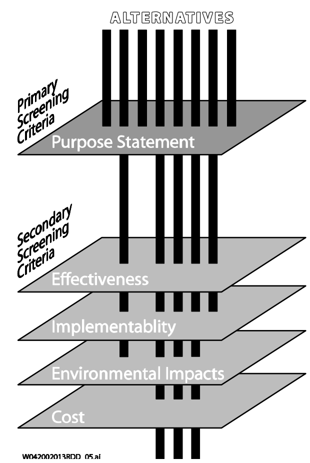
2.0 Description of Alternatives

This chapter describes the alternatives that were developed to restore fish passage at RBDD and improve the long-term ability to reliably provide water supplies into the TCCA systems (as described in the Purpose and Need Statement). This chapter also describes the no-action baseline. The full range of alternatives considered for the project is described in Section 2.1, including the screening criteria used to establish the five primary alternatives and related actions. Additional detail on the screening criteria is presented in the Alternatives Analysis Report included as Appendix A.

The alternatives were formulated from public input, scientific information, and professional judgement, in a manner consistent with NEPA and CEQA.

The alternatives were formulated from public input, scientific information, and professional judgement in a manner consistent with NEPA and CEQA. Anticipated impacts associated with each alternative are analyzed in Chapter 3.

2.1 Alternatives



Many alternatives were identified as reasonable for addressing the purpose statement for the project, which was considered the primary screening criterion. These alternatives were then considered against secondary screening criteria, which reduced the number of alternatives to the five described in this section. Following are the secondary screening criteria:

- Effectiveness
- Implementability
- Environmental Impacts
- Cost

In addition, a No Action Alternative was also fully analyzed. The No Action Alternative, or future without the proposed action, is the measure against which the environmental impacts and other aspects of the action alternatives were compared. Unless otherwise noted, the operations, policies, requirements, and other assumptions incorporated into the No Action Alternative are adopted into the other alternatives.

The No Action Alternative, or future without the proposed action, is the measure against which the environmental impacts and other aspects of the action alternatives were compared.

2.1.1 Existing Conditions

Current RBDD Operations (Gates-in May 15 through September 15)

In a cooperative effort to alleviate fish passage problems at RBDD, voluntary gate removal during the non-irrigation season began during the 1986 water year. In 1988, USBR and CDFG, NMFS, and USFWS entered into a 4-year Cooperative Agreement to implement actions to benefit winter-run Chinook salmon in the Sacramento River (NMFS, 1993). At that time it was agreed that RBDD gates would be raised from December 1 to April 1 to facilitate adult winter-run migration. Subsequently, gate operations were modified in 1992 in consultation with NMFS as part of the reasonable and prudent alternative contained in a jeopardy opinion of the operation of RBDD. At that time, USBR proposed that gates at RBDD be raised from November 1 through April 30 of each subsequent year with provisions for intermittent closures during March and April for recharging the TC and Corning canals.

The 1993 Biological Opinion for the Operation of the Central Valley Project and the State Water Project (NMFS, 1993) included the following operations: the RBDD gates would be raised through April 1, 1993; be raised beginning November 1, 1993, and remain raised through April 30, 1994. On September 15 of each year commencing in 1994 through at least May 14 of each subsequent year, the gates at RBDD should remain in the raised position.

The dam gates are currently raised on September 15. Thus, this DEIS/EIR refers to the gates-in period as occurring through September 15. Thus, this DEIS/EIR refers to the gates-in period as occurring "through September 15," and the gates-out period as beginning "September 16." From a practical standpoint, gate operations often occur across days, thus the dates used in this DEIS/EIR are approximations.

RBDD is a part of CVP and is owned and operated by USBR to deliver water to the 17 water districts served by TCCA.

Since implementation of the Reasonable and Prudent Conservation Measures for the protection of winter-run Chinook salmon (NMFS, 1993), operations at RBDD have resulted in reductions in losses of fishery resources. The current gates-out operation at RBDD (September 16 through May 14) has greatly reduced the period of time when adults are delayed and juveniles are adversely affected by RBDD operations. The effects of predation on juveniles was essentially eliminated with reduced gate operations. The current operations at RBDD also provide fall-run salmon spawning habitat immediately upstream of RBDD, which is lost when Lake Red Bluff is inundated (USFWS, 1998).

Existing Facilities at Red Bluff Diversion Dam

The existing facilities at RBDD and the TC Canal and Corning Canal are briefly described in the following paragraphs. Readers interested in a more detailed history and description of these facilities are referred to the Appraisal Report (USBR, 1992) and the Supplemental Report (USFWS, 1998). Figure 2.1-1 presents an overview of the existing RBDD facilities.

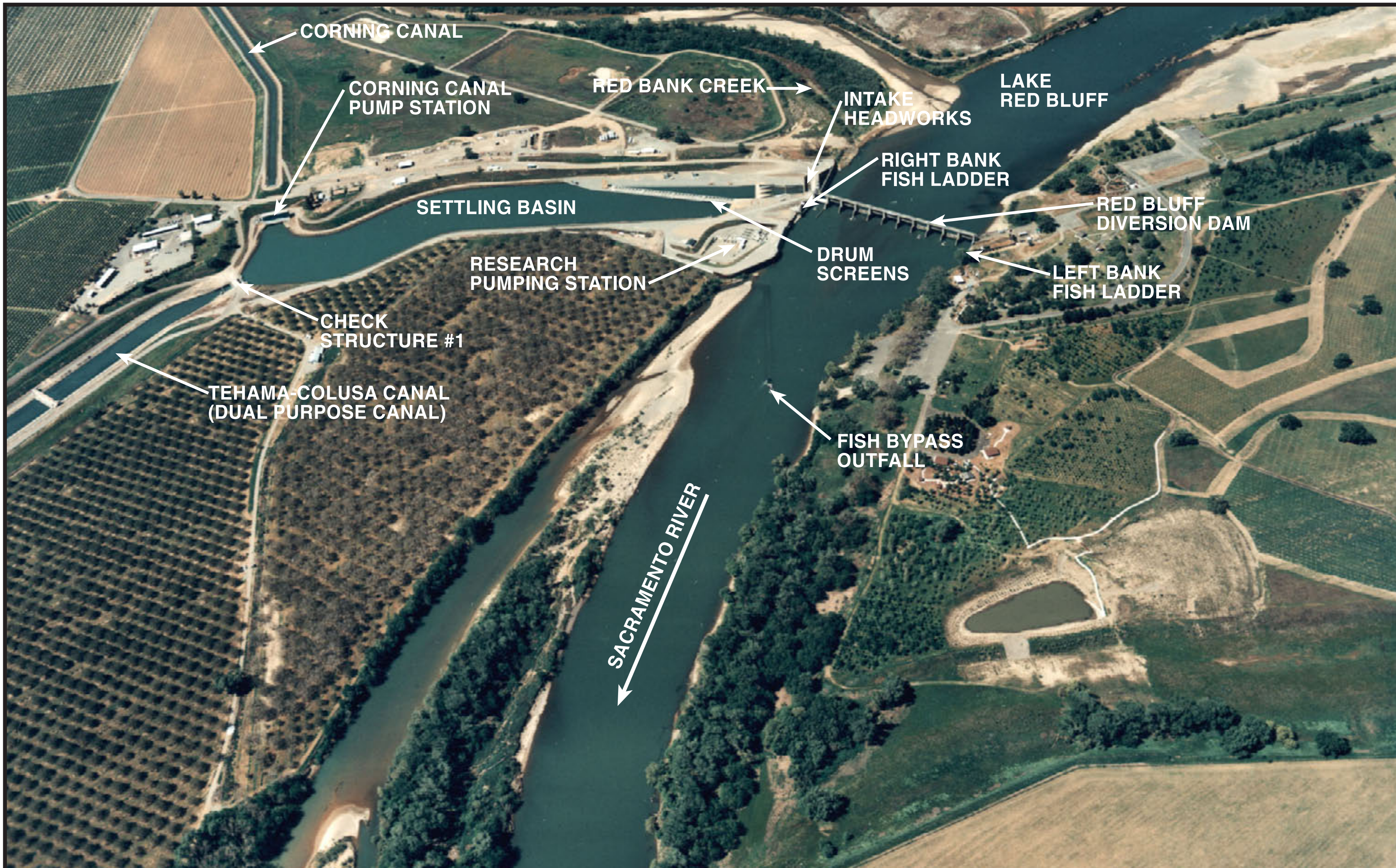


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FIGURE 2.1-1
EXISTING FACILITIES AT THE RED BLUFF DIVERSION DAM
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR
CH2MHILL

Red Bluff Diversion Dam. RBDD is a part of CVP and is owned and operated by USBR to deliver water to the 17 water districts served by TCCA. Located just downstream of the City of Red Bluff, California, RBDD was constructed by USBR in August 1964. The dam has 11 spillway bays, with Bay 11 adjacent to the right abutment of the dam being designed as a sluiceway. The 11 spillway bays are 60 feet wide and are separated by 8-foot-wide piers.

Each spillway bay has a 60-foot-wide by 18-foot-high fixed wheel gate. The gates were first lowered on August 18, 1966. Gate 11 has been modified to allow for 4 feet of top spill to sluice floating debris through Bay 11. Under current operations, the gates-in period is between May 15 and September 15. Riverflow is allowed to pass under each of the gates in a specific flow-related pattern to enhance attraction flow to the fish ladders. Although this specific gate operation pattern was developed by the fisheries resource agencies, the strategy has had limited success because of the shortcomings of the existing fish ladder flow in attracting adult fish.

Fish Ladders–Right and Left Bank. Pool-and-weir fish ladders on both the right and left abutments were included in the original design and construction of RBDD. These fish ladders are oriented slightly differently but basically provide 85 cfs of fish ladder flow and 253 cfs of additional attraction flow. This gives a total flow capacity of 338 cfs for each fish ladder. Fish-counting facilities are also included in the right and left bank fish ladders. When the gates are lowered and Lake Red Bluff is formed, the fish ladders become operational.

Each fish ladder has a flow capacity of 338 cfs.

A temporary fish ladder is installed and removed each year in spillway Bay 6. This fish ladder has a capacity of 100 cfs. It was initially installed in 1984, and it has been reported that it passes from 6 percent to 50 percent of the run, depending on the year and riverflow conditions.

As discussed above, the spillway gates are operated by USBR in strict accordance with a spill pattern developed in conjunction with the fisheries resource agencies. This pattern is not completely effective in guiding adult fish to the ladder entrances.

Right Bank Fish Ladder Pumps. The right bank fish ladder pump station is a temporary pumping facility that has the capacity to pump 165 cfs into the area just upstream of the drum screens. Fabricated metal fish screens are added to the area just downstream from the right bank fish ladder entrance any time that the fish ladder is out of service.

Canal Intake Headworks. The headworks are located on the right abutment of RBDD and comprise six top-seal radial gates, each 11.5 feet wide and 10 feet high.

Originally, RBDD was designed with five gates, but a sixth gate was added during construction of the drum screens in 1989 to 1990. At the normal operating differential of 2 feet, the headworks can deliver 3,100 cfs to the area upstream from the drum screens. Using 270 cfs for the right bank fish ladder attraction water and 240 cfs for the drum screen bypass system (60 cfs at each bypass), a remaining flow of 2,570 cfs would pass through the drum screens. This amount aligns with the peak design flow required for irrigation (2,500 cfs).

The invert of the headworks is 8 feet higher than the crest of the dam. Without the gates in place, the riverflow would need to be more than 24,000 cfs to reach the level of the headworks invert and 88,000 cfs to reach the normal operating level of Lake Red Bluff.

Drum Screens and Fish Bypass Outfall. Another major change was made at RBDD in April 1990 when rotary drum screens were installed to replace fish louvers. The fish louvers were not sufficiently effective in keeping fish out of the TC and Corning canals. The drum screens effectively exclude all salmon from the canal systems.

The original design capacity was 3,000 cfs. At the normal operating water elevation, using the current approach velocity of 0.40 foot per second (fps), the rated capacity of the drum screens is 2,400 cfs. To meet the design peak irrigation delivery amount of 2,500 cfs, the approach velocity would be 0.42 fps. After consulting with the fisheries resource agencies, it was determined that the drum screens should never be operated unless the approach velocity is at or below 0.40 fps. The resource agencies also recommended replacing the wire mesh on the drum screens with a mesh that meets current criteria as required by the normal replacement schedule.

The drum screens have four 48-inch-diameter bypass pipes, each with a design capacity of 60 cfs. These four pipes later merge into two 60-inch-diameter bypass pipes that convey the total bypass flow of 240 cfs to the outfall located in the middle of the river, approximately 1,100 feet downstream of RBDD.

Research Pumping Plant. In 1993, USBR installed a Research Pumping Plant (RPP) just downstream from RBDD. One purpose of RPP was to determine the feasibility of pumping Sacramento River water directly into the canals using screw or helical pumps. The advantage of this pumping system is that it would pump both water and fish. The fish are removed from the irrigation water stream through vertical fish screens downstream from the pump discharge and are returned through a piped bypass system to the river.

The RPP is located just downstream of the right bank fish ladder entrance and includes an intake structure with trashracks and four 48-inch-diameter intake pipes leading to four pump bays. Two Archimedes screw pumps and one helical pump were installed initially in three of the pump bays; the fourth bay is empty. Each pump lifts water to a flat plate "vee" screen. Of the 90-cfs pump discharge, 10 cfs is used for fish bypass flow. The remaining 80 cfs per pump is discharged into the settling basin behind the drum screens.

This system is being evaluated as a possible remedy to further remove fish passage impediments because it does not rely on RBDD to operate, and it can deliver water into the TC Canal year-round except during high river conditions when the fish bypass system does not work. A full-scale pumping plant would eliminate dependence on RBDD and thus allow gates-out and a free-flowing river year-round. The RPP is a 240-cfs capacity pumping plant complete with fish screen, pumps, and fish bypass facilities. The "experimental" or RPP has been operating since 1995. The survival rate of juveniles passing through the system is considered excellent. The combined direct and delayed mortality rates have been consistently lower than 5 percent. However, the water users are concerned about the long-term reliability and operation and maintenance (O&M) cost of the RPP technology if applied to a full-scale pumping operation. NMFS' approval will be required prior to a decision to use RPP as a source for permanent diversion.

TC Canal is owned by USBR but operated and maintained by TCCA.

The RPP testing was completed in 2001, and it appears that the technology has been accepted by the resource agencies for protecting fish. The total existing effective capacity of RPP is 240 cfs. With the fourth pump installed, the effective capacity would increase to 320 cfs.

The fish bypass from RPP passes through a juvenile evaluation facility and then continues on to attach to the drum screen bypass pipes. At high-river tailwater levels the bypass is not functional because there is no hydraulic differential. In addition to meeting the research objectives, the RPP has been used in recent years to partially meet irrigation demand when RBDD gates are opened.

Tehama-Colusa Canal. The TC Canal serves 14 of the 17 water districts served by the two canal systems and has delivery capacity to provide water to the Glenn-Colusa Irrigation District canal. The dual-purpose and single-purpose spawning channels initially built at or adjacent to the TC Canal are no longer in use for fish spawning. Water still passes through the dual-purpose channel to feed the TC Canal system. The TC Canal is approximately 111 miles long and extends from

Red Bluff in Tehama County (County) to below Dunnigan in Yolo County. The capacity of TC Canal is 2,530 cfs at the start and reduces capacity to 1,700 cfs at its terminus. The TC Canal is owned by USBR but is operated and maintained by TCCA under a long-term contract with USBR.

The Corning Canal and Corning Canal Pumping Plant are owned by USBR but are operated and maintained by TCCA.

Corning Canal and Pumping Plant. The Corning Canal serves 3 of the 17 water districts served by the two canal systems. The Corning Canal Pumping Plant lifts water from the settling basin downstream of the drum screens 55 feet up into the Corning Canal. The Corning Canal is 21 miles long (USFWS, 1998) and has a design capacity of 500 cfs at the head end and 88 cfs at its terminus. The Corning Canal Pumping Plant has six pumps that are used to meet the varying irrigation demands of the Corning, Proberta, and Thomes Creek water districts. The Corning Canal and Corning Canal Pumping Plant are owned by USBR but are operated and maintained by TCCA under a long-term contract with USBR.

Stony Creek Diversions. TCCA must annually supplement its water supply during the times that gravity diversion at RBDD is not available. During these times, TCCA obtains water, when it is available, from Black Butte Reservoir via a diversion from Stony Creek. Diversions from Stony Creek are currently permitted for 45-day periods between April 1 and May 15 and between September 15 and October 29. The Stony Creek Diversion depends on the USACE's operation of Black Butte Reservoir. It is operated primarily for flood control purposes and not irrigation; these two needs are not always compatible. Furthermore, the volume of water in Black Butte Reservoir is decreasing because the reservoir is silting in. Because of the relatively small size of the reservoir, it is kept at its minimum capacity until late in the rainy season. Because of this, the reservoir could be at its minimum level when diversions are needed due to a change in the season from a wet to a dry year. This arrangement does not provide TCCA and the 18~~17~~ water districts it serves with sufficient water diversion reliability and flexibility because significant demand for irrigation water also occurs during spring and fall, when RBDD gates are out.

Diversion from the TC Canal to Stony Creek was considered as part of the permanent solution but was rejected because of unreliable water supplies.

As an interim measure, CVP water stored in Black Butte Reservoir is released to Stony Creek for subsequent rediversion to the TC Canal to partially offset the loss of gravity flow diversion at RBDD when the gates at RBDD are out. In recent years, special water releases, when available, from Black Butte Reservoir into Stony Creek have been diverted into the TC Canal by reversing the flow through the Constant Head Orifice (CHO) on the canal at the Stony Creek canal siphon. The CHO was originally installed to enhance fish and wildlife by the release of TC Canal water into Stony Creek, but it has never been used for that purpose. Regular use of these diversions is planned to be discontinued as soon as a permanent solution is implemented at RBDD. Diversions from the TC Canal to Stony Creek are not currently planned as part of the permanent solution. This was considered, but rejected because of unreliable water supplies.

2.1.2 Selection of the Preferred Alternative

The TCCA Board of Directors (TCCA Board) determined the Gates-out Alternative to be the Preferred Alternative (Resolution No. 01-06). The Gates-out Alternative was chosen during a board meeting held on December 5, 2001. This decision stemmed from the idea that "selection of a Preferred Alternative at this time simply allows the work on the solution to the fish passage and water delivery reliability problems at the Red Bluff Diversion Dam to continue…" Through this resolution, the TCCA Board reserves the right to change the selected Preferred Alternative in the future. Additionally, the selection of the Preferred Alternative in no way commits the TCCA Board or TCCA to any particular course of action, nor does it commit any expenditure of funds for any purpose.

The TCCA Board reserves the right to change the selected Preferred Alternative in the future. The selection of the Preferred Alternative in no way commits the TCCA Board or TCCA to any particular course of action.

Following this decision, the TCCA Board held a subsequent meeting on February 6, 2002. One of the topics of discussion included the TCCA Board's commitment to the Gates-out Alternative but their willingness to consider alternatives such as the "Flexible Gate" Alternative.

USBR has not yet chosen a Preferred Alternative. A list of the alternatives that are currently being evaluated, including the No Action Alternative, follows.

2.1.3 No Action Alternative

CEQA requires that the Preferred Alternative be compared to an **existing conditions** baseline, whereas NEPA requires comparison with a No Action Alternative. The No Action Alternative represents ongoing activities and operations and corresponds to the "No Project" definition as outlined in the *CEQA Guidelines*, Section 15126, as "a condition that would be reasonably expected to occur if the project were not approved."

The No Action Alternative represents ongoing activities and operations.

- RBDD Operations: Gates-in 4 months (May 15 through September 15)
- Continue operating RPP and add a fourth pump
- Eliminate Stony Creek diversions (because of lack of feasible options for constructing a fish screen on the CHO)

2.1.4 1A: 4-month Improved Ladder Alternative

The 4-month Improved Ladder Alternative would continue the current operation of the dam with a 4-month gates-in period of May 15 through September 15. Improved agricultural water deliveries would be achieved through 1,700 cfs of pumping capacity (320 cfs at RPP; 1,380 cfs at Mill Site). Improvements to fish passage would be achieved with construction and operation of new ladders (right 800 cfs, left 831 cfs, for a total of 1,631 cfs).

- RBDD Operations: Gates-in 4 months (May 15 through September 15)
- Install a new 1,380-cfs pump station with fish screen on the right bank at Mill Site; continue operating the RPP and add a fourth pump resulting in a combined pumping capacity of 1,700 cfs
- Install a conveyance facility across Red Bank Creek to convey water from the pump station to the TC Canal
- Modify the left and right bank fish ladders
- Implement Adaptive Management Program as described in Section 2.4

2.1.5 1B: 4-month Bypass Alternative

The 4-month Bypass Alternative would continue the current operation of the dam with a 4-month gates-in period of May 15 through September 15. Improved agricultural water deliveries would be achieved through 1,700 cfs of pumping capacity (320 cfs at RPP; 1,380 cfs at Mill Site). Improvements to fish passage would be achieved with construction and operation of a new ladder at the right abutment (800 cfs). A 1,000-cfs bypass channel for fish passage would be constructed at the left abutment near the existing Sacramento River Discovery Center. This alternative requires an amendment to USFS, Mendocino National Forest Land and Resource Management Plan.

USFS has jurisdiction in the elements of the decision that would authorize construction of the bypass, and all associated actions that would affect Lake Red Bluff Recreation Area. The responsible official is the forest supervisor, Mendocino National Forest. A decision to implement Alternative 1B, co-signed by the forest supervisor, would authorize (1) an amendment of the Mendocino National Forest Land and Resource Management Plan to allow for the bypass, (2) the issuance of special use permits for the construction and operation of the bypass, and (3) implementation of all mitigations that occur within Lake Red Bluff Recreation Area.

- RBDD Operations: Gates-in 4 months (May 15 through September 15)
- Install a new 1,380-cfs pump station with fish screen at Mill Site; continue operating the RPP and add a fourth pump resulting in a combined pumping capacity of 1,700 cfs

- Install a conveyance facility across Red Bank Creek to convey water from the pump station to the TC Canal
- Install a new 1,000-cfs bypass around left abutment of dam
- Modify the right bank fish ladder
- Implement Adaptive Management Program as described in Section 2.4
- Amend Mendocino National Forest Land and Resource Management Plan to allow construction of the bypass facility

2.1.6 2A: 2-month Improved Ladder Alternative

The 2-month Improved Ladder Alternative would reduce the current operation of the dam to a 2-month gates-in period of July 1 through August 31. Improved agricultural water deliveries would be achieved through 2,000 cfs of pumping capacity (320 cfs at RPP; 1,680 cfs at Mill Site). Improvements to fish passage would be achieved with construction and operation of new ladders (right 800 cfs, left 831 cfs, total 1,631 cfs) and the reduced gates-in operation.

- RBDD Operations: Gates-in 2 months (July 1 through August 31)
- Install a new 1,680-cfs pump station with fish screen at Mill Site; continue operating RPP and add a fourth pump resulting in a combined pumping capacity of 2,000 cfs
- Install a conveyance facility across Red Bank Creek to convey water from the pump station to the TC Canal
- Modify the left and right bank fish ladders
- Implement Adaptive Management Program as described in Section 2.4

2.1.7 2B: 2-month with Existing Ladders Alternative

The 2-month with Existing Ladders Alternative would reduce the current operation of the dam to a 2-month gates-in period from July 1 through August 31. Improved agricultural water deliveries would be achieved through 2,000 cfs of pumping capacity (320 cfs at RPP; 1,680 cfs at Mill Site). Improvements to fish passage would be achieved through the reduction in gate operations. Existing ladders would continue to be operated at the right and left abutments (right 338 cfs, left 338 cfs, total 676 cfs).

- RBDD Operations: Gates-in 2 months (July 1 through August 31)
- Install a new 1,680-cfs pump station with fish screen at Mill Site; continue operating RPP and add a fourth pump resulting in a combined pumping capacity of 2,000 cfs

- Install a conveyance facility across Red Bank Creek to convey water from the pump station to the TC Canal
- Implement Adaptive Management Program as described in Section 2.4

2.1.8 3: Gates-out Alternative

The Gates-out Alternative would eliminate the gates-in period, leaving the gates in the raised position year-round. Improved agricultural water deliveries would be achieved through 2,500 cfs of pumping capacity (320 cfs at RPP; 2,180 cfs at Mill Site). Improvements to fish passage would be achieved through the reduction in gate operations. Existing ladders would no longer operate.

- RBDD Operations: Gates-in zero (0) months
- Install a new 2,180-cfs pump station with fish screen at Mill Site; continue operating RPP and add a fourth pump resulting in a combined pumping capacity of 2,500 cfs
- Install a conveyance facility across Red Bank Creek to convey water from the pump station to the TC Canal
- Implement Adaptive Management Program as described in Section 2.4

Table 2.2-1 presents a summary of each alternative and its associated proposed timing, facilities, and flow.

2.2 Proposed Facilities

2.2.1 Mill Site Pump Station

The preferred pump station option is a conventional vertical propeller pump station at the Mill Site used in conjunction with the existing RPP to meet the full peak water delivery needs. The Mill Site is located upstream from RBDD and Red Bank Creek. The general layout of the Mill Site facilities is shown on Figure 2.3-1.

Under all of the alternatives, the Mill Site Pump Station facilities would include a fish screen along the river.

Each pump station site configuration consists of trashracks and fish screens, a forebay or intake piping, pump station, and conveyance facilities. A fish bypass system may be needed, depending on the length of the fish screens and the type of pumping system. The length of the fish screen, the size of the forebay, and the pumping and conveyance capacities are dependent upon the alternative. Many potential combinations of intake and pumping facility options are associated with each alternative.

For the vertical propeller pump option, the discharge piping would be routed to a new discharge outlet structure at the sedimentation basin. It is assumed that the drum screens would be removed under the

TABLE 2.2-1
Summary of Final Alternatives

	Gates-in Operation		Fish Passage Facilities			Gates-out Water Supply				
Name	**Duration**	**Timing**	**Right Bank (cfs)**	**Center (cfs)**	**Left Bank (cfs)**	**Research Pumping Plant (cfs)**	**Right Fish Ladder (cfs)**	**Mill Site (cfs)**	**Stony Creek (cfs)**	**Total (cfs)**
Existing Conditions	4 months	May 15 through Sept 15	Existing 338	Existing 100	Existing 338	240	165		600	1,005
No Action	4 months	May 15 through Sept 15	Existing 338	Existing 100	Existing 338	320	165		600	485
1A: 4-month Improved Ladder Alternative	4 months	May 15 through Sept 15	New 800		New 831	320		1,380		1,700
1B: 4-month Bypass Alternative	4 months	May 15 through Sept 15	New 800		Bypass channel 1,000; existing 338	320		1,380		1,700
2A: 2-month Improved Ladder Alternative	2 months	July 1 through Aug 31	New 800		New 831	320		1,680		2,000
2B: 2-month with Existing Ladders Alternative	2 months	July 1 through Aug 31	Existing 338		Existing 338	320		1,680		2,000
3: Gates-out Alternative	0 months					320		2,180		2,500

Gates-out Alternative. The option to retain drum screens and current intake facilities may be considered in final design of the proposed project. When the gates are in, water would be diverted by gravity through the fish screens into the new forebay and would then bypass the pump station into the conveyance system for delivery to the sedimentation basin.

Under all of the alternatives, the Mill Site Pump Station facilities would include a fish screen along the river. The screens would be designed to provide a 0.33-fps approach velocity as required by CDFG. The length of the screen depends on the alternative selected and the characteristics of the river (i.e., depth, channel geometry, flow volume, and velocity under various operating conditions) at the screen location, which would be determined during preliminary design. For a 2,500-cfs pump station, the length of the screen would be approximately 1,100 feet. The screens would be installed in approximately 60 bays. For a 2,180-cfs pump station, the length of screen would be approximately 1,000 feet, and the screens would be installed in approximately 54 bays. Blowout panel(s) would be provided as an emergency hydraulic relief system in the event of differential heads between the river and the forebay. The top of bulkheads would be set at the 25-year flood elevation to limit the amount of debris in the forebay for most extreme flood events. A cofferdam would be constructed around the screens and the site dewatered to allow construction of the screens in the dry.

Water would flow through the fish screens into the pump station forebay and into the vertical propeller pump station. Approximately seven pumps would be required for the 4-month Alternative, eight pumps for the 2-month Alternative, and ten pumps for the Gates-out Alternative (2,180-cfs vertical propeller, 320-cfs RPP). The location of the pump station relative to the fish screens would be determined during preliminary design. Considerations for the location would include the cost of excavating the forebay versus piping, as well as the hydraulic flow characteristics entering the pump station.

The objective of the fish screen design is to provide safe fish passage for juvenile fish (primarily salmon and steelhead) past TCCA water diversion facilities.

The pumps would lift the water to the pump station outlet box. The water would flow by gravity from the outlet box through a siphon under Red Bank Creek. The water would discharge downstream of the fish drum screens in the sedimentation basin. The site plan area requirements and sizes of conveyance facilities are based on the pumping capacity requirement for the Gates-out Alternative. The required offsite pumping capacity would be smaller for the 2-month and 4-month alternatives.

The land where the pump station and conveyance facilities would be constructed is adjacent to land owned by the federal government for RBDD and is currently available for purchase. Power supply is nearby,

NOTE: CAPACITY AND SIZE OF FISH SCREEN DEPENDENT ON ALTERNATIVE SELECTED. LARGEST SIZE (2180cfs) SHOWN.

FIGURE 2.3-1
GENERAL LAYOUT OF MILL SITE FACILITIES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR
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and access is in place. Direct access to the pump station site from the existing RBDD site would likely require a bridge across Red Bank Creek.

Fish Screen Design Criteria

The objective of the fish screen design is to provide safe fish passage for juvenile fish (primarily salmon and steelhead) past TCCA water diversion facilities. This would be accomplished through the use of positive barrier on-river fish screens.

The required approach velocity of 0.33 fps would be used for on-river applications to meet CDFG criteria. The lengths and depths of the screens for each option were derived from preliminary hydrographic field surveys at each of the proposed pump station sites.

Fish Bypass System

A minimum of three internal fish bypasses would be required for the Mill Site vertical pump station option at the maximum 2,180-cfs pumping capacity, assuming the normal riverflow of 8,000 cfs during the irrigation season. A pumped bypass system would use the fish-friendly screw or helical pumps that have been tested at RPP over the past several years.

The fish bypass piping system would be sized to achieve a minimum velocity of 4 fps and designed to limit the exposure along the fish screen to 120 seconds.

The fish bypass piping system would be sized to achieve a minimum velocity of 4 fps to convey fish back to the river from the fish bypass pump station and minimize sediment deposition in the pipeline. At the minimum bypass entrance velocity of 2 fps, the required flow for each bypass pipeline at normal river elevations is about 36 cfs. The fish bypass would outlet just below the downstream end of the fish screen in the river channel. Alternatively, the fish could be conveyed in a separate pipeline from the fish bypass pumps to the existing drum screen bypass system pipeline. This would require a piped bypass system paralleling the discharge conveyance system to the sedimentation basin, about ½ mile long. The pipeline would be constructed across the sedimentation basins and connect to the existing fish bypass pipe from the drum screen bypass.

Fish bypasses would be designed to limit the exposure along the fish screen to 120 seconds, which is the current exposure time criterion, assuming a variance would be granted by NMFS. Separate pipelines from the entrance of each fish bypass would convey water and fish to a screw/helical pump station located on the east side of the forebay. An exception to the current “no pumped fish bypass” criterion would be required from NMFS, or an exception to the maximum exposure time would be required to eliminate the need for the fish bypass system.

The fish bypass pump station would be similar to the existing RPP located downstream of the irrigation gates. One 30- to 50-cfs pump would be required for the 4-month Alternative, two for the 2-month Alternative, and three for the Gates-out Alternative. A pipe from the pump station would convey the water and fish back to the river upstream of the current gravity-flow intake gates as shown on Figure 2.3-1.

Conveyance Facilities across Red Bank Creek

The conveyance system across Red Bank Creek would consist of pipes or culverts or a combination of both. The most advantageous combination would be considered in the preliminary design. The conveyance system would be sized for a maximum velocity of 8 fps at peak flow. The discharge structure at the sedimentation basin could be located anywhere along the westerly side of the sedimentation basin. The best apparent location and the specific design would be determined during the preliminary design.

A vehicle access bridge would most likely be constructed across Red Bank Creek to provide access for maintenance vehicles between the Mill Site and the existing TCCA facilities.

Fish ladder upgrades would entail entrance reconfiguration to improve entrance conditions, and increased attraction flow to better guide the upstream migrating fish to the ladders.

2.2.2 Fish Ladders

Alternatives including new ladders would include changes to the current RBDD fish ladders. These upgrades would entail entrance reconfiguration to improve entrance conditions, and increased attraction flow to better guide the upstream migrating fish to the ladders.

Right Bank Fish Ladder

The objective of this design is to modify the existing right bank fish ladder to provide improved adult fish passage. This would be accomplished by increasing the Auxiliary Water System (AWS) flow from 265 cfs to 715 cfs. The fish ladder flow would remain at 85 cfs, although new Ice Harbor-type weirs would be installed. The total maximum fish ladder flow would be 800 cfs, including the AWS flow. The fish ladder entrance bay would be reconfigured to enhance fish attraction and to accommodate the increased total flow. This main entrance would be 12 feet by 12 feet with a top-down slide gate to ensure proper entrance conditions at all design tailrace levels. A low-flow entrance (6 feet by 6 feet) would also be included to provide a jet parallel to the dam axis just downstream of the spillway Bay 11 end sill. The low-flow entrance would also have a top-down slide gate for closure or adjustment.

The lowest weir (weir number 1) of the existing fish ladder would be abandoned to provide for a larger entrance bay. The entrance bay invert would be at Elevation 232, which would provide 7 feet of water depth in the entrance bay at design low tailwater flows. The entrance bay would have a large floor diffuser and a smaller wall diffuser. The new fish ladder Pools 2 through 5 would have floor diffusers only.

At the design total flow of 800 cfs and the design maximum tailwater, the transit velocity in the entrance bay just before the high-flow fish ladder entrance is 3.6 fps, which is just below the design maximum transit velocity criterion of 4.0 fps.

The new AWS system would be operated with a constant-flow input to the wall diffuser at all design tailwater flows. Flow to the floor diffusers and the opening of the entrance gates would be controlled to provide a constant 1-foot differential from the entrance bay to the tailwater surface elevation. AWS energy dissipation would be designed to minimize air and hydraulic hot spots on all diffusers.

The existing AWS intake would be abandoned, and a new AWS intake would be constructed in the abandoned louver structure portion of the TC Canal. The AWS intake at the canal would need to be rebuilt to ensure proper flow conditions for the new AWS intake and the existing drum screens. The new AWS intake would have a trashrack with 1-inch bar spacing, an automated trashrack cleaner, and a gross approach flow velocity of 1.0 fps.

Left Bank Fish Ladder

After modeling and evaluating various fish ladder flow rates ranging from 1,000 to 3,000 cfs, USBR (1997a) recommended enlarging the left bank fish ladder to a total flow of 1,000 cfs. To simplify the modifications to the left bank fish ladder in the context of the overall configurations for alternatives including improved ladders, an 831-cfs ladder is proposed. This size would allow for diffuser placement similar to that proposed for the right bank fish ladder and substantially simplify the required modifications to the existing ladder.

The objective of this design is to modify the existing left bank fish ladder to provide improved adult fish passage. This would be accomplished by increasing the AWS flow from 265 cfs to 746 cfs. The fish ladder flow would remain at 85 cfs, although new Ice Harbor-type weirs would be installed. The fish ladder entrance bay would be reconfigured to enhance fish attraction and to accommodate the increased total flow. The existing AWS intake would be modified to include 1-inch bar spacing trashracks, an automated trashrack cleaner, and a gross approach velocity of 1.0 fps. The existing AWS intake would serve as a single 96-cfs wall diffuser in the entrance bay. A new AWS intake would be constructed on the left bank just upstream of the existing fish ladder exit. This intake would be similar to the one proposed for the right bank fish ladder and would be sized for the 650-cfs floor diffuser flow. The general layout of the left bank fish ladder is shown on Figure 2.3-2.

2.2.3 Research Pumping Plant

The proposed vertical propeller pump station at the Mill Site would be used in combination with the existing RPP to provide irrigation capacity. The existing RPP consists of a four-bay structure that has two Archimedes screw pumps and one Wemco hidrostal screw pump providing a total 240-cfs effective irrigation flow. The preliminary design would include adding an 80-cfs Wemco hidrostal screw pump in the spare pump bay to provide an additional 80-cfs effective irrigation flow capacity increasing the effective total capacity to 320 cfs from the pump station. Fish screens and a mechanical screen cleaning system would be designed for installation in the Bay 4 conveyance channel. USBR may install the fourth pump and also the fish screens prior to construction of improvements under this project.

2.2.4 Dam Bypass

Over the years, there has been consistent interest in various "bypass alternatives" that could be used to improve fish passage while allowing the dam to function. These bypass alternatives typically include proposals to construct a channel through historical river meanders or sloughs along the eastern bank of the river channel. The basic concept is that a bypass channel approximating natural river conditions would be more efficient for passing fish than fish ladders. Additionally, some bypass proponents assert that the channels would be adequate to allow for a return to an 8-month or 12-month gates-in operation at RBDD. The greatest interest in bypass alternatives has been from citizens of Red Bluff, many of whom are concerned about the fate of Lake Red Bluff, which is formed during the gates-in period.

The greatest interest in bypass alternatives has been from citizens of Red Bluff.

Bypass alternatives have been formally reviewed in at least three public documents: a 1992 Appraisal Report by USBR, a 1995 Bypass Evaluation Report by USBR, and a 2000 Prescoping Report by CH2M HILL. All three documents have resulted in recommendations that the bypass alternatives not be considered further. However, the general public has disputed all three recommendations.

The bypass channel concept that is being evaluated for this project has been configured to reduce costs, limit flood impacts and liability, and minimize adverse water quality changes to the Sacramento River near RBDD. Specifically, the objective has been to establish physical characteristics that allow for fish passage. The basic approach for the bypass channel has been to focus on non-salmonids, particularly sturgeon, which have more restrictive requirements than salmonids.

In order for the bypass channel to meet all of the concerns consistently expressed by the fishery agencies and engineers, the bypass channel must:

- **Be passable by all species of concern.**

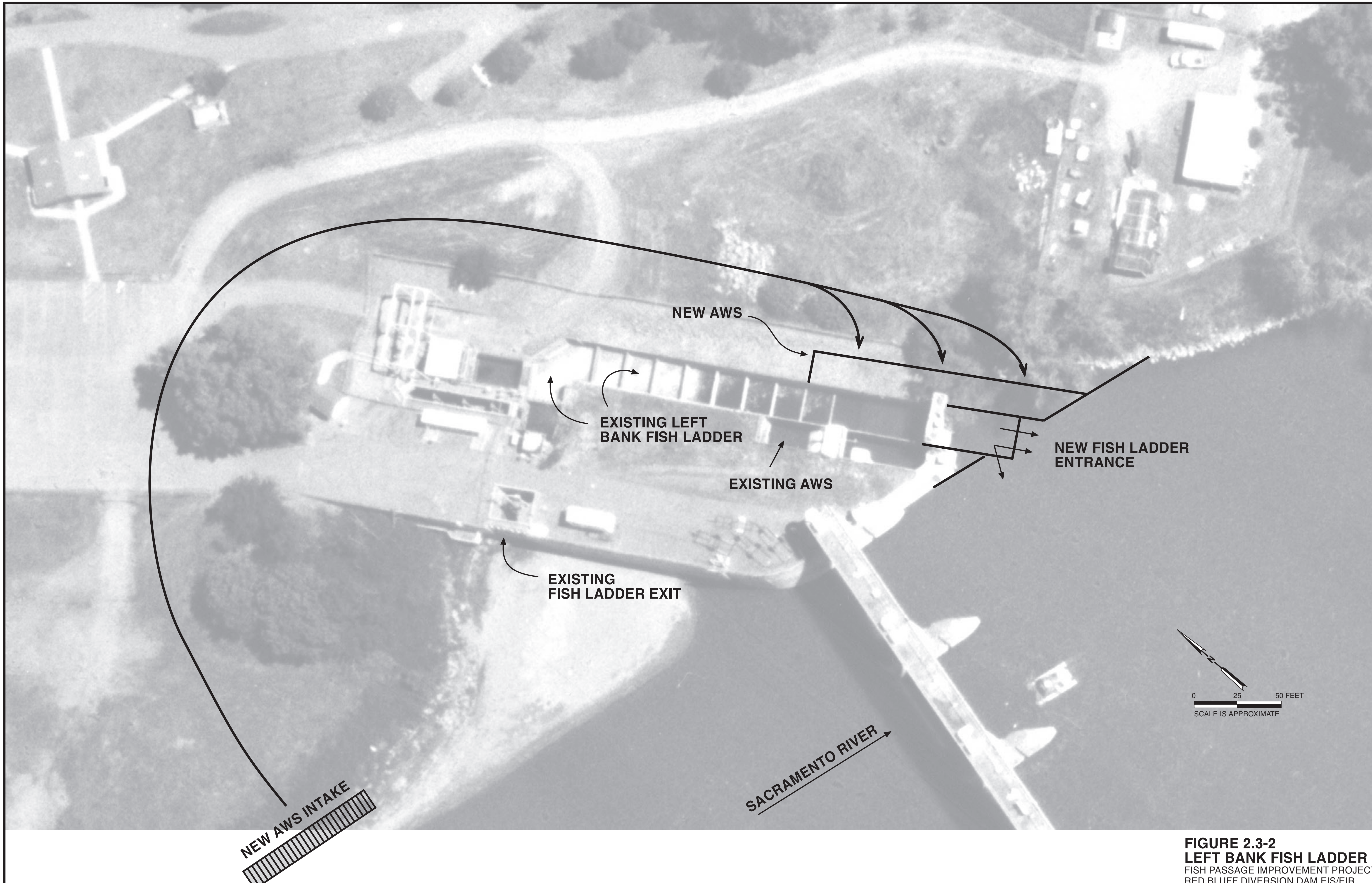

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FIGURE 2.3-2
LEFT BANK FISH LADDER
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR
CH2MHILL

Velocities in the channel should be considerably lower than in standard fish ladders. Literature review suggests that maximum velocities of 3.0 fps in the majority of the channel would be appropriate to pass non-salmonid species, with maximum velocities of 6.0 fps through very short reaches or slots.

The design includes concrete weirs about 2.5 feet high, placed at 150-foot intervals along the bypass channel. The weirs should be arch-shaped (in the horizontal direction) to provide more flow in the center of the channel and add complexity to the flow regime. The design also includes two full depth slots in each weir, approximately 5 feet wide, to provide fish passage without requiring the fish to swim over the weirs.

- **Avoid creation of slack waters and predator holding habitat either above or below the dam.**

The bypass channel is configured to minimize the distance between the bypass entrance and exit and the dam itself. This configuration is intended to eliminate any additional slack water created by the bypass facility. Further, the location of the downstream end of the channel is intended to supplement attraction water to the left bank fish ladder, theoretically improving the performance of the ladder.

- **Avoid areas or conditions of potential stranding.**

Like other fish passage facilities, the bypass channel will be designed with flow depths to provide adequate fish passage and the requisite pool volume for energy dissipation. The channel configuration will also ensure complete drainage without pools where fish could be stranded.

The design includes a small, V-shaped concrete subchannel on each side to provide drainage of the facility. The bottom of the main channel would be sloped to drain toward each V-shaped subchannel from the center of the bypass channel. The arched weirs are assumed to be configured convex relative to the direction of the flow based on the premise that this will reduce stranding and further enhance drainage. Additionally, it is assumed that the rock covering the bottom of the channel would be grouted to prevent juvenile fish from hiding in the voids between the rocks and becoming stranded.

- **Provide enough attraction flow for the fish to readily find the bypass.**

The bypass channel should re-enter the river as close as possible to the downstream side of RBDD to enhance the ability of migrating fish to find the channel.

- **Avoid new facilities that recreate or move existing barriers.**

To minimize cost, the bypass channel was located so as to minimize interference with the Discovery Center, the existing road, the USFS campground, and the existing fish ladder and its proposed improvements.

- **Be structurally stable at all flows (i.e., it must not trigger a shift in the river's channel).**

When the RBDD gates are in, only minor fluctuations in the water surface elevation behind the dam are expected. Therefore, flow control can be achieved with a simple weir concept. Another element of flow control is the ability to close off the bypass channel. A control structure will be constructed at the levee near the upstream entrance to the bypass channel to incorporate the weir and a set of large gates for closing the channel to reduce flood damage and maintenance.

- **Be able to accommodate the flow fluctuations that can be expected during the periods of use.**

The flow control structure should be designed to close off the bypass channel from the Sacramento River when there is potential for flooding. The existing levee is high enough to protect against a 100-year flood in the river. However, it may still be possible for overland flow from other adjacent waterways to enter the bypass channel downstream of the levee. Rock slope protection will be used to provide bank stability and protection from erosion.

- **Be free of constant or intensive maintenance efforts.**

Current designs of the bypass channel include three features intended to keep maintenance efforts at a reasonable level. The channel includes gates at the upstream end that will minimize the amount of debris in the channel during periods of non-use, particularly during winter flood events. The channel would also be contoured to allow drainage via subchannels along both sides of the floor of the channel. The floor of the channel would be grouted to avoid stranding juvenile fish during dewatering of the channel. The channel would be armored with rock to minimize scour and sloughing of the banks.

- **Be economically viable.**

At 1,000 cfs, the channel would carry approximately the same amount of flow as an improved fish ladder, while at the same time, the capacity would be small enough to keep the size and the cost of the facility at a

reasonable level. Final cost estimates will be available pending technical review of the design.

- **Be safe (i.e., not create a dangerous, attractive public nuisance).**

Most fish passage facilities, including this bypass channel, have inherent safety risks associated with high velocities, orifices and notches, submerged or exposed obstacles, and other elements of the facility.

Accordingly, boating and other potential public uses of the bypass channel would carry serious safety and liability issues. Public use of this facility is viewed as incompatible with the fisheries use. The perimeter of the bypass channel should be securely fenced, and the flow control structure at the upstream end should be designed to prevent boats from entering from the Sacramento River.

The proposed layout of the bypass channel is presented on Figures 2.3-3 and 2.3-4.

2.3 Construction Methods

The following descriptions of construction methods are intended to provide a general overview of the types of construction methods anticipated to be used during construction of the facilities described in the previous section. It is important to note that individual construction contractors may use different construction methods depending on construction timing, funding, developments in technology, or future permit conditions.

2.3.1 General Construction Methods

The primary features of construction would be excavation, construction of concrete structures, and fill and re-grading operations. In basic terms, this would require large pieces of equipment for digging, moving soil, and pouring concrete. Additionally, because a large portion of the construction activity would occur near the Sacramento River, long series of sheet pile would likely be required to establish dry areas for forming concrete structures. Sheet pile are installed using a pile driver, vibratory hammer, or other similar piece of equipment.

The primary features of construction would be excavation, construction of concrete structures, and fill and re-grading operations.

Overall, approximately 800,000 cubic yards (CY) of material would need to be excavated to facilitate the construction of the Fish Passage Improvement Project. At this time, it is anticipated that the majority of this soil, or approximately 600,000 CY of material, would be stored onsite (specific locations to be determined - possibly in the existing drainage/sedimentation basins onsite). Approximately 2,000 linear feet (LF) of sheetpile would be required to construct various cofferdams in several locations. The Fish Passage Improvement Project would require a myriad of construction equipment including cranes, front end loaders, pile drivers, backhoes, excavators, scrapers, bulldozers, dump trucks, and other construction equipment and tools.

Mill Site Pump Station and Conveyance Facilities

Construction of the Mill Site Pump Station would require excavation of a large forebay. Approximately 750,000 CY of material would be excavated under the Gates-out Alternative. It is anticipated that a large portion of that material (approximately 580,000 CY) would be disposed of onsite. The remainder of excavated material would likely be hauled offsite to a disposal facility. A complete pile-driving set-up would be required, as well as a construction barge and extensive earthmoving equipment. Divers would most likely be used to cut sheetpiling under water. A large cofferdam would be required adjacent to the river, approximately 1,400 LF under the Gates-out Alternative. The cofferdam would be dewatered prior to construction.

Right Bank Fish Ladder

Construction of the right bank fish ladder would require approximately 8,000 CY of excavation and would require an approximately 300-LF cofferdam.

Left Bank Fish Ladder

Construction of the left bank fish ladder would require the excavation of approximately 16,000 CY and an approximately 200-LF cofferdam.

Research Pumping Plant

The fourth bay in the RPP structure currently exists; therefore, no excavation would be required. A new pump would be installed in an existing bay.

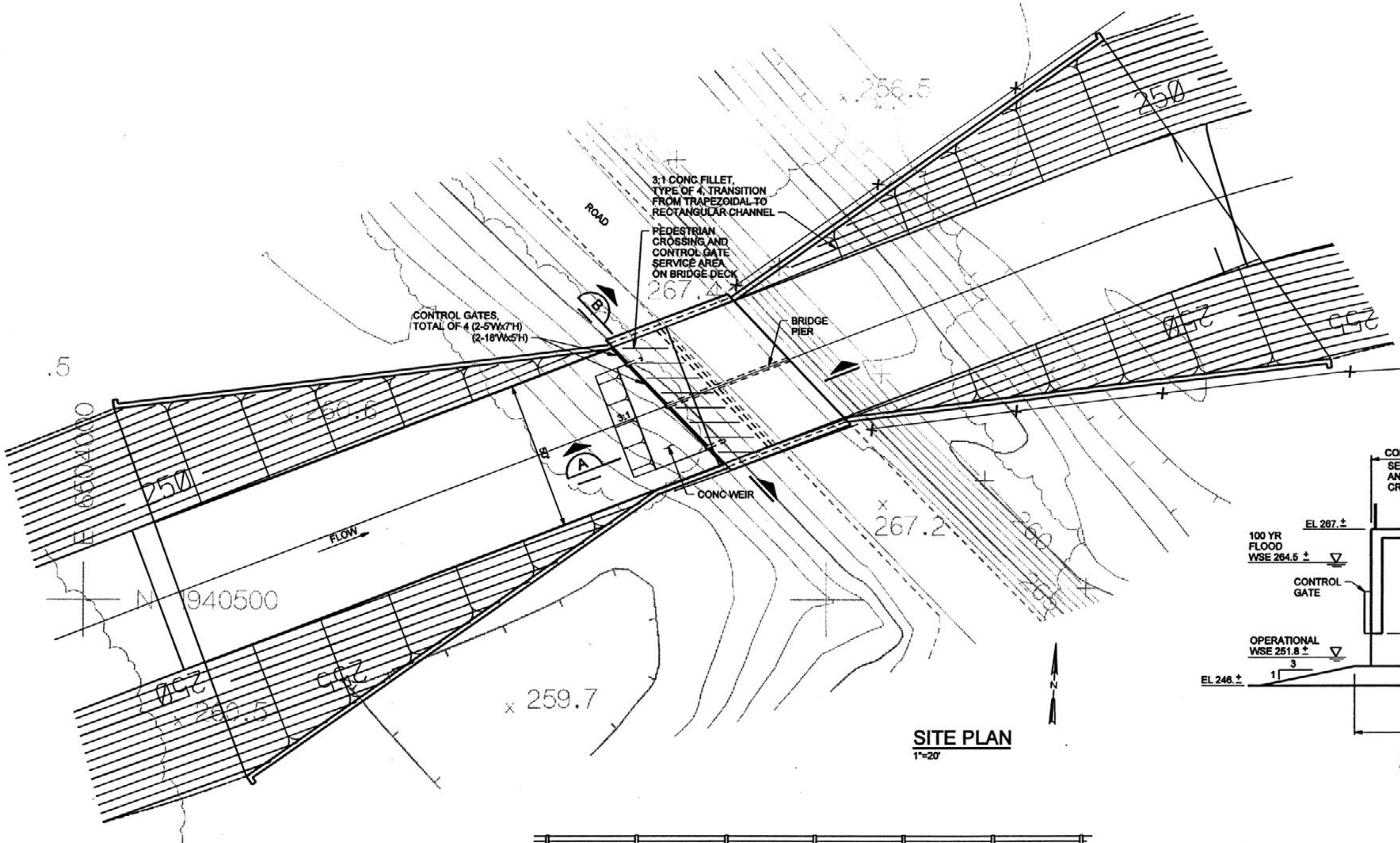
2.3.2 Construction Schedule

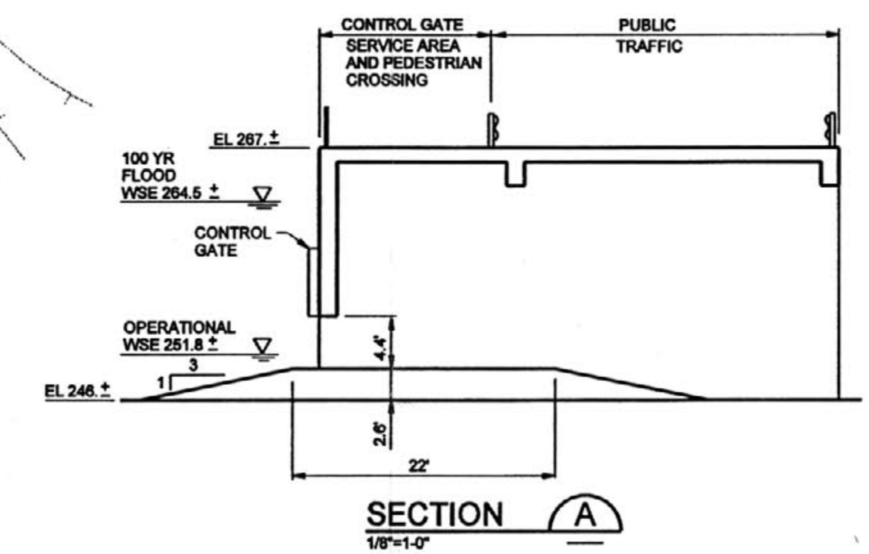
The project schedule is shown on Figure 2.3-5. The schedule depends primarily on funding, but other factors are also important, such as timely reviews and facility option and alternative selection, as well as acquisition of required permits and rights-of-way. The schedule has been updated from the schedule shown in the Prescoping Report, which was based on the assumption that the funding for the preliminary design would be available on or before January 1, 2000, as well as other unknowns. However, funds were not available until March 10, 2000, and reviews, approvals, and public processes are taking longer than initially anticipated. The construction schedule Phase IV assumes the most complex combination of facilities, which is the 4-month Improved Ladder Alternative. This is the most complex schedule because of the sequencing required to maintain operation of two of the current fish ladders while one of the fish ladders is being upgraded. If the Gates-out Alternative or 2-month Existing Ladders Alternative were selected (no fish ladder upgrades) and all of the pumping capacity were to be developed at an offsite pump station, then the schedule would be simplified or could be reduced.

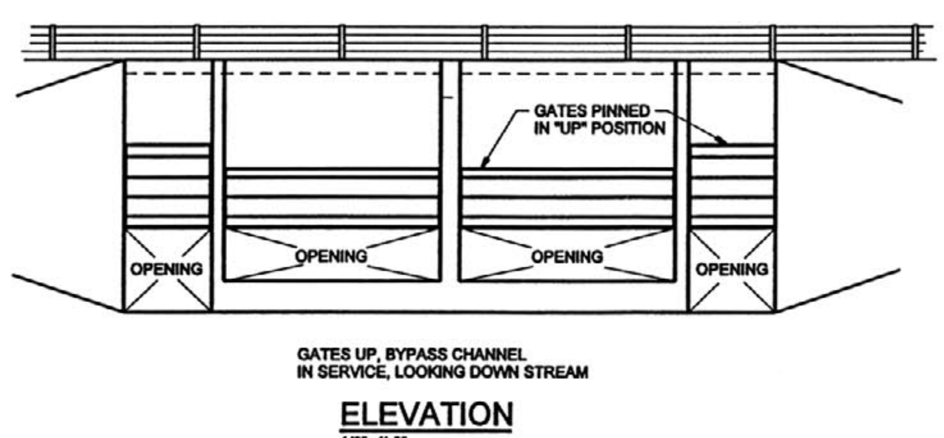
The schedule depends primarily on funding, but other factors are also important, such as timely reviews and facility option and alternative selection, as well as acquisition of required permits and rights-of-way.

2.4 Adaptive Management

Because of the inherent uncertainty in the diversion structure's interaction with fish~~involved in complex systems such as fisheries~~, all of







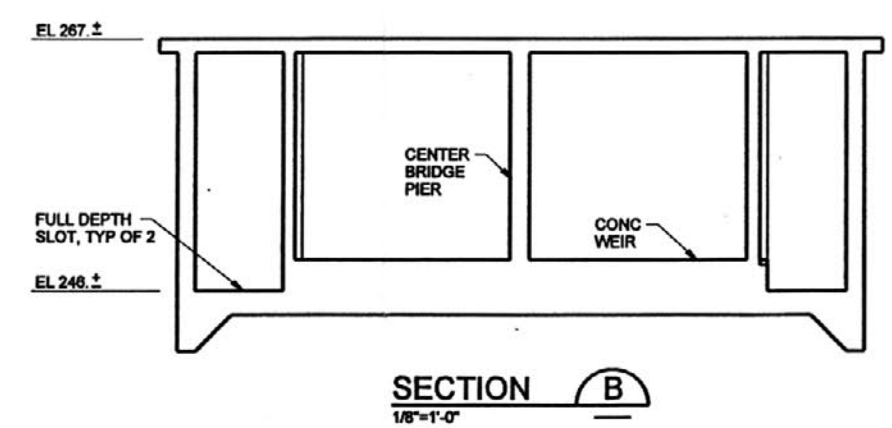


FIGURE 2.3-3
RBDD BYPASS CHANNEL CONTROL STRUCTURE PLAN AND SECTIONS
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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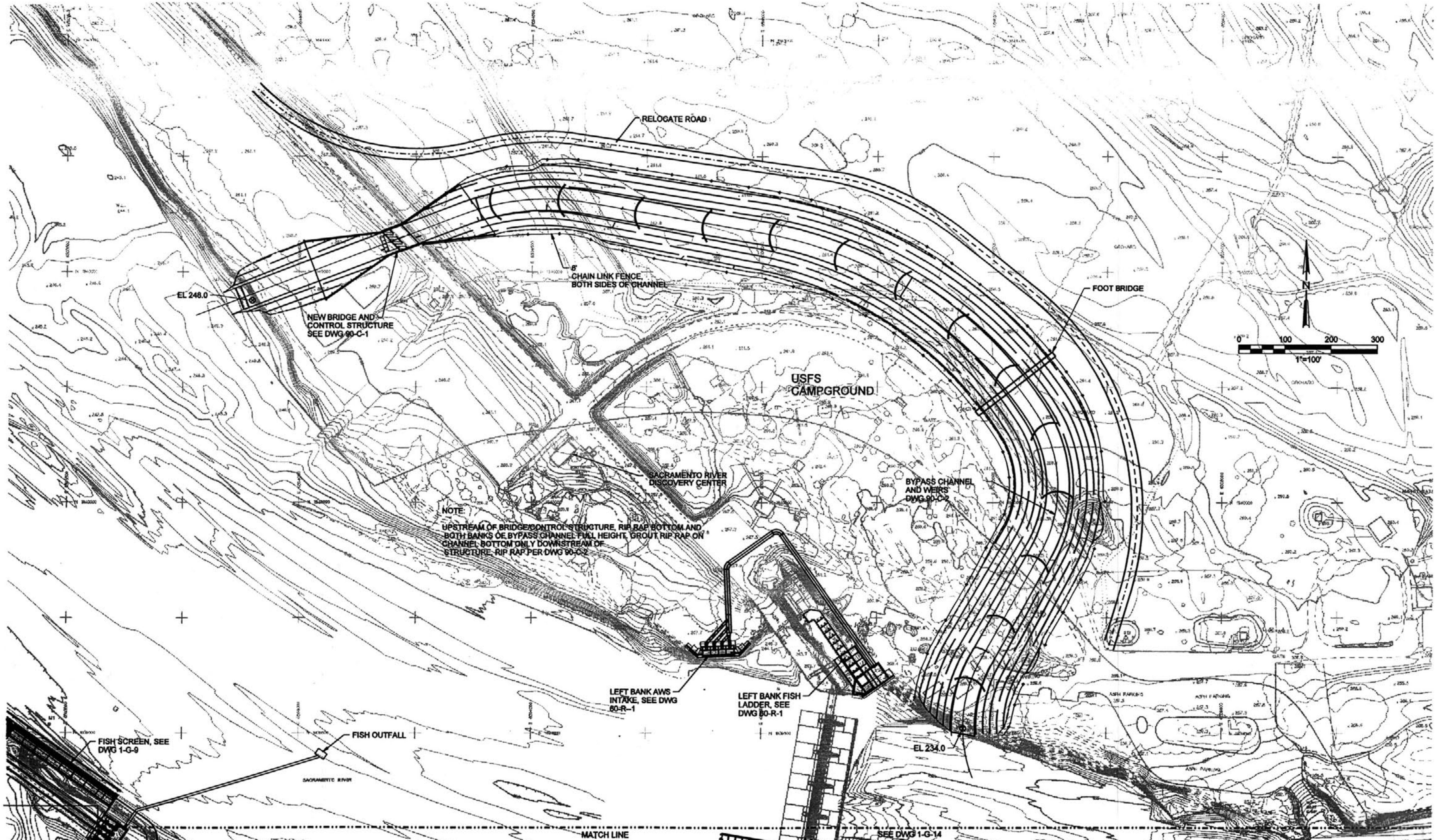

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FIGURE 2.3-4
RBDD SITE GRADING PLAN
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR
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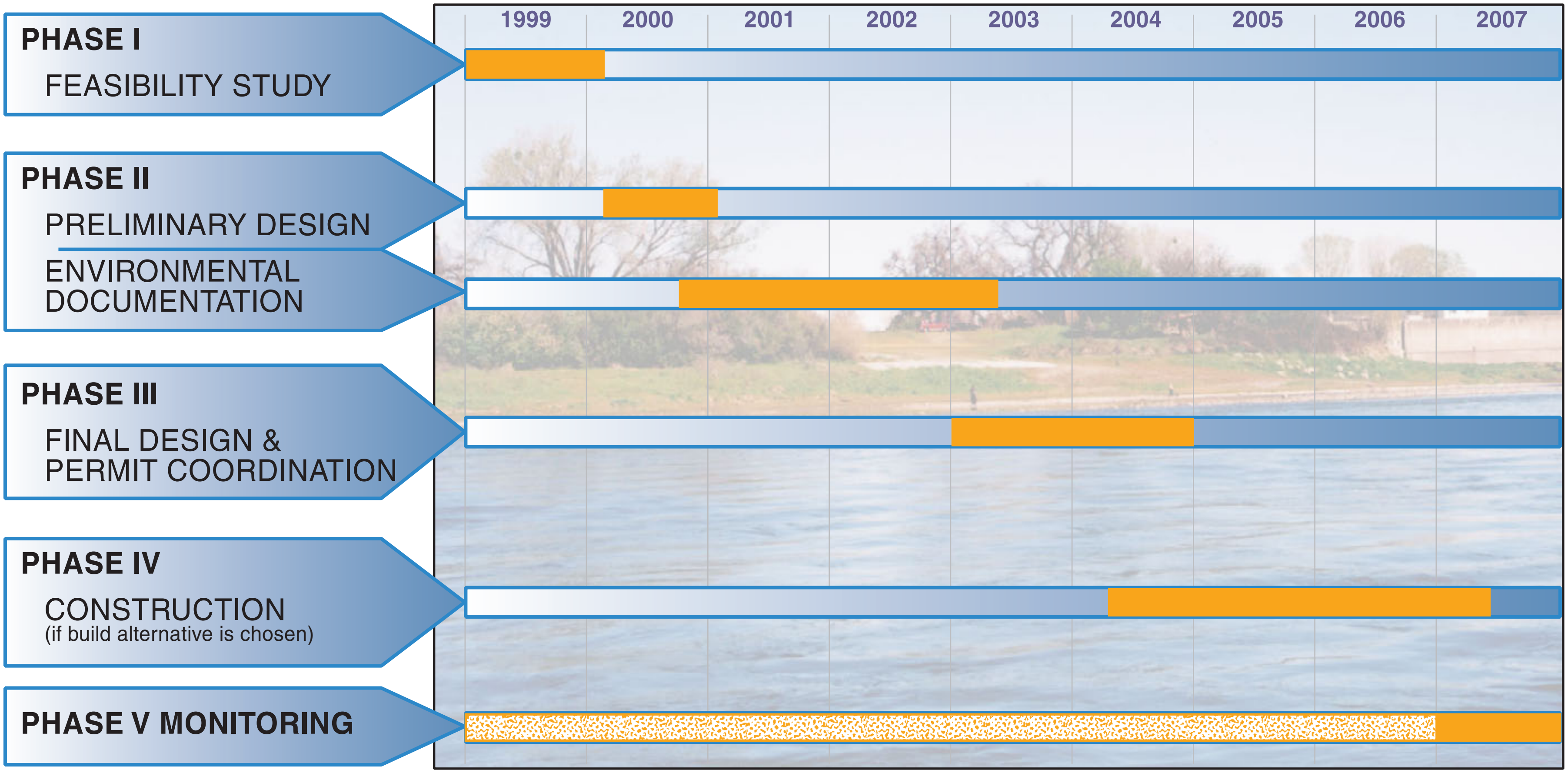

FIGURE 2.3-5
CONSTRUCTION SCHEDULE
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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the alternatives considered would include an Adaptive Management Program. Adaptive management acknowledges that there is a need to constantly monitor such systems and adapt actions that are taken to restore ecological health and improve water management. These adaptations are necessary because conditions continue to change, and the knowledge base and understanding of systems continues to improve. By including an Adaptive Management Program in all of the alternatives, it is possible to acknowledge areas of uncertainty in a given system and still allow decision makers to take action before scientific consensus is achieved. However, this places a great deal of importance on the design of the Adaptive Management Program. The Draft Adaptive Management Program is included as Appendix H.

All of the alternatives considered would include an Adaptive Management Program.

Experiments to evaluate established hypotheses would be designed after a specific alternative is selected. Because the design and implementation of experiments have important ramifications to future gate operations, it is important to also include a feedback loop that includes interested Sacramento River stakeholders, including representatives interested in maximizing gates-in operations. Therefore, the following administrative processes would also constitute an important part of the overall Adaptive Management Program:

- Technical actions would be selected by members of the Adaptive Management Science Team, which would include representatives from USBR, TCCA, USFWS, NMFS, CDFG, and California Department of Water Resources (DWR). Technical Actions would include:
  - Refinement of hypotheses to be tested
  - Design of experiments to test hypotheses
  - Review of applicable monitoring information from other, related efforts in the Sacramento River basin
  - Annual reporting on results of experiments, and summary reporting on results of experiments every 6 to 10 years
- Public workshops or other appropriate mechanisms for policy review would be used to provide an opportunity for stakeholder review and comment on proposed actions and annual and summary reporting of the Adaptive Management Science Team. Membership in the Policy Review Board would include representation from the following agencies/interest groups:
  - USBR
  - TCCA
  - City of Red Bluff
  - Lake Red Bluff special interest

- Sacramento River sport fishing
- Salmon commercial fishing

As appropriate, other special interests may be added to the Policy Review Board. The role of the Policy Review Board would be to provide input to the Adaptive Management Science Team regarding overall approach and focus.

3.0 Environment and Environmental Consequences

3.1 Introduction

Chapter 3 describes the affected environment and the environmental consequences of implementing the various alternatives described in Chapter 2. Issues discussed include the fishery resources, water resources, biological resources, recreation, land use, geology, agricultural resources, power resources, socioeconomics, cultural resources, visual and aesthetic resources, air quality, traffic and circulation, noise, and environmental justice.

Each section includes a discussion of the affected environment (CEQA existing conditions), environmental consequences (CEQA environmental impacts), methodology, significance criteria (if applicable), and mitigation measures (if applicable). Section 4.5, Environmental Commitments and Mitigation and Significant Unavoidable Impacts provides a summary of significant adverse environmental impacts and proposed mitigation, the anticipated level of significance after mitigation is implemented, and those impacts that cannot be avoided and remain significant in accordance with Public Resources Code Section 21100, subd. (b)(2) and *CEQA Guidelines* Section 15126. Section 4.3, Irreversible and Irretrievable Commitments of Resources and Significant Impacts that Would Remain Unavoidable Even after Mitigation, also addresses significant unavoidable impacts. Some sections address issues only required to satisfy federal law (e.g., NEPA), and are not required to comply with CEQA. For example, because CEQA generally does not require lead agencies to consider the purely economic or social effects of proposed projects, Sections 3.10 (Socioeconomics) and 3.16 (Environmental Justice) were not prepared with CEQA compliance in mind. Sections are generally organized in the following manner:

- Affected Environment (CEQA Existing Conditions): These subsections describe the existing regional and local conditions. Information presented is the most current available and is used as the CEQA baseline for analysis for all sections that are qualitatively analyzed.
- Environmental Consequences (CEQA Environmental Impacts): These subsections identify the anticipated impacts within the context of each alternative. Those impacts that are deemed to be potentially significant prior to mitigation are identified as such in

the text. The following subsections are also presented under Environmental Consequences:

– Methodology: These subsections identify the method used to analyze impacts, as well as the key assumptions used in the analysis process.

– Significance Criteria: These subsections present the criteria and thresholds used to identify potentially significant effects on the environment in accordance with Public Resources Code Section 21082.2, and *CEQA Guidelines* Sections 15064 and 15065. Thresholds include guidance provided by Appendix G of the *CEQA Guidelines*, as well as agency standards or legislative or regulatory requirements as applicable, in addition to professional judgement. All impacts that do not exceed the stated significance criteria described for each section are assumed to be less than significant and are therefore not discussed in detail in the document (Public Resources Code Section 21100 and *CEQA Guidelines* Sections 15128).

- Mitigation: These subsections identify what lead agency staff and consultants believe to be potentially feasible mitigation measures that would reduce significant impacts associated with each of the alternatives. Where no feasible mitigation can be identified, such impacts are identified as significant and unavoidable.

Each alternative was analyzed using the criteria identified in Chapter 2. The assumptions are listed below.

No Action Alternative—No changes to hydrology or surface-water management would occur. Gates would be operated during the current 4-month gates-in period. Construction activity would be limited to the installation of the fourth pump at RPP. No other construction activity would occur as a result of the No Action Alternative.

1A: 4-month Improved Ladder Alternative—Includes a new 1,380-cfs pump station at the Mill Site and new left bank and right bank fish ladders.

1B: 4-month Bypass Alternative—Includes a new 1,000-cfs bypass channel on the left bank, a new 1,380-cfs pump station at the Mill Site, and a new right bank fish ladder.

2A: 2-month Improved Ladder Alternative—Includes a new 1,680-cfs pump station at the Mill Site and new right bank and left bank fish ladders.

2B: 2-month with Existing Ladders Alternative—Includes a new 1,680-cfs pump station at the Mill Site.

3: Gates-out Alternative—Includes a new 2,180-cfs pump station at the Mill Site.

3.2 Fishery Resources

Fishery resources include fish populations, their habitats, and the harvest of those populations. This section discusses the existing environment within the Sacramento River Basin and Central Valley. The fishery resources in the Sacramento River near RBDD consist of a diverse assemblage of fish species including native anadromous salmonids (NAS), other native anadromous fish (NAO), non-native anadromous fish (NNA), and resident native and non-native fish (RN and RNN). Table 3.2-1, provides a species list of those fish that may likely be found at or near RBDD at some time during their life history.

TABLE 3.2-1
Fish Found in the Sacramento River Near Red Bluff

Common Name	Scientific Name	Group	Native	Introduced
Chinook salmon[a]	*Oncorhynchus tshawytscha*	NAS[b]	X	
Steelhead[c]	*Oncorhynchus mykiss irideus*	NAS	X	
Sockeye salmon	*Oncorhynchus nerka*	NNAS[d]		X[e]
Pink salmon	*Oncorhynchus gorbuscha*	NNAS		X[f]
Pacific lamprey	*Lampetra tridentata*	NAO[g]	X	
River lamprey	*Lampetra ayresi*	NAO	X	
Green sturgeon	*Acipenser medirostris*	NAO	X	
White sturgeon	*Acipenser transmontanus*	NAO	X	
Striped bass	*Morone saxatilis*	NNA[h]		X
American shad	*Alosa sapidissima*	NNA		X
Rainbow trout[i]	*Oncorhynchus mykiss*	RN[j]	X	
Hitch	*Lavinia exilicauda*	RN	X	
Sacramento splittail	*Pogonichthys macrolepidotus*	RN	X	
Hardhead	*Mylopharodon conocephalus*	RN	X	
Sacramento pikeminnow	*Ptychocheilus grandis*	RN	X	
Speckled dace	*Rhinichthys osculus*	RN	X	
California roach	*Hesperoleucus symmetricus*	RN	X	
Sacramento sucker	*Catostomus occidentalis*	RN	X	
Tule perch	*Hysterocarpus traski*	RN	X	
Prickly sculpin	*Cottus asper*	RN	X	
Riffle sculpin	*Cottus gulosus*	RN	X	
Sacramento blackfish	*Orthodon microlepidotus*	RN	X	
Threespine stickleback	*Gasterosteus aculeatus*	RN	X	
Brown trout	*Salmo trutta*	RNN[k]		X
Threadfin shad	*Dorosoma petenense*	RNN		X
Largemouth bass	*Micropterus salmoides*	RNN		X
Spotted bass	*Microterus punctulatus*	RNN		X
Smallmouth bass	*Micropterus dolomieui*	RNN		X
Green sunfish	*Lepomis cyanellus*	RNN		X
Bluegill	*Lepomis macrochirus*	RNN		X
Redear sunfish	*Lepomis microlophus*	RNN		X
Pumkinseed	*Lepomis gibbosus*	RNN		X
Black crappie	*Pomoxis nigromaculatus*	RNN		X

TABLE 3.2-1
Fish Found in the Sacramento River Near Red Bluff

Common Name	Scientific Name	Group	Native	Introduced
White crappie	*Pomoxis annularis*	RNN		X
Channel catfish	*Ictalurus punctatus*	RNN		X
White catfish	*Ictaurus catus*	RNN		X
Black bullhead	*Ictalurus melas*	RNN		X
Yellow bullhead	*Ictalurus nalalis*	RNN		X
Golden shiner	*Notemigonus crysoleucas*	RNN		X
Fathead minnow	*Pimephales promelas*	RNN		X
Goldfish	*Carassius auratus*	RNN		X
Carp	*Cyprinus carpio*	RNN		X
Mosquitofish	*Gambusia affinis*	RNN		X

Notes:

Sources: Moyle, 1976; Lee et al., 1980; Brown and Killam, pers. comm.

[a]Fall, late-fall, spring, and winter Chinook salmon runs
[b]Native anadromous salmonid
[c]Anadromous form of *O. mykiss*
[d]Non-native anadromous salmonid
[e]Likely non-native kokannee salmon
[f]Non-native to the Sacramento River
[g]Other native anadromous
[h]Non-native anadromous
[i]Resident form of *O. mykiss*
[j]Resident native
[k]Resident non-native

The Sacramento River in the vicinity of RBDD provides essential habitat for the freshwater life stages of Chinook salmon and steelhead.

3.2.1 Affected Environment

Native Anadromous Salmonids (Chinook Salmon and Steelhead)

The Sacramento River in the vicinity of RBDD provides essential habitat for the freshwater life stages of Chinook salmon and steelhead. Within California's Central Valley, the Sacramento River provides a corridor for the anadromous salmonid resources between upstream reaches and the tributaries to the Sacramento River and the Pacific Ocean. The Sacramento River is the largest river system in California with more than 90 percent of the Central Valley salmon spawning and rearing within the Sacramento River system. The Sacramento River supports four runs (races) of Chinook salmon: fall, late-fall, winter, and spring run. Table 3.2-2 shows the average, low, and high number of Chinook salmon and steelhead spawners estimated to pass upstream of RBDD from 1970 through 1999, as provided by CDFG on their annual "Grand-Tab" spreadsheet. Table 3.2-3 presents a summary of life history timing for native anadromous salmonids in the Sacramento River near RBDD.

The Sacramento River supports four runs (races) of Chinook salmon: fall, late-fall, winter, and spring run.

TABLE 3.2-2
Estimated Chinook Salmon Spawning Escapement Upstream of RBDD (1970 through 1999)[a]

Species	Average	Low (year)	High (year)
Fall	75,017	29,898 (1977)	205,487 (1997)
Late-fall	10,131	291 (1994)	19,261 (1975)
Winter	10,783	189 (1994)	53,089 (1971)
Spring	6,960	163 (1998)	25,095 (1976)
Steelhead	4,189	104 (1998)	13,240 (1970)

[a]Source: CDFG, unpublished. (Data from CDFG's annual Grand-Tab spreadsheet.)

TABLE 3.2-3
Life History Timing for Native Anadromous Salmonids in the Sacramento River Near RBDD

Name	Adult Immigration	Spawning	Incubation	Rearing	Juvenile Emigration
Fall Chinook	Jul-Dec	Oct-Dec	Oct-Mar	Dec-Jun	Dec-Jul
Late-fall Chinook	Oct-Apr	Jan-Apr	Jan-Jun	Apr-Nov	Apr-Dec
Spring Chinook	Apr-Jul	Aug-Oct	Aug-Dec	Oct-Apr	Oct-May
Winter Chinook	Dec-Jul	Apr-Aug	Apr-Oct	Jul-Mar	Jul-Mar
Steelhead	Aug-Mar	Dec-Apr	Dec-Jun	Year-round (1 to 2 years)	Jan-Oct

Figure 3.2-1 shows the annual trends in their escapement upstream of RBDD Chinook and steelhead over the last 30 years. (Note: the figures pertaining to Section 3.2 reference No Action Alternative as "NAA.")

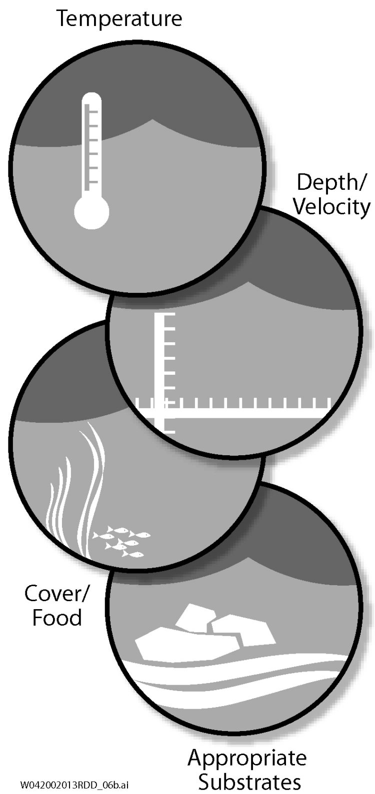
Life History Characteristics and Habitat Requirements. As shown on Figure 3.2-2, each of the five salmonid species have distinct periods when the adults are actively immigrating upstream through the project area. Factors that may affect the timing of adult passage include water-year type, river flows, weather events, and RBDD operations.

Factors that may affect the timing of adult fish passage include water-year type, river flows, weather events, and RBDD operations.

Habitat needs of the four runs of salmon and steelhead are similar, but each species differs somewhat in its freshwater habitat requirements. The habitat needs of salmon and steelhead include physical habitat for adult migration and holding, spawning and egg incubation, fry and juvenile rearing, and smolt emigration. Adequate flows, water temperatures, water depths and velocities, appropriate spawning and rearing substrates, and the availability of in-stream cover and food are critical for the propagation and survival of all salmonids in the Sacramento River.

In the vicinity of RBDD, the Sacramento River acts primarily as a transport corridor for adults immigrating upstream, juvenile fry rearing and dispersing, and smolts emigrating downstream. In addition, fall-run Chinook salmon and, to a lessor degree, the winter-run and other salmon species are known to spawn in the vicinity of RBDD both immediately upstream and, to a lessor degree, downstream of RBDD.

Critical Propogation and Survival Factors



The periods when juveniles (fry, pre-smolt, and smolt salmon; and fry, sub-yearling, and yearling steelhead) are migrating downstream past RBDD are shown on Figure 3.2-3. In addition to passage, fry and pre-smolt salmon and sub-yearling and yearling steelhead may rear or reside in the vicinity of RBDD. Timing of smolt emigration is dependent on species, flow conditions, and water-year type.

Species Listed or Proposed for Listing under ESA or CESA. All five anadromous salmonid species that are present at RBDD during some period in their life history are either listed by CESA and/or the federal ESA, or are listed as candidates under the federal ESA. The following list includes each species' status, date of listing, and their date of Critical Habitat Designation (if applicable):

- Winter-run Chinook salmon
  - CESA 9/22/89
  - ESA 1/4/94
  - Habitat Designated 3/32/99
- Spring-run Chinook salmon
  - California Threatened 2/5/99
  - Federal Threatened 9/16/99
  - Habitat Designated 2/16/00
- Steelhead-Central Valley Chinook salmon Evolutionary Significant Unit (ESU)
  - Federal Threatened 3/19/98
  - Habitat Designated 2/16/00
- Central Valley fall/late-fall Chinook salmon ESUs
  - Federal Candidate/Not Warranted for Listing, 9/16/99

All five anadromous salmonid species that are present at RBDD during some period in their life history are either listed by CESA and/or the federal ESA, or are listed as candidates under the federal ESA.

For Sacramento River winter-run Chinook salmon ESU, critical habitat is designated to include the Sacramento River from Keswick Dam, Shasta County (River Mile [RM] 302), to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (Delta); all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge.

For Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), critical habitat is designated to include all river reaches accessible to listed Chinook salmon in the Sacramento River and its tributaries in California. Also included are river reaches and estuarine areas of the Delta; all waters from Chipps Island westward to Carquinez

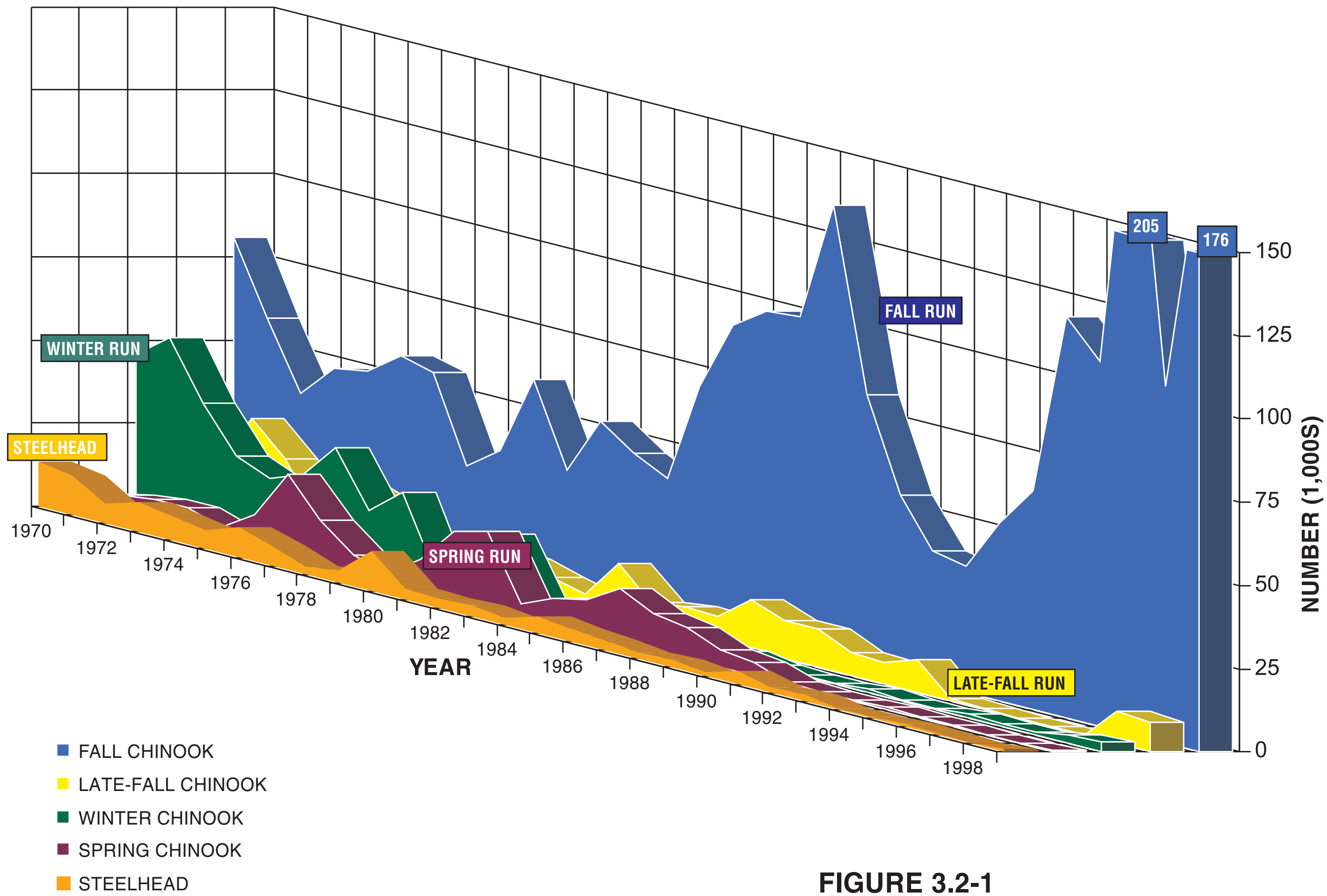


FIGURE 3.2-1
SACRAMENTO RIVER CHINOOK SALMON AND STEELHEAD SPAWNING ESCAPEMENT ESTIMATES FOR 1970 TO 1999 UPSTREAM OF RBDD

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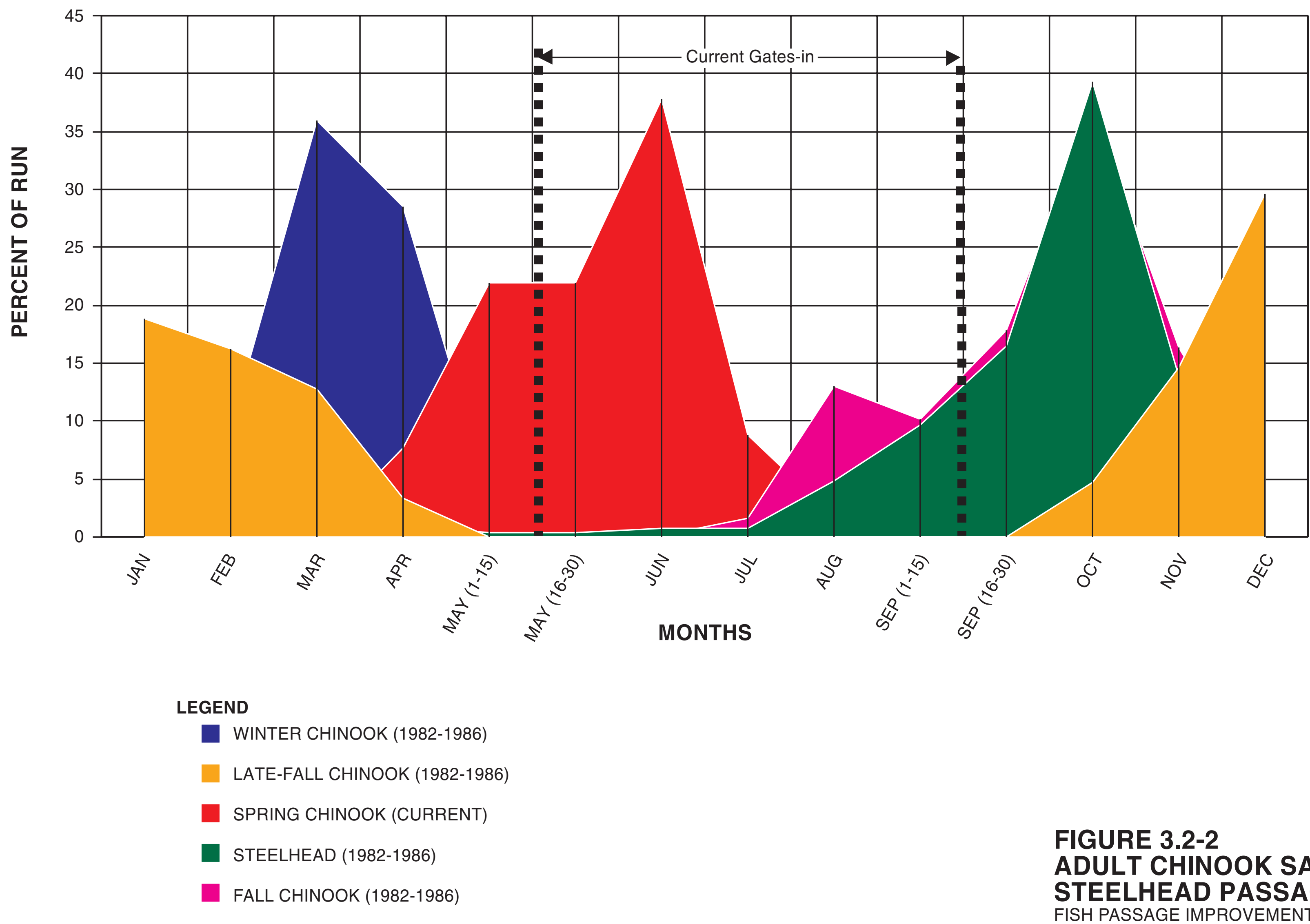

FIGURE 3.2-2
ADULT CHINOOK SALMON AND STEELHEAD PASSAGE AT RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR
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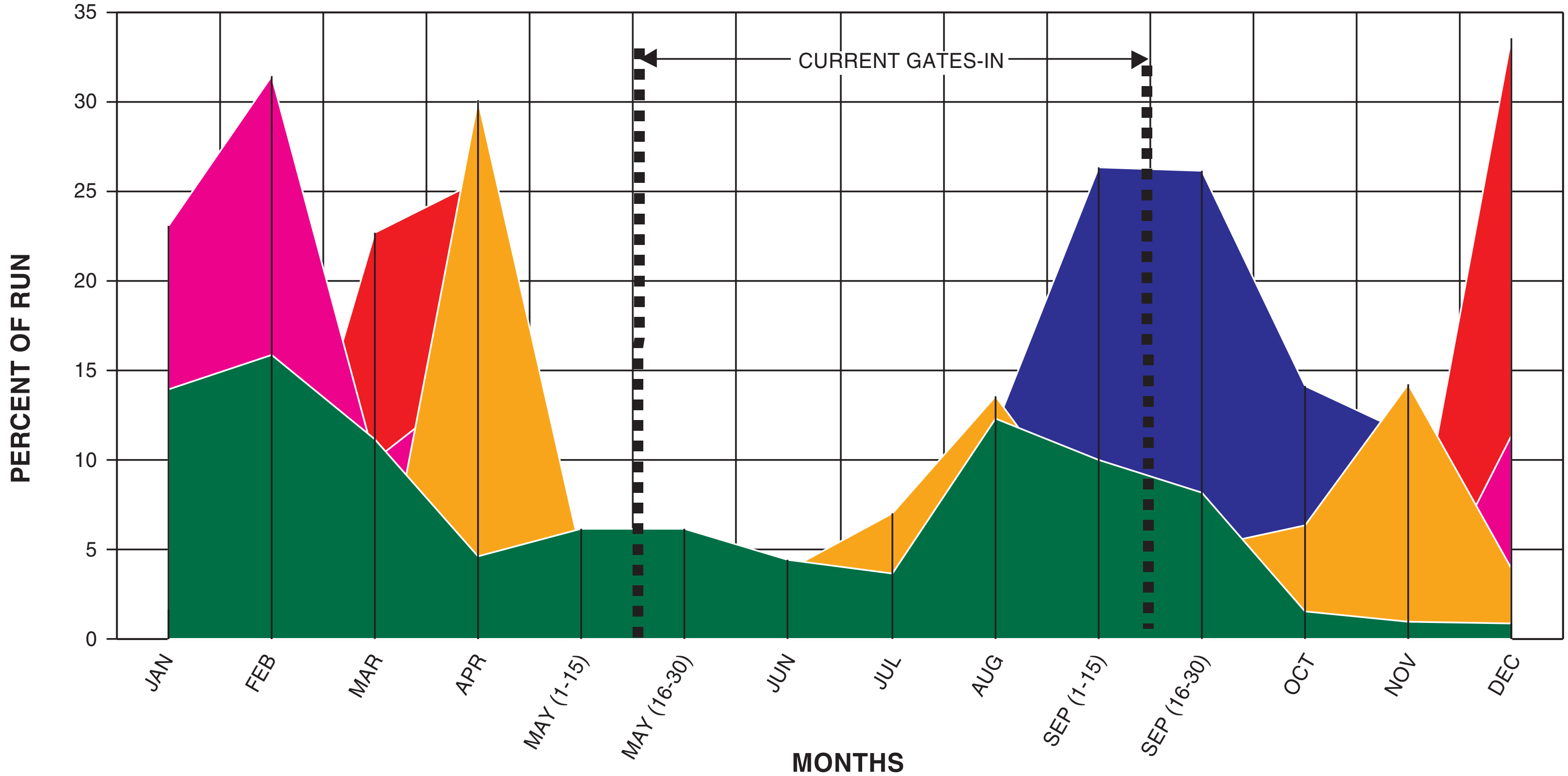

LEGEND

- WINTER CHINOOK (1995-2000)
- LATE-FALL CHINOOK (1995-2000)
- SPRING CHINOOK (1995-2000)
- STEELHEAD (1995-2000)
- FALL CHINOOK (1995-2000)

FIGURE 3.2-3
JUVENILE CHINOOK SALMON AND STEELHEAD PASSAGE AT RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

W072002003RDD_09D (8/15/02)

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Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years).

Critical habitat for Central Valley steelhead ESU is designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California. Also included are adjacent riparian zones, as well as river reaches and estuarine areas of the Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas of the San Joaquin River upstream of the Merced River confluence, tribal lands, and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years).

On April 30, 2002, the United States District Court for the District of Columbia approved a NMFS consent decree withdrawing critical habitat designations for 19 salmon and steelhead populations on the West Coast including the Sacramento River winter-run and spring-run Chinook salmon and Central Valley steelhead. The move was in response to litigation challenging the process by which this agency established critical habitat. Under the ESA, NMFS is required to analyze the economic impacts on affected businesses, communities, and individuals when designating critical habitat for salmon and steelhead. NMFS is currently conducting a new, more thorough analysis consistent with a recent decision of the United States 10th Circuit Court of Appeals and will re-issue critical habitat designations after that analysis is completed. This action does not significantly affect protection of listed Chinook salmon and steelhead. ESA status for these species is unchanged, and Sections 4, 7, 9, and 10 of the ESA involving protective actions remain in effect.

Impacts of Current Operations on Native Anadromous Salmonids. Current operation of RBDD includes a 4-month period of time (mid-May through mid-September) when the dam gates are placed in the river, creating a velocity barrier and whitewater turbulence that prevents or impedes adult fish passage. Other sources of impediment to fish passage include inadequate attraction flows to the fish ladders and the orientation of the entrances to the fish ladders. Placement of the dam gates into the river results in blockage and delay of migrating adult salmon and steelhead (Vogel et al., 1988; Hallock et al., 1982; Hallock, 1987). Vogel et al., (1988) determined from salmon tagging studies conducted from 1983 through 1998, that between 8 percent and 44 percent of adult Chinook salmon, depending on run, were blocked from passing upstream of RBDD. Similarly, Hallock et al., (1982) determined that passage of 15 percent to 43 percent of adult Chinook salmon, depending on run, were blocked atand RBDD. Fish ladders are currently operational on the east and west ends and at the center of RBDD. These currently operate during the gates-in period to provide upstream passage of adult salmonids. Vogel et al., (1988) determined that the mean time of delay in passage of adult Chinook salmon at RBDD was greater than 3 to greater than 13 days depending on the run. Vogel's (1988) determinations of passage delays were made during years when the RBDD gates were in for much longer periods annually than the current operations. Radio telemetry investigations conducted during the months of August and September from 1999 to 2001, using adult fall-run Chinook salmon, indicate that delay in passage, under existing conditions at RBDD, may average approximately 21 days (USFWS, unpublished data). CDFG has determined the existing fish ladders at RBDD may beare inefficient in passing spring-run Chinook salmon at RBDD (CDFG, 1998). Currently adult late-fall Chinook salmon pass unimpeded at RBDD because they immigrate during months (October through March) when the RBDD gates are out of the water and no barrier exists. Figure 3.2-2 shows timing of adult salmonids in the vicinity of RBDD. The passage timing for adult salmonids was obtained from data collected from fish ladder counts conducted at RBDD from 1982 to 1986 for fall, late-fall, and winter Chinook salmon and steelhead (USFWS/CDFG, unpublished data). For spring Chinook salmon, some of which may pass RBDD prior to installation of the RBDD dam gates, the current (1995 though 2000) ladder counts were used to estimate passage timing (USFWS/CDFG, unpublished data). For ladder counts made during 1995 and 2000, the average monthly percent (44 percent) of spring Chinook passing RBDD during May were distributed equally between the before gates-in (<May 15) and after gates-in (>May 15) periods.

Spring-run Chinook salmon are, by far, the andromous salmonid most affected by current gates-in operations.

Under current operations, approximately 15 percent of winter Chinook adult spawners passing through the project area may be blocked or delayed RBDD (CDFG, 1998; USFWS/CDFG, unpublished data). Up to 25 percent of the annual run of fall Chinook salmon may be affected by the current gates-in operation. By far, the greatest effect on adult anadromous salmonids is to spring-run Chinook salmon. As many as approximately 72 percent of the annual adult spring Chinook passing through the project area must do so during gates-in operation (Figure 3.2-2). Impedance of these adult spring Chinook by RBDD operations may adversely affect their ability to successfully pass upstream into and through the Sacramento River and into tributary streams and headwater reaches (CDFG, 1998). It is in these headwater reaches in the tributaries and the most upstream portion of the mainstem Sacramento River that the majority of spring-run Chinook salmon must hold throughout the summer months before spawning in the early fall. For migrating adult steelhead, approximately 17 percent of the annual adult steelhead, run may be affected by the current gates-in operation. The biological consequences of blockage or passage delay at RBDD results in changes in spawning distribution (Hallock, 1987), hybridization with fall Chinook (CDFG, 1998), increased adult pre-spawning mortality (USBR, 1985), and decreased egg viability (Vogel et al., 1988), all of which result in the reduction in annual recruitment of this species.

During gates-in periods at RBDD, juvenile life stages of all anadromous salmonids migrate downstream (emigrate) through the project facilities. During gates-in operation, existing pathways for juvenile salmonids at RBDD include passage under the dam gates; the fish ladders and their auxiliary water systems; or the bypass systems at RPP and TC Canal headworks; or impingement on the screens or entrainment into the canal. Existing RBDD operations may result in increased predation of juvenile salmonids by both Sacramento River pikeminnow and striped bass (also known as stripers) congregated immediately below the dam. Vondracek and Moyle (1983) reported that the cause of mortality of juvenile salmonids at RBDD was the result of a dysfunctional predator-prey relationship created by RBDD and Sacramento pikeminnow (formerly squawfish).

Through investigations conducted at RBDD, USFWS (1981) concluded that mortality of up to 42 percent of downstream migrant steelhead and greater than 50 percent of Chinook salmon occurred, likely as a result of predation of those juveniles by pikeminnow downstream of the dam. Using divers, surface observations, and stomach contents analysis, Vogel et al., (1988) determined that adult Sacramento pikeminnow were the principal predator on juvenile salmon passing RBDD. Hallock (1987) reported that stomach content analysis confirmed that adult striped bass were also preying on juvenile salmon passing through RBDD. Furthermore, Tucker et al., (1998) determined that during summer months (gates-in operations), approximately 66 percent (by weight) of the stomach contents of Sacramento pikeminnows consisted of juvenile salmonids.

Adult Sacramento pikeminnow are known to migrate upstream of RBDD in the spring months to spawn; therefore, when the RBDD gates go in, these fish can tend to congregate below the dam, especially when large numbers of juvenile salmonids are available as forage. The pikeminnow can and does readily pass through the existing fish ladders at RBDD. Operations of RBDD under the Winter-run Chinook Salmon Biological Opinion (NMFS, 1993) specified that the gates may not go in prior to May 15 each year. This has likely reduced predation impacts to juvenile salmonids because larger numbers of pikeminnows can move upstream more easily, and the period when the gates are now in coincides to low-abundance periods of juvenile salmonids. However, predators continue to congregate, including pikeminnows and striped bass, downstream of RBDD under existing conditions and the No Action Alternative when the gates are in. Striped bass currently congregate downstream of RBDD because this species does not readily use fish ladders designed for salmonids. These predators continue to feed on juvenile fish passing the facilities at RBDD (Tucker et al., 1998). Under current conditions, up to approximately 75 percent of the striped bass found at RBDD occur prior to July 1. Tucker et al. (1998) found that during sampling in 1994 to 1996, the largest catch/per unit effort (26 percent of annual total) of Sacramento pikeminnow occurred at RBDD during June when the gates were in.

Additionally, predation by avian species, especially on steelhead smolts (Vogel et al., 1988; USFWS/USBR, 1998), may be greater near RBDD as compared to undammed reaches of the Sacramento River. However, the current RBDD operations appear to have substantially reduced rates of predation to juvenile salmonids as compared to operations prior to implementation of the 1993 Biological Opinion (Tucker et al., 1998). The study found that nearly four times as many pikeminows passed the RBDD ladders in May and June of 1981 as compared to May and June of 1996. This is an indication that the densities of these predators are now much lower since the RBDD gates are in only from mid-May through mid-September. The current extent of predation on juvenile salmonids passing RBDD is unknown.

Figure 3.2-3 depicts juvenile salmonid passage at RBDD. The passage timing for juvenile salmonids was obtained from data collected from rotary screw trapping investigations conducted downstream of RBDD during 1994 through 2000 (Gaines and Martin, 2001). The following discussion is based on the timing information obtained from those investigations. With the current gates-in operations, on average, approximately 8 percent of annual juvenile fall-run Chinook salmon passing RBDD are subjected to the operational effects of the dam and its associated diversion facilities. For spring-run Chinook on average, less than 1 percent of the annual number of juveniles passing RBDD are vulnerable to operations and facilities at RBDD. However, a potentially large number of late-fall and winter Chinook salmon and steelhead juveniles are subject to operations and facilities of RBDD and its associated diversion facilities (Figure 3.2-3). For winter-run Chinook salmon, the earliest dispersing and outmigrating juveniles may be subjected to adverse effects from RBDD operations. On average, approximately 39 percent of juvenile winter Chinook salmon are subjected to the operational effects of RBDD and its associated diversion facilities, primarily during August through mid-September when the RBDD gates are in. On average, approximately 35 percent of the juvenile

A potentially large number of late-fall and winter Chinook salmon and steelhead juveniles are subject to operations and facilities of RBDD and its associated diversion facilities.

late-fall-run Chinook salmon passing RBDD and approximately 36 percent of juvenile steelhead passing RBDD during the gates-in period are subject to operational impacts. These effects appear to be small, but are not necessarily absent.

Other Native Anadromous Fish (Sturgeon, Pacific Lamprey, and River Lamprey)

In addition to the NAS species found in the vicinity of the project area, several NAO species occupy or have the potential to occupy the Sacramento River at various stages of their life history and during seasonal intervals. These include: white sturgeon (*Acipenser transmontanus*), green sturgeon (*Acipenser medirostris*), Pacific lamprey (*Lampetra tridentata*), and river lampry (*Lampetra ayresi*).

CDFG population estimates derived from their trawling surveys range from 11,000 to 128,000 white sturgeon in the San Francisco Bay estuary (Kohlhorst, 1991 as cited by Moyle et al., 1995). Because of the importance of the white sturgeon fishery in the Sacramento delta, the number and size of the annual white and green sturgeon catch is closely monitored. While there is no direct evidence that populations of green sturgeon are declining in the Sacramento River, the small size of the population increases the risk that a decline in numbers would be difficult to detect until a collapse in the population occurs (Moyle et al., 1995). NMFS is currently considering a petition to list green sturgeon under ESA.

Pacific lamprey are still common in most watersheds in California and throughout the Pacific northwest. In California, dams on several major watersheds have decreased the spawning distribution of Pacific lamprey. Population numbers in the Sacramento River are not known. Population trends of river lamprey are not known in California, but are assumed to have declined along with losses in habitat quantity and quality - especially within the Sacramento-San Joaquin River system (Moyle et al., 1995).

Life History Characteristics and Habitat Requirements.

White and Green Sturgeon. White sturgeon have been caught in salt water from Ensanada, Mexico, to the Gulf of Alaska (Miller and Lea, 1972). In California, large populations occur in the Sacramento and Feather rivers (Moyle, 1976). In California, spawning has been confirmed only in the Sacramento and Feather rivers (Moyle, 1976) and the San Joaquin River (Kohlhorst, 1991 as cited by PSMFC, 1992). In the Sacramento River, most spawning seems to occur upstream of the Feather River confluence (Moyle, 1976).

Female sturgeon spawn about once every 5 years, but may produce nearly 5 million eggs (Moyle, 1976). Table 3.2-4 summarizes white sturgeon life history characteristics. Figure 3.2-4 illustrates the estimated timing of white sturgeon spawning. Larval white sturgeon are flushed downstream and rear in the upper reaches of the Delta and Suisun-San Pablo Bay estuary. Except during spawning runs, adult white sturgeon are primarily found in the lower reaches of the Delta and in Suisun/San Pablo and San Francisco bays. White sturgeon are less marine-oriented than green sturgeon and tend to spend most of their lives in the estuaries of large rivers.

TABLE 3.2-4
Life History Timing for Other Native Anadromous Fish in the Sacramento River Near RBDD

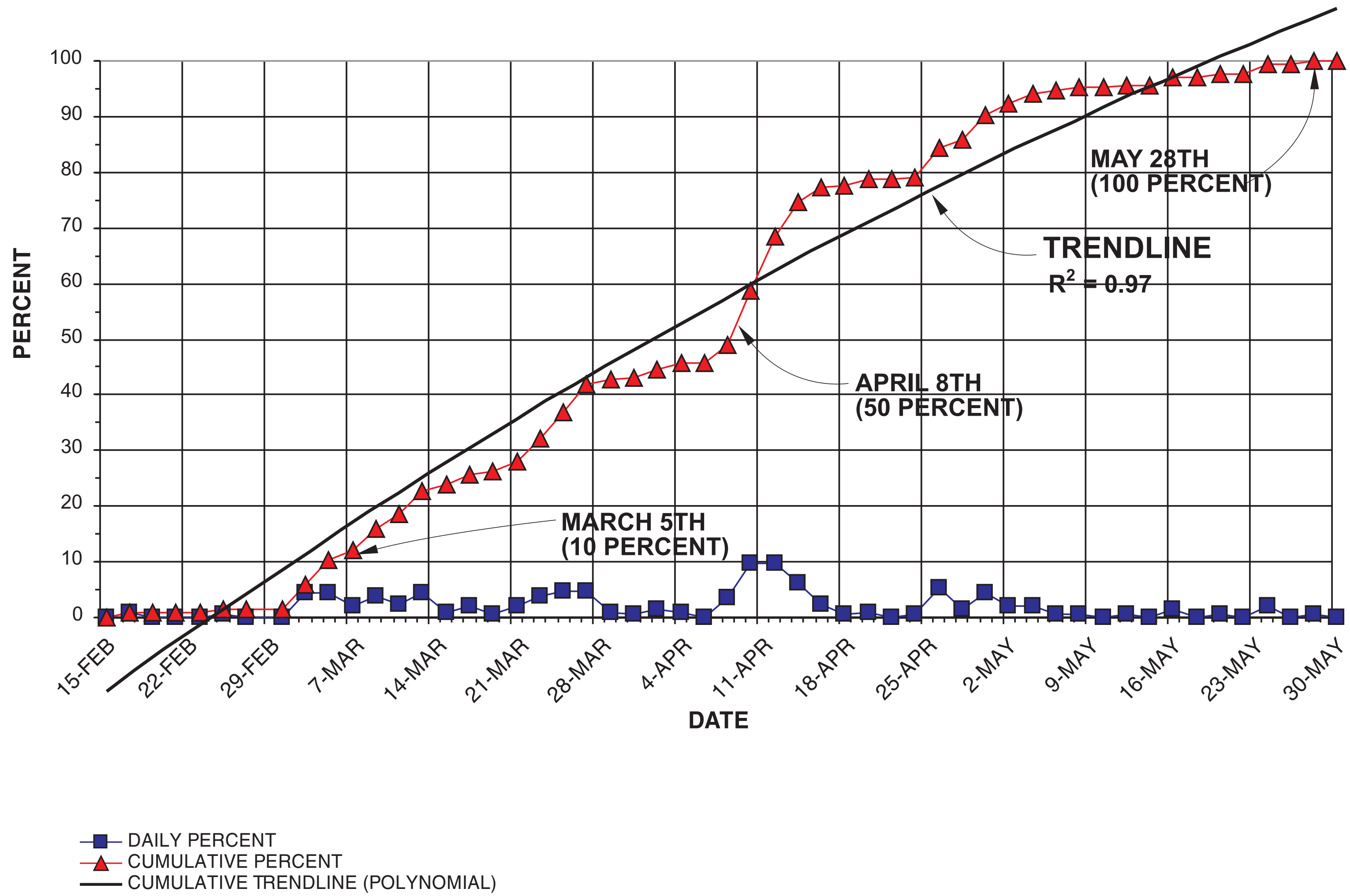
Name	Adult Immigration	Spawning	Incubation	Larval/Juvenile Rearing	Juvenile Emigration
White Sturgeon	Feb-May	Feb-Jun	Embryos planktonic drifting downstream	Larvae in river, juveniles in Delta	N/A
Green Sturgeon	Feb-Jun	Mar-Jul	Embryos planktonic drifting downstream	Larvae in river, juveniles in Delta	Jun-Aug
Pacific Lamprey	Feb-Jun	Spring-Summer	Brief followed by ammocoete larval stage	Up to 7 years	Sep-Apr
River Lamprey	Feb-Jun	Spring-Summer	Brief followed by ammocoete larval stage	Up to 5 years	Mar-Jun

N/A = White sturgeon are not known to spawn upstream of RBDD (Brown, pers. comm.).

USFWS routinely observes adult sturgeon in the vicinity and downstream of RBDD when the dam gates are in (Brown, pers. comm). It is unclear if these are all adult green sturgeon or not. However, to date, all sturgeon larvae that have been captured at RBDD and grown out to determine species have been green sturgeon (Killam, pers. comm.).

Green sturgeon life history characteristics are summarized in Table 3.2-4. The presumed timing of spawning green sturgeon passing in the vicinity of RBDD is generally March through June (Brown, pers. comm.).

The passage timing for juvenile green sturgeon was obtained from data collected from rotary screw trapping investigations conducted downstream of RBDD during 1994 through 2000 (Gaines and Martin, 2001). As indicated by trapping data, the majority of green sturgeon juveniles pass through the vicinity of RBDD from June through August (Figure 3.2-5). From investigations conducted at RBDD to date, there is evidence that juvenile salmonids may be less important, and other species (including juvenile sturgeon) may be preferred prey for Sacramento pikeminnows when free-flowing conditions occur at RBDD (Tucker et al., 1998). This suggests that juvenile sturgeon would be less vulnerable to predation as compared to salmonids during the June through August period when juvenile sturgeon are passing RBDD. Juvenile green sturgeon are transported and rear in the Delta and



SOURCE: KOHLHORST, 1976

FIGURE 3.2-4
ESTIMATED TIMING OF WHITE STURGEON SPAWNING IN THE SACRAMENTO RIVER DURING 1973
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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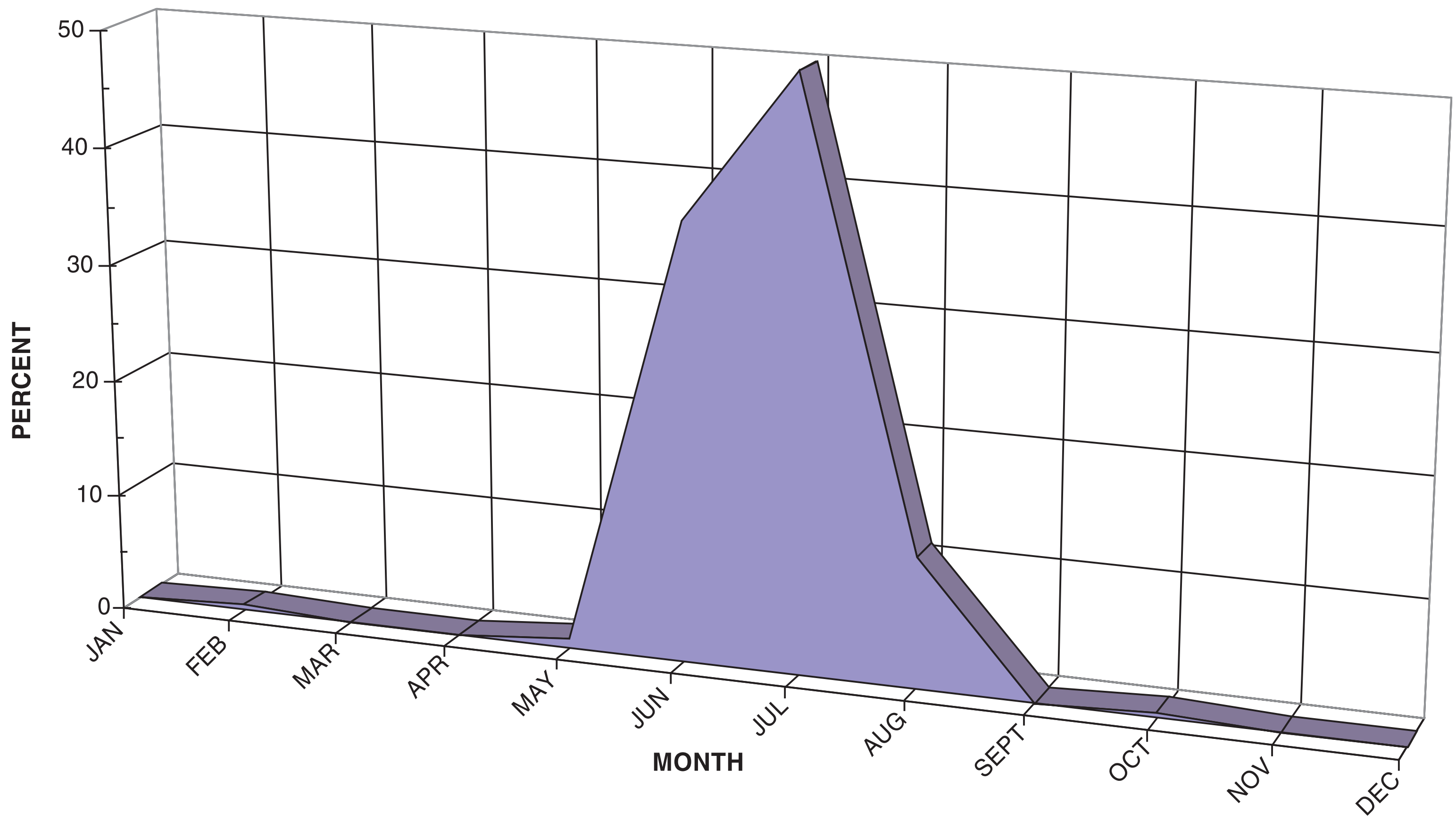

FIGURE 3.2-5
PRESENCE OF JUVENILE GREEN STURGEON IN THE SACRAMENTO RIVER CAPTURED IN THE VICINITY OF RBDD (1995 TO 1999)
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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Suisun-San Pablo Bay estuary for one or more years before entering the deeper San Francisco Bay and exiting into the ocean. They enter the ocean primarily during the summer and fall before they are 2 years old (Moyle et al., 1995).

Pacific Lamprey. Pacific lamprey are distributed along the Pacific coast from Unalaska, Alaska, south to California's Santa Ana River, with populations occurring in most coastal watersheds. Spawning runs into freshwater generally occur from April to late July. Trapping information at RBDD indicates that adult Pacific lamprey are migrating upstream past RBDD primarily in the spring and summer months. According to observations by CDFG and USFWS at RBDD, adult Pacific lamprey immigration at RBDD is presumed to occur in March to mid-May (Killam, pers. com).

Trapping information at RBDD indicates that adult Pacific lamprey are migrating upstream past RBDD primarily in the spring and summer months.

The timing of lamprey transformer life stages passing RBDD during downstream mitigation was obtained from data collected from rotary screw trapping investigations conducted downstream of the RBDD during 1994 through 2000 (Gaines and Martin, 2001). As indicated by trapping conducted at RBDD, the passage/presence of Pacific lamprey transformers at RBDD primarily occurs during the fall through spring months of September through May. The term transformer refers to an intermediate lamprey life stage that occurs at a body length of approximately 14 to 16 cm. The juvenile ammocoete stage begins to undergo a metamorphosis (transformation) and during this phase lampreys develop into adults with large eyes and an oral sucking disc.

River Lamprey. Adult river lamprey migration is thought to take place in winter months, with spawning taking place in clean, gravelly riffles and pool tails of small tributaries, usually during April and May (Moyle, 1976). The fecundity of female river lamprey is between 11,000 and 37,000 eggs. As indicated by trapping conducted at RBDD (Gaines and Martin, 2001), the passage/presence of river lamprey transformers at RBDD occurs during the spring and early summer months of March through June.

The passage/presence of river lamprey transformers at RBDD occurs during the spring and early summer months of March through June.

Species Listed or Proposed for Listing under ESA or CESA. None of the four species discussed above is currently listed as endangered or threatened or a candidate for listing as endangered or threatened under ESA or CESA. Green sturgeon was petitioned for listing under ESA (June 11, 2001), but NMFS has not yet issued findings of the review of the petition. However, the green sturgeon is a California Species of Special Concern Class 1: Qualify as Threatened. River lamprey is a California Species of Special Concern Class 3: Watch List. Pacific lamprey is a California Species of Special Concern Class 4: Population Status Apparently Secure (Moyle et al., 1995).

Impacts of Current Operations on Other Native Anadromous Fish. Under current operations, on average, approximately 35 percent of adult green sturgeon passing through the project area may be blocked by RBDD. In addition, some adult green sturgeon are delayed in their down-river migration by RBDD after spawning occurs upstream of the dam, if these fish arrive at RBDD on or after May 15 when the dam gates go in. With the current gates-in operations, on average, nearly all of the larval/ juvenile green sturgeon passing RBDD annually are subjected to the operational effects of the dam and its associated diversion facilities. The actual rate of predation of juvenile green sturgeon after passing under the RBDD gates by Sacramento River pikeminnow and striped bass congregated immediately below the dam is currently unknown.

Approximately 25 percent of the annual lamprey spawning run may be affected by the gates-in operation.

A majority of the adults of the two lamprey species are believed to pass RBDD during the months of February through August. Of these, on average, approximately 25 percent of the annual lamprey spawning run may be affected by the gates-in operation. Although there may be some impedance of migration during gates-in operation, adult lamprey are known to actively pass through fish ladders at RBDD (Killam, pers. comm.). Similar to salmon, lampreys have a limited supply of energy reserves for upstream migration and spawning. Excess use of energy during migration could result in exhaustive stress and ultimately reduce their survival. This may result in delayed passage, changes in adult spawning distribution (temporal and spatial), an increase in adult pre-spawning and mortality, and decreased egg viability, all of which may result in the reduction in annual recruitment of these species.

With the current gates-in operations, on average, approximately 6 to 7 percent of Pacific lamprey transformers annually passing RBDD are subjected to the operational effects of the dam and its associated diversion facilities. On average, the current gates-in operation annually affects approximately 30 percent of the annual run of river lamprey transformers passing RBDD. The actual rate of predation on juvenile, or transformer lampreys passing through the project area by Sacramento River pikeminnow and striped bass congregated immediately below the dam is unknown.

Non-native Anadromous Fish (Striped Bass and American Shad)

The two NNA fish species found in the Sacramento River in the vicinity of RBDD are striped bass and American shad (also known as shad). Both of these species were introduced into California from the eastern United States between 1871 and 1882 (Moyle, 1976). Life history characteristics of these species are shown in Table 3.2-5.

The average adult striped bass population in California during the period from 1967 to 1991 was approximately 1.25 million fish. By 1990, the annual population of adult striped bass had declined to approximately 680,000 adults. Sport catches of striped bass declined from an average annual catch of more than 300,000 fish in the early 1970s to less

TABLE 3.2-5
Habitat Requirements for Common Native and Non-native Resident and Anadromous Fish Near RBDD[a]

Common Name	Scientific Name	Temperature Requirements	Preferred Spawning Habitat; Substrate	Adult Food Preference	Preferred Habitat Types	Notes or Comments
Striped Bass	*Morone saxatilis*	Spawning at 58-70°F (63-68°F optimal)	Broadcast spawns in moving water; N/A	Highly predatory on fish	Open water-pelagic predators	Extensive migratory patterns in the rivers, Delta, San Francisco Bay, and ocean
American Shad	*Alosa sapidissima*	Spawning at 59-68°F	Broadcast spawns in moving water over sand, gravel, cobble	Large zooplankton, insects, crustaceans, molluscs	Prefers open water, but young will feed in dead-ended sloughs	Primarily found in saltwater except to spawn and early life stages
Sacramento Splittail	*Pogonichthys marcrolepidotus*	Optimal abundance in Delta: 59-73°F	Spawning over flooded vegetation in dead-ended sloughs	Bottom feeders: benthic invertebrates, insects, zooplankton, worms, and molluscs	Slow-moving sections of main channel in rivers and sloughs	Tolerant of salinities up to 10-18 parts per thousand; presently found in very restricted portions of their historical range
Hardhead	*Mylopharodon conocephalus*	Warm water conditions typical of low- to mid-elevation streams	Low-velocity riffles with gravel, (thought to be mass spawners)	Filamentous algae, small invertebrates, aquatic plants	Clear, warm streams with large, deep rock and sandy bottom pools	Found in undisturbed sections of larger streams; move into smaller tributaries to spawn
Sacramento Pikeminnow	*Ptychocheilus grandis*	Do not flourish in waters less than 59°F; spawn above 57°F	Gravel riffles, congregate to spawn over rocky-gravely areas	Highly predatory on fish and crayfish	Clear well-shaded sand-rock bottomed pools with rocks/logs	Sedentary habits, often remaining in one pool for long intervals; also known to migrate up/downstream to spawn and forage
Sacramento Sucker	*Catostomus occidentalis*	Wide temperature range, most abundant in cool streams/ pools	Congregate over clean gravel	Filamentous algae, detritus, invertebrates associated with the bottom	Feed in small groups at head of pools or edge beds of aquatic vegetation; deep pools	Typically spend 2-3 years in natal stream before migrating into larger rivers with high water (in the fall)

[a]Source: Moyle, 1976.
N/A = not applicable.
°F = degrees Fahrenheit.

than 150,000 by the late 1980s (USBR, 1997b). Beginning in 1981, juvenile striped bass were raised in hatcheries and released into the Delta and Bay to supplement the wild populations (USBR, 1997b).

A viable sport fishery for shad remains in the lower Sacramento River to Red Bluff and in the Feather and American rivers. CDFG estimated that population of adult shad in 1976 and 1977 were 3.04 million and 2.79 million adults, respectively (USBR, 1997b).

Life History Characteristics and Habitat Requirements.

Striped Bass. Stripers are an anadromous species with adults spawning in freshwater, larvae and juveniles rearing in the Delta, and then adults migrating between the Delta, San Francisco Bay estuary, and Pacific Ocean. Spawning begins in April in the Delta and May in the Sacramento River continuing through June. Spawning is dependent on water temperature, it begins when temperatures exceed approximately 58°C and intensifies when water temperatures are between 63 and 68°C. Approximately 40 percent of stripers spawn in the Delta and the lower San Joaquin River, and 60 percent spawn in the Sacramento River and its tributaries (USBR, 1997b). Spawning occurs during brief "peak" periods when most eggs are released during one or a few days. Moyle (1976) states that there are two major spawning areas in the Central Valley: the San Joaquin River from Venice Island downstream to Antioch and the Sacramento River from Isleton upstream to Butte City (approximately RM 165).

Their movements as juveniles following their first winter is similar to adults, migrating downstream into San Francisco Bay and Pacific Ocean in the summer and into Suisun Bay/Delta in the winter.

Near the project area adult striped bass are known to begin congregating in the late spring/early summer months in the vicinity of RBDD. These fish move into the project area after spawning in downstream areas of the Sacramento River (Tucker, pers. comm.). Investigations conducted to determine predatory habits of Sacramento pikeminnow and striped bass (Tucker et al., 1998) determined that the average catch per hour for striped bass captured near RBDD peaked in July during the years 1994 to 1996. Striped bass are present near RBDD from May through October (Killam, pers. comm.). During this period, adult striped bass congregate downstream of RBDD to prey on any appropriately sized juvenile fish, including salmonids that pass through the diversion complex (under the dam gates, through the fish ladders, or through the diversion bypasses). Striped bass are not generally known to pass through the fish ladder at RBDD (Tucker, pers. comm.).

American Shad. American shad are anadromous fish that are found in freshwater only when they move inland to spawn. Young shad migrate into saltwater almost immediately after hatching and spend the majority of their lives (3 to 5 years) in saltwater (Moyle, 1976). Adult shad move into the lower San Francisco Bay estuary in the fall but do not move into freshwater until temperatures exceed 50 to 52°C, usually in late March or April. Spawning runs begin in late May or June when water temperatures reach 59°C or greater. Some evidence has indicated that increased flows, as well as temperature, initiate spawning runs not just temperature (Painter et al., 1980 as cited by USBR, 1997b). Spawning runs will continue until water temperatures exceed 68°C, usually in July. Spawning is done in mass in the main channels of the San Joaquin and Sacramento rivers and their tributaries. In the mainstem Sacramento River, shad spawning runs reach as far as unimpeded passage allows. American shad do not pass generally above RBDD when the gates are in (Killam, pers. comm.) and generally do not use ladders to any appreciable extent (Skinner, 1962). When the gates are in, their passage past RBDD is observed to be very limited; but the dam does not entirely block the upstream migration of this species. Adult shad are commonly found near RBDD between the months of April and July, and larval shad are found near RBDD from May to August.

Adult shad are commonly found near RBDD between the months of April and July, and larval shad are found near RBDD from May to August.

Impacts of Current Operations on Non-native Anadromous Fish. Gates-in operations at RBDD restricts adult striped bass to reaches downstream of the dam following their spawning in the lower reaches of the Sacramento River. Reflecting either their inability or lack of desire to distribute upstream of RBDD, stripers currently congregate downstream of RBDD and feed on juvenile fish passing the facilities at RBDD (Tucker et al., 1998). Under current conditions, approximately up to 75 percent of the striped bass found at RBDD occur prior to July 1. After that time, apparently many of these fish move downstream within the Sacramento River and into the Delta. However, prior to July 1, near RBDD, predatory striped bass congregate and prey on juvenile fish migrating through the vicinity. Striped bass are not recognized as spawning or rearing in the Sacramento River upstream of RBDD. Therefore, there are no adverse impacts to these life stages as result of RBDD operations.

Striped bass are not recognized as spawning or rearing in the Sacramento River upstream of RBDD. Therefore, there are no adverse impacts to these life stages as result of RBDD operations.

American shad generally do not use the existing fish ladders at RBDD. Therefore, the gates-in operations ~~prevent~~limit this species from migrating upstream of RBDD to spawn. This restriction however, does not likely adversely affect their population because this reach of the Sacramento River is at the northernmost extent of their geographic range in the Sacramento River watershed. Optimal spawning temperature for American shad is 62 to 70°F (Skinnner, 1962), and these water temperatures are unlikely to occur in the Sacramento River during the period when American shad are in the vicinity of RBDD. Consequently, American shad are only occasionally observed upstream of RBDD (USBR, 1997b).

RBDD operations do not adversely affect American shad populations.

Resident Native and Non-native Fish (Sacramento Pikeminnow, Hardhead, Hitch, Sacramento Splittail, Resident Rainbow Trout, and Sacramento Sucker)

Life History Characteristics and Habitat Requirements. A large number of RN and RNN fish species are found in the Sacramento River near RBDD. Principal species include Sacramento pikeminnow, hardhead, hitch, and Sacramento splittail (all *Cyprinid* species); resident rainbow trout; and Sacramento suckers. Life history characteristics for many of these species are shown in Table 3.2-5. A large number of non-native sportfish species including large- and smallmouth bass; various sunfish, catfish, and crappie, as well as brown trout, are commonly found near RBDD. Non-game species such as carp, shiner, minnow, and mosquito fish are also commonly found at RBDD. Many of these species have life histories that require them to move up and downstream of the dam seasonally for spawning, rearing, or foraging life stages.

Pikeminnow are known to use the existing fish ladders at RBDD to migrate upstream during their spawning season.

Sacramento Pikeminnow. Population estimates do not exist for this species. Some recent investigations, however, have determined the seasonal changes in the relative abundance of Sacramento pikeminnow near RBDD (Tucker et al., 1998). Pikeminnow are known to use the existing fish ladders at RBDD to migrate upstream during their spawning season. A summary of the current pattern of Sacramento pikeminnow presence near RBDD is shown on Figure 3.2-6. This figure, based on captures of pikeminnows at RBDD, provides an approximate abundance estimate by month for this species at RBDD.

Adult trout are known to use the existing ladders at RBDD to pass upstream, and juveniles are commonly observed at RBDD.

Rainbow Trout. Resident native rainbow trout also are found in the Sacramento River near RBDD. The adults of this species migrate seasonally within the Sacramento River but, unlike steelhead, do not return to the ocean. Adult fish are known to use the existing ladders at RBDD to pass upstream, and juveniles are commonly observed at RBDD (Killam, pers. comm.). Adult rainbow trout migrate through RBDD mainly in August and September. These fish are seeking upstream or tributary locations for spawning and/or are re-distributing within the Sacramento River to forage. Juvenile rainbow trout are difficult to distinguish from steelhead juveniles and are captured while passing through RBDD as shown on Figure 3.2-7. The timing of juvenile rainbow trout/steelhead (O. mykiss) passing RBDD was obtained from data collected from rotary screw trapping investigations conducted downstream of RBDD during 1994 through 2000 (Gaines and Martin, 2001). The TAG Fishtastic! Subcommittee acknowledged that resident and anadromous forms of juvenile (O. mykiss) cannot be easily distinguished visually; therefore, these two life forms were treated the same in the analysis.

Other Resident Species. Populations of other RN species including hitch, hardhead, and Sacramento sucker (Killam, pers. comm.) have life histories that include seasonal migrations and re-distributions. Adults of

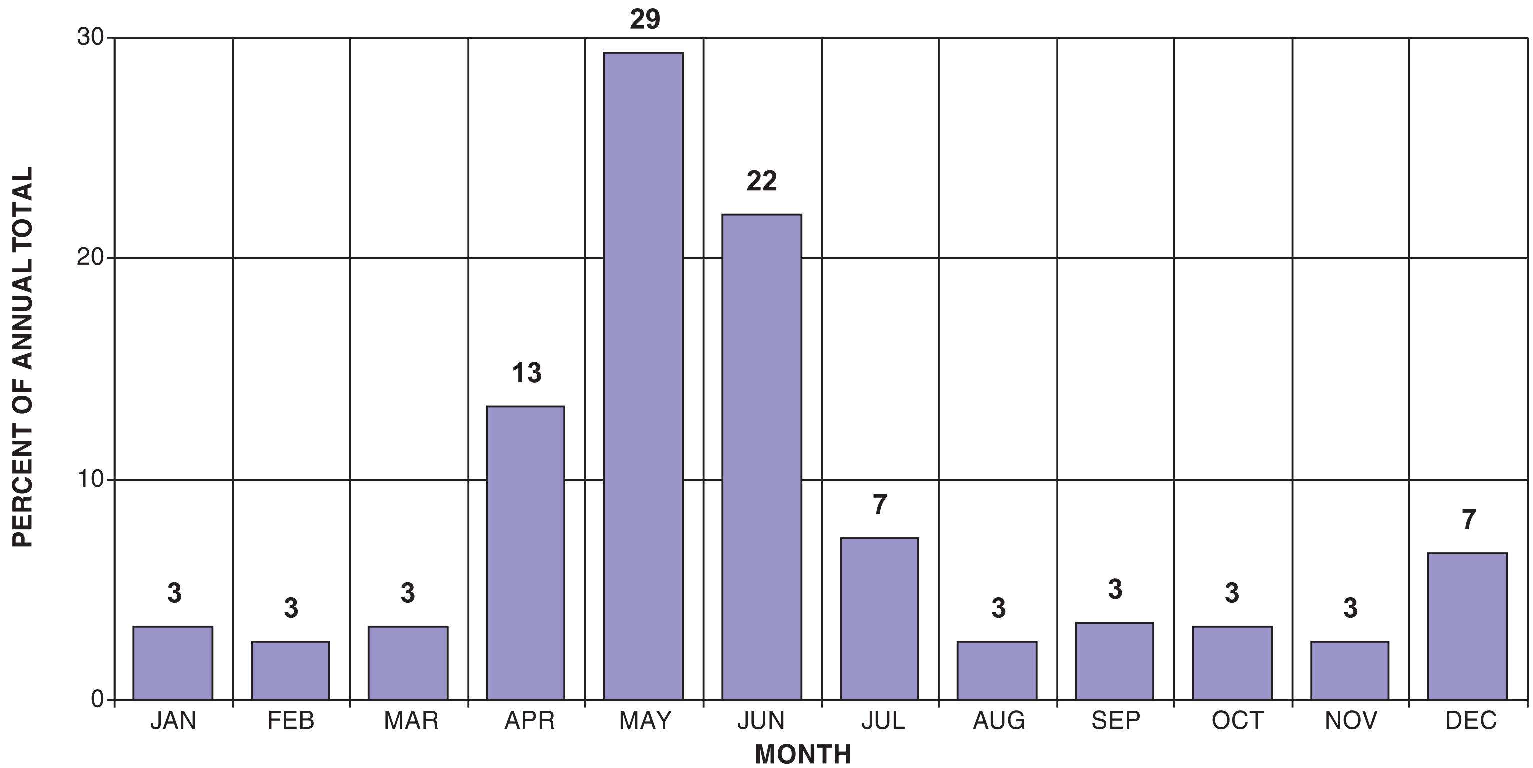


FIGURE 3.2-6
RELATIVE ABUNDANCE OF ADULT SACRAMENTO PIKEMINNOW AT RBDD (1994 TO 1996)
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR
CH2MHILL

W072002003RDD_09G (8/15/02)

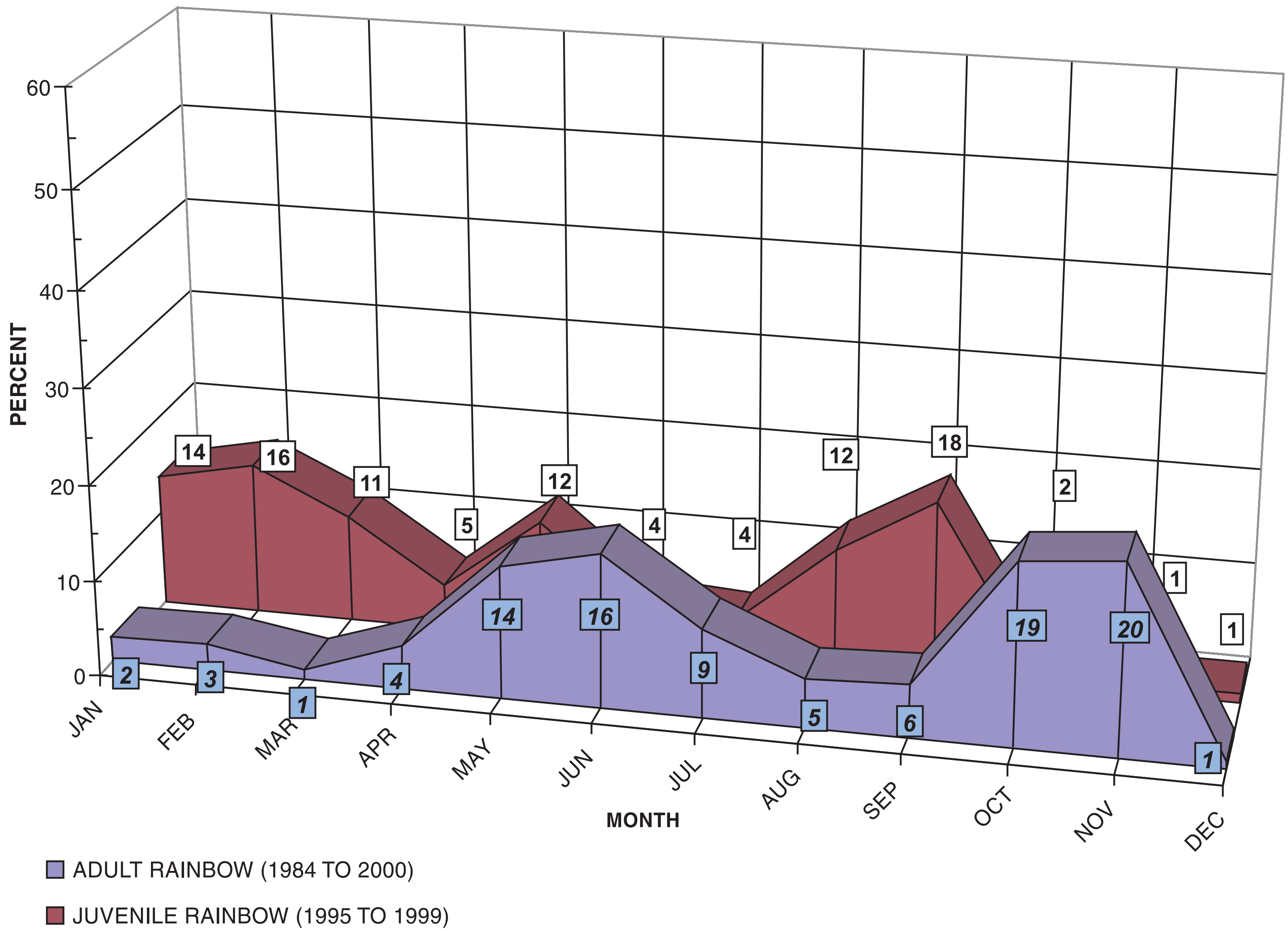


FIGURE 3.2-7
PRESENCE AND PASSAGE OF RAINBOW TROUT AT RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

W072002003RDD_09H (8/15/02)

CH2MHILL

some of these species are known to seasonally pass through the ladders at RBDD (e.g., hardhead and Sacramento sucker). Juveniles of these species are found at RBDD and are less preferred as forage species by the large predators that seasonally congregate at RBDD. Trapping investigations conducted by USFWS have determined the presence and the passage of juvenile hardheads and Sacramento sucker (Gaines and Martin, 2001). The operations of RBDD may largely be inconsequential to populations of non-native resident species such as bass, sunfish, and others. Furthermore, the status of these species' populations is generally unknown.

Species Listed or Proposed for Listing under ESA or CESA. The Sacramento splittail was first listed by USFWS as federal threatened on February 8, 1999. This listing applies to this species throughout its entire range within California. Splittail are native to California's Central Valley, where they were once widely distributed (Moyle, 1976). Historically, splittail were found as far north as Redding on the Sacramento River. In recent times, flow reductions caused by dams and diversions have increasingly prevented splittail from upstream access to the large rivers, and the species is now restricted to a small portion of its former range; however, during wet years, they migrate up the Sacramento River as far as RBDD (Moyle and Yoshiyama, 1992 as cited by Federal Register 64:25, February 8, 1999).

Impacts of Current Operations on Resident Native and Non-native Fish. Operation of the gates at RBDD may not directly adversely affect populations of most of the resident species, but operations may seasonally limit their access into their respective optimal habitats. Rates of predation on juveniles of species such as rainbow trout and other native fishes near RBDD may be increased over that for an undammed river. This may be due to congregations of adult pikeminnow and striped bass when the RBDD gates are in. However, the extent of any increase in predation as a result of RBDD operations is unknown. Except for juvenile rainbow trout, predation on juvenile RN and RNN fish may be inconsequential, as these species are less-preferred prey.

3.2.2 Environmental Consequences

Methodology

The analysis of the environmental consequences was conducted by comparing each of the proposed alternatives with the No Action Alternative. To compare the short-term impacts resulting from the construction of project-specific elements, each alternative was qualitatively compared to the No Action Alternative.

Each fish species' adult and juvenile monthly and annual passage indices were calculated with the Fishtastic! analysis tool. Fishtastic! output was used to determine operational effects of the project alternatives. The macro-based spreadsheet tool was developed to calculate an average annual index of fish passage efficiency at RBDD. This index is intended to represent an annual cumulative measure of energy expenditure, stress, delay, blockage, injury or loss, affecting a species as it transits the RBDD project area. The annual index calculated ranges from zero (the species is negatively affected fully) to 100 (the species is unaffected whatsoever). The index values represent the approximate portion of the species and life stage that is unaffected by operations of the RBDD facilities for the entire calendar year. For example, an adult passage index of 89 indicates that approximately 89 percent of the entire annual population would pass RBDD and Lake Red Bluff without blockage, delay, or some loss or injury because of the operation of RBDD. The greater the index value, the less adversely affected the species is.

See Attachment B1 of Appendix B for a detailed description and discussion of the development of Fishtastic!, its methodology, assumptions, and results. The following species were designated as focus species by an inter-agency TAG. The following species warranted additional consideration because of their life history requirement to be upstream of the dam and/or their special or pending status under the federal ESA, CESA, or as a California Species of Special Concern:

- Winter-run Chinook salmon
- Spring-run Chinook salmon
- Fall-run Chinook salmon
- Late-fall-run Chinook salmon
- Steelhead
- Rainbow trout
- Green sturgeon
- River lamprey
- Pacific lamprey

For the remaining fish species, a qualitative evaluation was conducted to determine the environmental consequences of project alternatives. It is important to note that the alternatives considered in this DEIS/EIR were designed to improve fish passage. Therefore, operation of the various alternatives would improve fish passage at the dam, albeit by differing degrees.

Construction impacts to fish species were estimated by evaluating the effects of other similar construction efforts on the Sacramento River. In some cases it was necessary to consider the overall effect of the project, where future benefits offset minor short-term impacts caused by construction.

Significance Criteria

Significance criteria represent the thresholds that were used to identify whether an impact would be potentially significant. Under CEQA, any adverse impact to state listed species would be considered significant, and mitigation would be required to reduce impacts to less than significant levels.

For the purposes of distinguishing project alternatives from the No Action Alternative, the following significance criteria for evaluating passage improvements were used in the analyses of impacts and benefits:

- No difference in passage indices = No change
- <10 percent difference in passage indices = No measurable impact (-) or benefit (+)
- ≥10 percent to <25 percent difference in passage indices = Measurable impact (-) or benefit (+)
- ≥25 percent difference in passage indices = Large measurable impact (-) or benefit (+)

Discussion of Results

This section provides a discussion of the consequences of the project alternatives on fishery resources as compared to the No Action Alternative. Additional analyses of the consequences of project alternatives on fishery resources are provided in Attachment B2 of Appendix B. The impact analysis is conducted for four groups of fish commonly found at RBDD:

- Native anadromous salmonid species
- Other native anadromous species
- Non-native anadromous species
- Resident native and non-native species

The results of the project alternatives analysis are summarized and discussed in the sections below. In the case of adult life stages of the four fish groups listed above, a discussion of the consequences of all of the alternatives is provided below by alternative. For analysis purposes, it was assumed the ladder and/or bypass elements of the alternatives would have no impact or benefit on juvenile life stages; therefore, juveniles are not included in the discussions for those alternatives. The project alternatives analyzed include:

- No Action Alternative (presented for adults and juveniles)
- 1A: 4-month Improved Ladder Alternative (presented for adults and juveniles)
- 1B: 4-month Bypass Alternative (presented for adults)
- 2A: 2-month Improved Ladder Alternative (presented for adults and juveniles)
- 2B: 2-month with Existing Ladders Alternative (presented for adults)
- 3: Gates-out Alternative (presented for adults and juveniles)

Summary tables for adult passage are as follows:

- Table 3.2-6—Native Anadromous Salmonids
- Table 3.2-8—Other Native Anadromous Species
- Table 3.2-10—Native Resident Species (Rainbow Trout)

Summary tables for juvenile passage are as follows:

- Table 3.2-7—Native Anadromous Salmonids
- Table 3.2-9—Other Native Anadromous Species
- Table 3.2-11—Native Resident Species (Rainbow Trout)

No alternative resulted in ~~significant (~~measurable~~)~~ adverse impacts to adults of any of the five native anadromous salmonid species.

The analysis of consequences of changes in passage indices for adult native anadromous salmonids is summarized in Table 3.2-6. In this table, the calculated adult passage indices and their differences from those for the No Action Alternative are presented for each of the five species. Also summarized in Table 3.2-6, for each species, is the percentage improvement from the No Action Alternative and the effect of each alternative compared to the No Action Alternative. In all cases, for all species and all alternatives, the adult passage indices were equal to or greater than those for the No Action Alternative. Therefore, no alternative resulted in ~~significant (~~measurable~~)~~ adverse impacts to adults of any of the five native anadromous salmonid species.

The results of the analyses of changes in juvenile NAS passage indices are summarized in Table 3.2-7. In this table, the calculated juvenile passage indices and their differences from those for the No Action Alternative are presented for each of the five species. Also summarized in Table 3.2-7, for each species, is the percentage improvement from the No Action Alternative and the effect of each alternative compared to the No Action Alternative. In all cases, for all species and all alternatives, the juvenile passage indices were equal to or greater than those for the No Action Alternative. Therefore, no alternative resulted in significant (measurable) adverse impacts to juveniles of any of the five native anadromous salmonid species.

The Fishtastic! analysis focused on the green sturgeon because this species is known to congregate downstream of RBDD during periods when the dam gates are in place.

The principal NAO fish species occurring at RBDD are green and white sturgeon and Pacific and river lamprey. Of these, the Fishtastic! analysis focused on the green sturgeon because this species is known to congregate downstream of RBDD during periods when the dam gates are in place (Brown, pers. comm.). Fish of an additional NNA species, white sturgeon, are believed to migrate into lower segments of the Sacramento River to approximately Colusa (River Kilometer 231) to spawn (Schaffter, 1997).

However, this species is generally not known to spawn upstream of RBDD (River Kilometer 405). For this reason, it was assumed for the analysis that white sturgeon are not presently affected by operations at RBDD, and further impacts analysis was not conducted.

TABLE 3.2-6
Index Value, Relative Difference, and Improvement in Passage Index for Adult Anadromous Salmonids

Alternative	Index Value[a]	Difference[a]	Percent Improved[a]	Effect
Winter-run Chinook Salmon				
No Action Alternative	89	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	91	2	2	*No Measurable Benefit*
4-month Bypass Alternative	91	1	1	*No Measurable Benefit*
2-month Improved Ladder Alternative	98	8	9	*No Measurable Benefit*
2-month with Existing Ladders Alternative	98	8	9	*No Measurable Benefit*
Gates-out Alternative	100	10	12	*Measurable Benefit*
Spring-run Chinook Salmon				
No Action Alternative	52	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	61	8	16	*~~No~~ Measurable Benefit*
4-month Bypass Alternative	57	5	9	*No Measurable Benefit*
2-month Improved Ladder Alternative	94	41	79	*Large Measurable Benefit*
2-month with Existing Ladders Alternative	93	40	77	*Large Measurable Benefit*
Gates-out Alternative	100	48	91	*Large Measurable Benefit*
Fall-run Chinook Salmon				
No Action Alternative	83	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	86	3	4	*No Measurable Benefit*
4-month Bypass Alternative	85	2	2	*No Measurable Benefit*
2-month Improved Ladder Alternative	91	8	9	*No Measurable Benefit*

TABLE 3.2-6
Index Value, Relative Difference, and Improvement in Passage Index for Adult Anadromous Salmonids

Alternative	Index Value[a]	Difference[a]	Percent Improved[a]	Effect
2-month with Existing Ladders Alternative	89	6	8	*No Measurable Benefit*
Gates-out Alternative	100	17	20	*Measurable Benefit*
Late-fall-run Chinook Salmon				
No Action Alternative	100	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	100	0	0	*No Change*
4-month Bypass Alternative	100	0	0	*No Change*
2-month Improved Ladder Alternative	100	0	0	*No Change*
2-month with Existing Ladders Alternative	100	0	0	*No Change*
Gates-out Alternative	100	0	0	*No Change*
Steelhead				
No Action Alternative	89	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	91	2	2	*No Measurable Benefit*
4-month Bypass Alternative	90	1	1	*No Measurable Benefit*
2-month Improved Ladder Alternative	97	8	9	*No Measurable Benefit*
2-month with Existing Ladders Alternative	96	7	8	*No Measurable Benefit*
Gates-out Alternative	100	11	12	*Measurable Benefit*

[a]Rounded to the nearest whole number.

TABLE 3.2-7
Index Value, Relative Difference, and Improvement in Passage Index for Juvenile Anadromous Salmonids

Alternative	Index Value[a]	Difference[a]	Percent Improved[a]	Effect
Winter-run Chinook Salmon				
No Action Alternative	96	n/a	n/a	*No Change*
4-month Gates-in	96	0	0	*No Change*
2-month Gates-in	99	3	3	*No Measurable Benefit*
Gates Out	100	4	4	*No Measurable Benefit*
Spring-run Chinook Salmon				
No Action Alternative	100	n/a	n/a	*No Change*
4-month Gates-in	100	0	0	*No Change*
2-month Gates-in	100	0	0	*No Change*
Gates Out	100	0	0	*No Change*
Fall-run Chinook Salmon				
No Action Alternative	97	n/a	n/a	*No Change*
4-month Gates-in	97	0	0	*No Change*
2-month Gates-in	100	2	2	*No Measurable Benefit*
Gates Out	100	3	3	*No Measaurable Benefit*
Late-fall-run Chinook Salmon				
No Action Alternative	93	n/a	n/a	*No Change*
4-month Gates-in	93	0	0	*No Change*
2-month Gates-in	98	4	5	*No Measurable Benefit*
Gates Out	100	7	7	*No Measurable Benefit*
Steelhead				
No Action Alternative	92	n/a	n/a	*No Change*
4-month Gates-in	92	0	0	*No Change*
2-month Gates-in	99	6	7	*No Measurable Benefit*
Gates Out	100	8	8	*No Measurable Benefit*

[a]Rounded to the nearest whole number.

TABLE 3.2-8
Index Value, Relative Difference, and Improvement in Passage Index for Adult Other Native Anadromous Species

Alternative	Index Value[a]	Difference[a]	Percent Improved[a]	Effect
Green Sturgeon				
No Action Alternative	65	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	65	0	0	*No Change*
4-month Bypass Alternative	69	4	6	*No Measurable Benefit*
2-month Improved Ladder Alternative	100	35	54	*Large Measurable Benefit*
2-month with Existing Ladders Alternative	100	35	54	*Large Measurable Benefit*
Gates-out Alternative	100	35	54	*Large Measurable Benefit*
Pacific Lamprey				
No Action Alternative	83	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	86	3	4	*No Measurable Benefit*
4-month Bypass Alternative	85	2	2	*No Measurable Benefit*
2-month Improved Ladder Alternative	97	14	17	*Measurable Benefit*
2-month with Existing Ladders Alternative	96	13	16	*Measurable Benefit*
Gates-out Alternative	100	17	20	*Measurable Benefit*
River Lamprey				
No Action Alternative	83	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	86	3	4	*No Measurable Benefit*
4-month Bypass Alternative	85	2	2	*No Measurable Benefit*
2-month Improved Ladder Alternative	97	14	17	*Measurable Benefit*
2-month with Existing Ladders Alternative	96	13	16	*Measurable Benefit*
Gates-out Alternative	100	17	20	*Measurable Benefit*

[a]Rounded to the nearest whole number.

TABLE 3.2-9
Index Value, Relative Difference, and Improvement in Passage Index for Juvenile (and transformer) Other Native Anadromous Species

Alternative	Index Value[a]	Difference[a]	Percent Improved[a]	Effect
Green Sturgeon				
No Action Alternative	73	n/a	n/a	*No Change*
4-month Gates-in	73	0	0	*No Change*
2-month Gates-in	88	15	21	*Measurable Benefit*
Gates out	100	27	38	*Large Measurable Benefit*
Pacific Lamprey				
No Action Alternative	99	n/a	n/a	*No Change*
4-month Gates-in	99	0	0	*No Change*
2-month Gates-in	100	1	1	*No Measurable Benefit*
Gates out	100	1	1	*No Measurable Benefit*
River Lamprey				
No Action Alternative	87	n/a	n/a	*No Change*
4-month Gates-in	87	0	0	*No Change*
2-month Gates-in	100	13	15	*Measurable Benefit*
Gates out	100	13	15	*Measurable Benefit*

[a]Rounded to the nearest whole number.

TABLE 3.2-10
Index Value, Relative Difference, and Improvement in Passage Index for Adult Rainbow Trout between Existing Conditions and the No Action Alternative, and the No Action Alternative and Project Alternatives

Alternative	Index Value[a]	Difference[a]	Percent Improved[a]	Effect
No Action Alternative	73	n/a	n/a	*No Change*
4-month Improved Ladder Alternative	78	5	7	*No Measurable Benefit*
4-month Bypass Alternative	76	3	4	*No Measurable Benefit*
2-month Improved Ladder Alternative	91	18	25	*Large Measurable Benefit*
2-month with Existing Ladders Alternative	90	17	23	*Measurable Benefit*
Gates-out Alternative	100	27	37	*Large Measurable Benefit*

[a]Rounded to the nearest whole number.

TABLE 3.2-11
Index Value, Relative Difference, and Improvement in Passage Index for Juvenile Rainbow Trout between Existing Conditions and the No Action Alternative, and the No Action Alternative and Project Alternatives

Alternative	Index Value[a]	Difference[a]	Percent Improved[a]	Effect
No Action Alternative	92	n/a	n/a	*No Change*
4-month Gates-in	92	0	0	*No Change*
2-month Gates-in	99	7	7	*No Measurable Benefit*
Gates out	100	8	8	*No Measurable Benefit*

[a]Rounded to the nearest whole number.

The timing and passage of both of the lamprey species are less precisely known than the anadromous native salmonid species. Therefore, conclusions concerning these species are based on their general life history characteristics, their physical morphology, and their observed passage at RBDD. The summary of the passage indices for all alternatives for adult NAO species is shown in Table 3.2-8. Juvenile passage indices for all project alternatives and the No Action Alternative for juvenile green sturgeon and transformer life stages of lampreys are shown in Table 3.2-9.

The adult passage index values for rainbow trout for all alternatives are summarized in Table 3.2-10. The juvenile passage indices for rainbow trout for all alternatives are shown in Table 3.2-11.

No Action Alternative

Under the No Action Alternative, there would be no impacts or benefits to adult or juvenile fishery resources from the construction/expansion of RPP. The expansion of the existing RPP would be built within the existing off-channel footprint of RPP and not within the Sacramento River proper.

Operations under the No Action Alternative would result in no adverse impacts or benefits to fishery resources compared to existing conditions. Under the No Action Alternative, the RPP's capacity would be expanded to 320 cfs from 240 cfs (existing conditions). There would be no significant adverse impacts or benefits from this operational increase in pumping capacity. The assumption was that, for all new screened diversion elements, all screens and bypasses would meet State of California and federal requirements/criteria for the protection of juvenile fish.

1A: 4-month Improved Ladder Alternative

Construction-related Impacts.
Impact 1A–F1: Construction. Impacts from constructing fish ladder and pump stations, including screens and bypasses, would include direct and indirect losses of adult and or juvenile fish. These impacts would principally occur during installation of cofferdams. The construction areas would include areas near the existing east and west bank fish ladders and the new pump station location at the Mill Site. At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF. Construction of the right bank fish ladder would require a 270-LF sheet pile cofferdam. Construction of the left bank fish ladder would require installation of a 166-LF sheet pile cofferdam.

In addition, impacts could also occur at these locations because of dewatering active channel areas following sheet pile installation. Both adults and juveniles may be stranded and lost during dewatering actions following the installation of sheet piling.

These activities would adversely affect migrating adult fish, rearing stages of fry and juveniles, and migrating salmonid smolts. These impacts would be significant and would require mitigation or conservation measures, depending on species, to reduce these impacts to less than significant.

Additionally, direct losses and adverse indirect effects to adults and juvenile life stages could occur as a result of sediment disturbances and turbidity that would result from construction of project fish ladders and pump stations. These impacts would be significant and would require mitigation to reduce them to less than significant. Impacts from construction on all life stages of fish present would be significant. For impacts of sedimentation and turbidity, mitigation/conservation measures are addressed in the Water Quality section (3.3.4).

The impacts from construction on fishery resources would be significant.

Operations-related Impacts. ***There would be no significant adverse impacts on fishery resources under Alternative 1A; therefore, no mitigation is required.***

Below is a summary of fish passage index values for this alternative.

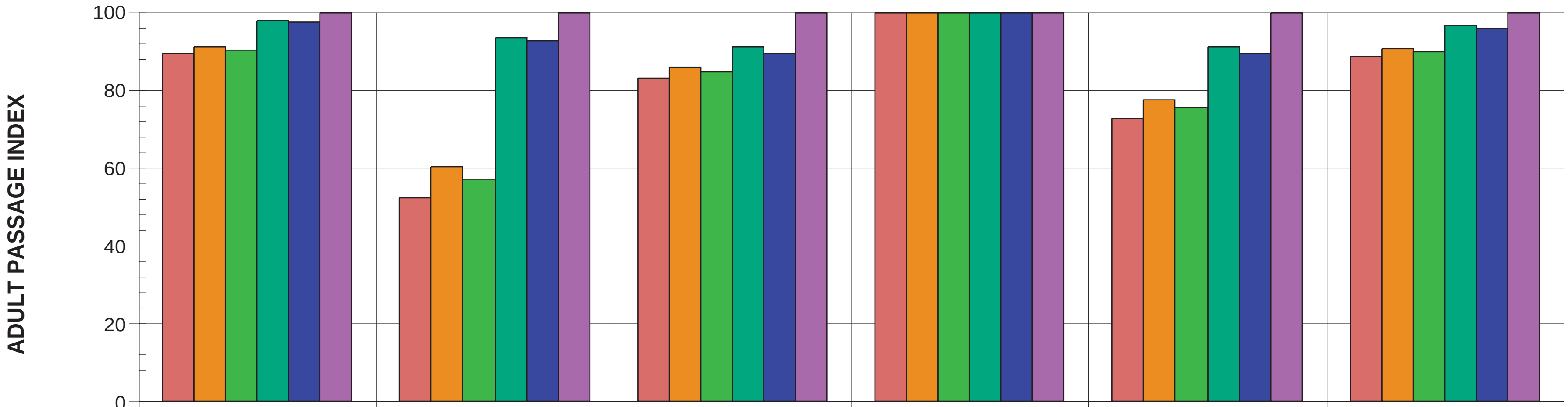
Native Anadromous Salmonid Species.

Adults. As previously discussed and shown in Table 3.2-6, the adult passage index values for Alternative 1A for NAS are equal to or greater than those for the No Action Alternative. The index values for these species are shown on Figure 3.2-8. There is no change in the adult passage index for late-fall Chinook salmon from implementing this alternative (Table 3.2-6). This is because this species does not migrate through RBDD during the gates-in operational period (mid-May through mid-September). There are small (2 to 4 percent) improvements in passage indices for adult winter-run and fall-run Chinook salmon and steelhead, and modest (16 percent) improvement for adult spring-run Chinook salmon. While the percent improvement in the passage index for adult spring-run Chinook salmon seems large (16 percent), the overall annual passage index for this species remains a rather low 61 (Table 3.2-6). These small to modest improvements in adult passage are a result of increased efficiencies in attraction to and passage within the new fish ladders featured in this alternative. The magnitude of these improvements however, is generally not sufficiently beneficial to be considered a measurable improvement for adult passage of NAS species. A rather large component (approximately 39 percent) of threatened adult spring-run salmon would continue to be blocked or impeded under this alternative. In addition, approximately 9 percent of endangered winter-run Chinook salmon and threatened adult steelhead would also continue to be blocked or impeded by the gates at RBDD under this alternative (Figure 3.2-8).

Juveniles. The juvenile passage indices for the NAS species are rather large (greater than 92 on a scale of 100) (Table 3.2-7). For Alternative 1A, there are no differences in the juvenile passage indices for the NAS species as compared to the No Action Alternative. This result is because of the lack of operational changes (gates in/out) for this alternative that affects the principal impact mechanism (predation) for juvenile anadromous salmonids at RBDD. The juvenile passage indices for the NAS, NAO, and RN/RNN species analyzed using the Fishtastic! tool are presented on Figure 3.2-9.

Other Native Anadromous Species.

Adults. The adult passage indices for the three NAO species for Alternative 1A are equal to or greater than those for the No Action Alternative (Table 3.2-8). These indices are also shown on Figure 3.2-10. There is no improvement in the adult passage index for green sturgeon from implementing this alternative (Table 3.2-8). This is because this species does not generally successfully use fish ladders constructed for salmonid species, and even with improvement in the fish ladders, this species would not benefit.



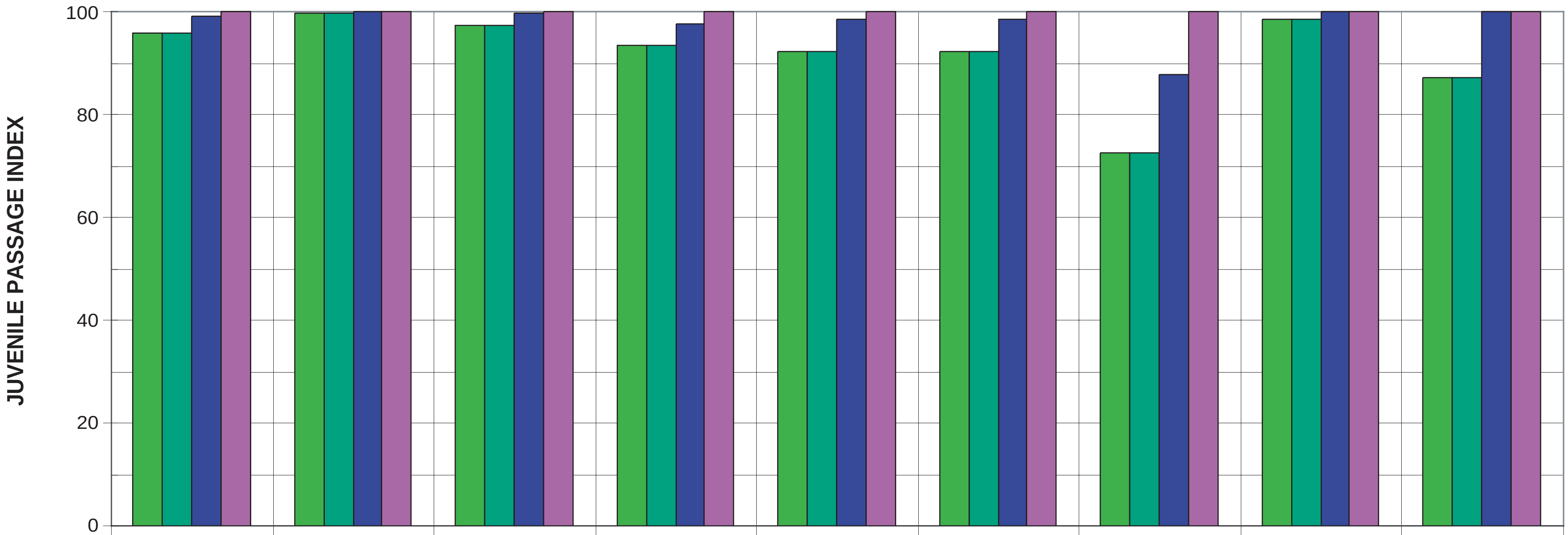
	WINTER-RUN CHINOOK SALMON	SPRING-RUN CHINOOK SALMON	FALL-RUN CHINOOK SALMON	LATE-FALL-RUN CHINOOK SALMON	RAINBOW TROUT	STEELHEAD
NAA	89	52	83	100	73	89
Alt. 1A	91	61	86	100	78	91
Alt. 1B	91	57	85	100	76	90
Alt. 2A	98	94	91	100	91	97
Alt. 2B	98	93	89	100	90	96
Alt. 3	100	100	100	100	100	100

- NAA
- ALTERNATIVE 1A
- ALTERNATIVE 1B
- ALTERNATIVE 2A
- ALTERNATIVE 2B
- ALTERNATIVE 3

FIGURE 3.2-8
ADULT PASSAGE INDICES FOR NATIVE ANADROMOUS SALMONID SPECIES AND RESIDENT NATIVE RAINBOW TROUT
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

W042002002RDD_104.ai (8/19/02)

CH2MHILL

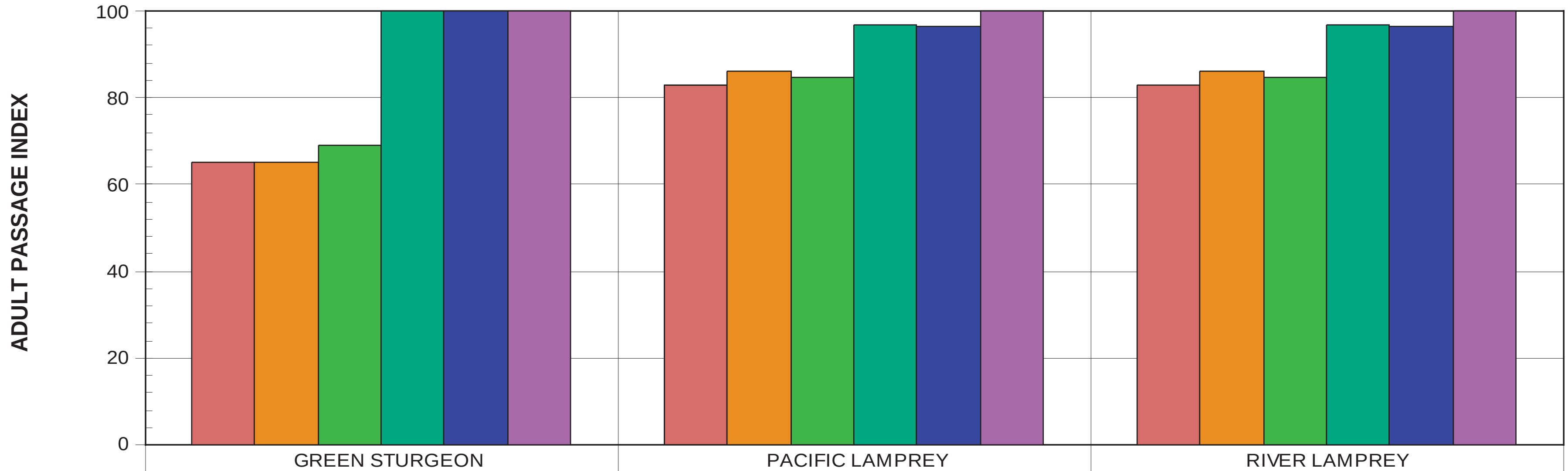


	WINTER-RUN	SPRING-RUN	FALL-RUN	LATE-FALL RUN	RAINBOW TROUT	STEELHEAD	GREEN STURGEON	PACIFIC LAMPREY	RIVER LAMPREY
NAA	96	100	97	93	92	92	73	99	87
ALT. 1	96	100	97	93	92	92	73	99	87
ALT. 2	99	100	100	98	99	99	88	100	100
ALT. 3	100	100	100	100	100	100	100	100	100

FIGURE 3.2-9
JUVENILE PASSAGE INDICES SPECIES ANALYZED USING THE FISHTASTIC! TOOL
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

W072002003RDD_222 (8/14/02)

CH2MHILL



	GREEN STURGEON	PACIFIC LAMPREY	RIVER LAMPREY
NAA	65	83	83
ALT. 1A	65	86	86
ALT. 1B	69	85	85
ALT. 2A	100	97	97
ALT. 2B	100	96	96
ALT. 3	100	100	100

FIGURE 3.2-10
ADULT PASSAGE INDICES FOR OTHER NATIVE ANADROMOUS SPECIES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

CH2MHILL

W072002003RDD_1031.ai (8/14/02)

The small (3 percent) improvements in adult Pacific and river lamprey passage indices are a result of increased efficiencies in attraction to and passage within the new fish ladders featured in this alternative.

However, the magnitude of these improvements is not sufficiently beneficial to be a measurable benefit for adult lamprey passage. For all project alternatives and the No Action Alternative, the passage indices for the lamprey species are great (>83 on a scale of 100). This is because of these species' passage timing and the assumption that these species efficiently pass salmonid-type fish ladders (Table 3.2-10). Lamprey are known to transit fish ladders by attaching to the ladder structures with their oral disc (sucker) (Killam, pers. comm.), thereby resting between bursts of swimming activity while passing through the ladder. How much energy is expended by passing through fish ladders as opposed to swimming upstream within an unobstructed river reach is unknown.

Juveniles. For this alternative, there are no differences in the juvenile passage indices for the three NAO species as compared to the No Action Alternative (Table 3.2-11). This result is because of the lack of operational changes for this alternative that affects the principal impact mechanism (predation) for juveniles of these species at RBDD. Juvenile passage indices are shown on Figure 3.2-9.

Non-native Anadromous Species.

Adults. NNA species that may occur periodically at RBDD include American shad (shad), and striped bass (stripers). These species more commonly occur in the lower portions of the Sacramento River and Delta, but seasonally occur at RBDD. It is not necessary for either of these introduced species to migrate to areas upstream of RBDD to spawn or rear their young. Adult shad would be expected to arrive at RBDD during their spawning run primarily from May through July. However, this species generally does not successfully use fish ladders that are primarily designed to pass salmon, steelhead, or trout. For this species, little if any benefit would be expected to occur from the implementation of Alternative 1A. Furthermore, the continued impedance of shad from passing RBDD is not likely to adversely affect the continued success of this species.

New ladders on the east and west banks would provide additional flow and passage improvement for salmonids but would likely not significantly improve adult passage of striped bass. It has been observed that striped bass arrive at RBDD in the spring/early summer months after spawning in the lower reaches of the Sacramento and Feather rivers. After arriving at RBDD, stripers seem to prefer to remain immediately downstream of the dam. These highly predatory fish continue to forage on juvenile fish passing through the dam (Tucker, pers. comm.). It is unlikely that this alternative would significantly alter this behavior, and therefore, this alternative would not alter adult passage of either American shad or striped bass.

Juveniles. Juvenile striped bass are not likely to be present in the project area as they typically spawn in the lower reaches of the Feather and Sacramento rivers and rear in the Delta. There would be no change from the No Action Alternative in operations that would affect juvenile American shad. Therefore, this alternative would neither benefit nor adversely impact juveniles of either shad or striped bass.

Resident Native and Resident Non-native Species.
Adults. Rainbow trout are a species of native resident fish that were analyzed using the Fishtastic! tool. For Alternative 1A, the adult rainbow trout passage is improved approximately 7 percent over that for the No Action Alternative (Table 3.2-11). The small improvement in adult rainbow trout passage for this alternative is a result of increased efficiencies in attraction to and passage within the new fish ladders featured in this alternative. However, the change in adult passage index for this species is small and not considered a significant improvement for rainbow trout, which can pass fairly readily through the existing ladders. A rather large component (approximately 22 percent) of adult rainbow trout remains blocked or impeded by the gates at RBDD with this alternative (Figure 3.2-8).

Other than rainbow trout, the principal resident native species found near RBDD include Sacramento pikeminnow, splittail, hardhead, and Sacramento sucker. These species have evolved within the Sacramento River and have distinct life history characteristics and requirements. All of these species maintain residency within the freshwater portion of the Sacramento River watershed. However, these species do migrate upstream and downstream throughout the river system to meet their spawning, rearing, and foraging needs; therefore, the operations of RBDD can hinder these species to a greater or lessor degree depending on time of year and the species' needs.

Adult Sacramento pikeminnow (formerly squawfish) are known to migrate upstream in the spring months to spawn, therefore when the RBDD gates go in, these fish tend to congregate below the dam. Operation of RBDD under the Reasonable and Prudent Alternatives specified in the Winter-run Chinook Salmon Biological Opinion (NMFS, 1993), which specified that the gates may not go in prior to May 15th, may reduce the impacts of predation on salmonids from pikeminnow. This species can and does readily pass through the existing fish ladders at RBDD. However, there continues to be a congregation of predators, including pikeminnow, downstream of RBDD under existing conditions and the No Action Alternative when the gates are in. Tucker (1998) found that during sampling in 1994 to 1996, the largest catch/per unit effort (26 percent of annual total) of Sacramento pikeminnow occurred at RBDD during June when the gates were in.

Under Alternative 1A there may be additional passage opportunity provided for adult pikeminnow through the new fish ladders proposed for the left and right banks. However, the incremental increase in ladder passage provided to pikeminnow by the new ladders is likely to be small and not measurably important to this species. Other species such as hardhead and Sacramento sucker are also not likely to significantly benefit from this alternative. These species also are known to successfully use fish ladders, but their passage is greatly restricted by fish ladders principally designed for salmonids. Ladder modifications to attract and pass salmonids may increase their use by these species, but not likely to a large degree. Splittail do not successfully pass fish ladders and, therefore, would not benefit from this alternative.

Adult passage of other resident non-native species (e.g., brown trout) may benefit somewhat from this alternative as this species readily passes fish ladders. Most of the other resident non-native fish such as bass, sunfish, catfish and shiner that are commonly found near RBDD (see Table 3.2-1) would not benefit from this alternative. On the other hand, most of these non-native species have life history characteristics that do not require migration over large geographic distance, and therefore, passage impediments such as RBDD do not greatly affect their populations.

Juveniles. For this alternative, there is no difference in the juvenile rainbow trout passage index when compared to the No Action Alternative (Table 3.2-11). This result is because of the lack of operational changes for the alternative that affects the principal impact mechanism (predation) for juvenile rainbow trout at RBDD. Juvenile passage indices are shown on Figure 3.2-9. Similarly, juveniles of other RN/RNN species would neither benefit nor be adversely affected by this alternative.

1B: 4-month Bypass Alternative

Construction-related Impacts.

Impact 1B–F1: Construction. Impacts from constructing a fish bypass channel, new right bank fish ladder, and a pump station, including screens and bypasses, could include direct and indirect losses of adult and or juvenile fish. These impacts would principally occur during installation of cofferdams. The construction areas would include areas near the existing right (west) bank fish ladder, the take-out and put-back confluence areas of the bypass channel on the left (east) bank of the Sacramento River, and the new pump station location at the Mill Site. At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF. Construction of the right bank fish ladder would require a 270-LF sheet pile cofferdam. The exact dimensions of the cofferdammed areas for the bypass channel take-out and put-back areas are unknown.

The impacts would occur during installation of sheet piling and dewatering of project areas following sheet pile installation. Both adults and juveniles may be stranded and lost during dewatering actions following the installation of sheet piling.

These activities would adversely affect migrating adult fish, rearing stages of fry and juveniles, and migrating salmonid smolts. These impacts would be significant and would require mitigation or conservation measures, depending on species, to reduce these impacts to less than significant.

Additionally, direct losses and adverse indirect effects to adults and juvenile life stages could occur as a result of sediment disturbances and turbidity that would result from construction of project bypass channel and the pump station. These impacts would be significant and would require mitigation to reduce them to less than significant. For impacts of sedimentation and turbidity, mitigation/conservation measures are addressed in the Water Quality section (3.3.4).

The impacts from construction on fishery resources would be significant.

Operations-related Impacts. ***There would be no significant adverse impacts on fishery resources under Alternative 1B; therefore, no mitigation is required.***

Below is a summary of fish passage index values for this alternative.

Native Anadromous Salmonid Species.
Adults. As shown in Table 3.2-6, the adult passage index values for Alternative 1B for the five NAS species are equal to or greater than those for the No Action Alternative. The index values for these NAS species are shown on Figure 3.2-8. As was previously stated for Alternative 1A, there is no change or improvement in the adult passage index for late-fall Chinook salmon for any project alternative (this species does not immigrate through RBDD during the gates-in operational period). There are small (approximately 1 to 2 percent) improvements in adult passage indices for winter-run, and fall-run Chinook salmon and steelhead. These small improvements in adult passage are a result of small incremental increases in adult passage that may occur by these species using the bypass channel and a new right bank fish ladder. A slightly more favorable improvement (approximately 9 percent) in adult passage of spring-run Chinook salmon would occur with the implementation of this alternative. However, the magnitudes of these improvements are generally not sufficiently beneficial to be considered a measurable passage improvement for these species. A rather large (approximately

43 percent) component of threatened adult spring-run Chinook salmon and smaller components of endangered adult winter-run and threatened adult steelhead (both approximately 9 to 10 percent) remains blocked or impeded by the RBDD gates (Figure 3.2-8).

Juveniles. See the discussion of juvenile passage of NAS species for Alternative 1A.

Other Native Anadromous Species.
Adults. The adult passage indices for the three NAO species for Alternative 1B are greater than those for the No Action Alternative (Table 3.2-8). These indices are shown on Figure 3.2-10. For this alternative, and compared to the No Action Alternative, there is a small (approximately 6 percent) improvement in adult passage of green sturgeon. This is because adult green sturgeon may use the constructed bypass channel. However, the likelihood and ability of this species to use the bypass channel is unknown. Therefore, the uncertainty of adult green sturgeon to successfully pass through this channel is reflected as only a small increase in passage index for this species.

There are similar, small (approximately 2 percent) improvements for passage of adult Pacific and river lamprey. These species may also use the bypass channel to some, but unknown, extent as well as pass through the improved right bank fish ladder featured for this alternative. The magnitude of these improvements as shown in Table 3.2-8 is generally not sufficiently great enough to be considered a measurable benefit for adult of these NAO species. As previously discussed, the passage indices for the lamprey species are high (>85 on a scale of 100) because of these species' life histories and the likelihood that they can pass through salmonid fish ladders even with some loss of efficiency.

Juveniles. See the discussion of juvenile passage of NAO species for Alternative 1A.

Non-native Anadromous Species.
Adults. Adult American shad and striped bass may benefit somewhat by successfully passing RBDD via the bypass channel that would be constructed for the alternative. A low-gradient bypass channel that would be designed to provide slower water velocities and abundant resting segments may assist species like shad and stripers, which have some difficulty with or reluctance to pass conventional fish ladders designed primarily for salmonids. However, the extent to which these two species would successful pass through the bypass channel is unknown. As previously stated, adult stripers currently prefer to remain immediately downstream of RBDD and generally do not pass the existing fish ladders. It is likely that with the RBDD gates in the river (similar to the No Action Alternative), stripers would chose to remain

downstream of the gates, preying on juvenile fish rather than re-distributing to upstream areas via the bypass channel.

The benefit to adult passage for either of these species is unknown and is likely small and insignificant. A more likely scenario, for this alternative, is that stripers would remain downstream of RBDD or possibly move into the bypass channel and continue to prey on juvenile salmonids or other species. Furthermore, given the opportunity to transit the bypass channel, shad may or may not actually move farther upstream to spawn.

Juveniles. Juvenile American shad would likely benefit from this alternative by the reduction in the rate at which they are preyed upon by adult striped bass and Sacramento pikeminnow. The RBDD gates would be out until July 1, and would likely discourage predatory species, particularly pikeminnow, from congregating downstream of RBDD. This would lessen the potential for predation and allow a greater number of shad to pass unmolested downstream through the project area. There would be no benefit or adverse impact to juvenile striped bass, as this species does not occur in the project area.

Resident Native and Non-native Species.

Adults. The improvement in passage of adult rainbow trout for Alternative 1B is 4 percent greater than the No Action Alternative (Table 3.2-10). The adult passage indices for this species are shown on Figure 3.2-8. The small improvement in passage index for adult rainbow trout for this alternative is a result of slight increases in efficiencies of attraction and passage in the new right bank fish ladder. There may also be some small but uncertain increase in passage through the bypass channel featured in this alternative. The magnitude of these improvements is generally not sufficient to be considered a measurable improvement in adult passage of rainbow trout, which can pass fairly readily through the existing ladders. A rather large component (approximately 24 percent) of adult rainbow trout remains blocked or impeded by the gates at RBDD under this alternative (Figure 3.2-8).

Adult passage of other RN/RNN species may benefit from the construction of the bypass channel. The channel would provide lower velocities than the existing fish ladders and would provide long segments of flat water. These conditions would potentially be more suitable for successful passage of most, if not all, of these species. However, the extent and the successful use of this channel to migrate around RBDD is unknown, and therefore, the benefits of this alternative to most RN/RNN species would have to be considered small and likely not measurable.

Juveniles. See the discussion of juvenile passage of RN/RNN species for Alternative 1A.

2A: 2-month Improved Ladder Alternative

Construction-related Impacts.

Impact 2A–F1: Construction. Impacts from constructing new left and right bank fish ladders and a pump station, including screens and bypasses, could include direct and indirect losses of adult and or juvenile fish. The major construction impact areas are the, the right and left bank fish ladder vicinities, and the pump station location at the Mill Site. These impacts would principally occur during installation of cofferdams. The construction areas would include areas near the existing east and west bank fish ladders and the new pump station location at the Mill Site. At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF. Construction of the right bank fish ladder would require a 270-LF sheet pile cofferdam. Construction of the left bank fish ladder would require installation of a 166-LF sheet pile cofferdam.

In addition, impacts could also occur at these locations because of dewatering active channel areas following sheet pile installation. Both adults and juveniles may be stranded and lost during dewatering actions following the installation of sheet piling.

These activities would adversely affect migrating adult fish, rearing stages of fry and juveniles, and migrating salmonid smolts. These impacts would be significant and would require mitigation or conservation measures, depending on species, to reduce these impacts to less than significant.

Additionally, direct losses and adverse indirect effects to adults and juvenile life stages could occur as a result of sediment disturbances and turbidity that would result from construction of project fish ladders and the pump station. These impacts would be significant and would require mitigation to reduce them to less than significant. For impacts of sedimentation and turbidity, mitigation/conservation measures are addressed in the Water Quality section (3.3.4).

The impacts from construction on fishery resources would be significant.

Operations-related Impacts. ***There would be no significant adverse impacts on fishery resources under Alternative 2A; therefore, no mitigation is required.***

Below is a summary of fish passage index values for this alternative.

Native Anadromous Salmonid Species.

Adults. As shown in Table 3.2-6, the adult passage indices for the five NAS species for Alternative 2A are equal to or greater than those for the No Action Alternative. These indices are shown on Figure 3.2-8. As previously stated for all alternatives, there is no change in the adult passage index for late-fall Chinook salmon with this alternative. There are, however, modest improvements in adult passage indices for winter-run and fall-run Chinook salmon and steelhead (9 percent each). The principal benefit of the alternative occurs for adult spring-run Chinook salmon where there was a passage improvement of 79 percent compared to the No Action Alternative (Table 3.2-6). This improvement is clearly a measurably large benefit to this species. The improvement to adult spring-run Chinook salmon would occur because the dam gates at RBDD would remain out until July 1, allowing nearly 94 percent of the adults of this species to annually migrate past RBDD unimpeded.

Improvement to adult passage for this alternative also occurs during months of gates-in operation from the new fish ladders on the left and right banks of the river. However, the magnitude of these improvements to the ladders are, by far, less beneficial than the removal of the gates during the early to mid-summer months. The ladder improvements would not generally be considered a significant improvement for adult passage by themselves. This alternative would be effective in reducing the impedance to immigration for adults of NAS species. However, approximately 6 percent of threatened adult spring-run, 2 percent of endangered adult winter-run Chinook salmon, and 3 percent of threatened adult steelhead remain blocked or impeded under this alternative (Figure 3.2-8).

Juveniles. Under this alternative, the juvenile passage indices for all five of the NAS species are greater compared to the No Action Alternative (Table 3.2-7). However, the differences are small, and not measurably beneficial. The percent improvement from the No Action Alternative for juvenile passage ranges from no change for spring-run to 5 percent for late-fall-run Chinook salmon, and 7 percent for steelhead. These results are because of the reduction in rates of predation of these species during longer gates-out periods, especially during the early to mid-summer months (mid-May through June 30). The operational changes (gates-out) featured in the alternative reduces the effects of the principal impact mechanism (predation) for juvenile NAS species. Juvenile passage indices are shown on Figure 3.2-9.

Other Native Anadromous Species.

Adults. The adult passage indices for the three NAO species Alternative 2A are all greater than those for the No Action Alternative (Table 3.2-8). The index values for these NAO species are shown on Figure 3.2-10. This alternative provides a large (54 percent) improvement in adult passage of green sturgeon compared to the No Action Alternative (Table 3.2-8). This benefit occurs because adults of this species principally migrate past RBDD in the late spring to early summer months ending July 1. This alternative would likely eliminate blockage and impedance of adult green sturgeon at RBDD.

There are also smaller (17 percent), but measurably beneficial improvements in passage of adult Pacific and river lampreys from the implementation of this alternative (Table 3.2-10). For this alternative, adult passage of the lamprey species may be improved to nearly 97 percent of unobstructed passage.

Juveniles. For this alternative, there are modest but measurable passage improvements compared to the No Action Alternative for juvenile green sturgeon (21 percent) and river lamprey transformers (15 percent) (Table 3.2-11). As compared to the No Action Alternative, there is only a small (approximately 1 percent), passage improvement for Pacific lamprey transformers. Juvenile passage indices are shown on Figure 3.2-9.

Non-native Anadromous Species.

Adults. The construction of new ladders as part of this alternative would provide little, if any, benefit for stripers because this species generally do not readily pass fish ladders designed principally for salmonid fish.

See the discussion of adult passage of NAS species for Alternative 1A.

Juveniles. Juvenile American shad would likely benefit from this alternative by the reduction in the rate at which they are preyed upon by adult striped bass and Sacramento pikeminnow. The RBDD gates would be out until July 1, and would likely discourage predatory species, particularly pikeminnow, from congregating downstream of RBDD. This would lessen the potential for predation and allow a greater number of shad to pass unmolested downstream through the project area. There would be no benefit or adverse impact to juvenile striped bass, as this species does not occur in the project area.

Resident Native and Non-Native Species.

Adults. For this alternative, adult rainbow trout passage index is approximately 25 percent greater than that for the No Action Alternative (Table 3.2-12). The indices for this species are shown on Figure 3.2-8. The improvement in adult rainbow trout passage for this alternative is a result of the gates-out operational period through June 30. A substantial number of adult rainbow trout pass RBDD during the period from May 15 through June 30. The adult passage index for this alternative is 91 (on a scale of 100). The magnitude of the passage improvement is considered measurably beneficial. However, approximately 9 percent of adult rainbow trout remain blocked or impeded by the gates at RBDD under this alternative (Figure 3.2-8).

This alternative would provide measurably beneficial conditions for passage of other adult RN/RNN species. The removal of the RBDD gates for 2 months from mid-May to June 30 and after September 1 would remove passage impedance for these species for 2 months compared to the No Action Alternative. The construction of a new fish ladder as a feature of this alternative would provide little or no benefit to most adults of RN/RNN species, with the exception of rainbow and brown trout.

Juveniles. For this alternative, there is a small improvement (approximately 7 percent) in passage for juvenile rainbow trout as compared to the No Action Alternative (Table 3.2-13). This small improvement in juvenile passage would not measurably benefit this species. The change in passage index is because of the reduction in rates of predation of these species during longer gates-out periods, especially during the early to mid-summer months (through June 30). The operational changes of this alternative reduce, although not significantly, the effects of the principal impact mechanism (predation) for juvenile rainbow trout. Juvenile passage indices are shown on Figure 3.2-9.

Other juvenile RN/RNN species would likely benefit from this alternative by reducing the rate somewhat at which they are preyed upon by adult striped bass and Sacramento pikeminnow. The RBDD gates would be out through June 30 and would likely discourage predatory species, particularly pikeminnow, from congregating downstream of RBDD. This would lessen the potential for predation and allow a greater number of juveniles of the RN/RNN species to pass unmolested downstream through the project area. This benefit, however, may be offset by the removal of Lake Red Bluff for 2 months. Under this alternative, the juvenile passage indices for all five of the NAS species are greater compared to the No Action Alternative (Table 3.2-9). However, the differences are small, and not measurably beneficial. The percent improvement from the No Action Alternative for juvenile passage ranges from no change for spring-run to 5 percent for late-fall-run Chinook salmon, and 7 percent for steelhead. These results are because of the reduction in rates of predation of these species during longer gates-out periods, especially during the early to mid-summer months (mid-May through June 30). The operational changes (gates-out) featured in the alternative reduce the effects of the principal impact mechanism (predation) for juvenile NAS species. Juvenile passage indices are shown on Figure 3.2-9. Habitats that are preferred by many of the RN/RNN species, particularly the non-native bass, sunfish, and catfish, would be reduced significantly under this alternative, especially nesting sites and rearing habitats for many RNN species.

2B: 2-month with Existing Ladders Alternative

Construction-related Impacts

Impact 2B–F1: Construction. Impacts from constructing a pump station, including screens and bypasses, could include direct and indirect losses of adult and or juvenile fish. The major construction impact areas are at the pump station location at the Mill Site. These impacts would occur during installation of sheet piling. At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF.

In addition, impacts could also occur at these locations because of dewatering active channel areas following sheet pile installation. Both adults and juveniles may be stranded and lost during dewatering actions following the installation of sheet piling.

These activities would adversely affect migrating adult fish and rearing stages of fry and juveniles, and migrating salmonid smolts. These impacts would be significant and would require mitigation or conservation measures, depending on species, to reduce these impacts to less than significant.

Additionally, direct losses and adverse indirect effects to adults and juvenile life stages could occur as a result of sediment disturbances and turbidity that would result from construction of the pump station. These impacts would be significant and would require mitigation to reduce them to less than significant. For impacts of sedimentation and turbidity, mitigation/conservation measures are addressed in the Water Quality section (3.3.4).

The impacts from construction on fishery resources would be significant.

Operations-related Impacts. ***There would be no significant adverse impacts on fishery resources under Alternative 2B; therefore, no mitigation is required.***

Below is a summary of fish passage index values for this alternative.

Native Anadromous Salmonid Species.

Adults. For Alternative 2B, the adult passage indices for all five NAS species are equal to or greater than those for the No Action Alternative (Table 3.2-6). These indices are shown on Figure 3.2-8. As previously stated for other alternatives, there is no beneficial impact in the adult passage index for late-fall Chinook salmon for this alternative. There are modest differences in passage indices for adult winter-run Chinook salmon (9 percent), fall-run Chinook salmon (8 percent), and steelhead (8 percent). The principal benefit of adult NAS passage at RBDD occurs to spring-run Chinook salmon. For this species, the adult passage index increased nearly 77 percent compared to the No Action Alternative (Table 3.2-6). This is clearly a significantly large benefit to this species. The large improvement to migrating adult spring-run Chinook salmon occurs because the dam gates at RBDD would remain out until July 1, allowing approximately 93 percent of this species to pass RBDD unimpeded. However, when compared to Alternative 2A, Alternative 2B benefits are nearly identical.

This alternative is quite effective in reducing RBDD's impedance to the NAS species. However, approximately 7 percent of threatened adult spring-run, 2 percent of endangered adult winter-run Chinook salmon, and 4 percent of threatened adult steelhead remain blocked or impeded under this alternative (Figure 3.2-8).

Juveniles. See the discussion of juvenile passage of NAS species for Alternative 2A.

Other Native Anadromous Species.
Adults. The adult passage indices for all three NAO species for Alternative 2B are greater than those for the No Action Alternative (Table 3.2-8). The index values for these species are shown on Figure 3.2-10. For this alternative, there is a large (54 percent) improvement in the adult passage index for green sturgeon (Table 3.2-8). This is a significantly beneficial passage improvement and occurs because this species primarily migrates past RBDD during late spring to early summer ending July 1. This alternative would eliminate blockage and impedance of adult green sturgeon at RBDD. The relative benefits of this alternative to the NAO species are nearly identical to those for Alternative 2A.

There are smaller (16 percent), but significantly beneficial, improvements in passage indices for adult Pacific and river lamprey from the implementation of this alternative (Table 3.2-8). Adult passage for the lamprey species may be improved to nearly 96 percent of unobstructed passage.

Juveniles. See the discussion of juvenile passage of NAS species for Alternative 2A.

Non-native Anadromous Species.
Adults. For this alternative, the RBDD gates would remain out until July 1. This gate operation would likely result in less congregation of predatory striped bass than would occur if gates remained in during this period. Stripers would either choose to move farther upstream of RBDD, remain in the deeper holding pools at RBDD, or possibly would not remain at RBDD in search of prey. This alternative, while it provides less restriction of upstream movement for stripers, may not be beneficial to this species because it removes the physical impediment that disorients and injures prey fish as they pass through the RBDD gates. Lake Red Bluff, which offers good habitat for predatory species like stripers, would exist for only 2 months annually under this alternative. This is a disadvantage for striped bass that have greater ambush opportunities to prey on juvenile salmonids and other species when they are transiting Lake Red Bluff. This alternative would allow adult stripers additional opportunity to migrate upstream as far as Redding, which may result in undesirable increases in predation of juvenile salmonid upstream of RBDD.

Upstream passage of adult shad upstream of RBDD would likely improve with this alternative. Approximately 80 percent of the annual spawning run would transit RBDD unimpeded during the gates-out period under this alternative. This would be in contrast to approximately 35 percent for the No Action Alternative. The removal of the gates until July 1 each year would allow shad to move farther upstream into habitats that may (or may not) be more suitable for successful spawning, incubation, and early fry rearing. This however, may not provide benefits to the species because the reach of the Sacramento River upstream of RBDD is at the northernmost extent of their geographic range in the Sacramento River watershed. Furthermore, optimal spawning temperatures for shad range from 62 to 70°F (Skinnner, 1962), and these water temperatures are unlikely to occur in the Sacramento River upstream of RBDD during the months when shad would have access upstream of RBDD.

Juveniles. See the discussion of juvenile passage of NNA species for Alternative 2A.

Resident Native and Resident Non-native Species.

Adults. The adult rainbow trout passage index value for Alternative 2B is approximately 23 percent greater than that for the No Action Alternative (Table 3.2-10). The passage indices for this species are shown on Figure 3.2-8. The improvement in adult rainbow trout passage indices for this alternative is a result of gates-out operations through June 30. A substantial number of adult rainbow trout pass RBDD during the period ending June 30. The magnitude of these passage improvements is sufficient to be considered a significant improvement for adult rainbow trout. However, approximately 10 percent of adult rainbow trout remain blocked or impeded by the gates at RBDD under this alternative (Figure 3.2-8).

This alternative would result in the same benefits and liabilities to other adult RN/RNN species as described in the discussion of operational impacts of Alternative 2A.

Juveniles. See the discussion of juvenile passage of RN/RNN species for Alternative 2A.

3: Gates-out Alternative

Construction-related Impacts.

Impact 3–F1: Construction. Impacts from construction on fishery resources under Alternative 3 would be the same as those identified for Alternative 2B (see Impact 2B–F1).

The impacts from construction on fishery resources would be significant.

Operations-related Impacts. ***There would be no significant adverse impacts on fishery resources under Alternative 3; therefore, no mitigation is required.***

Below is a summary of fish passage index values for this alternative.

Native Anadromous Salmonid Species.

Adults. The adult passage indices for all five NAS species for Alternative 3 are equal to or greater than those for the No Action Alternative (Table 3.2-6). In all instances, the adult passage indices indicate unobstructed passage (optimal fish passage conditions = adult passage index of 100). The index values for these NAS species are shown on Figure 3.2-8. As previously stated for other alternatives, there is no impact or improvement in the adult passage index for late-fall Chinook salmon from implementing this alternative (Table 3.2-6). There are significant differences (improvements) in passage indices for adult winter-run (12 percent) and fall-run (20 percent) Chinook salmon, and steelhead (12 percent). The principal benefit for passage of adult NAS species occurs to spring-run Chinook salmon. The passage index for spring-run Chinook increased 91 percent compared to the No Action Alternative (Table 3.2-6). This is a significant and large benefit for passage for this species. These increased improvements to migrating adult NAS species occur because the dam gates at RBDD would remain out year-round and allows those species to pass unimpeded.

Juveniles. The juvenile passage indices for all NAS species are improved, but do not significantly benefit these species when compared to the No Action Alternative (Table 3.2-7). These juvenile passage improvements range from no change for spring-run to 7 percent for late-fall-run Chinook salmon, and 8 percent for steelhead. These benefits are because of the reduction in rates of predation of these species when the RBDD gates are removed throughout the entire year, thereby eliminating the congregations of predatory fish downstream of the gates. Juvenile passage indices are shown on Figure 3.2-9.

Other Native Anadromous Species.

Adults. The adult passage indices for all three NAO species for Alternative 3 are greater than those for the No Action Alternative (Table 3.2-8). The index values for these species are shown on Figure 3.2-10. For green sturgeon adults, there is a large (54 percent) improvement from the No Action Alternative with this alternative (Table 3.2-8). For Pacific lamprey and river lamprey, adult passage indices indicate improved passage by greater that 20 percent over that for the No Action Alternative. This alternative would result in unimpeded passage (index of 100) for adults of the NAO species.

Juveniles. For Alternative 3 there is a significantly large difference (38 percent) in the juvenile passage index for green sturgeon Table 3.2-9. For juvenile river lamprey, a smaller (15 percent) but significantly beneficial increase in the passage index occurs. As compared to the No Action Alternative, there is a small (1 percent) but not significant improvement in the juvenile passage index for Pacific lamprey. Under Alternative 3, juvenile passage is optimal (indices of 100) for all NAO species. These results are because of the reduction in rates of predation of these species when the RBDD gates are removed throughout the entire year, thereby eliminating the congregations of predatory fish downstream of the gates and in Lake Red Bluff. Juvenile passage indices are shown on Figure 3.2-9.

Non-native Anadromous species.

Adults. This alternative would allow full, unimpeded passage of both American shad and striped bass to upstream habitat. However, as stated in the discussion for the 2-month Improved Ladder Alternative, this may or may not be beneficial for adults of these species. The alternative would allow adult stripers to migrate unimpeded as far as Redding, and by doing so, may result in undesirable increases in predation of rearing anadromous salmonids in the Sacramento River upstream of RBDD.

Juveniles. American shad would benefit from Alternative 3. This would occur because of dispersal of predator species like striped bass and particularly Sacramento pikeminnow. No benefit or adverse impact would occur to juvenile striped bass as they would not be expected to occur at RBDD.

Resident Native and Non-native Species.

Adults. The adult rainbow trout passage index for Alternative 3 is approximately 37 percent greater than that for the No Action Alternative (Table 3.2-10). The index values for rainbow trout is shown on Figure 3.2-8. The passage improvement in adult rainbow trout for this alternative is a result of gates-up operations year-round. The magnitude of these improvements over the No Action Alternative is sufficiently beneficial to be considered a significant improvement for passage of adult rainbow trout. This alternative would result in unimpeded passage of adult rainbows.

For the other resident native species at RBDD, this alternative would also greatly benefit adult passage. The reach of the Sacramento River at Red Bluff would return to natural riverine habitats with the RBDD Alternative 3. With the gates removed year-round, unrestricted movement for reproduction, rearing, and foraging needs would occur. Many of the resident non-native species however, would suffer losses in preferred habitats with this alternative. The lacustrine (lake) habitat created by Lake Red Bluff would be lost with Alternative 3. Many of the non-native species prefer these habitats, and without the lake, habitat quantity and quality would diminish. As a result, resident non-native species abundance may decline. This however, may be a benefit to the resident native and the anadromous native species because of less competition with and predation from aggressive and predatory species such as bass and crappie.

Juveniles. For Alternative 3, there is a small difference (approximately 8 percent) in the juvenile rainbow trout passage index compared to the No Action Alternative (Table 3.2-11). This difference in and of itself would not be significant, but with the implementation of Alternative 3, juvenile rainbow passage is optimal with an index of 100. The small improvement is because of the reduction in rates of predation of these species during the entire year by eliminating the congregations of predatory fish downstream of the gates. Juvenile passage indices are shown on Figure 3.2-9.

Juveniles of the resident native and non-native species would benefit from less predation downstream of RBDD than under the No Action Alternative. Furthermore, as previously described for the 2-month Alternative, juvenile resident native fish would benefit from less predation if Lake Red Bluff were to no longer exist. Juveniles of resident non-native species may not benefit from the elimination of Lake Red Bluff, as rearing habitats favoring these species would be lost.

3.2.3 Mitigation

This section discusses mitigations for each significant impact described in Environmental Consequences.

1A: 4-month Improved Ladder Alternative

Mitigation 1A–F1. Any in-stream construction activity would be conducted during season periods most likely to minimize the potential to impact listed, candidate, and/or Species of Special Concern. The most desirable in-stream construction activity period to avoid and/or minimize impacts to adult and juvenile salmonids and sturgeon would be during the months of June and July. To avoid impacts to the majority of the focus species, sheet pile installation and in-stream heavy equipment activity would be coordinated with USFWS, USBR, CDFG, and NMFS to avoid and or minimize potential impacts.

The construction activities within the wetted perimeter of the active channel would be observed and monitored by a qualified fisheries monitor to eliminate direct impacts to adult or juvenile fish. In-stream construction activities would cease, if the fisheries monitor determines there is potential for direct harm or harassment of fish species in the immediate vicinity of any in-stream activity.

All dewatered areas within sheet piling would be pumped down using a screened intake on the dewatering pumps. Pumping will continue until water levels within the contained areas are suitable for salvage of any juvenile or adult fish occupying these areas. Fish would be removed by methods approved by NMFS, USFWS, and CDFG prior to final dewatering.

Implementation of these measures would reduce any impacts of construction related activity to less than significant.

1B: 4-month Bypass Alternative

Mitigation 1B–F1. See Mitigation 1A–F1.

2A: 2-month Improved Ladder Alternative

Mitigation 2A–F1. See Mitigation 1A–F1.

2B: 2-month with Existing Ladders Alternative

Mitigation 2B–F1. See Mitigation 1A–F1.

3: Gates-out Alternative

Mitigation 3–F1. See Mitigation 1A–F1.