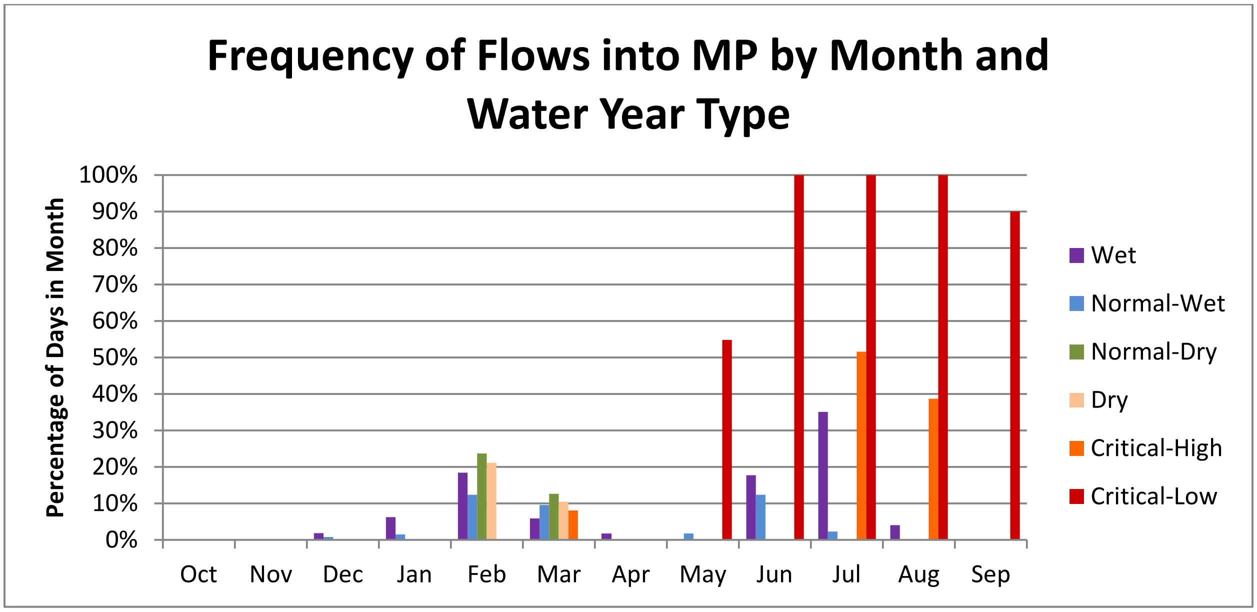



**Figure 4-2. Frequency of Days with Flows into Mendota Pool by Water Year Type**

Precautionary flood releases occur in the record every 3 ½ years on average, and with very few exceptions occur during February and March. These have occurred during all water year types except Critical–Low. Mandatory flood releases occur every 4 years on average, though not always on the same year that precautionary flood releases do. These typically occur during June and July, yet occasionally span from May through August in extremely wet years. All mandatory flood releases occur during Wet and Normal–Wet year types. Table 4–1 summarizes the approximate characteristics of floods that result in flows into Mendota Pool according to the Riverware modeling.

**Table 4-1. Characteristics of Flood Flows (for flood over 3 days in length)**

| Month | Flood Return Interval | Mean # of Days of Flood | Water Year Types | Flood Type |
|---|---|---|---|---|
| **Jan** | 27 years | 16 | Wet, Normal–Wet | Precautionary and Mandatory |
| **Feb** | 3.5 years | 18 | Wet, Normal–Wet, Normal–Dry, Dry | Precautionary |
| **Mar** | 3.9 years | 15 | Wet, Normal–Wet, Normal–Dry, Dry, Critical–High | Precautionary |
| **Apr** | 82 years | 8 | Wet | Precautionary |
| **May** | 16 years | 8 | Wet, Normal–Wet (Critical–Low for Exchange Contractor Releases) | Mandatory and EC Releases |
| **Jun** | 5.9 years | 18 | Wet, Normal–Wet (Critical–Low for Exchange Contractor Releases) | Mandatory and EC Releases |
| **Jul** | 4.3 years | 17 | Wet, Normal–Wet (Critical–High, Critical–Low for Exchange Contractor Releases) | Mandatory and EC Releases |
| **Aug** | 12 years | 15 | Wet, Normal–Wet (Critical–High, Critical–Low for Exchange Contractor Releases) | Mandatory and EC Releases |

## 4.3 Volume of Flows

The volume of flows that enters Mendota Pool varies by months and water year type (Figure 4–3). February averages about 6 TAF of volume into Mendota Pool, where March averages about 3 TAF, with this varying somewhat across water year types. Volumes vary broadly in May through September based on water year type, and can be as high as 58 TAF. Table 4–2 provides the average volumes across the modeling record for each month and water year type.

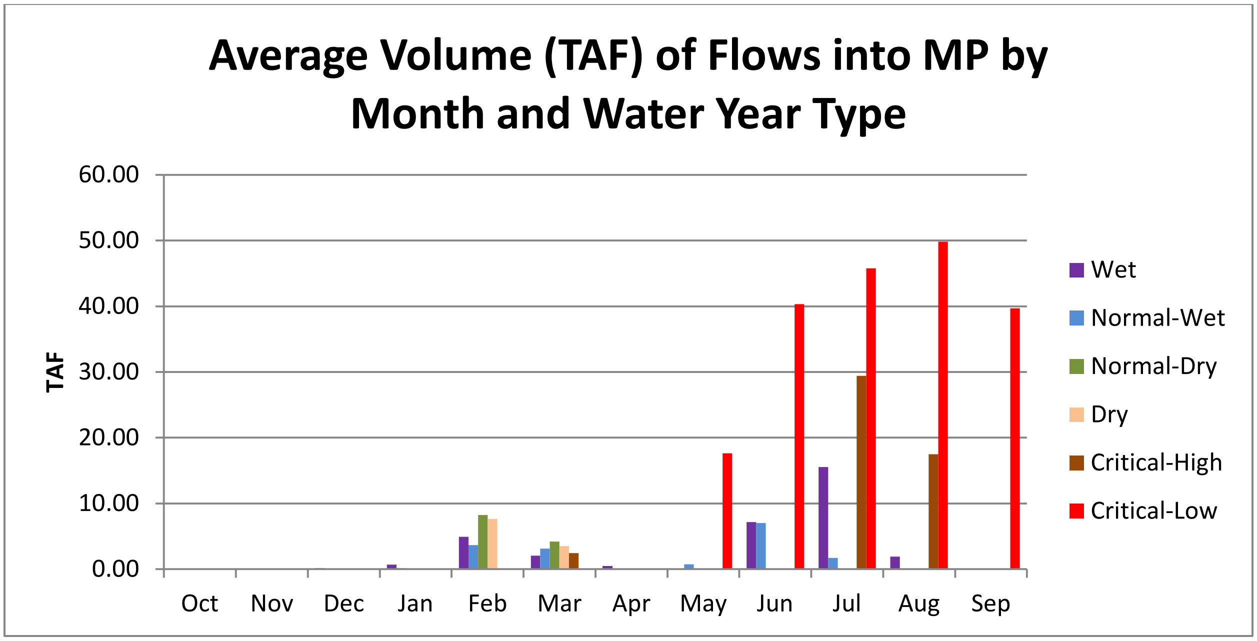



**Figure 4-3 Absolute Volume of Flows into Mendota Pool by Water Year Type**

**Table 4-2 Volumes of Flows by Month (Volume into Mendota Pool / Total River Volume) in Thousand Acre Feet (TAF)**

| Month | Wet | Normal-Wet | Normal-Dry | Dry | Critical High | Critical Low |
|---|---|---|---|---|---|---|
| Oct | 0 / 6.48 | 0 / 6.32 | 0 / 6.64 | 0 / 6.91 | 0 / 6.91 | 0 / 0 |
| Nov | 0 / 14.54 | 0.03 / 14.35 | 0 / 14.97 | 0 / 15.5 | 0 / 15.5 | 0 / 2.23 |
| Dec | 0.14 / 21.86 | 0.07 / 16.2 | 0 / 9.15 | 0 / 9.53 | 0 / 9.53 | 0 / 0 |
| Jan | 0.68 / 67.26 | 0.16 / 11.75 | 0 / 10.27 | 0 / 10.7 | 0 / 10.7 | 0 / 0 |
| Feb | 4.92 / 56.21 | 3.66 / 15.22 | 8.26 / 25.72 | 7.66 / 31.24 | 0 / 12.32 | 0 / 0 |
| Mar | 2.05 / 94.31 | 3.12 / 52.85 | 4.19 / 51.74 | 3.52 / 50.21 | 2.44 / 28.25 | 0 / 42.47 |
| Apr | 0.44 / 206.35 | 0 / 148.56 | 0 / 67.33 | 0 / 31.44 | 0 / 17.8 | 0 / 4.73 |
| May | 0 / 223.22 | 0.72 / 28.09 | 0 / 8 | 0 / 2.57 | 0 / 2.24 | 17.63 / 26.43 |
| Jun | 7.18 / 201.59 | 7.02 / 17.07 | 0 / 5.06 | 0 / 2.93 | 0 / 0 | 40.34 / 61.09 |
| Jul | 15.56 / 88.76 | 1.73 / 5.86 | 0 / 2.89 | 0 / 2.11 | 29.4 / 42.64 | 45.76 / 66.37 |
| Aug | 1.9 / 5.85 | 0 / 2.78 | 0 / 2.77 | 0 / 2.09 | 17.48 / 23.31 | 49.82 / 66.41 |
| Sep | 0 / 3.8 | 0 / 3.8 | 0 / 3.8 | 0 / 3.74 | 0 / 0 | 39.67 / 50.46 |
| Total | 33 / 990 | 17 / 323 | 12 / 208 | 11 / 169 | 49 / 169 | 193 / 320 |

Plotting the fractional volume of flow into Mendota Pool (Figure 4–4) shows a similar pattern to the frequency plot of Figure 4–1, though with greater amplitude. Figure 4–4 depicts the fraction of that entire water year's volume routed to Mendota Pool. Volume in July and August is higher in comparison to other months than its respective frequency, indicating that flows into Mendota Pool during this month tend to be larger (higher cubic feet per second). This is influenced by extreme flood events (i.e. 1969, 1982) that continued through the summer, and flow releases for the Exchange Contractors.

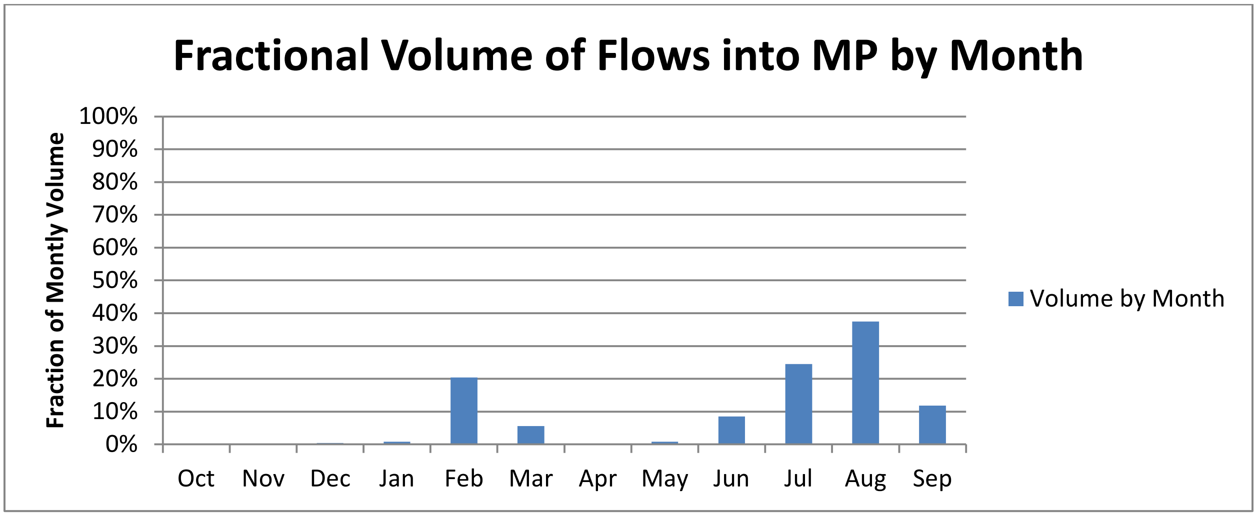



**Figure 4-4. Fractional Volume of Flows into Mendota Pool**

When broken out by Water Year Type, a more complex pattern emerges (Figure 4–5). Wet years have proportionally less of their volume released during February and March flood releases, whereas Normal–Wet, Normal–Dry, and Dry years have a fairly high proportion of their annual volume released in February flood flows. In nearly all cases, these February flows during non–Wet year types are mostly composed of precautionary flood releases. In many of those cases, subsequent months of lower precipitation did not result in actual spillway releases (i.e. mandatory flood releases).

Critical–High and Critical–Low water years are dominated by Exchange Contractor Releases, which constitute nearly all of the flow into Mendota Pool during those times, and only occur during the summer. Though the fractional volume of flows into Mendota Pool are conspicuous during Critical–High and Critical–Low water year types, their overall contribution is smaller because Critical–High and Critical–Low water years occur less frequently over the long–term record.

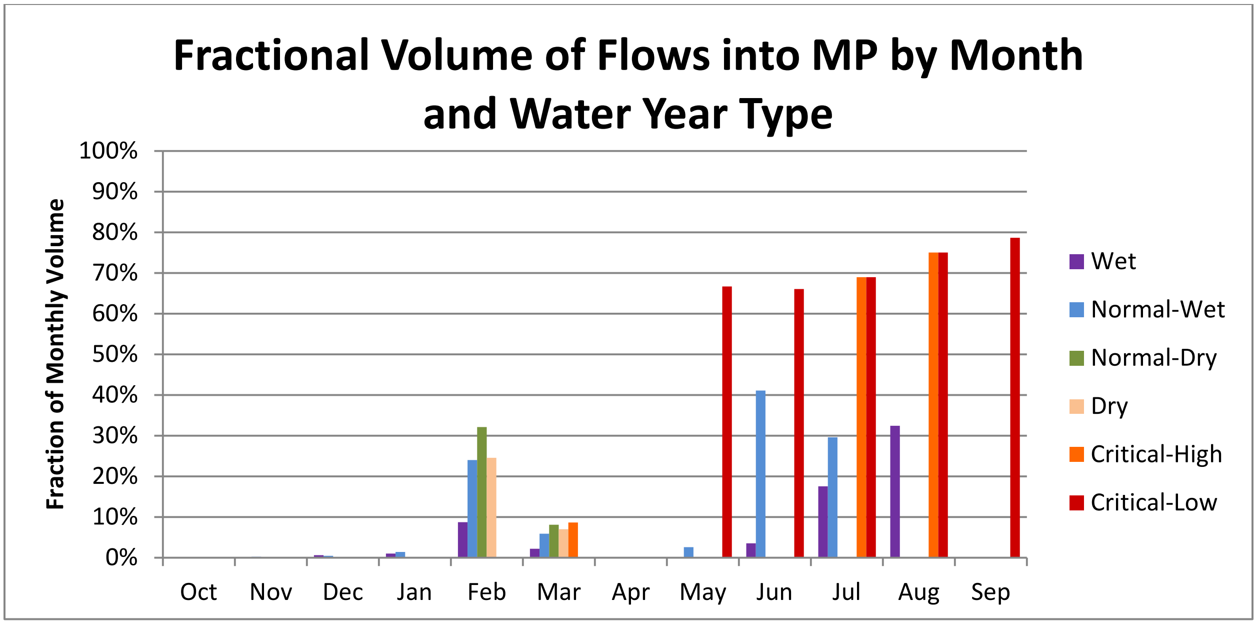



**Figure 4-5. Fractional Volume of Flows into Mendota Pool by Water Year Type**

Figure 4–6 shows the percentile distribution of Mendota Pool flow volumes. These are shown in absolute volume in units of thousand acre–feet. The median (50$^{th}$ percentile) of each and every month has zero volume, indicating that in a typical year there are no flows into Mendota Pool. The distribution is very positively skewed, with most of the volume into Mendota Pool in the 82–year model run being caused by large and infrequent events. In one out of twenty years (the 95$^{th}$ percentile), four months have greater than half their volume being directed to Mendota Pool. Conversely, in ten out of twenty years, no flows into Mendota Pool can be expected.

Table 4–3 shows the percentile fraction across all months. In ten out of twenty years (50$^{th}$ percentile), less than 1% of water flows into Mendota Pool. In one out of twenty years (95$^{th}$ percentile), 26% of annual flow total is routed into Mendota Pool.

Table 4–4 expands on Table 4–1, depicting percentile fraction of annual volume (expressed as a percentage as before) by month. There is virtually no flow into Mendota Pool in any month until percentiles climb to 80$^{th}$. Beyond the8 percentile, there are rapidly increasing fractions of volumes into Mendota Pool for February, March, June, July, and August. Zeros are shaded gray for clarity.

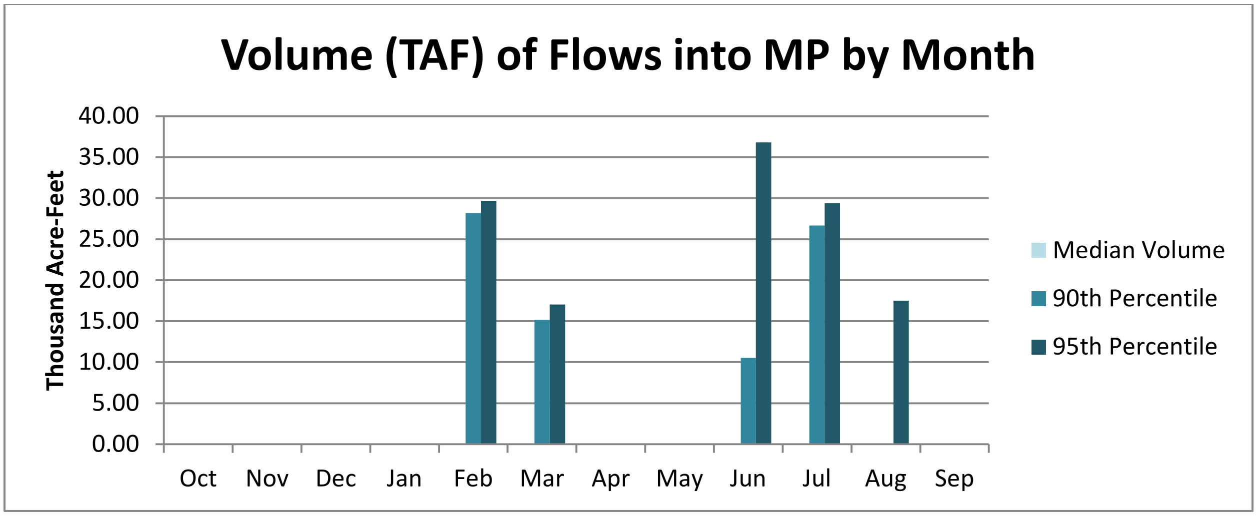



**Figure 4-6. Volume of Flows (TAF) into Mendota Pool by Percentile**

**Table 4-3. Percentile of Fraction of Annual Volume into Mendota Pool for All Years**

| | 50th Percentile | 60th Percentile | 70th Percentile | 80th Percentile | 90th Percentile | 95th Percentile |
|---|---|---|---|---|---|---|
| **All Years** | <1% | 2.8% | 8.2% | 14.3% | 17.1% | 25.6% |

**Table 4-4. Percentiles of Fraction of Monthly Volume into Mendota Pool by Month**

| Month | 50th Percentile | 60th Percentile | 70th Percentile | 80th Percentile | 90th Percentile | 95th Percentile |
|---|---|---|---|---|---|---|
| **Oct** | 0% | 0% | 0% | 0% | 0% | 0% |
| **Nov** | 0% | 0% | 0% | 0% | 0% | 0% |
| **Dec** | 0% | 0% | 0% | 0% | 0% | 0% |
| **Jan** | 0% | 0% | 0% | 0% | 0% | 0% |
| **Feb** | 0% | 0% | 0% | 30% | 54% | 65% |
| **Mar** | 0% | 0% | 0% | 6% | 21% | 25% |
| **Apr** | 0% | 0% | 0% | 0% | 0% | 0% |
| **May** | 0% | 0% | 0% | 0% | 0% | 0% |
| **Jun** | 0% | 0% | 0% | 0% | 26% | 56% |
| **July** | 0% | 0% | 0% | 6% | 69% | 87% |
| **Aug** | 0% | 0% | 0% | 0% | 2% | 75% |
| **Sep** | 0% | 0% | 0% | 0% | 0% | 0% |

## 4.4 Estimating Salmonid Entrainment

We examined the benefit of a fish screen by looking at what entrainment would occur without a screen in place. The likelihood of entrainment of both fall–run and spring–run Chinook salmon was estimated by multiplying the fish emigration model by the proportion of volume into Mendota Pool in each month of the analysis across 82 years. This provided a representative estimate of the long–term probability of entrainment at Mendota Pool without a fish screen. It was assumed that fish were evenly distributed in the river flow and responded equally to both the rising and falling hydrograph. Lower volumes were assumed to have higher “concentrations” of fish, therefore the proportion of volume to Mendota Pool was used in lieu of absolute volume of flows. The result of this mathematical operation is a fraction of the juvenile salmon population that is entrained. This should not be confused with absolute numbers of fish entrained, as Wet years should have larger numbers of fish entrained than Dry, Critical–High, or Critical–Low years.

Figure 4–7 depicts the fraction of the annual juvenile Chinook salmon population that is likely to be entrained into Mendota Pool by month. The majority of entrainment is expected in February and March when both fish emigration and flow into Mendota Pool is relatively high. The percentage of the annual population that is expected to be entrained averaged across all months and water year types is 3.47% for fall–run Chinook salmon, 3.96% of spring–run Chinook salmon, and 2.68% for steelhead (Table 4–5).

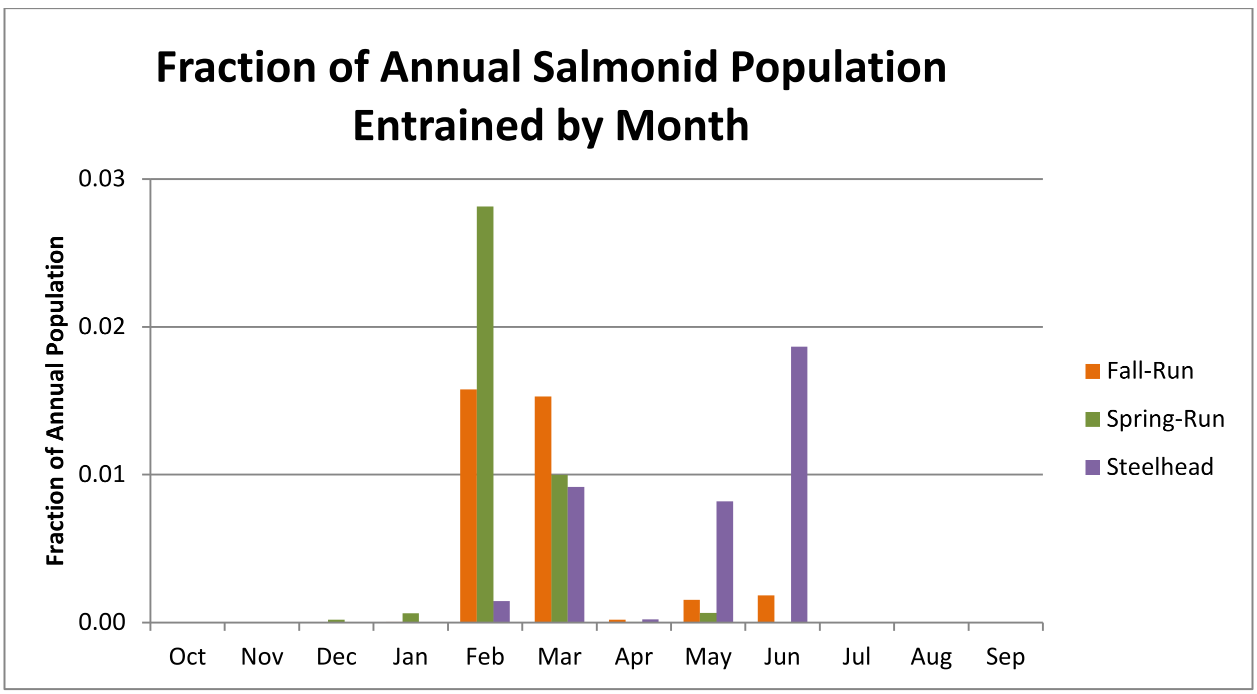



**Figure 4-7. Fraction of the Annual Salmonid Population that is Likely to be Entrained into Mendota Pool.**

**Table 4-5. Salmonid Population Likely to be Entrained at Mendota Pool**

| | Fall–Run Chinook salmon | Spring–Run Chinook salmon | Steelhead |
|---|---|---|---|
| **Percent of Annual Population** | 3.47% | 3.96% | 2.68% |

When fish entrainment is broken out by Water Year Type (Figure 4–8 for fall–run, Figure 4–9 for spring–run Chinook salmon, and Figure 4-10 for steelhead) the importance of February and March flows becomes even more striking. The difference between these two figures and Figure 4–5 is primarily due to the absence of emigrating fish during summer and fall months. Entrainment during February and March flood releases is similar across Wet, Normal–Wet, Normal–Dry, and Dry water year types. Note the different vertical scale between the two figures. Unexpectedly, entrainment exceeds 0.03 or 3% of both the fall–run and spring–run populations in March in Critical–High years. These values are due to precautionary flood releases that occurred in the model run in 1976 when a Critical–High year followed a Normal–Wet water year. For steelhead, with their later migration timing, most of the entrainment occurs during deliveries to Mendota Pool in the summer rather than flood flows. The importance of the fish migration curve is pronounced for steelhead. As the steelhead emigration curve used has high amounts of juvenile steelhead moving to the ocean in May and June, releases for the Exchange Contractors water supply in drier years becomes important, and results in very high proportions of fish entrained in Critical-Low years when these occur

Table 4–6 shows entrainment by water year type. Values range from 2% to 5% depending on the water year type, with the exception of Critical–Low years with the synthetic Exchange Contractor water release in mid–May causing higher entrainment for fall-run and steelhead (8% and 41%). A Critical–Low year only occurred once in the modeling scenario and therefore had a relatively small impact upon overall entrainment. In interpreting these figures, it is important to differentiate between the fraction of annual fish population, depicted here, with number of individuals, which would certainly vary from one year to another.

Table 4–7 shows percentile fraction of annual fish population entrained by month. Compare to Table 4–4 which shows volumes of water, instead of entrainment. Only at the 80$^{th}$ percentile and above do two months, February and March, have notable entrainment. The impact of flows for Exchange Contractors in May and June is very small, <2% for both months combined at the 95$^{th}$ percentile. The first value is color–coded for fall–run with the second value for spring–run and the third value for steelhead; zeros are shaded gray for clarity. This table is particularly useful for understanding the difference between long-term average, which incorporates many years of zero entrainment, with episodic events. Finally, Figures 4–11 and 4–12 depict fish entrainment of both fall–run and spring–run juveniles as a yearly time series. Most years have no entrainment, while moderate entrainment punctuates the time series. The highest annual entrainment in the model run for Chinook salmon was 1932, when 22%, and 27% of fall–run and spring–run juveniles were entrained due to a protracted precautionary flood release occurring January through March. For steelhead, the highest annual entrainment in the model run was in 1977, the Critical-Low water year, when the model predicts 41% entrainment for steelhead juveniles if a year like 1977 occurs in the future.

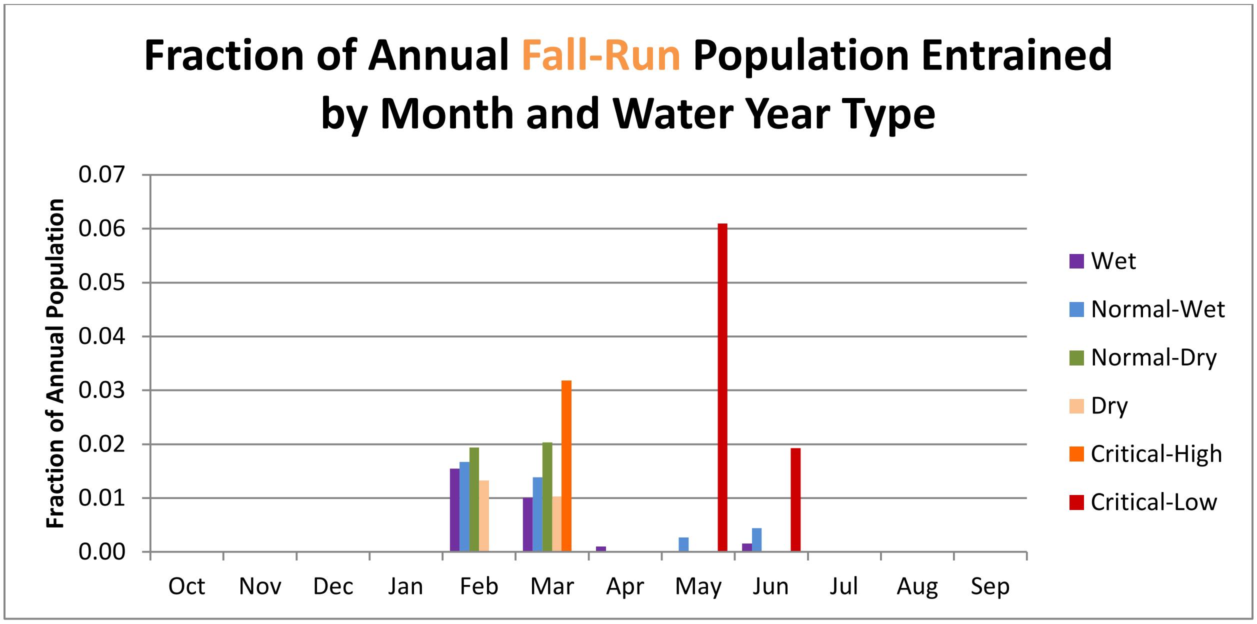



**Figure 4-8. Fraction of the juvenile Fall–run Chinook Salmon Population that is Likely to be Entrained into Mendota Pool by Water Year Type**

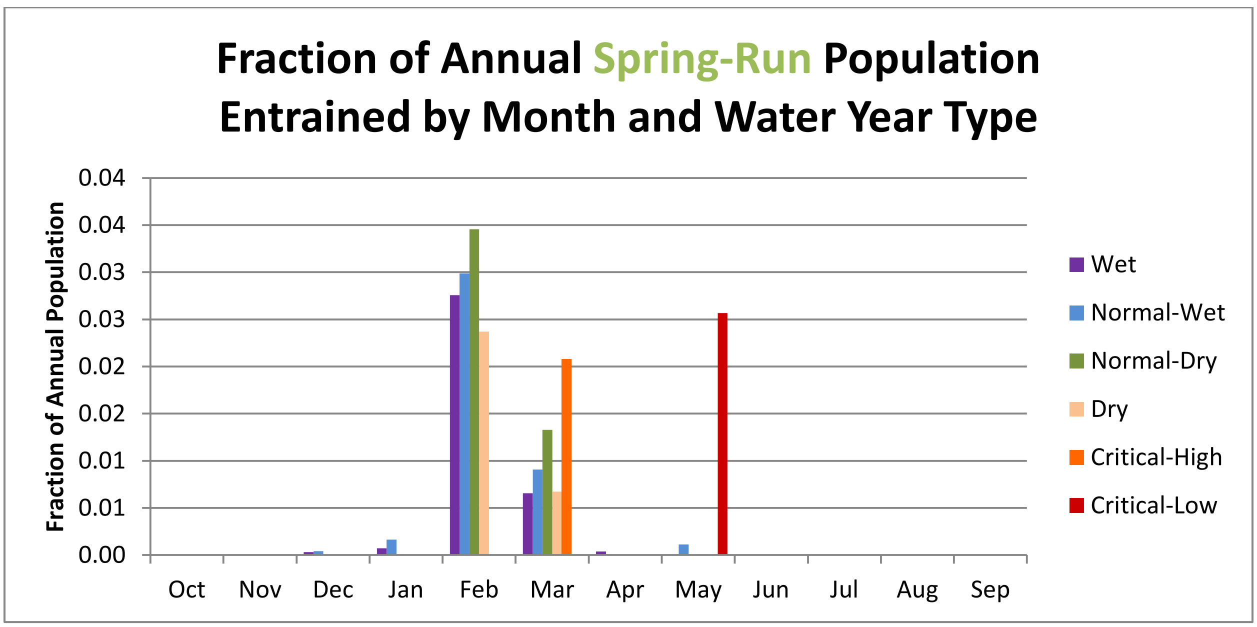



**Figure 4-9. Fraction of the juvenile Spring–run Chinook Salmon Population that is Likely to be Entrained into Mendota Pool by Water Year Type**

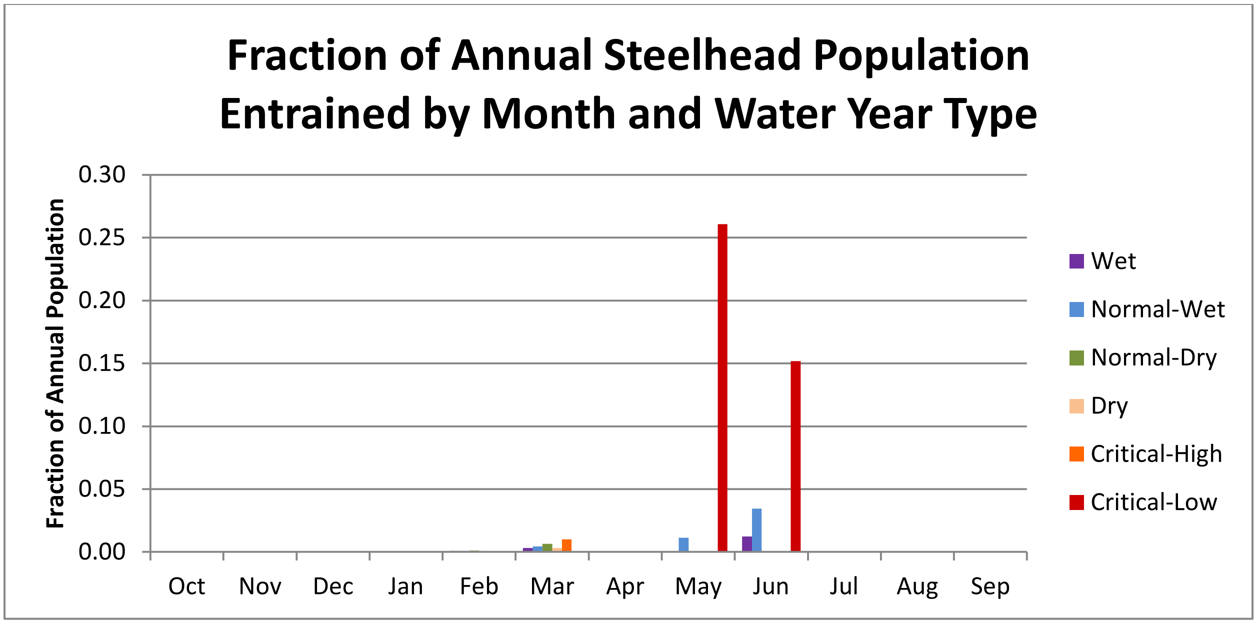


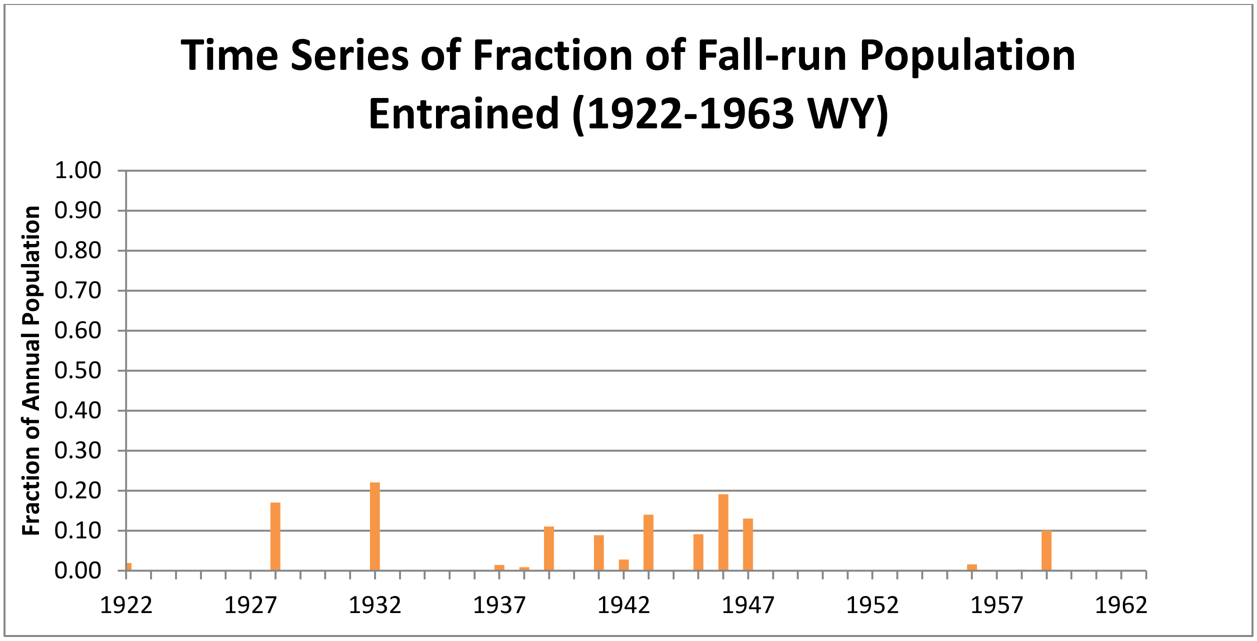

**Figure 4-10. Fraction of the juvenile Steelhead Population that is Likely to be Entrained into Mendota Pool by Water Year Type**

**Table 4-6. Fall–run and Spring–run Chinook Salmon and Steelhead Population Likely to be Entrained at Mendota Pool by Water Year Type**

| Water Year Type | Number of Years in Model Run | Fall–Run Chinook salmon | Spring–Run Chinook salmon | Steelhead |
|---|---|---|---|---|
| **Wet** | 16 | 2.8% | 3.6% | 1.7% |
| **Normal–Wet** | 24 | 3.8% | 4.2% | 5.1% |
| **Normal–Dry** | 25 | 4.0% | 4.8% | 0.8% |
| **Dry** | 12 | 2.4% | 3.0% | 0.4% |
| **Critical–High** | 4 | 3.2% | 2.1% | 1.0% |
| **Critical–Low** | 1 | 8.0% | 2.6% | 41.3% |

**Table 4-7. Percentiles of Fraction of Fall–run and Spring–run Chinook salmon and Steelhead entrained at Mendota Pool by Month**

| Month | 50th Percentile | 60th Percentile | 70th Percentile | 80th Percentile | 90th Percentile | 95th Percentile |
|---|---|---|---|---|---|---|
| Oct | 0% | 0% | 0% | 0% | 0% | 0% |
| Nov | 0% | 0% | 0% | 0% | 0% | 0% |
| Dec | 0% | 0% | 0% | 0% | 0% | 0% |
| Jan | 0% | 0% | 0% | 0% | 0% | 0% |
| Feb | 0% | 0% | 0% | 4% / 7% / 0% | 7% / 12% / 0% | 8% / 15% / 0% |
| Mar | 0% | 0% | 0% | 2% / 1% / 1% | 7% / 5% / 2% | 8% / 5% / 3% |
| Apr | 0% | 0% | 0% | 0% | 0% | 0% |
| May | 0% | 0% | 0% | 0% | 0% | 0% |
| Jun | 0% | 0% | 0% | 0% | <1% / 0% / 6% | 2% / 0% / 12% |
| July | 0% | 0% | 0% | 0% | 0% | 0% |
| Aug | 0% | 0% | 0% | 0% | 0% | 0% |
| Sep | 0% | 0% | 0% | 0% | 0% | 0% |



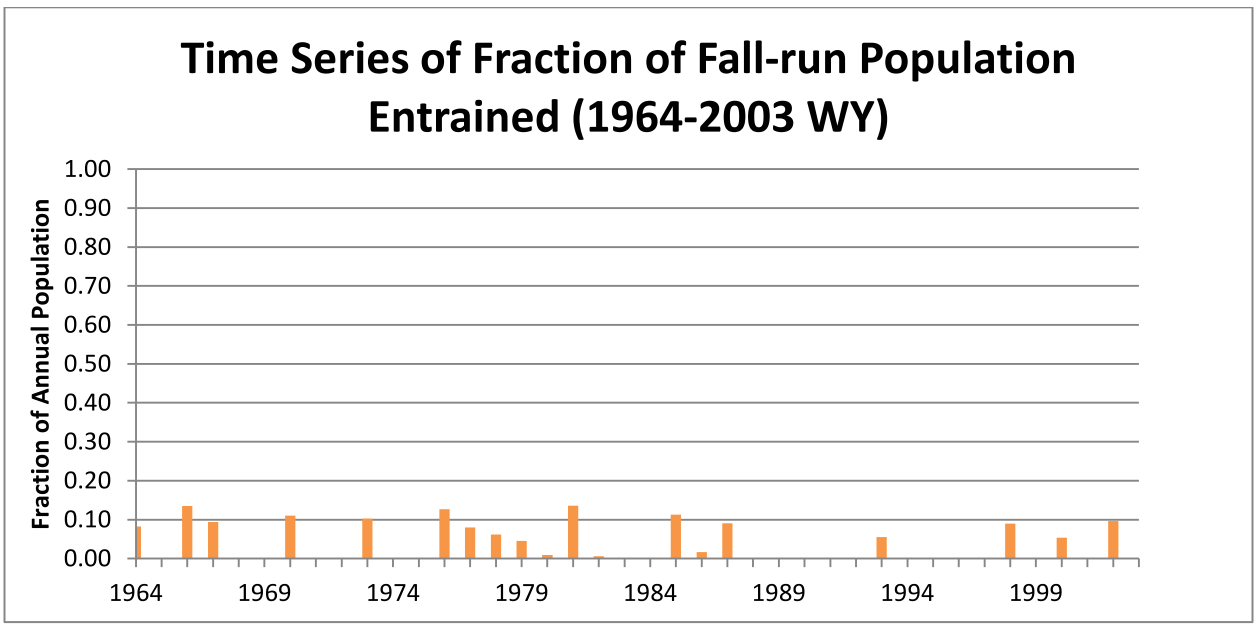
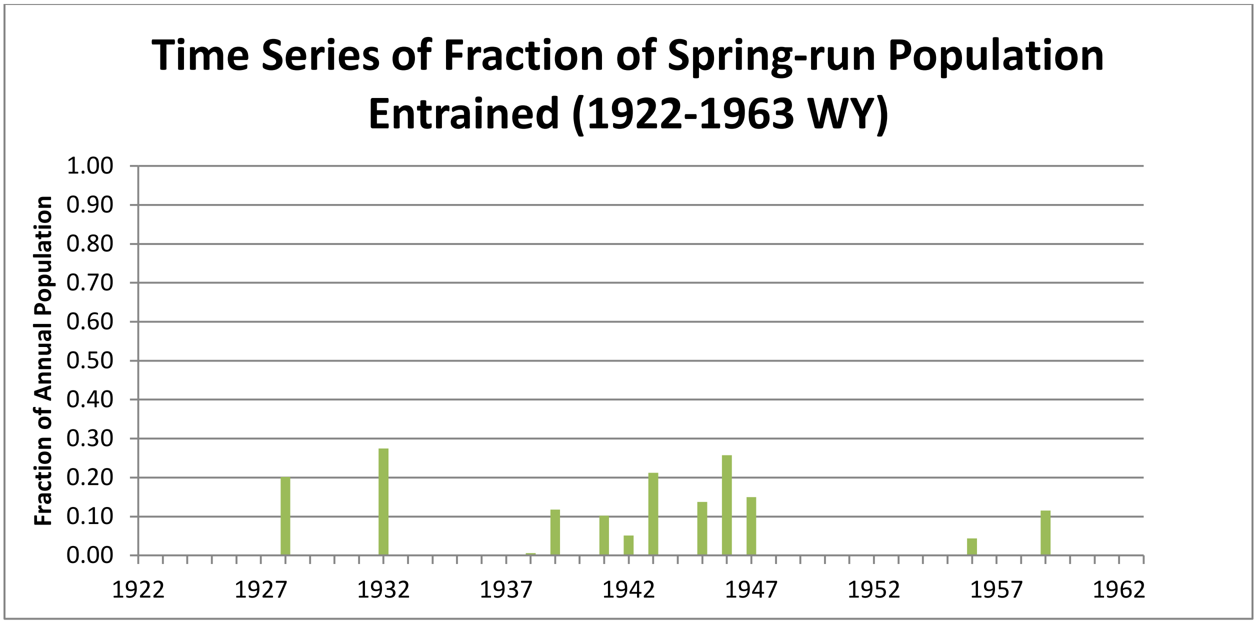




**Figure 4-11. Time Series of Fraction of Fall–run Chinook Salmon Population Entrained (set 1: 1922–1963, set 2: 1964–2003)**



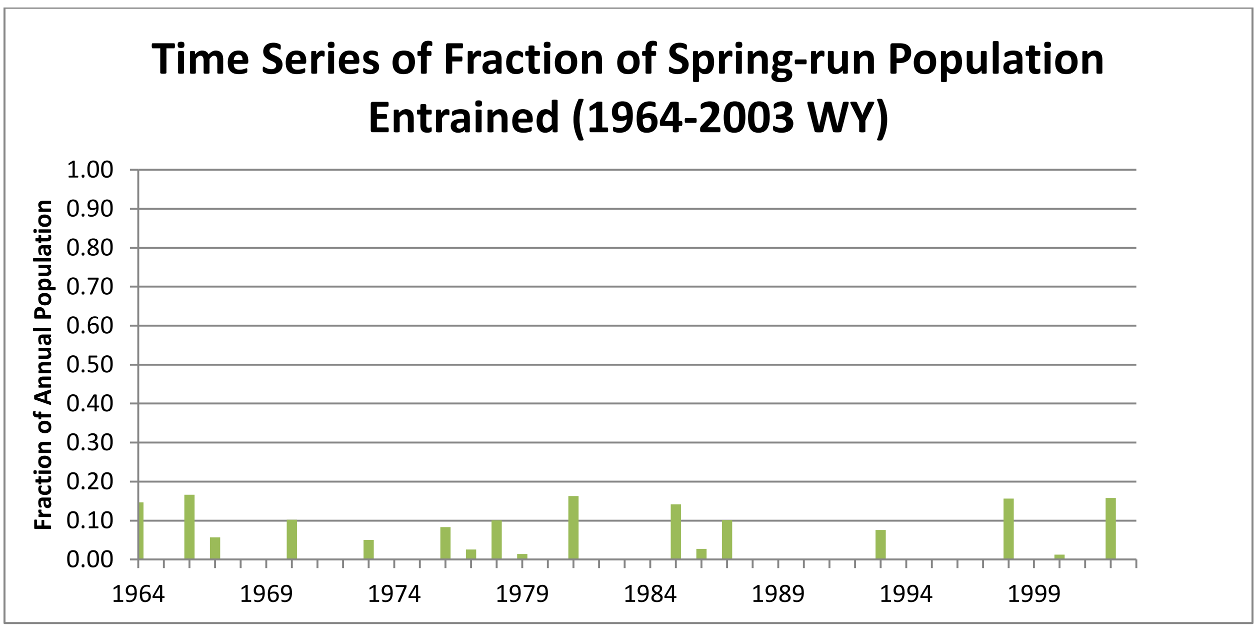
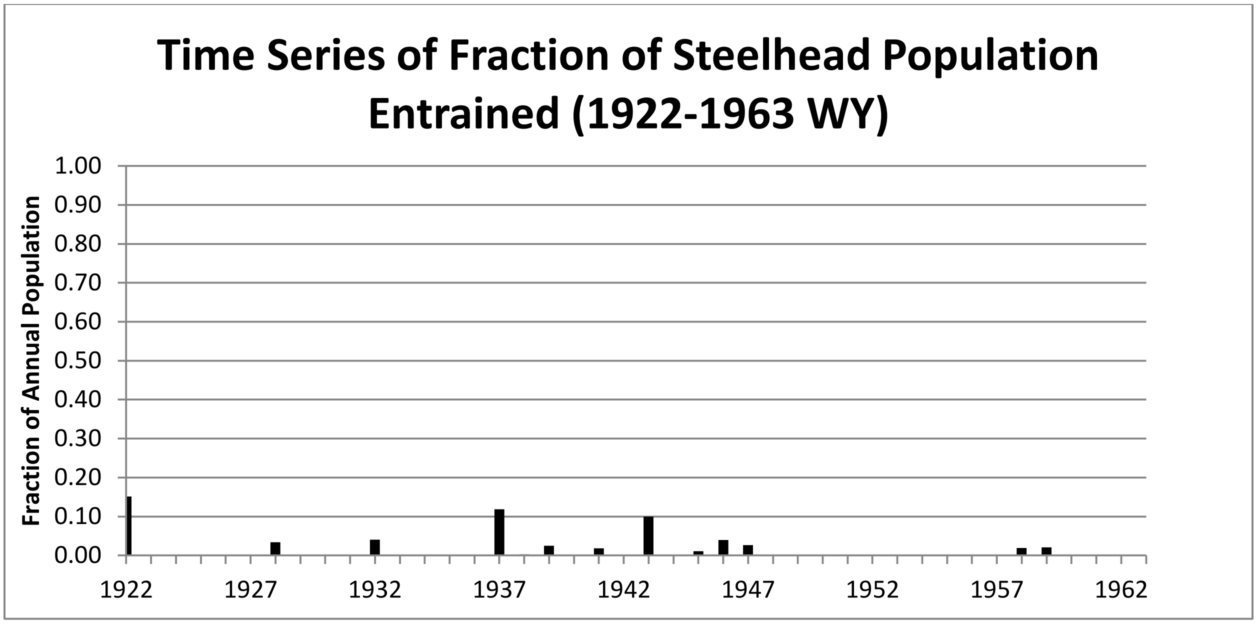




**Figure 4-12. Time Series of Fraction of Spring–run Chinook Salmon Population Entrained (set 1: 1922–1963, set 2: 1964–2003)**



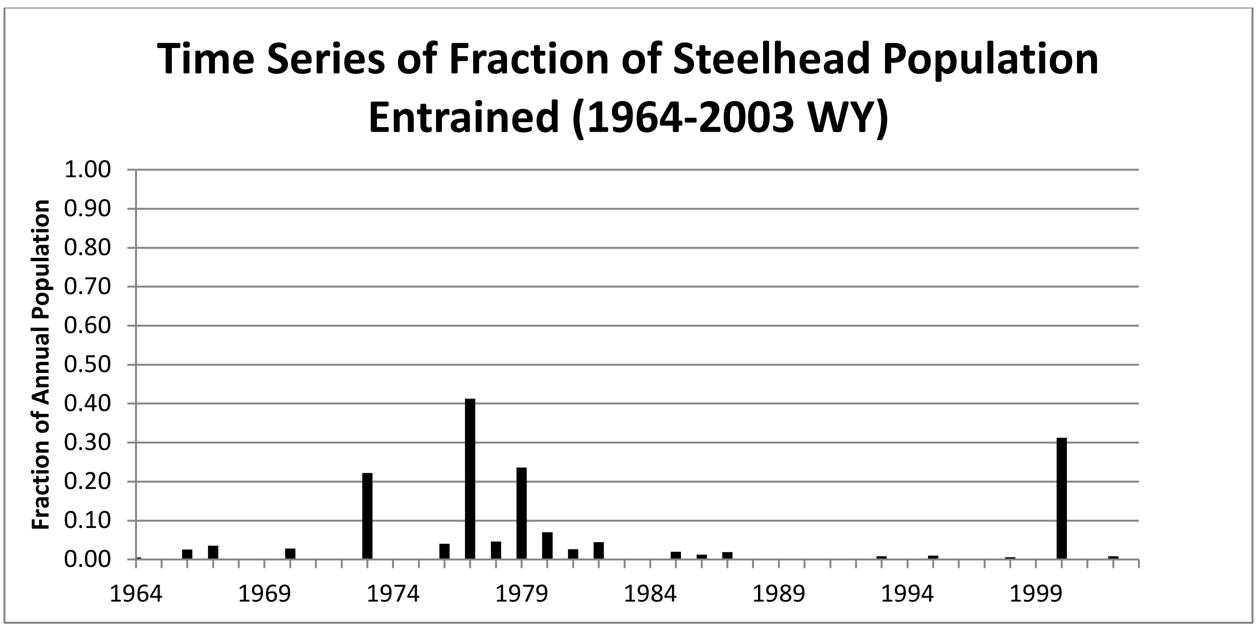




**Figure 4-13. Time Series of Fraction of Steelhead Population Entrained (set 1: 1922–1963, set 2: 1964–2003)**

Another way to depict the estimates of entrainment and its influence upon population dynamics is to plot a four-year running average. This approximately tracks the influence on the salmon population (the typical lifespan of a Chinook salmon is 3–7 years, and if high entrainment occurs for 4 years in a row, a significant population decrease would result). Figure 4–14, 4–15 and 4-16 depict this running average. For fall–run Chinook salmon entrainment exceeds the 10% for a 3–year period. For spring–run Chinook salmon, entrainment exceeds 10% for five years in a row. For steelhead, the model predicts entrainment exceeding 10% for 4 years in a row.

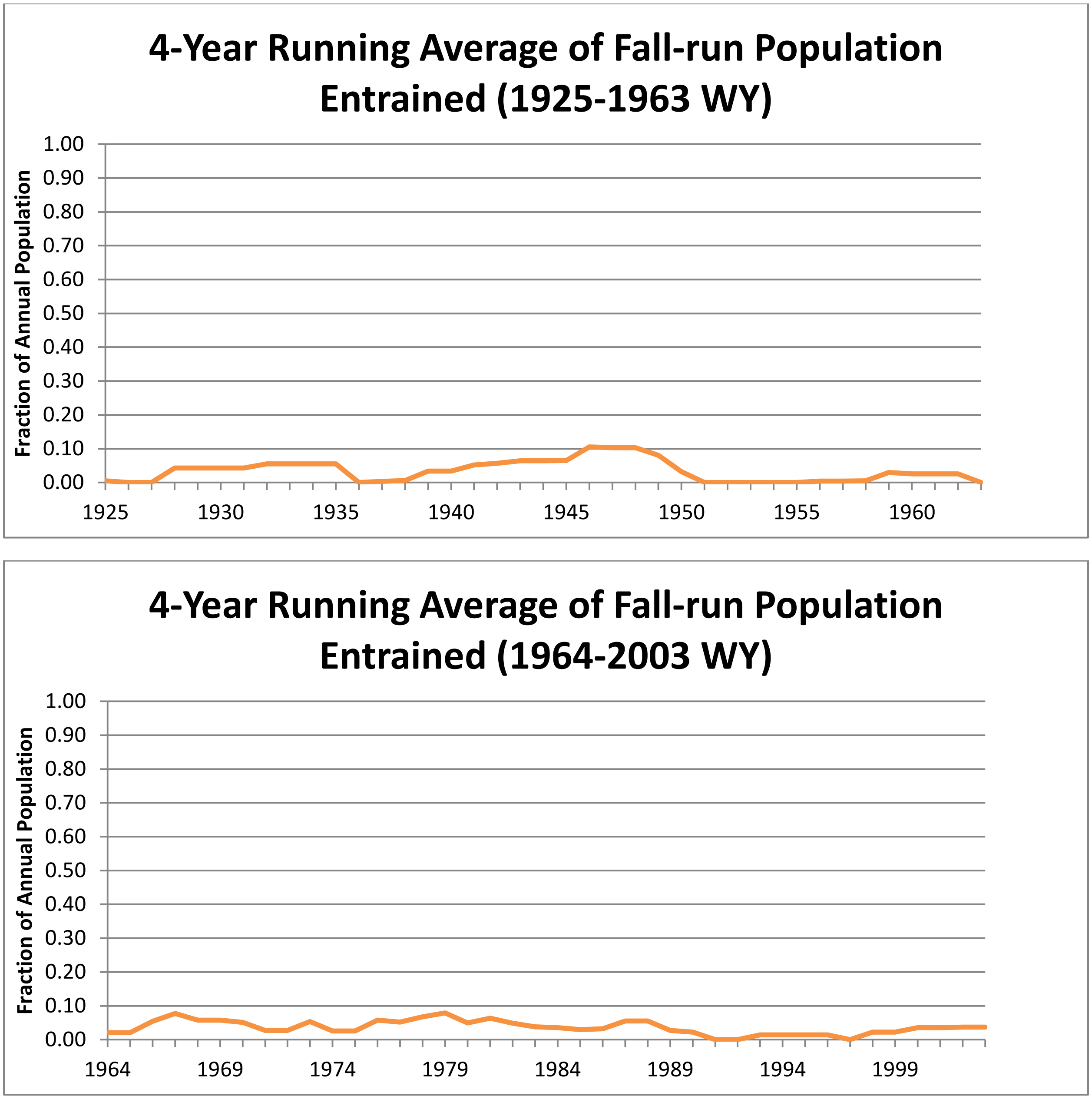
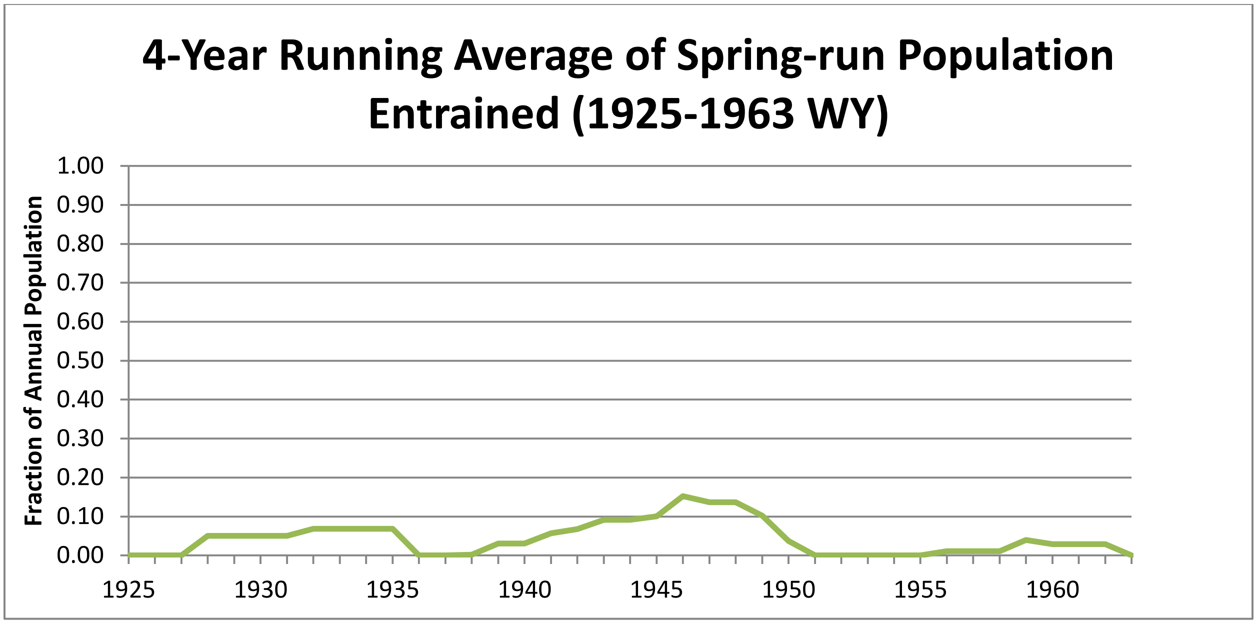



**Figure 4-14. Four-Year Running Average of Fraction of Fall–run Chinook Salmon Population Entrained (set 1: 1922–1963, set 2: 1964–2003)**



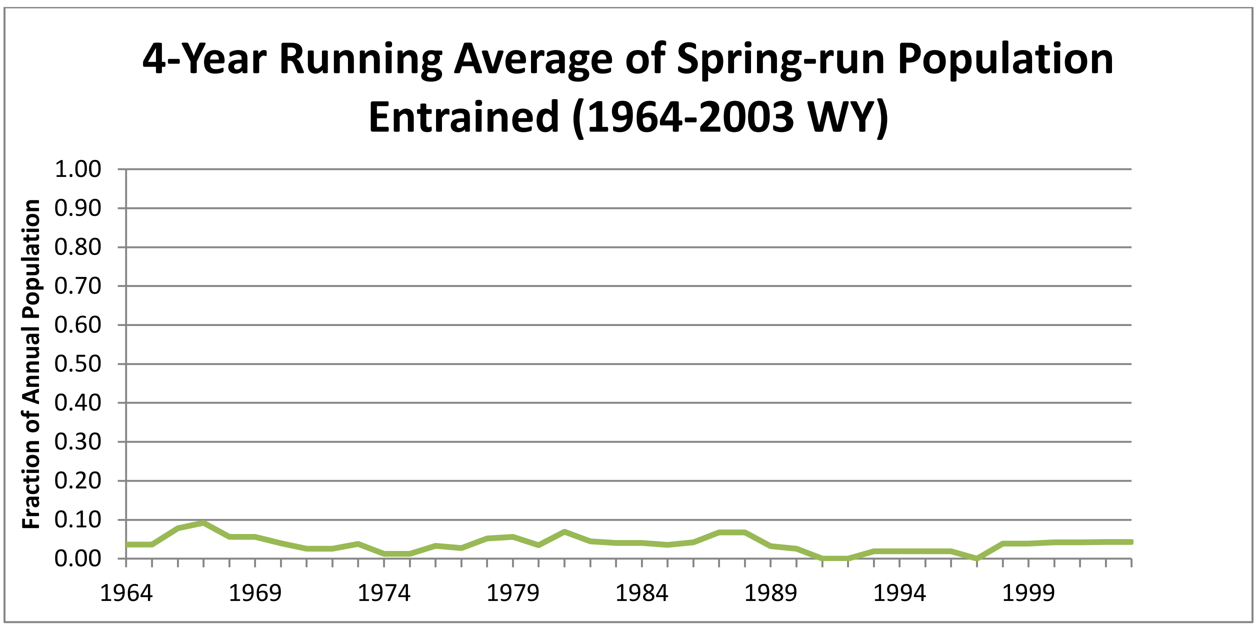
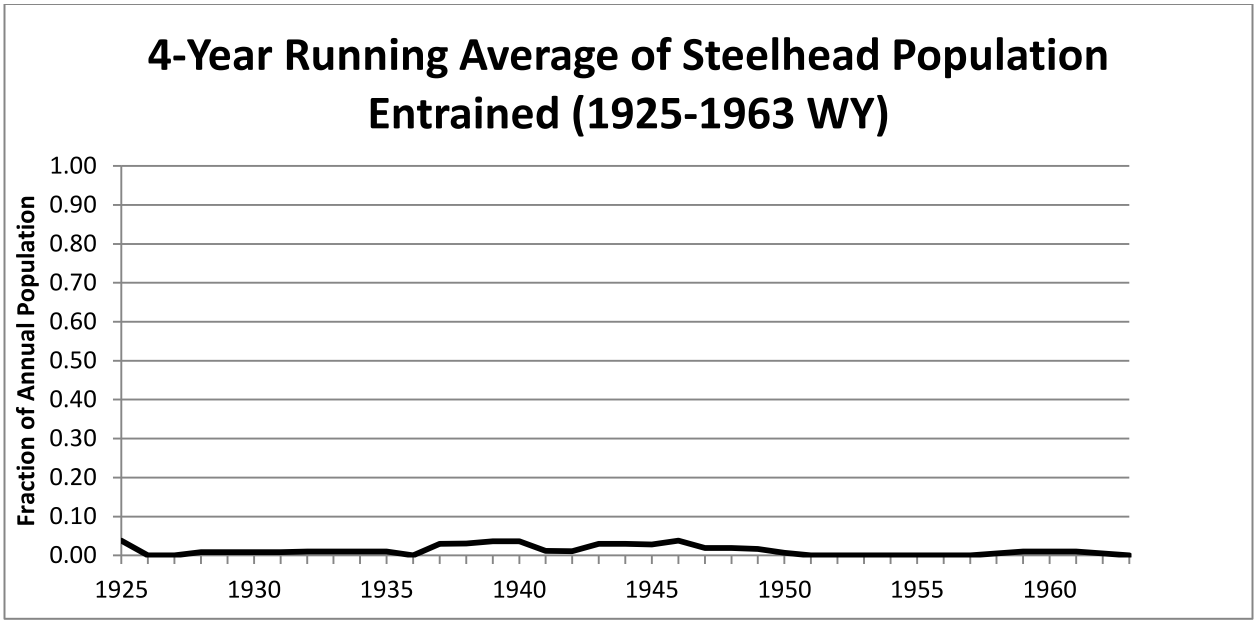




**Figure 4-15. Four-Year Running Average of Fraction of Spring–run Chinook Salmon Population Entrained (set 1: 1922–1963, set 2: 1964–2003)**



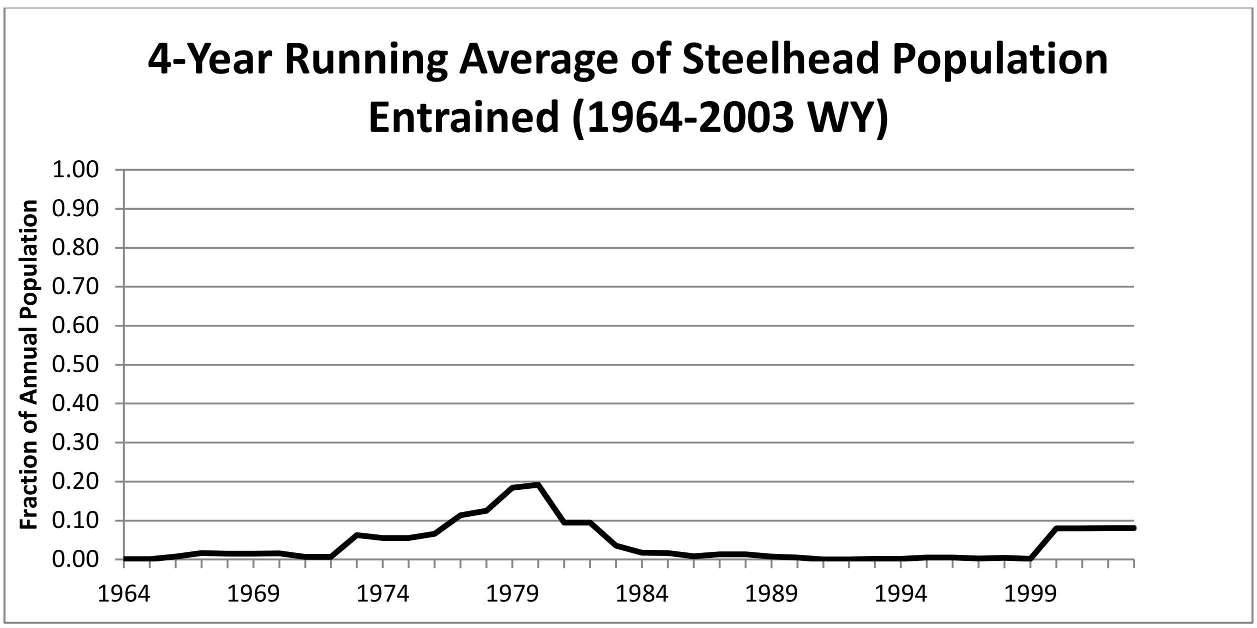




**Figure 4-16. Four-Year Running Average of Fraction of Steelhead Population Entrained (set 1: 1922–1963, set 2: 1964–2003)**

# 5.0 Discussion

The Daily Flow Model results, combined with the associated adjustments to the output, provide a solid foundation to assess juvenile salmon entrainment at Mendota Pool. The results are fairly insensitive to the precise volume of flows. However, the modeled flow is somewhat sensitive to the Friant Dam operations and Millerton Lake runoff forecast accuracy. In the absence of perfect foresight, the model generates several precautionary flood releases. The model is also sensitive to the fish emigration model that predicts when fish will be moving downstream of the spawning areas. Because of the lack of spring–run salmon and steelhead in the river system, the emigration models (Figure 3–2 and Figure 3-5) have the potential to be the largest source of error.

## 5.1 Model Assumptions and Limitations

The SJRRP Daily Flow Model used the default hydrograph, with Method 3.1 “Gamma” to smooth the hydrograph between water year types as found in the WY 2010 Interim Flows Project Final EA Appendix C Attachment 1 and agreed upon by the Settling Parties. This hydrograph releases water from Friant in blocks, which simplifies computation. In reality, ramping up and down of flows would be more gradual, and the actual hydrograph of Restoration Flows as recommended by the Restoration Administrator could be advanced or retarded by up to four weeks and possess other differing characteristics.

The model does not assume perfect foresight in estimating available water, instead it uses the forecast uncertainty exactly as it was revealed over the 82–year runoff history. Runoff forecast updates in the model are made five times annually, on February 10 of each year and then monthly through June. Integrating this forecast uncertainty is important in developing a realistic model, as several operating parameters, including the volume and timing of Restoration Flows, are linked to the runoff forecast.

Further detail on modeling methods can be found in the Reclamation Technical Report No.86–68210–2012–04 – San Joaquin River Restoration Daily Flow Model.

## 5.2 Frequency of Floods

Precautionary flood releases, which typically occur in February and March, are more numerous in the modeled record than actual spillway releases. The SJRRP Daily Flow Model uses the same operational logic as the Friant Dam operations use, and includes the absence of perfect foresight. Thus, many precautionary flood releases were technically unnecessary when the final runoff and releases were tallied. However, because of the necessarily conservative aspect of flood protection, such precautionary flood releases likely cannot be optimized out of future operations. However, the relative lack of precautionary flood control releases in the historical record may indicate that operators can do a better job than models, and thus the analysis may over-estimate precautionary flood control releases. They remain the most frequent source of potential entrainment during the fish emigration period.

### 5.2.1 Flow Coordination and Accurate Forecasting

The removal of a portion of flood flows in the model output that meet the criteria was important in developing a realistic assessment. As depicted in Table 3–1, flood releases that met the set of criteria were omitted as they were unlikely to occur in real operations. The primary justification for these omissions is due to the coordination that is in place between the SJRRP, Friant Dam operators, and the Restoration Administrator which can remove the need for flood releases because of Restoration Flows. All omitted flood releases, most of which were between 1 and 20 TAF, could either be accomplished within the current Restoration Flow Guidelines or were so small as to be inconsequential to the total water budget. These omissions provided more confidence in the accuracy of the model, yet had only a modest effect upon the frequency and volume of water into Mendota Pool. It is possible that these omissions were overly optimistic, which would produce a too low of an estimate of entrainment; however, if left in the hydrology record, there would still be too many instances of flood releases compared to the historic record of Friant Dam. The omissions are a reasonable and appropriate assumption to refine the model input.

The model output highlights the importance of coordination between SJRRP Restoration Flow scheduling and Friant Dam operations. Additionally, the model underscores the importance of accurate forecasting. Many flood releases in the record could be accomplished by adjustment of the default Restoration Flow hydrograph to accomplish both flood protection and restoration. The flexibility that is available to the Restoration Administrator in scheduling Restoration Flows can substantially influence the timing and magnitude precautionary flood releases. This could produce a positive benefit by reducing flood releases while simultaneously enhancing flood protection and potentially improving water supply in subsequent months. It is possible that through such coordination, entrainment could be further reduced by limiting flood flows. Discussion of adjustments to the default hydrograph are discussed in Section 5.6.

### 5.2.2 Influence of Climate Change

The following climate change projections are developed from four climate change scenarios (generated by Reclamation for the Central Valley Project Integrated Resource Plan) that are representative of 100+ discrete climate models simulations, and a fifth “consensus scenario” that is an ensemble of the central tendency of temperature and precipitation. The following climate predictions are for mid-century, with a date of 2055. Key conclusions for the San Joaquin River basin include:

- Consensus scenario predicts air temperatures in the basin to rise by 3.6° F (2.0° C), with the suite of four scenarios predicting a range from 1.8° to 4.7° F (1.0° to 2.6° C) (Reclamation, September 2014a)
- Consensus scenario predicts runoff in the basin to decline by 6%, with a suite of four scenarios predicting a range from +25% to -31%. (Reclamation, September 2014a)
- Consensus scenario predicts that reduction in runoff will be primarily from reduced number of “Normal-wet” years in favor of “Normal-dry” years. The proportion of “Dry”, “Critical-high” and “Critical-low” water year types are predicted to remain relatively stable under this scenario. (SJRRP, September 2012)
- All scenarios predict the timing of peak runoff to advance, occurring slightly earlier in the year. (Reclamation, September 2014; Reclamation, September 2014a)

The SJRRP Daily Flow Model used the historic record from 1922 to 2003. This was not adjusted for anticipated changes due to climate change. As described above, the consensus scenario predicts runoff to decline by 6%, and Normal-Wet years to be reduced in favor of Normal-Dry years. The 50-year average runoff is 1,831 thousand acre-feet, so a 6% reduction would reduce the average to 1,721 thousand acre-feet of average annual runoff.

As a simple and rough sensitivity analysis was done to account for the possible effects of climate change on fish entrainment. A 6% reduction in runoff reduces the average runoff for the 82 year period from 1,730 thousand acre-feet to 1,626 thousand acre-feet. When this change is done exclusively by changing Normal-Wet years into Normal-Dry years, the percentage of Normal-Wet water year types is reduced to approximately 12% of the years (from 30%), and Normal-Dry is increased to approximately 48% of the years (from 30%). To calculate the effect on fish populations, water year type average results for the 3 species are used. A monthly or more detailed analysis is not appropriate for this rough calculation, as it is based exclusively on a change in average water year type and doesn't include hydrologic variability.

Table 5-1 shows these adjustments. The changes are based on the water year type averages presented in Figures 4-8, 4-9, and 4-15 above, and just adjusting the percentage of water year types that occur when calculating the water year type weighted average. Fall-run and spring-run Chinook experience slight increases in the average annual entrainment, while steelhead entrainment is reduced, as Normal-Wet year types have higher steelhead entrainment than Normal-Dry (Table 4-9) due to the greater flood flows during the steelhead emigration period.

**Table 5-1. Average Annual Entrainment With and Without Climate Change**

| | Fall-Run Chinook Salmon | Spring-Run Chinook Salmon | Steelhead (with flood and Exchange contractor flows) |
|---|---|---|---|
| Current – without climate change | 3.47% | 3.96% | 2.68% |
| With climate change | 3.50% | 4.06% | 1.94% |

### 5.2.3 Mass Balancing of Flows

Because the SJRRP Daily Flow Model was created and run before the first Exchange Contractor delivery from Friant Dam in 2014, and uses a 1922-2003 hydrology, the model did not incorporate Exchange Contractor releases from Friant Dam. In lieu of rerunning the model, flows for Exchange Contractors in dry years were synthesized in Excel. For practicality reasons, additional flows were not compensated for by a commensurate draw–down of the reservoir. This added more water into Millerton Lake in the modeled scenario than would actually be available. The largest of these flows was 270 TAF assigned to the summer of 1977 (a Critical–Low water year type). The following water year, high runoff resulted in flood flows from February through June of 1978. A portion of these flood flows would not have occurred if the Exchange Contractor flows had been mass–balanced in the model. Due to the complexity of the model output and the large volume of water involved, no attempt was made to edit out these subsequent flood flows. This is a known bias in this analysis that should very slightly overestimate flood flows and thus slightly overestimate associated entrainment.

Additionally, small flood flows that are primarily an artifact of the SJRRP Daily Flow Model logic and not likely to occur in a realistic scenario were omitted. These were also not mass–balanced. However, in each case they were small volumes not exceeding 20 TAF and they were not omitted if it would have subsequently increased flood flows. Any bias to underestimate flood flows caused by these omissions would be small or negligible. This small bias would slightly underestimate associated entrainment.

## 5.3 Exchange Contractor Delivery Timing

Despite only two occurrences of deliveries to the SJREC under the Exchange Contract from Friant Dam in the actual 82–year history, it seemed appropriate to include more given the increased pressure upon water resources in California. Assigning five SJREC deliveries, one large one to the Critical–Low year and four smaller ones to the Critical–High years, was deemed a reasonable and perhaps conservative assumption. The results show that Exchange Contractor releases from Friant Dam are unlikely to have more than a minor overall impact upon juvenile salmon. This is due to the timing of each release, which based on the two recent instances in 2014 and 2015, would start on or later than May 15. In this analysis, Critical-High water years were assumed to have a July and August delivery, which is outside of the emigration period, and Critical-Low water year types were assumed to have an Exchange Contractor delivery from mid-May to the end of September. Given that Friant Dam releases to satisfy the Exchange Contractors' water rights are measures taken after other options have been exhausted, this mid–May or mid-July start was deemed a reasonable assumption. The timing of the start of Exchange Contractor releases is more important to fish entrainment than the duration, flow, or volume of releases. If such flows were advanced earlier in the season, they would overlap the time when a greater number of juveniles were emigrating and entrainment would rise sharply.

Other assumptions could be made regarding delivery timing, such as assigning deliveries based on Shasta critical year types instead of San Joaquin River year types, or assuming the Exchange Contractors are delivered water from March through August. This analysis uses assumptions based on 2 years of data on deliveries to the SJREC – 2014 and 2015 – and is highly uncertain.

When fish are in the San Joaquin River, close coordination between Reclamation and water contractors/operators during future Exchange Contractor releases will be important to keep impacts to salmon to a minimum. If future Exchange Contractor releases are more common than synthetically generated in this analysis, or involve more volume than anticipated, then negotiating the timing of water release or making other provisions to move fish out of the critical reaches before such flows should be considered.

## 5.4 Mendota Pool Entrainment Mortality

This analysis estimates entrainment at Mendota Pool. It is expected that fish mortality would be extremely high once entrainment occurred. A conservative assumption is that all entrained fish would be lost; however actually mortality may be slightly less than 100%. During flood flows, some fish may pass through Mendota Pool and over or through Mendota Dam and successfully complete their life history. Major flows would be directed at Mendota Dam from the San Joaquin

River and/or Kings River flood flows, and thus flow velocity and direction in Mendota Pool should direct juveniles towards and over the dam, instead of into canals. For the purposes of this analysis, 100% loss is assumed.

This analysis addressed the question of the overall entrainment into Mendota Pool, not the individual water intakes at the pool. Screening of individual intakes and other fish passage measures to reduce fish mortality are not evaluated here. The Mendota Pool Bypass and Reach 2B project required in the Stipulation of Settlement requires a Mendota Pool Bypass to keep fish out of Mendota Pool and avoid screening individual intakes.

Effects of structures may also cause impact to fish, including increased predation at structures and ladders, etc. These additional fisheries impacts were not considered as they would occur both with and without a Mendota Pool Fish Screen.

## 5.5 Fish Emigration Model Error

Spring–run Chinook salmon emigration was based on catch data from the Feather River of the Sacramento Valley, a higher latitude and lower elevation watershed than the San Joaquin River. To attempt to quantify the error that may be due to an inaccurate fish emigration model, four operations were conducted. One, the fish emigration curves for fall–run, spring–run, and steelhead were advanced 1 month. Two, the curves were delayed 1 month; three a Gaussian curve with 98% spanning 5 months centered on March 15, and fourth a “flatter” Gaussian curve with 98% spanning 7 months centered on March 31. These were iteratively substituted to examine the influence and potential error of the characteristic peaks and valleys of the analyzed fish emigration curve (Table 5–2 and Table 5–3). These three tests should likely define the bounds of error in the model (Table 5–3).

**Table 5-2. Average Entrainment Percentages for Salmon Emigration Curves (fall–run, spring–run, and steelhead) — Average and Percentiles**

| | Original Emigration Pattern | Advanced 1 Month | Delayed 1 Month | 5 month Gaussian centered on March 15 | 7 month Gaussian centered on March 31 |
|---|---|---|---|---|---|
| Average | 3.47% / 3.96% / 2.68% | 6.05% / 3.44% / 2.95% | 2.5% / 4.49% / 5.87% | 4.94% / 4.94% / 4.94% | 3.94% / 3.94% / 3.94% |
| February 50th Percentile | 0% / 0% / 0% | 0% / 0% / 0% | 0% / 0% / 0% | 0% / 0% / 0% | 0% / 0% / 0% |
| February 80th Percentile | 4% / 7% / 0% | 10% / 6% / 3% | 1% / 7% / 0% | 7% / 7% / 7% | 4% / 4% / 4% |
| February 90th Percentile | 7% / 12% / 0% | 18% / 12% / 6% | 1% / 13% / 0% | 13% / 13% / 13% | 8% / 8% / 8% |
| February 95th Percentile | 8% / 15% / 0% | 21% / 14% / 7% | 1% / 15% / 0% | 16% / 16% / 16% | 9% / 9% / 9% |
| March 50th Percentile | 0% / 0% / 0% | 0% / 0% / 0% | 0% / 0% / 0% | 0% / 0% / 0% | 0% / 0% / 0% |
| March 80th Percentile | 2% / 1% / 1% | 2% / 1% / 2% | 1% / 1% / 0% | 2% / 2% / 2% | 2% / 2% / 2% |
| March 90th Percentile | 7% / 5% / 2% | 9% / 3% / 6% | 3% / 5% / 0% | 8% / 8% / 8% | 6% / 6% / 6% |
| March 95th Percentile | 8% / 5% / 3% | 10% / 4% / 7% | 3% / 6% / 0% | 10% / 10% / 10% | 7% / 7% / 7% |

**Table 5-3. Average Entrainment Percentages for different Fish Emigration Curves (fall–run and spring–run and steelhead) — By Water Year Type**

| | Original Analysis | Emigration Advanced 1 Month | Emigration Delayed 1 Month | 5 month Gaussian centered on March | 7 month Gaussian centered on March |
|---|---|---|---|---|---|
| Wet Average | 2.8% / 3.6% / 1.7% | 5.3% / 3.2% / 2.2% | 2.3% / 3.9% / 10.7% | 4.2% / 4.2% / 4.2% | 3.7% / 3.7% / 3.7% |
| Normal–Wet Average | 3.8% / 4.2% / 5.1% | 6.2% / 3.7% / 3.2% | 3.5% / 5.1% / 7.7% | 5.1% / 5.1% / 5.1% | 4.5% / 4.5% / 4.5% |
| Normal–Dry Average | 4.0% / 4.8% / 0.8% | 7.5% / 4.2% / 3.3% | 1.1% / 5.0% / 0.0% | 6.0%/6.0% / 6.0% | 3.9% / 3.9% / 3.9% |
| Dry Average | 2.4% / 3.0% / 0.4% | 4.7% / 2.7% / 1.9% | 0.6% / 3.2% / 0.0% | 3.7% / 3.7% / 3.7% | 2.3% / 2.3% / 2.3% |
| Critical–High Average | 3.2% / 2.1% / 1.0% | 3.9% / 1.4% / 2.6% | 3.2% / 2.2% / 15.9% | 3.7% / 3.7% / 3.7% | 4.1% / 4.1% / 4.1% |
| Critical–Low Average | 8.0% / 2.6% / 41.3% | 1.9% / 0.0% / 15.3% | 34.8% / 12.0% / 59.5% | 4.7% / 4.7% / 4.7% | 14.7% / 14.7% / 14.7% |

These four scenarios provide an understanding of the sensitivity of this analysis to the prescribed emigration curve. Based on the original emigration curve, 3.47% of Fall–run Chinook salmon are predicted to be entrained overall, entrainment estimates range from 2.5% of juvenile fall-run predicted to be entrained to 6.05% of juvenile fall-run predicted to be entrained depending on the timing of the peak and the shape of the emigration curve.

For spring–run Chinook salmon 3.96% overall entrainment is predicted based on the original emigration curve, with entrainment percentages ranging from 3.44% to 3.94% depending on the emigration curve used. Because of the broader emigration curve of spring–run Chinook salmon, the entrainment analysis is less sensitive to the exact shape and timing of the emigration curve as compared to fall–run.

For steelhead, 2.68% overall entrainment is predicted based on the original emigration curve, with entrainment percentages ranging from 2.68% to 5.87% depending on the emigration curve used. As the steelhead migration extends later into spring, delaying it by another month has significant impacts on entrainment due to releases for the Exchange Contractors in the summer.

## 5.6 Other Salmon Considerations

This analysis makes no assessment as to the effect of the predicted entrainment at Mendota Pool upon salmon population dynamics or whether restoration fishery targets would be jeopardized. Entrainment is likely to be episodic, taking a higher toll upon fish in some years while the majority of years have little or no mortality from entrainment. This is a fundamentally different impact than a gradual loss of the population each and every year. Additionally, wetter years are likely to have a higher number of individual juvenile fish than drier years due to good river conditions creating high survival rates from emergence, and impacts during those wetter years would generally affect larger numbers of individuals than in drier years. It should be noted that the majority of entrainment occurs during the months of February and March across four water year types — Wet, Normal–Wet, Normal–Dry, and Dry; these represent 94% of the water years. Steelhead is a bit different, with impacts primarily in March, May and June. Entrainment impacts are not focused on one particular water year type, with the exception of steelhead in the critical year-types.

Mortality of individuals at the fry stage (a growth phase associated with December–March) can be considered to have a different magnitude of impact than individuals at a later growth stage (i.e. parr or smolt). A cohort of juvenile salmon is expected to winnow as the fish mature, at later life stages there are less individuals yet each individual represents a larger fraction of the total cohort. This analysis made no attempt to give differing weight to entrainment mortality by life history stage.

An assessment of the impact of predicted entrainment upon salmon population dynamics is recommended. This has the potential to reveal disparate weighting of mortality from one water year type to another, the importance of a particular cohort to the greater population health, and the impact of successive years of entrainment. Such an analysis could focus on the individual entrainment events.

Finally, and perhaps most importantly, the necessary simplification made in this analysis that proportion of flow volume represents proportion of fish entrained is certainly an important caveat in interpreting the results. Given the intended brevity of this analysis and the paucity of data on fish emigration, it was impractical to model variations in fish emigration simultaneously over time, space, and flow. Juvenile salmon are known to respond to falling hydrographs by emigrating downstream, thus one would expect a higher concentration of fish approaching Mendota Pool during such times. Alternatively, the rising hydrograph could also flush juvenile fish downstream to a greater degree than a steady flow. In reality we should expect emigration timing to be correlated with or triggered by flow changes, and this should be kept in mind when interpreting the results.

## 5.7 Adjustment of Restoration Hydrograph

The hydrograph used in this analysis was the default hydrograph that is constructed of “blocks” of flow. This analysis assumed that blocks could be moved forward and backward in the season (with the bounds dictated by the Settlement) to reduce the need for flood flows. However, other important characteristics of the flow, including the rate of rise and fall in the hydrograph and the temperature of the water, can alter the emigration behavior of fish. This analysis does not try to predict Restoration Administrator recommendations, which will likely be smoother and more varied than the block Settlement hydrographs.

Though this creates an uncertainty in the present analysis, it also provides an opportunity for the Restoration Administrator to prompt fish emigration by recreating natural cues. For example, if it is anticipated that juveniles will respond to a falling hydrograph at a certain time of year, Restoration Flows could be scheduled to immediately follow a flood pulse, thereby permitting passage down a safe route, such as the Mendota Pool Bypass.

## 5.8 Mendota Pool Bypass Operations

The SJRRP does not control flood operations. It is the Lower San Joaquin Levee District’s discretion how to route flood flows. However, juvenile fish mortality could be reduced if a portion of flows is routed though the Mendota Pool Bypass during flood flows. Similarly, juvenile fish mortality could be reduced if a portion of flows is routed though the Mendota Pool Bypass during Exchange Contractor deliveries. This proportion may be satisfied with the normal distribution of Exchange Contractors demand, of which about 80% is at Mendota Pool and 20% is at Arroyo Canal. Reclamation may coordinate with SJREC and the operator of Mendota Pool to discuss the potential for splitting delivery flows between Mendota Pool and the Mendota Pool Bypass.

## 5.9 Efficacy of a Mendota Pool Fish Screen

Design criteria for fish screens establish that screens should effectively handle the 95$^{th}$ percentile flows (i.e. all but the largest flows). Applying this criteria to Mendota Pool, flows greater than 2,368 cfs would overtop the fish screen or render it ineffective. However, because of operational logic at the Chowchilla and Mendota Pool bypasses, the maximum expected flow is only 2,500 cfs, barely larger than 2,368 cfs. Only during extreme flood events would flow into Mendota Pool exceed this amount. Assuming a 2,500 cfs design flow is chosen for a screen, there would be negligible entrainment due to overtopping or overwhelming of the screen.

Fish screens can be very effective in ideal circumstances. “Evaluation of several operational fish screens on the Yakima River using releases of marked Chinook salmon fry (50–60 mm fork length) showed 94–99% effectiveness (Neitzel et al., 1998)” (NMFS 1995). However, smaller fry can be entrained when larger than recommended 3.2 mm mesh openings are used, with entrainment losses documented at 17% in one location in Washington (Neitzel et al., 1990), and 6% in another (Mueller et al, 1995).

Because the majority of predicted entrainment in this model occurs in February and March, the critical challenge will be for the screen to be effective upon the very small fry (35–60 mm) expected during those months. This complicates design, as a tighter mesh increases the force of the river upon the structure, and is more likely to increase the maintenance needs. For steelhead, higher entrainment is during March, May and June. The fish screen would not have this issue during the May and June periods as the fish would be larger.

Other factors that may reduce effectiveness include blocking by debris of the screen or the outlet, and predation by piscivorous fish taking advantage of the velocity reduction at the structure for feeding. As discussed, an adequate outlet of water to route screened fish through the Mendota Pool Bypass is integral to the design and installation. Proper design and vigilant maintenance are essential to maximizing screen efficacy.

Fish screens can be an effective way to exclude juvenile fish from canals and other conveyance structures, however their effectiveness is less than 100%, especially in challenging locations and circumstances as is the case at Mendota Pool. The fraction of juvenile salmon population that can be saved by installation of a fish screen is not the full 6.0% (fall–run) or 6.9% (spring–run) of expected entrainment, but some lesser value based on screen efficiency.

Additionally, a screen at Mendota Pool will require an adequate outlet and suitable fraction of water to be diverted into the bypass. There is some uncertainty as to whether the normal split of SJREC demand at Mendota Pool and Arroyo Canal would be sufficient for fish screen escape or whether a greater minimum amount or fraction of flow would have to be maintained at the Bypass during flood flows and Exchange Contractor releases.

## 5.10 Other Fish Species

Although not analyzed here, other fish species may be at risk for entrainment at Mendota Pool. These species may benefit from a fish screen or other measures to reduce entrainment. Entrainment risks for other fish during flood flows are already present to varying degrees, and may not be caused by SJRRP Restoration Flows.

# 6.0 Conclusions

This analysis shows that modeled future flows combined with a hypothetical fish emigration pattern can estimate the fraction of a juvenile salmon cohort likely to be entrained in Mendota Pool. This was found to be 3.47%, 3.96%, and 2.68% of annual population for fall–run, spring–run, and steelhead respectively over the 82–year modeling run. The greatest entrainment came from precautionary flood releases in February and March, and for steelhead during flood and Exchange contractor deliveries in May and June. There is considerable variation in entrainment from year to year, with significant entrainment occurring in one out of four years. By water year type, fall–run entrainment ranges from an average of approximately 2.4% in Dry years, upwards to approximately 8% in the one Critical Low year type. For spring–run, values range from 2.1% in Critical–Low and Critical–High years to 4.8% in Normal–Dry water year types. For steelhead, entrainment ranges from an average of 0.4% in Dry water year types to 41.3% in the one Critical-Low water year type in the analysis (when fish could not successfully complete their life history anyway due to a lack of Restoration Flows and a dry river channel). The influence of Exchange Contractor releases upon salmon entrainment at Mendota Pool are predicted to account for 5 percent of the total predicted entrainment for fall–run (where 100 percent of the total predicted entrainment would mean the Exchange Contractor releases account for all of the entrainment), 3 percent of the total entrainent for spring–run, and 16 percent of the total entrainment for steelhead. Delaying Exchange Contractor releases till after emigration is complete could diminish these minor contributions to essentially zero.

Entrainment is episodic, being tied to occasional flood flows. Four out of five years have negligible entrainment, with the other one out of five years ($80^{th}$ percentile) typically having 6%, 8%, and 1% entrainment for fall–run, spring–run salmon, and steelhead, respectively. In one out of ten years ($90^{th}$ percentile), entrainment rises to 15% and 17% for fall–run and spring–runs, and to 9% for steelhead. In at least 3 out of 82 years predicted entrainment exceeds 15% for all 3 species. These high entrainment levels are significant if they occur in consecutive years. Occasionally significant entrainment can occur during successive years. A four-year running average of entrainment, corresponding to the 3-7 year lifespan of a salmon cohort, exceeds 10% for 3 years out of the 82–year run for fall-run, 5 years out of the 82-year scenario for spring-run Chinook, and for 4 years out of the 82-year run for steelhead.

Error resulting from uncertainty in the fish emigration models was estimated by shifting the emigration curves ahead and behind in the season, as well as comparing against two generic bell–shaped curves. This test indicated that the fall–run predictions of entrainment were more sensitive to shifts in timing and shape of the curve, while the spring–run predictions were more robust. However, because the fall–run data is informed by actual recent capture data on the San Joaquin River, there is more confidence in that particular emigration curve. The spring–run curve, though more resistant to errors in entrainment, is based on more speculative fish emigration behavior. Average fall-run predicted entrainment may range from 2.5% to 6.05%, average spring-run entrainment is predicted to range from 3.44% to 3.94%, and steelhead entrainment may range from 2.68% to 5.87% depending on the emigration curve used. Using the predicted result of 3.47% and 3.96% of fall–run and spring–run juvenile salmon entrainment, and 2.68% of steelhead, a properly designed fish screen is estimated to avert approximately 90% entrainment. Any fish screen installation can be made more effective by combining the facility with management actions such as altering flows to cue fish emigration.

## 6.1 Alternatives to Fish Screen Installation

There are a number of operational and management actions that can be taken to reduce entrainment at Mendota Pool in the absence of a fish screen. Some of these, such as adjusting the timing of Restoration Flows and shaping the hydrograph, are viable management options that are within the scope of the SJRRP. Others, such as maintaining a portion of flood flows to minimize entrainment, are speculative and would need agreement from other parties. The impact of Exchange Contractor releases is minor in the current analysis, and could be further mitigated by delaying such flows if juvenile fish are in the river, until water temperatures exceed a certain threshold, or emigration has ceased.

Some of these alternatives require adjustments to water delivery operations; and all of them require close coordination between Friant Dam operations, Implementing Agencies, the Restoration Administrator, and water users.

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# 8.0 Appendix A

**Table of Water Year Types**

| Water Year Type | Associated Unimpaired Runoff into Millerton Lake (TAF) | Approximate Percentile | Restoration Flow Allocation at Gravelly Ford (TAF) | Actual Water Years in 1922 – 2003 Record |
|---|---|---|---|---|
| **Wet** | > 2,500 | 80–100 | 560.3 | 1938, 1941, 1952, 1956, 1958, 1967, 1969, 1978, 1980, 1982, 1983, 1986, 1993, 1995, 1997, 1998 |
| **Normal–Wet** | 1,450 – 2,500 | 50–80 | 287.1 – 434.2 | 1922, 1923, 1927, 1932, 1935, 1936, 1937, 1940, 1942, 1943, 1945, 1946, 1951, 1962, 1963, 1965, 1973, 1974, 1975, 1979, 1984, 1996, 1999, 2000 |
| **Normal–Dry** | 930 – 1,449 | 20–50 | 217.1 – 287.0 | 1925, 1926, 1928, 1933, 1944, 1947, 1948, 1949, 1950, 1953, 1954, 1955, 1957, 1959, 1966, 1970, 1971, 1972, 1981, 1985, 1989, 1991, 2001, 2002, 2003 |
| **Dry** | 670 – 929 | 5–20 | 159.1 – 217.0 | 1929, 1930, 1934, 1939, 1960, 1964, 1968, 1987, 1988, 1990, 1992, 1994 |
| **Critical–High** | 400 – 669 | 1–5 | 74.6 | 1924, 1931, 1961, 1976 |
| **Critical–Low** | < 400 | <1 | 3.6 | 1977 |

# Mendota Pool Bypass and Reach 2B Improvements Project

## Final
## Environmental Impact Statement/Report

## Clean Water Act Section 404(b)(1) Information

SAN JOAQUIN RIVER
RESTORATION PROGRAM

Final
July 2016

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# Mendota Pool Bypass and Reach 2B Improvements Project

## Draft

## Clean Water Act Section 404(b)(1) Information

SAN JOAQUIN RIVER
RESTORATION PROGRAM

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# List of Abbreviations and Acronyms

| | |
|---|---|
| ACHP | Advisory Council on Historic Preservation |
| Act | San Joaquin River Restoration Settlement Act |
| BMP | best management practice |
| BO | biological opinion |
| CEQA | California Environmental Quality Act |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| CNDDB | California Natural Diversity Database |
| Corps | U.S. Army Corps of Engineers |
| CSLC | California State Lands Commission |
| CVP | Central Valley Project |
| CWA | Federal Clean Water Act |
| Delta | Sacramento-San Joaquin Delta |
| DFW | California Department of Fish and Wildlife |
| DWR | California Department of Water Resources |
| EFH | Essential Fish Habitat |
| EIS/R | Environmental Impact Statement/Environmental Impact Report |
| EPA | U.S. Environmental Protection Agency |
| Exchange Contractors | San Joaquin River Exchange Contractors |
| Guidelines | Federal Clean Water Act Section 404(b)(1) Guidelines |
| LEDPA | least environmentally damaging practicable alternative |
| LTS | less than significant |
| NEPA | National Environmental Policy Act |
| NMFS | National Marine Fisheries Service |
| NRDC | Natural Resources Defense Council |
| OHWM | ordinary high water mark |
| O&M | operation and maintenance |
| PEIS/R | Program Environmental Impact Statement/ Environmental Impact Report |
| PS | potentially significant |
| PSU | potentially significant and unavoidable |
| Project | Mendota Pool Bypass and Reach 2B Improvements Project |

| | |
|---|---|
| Reclamation | U.S. Department of the Interior, Bureau of Reclamation |
| ROD | Record of Decision |
| RWQCB | Regional Water Quality Control Board |
| S | significant |
| Secretary | Secretary of the Interior |
| Settlement | Stipulation of Settlement in NRDC, et al., v. Kirk Rodgers, et al. |
| Settling Parties | Natural Resources Defense Council, Friant Water Authority, and the U.S. Departments of the Interior and Commerce |
| SHPO | State Historic Preservation Officer |
| SJRRP | San Joaquin River Restoration Program |
| SJVAPCD | San Joaquin Valley Air Pollution Control District |
| State | State of California |
| SU | significant and unavoidable |
| SWP | State Water Project |
| SWRCB | State Water Resources Control Board |
| USFWS | U.S. Fish and Wildlife Service |

# 1.0 Introduction

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) proposes to implement the Mendota Pool Bypass and Reach 2B Improvements Project (Project), a Phase 1 project of the overall San Joaquin River Restoration Program (SJRRP). Project implementation would involve the discharge of dredged or fill material to waters of the United States. Accordingly, Reclamation will submit a Federal Clean Water Act (CWA) Section 404 permit application for the Project to the U.S. Army Corps of Engineers (Corps), Sacramento District. It also will submit an application for a CWA Section 401 water quality certification to the Central Valley Regional Water Quality Control Board (RWQCB).

This document provides information to the Corps and to the U.S. Environmental Protection Agency (EPA), which co-administers the CWA Section 404 regulatory program, to enable a determination that implementation of the Project complies with the CWA Section 404(b)(1) guidelines (Guidelines). More specifically, it includes information to support a recommendation that the preferred alternative for the Project is the Least Environmentally Damaging Practicable Alternative (LEDPA), as required by the Guidelines at 40 Code of Federal Regulations (CFR) 230.10(a) and described below in Section 2.1. This document also will assist the RWQCB in its review of the Project.

In order to provide information for the identification of the recommended LEDPA, this document summarizes relevant Guidelines requirements, describes the Project and the actions that led to its development, and identifies waters of the United States, including wetlands, that occur in the Project area. It describes Initial Alternatives and the No Action Alternative, analyzes the practicability of the four potential Project alternatives (Action Alternatives), and describes the potential impacts of the Action Alternatives to waters of the United States. The four Action Alternatives are:

- Alternative A – Compact Bypass with Narrow Floodplain and South Canal
- Alternative B – Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure, the Preferred Alternative
- Alternative C – Fresno Slough Dam with Narrow Floodplain and Short Canal
- Alternative D – Fresno Slough Dam with Wide Floodplain and North Canal

This document uses the information previously presented in the Draft Environmental Impact Statement/Environmental Impact Report (EIS/R) prepared for the Project by Reclamation and the California State Lands Commission (CSLC; SJRRP 2015a), including project description and wetland impact information. The draft EIS/R was provided to the State and Federal agencies responsible for regulating the Project, including the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California Department of Water Resources (DWR), California Department of Fish and Wildlife (DFW), EPA, and the Corps.

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# 2.0 Clean Water Act Section 404 Regulatory Requirements

Section 404 of the CWA (33 USC 1244) establishes a framework for regulating the discharge of dredged or fill material to waters of the United States including adjacent wetlands. The Corps and EPA each have specific responsibilities in the Section 404 regulatory program. The Corps' main role is to administer a program for authorizing individual discharges. The EPA's main role is to develop the Section 404 Guidelines, which the Corps applies when considering whether to authorize a proposed discharge. The EPA promulgated the Guidelines in 1980.

At the core of the Guidelines are four major restrictions on discharges. The Corps would authorize a project only if it complies with each of these restrictions, which are excerpted below.

## 2.1 Alternatives to the Proposed Discharge

As specified at 40 CFR 230.10(a), a discharge of dredged or fill material may not be permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem that does not have other significant adverse environmental consequences.

An alternative is considered practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purposes. As noted on page 85339 of the Guidelines preamble, "... to be practicable, an alternative must be capable of achieving the basic purpose of the proposed activity." Also, when identifying potential alternatives, "the only alternatives which must be considered are practicable alternatives."

If a project involving a discharge to a special aquatic site[1] is not water-dependent (i.e., does not require access or proximity to, or siting within, the special aquatic site in question to fulfill its basic purpose), then it is presumed that practicable alternatives that do not involve a discharge to a special aquatic site are available. Furthermore, these practicable alternatives are presumed to have less adverse impact to the aquatic ecosystem, unless demonstrated otherwise.

A practicable alternative that has the least adverse impact on the aquatic ecosystem and minimizes other adverse environmental consequences is designated as the LEDPA. Although this term is not used verbatim in the Guidelines, it is commonly used by the Corps and EPA and by State agencies responsible for certifying that a proposed discharge complies with State water quality standards.

[1] Special aquatic sites include sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, and riffle and pool complexes.

In summary, the Corps may only authorize a project alternative that it designates as the LEDPA.

## 2.2 Water Quality Standards/Toxic Effluent Standards/Endangered Species Act

As specified at 40 CFR 230.10(b), a discharge of dredged or fill material is not permitted if it causes or contributes to violations of State water quality standards, violates toxic effluent standards under Section 307 of the CWA, or jeopardizes the continued existence of an endangered or threatened species or results in the likelihood of destruction or adverse modifications to critical habitat under the Federal Endangered Species Act.

## 2.3 Significant Degradation

As specified at 40 CFR 230.10(c), a discharge of dredged or fill material is not permitted which would cause or contribute to significant degradation of the waters of the United States. Degradation includes adverse effects on: (1) human health through impacts to municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites; (2) life stages of aquatic life and wildlife dependent on aquatic ecosystems; (3) ecosystem diversity, productivity, and loss of fish and wildlife habitat; and (4) recreational, aesthetic, economic values.

## 2.4 Adverse Impact Minimization

As specified at 40 CFR 230.10(d), a discharge of dredged or fill material is not permitted unless appropriate and practicable steps have been taken which would minimize potential adverse impacts of the discharge on the aquatic ecosystem.

# 3.0 Project Background

The Project is a Phase 1 component of the overall SJRRP. The SJRRP is the program established to implement the Stipulation of Settlement (Settlement) in the lawsuit known as *Natural Resources Defense Council (NRDC), et al., v. Kirk Rodgers, et al.*

## 3.1 San Joaquin River Restoration Program

In 1988, a coalition of environmental groups, led by 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 Friant Division contractors. On September 13, 2006, after more than 18 years of litigation, the Settling Parties, including NRDC, Friant Water Authority, and the U.S. Departments of the Interior and Commerce, agreed on terms and conditions for a 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.

The Settlement establishes a framework for accomplishing the Restoration and Water Management goals that will require environmental compliance, design, construction, and monitoring of projects over a multiple-year period. To achieve the Restoration Goal, the Settlement calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River (referred to as Interim and Restoration flows), and reintroduction of Chinook salmon. 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.

The SJRRP is the program established to implement the Settlement. Implementing agencies responsible for managing and implementing the SJRRP are Reclamation, USFWS, NMFS, DWR, and DFW. The San Joaquin River Restoration Settlement Act (Act), included in Public Law 111-11, the Omnibus Public Lands Management Act of 2009, authorizes and directs the Secretary of the Interior (Secretary) to implement the terms and conditions of the Settlement.

## 3.2 Mendota Pool Bypass and Reach 2B Improvements

The Project includes the construction, operation, and maintenance of the Mendota Pool Bypass and improvements in the San Joaquin River channel in Reach 2B (Figure 3-1). The Project consists of a floodplain width which conveys at least 4,500 cubic feet per second (cfs), a method to bypass Restoration Flows around Mendota Pool, and a method to deliver water to Mendota Pool. The Project footprint (Figure 3-2) extends from approximately 0.3 mile above the Chowchilla Bifurcation Structure to approximately 1.7 miles below the Mendota Dam.

The Mendota Pool Bypass would include conveyance of at least 4,500 cfs around Mendota Pool (or the Pool) from Reach 2B to Reach 3. 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 if water deliveries are required for the San Joaquin River Exchange Contractors (Exchange Contractors) 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, if appropriate, to direct out-migrating fish into the bypass channel and minimize fish entrainment to the Pool.

Improvements to Reach 2B would include modifications to the San Joaquin River channel from the Chowchilla Bifurcation Structure to the new Mendota Pool Bypass to provide a capacity of at least 4,500 cfs with integrated floodplain habitat. Levee setbacks along Reach 2B would increase 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 bypass channel because Central Valley floodplains have been shown to be of value to rearing juvenile salmon as they migrate downstream (Jeffres et al. 2008, Grosholz and Gallo 2006, Sommer et al., 2001, Sommer et al., 2004). In addition, the SJRRP *Fisheries Management Plan* (SJRRP 2010) and *Minimum Floodplain Habitat Area for Spring and Fall-Run Chinook Salmon* report (SJRRP 2012a) describe 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 5.3.14.

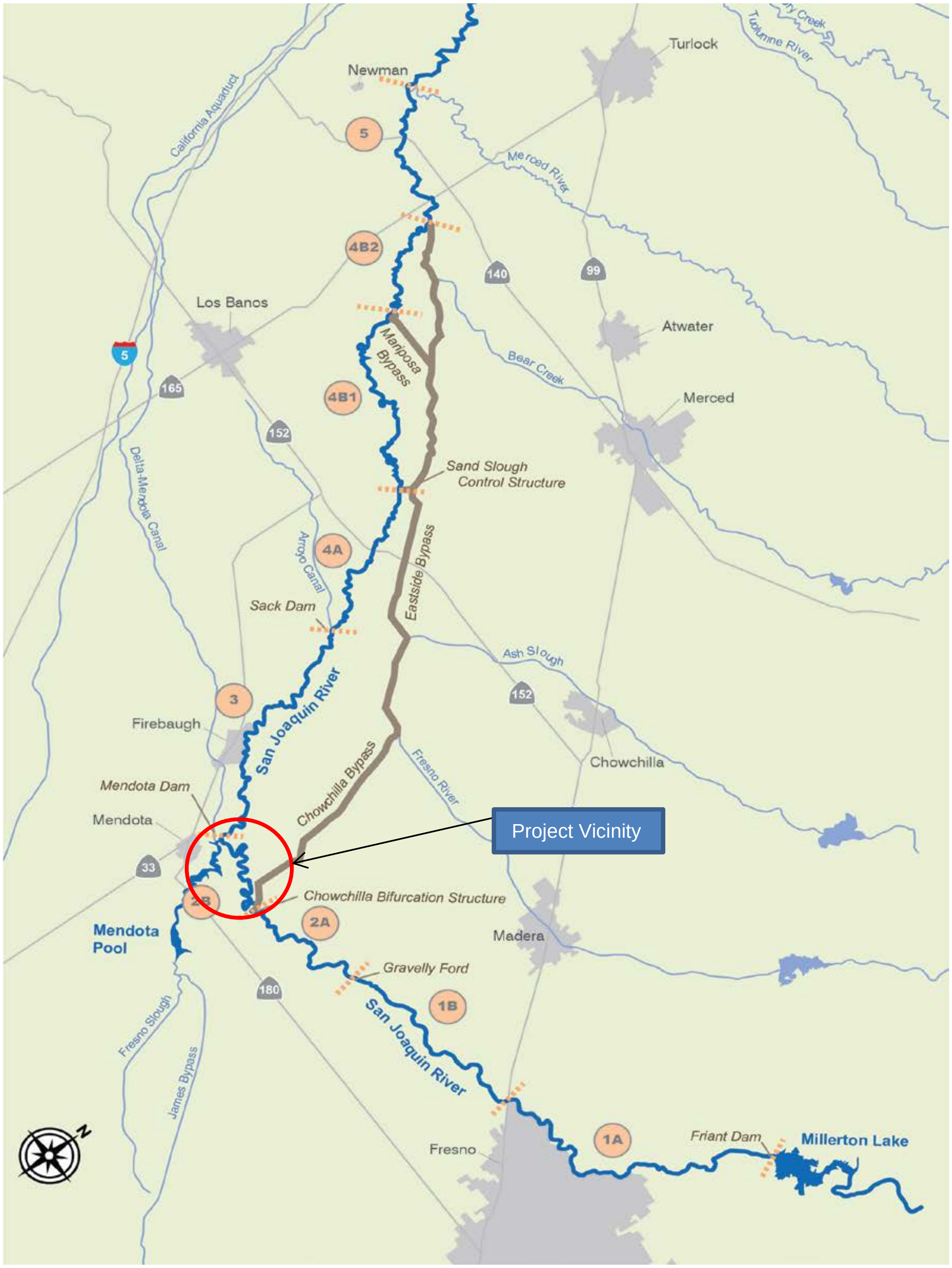


**Figure 3-1.**
**Overview of the SJRRP Restoration Area and the Project Vicinity**

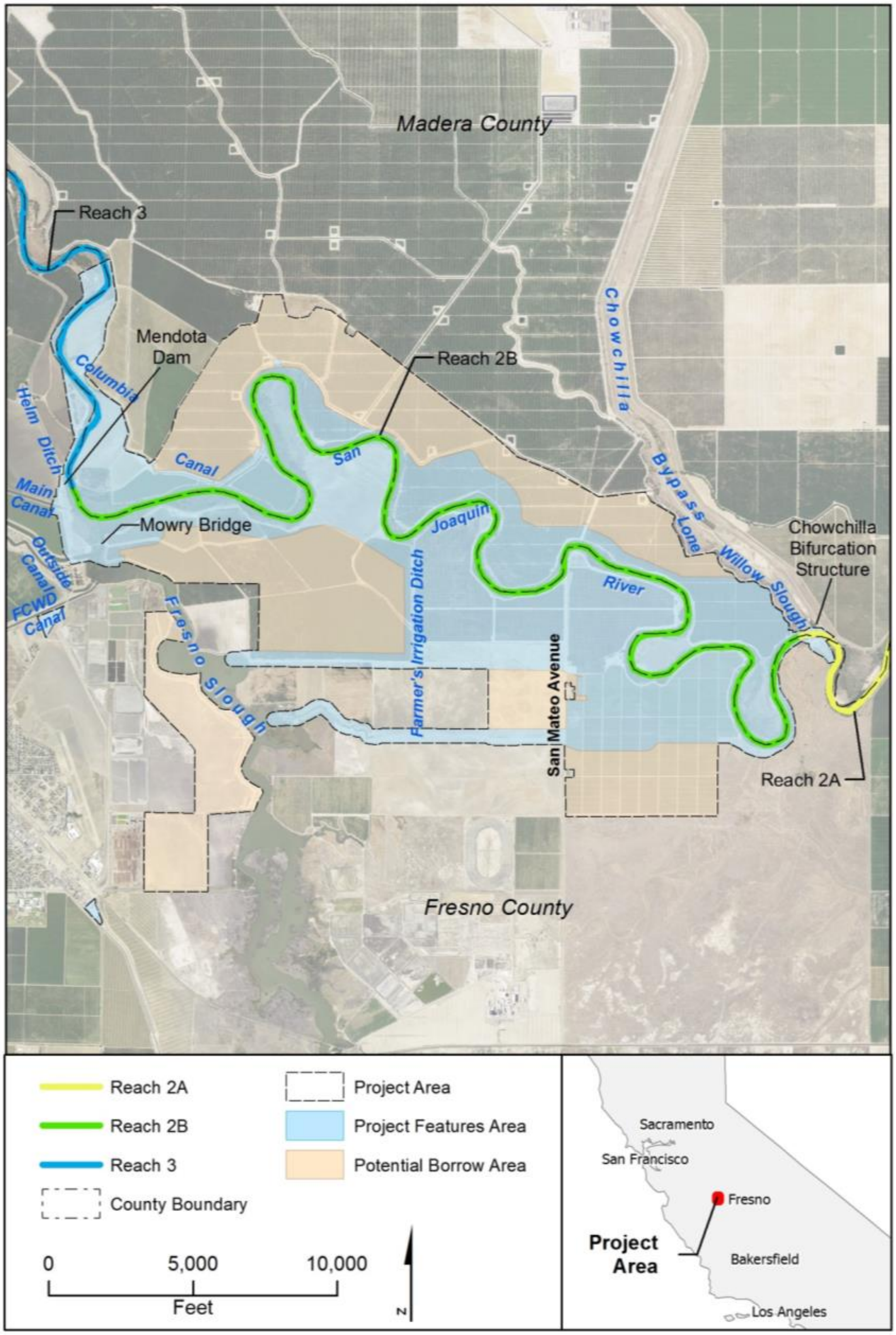


**Figure 3-2.**
**Project Footprint and Vicinity**

# 4.0 Project Purpose

Definitions of "project purpose" are key components of a Section 404(b)(1) document. This section describes the "Basic Project Purpose," which is used to establish water dependency for a project proposing a discharge to a special aquatic site (see Section 2.1). It also describes "Overall Project Purpose," which is the applicant's statement of project goals and objectives and is used to help identify practicable alternatives to the proposed project.

## 4.1 Basic Project Purpose

For purposes of this document, the basic purpose of the Project is to construct, operate, and maintain the Mendota Pool Bypass and improve the San Joaquin River channel in Reach 2B. Several Project activities (e.g., construction of the bypass channel, floodplain modifications, and fish passage structures) will require access to, proximity to, or siting within areas considered to be special aquatic sites, as defined at 40 CFR 230 Subpart E. In accordance with 40 CFR 230.10(a)(3), the Project's basic purpose, therefore, is considered to be "water dependent." As a result, there is no need in this document to rebut a presumption that there are practicable alternatives to the Project that do not involve a discharge of dredged or fill material to a special aquatic site.

## 4.2 Overall Project Purpose

The overall project purpose is to implement portions of the Settlement consistent with the Act. Specifically, this Project is intended to implement Paragraphs 11(a)(1) and 11(a)(2) of the Settlement, which are authorized in Section 10004(a)(1) of the Act.

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 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”).*

Without the Project in Reach 2B, restoration activities would be unlikely to achieve the Settlement goals.

# 5.0 Project Description

This section describes the project area, the existing conditions in the vicinity of the Project and the major Project elements.

## 5.1 Project Area Description

The Project study area or “Project area” includes areas that may be affected directly or indirectly by the Project alternatives. The Project footprint comprises the area that could be directly affected by the Project. The Project footprint (township 13S, range 15E), shown in Figure 3-2, has two major components: Reach 2B and the Mendota Pool Bypass. Reach 2B includes the area from the San Joaquin River control structure of the Chowchilla Bifurcation Structure downstream to Mendota Dam.

Potential Project improvements in Reach 2B, which vary by alternative, extend from the Chowchilla Bifurcation Structure on the upstream end to the head of the potential 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, as necessary to meet the Project purpose. The lateral extent of the Reach 2B improvements includes lands to the north and south of the San Joaquin River in Reach 2B.

The Mendota Pool Bypass element of the Project alternatives 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 element of the Project alternatives 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 portions of Reach 3 downstream and Reach 2A upstream that are outside the direct Project footprint.

## 5.2 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. The Delta-Mendota Canal terminates at the Pool, which distributes water deliveries from the Sacramento-San Joaquin Delta (Delta) to 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 provides only minimal transitory storage above the operating elevation and, therefore, does not provide substantial flood control protection. During flood releases, the flashboards 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 with the SJRRP). Accordingly during wet years, flow in Reach 2B may be reduced during flood control releases from Pine Flat Dam.

The Project 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 limit 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 and Restoration flows or flood releases from Friant Dam. Up until the recent past, the Pool and associated river channel were drained approximately every 2 years to inspect and perform maintenance on Mendota Dam. Recent repairs at Mendota Dam have reduced this need to dewater the Pool for dam inspections.

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.

### 5.2.1 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. Vegetation along the banks of the channel in these areas predominantly consisted of riparian scrub and willow scrub communities.

### 5.2.2 Existing Fish Population and Habitat Conditions

Prior to the start of Interim Flows in October 2009, Reach 2B upstream of San Mateo Avenue was dry except during flood flows (approximate frequency was every 2 to 3 years), consequently there was very limited in-channel habitat features. The Pool contained mostly introduced fishes and a few native fish. The biennial dewatering of the Pool, which occurred prior to the start of Interim Flows, left the Pool site mostly dry, but some locations held standing water during the several week period the Pool was drained in mid-winter.

The Reach 2B channel bed is composed of unconsolidated fine sand and, prior to Interim Flows, there was little definition of the channel bed, which is typical for sand bed systems. No pool-bar structure or bed features occurred 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 was limited because there is a long history of the channel being dry. Riparian vegetation was limited to the levees along the channel banks. In the lower portion of Reach 2B, the channel was defined where vegetation had been established along the backwatered portion from the Pool between Mendota Dam and San Mateo Avenue. The Pool was bordered by emergent, wetland and riparian vegetation including mature cottonwood trees. Aquatic habitat in this section of river was affected by the backwatering of Mendota Dam and sedimentation in the Pool.

Since the start of Interim and Restoration flows, Reach 2B has increased inundation and establishment of hydrophytic vegetation. Aquatic habitat between the Chowchilla Bifurcation Structure and San Mateo Avenue has developed into a series of low gradient riffles, flatwater glides, and mid-channel pools and the San Joaquin River arm of Mendota Pool continues to hold water year-round. Pool elevations are typically maintained near capacity.

### 5.2.3 Existing Structures

#### *Chowchilla Bifurcation Structure*

The most upstream structure is the Chowchilla Bifurcation Structure. This structure is used to route flood flows down the Chowchilla Bypass. The bifurcation has two structural components: the San Joaquin River control structure, which spans the San Joaquin River, and the bypass control structure, located at the head of the Chowchilla Bypass. The bifurcation 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. 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 riprap sitting against the concrete weir and above the sand bed of Reach 2B. Upstream and downstream of the structure is the sand bed of Reach 2A and 2B, respectively.

***San Mateo Avenue Crossing***

The present crossing of Reach 2B is a dip crossing or low-water crossing. 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.

***Mendota Dam and Mendota Pool***

Mendota Dam, 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 was drained about every 2 years for dam inspection and maintenance. Recent repairs at Mendota Dam have reduced this need to dewater the Pool for dam inspections.

## 5.3 Elements Common to All Action Alternatives

Action Alternatives would be designed to provide:

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

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

### 5.3.1 Fish Habitat and Passage

One of the primary focuses of the Action Alternatives is to provide floodplain and riparian habitat to benefit migrating juvenile and adult salmonids and other native fishes. Floodplain and riparian habitats in the Action Alternatives would include a variety of native plant communities suited to the hydrology, soils, and climate of Reach 2B and the San Joaquin Valley. The Action Alternatives also include provision of fish passage at structures for salmonids and other native fish. These structures vary by alternative, but overall include fish screens, fish passage facilities, grade control structures, and bifurcation structures (under certain flows).

### 5.3.2 Levees

Levees would be required along the Project area to contain Restoration Flows. While the height and footprint of the levees vary according to their locations along the channel and the ground elevation, the capacity, freeboard, and cross-section would be consistent. Localized backwater and redirection effects at Project structures would be considered during design of levee heights. Levees would be designed to maintain 3 feet of freeboard on the levees at 4,500 cfs. 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.

### 5.3.3 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 traveling 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.

### 5.3.4 Borrow

Borrow material (suitable soils) would primarily be required for the construction of the levees, but it may also be used 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.

### 5.3.5 Levee and Structure Protection

Action Alternatives generally provide a minimum 300-foot buffer between the existing channel and the proposed levee, where appropriate and feasible. Locations that require erosion protection in the form of 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.

### 5.3.6 Channel Bank Protection

Action Alternatives could include riparian vegetation, rock vanes, woody materials, revetment, or other measures designed to protect channel banks from erosion. Bank protection measures would be installed in locations susceptible to and likely to experience bank erosion.

### 5.3.7 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 would be 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.

### 5.3.8 Floodplain Grading

Floodplain and channel 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), by providing escape routes during receding flows, and by confining flows to a deeper, narrower channel to limit temperature increases.

### 5.3.9 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, and will be addressed in subsequent environmental analysis, as appropriate.

### 5.3.10 Existing Infrastructure Relocations or Floodproofing

Existing infrastructure such as groundwater wells, pumps, electrical and gas distribution lines, water pipelines, and canals is located in the Project area and would require relocation or floodproofing to protect them from future Restoration Flows and increased floodplain area.

### 5.3.11 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. 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.

### 5.3.12 Revegetation of Temporary Disturbance Areas

Areas temporarily disturbed during construction would be restored to their previous contours, if feasible, and then seeded with a native vegetation seed mixture to prevent soil erosion. Some areas, such as borrow areas, may not be feasible to restore previous contours, but these areas would be smoothed and seeded.

### 5.3.13 Land Acquisition

Additional lands would be acquired to accommodate the floodplain, levees, bypass channel, structures, and borrow. The amount of land acquisition varies with alternative.

### 5.3.14 Phased Implementation

The Project may utilize a phased approach to implementation 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.

### 5.3.15 Operations and Maintenance

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

### 5.3.16 Monitoring Activities

Monitoring activities in Reach 2B could include flow monitoring, groundwater level monitoring, aerial and topographic surveys, vegetation surveys, sediment mobilization and monitoring, and passage and screen effectiveness.

### 5.3.17 Structure Design and Subsidence

All design work would be completed in general accordance with Reclamation Design Standards, applicable design codes, and commonly accepted industry standards. Where design criteria are missing for a specific project element, either Reclamation would be consulted for design specifications or standard engineering practice methods would be employed. In addition, ground subsidence effects are anticipated to be experienced in the Project area. During the design process, causes of the observed subsidence, data from previously conducted studies, subsidence locations expected to require special design considerations, anticipated subsidence rates, and methods to mitigate the anticipated ground subsidence would be identified and incorporated into the design.

### 5.3.18 Environmental Commitments

Environmental commitments are measures or practices adopted by a project proponent to reduce or avoid adverse effects that could otherwise result from project construction or operations. The following section describes additional environmental commitments that would be implemented with the Action Alternatives to avoid potentially adverse environmental consequences. These commitments are consistent with those commitments provided in the Program Environmental Impact Statement/Environmental Impact Report (PEIS/R).

#### *Conservation Strategy*

As part of SJRRP implementation, a comprehensive strategy for the conservation of listed and sensitive species and habitats has been prepared, and will be implemented in coordination with USFWS, NMFS, and DFW. The goals of the strategy are as follows:

- Conserve riparian vegetation and waters of the United States, including wetlands
- Control and manage invasive species
- Conserve special-status species

The SJRRP's Conservation Strategy includes conservation measures for biological resources that may be affected by Project actions (summarized in Table 5-1 and described in full in Appendix A). These measures are the same as those presented in the Draft EIS/R (SJRRP 2015a).

**Table 5-1.**
**Conservation Measures for Biological Resources**

| Identifier | Conservation Measure |
|---|---|
| VELB | Valley Elderberry Longhorn Beetle |
| VELB-1 | Avoid and minimize effects to species |
| VELB -2 | Compensate for temporary or permanent loss of habitat |
| BNLL | Blunt-Nosed Leopard Lizard |
| BNLL-1 | Avoid and minimize effects to species |
| BNLL-2 | Compensate for temporary or permanent loss of habitat or species |
| PLANTS | Other Special-Status Plants |
| PLANTS-1 | Avoid and minimize effects to special-status plants |
| GGS | Giant Garter Snake |
| GGS-1 | Avoid and minimize loss of habitat for giant garter snake |
| GGS-2 | Compensate for temporary or permanent loss of habitat |

**Table 5-1.**
**Conservation Measures for Biological Resources**

| Identifier | Conservation Measure |
|---|---|
| WPT | Western Pond Turtle |
| WPT-1 | Avoid and minimize loss of individuals |
| 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) |
| SWH | Swainson's Hawk |
| SWH-1 | Avoid and minimize impacts to Swainson's Hawk |
| SWH-2 | Compensate for loss of nest trees and foraging habitat |
| RAPTOR | Other Nesting Raptors |
| RAPTOR-1 | Avoid and minimize loss of individual raptors |
| RAPTOR-2 | Compensate for loss of nest trees |
| RNB | Riparian Nesting Birds: Least Bell's Vireo |
| RNB-1 | Avoid effects to species |
| RNB-2 | Avoid, minimize, and compensate for effects to species |
| MBTA | Other Birds Protected by the Migratory Bird Treaty Act |
| MBTA-1 | Avoid and minimize effects to species |
| BRO | Burrowing Owl |
| BRO-1 | Avoid loss of species |
| BRO-2 | Minimize impacts to species |
| BAT | Special-Status Bats |
| BAT-1 | Avoid and minimize loss of species |
| BAT-2 | Compensate for loss of habitat |
| FKR | Fresno Kangaroo Rat |
| FKR-1 | Avoid and minimize effects to species |
| FKR-3 | Compensate for temporary or permanent loss of habitat or species |
| SJKF | San Joaquin Kit Fox |
| SJKF-1 | Avoid and minimize effects to species |
| PL | Pacific Lamprey |
| PL-1 | Avoid and minimize effects to species |
| RHSNC | Riparian Habitat and Other Sensitive Natural Communities |
| RHSNC-1 | Avoid and minimize loss of riparian habitat and other sensitive natural communities |
| RHSNC-2 | Compensate for loss of riparian habitat and other sensitive natural communities |
| WUS | Waters of the United States/Waters of the State |
| WUS-1 | Identify and quantify wetlands and other waters of the United States |
| WUS-2 | Obtain permits and compensate for any loss of wetlands and other waters of the United States/waters of the State |
| INV | Invasive Plants |
| INV-1 | Implement the Invasive Vegetation Monitoring and Management Plan |
| CP | Conservation Plans |
| CP-1 | Remain consistent with approved conservation plans |

**Table 5-1.**
**Conservation Measures for Biological Resources**

| Identifier | Conservation Measure |
|---|---|
| CP-2 | Compensate effects consistent with approved conservation plans |
| GS | Southern Distinct Population Segment of North American Green Sturgeon |
| GS-1 | Avoid and minimize loss of habitat and individuals |
| CVS | Central Valley Steelhead |
| CVS-1 | Avoid loss of habitat and risk of take of species |
| CVS-2 | Minimize loss of habitat and risk of take of species |
| SRCS | Central Valley Spring-Run Chinook Salmon |
| SRCS-1 | Avoid and minimize loss of habitat and individuals |
| EFH | Essential Fish Habitat (Pacific Salmonids) |
| EFH-1 | Avoid loss of habitat and risk of take of species |
| EFH-2 | Minimize loss of habitat and risk of take from implementation of construction activities |

***Minimize Flood Risk from Restoration Flows***

The SJRRP's strategy for minimizing flood risk is to limit the maximum downstream extent and rate of Interim and Restoration flows for the given reach to then-existing channel capacities. This strategy is incorporated by reference from the PEIS/R (SJRRP 2011a, pages 2-22 through 2-28) and summarized in Section 2.2.10 of the EIS/R. These Program-wide commitments are documented in the PEIS/R Record of Decision (ROD), and no new Project-level actions to minimize flood risk from Interim and Restoration flows are being proposed.

***Other Environmental Commitments***

The Project proponents will implement additional Project-specific measures to avoid potentially adverse environmental consequences for the resource areas listed below (see Section 2.2.10 of the EIS/R) (SJRRP 2015a). Many of the Project-specific measures are consistent with those specified in the PEIS/R ROD.

- Air Quality
- Cultural Resources
- Geology and Soils
- Hydrology – Groundwater
- Hydrology – Surface Water Resources and Water Quality
- Land Use Planning and Agricultural Resources
- Noise and Vibration
- Paleontological Resources
- Public Health and Hazardous Materials
- Recreation

- Transportation and Traffic
- Utilities and Service Systems
- Visual Resources

***Permitting***

Reclamation will obtain all necessary permits, as required by law. Implementation of the Project may require the permits and approvals described in Table 5-2. In general, Federal and State actions (permit issuance) will require a signed ROD (National Environmental Policy Act [NEPA]) and findings, EIR certification, and Notice of Determination documents (California Environmental Quality Act [CEQA]). Additional information on permit acquisition procedures, submittal package requirements, critical issues, timing, and permit fees is discussed in the Project's Regulatory Compliance Technical Memorandum (SJRRP 2011b).

**Table 5-2.**
**Summary of Permits and Approvals that May be Required for the Project**

| Agency and Associated Permit or Approval | Lead Agency for Submittal |
|---|---|
| **Corps**<br>Clean Water Act Section 404 Individual Permit<br>Rivers and Harbors Act Section 10 Permit<br>Rivers and Harbors Act Section 14 Permit (Section 408)<br>33 Code of Federal Regulations 208.10 | Reclamation |
| **USFWS/NMFS**<br>Endangered Species Act Section 7 Consultation<br>Magnuson-Stevens Fisheries Conservation and Management Act | Reclamation |
| **USFWS**<br>Fish and Wildlife Coordination Act Report | USFWS/NMFS |
| **SHPO/ACHP**<br>National Historic Preservation Act, Section 106 | Reclamation |
| **U.S. Coast Guard**<br>General Bridge Act and Rivers and Harbors Act Section 9 | Reclamation |
| **Central Valley RWQCB**<br>Clean Water Act Section 401 Water Quality Certification | Reclamation |
| **SWRCB/Central Valley RWQCB**<br>Clean Water Act Section 402 Construction General Permit | Reclamation |
| **SWRCB**<br>Amended water rights | Reclamation |
| **CSLC**<br>Land Use Lease | Reclamation |
| **SJVAPCD**<br>Air Impact Analysis<br>Regulation VIII Dust Control Plan<br>Federal Clean Air Act | Reclamation |
| **Fresno/Madera Counties**<br>Williamson Act Contracts<br>Land Use/Zoning | Reclamation |

Key:
ACHP = Advisory Council on Historic Preservation
Central Valley RWQCB = Central Valley Regional Water
Reclamation = U.S. Department of the Interior, Bureau of Reclamation

**Table 5-2.**
**Summary of Permits and Approvals that May be Required for the Project**

| Agency and Associated Permit or Approval | Lead Agency for Submittal |
|---|---|

Quality Control Board
Corps = U.S. Army Corps of Engineers
CSLC = California State Lands Commission
NMFS = National Marine Fisheries Service
SHPO = State Historic Preservation Officer
SJVAPCD = San Joaquin Valley Air Pollution Control District
SWRCB = State Water Resources Control Board
USFWS = U.S. Fish and Wildlife Service

# 6.0 Jurisdictional Waters in the Project Area

This chapter describes the environmental setting for wetlands and other non-wetland waters of the United States in the Project area as analyzed in the EIS/R. The EIS/R used the following wetland types to describe the wetland and aquatic ecosystem in the Action Area of each Action Alternative: Riparian Wetlands, Wet Meadows, Marshes, and Non-Wetland Waters of the United States. At the request of the Corps, the Cowardin Classification System was used to describe the aquatic ecosystem in the Action Area of the preferred alternative (Alternative B) in the Preliminary Jurisdictional Wetland Delineation Report. The Cowardin Classification System is not used in this document because it has not been applied to Alternatives A, C, or D and because the classification terminology cannot be easily translated; considerable professional judgment and on-the-ground experience was used to re-categorize the preferred alternative EIS/R wetlands into the Cowardin Classification System. Table 6-1 includes both the EIS/R and Cowardin terminology.

**Table 6-1.**
**EIS/R and Cowardin Terminology**

| EIS/R Wetland Type | Cowardin Classification (in Jurisdictional Delineation) |
|---|---|
| Riparian Wetlands | Palustrine, Forested, Broad-Leaved Deciduous (PFO1) |
| | Palustrine, Scrub-Shrub, Broad-Leaved Deciduous (PSS1) |
| | Riverine, Intermittent, Unconsolidated Shore, Vegetated (R4US5) |
| Wet Meadows | Lacustrine, Littoral, Unconsolidated Shore, Vegetated (L2US5) |
| | Palustrine, Emergent, Persistent (PEM1) |
| | Palustrine, Scrub-Shrub, Broad-Leaved Deciduous (PSS1) |
| Marshes | Palustrine, Emergent, Persistent (PEM1) |
| Non-Wetland Waters of the United States | Lacustrine, Limnetic, Unconsolidated Bottom, Mud (L1UB3) |
| | Riverine, Lower Perennial, Unconsolidated Bottom, Sand (R2UB2) |

## 6.1 Environmental Setting

During the past century, the aquatic resources of the San Joaquin River and the Project area have undergone substantial changes because of human related activities. Extensive wetland areas were drained or filled. Many introduced species have spread and contributed to elimination or marginalization of native species. The decline of wetlands and associated native species has become a matter of public concern.

### 6.1.1 Existing Conditions

Biological resources addressed in this section include wetlands and other non-wetland waters of the United States. Existing conditions are the baseline biological resource conditions at the time of the Notice of Preparation/Notice of Intent distribution in July 2009. The baseline condition of these biological resources was determined through review of scientific literature, existing data sources, and field wetland delineations. In the case of wetlands, field data were collected at later dates, after the start of Interim Flows. Therefore, the best available information to describe existing conditions was typically from the period after the start of Interim Flows. Interim Flows substantially amplified flows in the river and elevated ordinary high water marks (OHWM).[2]

Three categories of potential jurisdictional wetlands were identified in the Project area, as well as potential other waters of the United States. The three wetland categories were riparian wetland, wet meadow, and marsh. Table 6-2 summarizes the acreage of each category of potential jurisdictional wetland and other waters of the United States in the Project area. The DFW considers riparian wetland, wet meadow, and marsh as sensitive natural communities due to their limited distribution in California (DFW 2009; Hickson 2009). These wetland habitat types are described below.

**Table 6-2.**
**Project Area Wetlands and Waters of the United States**

| Wetland and Non-Wetland Type | Area (acres) |
|---|---|
| Riparian Wetlands | 181.3 |
| Wet Meadows | 54.5 |
| Marshes | 81.3 |
| Non-Wetland Waters of the United States | 473.3 |
| Total Riparian, Wetlands, and Other Waters | 790.4 |

***Riparian Wetlands***

There are two primary types of riparian wetlands in the Project area – riparian forest and riparian scrub. They are described and analyzed together because they typically co-occur.

Riparian forest consists of the Fremont cottonwood forest (*Populus fremontii* forest alliance) and Oregon ash groves (*Fraxinus latifolia* forest alliance), and these typically occur along levees, floodplain terraces, and in concave depressions. At higher elevation and better drained soils, Fremont cottonwood forest dominates and integrates with sandbar and black willow.

Riparian scrub usually occurs in disturbed habitats along ditches and levees. Riparian scrub vegetation grows 10 to 30 feet tall and is dominated by the following vegetation alliances: black willow thickets (*Salix gooddingii* woodland alliance), buttonwillow thickets (*Cephalanthus occidentalis* shrubland alliance), red willow thickets (*Salix*

[2] The OHWM is defined as the upper boundary of the active river channel along the bank and by lack of vegetation below it.

*laevigata* woodland alliance), arrow weed thickets (*Pluchea sericea* shrubland alliance), blue elderberry stands (*Sambucus nigra* shrubland alliance), California rose briar patches (*Rosa californica* shrubland alliance), sandbar willow scrub (*Salix exigua* shrubland alliance) and silver bush lupine scrub (*Lupinus albifrons* shrubland alliance). Black willow prevails at lower elevations near the bankfull elevation[3] in areas dominated by poorly drained soils and flat topography. Mixed marsh and wet meadow species often occur in the adjacent understory in the vicinity of the riparian wetlands.

### *Wet Meadows*

Meadows are herbaceous communities dominated by mixtures of perennial grasses and forbs with other grass-like species, such as rushes (*Juncus* species) and sedges (*Carex* species). Some meadows in the Project area include scattered riparian shrubs and trees, but do not contain enough woody vegetation to be included in the riparian scrub or riparian woodland wetland categories. Wet meadows are often located adjacent to dry meadows and other upland areas that are higher above the groundwater table. They typically include flat or concave surface relief and occur in low-lying troughs and basins with poorly drained soils near the San Joaquin River or its tributaries. These site characteristics help maintain extended periods of soil saturation or flooding during the growing season. The vegetation alliances that occur in the wet meadow wetlands are yerba mansa meadows (*Anemopsis californica* herbaceous alliance), creeping rye grass turfs (*Leymus triticoides* herbaceous alliance), salt grass flats (*Distichlis spicata* herbaceous alliance) and non-native annual grasslands.

Wet meadows occur throughout the Project area and are sometimes used for livestock grazing. They occur in swales, drainages, and on lower riparian terraces. These wetlands receive water from the high water table, overbank flooding and sheet drainage from excessive runoff during winter, spring, and early summer. Tarplant (*Centromadia pungens*), yerba mansa (*Anemopsis californica*), alkali heath (*Frankenia grandiflora*), salt grass (*Distichlis spicata*), and creeping wildrye (*Leymus triticoides*) often occur in wet meadows in the Project area. The higher quality wetlands of this type are located in the downstream portion of the reach, near Mendota Pool.

### *Marshes*

The marsh wetlands in the Project area consist of mixed marsh vegetation alliances that are dominated by annual and perennial emergent vegetation with varying amounts of herbs and grass-like species. The vegetative cover is often very dense. In contrast to meadow communities, which have seasonally saturated soils, marsh communities have saturated or inundated soils throughout most of the year, except in some cases, during the dry months of late summer. River water retained by the Mendota Dam is the principal source of water for marshes in the Project area. The vegetation alliances that were observed in the marsh wetlands are California bulrush marsh (*Schoenoplectus californicus* herbaceous alliance), pale spike rush marshes (*Eleocharis macrostachya* herbaceous alliance) and cattail marshes (*Typha* species herbaceous alliance).

[3] The bankfull elevation occurs where the stream completely fills its channel at maximum capacity.

***Potential Non-Wetland Other Waters of the United States***

Additional aquatic elements in the Project area were identified as potential, jurisdictional non-wetland other waters of the United States based on the presence of defined bed and bank, drift lines and/or OHWM. These features (typically, the river channel between the OHWMs, areas of backed up water upstream of Mendota Dam, non-maintained irrigation and drainage ditches, and other small tributaries in the Project area) were mapped using a combination of field measurements and aerial photography. These waters of the United States lack hydrophytic vegetation[4] typically required to qualify as a wetland. Their limits are set by the OHWM. As directed by the Corps, the OHWM for potential other waters of the United States that are connected to the river is defined by the level on the bank that water reached during the highest Interim Flows in 2010. The limits of the OHWM for historical natural water features that are no longer connected to the river is indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas (Corps 2005). Actively managed agricultural irrigation ditches, stock ponds and larger agricultural ponds were not considered other waters of the United States.

[4] Hydrophytic vegetation refers to plants that are adapted to live in saturated soil, flooded areas, or high groundwater conditions.

# 7.0 Project Alternatives

Reclamation evaluated a wide range of alternatives that could meet the Project purpose. This section describes the alternatives evaluated and eliminated during these efforts. It also describes the alternatives most recently analyzed in the EIS/R and retained herein for further discussion in Chapter 8.0.

## 7.1 Alternatives Eliminated

Formulation of a range of Project alternatives 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 summarized here and described in greater detail in the Project Description Technical Memorandum, Attachment A – Initial Alternatives Evaluation (SJRRP 2012b).

### 7.1.1 Formulation of Initial Alternatives

The Initial Alternatives were formulated based on 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 pertain 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. Initial screening involved reviewing the options for consistency with the Settlement requirements and for technical feasibility. Any option deemed technically infeasible or beyond the scope of the Settlement or contrary to its requirements were not carried forward for further consideration.

### 7.1.2 Description of Initial Alternatives

The Initial Alternatives include five floodplain options (Floodplain Initial Alternatives) and three options to bypass water around Mendota Pool (Bypass Initial Alternatives). The Initial Alternatives were designed such that one Floodplain Initial Alternative could be paired with one Bypass Initial Alternative to create a complete Project Alternative. All paired combinations of the Initial Alternatives would meet the Settlement Restoration

Goal of providing suitable passage conditions for adult and juvenile salmonids and transient rearing habitat for juvenile salmonids. All paired combinations of the Initial Alternatives would also meet the requirements of the Project-specific improvements in the Settlement, namely to bypass Mendota Pool, convey at least 4,500 cfs in the Mendota Pool Bypass, design in-channel and levee structures that allow the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary, design 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, and incorporate new floodplain and related riparian habitat between the Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel.

The Floodplain Initial Alternatives include building levees capable of conveying flows up to 4,500 cfs and restoring floodplain habitat to provide benefit to salmonids and other native fishes in Reach 2B. 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 levee alignments (FP-1 through FP-5) with varying widths and varying amounts of floodplain grading were considered and are summarized in Table 7-1 below. FP-1 was the narrowest Floodplain Initial Alternative with an approximate average floodplain width of 2,340 feet. It provided the least amount of floodplain acreage and rearing habitat but also requiring the least amount of land acquisition. The constricted conditions of this narrow floodplain would result in the deepest inundation depths and poor quality floodplain. FP-2 was the second narrowest Floodplain Initial Alternative with an approximate average floodplain width of 3,070 feet. FP-2 would provide a moderate amount of good-quality floodplain habitat resulting in sufficient acres of the very shallow water habitat for primary production as well as sufficient acres of habitat that support direct rearing. FP-3 had the same levee alignments as FP-2 but included grading on the floodplain to establish greater heterogeneity of water depths on the floodplain. FP-4 was the second widest floodplain with an approximate average floodplain width of 4,200 feet. Finally, FP-5 was the widest floodplain with an approximate average floodplain width of 5,600 feet. FP-5 would provide the most floodplain acreage, but would also require the most land acquisition.

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. Three bypass options (Settlement Alignment, Compact Bypass, and Fresno Slough Dam) were considered and are summarized in Table 7-1 below. The Settlement Alignment would convey 4,500 cfs around the Mendota Pool consistent with the location and layout of the channel as described in exhibits created during negotiation of the Settlement. This Initial Alternative would include excavating the bypass channel, constructing levees and in-channel structures, relocating or modifying existing infrastructure, and acquiring approximately 710 acres of land. The Compact Bypass would 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 approximately 240 acres of land. The 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 approximately 36 acres of land.

**Table 7-1.**
**Comparison of Project Initial Alternatives**

| | Upfront Costs | | | | | Channel Stability | Seepage impacts | | |
|---|---|---|---|---|---|---|---|---|---|
| | Capital Improvement | Land | Rearing Habitat (>1.0 feet inundation at 2,500 cfs; acres) | Shallow Water Habitat Quality (1=poor, 2=moderate, 3=good) | Average Floodplain Width (feet) | Potential for lateral migration to impact levees (estimated erosion protection cost) | Acres of land in which groundwater levels rise above 5-foot monitoring threshold | Acres of land in which groundwater levels rise above 7-foot monitoring threshold | Total Farmland Removed from Production (acres) |
| FP-1 | $194,430,000 | $15,300,000 | 373 | 1 | 2340 | $1,935,000 | 490 | 580 | 400.5 |
| FP-2* | $192,480,000 | $19,800,000 | 482 | 3 | 3070 | $1,123,000 | 330 | 390 | 658.7 |
| FP-3 | $194,780,000 | $19,800,000 | 481 | 3 | 3070 | $1,123,000 | 330 | 390 | 658.7 |
| FP-4* | $218,110,000 | $27,300,000 | 585 | 2 | 4200 | $315,000 | 300 | 360 | 1159.2 |
| FP-5 | $266,900,000 | $36,300,000 | 762 | 1 | 5600 | $130,000 | 230 | 320 | 1797.1 |
| Settlement Alignment Bypass | $225,370,000 | $13,000,000 | 58 | 1 | N/A | $8,455,000 | 0 | 0 | 717.8 |
| Compact Bypass* | $234,970,000 | $ 7,000,000 | -91 | 1 | N/A | $7,824,000 | 0 | 0 | 158.3 |
| Fresno Slough Dam* | $375,990,000 | $ 8,890,000 | 39 | 1 | N/A | $2,306,000 | 0 | 0 | 389.1 |

*Initial alternatives carried forward to EIS/R

### 7.1.3 Screening of Initial Alternatives

Criteria for the Floodplain Initial Alternatives and Bypass Initial Alternatives were created 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 Action Alternatives without the need to evaluate all possible combinations. Initial Alternatives were evaluated 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 to evaluate whether the Initial Alternatives meet the Project purpose.

Based on the Initial Alternative evaluation, three Initial Alternatives performed poorly and were therefore eliminated from further consideration:

- **FP-1** would not effectively meet the Project purpose relative to other options because it 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. FP-1 would provide low amounts of rearing habitat, poor quality shallow water habitat, and low amounts of restoration area. It also had a relatively greater risk of channel instability and relatively larger nuisance seepage impacts.
- **FP-5** would not effectively meet the Project purpose relative to other options because it would result in large areas too shallow and dry to provide effective floodplain rearing and primary production benefits. FP-5 would provide poor quality shallow water habitat and would have relatively high restoration and land costs. Relatively greater land would be removed from production. There would be limited additional fish habitat and passage benefits for the added costs and FP-5 would create the potential for fish strandings.
- The **Settlement Alignment** would not effectively meet the Project purpose relative to other options because it provides less restoration area than the Compact Bypass but with larger land requirements. It also provides minimal additional shallow water or rearing habitat and poses a relatively greater risk of channel instability.

Of the remaining Initial Alternatives, FP-3 differed from FP-2 only in grading options and was nested within FP-2 as a single alternative. The Initial Alternatives carried forward for further evaluation were:

- FP-2/FP-3, the Narrow Floodplain;
- FP-4, the Wide Floodplain;
- Compact Bypass; and
- Fresno Slough Dam.

### 7.1.4 Formulation of Action Alternatives

Following the Initial Alternatives evaluation, Initial Alternatives for each component (Floodplain and Bypass) were combined together to form complete Action Alternatives. Each of the four Action Alternatives developed for the Project consists of a floodplain width that would pass 4,500 cfs, a method to bypass Restoration Flows around Mendota Pool, and a method to deliver water to Mendota Pool.

Subsequent to the initial development of the Action Alternatives, an additional floodplain alignment was created. The Consensus-Based Floodplain was a refinement in the levee alignment based upon those lands located within the Narrow and Wide floodplains owned by willing sellers. This area constitutes the Project footprint for the Consensus-Based Floodplain and would be approximately 4,200 feet wide on average, equivalent to the average width of the Wide Floodplain (FP-4).

The Initial Alternatives were combined into the Action Alternatives as follows:

- Alternative A: Compact Bypass with Narrow Floodplain (FP-2/FP-3) and South Canal.
- Alternative B: Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure.
- Alternative C: Fresno Slough Dam with Narrow Floodplain (FP-2/FP-3) and Short Canal.
- Alternative D: Fresno Slough Dam with Wide Floodplain (FP-4) and North Canal.

### 7.1.5 No-Action Alternative

The conditions under the No-Action/No-Project Alternative (hereafter called 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. The No-Action Alternative assumes that other components of the SJRRP, as described in the 2012 Record of Decision, and other reasonably foreseeable actions consistent with current management direction expected to occur in the Project area, would be implemented.

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. 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.

Under this alternative, the Project would not be implemented. The No-Action Alternative is not consistent with the Settlement and would not meet the Project purpose.

The No Action Alternative fails to meet any of the elements of the Project purpose and is therefore eliminated from further discussion. The No Action Alternative will not be discussed in the subsequent sections.

## 7.2 Alternatives Retained for Further Discussion

This document provides information for the evaluation of four Action Alternatives to implement the Project. 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:

- Alternative A (Compact Bypass with Narrow Floodplain and South Canal).
- Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative.
- Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal).
- Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal).

Each of the Action Alternatives consists of a floodplain width which passes 4,500 cfs, a method to bypass Restoration Flows around Mendota Pool, and a method to deliver water to Mendota Pool. Action Alternatives are considered to comply with the terms of the Settlement, substantially meet the Project purpose, and have benefits potentially offsetting their impacts.

### 7.2.1 Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

Alternative A (Compact Bypass with Narrow Floodplain and South Canal) 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 Bifurcation Structure 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. See Figure 7-1 and Figure 7-2 for a plan view of the alternative’s features.

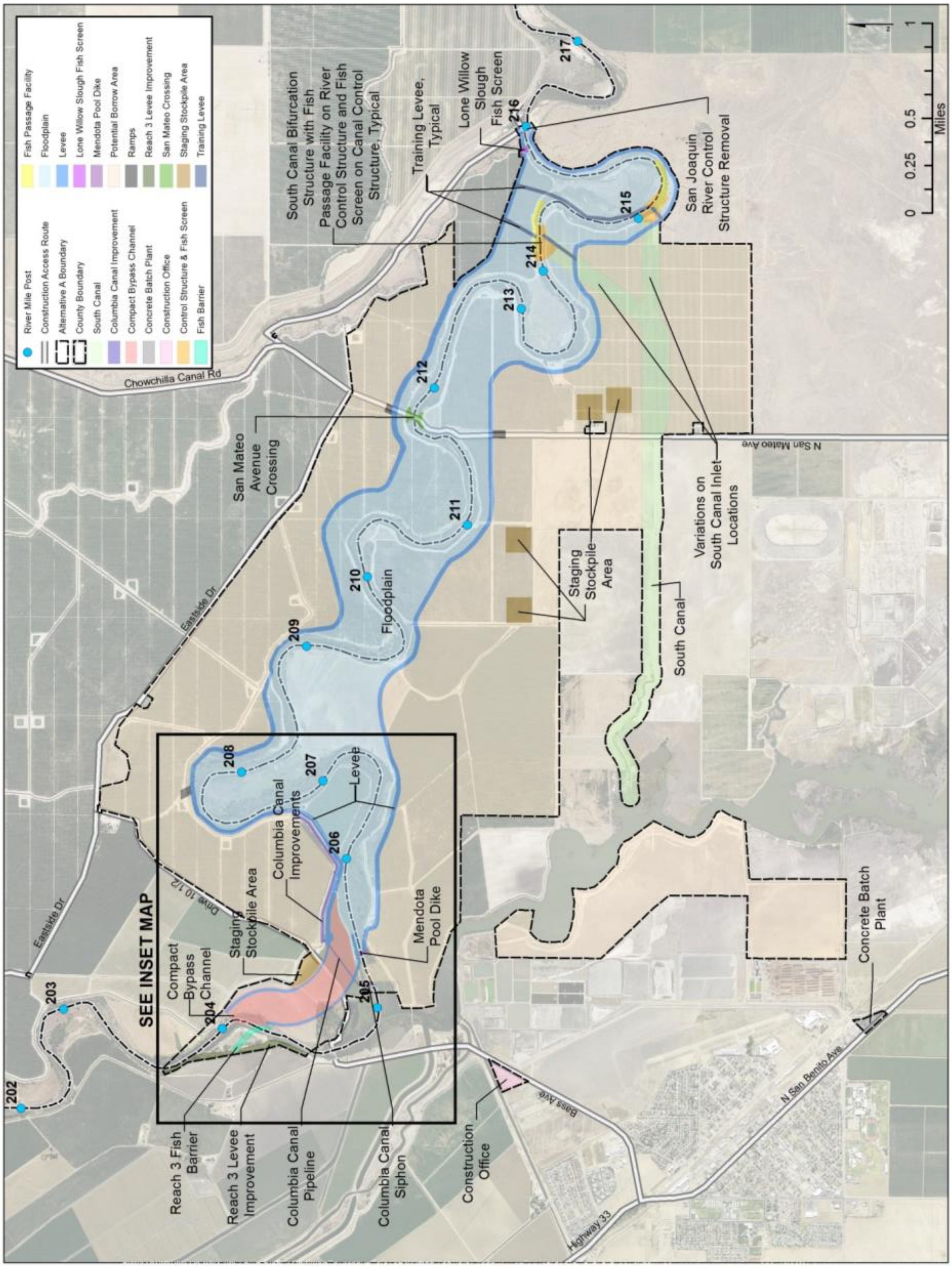


**Figure 7-1.**
**Plan View of Alternative A**
**(Compact Bypass with Narrow Floodplain and South Canal)**

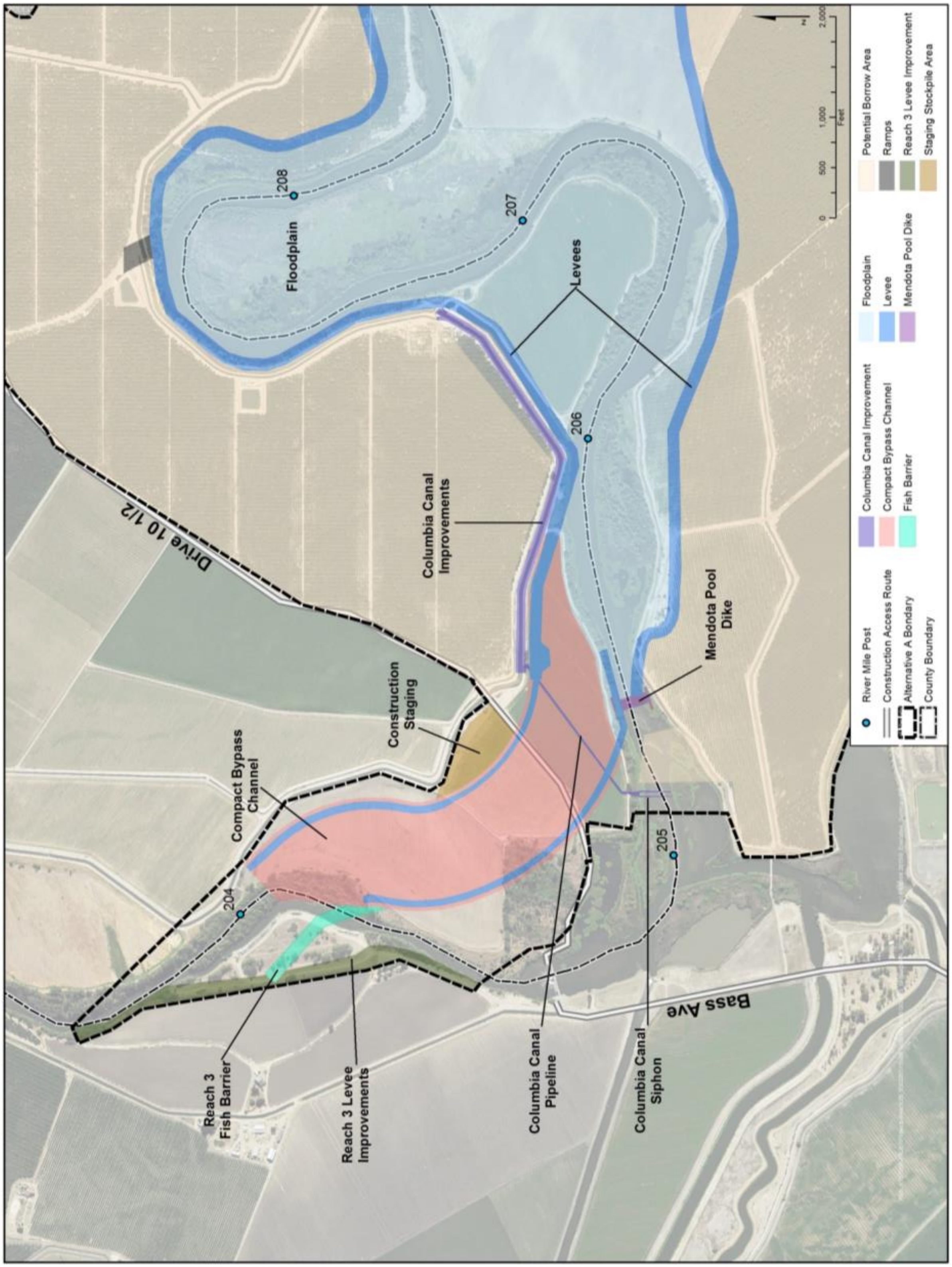


**Figure 7-2.**
**Inset Map of Alternative A**
**(Compact Bypass with Narrow Floodplain and South Canal)**

### 7.2.2 Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the preferred 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 Bifurcation Structure. A bifurcation structure would be built at the head of the Compact Bypass channel to control diversions into Mendota Pool. Fish passage facilities would be built at the Compact Bypass bifurcation structure to provide passage around the structure. The existing San Mateo Avenue crossing would be removed. See Figure 7-3 and Figure 7-4 for a plan view of the alternative's features.

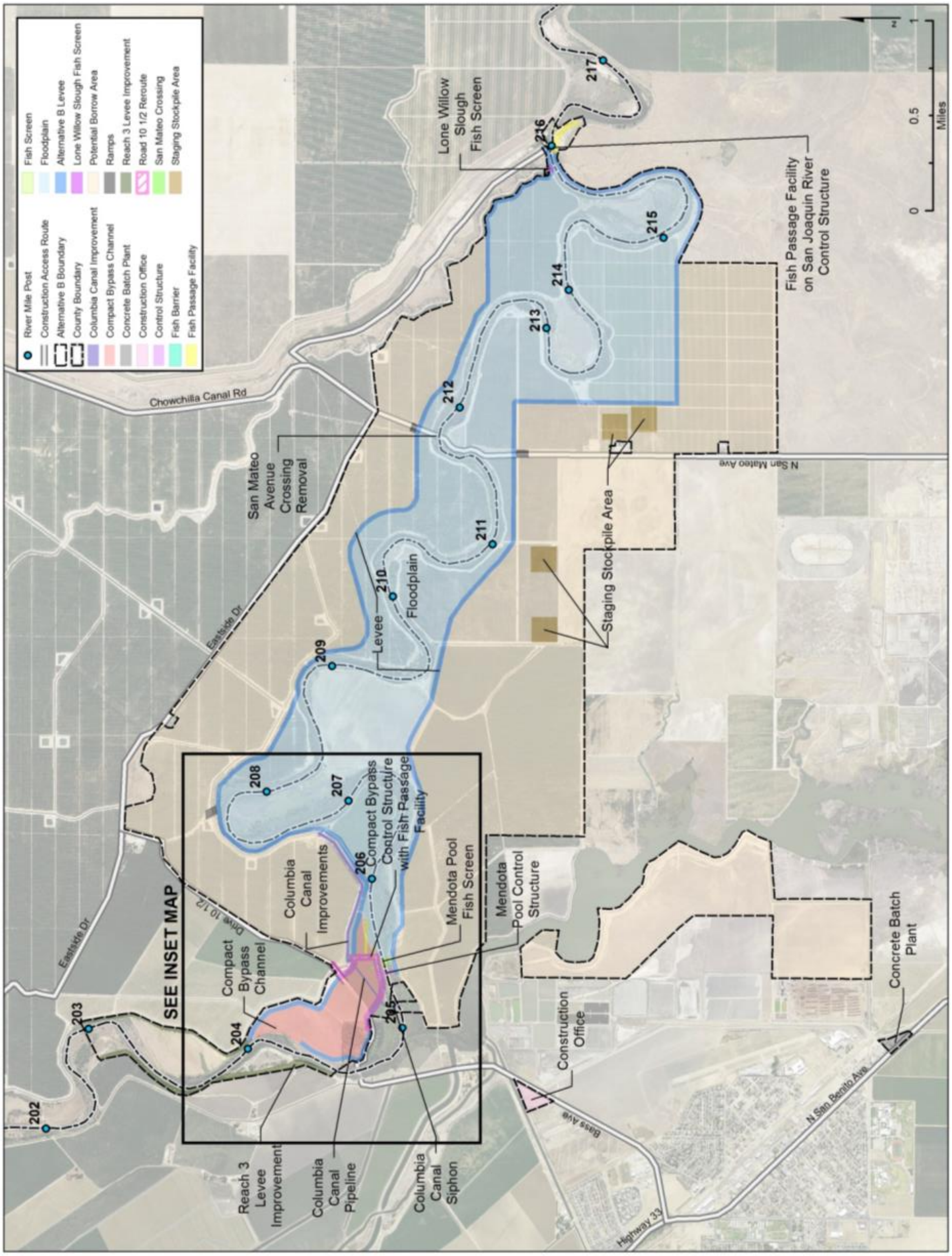


**Figure 7-3.**
**Plan View of Alternative B**
**(Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure)**

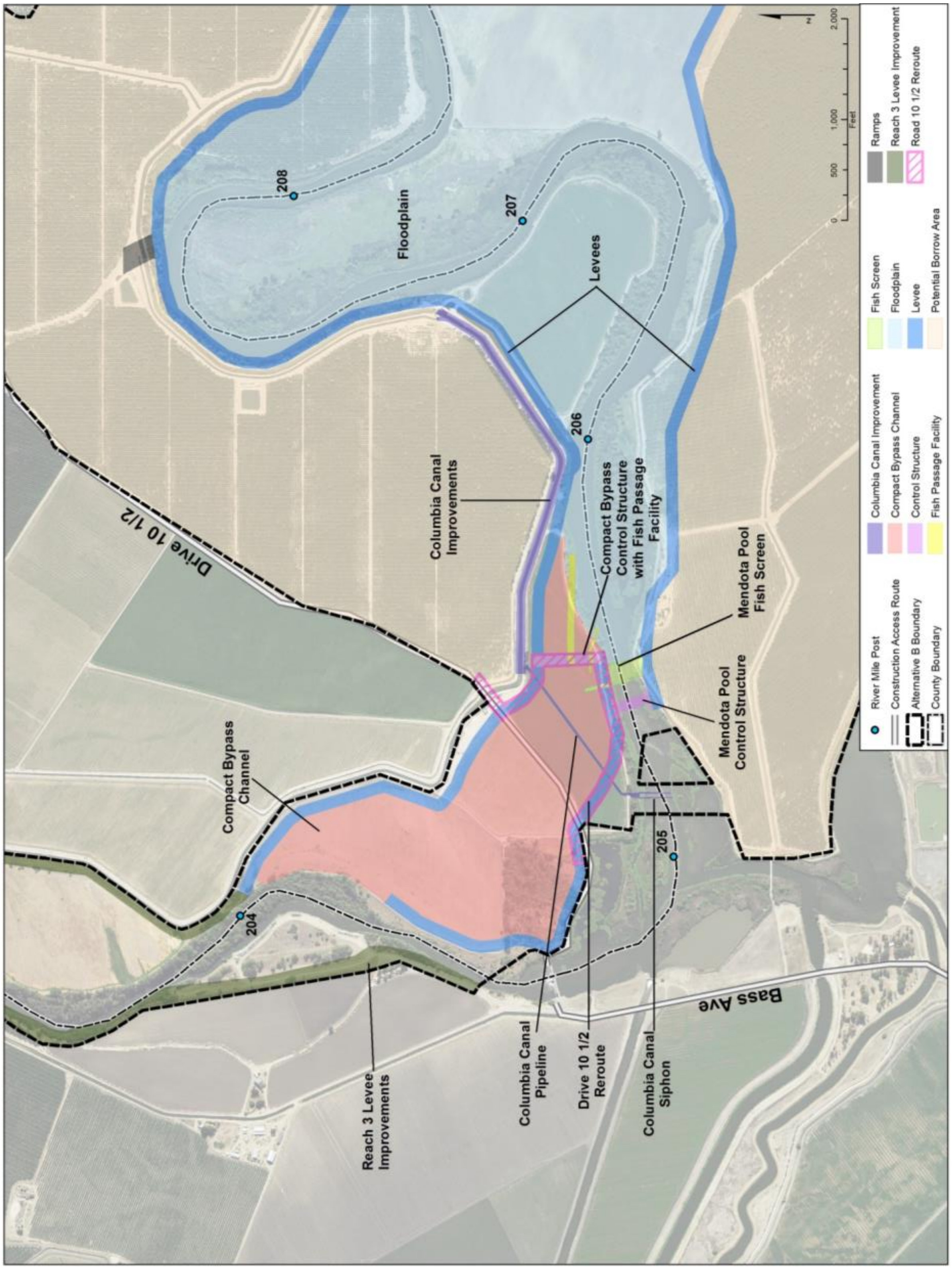


**Figure 7-4.**
**Inset Map of Alternative B**
**(Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure)**

### 7.2.3 Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal) 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 Bifurcation Structure. 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. See Figure 7-5 and Figure 7-6 for a plan view of the alternative's features.

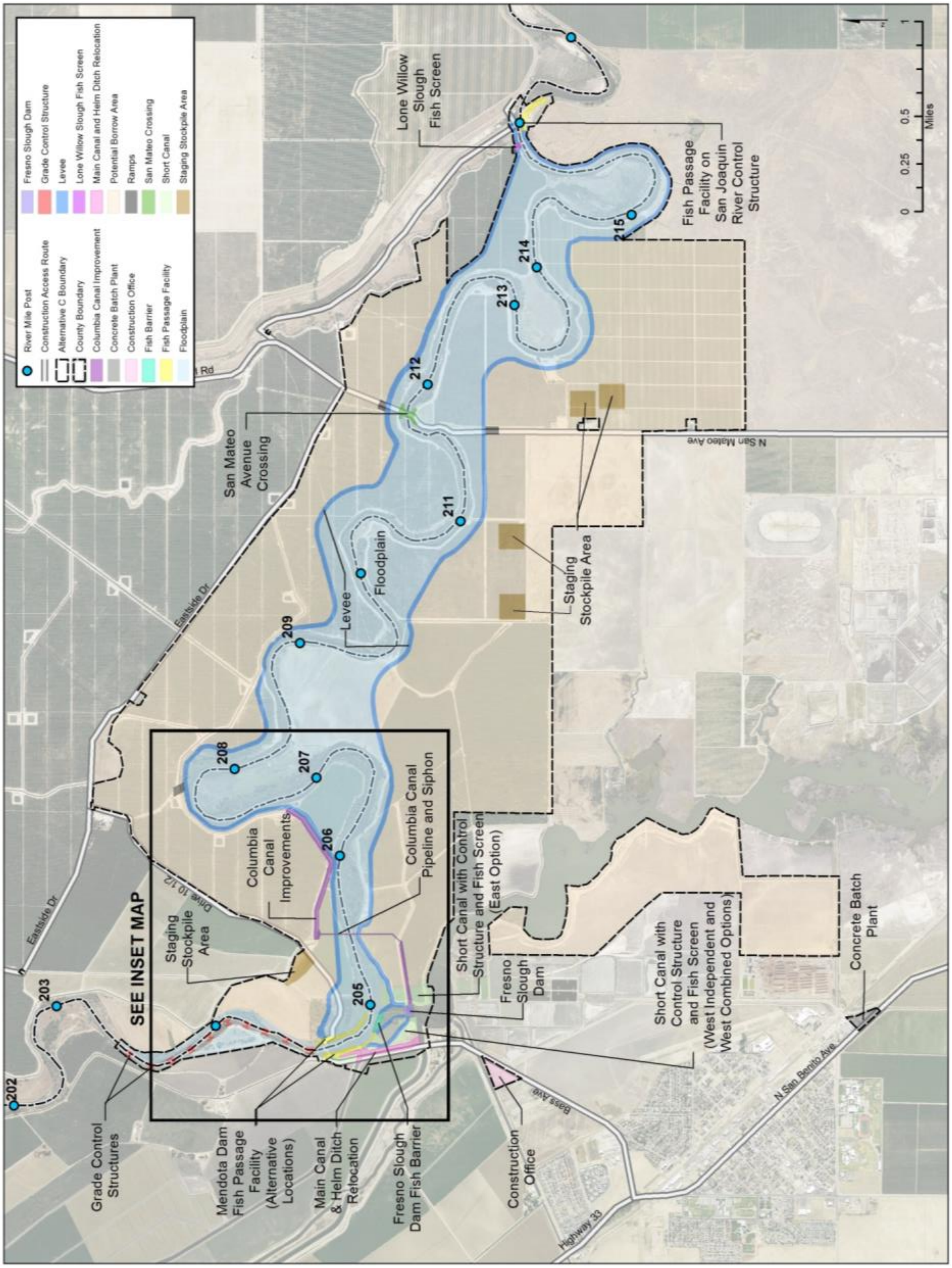


**Figure 7-5.**
**Plan View of Alternative C**
**(Fresno Slough Dam with Narrow Floodplain and Short Canal)**

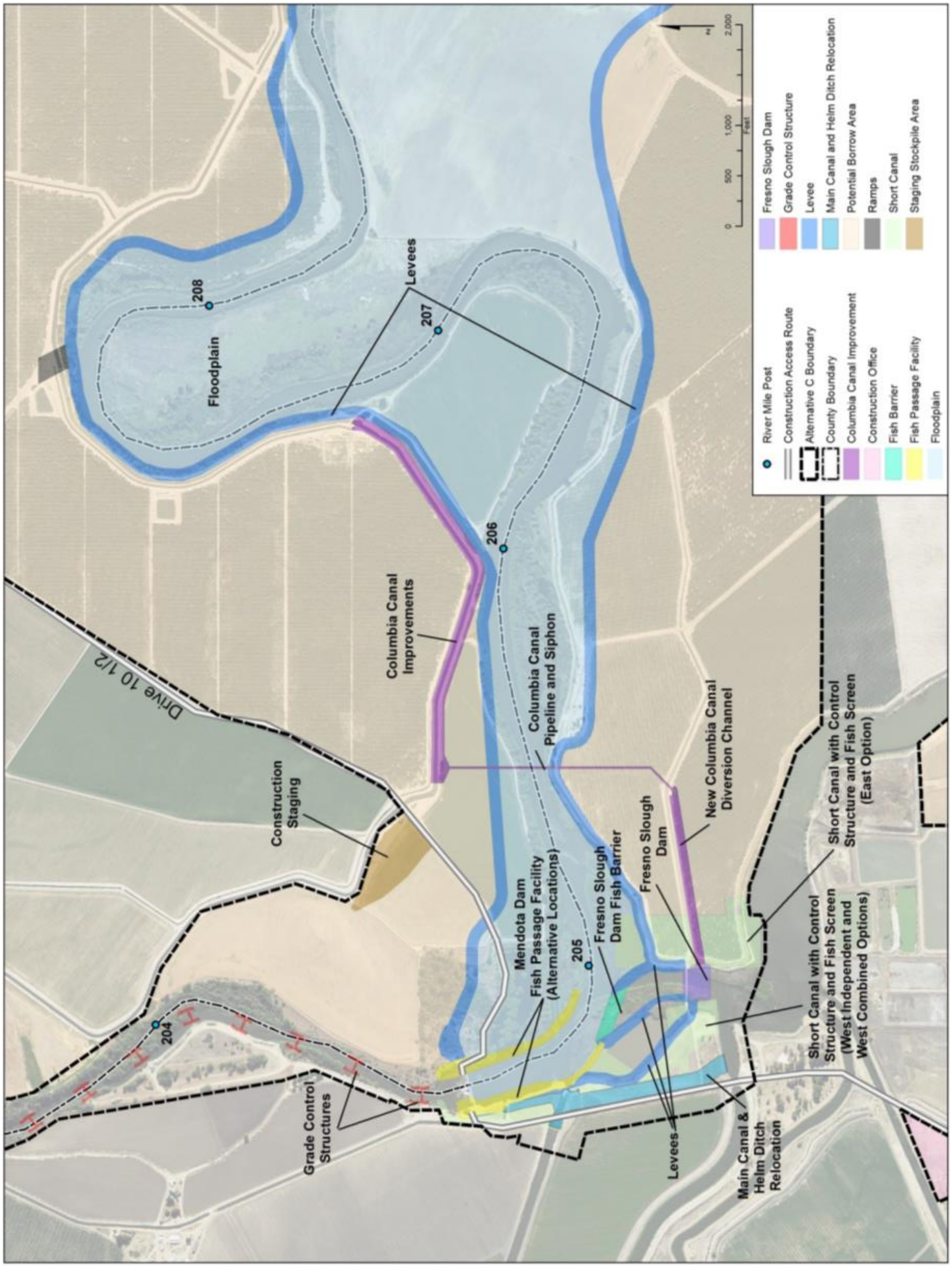


**Figure 7-6.**
**Inset Map of Alternative C**
**(Fresno Slough Dam with Narrow Floodplain and Short Canal)**

### 7.2.4 Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal) 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 Bifurcation Structure 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. The existing San Mateo Avenue crossing would be removed. See Figure 7-7 and Figure 7-8 for a plan view of the alternative's features.

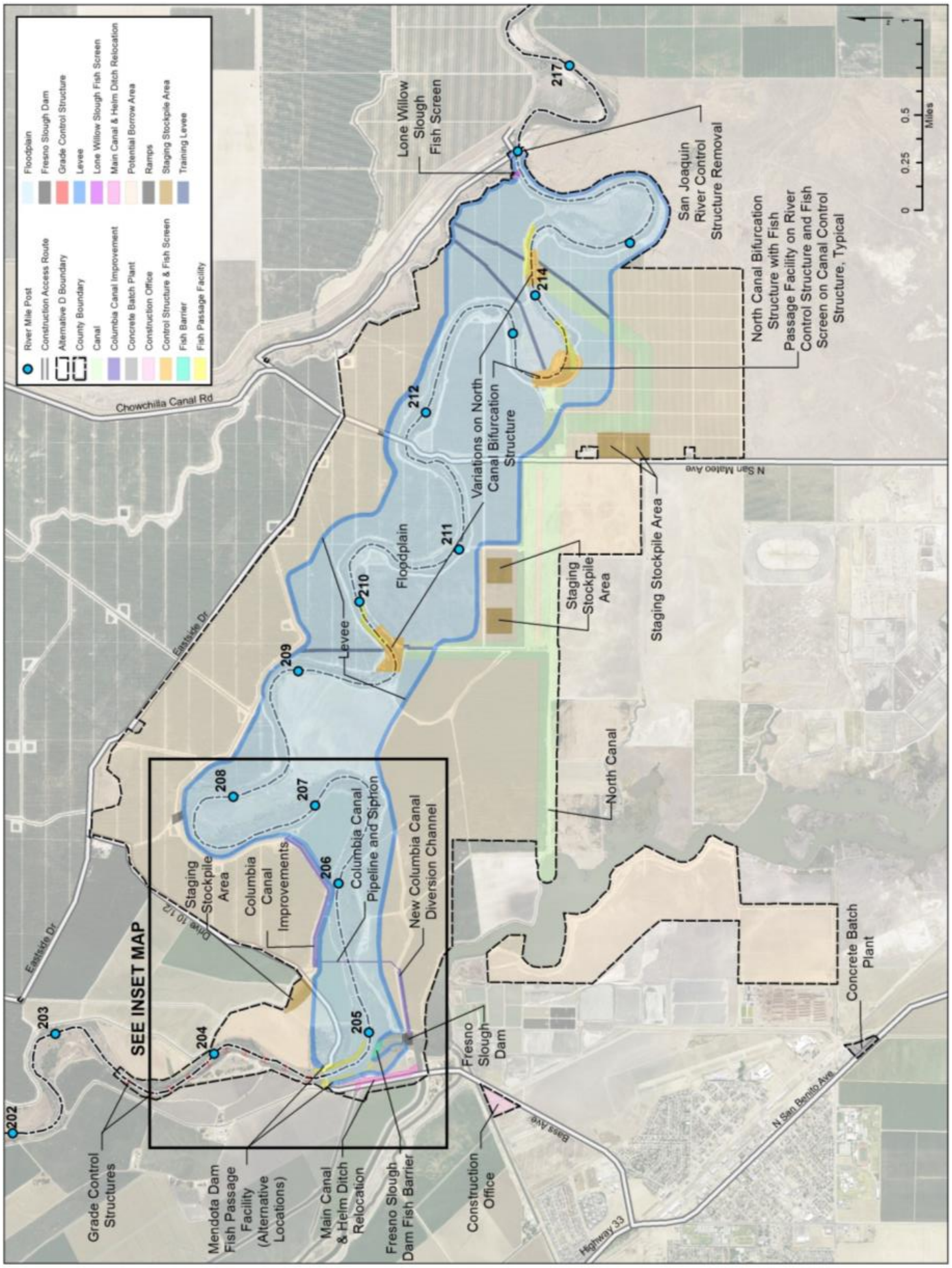


**Figure 7-7.**
**Plan View of Alternative D**
**(Fresno Slough Dam with Wide Floodplain and North Canal)**

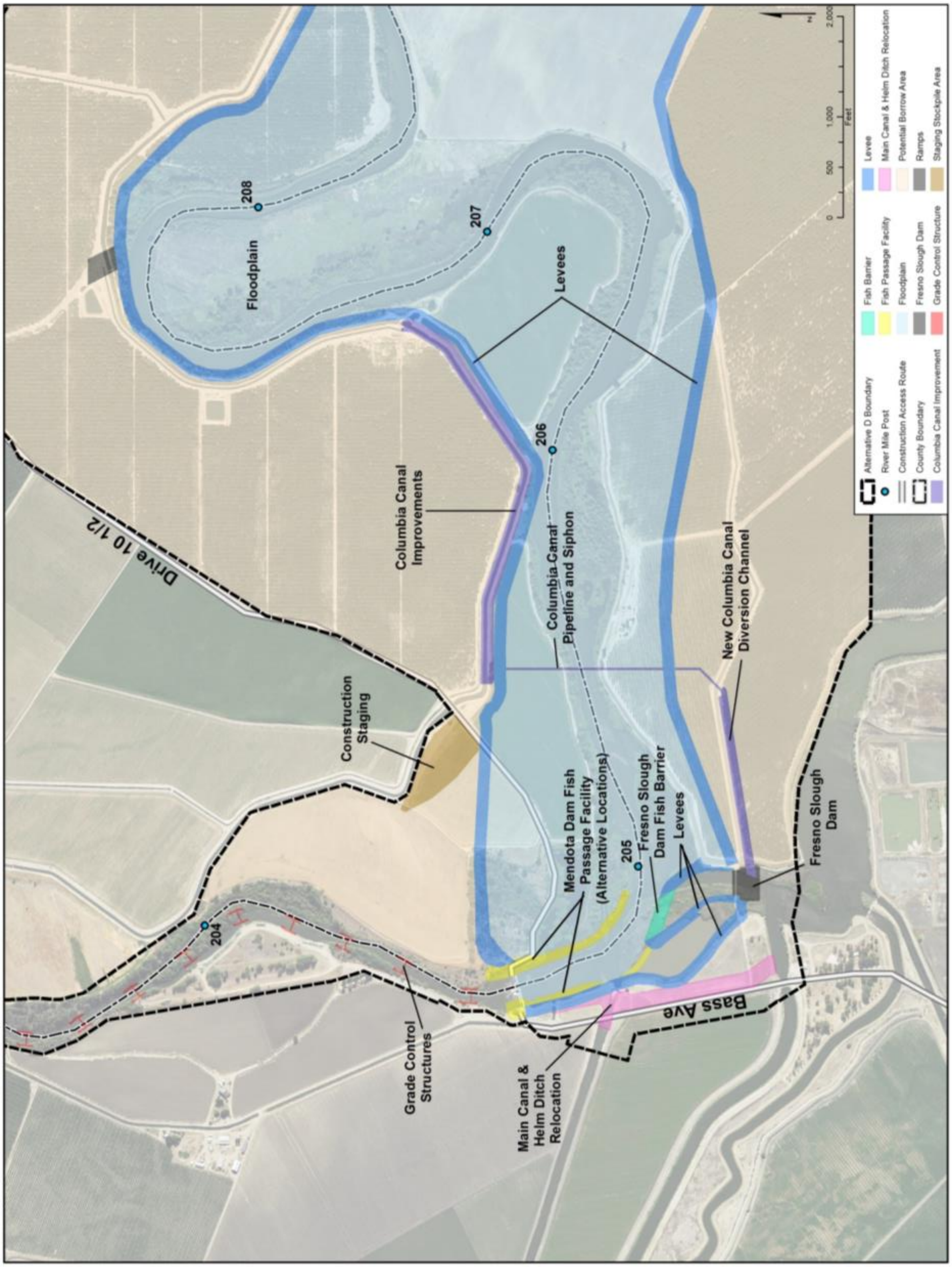


**Figure 7-8.**
**Inset Map of Alternative D**
**(Fresno Slough Dam with Wide Floodplain and North Canal)**

### 7.2.5 Alternatives Comparison Tables

The table below (Table 7-2) provides a summary of the physical characteristics of the Action Alternatives.

**Table 7-2.**
**Levees, Relocations, and Land Acquisition**

| | Alternative A | Alternative B | Alternative C | Alternative D |
|---|---|---|---|---|
| **Levees** | | | | |
| 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 and Construction Schedule** | | | | |
| Land Acquisition[1] | 2,700 acres | 2,900 acres | 2,450 acres | 3,300 acres |
| Time to Build[2] | 132 months | 157 months | 133 months | 158 months |

[1] Total acreage includes areas that are sovereign and public trust lands.

[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.

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# 8.0 Evaluation of Retained Alternatives

This section provides the information used to identify the recommended LEDPA for the proposed project. The retained alternatives are evaluated in this section based on practicability, potential impacts to the aquatic ecosystem, and other potential adverse environmental consequences. The retained alternatives include Alternative A, Alternative B, Alternative C, and Alternative D.

## 8.1 Practicability

As defined by the 404(b)(1) Guidelines, an alternative is practicable if it is capable of being implemented after taking into consideration cost, existing technology, and logistics in light of the overall project purpose.

This section evaluates the practicability of the Project alternatives in a sequential process. It first indicates how well each of the alternatives meets the overall project purpose. It then assesses the alternatives using the three standard criteria used to determine practicability: cost, existing technology, and logistics.

### 8.1.1 Ability to Meet Overall Project Purpose

As described in Section 4.2, the overall project purpose includes the following elements:

- 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;
- 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; and
- Support of the SJRRP's Restoration Goal 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.

Each of the Action Alternatives (Alternative A, Alternative B, Alternative C, and Alternative D) meets all three elements of the Project purpose.

### 8.1.2 Cost

Analysis of Project costs includes upfront costs, which would be a one-time expenditure, and operation and maintenance (O&M) costs, reported in dollars per year. The cost of the Project alternatives varies considerably, however cost is not a primary determining factor in eliminating alternatives for the Project. Rather, maximization of floodplain size and fish habitat, ability to meet water management needs, and use of a consensus-based process in determining the preferred alternative are the driving factors.

Upfront and O&M cost estimates for each Project alternative were calculated based on preliminary designs and are shown in Table 8-1. Upfront costs include capital improvement costs and land costs. Alternative B, the preferred alternative, is the least expensive Action Alternative ($479,980,000 upfront, $1,241,000 per year for O&M), while Alternative A is the most expensive Action Alternative ($517,330,000 upfront, $1,746,000 per year for O&M). The cost estimate for Alternative B was updated for the *Revised Framework for Implementation* and is lower than those included in Table 8-1 (SJRRP 2015b). However, because cost estimates were not updated for all Action Alternatives, the cost estimate from the *Revised Framework for Implementation* is not presented in this document.

**Table 8-1.**
**Upfront and O&M Costs for Each Project Alternative**

| Alternative | Upfront Costs (dollars) | O&M Costs (dollars/year) |
|---|---|---|
| Alternative A | $517,330,000 | $1,746,000 |
| Alternative B, the Preferred Alternative | $479,980,000 | $1,241,000 |
| Alternative C | $490,170,000 | $1,100,000 |
| Alternative D | $505,390,000 | $1,387,000 |

### 8.1.3 Existing Technology

Construction of any of the Action Alternatives would present an array of technical challenges. Although the specific suite of construction activities would vary among the alternatives, the general kinds of activities undertaken, and the level of their technical challenges, would be similar. These activities include:

- Mobilization
- Staging area construction
- Traffic control
- Grubbing and clearing
- Removal, relocation, or retrofitting of existing structures
- Site dewatering
- Transport of demolished materials
- Sediment removal and stabilization or transport
- Excavation and grading
- Concrete work

- Construction of fish passage structures and levees
- Habitat restoration

These types of construction activities are implemented for river restoration projects throughout the United States and have evolved over many decades of standard engineering practices. As a result, it is reasonable to assume that there are no obvious, major technical constraints that could not be overcome and which would render any of the Action Alternatives impracticable.

### 8.1.4 Logistics

Analysis of logistics includes consideration of overall Project coordination and construction issues as well as day-to-day implementation of Project activities. This section of the discussion outlines logistical issues and difficulties in constructing each of the Action Alternatives. For this project, significant logistical considerations include cultivating and maintaining stakeholder involvement, particularly from landowners, and minimizing impacts to water management operations, where possible.

#### *Stakeholder Involvement by Landowners*

Stakeholder involvement by landowners was a critical component in the development and analysis of the Action Alternatives. Without stakeholder involvement from landowners both adjacent to and within Project boundaries, it would be difficult to balance conflicting needs while acquiring the land necessary to construct the Mendota Pool Bypass, the expanded floodplain, the Mendota Pool conveyance structure, and the necessary associated infrastructure. Because of the importance of stakeholder involvement in this project, a consensus-based decision process was used to determine the best option for each component of the Project (Mendota Pool bypass, floodplain, and Mendota Pool conveyance structure). Other logistical and environmental factors were thoroughly considered, but landowner coordination and involvement in the decision-making process was vital.

Landowners prefer the Compact Bypass (Alternatives A and B) over the Fresno Slough Dam (Alternatives C and D). The wider floodplain alignments (Alternatives B and D) maximize potential fish habitat, in comparison to the narrow floodplain levee alignment (Alternatives A and C). The consensus-based floodplain (Alternative B), which was developed by creating a levee alignment based on land that could be purchased from willing sellers, is preferred by landowners over the wide floodplain levee alignment (Alternative D). The alternatives that include construction of a lengthy canal to convey water from Reach 2B to Mendota Pool (Alternatives A and D) would create access issues to farms and would require construction of bridges, while the Bifurcation Structure (Alternative B) would not create these issues. Alternative B contains the landowner preferred-options for the Mendota Pool bypass, the floodplain alignment, and the Mendota Pool conveyance structure.

#### *Water Management Needs*

An important logistical factor in the evaluation of the Action Alternatives is minimizing impacts to water management operations, where possible. Of the two Mendota Pool bypass options, the Compact Bypass would not require a substantial change in Delta-

Mendota Canal and Mendota Pool operations, while the Fresno Slough Dam would require more substantial changes to Mendota Pool operations. The Fresno Slough Dam would cause greater reductions in the volume of Mendota Pool, making the timing of inflows and outflows from the Pool more critical. Therefore, the Compact Bypass (Alternatives A and B) is preferred over the Fresno Slough Dam (Alternatives C and D) with respect to water management needs. Levee alignment would not impact water management operations. The North and South Canal Bifurcation structures would serve a similar flood flow routing function as the San Joaquin River control structure of the Chowchilla Bifurcation Structure. Therefore, to reduce the number of structures requiring fish passage, the San Joaquin River control structure of the Chowchilla Bifurcation Structure was removed from Alternatives A and D. The use of the North or South Canal Bifurcation Structure for flood flow routing to the Chowchilla Bypass would be change in flood operations. Use of the Bifurcation Structure (Alternative B) would not change flood operations. Overall, Alternative B contains the Mendota Pool bypass and Mendota Pool conveyance structure options that would best preserve water management operations.

***Construction Timeline***

The length of construction and overall project timeline are factors in determining a project's practicability. As with most projects, the magnitude of a particular logistical issue is related to the length of time construction is underway. Alternatives that can be completed quickly, especially when this reduces the number of work seasons, usually face fewer logistical issues than those that take longer to construct. While project timeline is considered in the evaluation of alternatives, it is not a primary determining factor. As described in Section 8.1.2, maximization of floodplain size and fish habitat, ability to meet water management needs, and use of a consensus-based process are the driving factors in identifying the preferred alternative. A summary of construction durations is included in Table 8-2.

**Table 8-2.**
**Construction Duration for each Project Alternative**

| Alternative | Months to Complete |
|---|---|
| Alternative A | 132 |
| Alternative B | 157 |
| Alternative C | 133 |
| Alternative D | 158 |

### 8.1.5 Conclusions Regarding Practicability

The following conclusions regarding the practicability of the Action Alternatives are based on the evaluation of each element presented above:

- Alternative A is not the most practicable alternative, but will still be carried forward in the document. Construction of the South Canal would create access issues to farms, requiring construction of bridges, and is not preferred by landowners. The South Canal would replace the flood flow routing function of the San Joaquin River control structure of the Chowchilla Bifurcation Structure changing flood operations. Alternative A is also the most expensive alternative.

- Alternative B is the most practicable alternative. It has the fewest number of logistical challenges as it is the landowner-preferred alternative and best preserves water management operations. Alternative B is also the least expensive alternative.
- Alternative C is not the most practicable alternative, but will still be carried forward in the document. Several components of Alternative C were considered undesirable by landowners and they require significant alterations to water management and flood operations.
- Alternative D is not the most practicable alternative, but will still be carried forward in the document. None of the components of Alternative D are preferred by landowners and they require significant alterations to water management and flood operations.

## 8.2 Potential Impacts to the Aquatic Ecosystem

This section describes the impacts to the aquatic ecosystem associated with each Action Alternative. With respect to wetlands and other waters of the United States, the primary environmental impact issue and concern is the following:

**Impact WET-1**: Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during Construction.

**Impact WET-2**: Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands or Other Waters during the Operations and Maintenance Phase.

**Impact WET-3**: Conflict with Provisions of Local or Regional Plans Regarding Conservation Lands.

### 8.2.1 Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

Alternative A would include construction of Project facilities including a Compact Bypass channel, a new levee system encompassing the existing river channel in a narrow floodplain, and the South Canal. Other key features include construction of the Mendota Pool Dike (separating the San Joaquin River and Mendota Pool), a fish barrier below Mendota Dam, and the South Canal bifurcation structure and fish passage facility, modification of the San Mateo Avenue crossing, and the removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure. Construction activity is expected to occur intermittently over an approximate 132-month timeframe.

This alternative includes passive riparian habitat restoration and grazing or farming in the floodplain. It is assumed that over time wetland communities would develop within the main channel and that a dense riparian scrubland would develop along the main river channel banks. The Restoration Flows would be used to recruit new vegetation along the channel from the existing seed bank. Between the main river channel banks and the proposed levees, limited agricultural practices (e.g., annual crops, pasture, or floodplain-compatible permanent crops) would occur.

**Impact WET-1 (Alternative A): *Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during Construction.*** Construction activities have the potential to result, indirectly or directly, in adverse effects on jurisdictional waters of the United States and waters of the State, including wetlands. Compared to the No-Action Alternative, implementing Alternative A would result in channel modifications in Reach 2B to divert the river into the Compact Bypass channel for fish passage. This and other actions may involve dredging, grading, and recontouring within the OHWM of waters of the United States. As a result, dredged or fill materials would be discharged into waters of the United States, and permanent fill of Corps jurisdictional wetlands could occur.

Project actions to manage channel habitat may also result in temporary or permanent fill of waters of the United States, including wetlands. Channel habitat enhancement could involve dredging, grading, and recontouring to connect the existing channel to the Compact Bypass, which would result in discharge of fill material. In addition, some adjacent wetlands could be permanently filled or isolated by constructing control structures within the channel. These actions could result in loss of not only the filled wetlands, but any associated adjacent wetland habitat.

Construction of haul roads, staging areas, new levees, and other potential ancillary facilities could result in temporary or permanent fill of waters of the United States, including wetlands. Constructing and installing fish passage facilities, fish barriers, and new control structures, as well as modifying existing control structures and road crossings, and other Project actions, could also result in placement of fill into waters of the United States.

Although many of the Project actions could result in discharge of dredged or fill material into waters of the United States, including wetlands, most of these activities would not result in permanent loss of acreage, functions, or values of wetland habitats. New low-flow channel, side-channel, bypass channel, and floodplain habitat would be created and these and other modified areas of river reaches and bypasses would continue to convey water and support aquatic habitat.

Table 8-3 summarizes the impact acreage for Alternative A for each category of potentially jurisdictional wetlands and other waters in the Project area. These acreages represent the worst-case scenario where all existing floodplain areas are assumed to be impacted. Areas temporarily disturbed during construction would be restored to previous contours, if feasible, and then seeded with a native vegetation seed mixture to prevent soil erosion.

**Table 8-3.**
**Wetlands and Waters of the United States Potentially Affected by Alternative A**

| Type | Maximum Impacted Area (acres) | |
|---|---|---|
| | **Permanent** | **Temporary** |
| Riparian Wetlands | 102.1 | 23.2 |
| Wet Meadows | 55.4 | <0.02 |
| Marshes | 47.5 | 0.9 |
| Non-Wetland Waters of the United States | 412.0 | 31.9 |
| **Total Riparian, Wetlands, and Other Waters** | **617.1** | **56.0** |

The Project alternatives (including Alternative A) include specific conservation measures to avoid, minimize, or compensate for adverse effects on waters of the United States and waters of the State, including wetlands (as outlined in Section 5.3.18, Table 5-1 and described in Appendix A), and these measures would be implemented as part of the Project alternative. Temporary impacts of the Project alternative would be minimized by implementation of conservation measures that require coordination with the Corps, identification and quantification of wetlands and waters of the United States/waters of the State, obtaining permits, and full compensation for any loss of wetlands and other waters of the United States/waters of the State. Implementing Conservation Measures WUS-1 and WUS-2 would ensure that loss and degradation of waters of the United States, and other wetland habitats, would be avoided and minimized during construction activities, to the extent feasible. Implementing Conservation Measures WUS-1 and WUS-2 would ensure that any wetland habitat or other waters of the United States that could not feasibly be avoided would be replaced, restored, or enhanced so that the Project would result in no net loss of aquatic acreage, functions, and values. Because conservation measures will be implemented as part of the Project, Alternative A would not have substantial effects on jurisdictional wetlands by construction of facilities or during other construction-related Project actions (e.g., habitat restoration).

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to No-Action Alternative). Impacts would be **less than significant**.

**Impact WET-2 (Alternative A):** ***Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during the Operations and Maintenance Phase.*** Compared to the No-Action Alternative, Alternative A would result in expanding the river’s floodplain and increasing the flow conveyance capacity of the reach. These changes, in combination with Restoration Flows, have the potential to result in both adverse and beneficial effects on jurisdictional waters of the United States and waters of the State, including wetlands. The increase in flows could permanently inundate and thus eliminate some wetlands, but also expand or create additional areas of wetlands. Additionally, the reduction in normal water elevation in certain portions of Reach 2B caused by removal of the influence of Mendota Pool would drain and dewater some wetlands during some portions of the year, but would also expand or create additional areas of wetlands. After Project completion, in most instances, affected waters of the United States would be expected to have improved habitat functions as compared to No-Action conditions for several reasons: (1) fish habitat would be enhanced, (2) floodplain habitat would be expanded and enhanced, and (3) riparian habitat would be enhanced.

Long-term passive riparian habitat restoration of the San Joaquin River would improve native floodplain and in-channel habitats. Perennial base flows and seasonal high flows in the river would promote the establishment of riparian vegetation, wet meadows, and marshes and increase overall floodplain connectivity. Alternative A would restore river-floodplain connectivity and longitudinal connectivity of riparian vegetation near the channel and enhance landscape connectivity between the river corridor and adjacent sloughs or tributary channels.

When comparing Alternative A to existing conditions, effects would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). According to habitat restoration estimates, Alternative A could support up to 720 acres of wetlands and other waters within hydric soils in of the floodplain and bypass area. This is a 10 percent increase in acreage as compared to existing conditions. Wetland plant species can also become established in other areas of the floodplain, however without hydric soils these other areas would not qualify as jurisdictional wetlands.[5] Alternative A is expected to result in long-term **beneficial** effects to wetlands and other waters.

**Impact WET-3 (Alternative A): *Conflict with Provisions of Local or Regional Plans Regarding Conservation Lands.*** Compared to the No-Action Alternative, Alternative A would not conflict with the provisions of the Fresno and Madera counties' general plans regarding conservation lands. The Project would not result in long-term net loss of acreage, functions, or values of wetland habitats or riparian areas, interfere with the management of conserved lands, or eliminate opportunities for conservation actions. The Project is expected to result in a long-term increase in wetland and riparian habitats. These consequences of implementing the Project would benefit general plans that strive to conserve, restore, and enhance these habitats. The Project would enhance opportunities to implement conservation strategies and attain conservation goals by providing hydrologic conditions and floodplain areas necessary to restore wetlands.

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraph (i.e., the comparison of Alternative A to the No-Action Alternative) and would result in supporting county general plans. This is a **beneficial** effect.

[5] Growth of hydrophytic plants in areas without hydric soils is generally rare and usually only happens in transition zones between wetlands and uplands, transitional zones at and below the OHWM, and where fill has occurred recently.

### 8.2.2 Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Alternative B would include construction of Project features including a Compact Bypass channel, a new levee system with a wide, consensus-based floodplain encompassing the river channel, and the Compact Bypass Bifurcation Structure with fish passage facility. Other key features include construction of a fish passage facility at the San Joaquin River control structure at the Chowchilla Bifurcation Structure, the re-route of Drive 10 ½ (across the Compact Bypass control structure), and removal of San Mateo Avenue crossing. Construction activity is expected to occur intermittently over an approximate 157-month timeframe.

This alternative includes a mixture of active and passive riparian and floodplain habitat restoration and compatible agricultural activities in the floodplain. Active restoration planting would occur along the low flow channel of the river and in riparian establishment areas to establish a riparian area and seed bank, and floodplain areas would be seeded with native plants. Natural riparian recruitment (passive restoration) would promote continual habitat succession, particularly in areas where sediment is deposited or vegetation is removed by natural processes. Plantings that are wetland species or borderline wetland species would be irrigated as necessary during the establishment period of 3 to 5 years. Maintenance, monitoring, and long-term management would be conducted following revegetation.

**Impact WET-1 (Alternative B):** ***Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during Construction.*** Refer to Impact WET-1 (Alternative A). Potential impacts of Alternative B would be similar to potential impacts of Alternative A, with the following exceptions. Construction of the Project under Alternative B would affect the acreages of wetlands and other waters shown in Table 8-4. Alternative B has less potentially impacted area compared to Alternative A. As described under Impact WET-1 (Alternative A), avoidance, minimization, and compensation for loss of wetlands and other waters would reduce adverse effects during construction. Impacts of Alternative B would be **less than significant**.

**Table 8-4.**
**Wetlands and Waters of the United States Potentially Affected by Alternative B**

| Type | Maximum Impacted Area (acres) | |
|---|---|---|
| | Permanent | Temporary |
| Riparian Wetlands | 106.9 | 3.9 |
| Wet Meadows | 51.3 | - |
| Marshes | 50.6 | 0.9 |
| Non-Wetland Waters of the United States | 366.3 | 13.3 |
| **Total Riparian, Wetlands, and Other Waters** | **575.1** | **18.1** |

**Impact WET-2 (Alternative B):** ***Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during the Operations and Maintenance Phase.*** Refer to Impact WET-2 (Alternative A). Potential impacts for Alternative B are similar to potential impacts of Alternative A, with the following exceptions. According to habitat restoration estimates, Alternative B could support up to 840 acres of wetlands and other waters within hydric soils in of the floodplain and bypass area. This is more than a 40 percent increase in acreage compared to existing conditions. Wetland plant species could also become established in other areas of the floodplain, however without hydric soils these other areas would not become jurisdictional wetlands. Alternative B also includes natural channel erosion in Reach 2B (in the approximate 4 miles upstream of the Compact Bypass) and some sediment deposition in Reach 3 (in the approximate 1 mile downstream of the Compact Bypass) in order to re-establish stable sediment transport. Downcutting and sedimentation may affect existing wetland vegetation adjacent to the river channel, but new wetland vegetation would be expected to establish in these areas. Alternative B is expected to have long-term **beneficial** effects to wetlands and other waters.

**Impact WET-3 (Alternative B):** ***Conflict with Provisions of Local or Regional Plans Regarding Conservation Lands.*** Refer to Impact WET-3 (Alternative A). Potential impacts for Alternative B would be the same as potential impacts of Alternative A. This would be a **beneficial** effect.

### 8.2.3 Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Alternative C would include construction of Project features including Fresno Slough Dam, a new levee system with a narrow floodplain encompassing the river channel, and the Short Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the Short Canal control structure and fish screen, the Chowchilla Bifurcation Structure fish passage facility, modification of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 133-month timeframe.

Similar to Alternative B, Alternative C includes active riparian and floodplain habitat restoration. It is assumed that wetland communities 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, monitored, maintained, and managed as necessary during the establishment period.

**Impact WET-1 (Alternative C):** ***Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during Construction.*** Refer to Impact WET-1 (Alternative A). Potential impacts of Alternative C would be similar to potential impacts of Alternative A. Construction of the Project would affect the acreages wetlands and other waters shown in Table 8-5. As described under Impact WET-1 (Alternative A), avoidance, minimization, and compensation for loss of wetlands and other waters would reduce adverse effects during construction. Impacts of Alternative C would be **less than significant**.

**Table 8-5.**
**Wetlands and Waters of the United States Potentially Affected by Alternative C**

| Type | Maximum Impacted Area (acres) | |
|---|---|---|
| | Permanent | Temporary |
| Riparian Wetlands | 137.6 | 18.6 |
| Wet Meadows | 52.2 | <0.02 |
| Marshes | 57.5 | 7.2 |
| Non-Wetland Waters of the United States | 441.2 | 64 |
| **Total Riparian, Wetlands, and Other Waters** | **688.5** | **89.8** |

**Impact WET-2 (Alternative C): *Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during the Operations and Maintenance Phase.*** Refer to Impact WET-2 (Alternative A). Potential impacts for Alternative C are similar to potential impacts of Alternative A with the following exceptions. Alternative C includes active riparian and floodplain habitat restoration. Wetland, floodplain, and riparian areas would be planted following construction and then irrigated and managed as necessary during the establishment period. According to habitat restoration estimates, Alternative C could support up to 760 acres of wetlands and other waters within hydric soils in of the floodplain and Fresno Slough Dam area. This would be a slight increase in acreage compared to existing conditions. Wetland plant species can also become established in other areas of the floodplain, however without hydric soils these other areas would not qualify as jurisdictional wetlands. Alternative C is expected to have long-term **beneficial** effects to wetlands and other waters.

**Impact WET-3 (Alternative C): *Conflict with Provisions of Local or Regional Plans Regarding Conservation Lands.*** Refer to Impact WET-3 (Alternative A). Potential impacts for Alternative C would be the same as potential impacts of Alternative A. This would be a **beneficial** effect.

### 8.2.4 Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Alternative D would include construction of Project features including Fresno Slough Dam, a new levee system with a wide floodplain encompassing the river channel, and the North Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the North Canal bifurcation structure and North Canal fish passage facility, removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure, removal of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 158-month timeframe.

Similar to Alternative A, Alternative D includes passive riparian habitat restoration and farming in the floodplain. It is assumed that over time wetland communities would develop within the main channel and that a dense riparian scrubland would develop along the main river channel banks. The Restoration Flows would be used to recruit new vegetation along the channel from the existing seed bank. Between the main river channel banks and the proposed levees, limited agricultural practices (e.g., annual crops, pasture, or floodplain-compatible permanent crops) would occur.

**Impact WET-1 (Alternative D):** ***Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during Construction.*** Refer to Impact WET-1 (Alternative A). Potential impacts of Alternative D are similar to potential impacts of Alternative A, with the following exception. Construction of the Project would affect the acreages of wetlands and other waters shown in Table 8-6. As described under Impact WET-1 (Alternative A), avoidance, minimization, and compensation for loss of wetlands and waters would reduce the potential for adverse effects during construction. Impacts of Alternative D would be **less than significant**.

**Table 8-6.**
**Wetlands and Waters of the United States Potentially Affected by Alternative D**

| Type | Maximum Impacted Area (acres) | |
|---|---|---|
| | Permanent | Temporary |
| Riparian Wetlands | 137.1 | 15.9 |
| Wet Meadows | 52.2 | <0.02 |
| Marshes | 56.0 | 8.1 |
| Non-Wetland Waters of the United States | 447.7 | 58.2 |
| **Total Riparian, Wetlands, and Other Waters** | **693.1** | **82.2** |

**Impact WET-2 (Alternative D):** ***Fill, Fragment, Isolate, Divert, or Substantially Alter Potentially Jurisdictional Wetlands and Other Waters during the Operations and Maintenance Phase.*** Refer to Impact WET-2 (Alternative A). Potential impacts for Alternative D are similar to potential impacts of Alternative A. Alternative D includes passive riparian habitat restoration and farming in the floodplain. Restoration Flows would be used to recruit new vegetation along the channel from the existing seed bank. Between the main river channel banks and the proposed levees, agricultural practices (e.g., annual crops, pasture, or floodplain-compatible permanent crops) would occur. According to habitat restoration estimates, Alternative D could support up to 880 acres of wetlands and other waters within hydric soils in of the floodplain and Fresno Slough Dam area. This is more than a 15 percent increase in acreage compared to existing conditions. Wetland plant species can also become established in other areas of the floodplain, however without hydric soils these other areas would not qualify as jurisdictional wetlands. Alternative D is expected to result in long-term **beneficial** effects to wetlands and other waters.

Impact WET-3 (Alternative D): Conflict with Provisions of Local or Regional Plans Regarding Conservation Lands. Refer to Impact WET-3 (Alternative A). Potential impacts for Alternative D would be the same as potential impacts of Alternative A. This would be a beneficial effect.

## 8.3 Other Potential Adverse Environmental Consequences

The Guidelines specify that an alternative may be designated the LEDPA only if it "does not have other significant adverse environmental consequences." This section presents information on environmental issues for which the EIS/R indicates there would be a significant, unavoidable project impact after mitigation. These issues include Air Quality, Land Use Planning and Agricultural Resources, and Transportation and Traffic. As shown in Table 8-7, implementing the Project would have several significant and unavoidable environmental impacts. Where feasible mitigation exists, it has been included to reduce these impacts; however, the mitigation would not be sufficient to reduce these impacts to a less-than-significant level.

**Table 8-7.**
**Summary of Significant and Unavoidable Impacts**

| Impacts | Alternative | Level of Significance before Mitigation | Mitigation Measures | Level of Significance after Mitigation |
|---|---|---|---|---|
| **Air Quality** | | | | |
| AQ-3: Expose Sensitive Receptors to Substantial Air Pollutants Associated with Construction | A | S | AQ-3A: Reduce Diesel Particulate Matter Emissions from Construction Equipment<br>AQ-3B: Reduce Diesel Particulate Matter Emissions from Material Hauling Vehicles | SU |
| | B | S | | SU |
| | C | S | | SU |
| | D | S | | SU |
| **Land Use Planning and Agricultural Resources** | | | | |
| LU-1: Removal of Land from Agricultural Production | A | S | LU-1: Preserve Agricultural Productivity od Designated Farmland to the Extent Possible | SU |
| | B | S | | SU |
| | C | S | | SU |
| | D | S | | SU |
| LU-2: Conversion of Designated Farmland to Non-Agricultural Uses | A | S | LU-2: Preserve Agricultural Productivity od Designated Farmland to the Extent Possible | SU |
| | B | S | | SU |
| | C | S | | SU |
| | D | S | | SU |
| LU-3: Conflict with Williamson Act Contracts | A | S | LU-3: Preserve Agricultural Productivity od Designated Farmland to the Extent Possible | SU |
| | B | S | | SU |
| | C | S | | SU |
| | D | S | | SU |

**Table 8-7.**
**Summary of Significant and Unavoidable Impacts**

| Impacts | Alternative | Level of Significance before Mitigation | Mitigation Measures | Level of Significance after Mitigation |
|---|---|---|---|---|
| **Transportation and Traffic** | | | | |
| TRA-4. Potential to Result in Inadequate Emergency Access | A | PS | TRA-4A: Provide Temporary Roadway and Crossing at San Mateo Avenue | SU |
| | B | PS | TRA-4B: Use Construction Sequencing to Provide Continuous Emergency Access at Drive 10 ½ | SU |
| | C | PS | TRA-4A: Provide Temporary Roadway and Crossing at San Mateo Avenue | SU |
| | D | PSU | -- | PSU |

Key:
LTS = less than significant
PS = potentially significant
PSU = potentially significant and unavoidable
S = significant
SU = significant and unavoidable

### 8.3.1 Construction-Related Air Pollutants

Diesel fueled equipment emits the toxic air contaminant diesel particulate matter. Project construction emissions were estimated for off-road construction equipment and material hauling vehicles which are diesel fueled, and an exposure assessment and health risk assessment was conducted for sensitive receptors in the Project area. Sensitive receptors were found to have a significant increase in cancer risk for both a resident child and school child exposure scenarios. Mitigation measures would be implemented to reduce diesel particulate matter emissions from construction equipment and material hauling vehicles. All off-road construction diesel equipment and material-hauling diesel equipment would use the cleanest reasonably available equipment or consider alternative fueled equipment or addition of after-market control devices (e.g., diesel particulate filters). Material hauling trips would also be consolidated into the fewest trips possible. If these mitigation measures reduce emissions by 85 percent, which is the maximum estimated reduction when diesel particulate filters are used by all equipment and trucks, the excess cancer risk for the resident child would still be above target values. This is due to the size of the construction Project and the close proximity of the receptor to the roadway.

### 8.3.2 Agricultural Resources

Project actions would remove substantial amount of agricultural lands from production, including Prime Farmland, Farmland of Statewide Importance, and Unique Farmland, and potentially conflict with Williamson Act contracts. Mitigation measures would require the Project proponents to recognize and minimize adverse effects on agricultural lands to the extent practicable. Measures include selection of borrow areas to minimize fragmentation of agricultural lands; locating construction laydown and staging areas on sites that are fallow, disturbed, or to be discontinued for use as agricultural land to the extent possible, and using existing roads to access construction areas to the extent possible; stockpiling of topsoil in designated farmland areas to be used in subsequent habitat restoration, restoration of agricultural uses, or redistributed for agricultural purposes; coordinate with landowners and agricultural operators to minimize construction-related impairment of agricultural productivity; and providing access to potential agricultural areas on the floodplain. The Project proponent would also acquire agricultural conservation easements to be held by land trusts or public agencies or provide funds to a land trust or government program that conserves agricultural lands. However, implementation of these measures would not avoid the conversion of agricultural land to non-agricultural uses or fully mitigate the loss of farmland and the residual effect is significant and unavoidable.

### 8.3.3 Emergency Response Times

Project construction activities would create temporary or permanent roadway closures that may affect emergency access/emergency response times to areas immediately north of the San Mateo Avenue crossing or near Drive 10 ½. For those alternatives that improve the San Mateo Avenue crossing, mitigation measures would require a temporary roadway and crossing to allow for thru-traffic and access across levee, canal, and river crossing construction areas, as applicable. The mitigation measure for Alternative B requires construction sequencing to provide continuous emergency access at Drive 10 ½. In both cases, local emergency dispatchers will be notified of temporary road closures. No feasible mitigation exists for long-term impacts to emergency response times near areas with permanent roadway closures.

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# 9.0 Summary and Conclusions

This document provides information to identify the recommended LEDPA for the Project. It presents the substantive requirements of the CWA Section 404(b)(1) Guidelines, describes the Project and its basic and overall project purposes, describes the potential waters of the United States in the Project area, and traces the evolution of Project alternatives. It evaluates the four Action Alternatives: Alternative A (Compact Bypass with narrow Floodplain and South Canal), Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure, the preferred alternative), Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal), and Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal). For each of these alternatives, this document: 1) assesses the extent to which it meets the overall project purpose; (2) evaluates practicability using the factors of cost, available technology, and logistics; (3) describes potential impacts to waters of the United States; and (4) identifies other potential adverse environmental consequences. Table 9-1 summarizes some of the key information used in the evaluation.

This document finds that the No Action Alternative does not meet the Project purpose and it was eliminated from further discussion. The four Action Alternatives meet all three elements of the project purpose and are evaluated further for their practicability, including logistics, costs, technology and other environmental consequences.

Alternative A, C, and D are not the most practicable alternatives as they contain significant logistical hurdles. Both Alternative C and D include the Fresno Slough Dam, which landowners did not prefer in comparison with the Compact Bypass. The Fresno Slough Dam would also require alterations to Mendota Pool operations and would reduce the volume of the Mendota Pool. The canal options in Alternatives A and D would create access issues to farms, require construction of bridges, and would require changes in flood management, as the control structure for the Chowchilla Bypass would be moved downstream. Alternative A has a narrow floodplain alignment which provides the smallest floodplain acreage for potential fish habitat.

Alternative D has the greatest permanent impact on waters of the United States (693.1 acres), followed by Alternative C (688.5 acres), Alternative A (617.1 acres), and Alternative B (575.1 acres). Alternative C has the greatest temporary impact on waters of the United States (89.8 acres), followed by Alternative D (82.2 acres), Alternative A (56.0 acres), and Alternative B (18.1 acres). All of the Action Alternatives will have similar potential adverse environmental consequences on air quality, agricultural resources, and emergency response times.

Alternative B meets the overall project purpose. It is the most practicable alternative because it has fewer logistic hurdles. Alternative B has the smallest impact on waters of the United States and has similar potential adverse environmental consequences as compared to the other Action Alternatives. Based on the information presented in this document, Alternative B is the recommended LEDPA.

**Table 9-1.**
**Key Factors for LEDPA Recommendation**

| | # Project Purpose Elements Met | Upfront Costs (dollars) | O&M Costs (dollars/year) | Landowner Preferred | Meets Water Management Needs | Months to Build | Impacts to Wetlands and Other Waters (acres) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Permanent | Temporary |
| Alternative A (Compact Bypass with Narrow Floodplain and South Canal) | 3 | $517,330,000 | $ 1,746,000 | Moderate Approval | Yes/No | 132 | 617.1 | 56.0 |
| Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative | 3 | $479,980,000 | $ 1,241,000 | Yes | Yes | 157 | 575.1 | 18.1 |
| Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal) | 3 | $490,170,000 | $ 1,100,000 | No | No | 133 | 688.5 | 89.8 |
| Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal) | 3 | $505,390,000 | $ 1,387,000 | No | No | 158 | 693.1 | 82.2 |

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# Appendix A
# Conservation Measures

**Table A-1.**
**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 |
|---|---|---|
| **VELB** | **Valley Elderberry Longhorn Beetle** | |
| VELB-1. Avoid and Minimize Effects to Species | 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.<br>If elderberry shrubs are found on or adjacent to the construction project site, if feasible, a 100-foot-wide avoidance buffer – measured from the dripline of the plant – will be established around 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 | 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.<br>Compensatory mitigation for adverse effects may include 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.<br>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 |

**Table A-1.**
**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 |
|---|---|---|
| **BNLL** | **Blunt-Nosed Leopard Lizard** | |
| BNLL-1. Avoid and Minimize Effects to Species | 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 DFW, 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 DFW and implemented before ground disturbing activities. | USFWS<br>DFW |
| BNLL-2. Compensate for Temporary or Permanent Loss of Habitat or Species | Compensation for impacts to the species, if needed, will be determined in coordination with USFWS and DFW, as appropriate. | USFWS<br>DFW |
| **PLANTS** | **Other Special-Status Plants** | |
| PLANTS-1. Avoid and Minimize Effects to Special-Status Plants | 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 the PEIS/R, “Biological Resources – Vegetation and Wildlife,” that are applicable to Reach 2B will be conducted by a qualified botanist, in accordance with the most recent USFWS and DFW guidelines and at the appropriate time of year when the target species would be in flower or otherwise clearly identifiable.<br>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.<br>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 | USFWS<br>DFW |

**Table A-1.**
**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 |
|---|---|---|
| | site-specific to avoid impacts to special-status plants. | |
| **GGS** | **Giant Garter Snake** | |
| GGS-1. Avoid and Minimize Loss of Habitat for Giant Garter Snake | 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 DFW 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 DFW, will occur by demarcating and maintaining a 300-foot-wide buffer around these areas.<br>For projects within potential giant garter snake habitat, all activity involving disturbance of potential giant garter snake habitat will be 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.<br>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.<br>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 DFW guidance.<br>If a giant garter snake is found during construction activities, USFWS, DFW, 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 DFW will be consulted.<br>All construction-related holes shall be covered to prevent entrapment of | Reclamation<br>USFWS<br>DFW |

**Table A-1.**
**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 |
|---|---|---|
| | 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 | 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 DFW.<br>Permanent loss of giant garter snake habitat will be compensated at a ratio and in a manner consulted on with USFWS and DFW. Compensation may include preservation and enhancement of 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. | USFWS<br>DFW |
| **WPT** | **Western Pond Turtle** | |
| WPT-1. Avoid and Minimize Loss of Individuals | 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 DFW-approved areas of suitable habitat that will not be disturbed by project construction. | DFW |

**Table A-1.
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 |
|---|---|---|
| **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) | 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 DFW *Bald Eagle Breeding Survey Instructions* or current guidance (*USFWS Draft Project Design Criteria and Guidance for Bald and Golden Eagles*).<br>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 DFW, 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.<br>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 implemented. | USFWS<br>DFW |
| **SWH** | **Swainson's Hawk** | |
| SWH-1. Avoid and Minimize Impacts to Swainson's Hawk | Preconstruction surveys for active Swainson's hawk nests will be conducted in and around all potential nest trees within ½-mile of project-related disturbance (including construction-related traffic). These surveys will be conducted in accordance with *the Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley* (Swainson's Hawk Technical Advisory Committee 2000) or current guidance.<br>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).<br>Worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented. | DFW |
| SWH-2. Compensate for Loss of Nest Trees and Foraging Habitat | If foraging habitat for Swainson's hawk is removed in association with project implementation, foraging habitat compensation will occur in coordination with DFW. Foraging habitat mitigation may consist of planting and establishing alfalfa, row crops, pasture, or fallow fields.<br>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 | DFW |

**Table A-1.**
**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 |
|---|---|---|
| | Swainson's hawk nest trees with a number of equivalent native trees that were previously determined to be impacts through consultation with DFW. 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. | |
| **RAPTOR** | **Other Nesting Raptors** | |
| RAPTOR-1. Avoid and Minimize Loss of Individual Raptors | Construction activity, including vegetation removal, will only occur outside the typical breeding season for raptors (September 16 to December 31), if raptors are determined to be present.<br>Preconstruction surveys will be conducted by a qualified biologist in areas of suitable habitat to identify active nests in the project footprint.<br>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 DFW based on the sensitivity of the resource, the type of disturbance activity, and nesting stage. 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. | DFW |
| RAPTOR-2. Compensate for Loss of Nest Trees | Native trees removed during project activities will be replaced with an appropriate number of native trees, in coordination with DFW. | DFW |
| **RNB** | **Riparian Nesting Birds: Least Bell's Vireo** | |
| RNB-1. Avoid Effects to Species | If least Bell's vireo is anticipated within a project area, a qualified biologist shall make an initial site visit to determine if suitable habitat for the species may exist within the project footprint.<br>Where suitable habitat may be present, reconnaissance-level surveys would be conducted by biologists adhering to guidance offered in *Least Bell's Vireo Survey Guidelines* (USFWS 2001). | USFWS<br>DFW |
| RNB-2. Avoid, Minimize, and Compensate for Effects to Species | If least Bell's vireo is detected or suspected to be present in the project footprint, information would be collected according to the guidelines stated in RNB-1. USFWS and DFW would be contacted to determine the approach for avoidance, minimization, or compensation. | USFWS<br>DFW |

**Table A-1.**
**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 |
|---|---|---|
| **MBTA** | **Other Birds Protected by the Migratory Bird Treaty Act** | |
| MBTA-1. Avoid and Minimize Effects to Species | 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.<br>An Avian Protection Plan shall be established in coordination with USFWS and DFW. 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<br>DFW |
| **BRO** | **Burrowing Owl** | |
| BRO-1. Avoid Loss of Species | 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. These surveys and mitigation will be conducted in accordance with the *Burrowing Owl Survey Protocol and Mitigation Guidelines* (The California Burrowing Owl Consortium 1993), or current guidance.<br>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. | DFW |
| BRO-2. Minimize Impacts to Species | If a DFW-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 DFW to offset burrow habitat and foraging areas on the project site if burrows and foraging areas are taken by SJRRP actions. Mitigation measures will be consistent with the *Staff Report on Burrowing Owl Mitigation* (DFW 2012), or current guidance.<br>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 DFW.<br>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 entrances. These doors shall be in place at least 48 hours before excavation to insure the owls have departed.<br>The project area shall be monitored daily for 1 week to confirm owl | DFW |

**Table A-1.**
**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 |
|---|---|---|
| | departure from burrows before any ground-disturbing activities.<br>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 | 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 and will include trees within ¼-mile of project construction activities. 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.<br>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.<br>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 DFW 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). | DFW |
| BAT-2. Compensate for Loss of Habitat | The loss of each roost will be replaced, in consultation with DFW, 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. | DFW |
| **FKR** | **Fresno Kangaroo Rat** | |
| FKR-1. Avoid and Minimize Effects to Species | Preconstruction surveys will be conducted by a qualified biologist per USFWS and DFW 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 | USFWS<br>DFW |

**Table A-1.**
**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 |
|---|---|---|
| | 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 DFW. Transects shall be used to identify the presence of kangaroo rat burrows. When burrows are found within 100 feet of the Project footprint, focused live trapping surveys shall be conducted by a qualified and permitted biologist, following a methodology approved in advance by USFWS and DFW. Additional conservation measures may be developed pending the results of surveys, and in consultation with USFWS and DFW.<br>Construction activities shall be conducted when they are least likely to affect the species (i.e., after the normal breeding season of December through September (Ahlborn 1999)). This timing shall be coordinated with USFWS and DFW. | |
| FKR-3. Compensate for Temporary or Permanent Loss of Habitat or Species | Compensation for impacts to the species, if needed, will be determined in coordination with DFW and USFWS, as appropriate. | USFWS<br>DFW |
| **SJKF** | **San Joaquin Kit Fox** | |
| SJKF-1. Avoid and Minimize Effects to Species | 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 DFW in writing of the results of the preconstruction survey within 30 days after these activities are completed.<br>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.<br>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).<br>The project proponent will notify USFWS and DFW 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.<br>Construction activities shall be conducted when they are least likely to affect the species (i.e., after the normal breeding season of December–April (Ahlborn 2000)). This timing shall be coordinated with USFWS and | USFWS<br>DFW |

**Table A-1.**
**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 |
|---|---|---|
| | DFW. | |
| **PL** | **Pacific Lamprey** | |
| PL-1. Avoid and Minimize Effects to Species | 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).<br>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).<br>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 | Biological surveys will be conducted to identify, map, and quantify riparian and other sensitive habitats in potential construction areas.<br>Construction activities will be avoided in areas containing sensitive natural communities, as appropriate. | DFW |
| RHSNC-2. Compensate for Loss of Riparian Habitat and Other Sensitive Natural Communities | The Riparian Habitat Mitigation and Monitoring Plan for the SJRRP will be developed and implemented in coordination with DFW. 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.<br>If losses of other sensitive natural communities (e.g., recognized as sensitive by CNDDB, but not protected under other regulations or 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 DFW, depending on agency jurisdiction. | DFW |
| **WUS** | **Waters of the United States/Waters of the State** | |
| WUS-1. Identify and Quantify Wetlands and Other Waters of the United | 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.<br>The project proponent will determine, based on the mapped distribution | Corps |

**Table A-1.**
**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 |
|---|---|---|
| States | of these wetlands and hydraulic modeling and field observation, the acreage of effects, if any, on waters of the United States.<br>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 the Corps for verification. The delineation will be conducted according to methods established in the Corps *Wetlands Delineation Manual* and *Arid West Supplement* (Corps Environmental Laboratory 1987, 2008).<br>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. | |
| WUS-2. Obtain Permits and Compensate for Any Loss of Wetlands and Other Waters of the United States/Waters of the State | The project proponent, in coordination with the Corps, 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.<br>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 the Corps and the Central Valley RWQCB, and DFW, as appropriate, depending on agency jurisdiction.<br>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.<br>The compensation will be consistent with recommendations in the Fish and Wildlife Coordination Act Report (Appendix F of the PEIS/R). | Corps |
| **INV** | **Invasive Plants** | |
| INV-1. Implement the Invasive Vegetation Monitoring and Management Plan | Reclamation will implement the Invasive Vegetation Monitoring and Management Plan for the SJRRP (Appendix L of the PEIS/R), which includes measures to monitor, control, and where possible eradicate, invasive plant infestations during flow releases and construction activities.<br>The implementation of the Invasive Vegetation Monitoring and Management Plan (Appendix L of the PEIS/R) will include monitoring procedures, thresholds for management responses, success criteria, and adaptive management measures for controlling invasive plant species.<br>The control of invasive weeds and other recommended actions in the Invasive Vegetation Monitoring and Management Plan (Appendix L of the PEIS/R) will be consistent with recommendations in the Fish and Wildlife Coordination Act Report (Appendix F of the PEIS/R). | Reclamation |

**Table A-1.**
**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 |
|---|---|---|
| **CP** | **Conservation Plans** | |
| CP-1. Remain Consistent with Approved Conservation Plans | 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 DFW, as appropriate. | USFWS<br>DFW |
| CP-2. Compensate Effects Consistent with Approved Conservation Plans | The project proponent shall compensate effects consistent with applicable conservation plans and implement all applicable measures required by the plans. | USFWS<br>DFW |
| **GS** | **Southern Distinct Population Segment of North American Green Sturgeon** | |
| GS-1. Avoid and Minimize Loss of Habitat And Individuals | The SJRRP will be operated in such a way that actions affecting 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 | 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 rearing habitat, etc.) must be analyzed in consultation with NMFS.<br>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.<br>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.<br>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.<br>Disturbance of riparian vegetation will be avoided to the greatest extent practicable. | NMFS |

**Table A-1.**
**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 |
|---|---|---|
| | 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.<br>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.<br>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.<br>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 | 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.<br>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.<br>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.<br>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.<br>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.<br>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. | NMFS |

**Table A-1.**
**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 |
|---|---|---|
| **SRCS** | **Central Valley Spring-Run Chinook Salmon** | |
| SRCS-1. Avoid and Minimize Loss of Habitat and Individuals | 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.<br>SJRRP actions shall be performed in accordance with the Experimental Population 4(d) rule, as it is developed, and where applicable. | NMFS<br>DFW |
| **EFH** | **Essential Fish Habitat (Pacific Salmonids)** | |
| EFH-1. Avoid Loss of Habitat and Risk of Take of Species | 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.<br>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. Under historical operations, the Hills Ferry Barrier is operated September through mid-December. The period of operation under this measure may vary from historical operations.<br>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.<br>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.<br>Disturbance of riparian vegetation will be avoided to the greatest extent practicable.<br>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.<br>Stockpiling of materials, including portable equipment, vehicles and supplies, such as chemicals, shall be restricted to the designated | NMFS |

**Table A-1.**
**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 |
|---|---|---|
| | construction staging areas, exclusive of any riparian and wetland areas.<br>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.<br>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 | 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.<br>In-channel construction activities that could affect habitat for Pacific salmonids will be limited to daylight hours during weekdays, leaving a nighttime and weekend period of passage for Federally listed fish species.<br>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.<br>Riparian vegetation removed or damaged will be replaced, as applicable, in accordance with the Riparian Habitat Monitoring Management and Mitigation Plan, and will be coordinated with the USFWS and NMFS and/or other agencies as appropriate.<br>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.<br>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. | NMFS |

Acronyms:
BMP = best management practice
BO = Biological Opinion
CNDDB = California Natural Diversity Database
Corps = U.S. Army Corps of Engineers
CVP = Central Valley Project
DFW = California Department of Fish and Wildlife
NMFS = National Marine Fisheries Service
PEIS/R = Program Environmental Impacts Statement/Report
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
RWQCB = Regional Water Quality Control Board
SJRRP = San Joaquin River Restoration Program
State = State of California
SWP = State Water Project
USFWS = U.S. Fish and Wildlife Service