5.0 Consultation and Coordination

5.1 Lead and Participating Agencies

TCCA and USBR are co-lead agencies for this project. TCCA is the state lead agency responsible for CEQA. USBR is the federal lead agency responsible for NEPA. Throughout the project, both agencies have worked closely with a number of participating agencies, building upon a history of cooperation. Participating agencies have formally been incorporated into the project through TAG.

TAG has served as the principal resource for data and evaluation of the technical issues and alternatives. Research findings of TAG are reported to policy-level representatives of the various agencies. TAG is responsible for reviewing and commenting on technical studies and the EIS/EIR sections and approaches.

TAG includes representatives from the following agencies:

- DWR
- USBR
- NMFS
- CDFG
- USFWS
- TCCA

TAG has met regularly throughout the project and will continue to do so throughout the project, based on the need for technical evaluation of ongoing efforts. To date, TAG has met approximately twice every 3 months.

The project has also convened the SWG that served as the major mechanism for collaborative problem solving among interest groups most likely to be affected by the project. SWG has provided guidance on aspects of the alternatives and made recommendations to TAG. SWG meetings have included presentations and opportunities to discuss issues and alternatives. SWG has played a critical role in defining positions and concerns of the various interests.

The 4-month Bypass Alternative is not implementable without the Mendocino National Forest Supervisor's approval. Therefore, if the 4-month Bypass Alternative is chosen as the Preferred Alternative, the Mendocino National Forest, USFS, would play an integral role in its development in Phase III, Final Design.

5.1.1 Applicable Laws, Policies, and Programs

ESA requires federal agencies to consult with USFWS and/or NMFS on any activities that may affect species listed as endangered or threatened.

Endangered Species Act. ESA, most recently amended in 1988 (16 USC 1536), establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the preservation of the ecosystems upon which they depend. Section 7(a) of ESA requires federal agencies to consult with USFWS and/or NMFS on any activities that may affect species listed as endangered or threatened. The federal co-leads will consult with USFWS and NMFS as appropriate.

California Endangered Species Act. The current version of CESA was enacted in 1984 and patterned after the federal ESA. CDFG is responsible for CESA implementation. CESA requires lead agencies to consult before implementing projects to ensure that any action carried out by the lead agency is not likely to jeopardize the continued existence of any listed endangered species, or destroy or adversely modify essential habitat. "Essential habitat" is defined as habitat necessary for the continued existence of the species. USBR will consult with CDFG regarding impacts to state-listed endangered and threatened species as appropriate.

Section 1601 Lake or Streambed Alteration Agreement. CDFG regulates work that will substantially affect resources associated with rivers, streams, and lakes in California, pursuant to Fish and Game Code Section 1600-1607. Authorization (known as a Lake or Streambed Alteration Agreement) is required from CDFG for projects prior to any action that substantially diverts, obstructs, or changes the natural flow of a river, stream, or lake, or uses material from a streambed. This agreement applies to any work undertaken within the 100-year floodplain of a body of water or its tributaries. The co-leads will work with CDFG to ensure that all applicable legal requirements are fulfilled.

National Historic Preservation Act. Section 106 of the ~~National Historic Preservation Act (~~NHPA~~)~~ requires that federal agencies evaluate the effects of federal undertakings on ~~historical, archaeological, and cultural resources and afford the Advisory Council on Historic Preservation the opportunity to comment on the proposed undertaking. The first step in the process is to identify cultural resources included on (or eligible for inclusion on) NRHP that are located in or near the project area. The second step is to identify the possible effects of proposed actions. The lead agency must examine whether feasible alternatives exist that would avoid such effects. Compliance with NRHP is discussed in Section 3.11.~~ historic properties and afford the Advisory Council an opportunity to comment on the proposed undertaking. Federal agencies are required to identify historic properties that lie within the area of potential effect and to assess effects to such properties. If the undertaking results in an adverse effect to historic properties, then the federal agency seeks to resolve adverse effects to the property through consultation with consulting parties and through development of a memorandum of agreement. Compliance with the 36 CFR Part 800 regulations that implement the NHPA is discussed in Section 3.11.

Central Valley Project. CVP was initially authorized under the Act of October 26, 1937 (50 Stat. 844,850), and re-authorized under the Act of October 17, 1940 (54 Stat. 1198, 1199). The TC Canal (at the time called the Tehama-Colusa Conduit), including all necessary dams, pumping plants, and other appurtenant works, was a unit of CVP as authorized under state law prior to 1946 (Senate Document 113 1949). Senate Document 113 (1949), a report updating progress on CVP, proposed for further investigations the Red Bluff-Dunnigan Canal (similar in location to the TC Canal) and distribution system, with a cost of $22.4 million, length of 115 miles, and capacity of 3,000 cfs for irrigation of 100,000 acres.

Although Senate Document 113 does not mention RBDD, it does state that flow for the Red Bluff-Dunnigan Canal would be diverted by gravity from the west bank of the Sacramento River just below Red Bluff. A USFWS report included as part of Senate Document 113 recommended screens at the diversion point of the Red Bluff-Dunnigan Canal, siphons on the canal at stream crossings to reduce impacts on salmon, and estimated water requirements of 55 cfs (40,000 acre-feet/year) for the Sacramento National Wildlife Refuge.

On September 26, 1950, Public Law 839 (81st Congress; 64 Stat. 1036) was approved by President Truman, authorizing the Sacramento Canals Unit of the CVP, and re-authorizing the entire CVP, for the purposes of "…regulating flow…controlling floods, providing for the storage and for the delivery of the stored waters thereof…for the reclamation of arid lands and…other beneficial uses." The features authorized in the 1950 legislation included the "Tehama-Colusa Conduit, to be located on the west side of the Sacramento River and equipped with all necessary pumping plants…beginning at the Sacramento River near Red Bluff, California, and extending southerly through Tehama, Glenn, and Colusa Counties…"

Section 5 of the 1950 legislation provided that no expenditure of funds would be made for construction of the Sacramento canals until the Secretary of the Interior, with approval of the President, submitted to Congress a completed report finding the project feasible under provisions of the federal reclamation laws. The selected plan for development presented in that report (House Document No. 73, 83rd Congress, 1st Session) provided for the Corning Canal, the TC Canal, and RBDD.

1951 Preliminary Evaluation Report. USFWS issued a preliminary evaluation report on fish and wildlife resources affected by the Sacramento Canals Unit of the CVP. This report identified potential impacts, the need for fish passage and screening facilities, and the potential of incorporating fish spawning areas in the TC Canal as mitigation features of the canal complex. The service made an assessment of the project impacts that were based on the assumption that the RBDD gates would be open from November through March.

1963 Interim Evaluation Report. USFWS conducted further evaluation of RBDD in conjunction with USBR and CDFG. This led to an interim report that contained updated assessment of project impacts and mitigation and enhancement recommendations. The report stated that there would be a considerable loss of downstream migrant salmon without effective screening of the TC Canal intake. In addition, there would be a loss of spawning habitat as a result of inundation from the impoundment of Lake Red Bluff. As part of the proposed mitigation, a dual-purpose salmon spawning and water conveyance channel and a downstream access channel to the dual-purpose spawning channel was designed as part of the facility.

Support for fishery spawning in the canal was not shared by USBR because of the many problems and unknowns associated with the design criteria, the construction, and the O&M of said facilities.

1967 Fish and Wildlife Coordination Act Report. A Fish and Wildlife Coordination Act (FWCA) Report was submitted by USFWS to USBR on January 5, 1967. The report described RBDD and TC Canal project features, identified fish and wildlife resources, and addressed project impacts. The report also estimated that releases of water to Thomes and Stony creeks from the TC Canal would result in salmon enhancement and compensation from the proposed project. The report supported the Tehama-Colusa Fish Facilities plan for compensating salmon impacts and taking advantage of large-scale enhancement opportunities. In addition, the report listed several mitigation measures to reduce project impacts.

The Red Bluff Fish Passage Program was undertaken to develop solutions to identified causes of declines in anadromous fish populations attributed to RBDD.

1992 Appraisal Report. In 1992, together with USFWS, NMFS, and CDFG, USBR created the Red Bluff Fish Passage Program. The purpose and need for the Red Bluff Fish Passage Program was to improve fish passage capability at RBDD for salmon migrating upstream and downstream of the river. The Red Bluff Fish Passage Program was undertaken to develop solutions to identified causes of declines in anadromous fish populations attributed to RBDD. The primary objectives of the report included the following:

- Identify alternative solutions to the causes (Items 1 through 4, above)
- Perform a preliminary comparative evaluation and screening of those alternatives
- Determine if any of the alternatives are reasonable

- Identify additional analyses required to perform a final comparative evaluation of the reasonable alternatives for the ultimate purpose of selecting a preferred plan

The report summarized all of the proposed alternatives and reviewed details of the 11 selected alternatives. Additional analysis of the selected alternatives included hydrology, design and costs, economics, social factors, recreation, and water quality.

The report concluded that 4 of the 11 selected alternatives were reasonable to consider for further development.

1998 Supplemental Fish and Wildlife Coordination Act Report. The 1998 Supplemental FWCA Report was a joint effort by USBR and USFWS. The purpose of the Supplemental FWCA Report was to: (1) supplement the 1967 FWCA, (2) address previous and current impacts of RBDD and the TC Canal on fish and wildlife resources, (3) recommend interim mitigation actions that can be implemented in a short time frame, and (4) provide recommendations to identify the long-term solution at RBDD. Based on historical and current data, the Supplemental FWCA Report made several recommendations to USBR regarding short-term and long-term procedural and operational changes. These recommendations were made to further mitigate previously identified RBDD/TC Canal-specific impacts and also benefit fish and wildlife resources on a basinwide scope.

5.1.2 Required Permits

Section 1.6 presented a simplified list of permits required. Following is a more detailed discussion of permits the decisions reached on the particular requirements.

Clean Water Act, Section 404

USACE has jurisdictional authority to regulate discharge of dredging material and fill into "waters of the United States (including wetlands)" under Section 404 of the Clean Water Act. The Code of Federal Regulations (33 CFR Section 328.3) defines waters of the United States as all navigable waters, including: (1) all tidal waters; (2) all interstate waters and wetlands; (3) all other waters such as lakes, rivers, streams (perennial or intermittent), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate commerce; (4) all impoundments of water mentioned above; (5) all tributaries to waters mentioned above; (6) territorial seas; and (7) all wetlands adjacent to waters mentioned above.

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration (wetland hydrology) sufficient to support, and that under normal circumstances do support, a prevalence of wetlands vegetation (hydrophytic vegetation) typically adapted for life in saturated soil conditions (hydric soils). Wetlands generally include swamps, marshes, bogs, and similar areas (40 CFR 230.3 and 33 CFR 328). Any actions that involve the placement of fill material into jurisdictional waters and wetlands, including such activities as sidecasting material during ditch excavation or temporary fills to provide equipment access during construction, must comply with Section 404 of the Clean Water Act.

The 1987 Wetland Delineation Manual requires an examination for the presence of indicators of three mandatory diagnostic characteristics. These characteristics, or wetland parameters, are hydrophytic vegetation, wetland hydrology, and hydric soils. Except in limited instances, the 1987 Wetland Delineation Model requires that evidence of a minimum of one positive indicator from each of the three mandatory wetlands parameters be present for an area to be called a "wetland" under Section 404 jurisdiction.

Clean Water Act, Section 10

Under Section 10 of the Rivers and Harbors Act of 1899, USACE also regulates the obstruction or alteration of navigable waters (including tidal waters) of the United States. It is important to note that Section 10 jurisdiction includes navigable waters within the mean high water line that have been diked or filled.

~~The 1987 Wetland Delineation Manual requires an examination for the presence of indicators of three mandatory diagnostic characteristics. These characteristics, or wetland parameters, are hydrophytic vegetation, wetland hydrology, and hydric soils. Except in limited instances, the 1987 Wetland Delineation Model requires that evidence of a minimum of one positive indicator from each of the three mandatory wetlands parameters be present for an area to be called a "wetland" under Section 404 jurisdiction.~~

Endangered Species Act, Section 7 Consultation

Pending biological assessment and decision on terrestrial compliance.

Federal Fish and Wildlife Coordination Act Report

Report from USFWS pending.

National Flood Insurance Program Letter of Map Revision

Pending determination on level of compliance necessary from Federal Emergency Management Agency.

California Fish and Game Streambed Alteration Agreement

Issued by CDFG.

Authorization from the Mendocino National Forest.

Pending information from USFS Mendocino National Forest.

California Endangered Species Act Consultation

Pending final determination from CDFG.

Clean Water Act Section 401 Water Quality Certification

Pending results from site investigation at the Mill Site (Central Valley RWQCB).

Federal Clean Water Act Section 402 General Construction Activity Stormwater

Pending results from site investigation at the Mill Site (Central Valley RWQCB).

Petition to Change Point of Diversion

Pending language from USBR and TCCA following selection of preferred alternatives.

State Lands Commission Public Agency Lease/Encroachment Permit

Issued by the State Lands Commission.

Encroachment Permit

Issued by the State Reclamation Board.

National Historic Preservation Act Section 106 Authorization

The proposed TCCA fish screen project requires compliance with Section 106 of NHPA of 1966. Section 106 requires that federal agencies take into account the effect of their actions on properties that may be eligible for, or listed in, the NRHP.

The Section 106 review process is implemented using a five-step procedure: (1) identification and evaluation of historic properties, (2) assessment of the effects of the undertaking on properties that are eligible for NRHP, (3) consultation with the State Historic Preservation Office and other agencies for the development of a MOA that addresses the treatment of historic properties, (4) receipt of Advisory Council on Historic Preservation comments on the MOA or results of consultation, and (5) the project implementation according to the conditions of the MOA.

The Section 106 compliance process may not consist of all the steps above, depending on the situation. For example, if identification and evaluation result in the documented conclusion that no properties included in or eligible for inclusion are present, the process ends with the identification and evaluation step. The proposed activity area incorporates two areas administered by federal agencies: USFS and USBR. Contact was made with both agencies regarding permitting requirements. An archaeological investigation prepared as part of this project concluded that no archaeological resources would be affected by implementation of the action alternatives. The results of the archaeological investigation are currently being reviewed by USBR.

Clean Air Act Permit

Issued by Tehama County Air Pollution Control District.

5.2 List of Contributing Individuals

This EIS/EIR is the product of a wide-ranging collaborative effort that has benefited from input, suggestions, and original content from the following partial list of contributing individuals:

Tehama-Colusa Canal Authority

Art Bullock, General Manager and Chief Engineer

Bob Williams, Board Chairman

Ken LaGrande, TCCA Vice Chairman, Member of Red Bluff Solutions Committee

Mike Alves, Committee Member, Member of Red Bluff Solutions Committee

Winnie Jones, Committee Member, Member of Red Bluff Solutions Committee

Mary Wells, Committee Member, Member of Red Bluff Solutions Committee

Doug Griffin, Committee Member, Member of Red Bluff Solutions Committee

U.S. Bureau of Reclamation

Max Stodolski, Chief, RBDD
Buford Holt, Shasta Dam
Sandy Borthwick, RBDD
Al Candlish, Sacramento
Alan Oto, Sacramento
Brent Mefford, Denver
Barry Mortimeyer, Sacramento
Dave Robinson, Sacramento

U.S. Fish and Wildlife Service

Jim Smith, Project Leader, Red Bluff

Tom Kisanuki, Assistant Project Leader, Red Bluff
Ryan Olah, Sacramento
Leigh Bartoo, Sacramento
Curt Brown, Red Bluff

National Marine Fisheries Service

Mike Tucker, Sacramento
John Johnson, Portland

U.S. Forest Service

Mike Van Dame, Mendocino National Forest
Fred Bell, Mendocino National Forest

California Department of Fish and Game

Harry Rectenwald, Redding
Doug Killam, Red Bluff
Steve Turek, Redding
Randy Benthin, Redding
George Heise, Sacramento

California Department of Water Resources

Ralph Hinton, Red Bluff
Dwight Russell, Chief Northern Division
Kevin Dossey, Red Bluff

NewFields

Andrea Schmid, Sacramento
Mike Urkov, Sacramento

CH2M HILL

John Schoonover/Redding
Mark Oliver/Redding
Pete Rude/Redding
Stacia Dugan/Seattle
Clay Hinkle/San Diego
Hong Zhuang/San Diego
Dale Cannon, Redding
Mike Urkov, Redding
Lenny Kerr, Redding
Tim Hamaker, Redding
Heather Waldrop, Redding
Ken Iceman, Redding
Andrew Sloan, Redding
Laurel Karren, Sacramento
Eric McClelland, Redding
Tim Carlton, Redding

Chris MacInnis, Redding
Beth Doolittle, Redding
Chris Proud, Oakland
Leslie Regos, Denver
Sharon Younkers, Redding
Sandi Staack, Redding
Al Farber, Redding
Jason DeGrasse, Oakland
Doug Simpson, Redding
Harold Robertson, Redding
Ron Fehringer, Redding
Kevin Butcher, Redding
Bob Gatton, Redding
Don Merideth, Redding
Vera Nevens, Redding
Alexa Stamets, Redding
Celeste Brandt, Redding
Brenda Eells, Redding
Russell Huddleston, Sacramento
Kent Ennis, Phoenix
Mike Pappalardo, Corvallis
Darryl Hayes, Sacramento
Pam Bates, Redding
Carol Hullinger, Redding
Bob Lawson, Redding
Dan Pitzler, Seattle
Sandy Taylor, Sacramento
Peter Griggs, Redding
Sara Monteith, Redding
Jan Loring, Redding
Howard Wilson, Redding
Heather Rectenwald, Redding
Matt Franck, Sacramento
Marjorie Eisert, Sacramento
Suzanne Moreland, Redding
Tim Hill, Redding
Cheri Randall, Redding
Katrina Reed, Redding
Jeff Morris, Redding
Sam Moss, Redding
Jeff Perry, Redding
Tom Priestly, Oakland
Mike Ostrom, Redding
Calvin Sugg, Redding
Nancy Horrick, Redding
Elisabeth Pierce, Redding
Mary Hall, Redding

Brad Shearer, Redding
Kevin Porter, Redding
Gary Brown, Denver
Bruce Straughan, Denver
Curt Bagnall, Portland
Mary Coe, Redding
Ted Stavedahl, Redding
Heather Johnson, Sacramento

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Attachment A
Acronyms and Abbreviations and Glossary of Terms

ATTACHMENT A

Acronyms and Abbreviations and Glossary of Terms

Acronyms and Abbreviations

AB	Assembly Bill
ACID	Anderson-Cottonwood Irrigation District
ADT	average daily trip
Agreement	Sacramento Valley Water Management Agreement
Alternative 1A	4-month Improved Ladder Alternative
Alternative 1B	4-month Bypass Alternative
Alternative 2B	2-month with Existing Ladders Alternative
Alternative 3	Gates-out Alternative
Alternative2A	2-month Improved Ladder Alternative
AWS	Auxiliary Water System
Basin Plan	Regional Water Quality Control Board Basin Plan
BMP	Best Management Practices
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	cubic feet per second
CHO	Constant Head Orifice
City	City of Red Bluff
CNDDB	California Natural Diversity Data Base
CNPS	California Native Plant Society
CO	carbon dioxide
COD	chemical oxygen demand
County	Tehama County
CVP	Central Valley Project

CVPIA	Central Valley Project Improvement Act
CY	cubic yard
dB	decibel
dBA	decibels on the A-weighted scale
DEIS/EIR	Draft Environmental Impact Statement/Environmental Impact Report
Delta	Sacramento-San Joaquin River Delta
Discovery Center	Sacramento River Discovery Center
DO	dissolved oxygen
DOC	dissolved organic carbon
DWR	California Department of Water Resources
EDR	Environmental Data Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	federal Endangered Species Act
ESU	Evolutionary Significant Unit
FEIS/EIR	Final Environmental Impact Statement/Environmental Impact Report
fps	feet per second
FWCA	Fish and Wildlife Coordination Act
gpm	gallons per minute
I-5	Interstate 5
I-O	input-output
IOU	investor-owned utilities
ITA	Indian trust asset
kW	kilowatt
kWh	kilowatt-hour
L_{10}	noise level exceeded for 10 percent of the measurement period
L_{90}	noise level exceeded during 90 percent of the measurement period
lb/day	pounds per day

L_{eq}	sound pressure level
LF	linear feet
LOS	level of service
maf	million acre-feet
MCL	Maximum Contaminant Limit
μg/L	micrograms per liter
mg/L	milligrams per liter
μg/m^3	micrograms per cubic meter
MIREC	Micro-Implan Recreation Economic Impact Estimation System
MOA	Memorandum of Agreement
MW	Monitoring Well
MWh	megawatt-hour
NAAQS	National Ambient Air Quality Standard
NAO	other native anadromous
NAS	native anadromous salmonid
NEC	not elsewhere classified
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NNA	non-native anadromous
NO_x	nitrogen oxide
NRHP	National Register of Historic Places
O&M	operations and maintenance
Pactiv	Pactiv Corporation
PEIS/EIR	Programmatic Environmental Impact Statement/Environmental Impact Report
PG&E	Pacific Gas and Electric Company
PH	peak hour
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter

ppm	parts per million
PRG	Preliminary Remediation Goal
PUP	Project Use Power
PX	Power Exchange
RBDD	Red Bluff Diversion Dam
Recreation Area	Lake Red Bluff Recreation Area
RM	River Mile
RN	resident native
RNN	resident non-native
ROD	Record of Decision
ROG	reactive organic gas
RPP	Research Pumping Plant
RWQCB	Regional Water Quality Control Board
SCAQMD	South Coast Air Quality Management District
SO_2	sulfur dioxide
SO_x	sulfur oxide
Storage Project	North-of-the-Delta Offstream Storage Project
SWG	Stakeholder Working Group
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TAG	Technical Advisory Group
TC	Tehama-Colusa
TCCA Board	Tehama-Colusa Canal Authority Board of Directors
TCCA	Tehama-Colusa Canal Authority
TCP	Traffic Control Plan
TDS	total dissolved solids
TMDL	total maximum daily load
TOC	total organic carbon
TOG	total organic gas
TSS	total suspended solids

USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VC	volume to capacity
VELB	valley elderberry longhorn beetle
VOC	volatile organic compound
Western	Western Area Power Administration

Glossary of Terms

Acre-feet—The quantity of water required to cover 1 acre to a depth of 1 foot. Equal to 1,233.5 cubic meters (43,560 cubic feet).

Air quality—Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances.

Affected environment—Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as a result of a proposed human action.

Anadromous—In general, this term is used to refer to fish, such as salmon or steelhead, that hatch in freshwater, migrate to and mature in the ocean, and return to freshwater as adults to spawn. Section 3403(a) of the Central Valley Project Improvement Act (CVPIA) defines anadromous as "those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin Rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean.

Anadromous Fishery Restoration Program—A program authorized by the Central Valley Project Improvement Act to address anadromous fish resource issues in Central Valley streams that are tributary to the Delta. This program is lead by the U.S. Fish and Wildlife Service.

Aquatic—Living or growing in or on the water.

Aquifer—An underground geologic formation in which water can be stored.

Artificial propagation/production—As defined in Section 3403(b) of the CVPIA, "spawning, incubating, hatching, and rearing fish in a hatchery or other facility constructed for fish production."

Beneficial use—Those uses of water as defined in the State of California Water Code (Chapter 10 of Part 2 of Division 2), including but not limited to agricultural, domestic, municipal, industrial, power generation, fish and wildlife, recreation, and mining. Such use is beneficial to the extent of being consistent with Congressional directives concerning the project.

Biological Opinion—Document issues under the authority of the Endangered Species Act stating U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service finding as to whether a federal action I likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

CALFED—Interagency effort involving state and federal agencies with management and regulatory responsibilities in the Bay-Delta.

Candidate species—As defined by the U.S. Fish and Wildlife Service, candidate species are plant or animal species not yet proposed for listing as threatened or endangered under the federal Endangered Species Act, but for which there is sufficient data to warrant listing (formerly designated Category 1 candidate species). As defined by the National Marine

Fisheries Service, candidate species are any species being considered for listing as endangered or threatened (including those with insufficient data), but not yet the subject of a proposed rule.

Central Valley Project—As defined by Section 3403(d) of the Central Valley Project Improvement Act, "All Federal reclamation project located within or diverting water from or to the watershed of the Sacramento and San Joaquin rivers and their tributaries as authorized by the Act of August 26, 1937 (50 Stat. 850) and all Acts amendatory or supplemental thereto,…"

Channel—Natural or artificial watercourse, with a definite bed and banks to confine and conduct continuously or periodically flowing water.

Cooperating agency—This is defined as a federal agency that (1) has study area-wide jurisdiction by law or special expertise on environmental quality issues; (2) has been invited by the lead agency to participate as a cooperating agency; or (3) has made a commitment of resources (staff and/or funds) for regular attendance at meetings, participation in work-groups, or in actual preparation of portions of a National Environmental Policy Act (NEPA) document.

Cubic feet per second—A measure of the volume rate of water movement. As a rate of streamflow, a cubic foot of water passing a reference section in 1 second of time. One cubic foot per second equals 0.0283 cubic meters per second (7.48 gallons per minute). One cubic foot per second flowing for 24 hours produces approximately 2 acre-feet.

Delivery—In general, deliveries are water diversions from CVP facilities to CVP contractors at the division level. This may be different than the amount delivered to irrigated land.

Delta—A low, nearly flat alluvial tract of land formed by deposits at or near the mouth of a river. In this report, delta usually refers to the delta formed by the Sacramento and San Joaquin Rivers.

Dissolved oxygen—A commonly employed measure of water quality.

Endangered species—Any species designated under the Endangered Species Act or California Endangered Species Act that is in danger of extinction throughout all, or a significant portion, of its range. Federally endangered species are under the jurisdiction of the U.S. Fish and Wildlife Service or National Marine Fisheries Service. State endangered species are under the jurisdiction of the California Department of Fish and Game.

Entrainment—The drawing of fish and other aquatic organisms into water diversions.

Environmental consequences—The impacts to the affected environment that are expected from implementation of a given alternative.

Escapement—For purposes of this report, escapement (sometimes referred to as inriver spawner escapement) is the number of salmon that "escape" harvest in ocean and inriver fisheries each year and return to a stream to spawn.

Estuary—A water passage where the tide meets a river current; an arm of the sea at the lower end of a river.

Existing Conditions—Existing conditions, sometimes referred to as "1995 existing conditions" is required by CEQA for purposes of comparing future conditions under the Preferred Alternative to current conditions. For purposes of this DEIS/EIR, existing conditions typically consists of (1) a PROSIM simulation of water impacts and conditions based on 1995 assumptions and operating criteria, or (2) the best available data that represents 1995 conditions (e.g., Census Bureau economic data).

Federal Species of Concern—Species that may warrant consideration for listing as endangered or threatened; however, the data is inconclusive. Formerly designated Category 2 candidate species pursuant to the federal Endangered Species Act, the species were re-categorized in 1996. The species have no legal protection under the federal Endangered Species Act.

Fish ladders—A series of ascending pools constructed to enable salmon or other fish to swim upstream around or over a dam.

Fish population—The total number of fish alive for a defined life stage and/or area.

Fishery—The industry or occupation of catching fish, and a place where such fish are caught.

Flow—The volume of water passing a given point per unit of time.

> *Fishery flow*—The total volume of water and its release pattern that are scheduled to maintain fish populations.
>
> *Instream flow requirements*—Amount of water flowing through a stream course needed to sustain instream values.
>
> *Peak flow*—Maximum instantaneous flow.

Fry—Life stage of fish between the egg and fingerling stages. For salmon this typically refers to fish less than 50 millimeters long.

General Plan—A comprehensive, long-term plan for the physical development of both a city and any land outside the city's boundary. Under state planning law, each city in California must adopt a general plan. The plan must consist of a statement of development policies and include diagrams and text setting forth objectives, principles, standards, and land use plan proposals. The plan must consist of seven mandatory elements and an optional element that the city may choose to adopt. The seven mandatory elements include the following: land use, circulation, housing, conservation, open space, noise, and safety.

Groundwater—Water stored underground in pore spaces between rocks and in other alluvial materials and in fractures of hard rock occurring in the saturated zone.

Groundwater level—Refers to the water level in a well and is defined as a measure of the hydraulic head in the aquifer system.

Habitat—Area where a plant or animal lives.

Irrigation water—Water made available from the project, which is used primarily in the production of agricultural crops or livestock, including domestic use incidental thereto, and the watering of livestock.

Juvenile—Young fish that are no longer fry, but have not reached reproductive age.

Mitigation—One or all of the following: (1) avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating an impact over time by preservation and maintenance operations during the life of an action; and (5) compensating for an impact by replacing or providing substitute resources or environments. National Environmental Policy Act requires agencies to identify feasible mitigation, whereas California Environmental Quality Act require agencies to implement feasible mitigation.

Preference power customers—Publicly owned systems and non-profit cooperatives that, by law, have preference over investor-owned systems for purchase of power from federal projects.

Project Use Power—is electrical power as defined by Reclamation law and / or that is used to operate the Central Valley Project or the Washoe Project facilities. PUP can also be provided to Reclamation-designated facilities that meet authorized purposes under Reclamation law, to meet statutory and contractual obligations, and in water rights settlements. Other PUP uses include station-service requirements at Reclamation dams, power plants, pumping plants, and designated loads directly associated with the Federal project. PUP is only available to those Reclamation project features in which the United States retains ownership.

Public involvement—Process of obtaining citizen input into each stage of the development of planning documents. Required as a major input into any Environmental Impact Statement.

Riparian—The banks of a natural course of water. The soil moisture along such areas typically exceeds that found farther from the water course.

> ***Early-successional riparian community—*** A group of plant recently established or beginning to establish in an area.

Recreation Visitor Day—A measure of the actual user day for a particular recreational activity.

Reservoir—Artificially impounded body of water.

Responsible agency—As defined by CEQA, a public agency, other than the lead agency, which has responsibility for carrying out or approving the project .

Riparian—The banks of a natural course of water (e.g., river, stream). The soil moisture along such areas typically exceeds that found farther from the water course.

Salmonids—Fish of the family *Salmonidae*, such as salmon and trout.

Smolt—A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.

Spawning—The releasing and fertilizing of eggs by fish.

Special-status species—Species that are listed, proposed, or candidates for listing as endangered or threatened pursuant to federal or state endangered species acts, federal Species of Concern, Forest Service Sensitive Species, California Species of Special Concern, California Fully Protected Species, and plant species on list 1 through 4 maintained by the California Native Plant Society.

Spillway—Overflow structure of a dam.

Threatened species—Any species designated under the federal Endangered Species Act or California Endangered Species Act that is likely to become an endangered species within the foreseeable future throughout all, or a significant portion, of its range. Federally threatened species are under the jurisdiction of the U.S. Fish and Wildlife Service or National Marine Fisheries Service. State-threatened species are under the jurisdiction of the California Department of Fish and Game.

Tributary—A stream feeding into a larger stream or a lake.

Wetlands—An area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wildlife habitat—An area that provides a water supply and vegetative habitat for wildlife.

Appendix A
Alternatives, Fish Passage Benefit, and Agricultural Water Supply Benefit Analysis

Alternatives Analysis

Introduction

Several alternatives for the Environmental Impact Statement/Environmental Impact Report (EIS/EIR), including the No Action Alternative, were developed as part of the effort to improve fish passage and water reliability at Red Bluff Diversion Dam (RBDD). This report outlines the development and assessment of the project alternatives identified as part of the fish passage improvement project at RBDD. As a result of this effort, the following alternatives are being carried through a thorough analysis via the EIS/EIR process. Three gate operation scenarios generally describe alternatives: (1) a 4-month gates-in operation, (2) a 2-month gates-in operation, and (3) a 0-month gates-in operation. It is worth noting that this project uses a unique nomenclature for the alternatives. Gates-in refers to dam operations where the dam's gates are lowered into the Sacramento River, thus allowing gravity diversion of water into the Tehama-Colusa Canal (TC Canal). In contrast, gates-out refers to dam operations where the gates are in the raised position, precluding diversion of water by gravity except under extremely high flows.

- 1A: 4-month Improved Ladder Alternative. This alternative would continue the current 4-month gate operation (May 15 through September 14), improve the fish ladders (total fish passage flow approximately 1,600 cubic feet per second [cfs]), and require a conventional pump station located immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 1,700 cfs.
- 1B: 4-month Bypass Alternative. This alternative would continue the current 4-month gate operation (May 15 through September 14). Fish passage would improve with construction of a 1,000-cfs bypass channel around the left abutment of the dam to provide passage for adult fish. The existing left bank ladder would remain in operation, but the right bank ladder would be improved to increase the amount of attraction flow. Total flow for fish passage would be 1,800 cfs. A conventional pump station would be constructed immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 1,700 cfs.
- 2A: 2-month Improved Ladder Alternative. This alternative would decrease the gates-in operation to 2 months (July 1 through August 31), improve fish ladders (total fish passage flow approximately 1,600 cfs), and require a conventional pump station located immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 2,000 cfs.
- 2B: 2-month with Existing Ladders Alternative. This alternative would decrease the gates-in operation to 2 months (July 1 through August 31), improve the fish ladders (total fish passage flow approximately 1,600 cfs), and require a conventional pump station located immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 2,000 cfs.

- 3: Gates-out Alternative. Gates would remain out of the water year-round. Fish ladders would not be needed because there is no impedance of passage when the gates are out of the water. A conventional pump station would be constructed immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 2,500 cfs.

These alternatives were developed from an existing knowledge base built from decades of study at RBDD. The fish passage project considered hundreds of alternatives previously proposed to address the conflicting uses of RBDD. The broad range of alternatives were considered against the purpose of the project and a set of secondary screening criteria which resulted in four of the five alternatives described above. The fifth alternative, Alternative 1B, was added following a number of public comments requesting its inclusion.

These alternatives were developed and considered in a manner consistent with National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA). Additionally, net benefits of the alternatives were calculated in an effort to determine cost-effectiveness. This economic analysis was based on the requirements of the Principles and Guidelines published by the U.S. Water Resources Council in 1983.

Primary Screening Criteria

During the initial phases of the project, a two-fold project purpose was carefully crafted to respond to the need for the project. The resultant purpose and need statement is a requirement of the NEPA process and served as an initial screen for previously developed alternatives. The purpose of the project is as follows:

- Substantially improve the long-term ability to reliably pass anadromous fish and other species of concern, both upstream and downstream, past RBDD.
- Substantially improve the long-term ability to reliably and cost-effectively provide water supplies into the Tehama-Colusa Canal Authority (TCCA) systems.

The need for the project is driven by the continued and well-documented fish passage and agricultural water diversion reliability problems associated with the operation of RBDD. Even with three separate fish ladders in operation, RBDD acts as an impediment to fish passage during the gates-in period each year. Impacts to fish passage have been eliminated during the 8-month gates-out period, but continue to occur during the 4-month gates-in period. The 4-month window of operation has constrained operation of the dam for diversion purposes to the point that TCCA cannot meet the water needs of its customers during certain periods of the year when the gates are out. Further shortening the window operation, even if only for a few days, will significantly exacerbate this water supply deficiency.

In order for proposed alternatives to be carried forward for further consideration, alternatives need to demonstrate the ability to meet the purposes of the project. Alternatives were carried forward if they could both permanently benefit fish passage by reducing fish passage impediments and permanently benefit TCCA by reducing or eliminating water delivery shortfalls that can occur outside the annual period of permitted RBDD operations.

Generic Projects

In February 1992, U.S. Bureau of Reclamation (USBR) issued an "Appraisal Report on the Red Bluff Diversion Dam Fish Passage Program" (referred to here as the Appraisal Report). USBR, with assistance from the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the California Department of Fish and Game (CDFG), identified 22 alternatives for improvements to mitigate fish passage impediments at the dam.

Additionally, USFWS issued a supplemental Fish and Wildlife Coordination Act Report titled "Red Bluff Diversion Dam and the Tehama-Colusa Canal" in February 1998. This report provides a summary of the fish passage issues and a reference of the project background and history. Table A-1 presents a summary of alternatives identified in prior studies.

Initial Screening of Alternatives

The selection of feasible alternatives, which will ultimately lead to a preferred alternative, was driven by a number of factors. For an alternative to be considered feasible (and therefore subject to full NEPA and CEQA analysis) it must have the ability to address the purposes of the project. Alternatives that failed to address both purposes of the project were rejected.

A primary result of this initial screening exercise was the conclusion that alternatives requiring an increase in gates-in operations would not improve fish passage. Even with improvements to existing ladders, it was determined that maximum fish passage efficiency is achieved with gates out; therefore, an increase in gates-in operations would reduce fish passage by some degree and would not address the dual project purposes. Further, it is recognized that the current gate operating procedure was a direct result of the Biological Opinion for Winter-run Chinook Salmon, and an increase in the gates-in period would require a re-evaluation of the species under the Endangered Species Act (ESA). Administratively, this process would have the potential to make any such alternative infeasible. Likewise, alternatives that only address agricultural deliveries without improvements to fish passage were also eliminated. However, all of the specific components of previously developed alternatives were considered for their applicability to a 4-month-or-less gates-in alternative.

Alternatives considered in greater detail all required 4-month-or-less-gates-in operations. This resulted in alternatives that were largely similar in their gate operation assumptions, but covered a wide variety of facility options for pumping water for agricultural deliveries or providing improved fish passage. By limiting the gate operations, the number of feasible facility options was greatly reduced, although there were still a large number of potential options for facilities. The different combinations of potential facility options narrowed the number of potentially feasible alternatives to approximately 300. Many of these facility options could be sized to meet a range of requirements, resulting in even more possible alternatives.

TABLE A-1
Alternatives Identified in Prior Studies

Alternative	Description	Gates-in Operating Period (months)
Pumping Plant Alternative 4A	Fish Ladders: Left Abutment: None Right Abutment: None Center: None Pumping Plant Size: 2,720 cfs Gates-in Fish Ladder Operation: Gates-out year-round	0
Pumping Plant Alternative 4B	Fish Ladders: Left Abutment: None Right Abutment: None Center: None Pumping Plant Size: 2,480 cfs Gates-in Fish Ladder Operation: Mid-May to mid-July	2
Fish Ladder and Gate Operation Alternative 3A4	Fish Ladders: Left Abutment: 800 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: April 1 to December 1	8
Fish Ladder and Gate Operation Alternative 3C4	Fish Ladders: Left Abutment: 3,000 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: April 1 to December 1.	8
Conveyance from Shasta Dam	Pipeline or canal from Shasta Dam to TC Canal.	0
Low Upstream Diversion and Conveyance	Structure placed upstream would divert flows and convey directly to TC Canal by pipeline or canal.	0
Artificial River Channel through Payne Slough	An artificial river channel would convey all Sacramento River flows except RBDD diversion flows around the east side of RBDD. Gates would be kept lowered to allow diversions. Channel would follow alignment of Payne Slough and would require low fish weirs. Would require new diversion structure with fish ladders to divert RBDD into the natural channel for later diversion at RBDD.	12
Terraced Artificial Channel on Left Abutment of RBDD	Would include a shorter channel than the Payne Slough alternative. Steeper longitudinal slope would require fish ladders instead of fish weirs. Gates at RBDD would still be lowered to allow gravity-flow diversion.	12
Iowa Vanes	Iowa vane flow deflectors would be installed to deflect water toward the downstream end of existing fish ladders. Iowa vanes about 9 feet long and 3 feet high.	12
Smaller Pumping Plant with Regulatory Storage	Continuously pump flow to a regulatory reservoir for later use.	0
Fish Passage Effectiveness Alternative 1	Modify right abutment fish ladder to 800 cfs. Retain existing 338-cfs left abutment fish ladder.	12
Fish Passage Effectiveness Alternative 2A	Add 1,000-cfs center fish ladder. Retain 338-cfs left and right abutment fish ladders.	12

TABLE A-1
Alternatives Identified in Prior Studies

Alternative	Description	Gates-in Operating Period (months)
Fish Passage Effectiveness Alternative 2B	Modify right abutment fish ladder to 800 cfs and add 1,000-cfs center fish ladder. Retain existing 338-cfs left abutment fish ladder.	12
Fish Passage Effectiveness Alternative 3A1	Modify left abutment fish ladder to 800-cfs capacity. Retain 338-cfs right abutment fish ladder.	12
Fish Passage Effectiveness Alternative 3A2	Modify left abutment fish ladder to 800 cfs and modify right abutment fish ladder to 800 cfs.	12
Fish Passage Effectiveness Alternative 3B1	Add new 2,100-cfs fish ladder on left abutment to replace existing fish ladder.	12
Fish Passage Effectiveness Alternative 3B2	Add new 2,100-cfs fish ladder on left abutment to replace existing modify right abutment fish ladder to 800 cfs.	12
Fish Passage Effectiveness Alternative 3C1	Add new 3,000-cfs fish ladder to replace existing fish ladder on the left abutment. Retain 338-cfs right abutment fish ladder.	12
Fish Passage Effectiveness Alternative 3C2	Add new 3,000-cfs fish ladder to replace existing; modify right abutment fish ladder to 800 cfs.	12
Fish Passage Effectiveness Alternative 3D1	Add new 5,000-cfs fish ladder on left abutment to replace existing fish ladder. Retain 338-cfs right abutment fish ladder.	12
Fish Passage Effectiveness Alternative 3D2	Add new 5,000-cfs left abutment fish ladder; modify right abutment fish ladder to 800 cfs.	12
Fish Passage Effectiveness Alternative 3D3	Add new 5,000-cfs left abutment fish ladder; modify right abutment fish ladder to 800 cfs; add new 1,000-cfs center ladder.	12
Fish Ladder Alternative 3A3	Fish Ladders: Left Abutment: 800 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: All year	12
Fish Ladder Alternative 3B3	Fish Ladders: Left Abutment: 2,100 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: All year	12
Fish Ladder Alternative 3C3	Fish Ladders: Left Abutment: 3,000 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: All year	12

TABLE A-1
Alternatives Identified in Prior Studies

Alternative	Description	Gates-in Operating Period (months)
Pumping Plant Alternative 4C	Fish Ladders: Left Abutment: None Right Abutment: None Center: None Pumping Plant Size: 1,360 cfs Gates-in Fish Ladder Operation: Mid-April to mid-October	6
Fish Ladder and Pumping Plant Alternative 4C1	Fish Ladders: Left Abutment: 800 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: 1,360 cfs Gates-in Fish Ladder Operation: Mid-April to October	5.5
Fish Ladder and Pumping Plant Alternative 4C2	Fish Ladders: Left Abutment: 2,100 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: 1,360 cfs Gates-in Fish Ladder Operation: Mid-April to October 1	5.5
Fish Ladder and Gate Operation Alternative 3B4	Fish Ladders: Left Abutment: 2,100 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: April 1 to December 1	8
Paynes Creek Slough Alignment	Provides a 2,500-cfs capacity bypass around RBDD. Underwater acoustic barriers would be used to guide fish into the bypass.	12
Connor's No Name Slough Alignment	8,900-foot-long, 20,000-cfs capacity single channel or 5,000- to 7,000-cfs multiple bypass channels. Would require gated headworks to maintain constant lake level while varying flow to bypass depending on the riverflow.	12
TCCA/Montgomery-Watson Alignment	2,000-foot-long rock-lined channel. A 200- to 500-foot intake sill would be constructed with a fixed crest elevation of 248 feet. Inflatable gates along the top of the sill would control water surface in the lake.	12
Weir Gates	Variable-flow gates would be installed in the existing gates to allow for flow over the gates rather than underneath the gates.	12

To organize the alternatives into a more manageable format, three primary alternatives were developed:

- Alternative 1 – Current 4-months gate operation with fish passage improvements and 1,700-cfs total pumping capacity.

- Alternative 2 – A reduction in gate operation to the 2 months correlating with peak agricultural demand (July and August), fish passage improvements, and 2,000-cfs total pumping capacity.
- Alternative 3 – Elimination of gates-in operation and need for fish ladders; 2,500-cfs total pumping capacity.

Fish Passage

Facility options for fish passage were considered separately from facility options for pump stations. Detailed hydraulic physical model studies conducted by USBR's Technical Services Center indicated that the flow in the existing right, center, and left fish ladders should be improved. A detailed field investigation of the right fish ladder was also conducted by the Technical Services Center, and it pointed to the need for improvements in the attraction water system (AWS). Past investigations and current technology being used in other fish passage projects were identified as potential facility options at RBDD. Details regarding specific improvements to fish ladders were a focus of the Technical Advisory Group (TAG) for the Fish Passage Improvement Project.

None of the alternatives with a gates-in operation greater than 4 months was carried forward for additional analysis. As noted previously, it was determined that increasing the gates-in period would reduce fish passage at the dam, and was therefore contrary to the purpose of the project relating to fish passage. However, many of the facility options from alternatives that were dropped were considered as part of alternatives with gates in 4 months or less. These facility options included ladders, bypass channels, locks/fish elevators, and flow deflectors (Iowa vanes and weir gates).

Specific designs for the improved fish ladders were developed and refined in conjunction with TAG. Through group deliberations, it was determined that alternatives with continued gates-in operation should include designs for three fish ladder facilities. The attraction water system for the left and right bank ladders would be increased, resulting in a total flow of 831 cfs and 800 cfs in the respective ladders. TAG determined that the combined 1,631 cfs of attraction flow would be adequate in the vast majority of flow conditions at the dam.

Following a public scoping meeting, numerous public comments were received regarding another method of improving fish passage at the dam, commonly referred to as the "Bypass Alternative." Bypass alternatives were generally a constructed channel that would divert river flow around the left abutment of the dam, thus providing fish passage and potentially allowing for increased gates-in operation. During previous studies of fish passage conditions at the dam, a series of bypass alternatives were developed as a means to increase the gates-in period while improving fish passage at the dam. Previous bypass alternatives were abandoned because of the uncertainty surrounding the effectiveness of bypass channels to effectively pass fish and the relatively high costs estimated for construction of such facilities. However, because of the intense public interest in bypass facilities as a method for passing fish, the general concept of a bypass channel was carried forward for additional evaluation.

Agricultural Water Delivery

Peak demand estimates were developed by TCCA to evaluate facility options for delivering water to the TC and Corning canals. Generally, agricultural demand increases as temperature and crop demands increase, reaching a maximum demand in July and August, then decreasing as temperatures fall and crops are harvested. Common practices and crop demands in spring can also cause a second, smaller peak to occur in early May. Average water deliveries are presented graphically on Figure A-1. In response to a request from USBR, TCCA prepared a second report documenting historical water orders. The report included calculations of potential demands that could occur if peak water orders occurred simultaneously. Peak water demands are summarized in Table A-2.

TABLE A-2
Actual and Potential TCCA Water Demands[a]

Period	Peak Historical Water Order[b]	Historical Potential Peak Water Order[c]	Maximum Potential Peak Water Order[d]	Facilities Design Assumptions[e]
May 1 to 15	1,901 cfs	1,901 cfs	2,151 cfs	1,700 cfs
May 16 to 31	1,231 cfs	1,292 cfs	2,137 cfs	2,000 cfs
June	1,545 cfs	1,596 cfs	2,386 cfs	2,000 cfs
July	2,209 cfs	2,838 cfs	2,838 cfs	2,500 cfs
August	1,125 cfs	2,282 cfs	2,282 cfs	2,500 cfs
September 1 to 15	1,049 cfs	1,540 cfs	1,865 cfs	2,000 cfs

[a]Derived from actual water deliveries between 1989 and 1999.

[b]Highest single day water order, comprised combined actual water order from TCCA member districts and Glenn-Colusa Irrigation District (GCID).

[c]Highest TCCA member district water order plus highest GCID water order in period (may not have occurred on same day, but could reasonably occur).

[d]Highest TCCA member district water order plus highest potential GCID water order (1,125 cfs).

[e]Assumptions used in developing project alternatives.

Facilities design assumptions were used to determine the capacity needed under various gate operation scenarios. For example, under the current 4-month gates-in scenario, it is assumed that 1,700 cfs of water supply capacity is needed. During gates-in operations, the dam can divert water in excess of the design capacity of the TC Canal headworks, which is 3,180 cfs. Thus, diversions from the river are not a limiting factor during gates-in operations. During gates-out operations, however, diversions from the Sacramento River are limited to 405 cfs of pumping capacity at RBDD.

Sacramento River diversions during the gates-out period are currently supplemented by diversions from Stony Creek. Stony Creek diversions are conveyed into the TC Canal through a constant head orifice (CHO) on the creek, which was originally intended to supply supplemental flows from the TC Canal to Stony Creek. By operating the CHO backwards, TCCA is able to divert approximately 600 cfs from Stony Creek into the canal when water is available from Black Butte Reservoir. Considering pumping capacity at RBDD in conjunction with Stony Creek diversions, total diversion capacity during the gates-out period is 1,005 cfs, leaving the TCCA approximately 700 cfs short in the early May

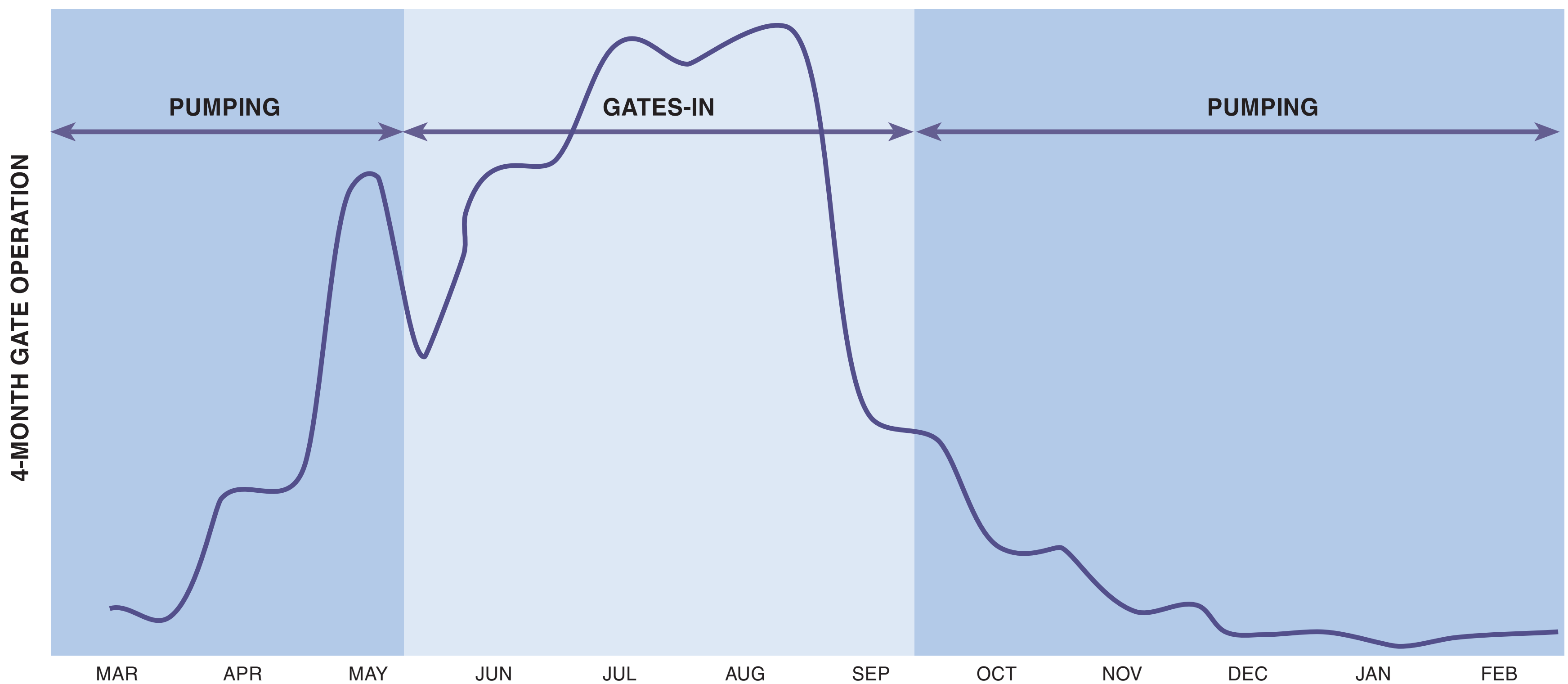

FIGURE A-1
AVERAGE WATER DELIVERIES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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period. However, it is important to note that diversions from Stony Creek are not considered to be a long-term sustainable resource because of concerns about fishery resources in Stony Creek and the unreliable nature of Stony Creek hydrology.

Facility options were considered according to their ability to meet the design assumptions listed in Table A-2 during gates-out operation. The review of offsite facility options for pump stations began with the identification of potential pump station locations. The locations identified are presented on Figure A-2 and in Table A-3. Additionally, the potential for building new onsite pumping plants was considered. The following three locations were considered: the Research Pumping Plant (RPP) (called the Tailwater Pump Station), the intake headworks, and the settling basin.

TABLE A-3
Offsite Intake Facility Locations

Site Number/Name	River Mile	Distance to TC Canal from Intake
11/Mill Site	242.7	0.5 mile to TC Canal
1/Existing Site	242.2	At canal
2/Orchard	240.7	0.8 mile to TC Canal; in orchard in floodplain; 15’ average water depth
3/Bow River	238.3	1.5 miles to TC Canal; 11’ average water depth
4/Coyote Creek	232.7	2.2 miles to TC Canal; 22’ average water depth
5/Upstream of Tehama	229.8	1.9 miles to TC Canal; 15’ average water depth
6/Downstream of Tehama	228.7	1.4 miles to TC Canal; 12’ average water depth
7/McClure Creek	226.5	1.1 miles to TC Canal; 14’ average water depth
8/Thomes Creek	223.8	2.1 miles to TC Canal; 11’ average water depth
9/Deer Creek	220.2	2.6 miles to TC Canal; 15’ average water depth
10/Woodson Bridge	218.5	2.4 miles to TC Canal; 17’ average water depth

The type of pumps proposed for the pump stations was also considered. Typically, pump stations as large as those being considered are outfitted with vertical turbine pumps. However, the existing RPP at the RBDD uses two types of non-standard pumps: helical and Archimedes pumps. These non-standard pumps are unique in that they do not use fish screens at the point of diversion. Instead, they pump water out of the river, then screen fish into a bypass for conveyance back into the river. Research conducted on these non-standard pumps indicates that there is minimal impact on fish pumped into the bypass facility. Accordingly, these pumps were considered in greater detail.

Secondary Screening Criteria

Additional screening criteria were developed to narrow the list of potentially feasible alternatives. The express purpose was to identify facility options that would create alternatives that have the greatest likelihood of success. Facility options were compared and evaluated against the following criteria:

- Effectiveness – technology, management of water delivery, and biological requirements that combine to provide a high likelihood of long-term success. Methods, processes, and equipment that have documented long-term successful performance were considered superior to those that were relatively untried.
- Implementation – practical execution, including potential public acceptance issues, permitting, and land use issues. Constructibility and complexity of maintaining effective fish passage and water delivery operations during the construction of new facilities were considered.
- Environmental – impact to environmental resources with emphasis on special-status species, including native fish species, and including both short-term (construction-related) and long-term impacts. Sites where construction can be limited in riparian zones, agricultural land, or other sensitive areas were considered superior to those where such areas would be disturbed.
- Cost – relative comparison of estimated life-cycle costs for each alternative, including initial capital costs and operation and maintenance (O&M) costs, including availability of project energy. At this level of consideration, costs were used to identify alternatives that were grossly out of proportion with other alternatives.

Results of Secondary Criteria

Fish Passage Facilities

Fish passage facilities were evaluated using the secondary criteria. Specific details about the facilities were developed in conjunction with TAG and built upon previous investigations conducted at the site. Fish passage facilities were originally considered as part of the 4-month gates-in and 2-month gates-in alternatives. The Gates-out Alternative would not lower gates into the water and would thus not require fish ladders. However, Alternative 2B was added to the alternatives that were considered following the detailed fish passage analysis, described in the next section.

Site conditions related to adult fish passage at RBDD are described in the following reports, which form the basis for the fish ladder designs considered as part of this project:

- *Prescoping Report: Tehama-Colusa Canal Authority Fish Passage Improvement Project at the Red Bluff Diversion Dam* (CH2M HILL, 2000)
- *Hydraulic Field Evaluation of the Right Abutment Fish Ladder at RBDD* (USBR, 1997b)
- *Physical Model Study of Enlarged Fish Ladders for RBDD* (USBR, 1997a)

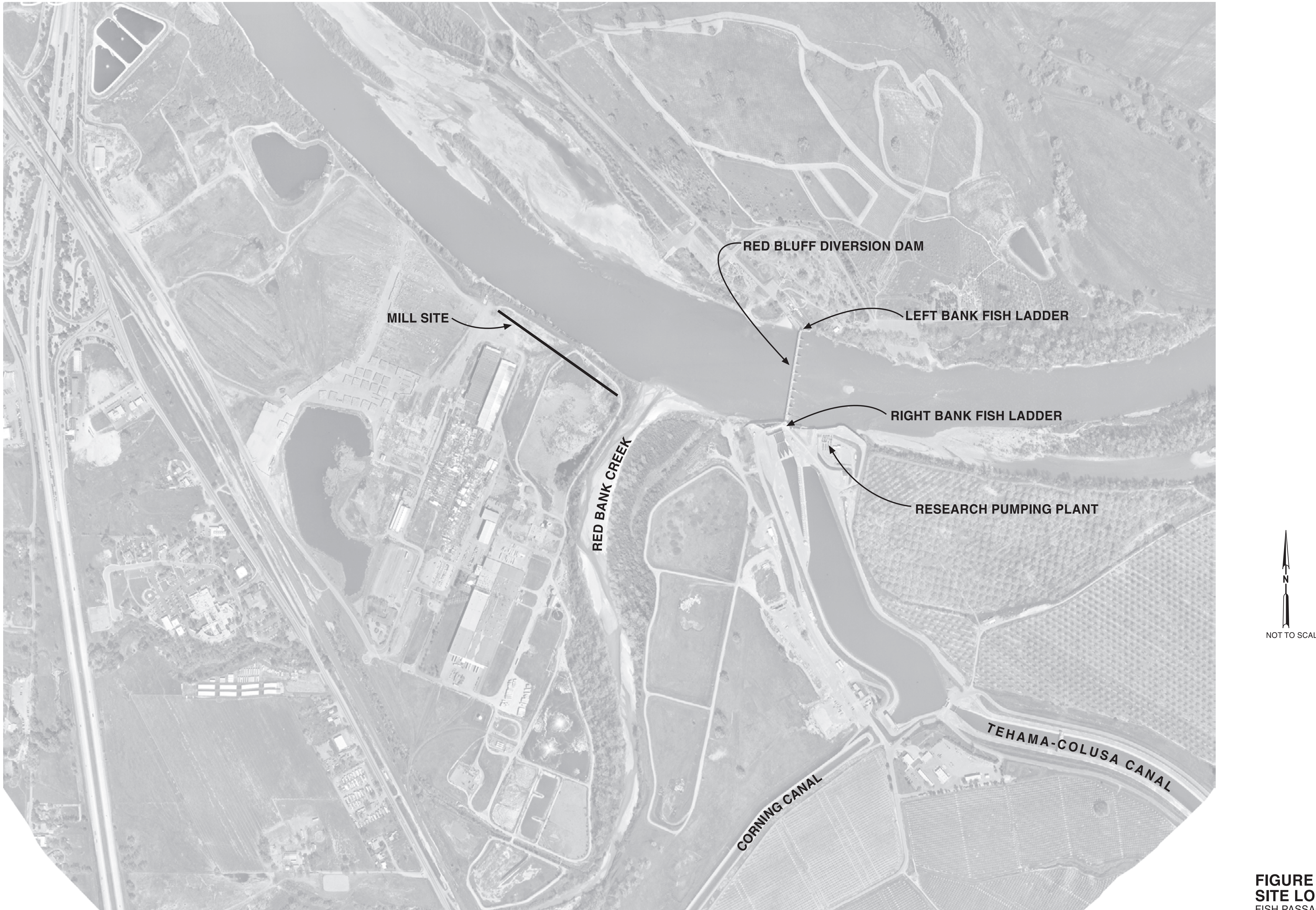

FIGURE A-2
SITE LOCATION MAP
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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Right Bank Fish Ladder. The existing right bank fish ladder will be improved to provide improved adult fish passage. This will be accomplished by increasing the AWS flow from 265 cfs to 715 cfs. The fish ladder flow will remain at 85 cfs, although new Ice Harbor-type weirs will be installed. The total maximum fish ladder flow will be 800 cfs, including AWS flow. The fish ladder entrance bay will be reconfigured to enhance fish attraction and to accommodate the increased total flow. This main entrance will be fitted with a top-down slide gate to ensure proper entrance conditions at most flow levels. A low-flow entrance will also be included to provide a jet parallel to the dam just downstream of the spillway. The low-flow entrance will also have a top-down slide gate for closure or adjustment.

The lowest weir (Weir Number 1) of the existing fish ladder will be abandoned to provide for a larger entrance bay. At the design total flow of 800 cfs and the design maximum tailwater, the water velocity in the entrance bay just before the high-flow fish ladder entrance is 3.6 feet per second (fps), which is just below the design maximum water velocity criterion of 4.0 fps.

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

The design criteria that will be used in the preliminary design of the right bank fish ladder are shown in Table A-4.

Advantages. The primary advantage of this ladder design is that the basic structures currently exist, which minimizes construction impacts. Other advantages are that the technology is widely accepted and has been implemented in other fish passage projects.

Disadvantages. A biological disadvantage of fish ladder improvements is that they might not address problems relating to delay at the dam. Additionally, ladders would not provide passage for sturgeon, and thus may pose a risk to future operations if sturgeon, or other fish with similar swimming characteristics, are listed under ESA or otherwise require changes in dam operations.

Screening Evaluation.

Effectiveness

- This type of fish ladder design has proven to be effective in other locations and would likely represent an improvement over the existing ladders.
- Improved passage for sturgeon would not be achieved with these facilities, unless they were implemented with a reduction in gates-in operation.
- It is possible that improved ladders would not reduce delay at the dam, which is considered to be the major effect of the dam on migrating fish.

TABLE A-4
Design Criteria for the Right Bank Fish Ladder

River Design Flows	**cfs**
100-year Flood	206,000
Maximum River Flow for Fish Ladder Operations	20,000
Minimum River Flow for Fish Ladder Operations	2,200
River Elevations and Gross Heads (refer to tailwater rating curves)	**feet**
Forebay Level	252.5 ± 0.2
Maximum Tailwater Level (for fish ladder design)	242.0
Minimum Tailwater Level (for fish ladder design)	237.6
Maximum Gross Head	14.9
Minimum Gross Head	10.5
Fisheries Criteria	**each**
Type of Fish Ladder	Pool and weir
Weir Type	Ice Harbor with 9-inch sidewall slots
Number of Pools	14
Pool-to-Pool Differential	1.0 ft or less
Pool Turbulence Factor	4.0 ft-lb/sec/ft^3
Fish Ladder Entrance Velocity (average)	5.6 fps
Entrance Bay to Tailwater Differential	1.0 ft
Floor Diffuser V_n	0.5 fps
Wall Diffuser V_n	1.0 fps
AWS Trashrack V_n	1.0 fps
Transport Channel Maximum Velocity	4.0 fps
Transport Channel Minimum Velocity	2.0 fps
Monitoring and Evaluation Facilities	
Viewing Window	To be determined
Counting Facilities	To be determined
Adult Trap	To be determined
Fish Ladder Hydraulic Performance	**cfs**
Weir Flow	85
AWS Flow	715
Floor Diffuser Flow	650
Wall Diffuser Flow	65

ft-lb/sec/ft^3 = foot-pound per second per cubic foot.

Environmental

- Because of the current dam operations, it is considered likely that this type of facility could be built without incurring impacts to fish passage during construction.
- Future listings of fish, particularly sturgeon, could require additional operational changes at the dam if this facility option is selected.
- No significant changes to the existing environmental setting are anticipated with this option.

Implementability

- Because the structures are already in place, there is no need for in-river construction; therefore, this option should have minimal impact on continued uninterrupted water delivery and should not impact fish passage during construction.
- Construction of this facility would not preclude land use near the proposed locations, and operation of the fish ladders is consistent with the management objectives of the proposed locations.
- Since the site is already in use for water delivery, no new permits are expected, and no land acquisition is needed.

Cost

- The construction cost per unit of fish passage is greater than that for gates-out operation.
- Overall, the O&M cost of this alternative is expected to be slightly, but not significantly, higher than the existing fish ladders.

Conclusion. Improved fish ladders would rely on accepted technologies used at other facilities to improve salmonid passage. However, the improvements to the ladders do not guarantee improvements to fish passage because delay caused by the dam may be caused by the operations of the gates. Further, fish ladders represent some degree of risk because they would not improve passage for sturgeon. It is recommended that the improved fish ladders be considered as part of the overall project alternatives.

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 1 and 2, and reflecting the potential addition of a third (center) fish ladder among other conditions, an 831-cfs ladder is proposed. This size will allow for diffuser placement similar to that proposed for the right bank fish ladder and substantially simplify the required modifications to the existing ladder.

Improvements to the existing left abutment fish ladder will provide improved adult fish passage. This will be accomplished by increasing AWS flow from 265 cfs to 746 cfs. The fish ladder flow will remain at 85 cfs, although new Ice Harbor-type weirs will be installed. The fish ladder entrance bay will be reconfigured to enhance fish attraction and to accommodate the increased total flow. The existing AWS intake will be modified to include trashracks, an automated trashrack cleaner, and a gross approach velocity of 1.0 fps. The existing AWS intake will serve as a single 96-cfs wall diffuser in the entrance bay. A new AWS intake will be constructed on the left bank just upstream of the existing fish ladder exit. This intake will be similar to the one proposed for the right bank fish ladder and will be sized for the 650-cfs floor diffuser flow. The design criteria that will be used in the preliminary design of the left bank fish ladder are shown in Table A-5.

Advantages. The primary advantage of this ladder design is that the basic structures currently exist, which minimizes construction impacts. Other advantages are that the technology is widely accepted and has been implemented in other fish passage projects.

TABLE A-5
Design Criteria for the Left Bank Fish Ladder

River Design Flows	**cfs**
100-year Flood	206,000
Maximum River Flow for Fish Ladder Operations	20,000
Minimum River Flow for Fish Ladder Operations	2,200
River Elevations and Gross Heads (refer to tailwater rating curves)	**feet**
Forebay Level	252.5 ± 0.2
Maximum Tailwater Level (for fish ladder design)	242.0
Minimum Tailwater Level (for fish ladder design)	237.6
Maximum Gross Head	14.9
Minimum Gross Head	10.5
Fisheries Criteria	**each**
Type of Fish Ladder	Pool and weir
Weir Type	Ice Harbor with 9-inch sidewall slots
Number of Pools	14
Pool-to-Pool Differential	1.0 ft or less
Pool Turbulence Factor	4.0 ft-lb/sec/ft^3
Fish Ladder Entrance Velocity (average)	5.6 fps
Entrance Bay to Tailwater Differential	1.0 ft
Floor Diffuser V_n	0.5 fps
Wall Diffuser V_n	1.0 fps
AWS Trashrack V_n	1.0 fps
Transport Channel Maximum Velocity	4.0 fps
Transport Channel Minimum Velocity	2.0 fps
Monitoring and Evaluation Facilities	
Viewing Window	To be determined
Counting Facilities	To be determined
Adult Trap	To be determined
Fish Ladder Hydraulic Performance	**cfs**
Weir Flow	85
AWS Flow	746
Floor Diffuser Flow	650
Wall Diffuser Flow	96

Disadvantages. A biological disadvantage of fish ladder improvements is that they might not address problems relating to delay at the dam. Additionally, ladders would not provide passage for sturgeon, and thus may pose a risk to future operations if sturgeon, or other fish with similar swimming characteristics, are listed under ESA or otherwise require changes in dam operations.

Screening Evaluation.

Effectiveness

- This type of fish ladder design has proven to be effective in other locations and would likely represent an improvement over the existing ladders.
- Improved passage for sturgeon would not be achieved with these facilities, unless they were implemented with a reduction in gates-in operation.

- It is possible that improved ladders would not reduce delay at the dam, which is considered to be the major effect of the dam on migrating fish.

Environmental

- Because of the current dam operations, it is considered likely that this type of facility could be built without incurring impacts to fish passage during construction.
- Future listings of fish, particularly sturgeon, could require additional operational changes at the dam if this facility option is selected.
- No significant changes to the existing environmental setting are anticipated with this option.

Implementability

- Because the structures are already in place, there is no need for in-river construction; therefore, this option should have minimum impact on continued uninterrupted water delivery and should not impact fish passage during construction.
- Construction of this facility would not preclude land use near the proposed locations, and operation of the fish ladders is consistent with the management objectives of the proposed locations.
- Since the site is already in use for water delivery, no new permits are expected, and no land acquisition is needed.

Cost

- The construction cost per unit of fish passage is greater than that for gates-out operation.
- Overall, the O&M cost of this alternative is expected to be slightly, but not significantly, higher than the existing fish ladders.

Conclusion. Improved fish ladders would rely on accepted technologies used at other facilities to improve salmonid passage. However, the improvements to the ladders do not guarantee improvements to fish passage because delay caused by the dam may be caused by the operations of the gates. Further, fish ladders represent some degree of risk because they would not improve passage for sturgeon. **It is recommended that the improved fish ladders be considered as part of the overall project alternatives.**

Bypass Channel. 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. 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.

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, it must meet the following criteria:

- Be passable by all species of concern.

Velocities in the channel should be considerably lower than in standard fish ladders. Literature review suggests that maximum velocities of 3 fps in the majority of the channel would be appropriate to pass non-salmonid species, with maximum velocities of 6 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 will 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 using the premise that this will reduce stranding and further enhance drainage. Additionally, it is assumed that the rock covering the bottom of the channel will 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 to minimize interference with the Sacramento River Discovery Center (SRDC), the existing road, the U.S. Forest Service (USFS) campground, and the existing fish ladder and its proposed improvements.

- 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 with respect to the 1,000-cfs operational condition 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.

- 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.

- Not be subject to 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 will also be contoured to allow drainage via a subchannel along both sides of the channel floor. The channel floor will be grouted to avoid stranding juvenile fish during dewatering of the channel. The channel will be armored with rock to minimize scour and sloughing of the banks.

- Economically viable.

At 1,000 cfs, the channel will carry approximately the same amount of flow as an improved fish ladder, while at the same time, the capacity will 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.

- 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 A-3 and A-4.

Screening Evaluation.

Effectiveness

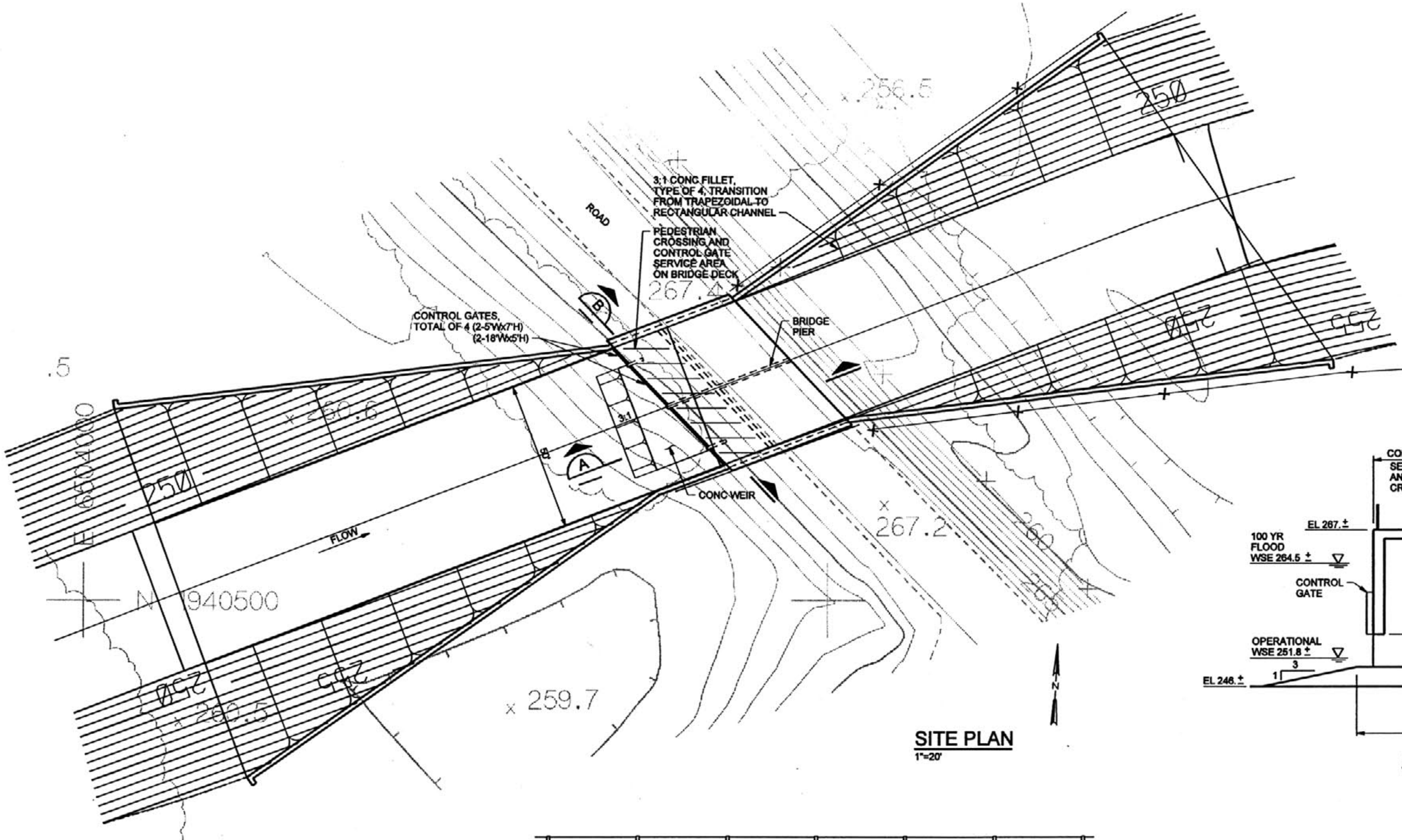
- This type of fish passage facility is considered experimental, with a significant risk of failure to achieve the intended improvements to fish passage.
- Improved passage for sturgeon might be achieved with these facilities because the flow conditions used as design criteria are considered to be compatible with sturgeon passage.
- It is possible that a bypass facility would not reduce delay at the dam, which is considered to be the major effect of the dam on migrating fish.

Environmental

- Because of the current dam operations, it is considered likely that this type of facility could be built without incurring impacts to fish passage during construction.
- Future listings of fish, particularly sturgeon, could require additional operational changes at the dam if this facility option is selected.
- This alternative would require replanting a portion of a mitigation area located east of the campground on the left bank of the river.

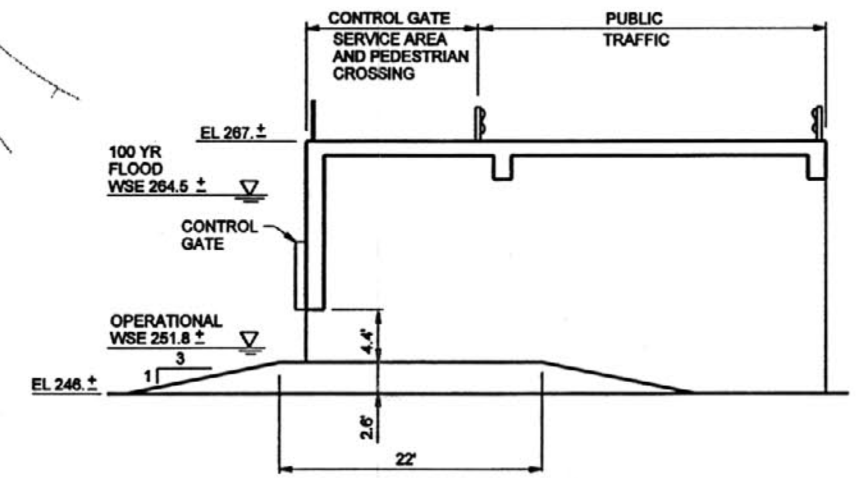
Implementability

- This structure would affect existing uses of the area near the left abutment of the dam. The SRDC, campground, and nearby facilities would require relocation. Finding a suitable replacement site might not be feasible.
- USFS is the land management agency for the proposed site. USFS has issued a preliminary opinion stating that the bypass channel would not be consistent with its land management plan. Building a facility that is inconsistent with the existing land management plan might not be feasible.



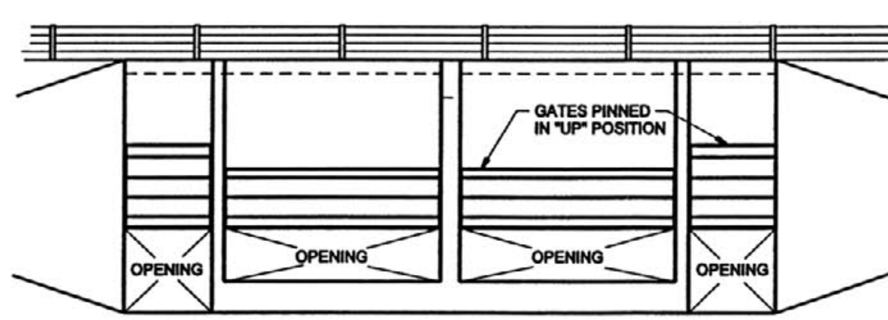
SITE PLAN

1"=20'



SECTION A

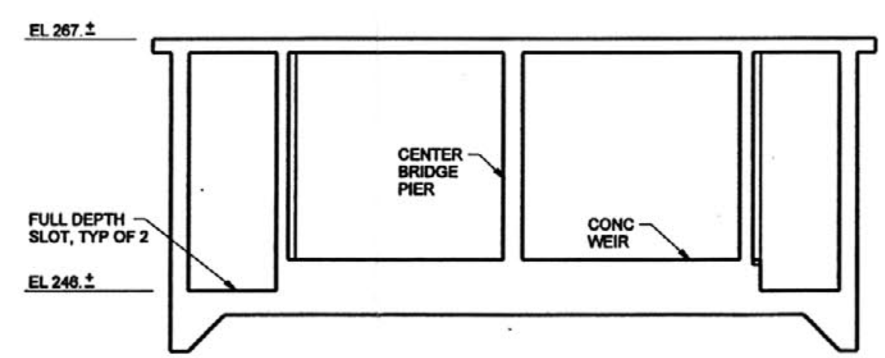
1/8"=1'-0"



GATES UP, BYPASS CHANNEL IN SERVICE, LOOKING DOWN STREAM

ELEVATION

1/8"=1'-0"



SECTION B

1/8"=1'-0"

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

CH2MHILL

W042002002RDD_981 (8/15/02)

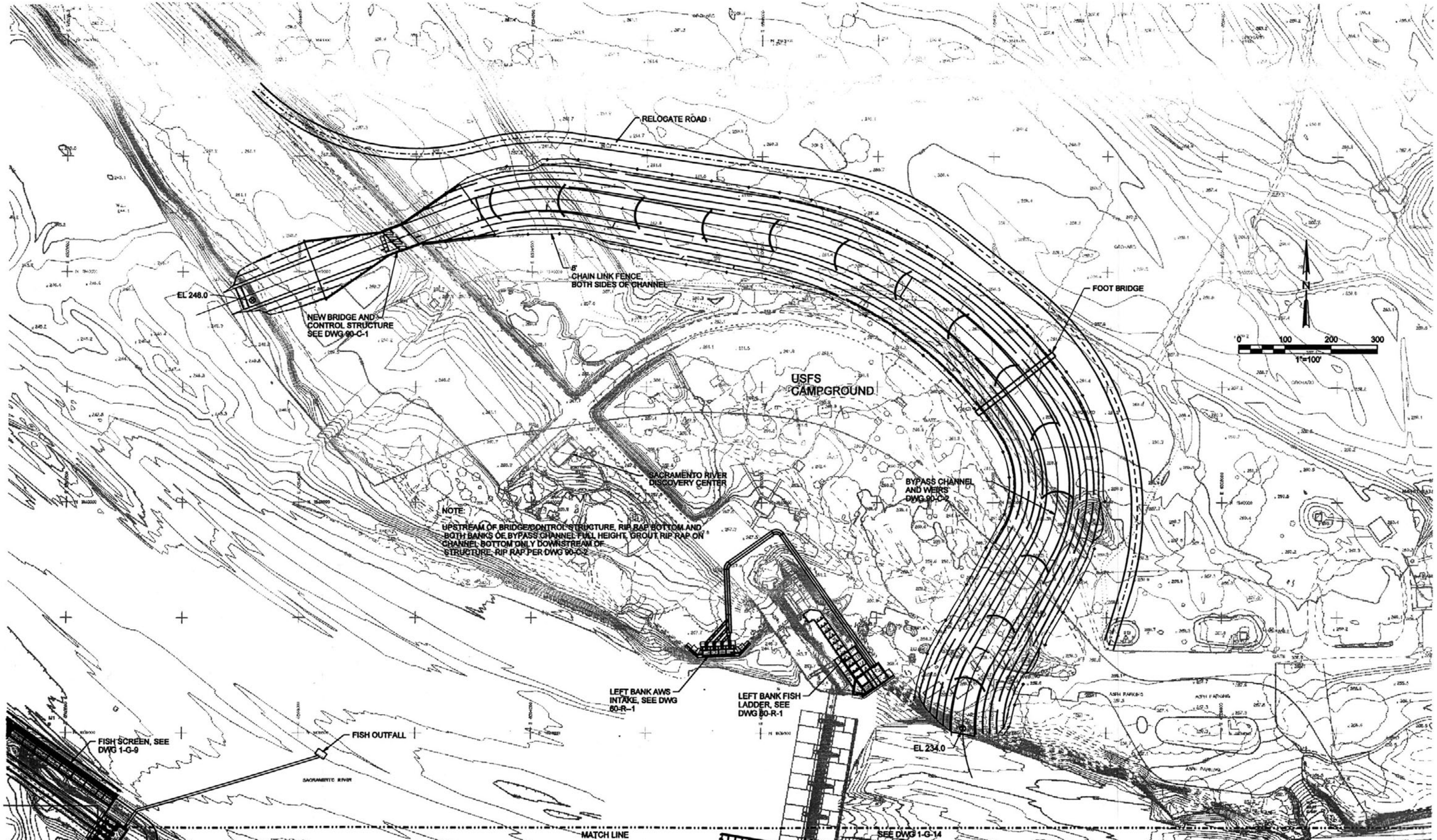


FIGURE A-4
RBDD SITE GRADING PLAN
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR
CH2MHILL

W042002002RDD_991 (8/15/02)

- Construction of this facility would not preclude land use near the proposed locations, and operation of the fish ladders is consistent with the management objectives of the proposed locations.
- Since the site is already in use for water delivery, no new permits are expected, and no land acquisition is needed.

Cost

- The construction cost per unit of fish passage is greater than that for gates-out operation.
- Overall, the O&M cost of this alternative is expected to be slightly, but not significantly, higher than the existing fish ladders.

Conclusion. Decisions to reject the bypass alternatives have been presented in a number of public forums, most recently in August 2000 at a Public Scoping Meeting, and in September 2000 at a Public Stakeholder Meeting. At both of these meetings the public was overwhelmingly critical of the decisions to reject bypass alternatives as a viable solution to fish passage problems at RBDD. Public meetings that were held on the 1992 Appraisal Report and 1995 Bypass Evaluation Report also received negative reviews. Major concerns were voiced by members of the public regarding the process by which decisions were made, the cost of proposed alternatives, and the need for action at RBDD. Comments in support of bypass alternatives have primarily come from citizens of Red Bluff. Implementation of the bypass channel, as currently designed would be difficult because of the land use conflicts it would incur; however, in response to intense public interest, the facility is being carried forward. **Accordingly, it is recommended that a bypass alternative be added to the EIS/EIR as an alternative warranting full consideration.**

Pumping Facilities

Pumping options were evaluated using the secondary screening criteria for each potential facility. Three onsite and ten offsite locations for pumping facilities were identified and screened in the Prescoping Report (CH2M HILL, 2000). The potential onsite locations considered in the Prescoping Report were the headwater, tailwater, and sedimentation basin locations. The offsite locations considered were distributed along the Sacramento River from about ½ mile upstream of RBDD to Woodson Bridge, which is approximately 24 miles downstream of RBDD.

Each pump station site configuration consists of trashracks or fish screens, a forebay or intake piping, a 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. Many potential combinations of intake and pumping facilities options are associated with each alternative. Both Archimedes screw or helical pumps and vertical propeller pumps were considered.

Onsite Pump Station Facilities

Tailwater Pump Station – Screw/Helical Pumps. The Tailwater Pump Station (TPS) would be located immediately downstream of the right bank fish ladder at the current site of the RPP. TPS options fall into two categories: incorporating the existing RPP with modifications, and constructing a new TPS using conventional vertical propeller pumps in place of the screw and helical pumps in RPP.

The screw/helical pump option would use the existing RPP intake and discharge facilities and structures, and fish bypass system. The two existing Archimedes screw pumps and the helical pump would be retained, and one new helical pump would be installed in the currently unused fourth bay. The existing trashrack, intake and discharge piping, fish screen, and fish bypass system would remain in place with little or no modification. A fish screen would need to be installed in the new pump discharge channel.

Advantages. The primary advantage of this pumping option is that the basic structures and three of the pumps already exist, which minimizes construction impacts. Other advantages are that access and power are in place, a new fish screen facility would not be required in the river or RPP, and the capital investment that it represents would be used, minimizing new development cost. This pumping option is the easiest to implement and the least expensive means of achieving 320 cfs of installed capacity.

Disadvantages. A biological disadvantage of the screw pump option is that it removes more fish from the river via the bypass system than the options that include fish screens along the river. However, studies have documented low fish mortality rates, less than 5 percent, with the screw or helical pumps.

Unless the drum screen fish bypass is active, fish bypass flow velocities would not meet agency minimum velocity in bypass outfall criteria without modifying the outfall.

Another operating disadvantage of the screw/helical pump option is that water users are concerned about the long-term reliability and O&M costs of RPP technology. Because of limited operating experience for screw and helical pumps in this pump size, it is difficult to forecast the long-term reliability and O&M cost of the facility.

Additional pumping capacity would be needed at another location to satisfy peak water needs. Pumping from more than one location complicates operations. Another potential disadvantage is that RPP may not be available for research once it is dedicated to delivering irrigation water. These are not expected to be significant disadvantages.

Screening Evaluation.

Effectiveness

- This pumping option is not considered as biologically effective as options that leave the fish in the river.
- Because of the need to provide additional water to meet the minimum flow velocity criteria in the fish bypass piping system, this pumping option may not be as effective in delivering water as other pumping options.
- The long-term operating performance and O&M costs of the screw and helical pumps is unknown, so the operational effectiveness of using these pumps is considered less than TPS using the more conventional vertical propeller pumps.

- This pumping option would need to be used in combination with other facility options at another location or locations. The operational effectiveness is somewhat more complicated with the multiple locations for pumping.
- These pumps could be limited to delivering water during peak periods to minimize the operation time.
- Overall, this option is not considered to be as biologically or technically effective as other options (in terms of reliability of mechanical equipment).

Environmental

- Because the structure is already in place, the TPS RPP option is the least disruptive to the environment.
- If this option were used with an offsite pump station, the size of the offsite pump station would be reduced from a full-capacity pump station, which would decrease the impacts associated with developing a new site.
- No significant changes to the existing environmental setting are anticipated with this option.

Implementability

- Because the pumps and pump station structure are already in place, there is no need for in-river construction; therefore, this option should have minimal impact on continued uninterrupted water delivery and should not impact fish passage during construction.
- Since the site is already in use for water delivery, no new permits are expected, and no land acquisition is needed.
- This is the easiest option to implement; however, it is contingent upon NMFS acceptance.

Cost

- The construction cost per unit of water delivered is significantly lower for this option than for all other pumping options because the pump station structure and three of the four pumps are already in place.
- The power costs of operating screw/helical pumps at this location is comparable to operating vertical propeller pumps at the Mill Site and is less than the power costs at Site 2, Walnut Orchard Site, for a comparable amount of water delivered.
- This site is downstream from Red Bank Creek and therefore is expected to have a higher potential for sediment deposition and need for dredging.
- Overall, the O&M cost of this alternative is expected to be slightly, but not significantly, higher than the Mill Site vertical propeller pump option.

Conclusion. The screw and helical pumps in RPP have been characterized by poor past mechanical performance. The lack of long-term experience with the fish-friendly pumps in a full-scale application makes it difficult to assess long-term reliability and O&M

requirements in comparison to propeller pumps. The intake structure and three pumps are already in place making this the lowest construction cost per unit of water delivered pumping option. This option should have only limited environmental impacts because structures are already in place, and the site is already being used for water intake facilities. Construction should have little or no impact on operations of the existing facilities. It is the easiest option to implement since the structure is already in place. Using the pump station only during peaks could also allow further research on the screw/helical pump performances during off-peak periods. **It is recommended that RPP modifications be considered as part of the long-term pumping option.**

Tailwater Pump Station – Vertical Propeller Pumps. These TPS options would replace the screw pumps in the existing RPP structure with vertical propeller pumps. This would require that the trashracks along the river be replaced with fish screens. The pumping capacity is limited and depends on the length of the fish screen. The existing trashrack, intake and discharge piping, and fish bypass system would be demolished; and a new forebay and new discharge piping from the pumping station to the sedimentation basin would be constructed. A fish bypass system is not expected to be required for this option because of the relatively short fish screen length.

Two capacity variations were considered for the vertical propeller pump option: 600 cfs and 750 cfs. The water delivery capacity is limited by the length of the fish screen.

Advantages. Installing vertical propeller pumps in place of RPP overcomes most of the disadvantages associated with the screw/helical pumps. For the 600-cfs option, it is assumed that the fish are screened on the river, and no fish bypass would be required, which would eliminate increased predation or migration delays.

The vertical propeller pumps have an excellent long-term operating history. The length of the discharge piping is short compared to offsite pumping options. The existing RPP structure can be modified to accommodate the vertical propeller pumps, thereby taking advantage of the existing capital investment in the structure.

Disadvantages. The primary disadvantage of these options is that substantial demolition and reconstruction of the existing RPP structure would be required. Cofferdams would need to be built in the river and around the existing facilities for construction of the in-river fish screens and the pump station forebay. Modification of the internal structure of the existing pump station bays would be required to accommodate the different type of pumps.

Construction scheduling for the TPS vertical propeller pump station option would be more complicated than for the full-capacity pump station at an offsite location. The operation of the existing facilities could be impacted by construction of TPS.

Construction of new conventional vertical propeller pumps at the tailwater site would require new fish screens. The design of the fish screens would be subject to the criteria and approval of the fishery agencies.

This site is downstream from Red Bank Creek and could result in sediment deposits from Red Bank Creek in front of the screens or in the TPS forebay, requiring periodic dredging.

Another disadvantage is that the physical constraints of the site limit the pumping capacity; thus, a pump station would be required at one or two other offsite locations to satisfy the total peak water need, which could complicate operations.

Screening Evaluation.

Effectiveness

- The TPS with vertical propeller pumps would be effective in delivering water and, once construction is begun, should be biologically effective.
- Having an offsite pump station is considered to be less effective than operating one pump station.

Environmental

- Because of the need to construct a cofferdam in the river at the downstream end of the existing fish ladders, this option could have some temporary negative water quality and biological impacts associated with working in the water. The full impacts on fish passage from the construction in the river near the fish ladder are unknown.
- There would be no change in land use because this site is already used for intake and pumping.

Implementability

- Permits from the U.S. Army Corps of Engineers (USACE) and the Regional Water Quality Control Board (RWQCB) are required for construction activities in the river.
- The scheduling of this option is more complex than using the RPP or the offsite pumping options.
- The existing RPP would need to be removed from service at the start of the construction of the vertical propeller pump options; therefore, RPP capacity would not be available for water deliveries.
- During construction, the available peak pumping capacity would be less than the peak design pumping capacity.

Cost

- The construction cost per unit of water delivered is less for both the 600-cfs and 750-cfs vertical propeller pump options than for developing full pumping capacity offsite. However, in combination with an offsite pump station, there is an apparent cost disadvantage to converting RPP to a vertical propeller pump station. The combination of the expanded RPP and an offsite pump station is the least-cost option.
- The maintenance costs are expected to be somewhat higher at the TPS site because of the anticipated dredging needs and the operation of more than one pump station.

Conclusion. The TPS vertical propeller pump options do not have any apparent advantage compared to developing the total pumping capacity using a combination of RPP and a new pump station at an offsite location or a new full-capacity pump station at a single offsite location for the following reasons:

- Substantial demolition and potential interference with existing structures
- Complexity of scheduling
- Potential interference with current operations
- Reduced delivery capacity during construction
- Increased complexity in operating multiple pump stations

While the cost of this pump station option in combination with the Mill Site Pump Station is lower than developing full capacity at the Mill Site Pump Station alone, it is greater than the combination of the RPP and the Mill Site Pump Station. **Because of this, there is no apparent advantage to further considering the TPS option using a vertical propeller.**

Headwater Pump Station. The Headwater Pump Station (HPS) would be located in front of the existing RBDD headworks and right bank fish ladder exit just outboard of the existing sheet pile wall that directs flow and controls sediment. A new fish screen, forebay, and pumping station would be constructed; and a new discharge pipe would be installed to the existing gravity intake channels. The fish screen length is approximately 230 feet including a blowout panel. A fish bypass system is not anticipated for the HPS because of the short fish screen length.

HPS would be used only during gates-out operation. Fish screens installed in the river must be removable to allow the operation of the fish ladders during gates-in operation. When the gates are in and the right bank fish ladder is in service, the fish screens would be removed from the water to allow a free inlet for the headworks and a free exit for the fish ladder. This is similar to the current operation of the right bank fish ladder pump station.

Advantages. Many of the same advantages of TPS apply to HPS. The fish screen is short enough that it is assumed that NMFS would grant a variance to the 60-second exposure criterion. Because it is assumed that there would be no fish bypass, the fish would stay in the river, and the risks to fish associated with the bypass would be obviated. Also, HPS is onsite, and access and power to the site already exist. In addition, the length of discharge piping is short compared to offsite options because of the proximity to the TC and Corning canal forebay.

Disadvantages. The operation of a pump station at HPS would be more complicated than operation of a pump station at other locations. During the time that the gates are in, the screens would need to be removed from the river and panels placed in the forebay to guide upstream migrating fish to the river from the right bank fish ladder exit. The pumps and screens could be permanently installed for the gates-out option, but permanent screens would remove all flexibility for gates-in operations, even for short periods. The operation of the total pumping system also would be more complex if HPS was developed as a part of the total pumping system because of the need to pump from more than one pump station to achieve the required pumping capacity.

Because of its proximity to Red Bank Creek, the HPS option is the most vulnerable of the pump station locations to sedimentation deposits and the need for periodic dredging. Continuous sediment management, including periodic dredging, would be required.

Scheduling for the construction of the HPS would require careful sequencing with the operation of the existing system. The total available peak capacity would be reduced during construction.

Screening Evaluation.

Effectiveness

- This option should have a relatively high biological effectiveness because no fish bypass is anticipated.
- This option is considered the most complicated to operate. The fish screens would need to be removed at any time the gates are in to allow operation of the right bank fish ladder.
- The need for sediment removal in the forebay and area in front of the screens is expected to be more intensive at this location than at other pumping locations.

Environmental

- This option could have some temporary biological and water quality impacts associated with working in the water near the cofferdam location in relation to the fish ladder. The time period that the cofferdam would be in the water would be limited to the period when gates are out and the fish ladders are not operating. This could result in the need to construct the new facilities in the fall, winter, and spring when the risk of flooding and weather-related damage is greatest.
- The site is already used for intake and pumping, so there would be no new long-term site impacts, no land acquisition required, and no change in land use.

Implementability

- Permits from USACE, RWQCB, and CDFG would be required.
- The scheduling for this option would be one of the most complicated of all pumping options since the construction period would be limited to the time when gates are out and the fish ladders are not in use.
- The gravity-flow intake would not be operable when the cofferdam is in the water.

Cost

- The construction cost per unit of pumping capacity is higher than the other onsite options but is virtually the same as for the Mill Site vertical propeller pump option.
- Of all options presented, this pumping option is considered the most complicated to operate.
- The need for sediment removal in the forebay and area in front of the screens is expected to be more intensive at this location than at other pumping locations because of the location immediately downstream from the confluence of Red Bank Creek.

- The power costs would be similar to the TPS and Mill Site vertical propeller pump options.
- The overall O&M costs are expected to be higher.

Conclusion. The complexity of construction scheduling, the higher O&M cost because of the need to remove the screens during gates-in operation, and the higher potential for sediment deposition requiring dredging offset the apparent advantages of developing HPS. **There is no apparent construction cost advantage for developing this option compared to the offsite Mill Site vertical propeller pumping option; therefore, HPS will not be considered further.**

Sedimentation Basin Pump Station. The Sedimentation Basin Pump Station was identified as an option because all of the needed pumping capacity could be developed onsite. Access and power already exist at the site. The operation of the pump station would be simpler compared to options that include pump stations located at multiple sites or at on offsite location. The discharge conveyance system is short compared to offsite options.

For the Sedimentation Basin Pump Station option, TPS and HPS would not be used. All of the needed pumping capacity could be developed at the Sedimentation Basin Pump Station using conventional vertical propeller pumps or screw/helical pumps. For this option a new intake would be needed. The intake would be immediately downstream from the entrance to the right bank fish ladder. New trashracks would be required on the river to remove large debris and keep larger fish from entering the intake. A wall would be constructed across the sedimentation basin to isolate the existing drum screens and the southern end of the existing sedimentation basin. The wall would be necessary to optimize the balance of the flow rates through the fish screens.

For the Vertical Propeller Sedimentation Basin Pump Station option, a fish screen would be constructed in the basin, and a pump station would be constructed to lift the water to a new canal where it would then gravity flow to a discharge location just upstream from the TC and Corning canal intakes. The drum screens would be isolated and out of service during operation of the Sedimentation Basin Pump Station. A fish bypass system would be constructed to remove the fish from the front of the screens. Fish bypass pipelines would convey water and fish from the screens to fish-friendly screw or helical pumps. These fish bypass pumps would lift the water and fish to an elevation necessary to discharge into the existing fish bypass system.

For the Screw/Helical Pump Sedimentation Basin Pump Station option, a bank of screw or helical pumps would lift the water and fish to a discharge channel where the fish would be removed from the water by vertical fish screens similar to those at RPP. The fish and bypass water would enter a new fish bypass system that connects to the existing drum screen bypass system for conveyance to the existing bypass outlet in the Sacramento River.

Advantages. The sedimentation basin pump station was identified as an option because all of the needed pumping capacity could be developed onsite. Access and power already exist at the site, and the operation of the pump station would be simpler compared to options that include pump stations located at multiple sites or at one offsite location. The discharge conveyance system is short compared to offsite options.

Disadvantages. Biologically, this option appears to be the least desirable. A pumped fish bypass would have to be constructed. The biological risks are that fish would not find the bypass system and would be delayed in their pool area in front of the fish screen, or that predators would have an unnatural advantage over juvenile salmonids where the fish congregate in the slow-moving pools, particularly during minimum water delivery periods.

This is also the most complex construction scheduling pumping option. The schedule would need to be phased to consider and avoid impacts to existing operations. The water supply provided by the RPP screw pumps might not be available during construction of the Sedimentation Basin Pump Station because of the intake channel and fish screen structure.

Property acquisition would be required for this option. Part of an existing walnut orchard would be removed from production. A land use variance may be required to remove the land from existing agricultural use.

The sedimentation basin would be highly vulnerable to sediment deposition in front of the fish screens. This condition would warrant continuous sediment management and would require periodic dredging.

Screening Evaluation.

Effectiveness

- This option is considered the least biologically effective because of the "dead end" pool in front of the fish screens. Effective fish management depends on the ability of the fish to find and use the bypass entrance along the fish screens.
- This option is not considered as fish friendly as the options that screen the fish in the river.
- Sediment deposition could be a significant maintenance requirement to maintain the effective wetted fish screen areas.

Environmental

- There would be some impact associated with construction of the intake facilities. Cofferdams would be constructed in the river for the construction of the intake channel. The cofferdams could impact the effectiveness of the right bank fish ladder.
- ~~The site in the~~ The area near the intake channel is already used for water diversion, so there are no impacts on cultural resources or land uses.
- The proposed forebay, pump station, and discharge channel would be sited on land that is presently in agricultural use. Several mature walnut trees would be removed from production under the proposed facility layout.

Implementability

- A USACE permit would be required to perform construction in the Sacramento River.

Cost

- Land purchase would be required to implement this option, and a variance may be required to remove the land from agricultural use.
- The complexity of construction scheduling is high for this option; the existing facilities would need to remain in operation during the construction of the new Sedimentation Basin Pump Station facilities.
- Discharge piping from the existing RPP may need to be rerouted to permit the construction of the intake channel and the fish screen structures.

Conclusion. The disadvantages of the sedimentation basin pump station option, particularly the negative biological impacts to fish, the complexity of construction sequencing, and the high potential for sediment deposition far outweigh the advantage of developing a full-capacity pump station onsite. **Therefore, the Sedimentation Basin Pump Station will not be considered further**.

Offsite Pump Station Facilities

Ten potential pump station locations were identified in the Prescoping Report in addition to the existing location at RBDD. After preliminary screening during Phase I, one upstream site, the Mill Site, and one downstream site, Site 2, were judged to be superior to other site options and retained for further evaluation during Phase II.

A pumped fish bypass would be required for either of the offsite locations because there is not enough gradient in the river to drive a gravity bypass system. The river characteristics are similar at the Mill Site and Site 2, although Site 2 has a greater water depth, which reduces the required length of the fish screens. The entire peak pumping capacity could be developed at either of the offsite locations, thus eliminating the disadvantages of multiple pump station locations and the complexity associated with construction scheduling and sequencing at RBDD, potential interference from the existing structures, and the potential operating impacts.

Mill Site Pump Station – Screw/Helical Pumps. Fish-friendly pumps were identified as a potential option because the existing drum screens and fish bypass system could be used, and a new fish screen along the river would not be required. Trashracks would be similar to the existing trashracks used in front of RPP and would be installed along the river. The Outlet B screens would be used to screen fish. The fish bypass system would be over 4,000 feet long, including the discharge piping from the intake location to the sedimentation basin and the existing bypass piping from the drum screens in the sedimentation basin to the fish bypass outlet in the Sacramento River.

Advantages. The Mill Site screw/helical pump station option would use the existing drum screens and fish bypass system. New on-river fish screens would not be required, but trash-racks and louvers would be needed. The pump station could be constructed independently of the existing RBDD, so there would be no risk of interruptions to current water delivery operations during construction. The site is closest to the existing TC Canal forebay among the potential offsite locations. Power supply is nearby. The proposed use is more compatible with past and current land use on the site and in its vicinity. The potential for bank erosion does not appear to be as great for the Mill Site as for Site 2.

Disadvantages. A biological disadvantage of the screw/helical pump option is that it removes more fish from the river than the options with fish screens along the river. Because this option potentially removes more fish from the river than any other pump station option being considered, it would appear to be the least biologically desirable option.

Another disadvantage is the limited operating experience with the screw/helical pumps. There is no long-term operating experience with this type and size of pump in this configuration. Thus, it is considered the highest operational-risk pumping option and is the least acceptable to water users.

Furthermore, the drum screen mesh size does not meet the current agency fish screening criteria. NMFS has indicated that the mesh size will be acceptable until the mesh needs to be replaced.

At least three times the number of pumps would be required for the screw/helical pump option compared to the vertical propeller pump option because the upper capacity of the screw/helical pumps is limited to about 80 cfs, whereas a 250-cfs vertical propeller pump could be used. Consequently, the cost of a pump station that uses screw/helical pumps is about three times the cost of a pump station that uses vertical propeller pumps. Also, because this option would require more pumps, a larger structure is needed to generate an equivalent pumping capacity compared to a facility that uses propeller pumps.

In addition to a siphon under Red Bank Creek, access from the RBDD site would be provided by a new bridge crossing of the creek. Construction of both the siphon and bridge would result in construction-phase environmental impacts.

Screening Evaluation.

Effectiveness

- The full screw/helical pump option is considered the least biologically effective of the options being evaluated because it removes the most fish from the river.
- The operational effectiveness (long-term performance) of the screw/helical option is unknown because of the short operational history for these pump types in this application.

Environmental

- Because of the need to construct a siphon under Red Bank Creek and a bridge across the creek, this option would have some temporary negative environmental impacts associated with the need to remove riparian vegetation.
- A cofferdam would need to be constructed in the river to allow the construction of the trashracks and louvers. This would have some short-term biological and water quality impacts.
- The Mill Site is currently vacant. It was used in the past for industrial purposes. However, because of its previous uses, there is some concern about hazardous waste

contamination. Preliminary investigations suggest that any cleanup would be relatively minor, but further investigation is needed to confirm the preliminary findings. Because this site was previously in industrial use, no significant long-term site impacts are anticipated.

Implementability

- Construction of pumping facilities at this offsite location would have very limited interference with the operation of the existing facilities.
- Construction of trashracks along the river would require a USACE permit.
- This option would require purchase of land.
- Compared to Site 2, the property at the Mill Site appears to be more available for purchase. It is currently being offered for sale.
- NMFS's acceptance of the screw/helical pumps for full-scale operation would be required to implement this option. If NMFS does not approve the use of screw/helical pumps, this option would not be implementable.

Cost

- The cost of developing the Mill Site using screw/helical pumps is higher than the cost of using vertical propeller pumps at this site. The cost of each screw or helical pump is much greater than the cost of each vertical propeller pump even though the capacity is about one-third. Although fish screens are not needed, an intake structure is still required along the river, which partially offsets the advantage of not having to install the in-river fish screens.
- The O&M costs are expected to be higher than those for the option of using vertical propeller pumps at this site because of the slightly less efficient pumps and the greater number of pumps to maintain.
- The long-term performance O&M costs are unknown because of the limited operating experience in this size, configuration, and application.

Conclusion. Because of the biological disadvantages associated with removing fish from the river and the long bypass, the lack of long-term operating experience, the limited mechanical performance history, and the higher cost and lower efficiency of screw pumps compared to vertical propeller pumps, **the pumping option of using screw/helical pumps for full capacity pumping at the Mill Site will not be considered further.**

Mill Site Pump Station – Vertical Propeller Pumps. For the vertical propeller pump option, the discharge piping would be routed to a new outlet structure at the sedimentation basin. It is assumed that the drum screens would be removed under this option. 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.

Advantages. The Mill Site pump station could be constructed independently of the existing facilities and, therefore, would not interfere with the operation of, nor be impacted by, the existing structures. This site has several advantages compared to Site 2. The facility is near the existing RBDD, which requires a shorter conveyance pipeline than would be needed at Site 2. The land where the pump station would be constructed is adjacent to land owned by the federal government for RBDD and is currently available for purchase. Power supply is nearby, and access is in place. However, direct access to the site from the existing RBDD site would require a bridge across Red Bank Creek.

The conveyance system is shorter for the Mill Site Pump Station option compared to the Site 2 Pump Station option. The use of the Mill Site for a pump station is more compatible with current and past land uses.

The existing RBDD provides a hard point in the river that would help to protect bank stability. The potential for bank erosion is not as great for the Mill Site as for Site 2.

Disadvantages. A disadvantage with the Mill Site is that the conveyance system would need to cross under Red Bank Creek by means of a siphon. This could result in temporary environmental impacts during construction because of the need to remove riparian vegetation and disturb riparian habitat. Because the site was used for industrial purposes, there is a potential that hazardous wastes occupy the site, which would have to be cleaned up during construction. However, preliminary data searches and site observations have suggested that very little cleanup would be required. This option also would require a pumped fish bypass because of the long exposure time along the in-river fish screens.

Screening Evaluation.

Effectiveness

Internal fish bypasses would be required at this location. The number of bypasses depends on the pumping capacity that is developed at this location.

- Because of the longer screen length than at Site 2, this option could have one more bypass pipe and pump than required for the same capacity at Site 2.
- The use of in-river fish screens is considered more biologically effective than the options that remove fish from the river.
- Vertical propeller pumps are slightly more efficient than screw/helical pumps and have a longer-term operational history. Construction of offsite pumping facilities would have no impact on present water deliveries.

Environmental

- Like the screw/helical option, this option requires the construction of a siphon under Red Bank Creek and a bridge across the creek. This construction would result in some temporary negative environmental impacts associated with the need to remove riparian vegetation and disturb riparian habitat.
- There would be a need to construct a cofferdam in the river to allow the construction of the fish screens. This could have temporary biological and water quality impacts.
- The length of the fish screens is longer at this location compared to the Site 2 for the same amount of intake capacity because of the shallower depth at the Mill Site.

- Because of its previous industrial uses, there is some concern about hazardous waste contamination.

Implementability

- Construction of pumping facilities at this offsite location would have very limited interference with the operation of the existing facilities.
- Construction of fish screens along the river would require USACE, CDFG, and RWQCB permits.
- This option would require purchase of land. It is currently offered for sale.
- NMFS's acceptance of the screw/helical pumps for the internal fish bypass system would be required.

Cost

- The construction cost per unit of water delivery capacity is less for the Mill Site vertical propeller pump station option than for Site 2. It is also less than for the screw/helical pump option at the Mill Site.

Conclusion. The Mill Site vertical propeller pump station has several advantages compared to the other options. It can be built without interfering with current operations at RBDD and has lower construction costs than the other offsite pump station location that is being considered. Land is currently available for purchase at this site. **Because of these positive benefits compared to other offsite pump station options, the Mill Site vertical propeller pump option will be carried forward into the preliminary design.**

Site 2 Pump Station – Vertical Propeller Pumps. Site 2, the Walnut Orchard Site, is located approximately 2 miles downstream from the existing RBDD. The site is currently used for a walnut orchard. The intake from the Sacramento River would be about 1 mile east of the TC Canal. A pump station using either Archimedes screw or helical pumps was identified as a possible option for this location. Because of the cost and capacity limitation of the screw/helical pumps, that option was disqualified from further consideration.

Site 2 facilities would include fish screens in the Sacramento River, a forebay, a structure for the pumps, an electrical building, conveyance pipelines, and discharge structures. Peak pumping capacity would vary from zero to 2,500 cfs, similar to the required capacities for the Mill Site, depending on the alternative and combination of onsite and offsite pump stations selected.

Advantages. The principal advantage of all offsite pump station options is that the pump station and related facilities can be constructed completely independently of the existing facilities. Therefore, construction would not impact current operations and would not be impacted by the existing facilities. The river at Site 2 is deeper than at the Mill Site. The greater water depth is more favorable for an intake, results in a shorter fish screen, and potentially requires one less fish bypass than at the Mill Site.

Disadvantages. A biological issue of concern at Site 2 is the potential for the presence of valley elderberry shrub. This shrub provides essential habitat for the valley elderberry longhorn beetle, which is listed as a threatened species under the federal ESA. This vegetation would need to be permanently removed for the construction of in-river fish screens at this location.

Site 2 is not as desirable as the Mill Site because it is more remote from RBDD, being about 2 miles downstream. The intake site is approximately 1 mile from the TC Canal, compared to about one-half mile for the Mill Site. Therefore, the conveyance system is about twice the length of that needed for the Mill Site.

The land uses at and adjacent to the Mill Site are more compatible with the pump station than at Site 2 because all of the facilities at Site 2 would be constructed on currently private lands. Site 2 is in agricultural production, whereas the Mill Site was previously used for industry. A substantial number of productive walnut trees would need to be removed for construction of the facilities. Site 2 would also require more land purchase than the Mill Site because of the greater length of the conveyance system. About one-half of the conveyance system required for delivering water to the TC Canal at the Mill Site is already on USBR-administered property.

Power is not available at Site 2; therefore, a power supply would have to be developed. Access to the site would also need to be developed. The access road would follow the route of the conveyance facilities from the TC Canal to the river. The access road would be approximately 1 mile long.

The land immediately downstream from Site 2 was recently purchased under SB 1086 as part of the program to restore the riparian wetland zones along the Sacramento River. The land where the pump station would be located could be purchased for riparian restoration, or at least development of the site could meet stiff opposition from groups interested in restoring that reach of the Sacramento River to a natural meandering river. Even if the site itself were not within the free and natural river restoration area, converted nearby lands that were restored to the natural and meandering state would significantly influence the stability of the river at that location.

The preliminary geotechnical engineering evaluation, which included site observations from the river and a review of the foundation drawings of the existing RBDD, indicated that H-piles could be required to support the pump station structure at Site 2. Preliminary geotechnical review also indicated that H-piles and their associated higher cost would not be necessary at the Mill Site. Exploratory test hole excavations and laboratory analysis of soil samples are needed to confirm foundation conditions.

Screening Evaluation.

Effectiveness

- Internal fish bypasses would be required at this location. The number of bypasses depends on the pumping capacity that is developed at this location, and could potentially have one less bypass pipe and pump than required for the same capacity at the Mill Site.
- Land downstream from this location was recently purchased under SB 1086 to restore the river to a natural meandering waterway. The land upstream from the site could also be purchased for the same purpose, and would make this location much more vulnerable to erosion than the Mill Site, which is protected by the existing RBDD structure.

- Of the two offsite locations being considered, Site 2 is the more remote from RBDD, which reduces the effectiveness of operations.

Environmental

- The length of the fish screens is shorter at Site 2 compared to the Mill Site for the same amount of intake capacity because of the deeper water at Site 2.
- More riparian vegetation would be removed at Site 2 compared to the Mill Site, resulting in permanent removal of existing riparian vegetation and wildlife habitat.
- There is a need to construct a cofferdam in the river to allow the construction of the fish screens. This could cause temporary biological and water quality impacts.
- Site 2 is currently a walnut orchard with mature producing walnut trees that would need to be removed. Since this pump station would be a change to the current agricultural land use, there would be long-term site impacts, such as increased noise and traffic in the local vicinity.

Implementability

- Construction of pumping facilities at this offsite location would have very limited interference with the operation of the existing facilities.
- Construction of fish screens along the river would require USACE, CDFG, and RWQCB permits.
- This option would require purchase of land. Land acquisition at this site is anticipated to be more difficult than at the Mill Site since the Mill Site is currently offered for sale.
- The acquisition of land at Site 2 may be opposed by river restoration enthusiasts who would like to see this stretch of the river restored to its natural and wild state and would oppose a hard point on the river at this location.
- NMFS's acceptance of the screw/helical pumps for the internal fish bypass system would be required.

Cost

- The construction cost of this pump station option is higher than the Mill Site vertical propeller pump station option primarily because of the longer conveyance pipeline and the anticipated need to support the structures on piles.
- The pumping cost would also be higher because of the higher lift requirements.

Conclusion. The Mill Site Pump Station has several apparent advantages over the Site 2 Pump Station. **Because of these advantages, the pump station option at the Mill Site is the preferred option and will be carried into preliminary design.**

However, **because only preliminary site investigations have been completed at the Mill Site, site constraints and development requirements are not fully known. With these unknown factors, Site 2 will be retained in abeyance but will not be carried into preliminary design.** If it becomes apparent as the design process and the NEPA/CEQA documentation proceed that the Mill Site is no longer feasible, then Site 2 will be reconsidered.

Bow River Pump Station. Site 3, the Bow River Site, is about two-thirds mile downstream of the confluence of the Bow River with the Sacramento River across from the Bow River trailer park. The project reach is about 1,600 feet long in water depths of 9 to 10 feet at low river flows along the outside of a very gradual bend. There is an approximate 0.5-mile bench area from the river's edge to another bank lined with trees. The length of the site would not limit the pump station capacity with the available water depths. The conveyance distance to the TC Canal would be approximately 1.5 miles using a combination of open channel and pipeline. There may be a conflict with existing refuge land associated with this site.

Advantages. The advantages include very sparse vegetation with an exposed steep, stable bank. It is a suitable site to divert the required peak flow of 2,500 cfs.

Disadvantages. A biological issue of concern at Bow River Site is the potential existence of California threatened bank swallow habitat in the area. In addition, there is a potential for the presence of valley elderberry shrub. This shrub provides essential habitat for the valley elderberry longhorn beetle, which is listed as a threatened species under the federal ESA. This vegetation would need to be permanently removed for the construction of in-river fish screens at this location.

Screening Evaluation.

Effectiveness

- Has over 1,000 feet of available shoreline and water depths at low riverflow of about 10 feet, thus presenting no restrictions on screen length.
- Location is on the outside of a gradual bend, and during low river flows would permit screens and diversion capacities to 2,500 cfs.

Environmental

- Requires removal of riparian tree and shrub vegetation along river bank, although vegetation is very sparse.
- California threatened bank swallows were observed in the area, as well as potential swallow habitat.
- Extensive riparian vegetation was found to be present upland of the slope and appeared to be a remnant riparian forest associated with the pre-dam Sacramento River floodplain.
- Elderberry shrubs are present, which are a host plant for federal-listed valley elderberry longhorn beetle.

Implementability

- Construction of pumping facilities at this offsite location would have very limited interference with operation of the existing facilities.

- Construction of fish screens along the river would require USACE, CDFG, and RWQCB permits.
- This option would require purchase of land. Land acquisition at this site is anticipated to be more difficult than at the Mill Site since the Mill Site is currently offered for sale.
- The acquisition of land at Site 3 may be opposed by river restoration enthusiasts who would like to see this stretch of the river restored to its natural and wild state and would oppose a hard point on the river at this location.

Cost

- The construction cost of this pump station option is higher than the Mill Site vertical propeller pump station option primarily because of the longer conveyance.

Conclusion. This site is similar to the orchard site. The shallower depths, longer distance to the TC Canal, and location in protected refuge lands makes this site undesirable. Because of these issues, **Bow River Site will not be considered further**.

Coyote Creek Pump Station. Coyote Creek Site is located just downstream of the confluence of Coyote Creek and the Sacramento River, near the high point of a bend. The bank has been experiencing significant erosion over the last several years, and may have migrated as much as 100 feet. There is evidence of significant bank sloughing, and exposed irrigation pipe remains hanging in the river. The property next to the river is planted in orchards that extend more than half the distance to the TC Canal. The conveyance length from the pump station to the TC Canal is approximately 2.2 miles. The existence of refuge lands is associated with Site 4.

Advantages. The principle advantage to this site is that it has the deepest river depths of all other sites. It is also very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. The amount of erosion to the bank is of large concern for this site. Orchards exist approximately one-half the distance to the TC Canal. A biological issue of concern at Coyote River Site is the potential existence of California threatened bank swallow habitat in the area. There would be a restricted screen length of about 800 feet and a significant need for bank stabilization. Conveyance length would be more than 2 miles and would require significant operation costs.

Screening Evaluation.

Effectiveness

- Depths at this site were the deepest found.
- The location is on the outside of the apex of a substantial bend in the river. During low riverflows, the deep water at this site would permit screens and diversion capacities to 2,500 cfs.

Environmental

- Requires removal of riparian tree and shrub vegetation along river bank, although vegetation is very sparse and the bank has been severely eroded by recent river scouring.
- California threatened bank swallows were observed in the area, as well as a number of active nests in the exposed bank.
- Vegetation upslope of Coyote Creek Site is currently an orchard, and would need to be removed. Since this pump station would be a change to the current agricultural land use, there would be long-term site impacts, such as increased noise and more traffic in the local vicinity.

Implementability

- The overbank materials are composed of meander point bar scrolls. The river has meandered westward at this location over the past 100 years. There is a significant erosion problem at this location.
- The cutbank is near vertical, approximately 15 feet high, and composed almost entirely of fine silty sand. Riprap has been placed immediately downstream of this site but has appeared to be ineffective.
- The site would be restricted to about 800 feet long, indicated by the depth measurements and proximity to braided junctions of the river downstream.

Cost

- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. This site has very unstable river conditions. It is located within protected refuge lands and has a conveyance length of over 2 miles. Because of these conditions, **Coyote Creek Site will not be considered further**.

Tehama Upstream Pump Station. Tehama Upstream Site at the Town of Tehama lies in a straight reach of the river with orchards on the nearby property. The site is more than 1,000 feet long and has signs of local erosion. According to the geomorphic review, the area upstream of Tehama has been a stable location. The conveyance length from the pump station to the TC Canal is approximately 1.9 miles.

Advantages. The bank is stable more than 1,000 feet along this site. It is also very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. The primary disadvantage is the long conveyance system, approximately 2 miles, being located in orchards. Quite a bit of development is within a close proximity to the site.

Screening Evaluation.

Effectiveness

- Depths at this site are a minimum of 13 feet, making diversion capacities of up to 2,500 cfs achievable.

Environmental

- The bank is generally exposed, although a small number of elderberry shrubs exist directly adjacent to a large oak located toward the downstream portion of the site.
- Bank swallow habitat is very limited at this site, given the exposed portions of the bank. The soils are not suitable for nesting.
- Upslope vegetation is a combination of riparian forest and orchard. A large portion of it would have to be permanently removed upon construction.

Implementability

- The overbank materials are composed of undifferentiated stream alluvium. This site is immediately upstream of the Tehama Bridge, and the bank slope has had riprap placed for protection.
- According to the DWR geomorphic maps, there has been no meander of the river at this location over the past 100 years.

Cost

- The construction, and possibly the operational costs of this pump station option would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. The location of this site, being upstream of the Town of Tehama, is within close proximity to city development. The location of the 1.9-mile conveyance system is within orchards. The conveyance location would require railroad crossing at one point. Because of these conditions, **Tehama Upstream Site will not be considered further**.

Tehama Downstream Pump Station. Tehama Downstream Site is located just downstream of the Town of Tehama, and has similar characteristics as the upstream site. The site was located along a straight segment of the river and was identified as a stable site in the geomorphic review. The nearby property is open orchards containing grains and alfalfa. The conveyance distance from the pump station to the TC Canal is approximately 1.4 miles.

Advantages. No riparian tree or shrub species exist on the site. The site appears to be benign of environmental issues. The upstream riprap protects the site, and there are no screen length restrictions. The conveyance length from the pump station to the TC Canal is approximately 1.4 miles. It is also very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. Installing the conveyance system through farm land and orchards is a big disadvantage. There is also significant development within close proximity to the site.

Screening Evaluation.

Effectiveness

- The available bank frontage is more than 1,000 feet long with minimum water depths of 10 feet. Screen length and diversion capacity up to 2,500 feet would be achievable at this site.
- The local area around the Town of Tehama is known for overbank flooding during the winter high flows. Evaluation and documentation of the flood-prone areas and depths/elevation would be an important component for the development of the site to assure protection of the pump station and conveyance facilities.

Environmental

- Bank vegetation is limited to exotic grasses, as no riparian tree or shrub species are present within the vicinity of the site along the riverbank. Upslope vegetation is generally agricultural in nature, and Tehama Downstream Site appears to be a benign site in terms of environmental issues.

Implementability

- The bank materials are composed of undifferentiated stream alluvium.
- This site is immediately downstream of the Tehama Bridge, near significant development.
- The river has had very little westward meander over the past 75 to 100 years and is protected by riprap, which was put in place in 1975.

Cost

- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. The location of the site, being downstream from the Town of Tehama, is within an area that is prone to flooding. Extensive studies are anticipated to evaluate impacts of new intake facilities on upstream flooding. This site is a relatively long conveyance delivery system compared to other options. Because of these conditions, **Tehama Downstream Site will not be considered further**.

McClure Creek Pump Station. McClure Creek Site is located on the outside of a significant bend in the river and is currently experiencing a bend cutoff. The upland area is a combination of planted fields and riparian lands. The potential project site has a length of more than 1,000 feet with somewhat swift water velocity because of the restricted river width during low flow. The conveyance distance from the pump station to the TC Canal is approximately 1.1 miles; the river and TC Canal tend to converge at this location.

Advantages. The conveyance distance of 1.1 miles between the river and the canal is relatively short, compared to other locations. The location in the river makes it suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. The river has had significant bank meander over the past 100 years. The bend dynamics pose significant problems and has begun to cut the site off. Extensive riparian vegetation exists.

Screening Evaluation.

Effectiveness

- The project at this site has a significant problem with bend dynamics and has begun to cut off.
- The river width along this branch is somewhat narrow, and the velocity was estimated at more than 3 fps.
- The water depth is 12 feet over a length of the site and should support a screen length of more than 1,000 feet. Screen length and diversion capacity up to 2,500 cfs would be achievable at the site.

Environmental

- Very little vegetation is present along the steep riverbank. The slope is dominated by riprap.
- Vegetation upslope from the site is generally mature riparian. Given the density of the trees, it was undetermined how far this vegetation extends beyond the upper point of the riverbank.

Implementability

- The overbank materials are composed of historical meander belt deposits.
- There has been significant meander at this location over the past 100 years.
- The slope is protected by riprap placed in 1978. The river has recently created cutoff upstream of this location.

Conclusion. Because of unstable river conditions, **McClure Creek Site will not be considered further**.

Thomes Creek Pump Station. Thomas Creek Site is along a relatively straight reach of the river just downstream of the confluence with Thomes Creek. The local overbank area is open farmland planted in grains and pasture. The project location is nearly 1.0 mile long with essentially unrestricted potential for screen length. Agricultural land use extends up to the riverbank along the entire reach with few, if any, buildings. The conveyance distance from the river to the TC Canal extends over 2.5 miles because of the eastern direction the river takes.

Advantages. Vegetation is limited at the site. The slope is protected by large riprap, which makes it quite stable. The river at this location is also very stable and has exhibited little meandering over a long period of time. This site is very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. A large, active osprey nest is located upslope on an artificial roost. The length of the conveyance system from the river to the TC Canal would be over 2 miles.

Screening Evaluation.

Effectiveness

- The site lies along an extremely long, straight reach of the river with continuous depths of 9 feet expected at low riverflows.
- The river has been very stable in this area, exhibiting little meander at this location over the past 100 years.

Environmental

- The banks contain a limited amount of riparian vegetation scattered within riprap areas, but ultimately contains little vegetation. Some pockets of vegetation are located downstream and upstream of the site, but overall such vegetation is very limited.
- A large, active nest was observed for the osprey which is on the federal ESA list as threatened. It was situated upslope from the site on an artificial roost directly adjacent to an electric distribution line and dirt road.
- Vegetation in the area is dominated by agriculture.

Implementability

- The overbank materials are composed of undifferentiated stream alluvium.
- The slope is protected by large riprap.

Cost

- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. This site has considerably higher development costs because of the length of the conveyance facilities. The over 2-mile canal is subject to high energy use and annual O&M costs. Because of these constraints, **Thomes Creek Site will not be considered further.**

Deer Creek Pump Station. Deer Creek Site lies along the outside of a bend just upstream of the confluence with Deer Creek. The site is located within a significant bend in the river, which has caused a cutoff to form. Substantial evidence of high flows is noticeable, with large tree trunks embedded in the river bottom. The local overbank area is heavily forested in riparian growth with agriculture within 500 feet.

The project site has a length of over 1,200 feet and would provide unrestricted capacity for a pump station. The conveyance distance from the pump station to the TC Canal is approximately 2.6 miles as the river continues to move to the east at this location.

Advantages. This site is located on a stable bank and is very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. This site would require the longest conveyance distance from the river to the TC Canal. Bend dynamics pose significant problems at this site because a cutoff has formed in recent time, and the river is now braided. This site is also located within a heavily forested riparian area.

Screening Evaluation.

Effectiveness

- The site is severely limited by the bend dynamics and has begun to cut off. The river width along this branch is narrow and sustains high velocities estimated in excess of 4 fps.
- The water depths are about 13 feet along the site and should support a screen length of more than 1,000 feet. Screen length and diversion capacity up to 2,500 cfs would be achievable at this site.

Environmental

- The 10-foot riverbank is dominated by riprap and rock. It contains limited riparian trees and shrubs. A dense riparian forest is upslope from the slope.
- Agricultural lands exist near the site.

Implementability

- The overbank materials are composed of stream channel, point bar, and floodplain deposits.
- There has been significant meander at this location over the past 100 years.
- The slope is protected by riprap, which was placed onsite in 1963.
- The river has recently created a cutoff upstream of this location. There has been significant erosion downstream of this site.

Cost

- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. Unstable river conditions and an excessively long conveyance delivery system create a high energy use and annual maintenance cost**.** Because of these constraints, **Deer Creek Site will not be considered further.**

Woodson Bridge Pump Station. Woodson Bridge Site at Woodson Bridge is both upstream and downstream of the bridge along a steep bluff, just below a 90-degree bend in the river. Substantial depths were noted for more than 1,500 feet; however, these depths were located entirely within the residential/commercial zone. Downstream of the developed area the water depths decreased to below desired levels. The conveyance distance from the pump station to the TC Canal is approximately 2.4 miles.

Advantages. The bank is very stable and suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. The length of the conveyance system from the river to the TC Canal would be over 2 miles. The conveyance location would be in residential/commercial land use zones and would require costly utility relocations.

Screening Evaluation.

Effectiveness

- The project site includes a total length of more than 1,400 feet with water depths over 14 feet expected at low riverflow.
- About 600 feet upstream of the bridge and 800 feet downstream a project could be located without limiting diversion capacity.
- Although the site is just below a severe bend in the river, the Riverbank Formation was exposed along the bank and has exhibited stable conditions.
- Screen length and diversion capacity up to 2,500 cfs would be achievable at the site.

Environmental

- The project site is located within a developed residential and commercial area that would have significant environmental impacts associated with this location.
- Extensive mitigation requirements and right-of-way/easements would be needed for a project at this location.
- The area is heavily wooded along the banks throughout the residential area and is bisected by the Woodson Bridge.

Implementability

- The overbank materials are composed of Riverbank Formation as evidenced by the steep banks.
- There has been very little migration of the river at this location over the past 100 years.
- The site was identified as a stable location during the geomorphic review.

Cost

- Utility replacement and relocation would require a substantial project investment that would not appear to be outweighed by benefits of the site.
- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. This site has considerably higher development costs because of the length of the conveyance facilities. This site also has the highest energy use and annual maintenance cost of any other site. Because of these constraints, **Woodson Bridge Site will not be considered further.**

Development of Final Alternatives

Following the full consideration of the facility options and gate operation restrictions engendered by ESA, the following alternatives are proposed for full environmental analysis. Additionally, these alternatives will be subjected to a maximum benefit analysis consistent with the requirements of the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies published by the U.S. Water Resources Council in 1983 (commonly referred to as the "Principles and Guidelines" or "P&G"). The final alternatives are summarized in Table A-6. Table A-6 also includes a summary of the existing condition presented by operation of RBDD and the likely condition that would exist under the No Action condition.

As initially proposed, the alternatives consisted of a range of gate operations from current 4-month gates-in operations to gates-out operation. Nomenclature for these alternatives initially consisted of the following:

Alternative 1: 4-month gates-in with improvements to agricultural water reliability and fish passage.

Alternative 2: 2-month gates-in with improvements to agricultural water reliability and fish passage.

Alternative 3: 0-month gates-in with improvements to agricultural water reliability and fish passage.

The final alternatives that will be carried forward consist of variations of these initial alternatives with specific details about the facilities associated with these alternatives.

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 (May 16 to Sept 15) period. Improved agricultural water deliveries would be achieved with operation of 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). If deemed necessary, the center ladder would be constructed following a period of fish passage monitoring.

1B: 4-month Bypass Alternative

The 4-month Bypass Alternative would continue the current operation of the dam with a 4-month gates-in (May 16 to Sept 15) period. Improved agricultural water deliveries would be achieved with operation of 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 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 SRDC. If deemed necessary, the center ladder would be constructed following a period of fish passage monitoring with a bypass channel.

TABLE A-6

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 Alternative	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	Add if needed	New 831	320		1,380		1,700
1B: 4-month Bypass Alternative	4 months	May 15 through Sept 15	New 800	Add if needed	Bypass channel 1,000; existing 338	320		1,380		1,700
2A: 2-month Improved Ladder Alternative	2 months	July 1 through August 31	New 800	Add if needed	New 831	320		1,680		2,000
2B: 2-month with Existing Ladders Alternative	2 months	July 1 through August 31	Existing 338	Existing 100	Existing 338	320		1,680		2,000
3: Gates-out Alternative	0 months					320		2,180		2,500

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 (July 1 to Aug 31) period. Improved agricultural water deliveries would be achieved with operation of 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, for a total of 1,631 cfs) and the reduction in gates-in operation. If deemed necessary, the center ladder would be constructed following a period of fish passage monitoring, although this is considered unlikely because of the absence of spring-run Chinook salmon under this condition.

2B: 2-month with Existing Ladders Alternative

The 2-month with Existing Ladder Alternative would reduce the current operation of the dam to a 2-month gates-in (July 1 to Aug 31) period. Improved agricultural water deliveries would be achieved with operation of 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, for a total of 676 cfs). If deemed necessary, the center ladder would be constructed following a period of fish passage monitoring, although this is considered unlikely because of the absence of spring-run Chinook salmon under this condition.

3: Gates-out Alternative

The Gates-out Alternative would reduce the current operation of the dam to a 0-month gates-in period, leaving the gates in the raised position year-round. Improved agricultural water deliveries would be achieved with operation of 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.

Fish Passage Benefits Analysis

A fish passage evaluation was conducted for final alternatives using a spreadsheet tool developed expressly for the Fish Passage Improvement Project at the Red Bluff Diversion Dam. The fish passage tool (informally referred to as "Fishtastic!") was used as a tool for evaluating RBDD Fish Passage Improvement Project alternatives against one another. Although the methodology is built upon biological data, it is not a biological evaluation of fish passage conditions at RBDD. It is intended solely to focus attention on aspects of the alternatives that have the greatest potential for improving fish passage at RBDD and to provide a means for conducting sensitivity analyses on different assumptions.

General Approach

Fishtastic! uses temporal species distribution to determine when different life stages of fish are expected to encounter RBDD. The "cost" or "effect" of encountering RBDD was assigned a score of zero to one (where zero is completely ineffective and one is totally effective) based on subjective assumptions about the relative effect of existing facilities compared to potential future facilities. The effects of the dam were separated into two distinct parts – upstream effect on adults and downstream effect on juveniles. A number of studies on the physical effects of the dam were reviewed and updated according to current investigations and professional judgement.

For adults, the primary effects are based on delay at the dam and ability to pass ladders or bypass facilities. For juveniles, the primary effects are the combined presence of predators below the dam and juveniles migrating downstream. Other factors considered included flow, size of the facilities, and physiology of different species of fish. The degree of effect for the various facilities was estimated using existing information and studies that have been conducted at the dam, peer-reviewed research at other facilities, and professional judgement. The results of the Fishtastic! analysis have been reviewed by the agency development team.

Fishtastic! results are characterized by the degree of effect each alternative has on the annual percentage of fish species, both adult and juvenile, that passes the dam. When the dam gates are raised, there is no effect. When the gates are lowered, there is a variable amount of effect that depends on the physical characteristics of the fish, facility assumptions, and flows. The maximum fish passage index is 100, which would be interpreted as 100 percent of either adult or juvenile fish passing the dam with no effect.

Fishtastic! initially evaluated impacts to all fish that migrate past the dam, but following a series of workshops, the analysis narrowed its scope to key focus species, which include the four runs of Chinook salmon (winter, spring, fall, and late-fall runs), resident rainbow trout, anadromous steelhead, and green sturgeon. These fish were deemed to warrant a higher level of analysis than other fish because of their life cycle requirement to be upstream of the dam in combination with their commercial, recreational, and/or protected status. Results of the Fishtastic! focus species analysis are summarized in Tables A-7, A-8, A-9, and A-10.

Tables A-7 and A-8 show that operation of the dam gates has a variable effect on all adult focus species with the exception of late-fall-run salmon, which is unaffected by dam gates operation. Because there is no impediment to fish passage when the dam gates are raised, the Gates-out Alternative provides the greatest benefit to adult focus species, with a total fish passage score of 148. 2-month Improved Ladder and 2-month Existing Ladders alternatives also provide a significant benefit to adult focus species fish passage, with total scores of 119 and 114, respectively. 4-month Improved Ladder and 4-month Bypass Channel alternatives represent minimal benefit to adult focus species fish passage, with total scores of 20 and 16, respectively.

TABLE A-7
Summary of Fishtastic! Adult Focus Species

	Alternatives					
Adult Focus Species	**No Action**	**4-month Improved Ladder**	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Winter-run salmon	90	91	91	98	98	100
Spring-run salmon	52	61	57	94	93	100
Fall-run salmon	83	86	85	91	89	100
Late-fall-run salmon	100	100	100	100	100	100
Rainbow trout	73	78	76	91	90	100
Steelhead	89	91	90	97	96	100
Green sturgeon	65	65	69	100	100	100

TABLE A-8
Comparison of Final Alternatives Adult Focus Species Analysis to No Action Alternative

	Alternatives Difference from No Action Alternative				
Adult Focus Species	**4-month Improved Ladder**	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Winter-run salmon	1	1	8	8	10
Spring-run salmon	9	5	42	41	48
Fall-run salmon	3	2	8	6	17
Late-fall-run salmon	0	0	0	0	0
Rainbow trout	5	3	18	17	27
Steelhead	2	1	8	7	11
Green sturgeon	0	4	35	35	35
Total	**20**	**16**	**119**	**114**	**148**

TABLE A-9
Summary of Fishtastic! Juvenile Focus Species

	Alternatives					
Juvenile Focus Species	**No Action**	**4-month Improved Ladder**	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Winter-run salmon	96	96	96	99	99	100
Spring-run salmon	99	99	99	100	100	100
Fall-run salmon	97	97	97	99	99	100
Late-fall-run salmon	94	94	94	98	98	100
Rainbow trout	92	92	92	98	98	100
Steelhead	92	92	92	99	99	100
Green sturgeon	73	73	73	88	88	100

TABLE A-10
Comparison of Final Alternative Juvenile Focus Species Analysis to No Action Alternative

	Alternatives Difference from No Action Alternatives				
Juvenile Focus Species	**4-month Improved Ladder**	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Winter-run salmon	0	0	3	3	4
Spring-run salmon	0	0	1	1	1
Fall-run salmon	0	0	2	2	3
Late-fall-run salmon	0	0	4	4	6
Rainbow trout	0	0	6	6	8
Steelhead	0	0	7	7	8
Green sturgeon	0	0	15	15	27
Total	**0**	**0**	**38**	**38**	**57**

Tables A-9 and A-10 show that operation of the dam gates has a minimal effect on all juvenile focus species. Again, the Gates-out Alternative represents no impediment to fish passage. Consequently, the Gates-out Alternative provides the greatest benefit to juvenile focus species, with a total fish passage score of 57. The 2-month Improved Ladder and 2-month Existing Ladders alternatives result in a fish passage score of 38, and both 4-month alternatives result in a fish passage score of 0.

Table A-11 illustrates the breakdown of capital and O&M costs into fish passage costs and agriculture costs. Column A, Fish Passage, shows the set costs for fish passage facilities (e.g., fish ladders, bypass channel) for each alternative. Column A, Pumping Facilities, shows the

TABLE A-11

Alternatives Cost Comparison Allocated to Fish Passage and Agriculture

	Capital Costs				O&M Costs			
	A	B	C	D	E	F	G	H
Alternative	**Fish Passage**	**Fish Share of Pumping**	**Total Fish Capital Cost**	**Annualized Cost**	**Passage Facility Maintenance**	**Fish Share of Pumping Maintenance**	**Total Fish O&M**	**Total Fish Passage Annualized Cost**
No Action								
4-month Improved Ladder	$15,400,000	$36,208,400	$51,608,400	$3,139,249		$244,425	$244,425	$3,383,674
4-month Bypass Channel	$21,100,000	$36,208,400	$57,308,400	$3,485,970		$244,425	$244,425	$3,730,395
2-month Improved Ladder	$15,400,000	$46,108,400	$61,508,400	$3,741,499		$212,843	$212,843	$3,954,292
2-month with Existing Ladders		$46,108,400	$46,108,400	$2,804,693		$212,843	$212,843	$3,017,536
Gates-out		$55,108,400	$55,108,400	$3,352,148		$188,575	$188,575	$3,540,722
	Pumping Facilities	**Agriculture Share of Pumping Facilities**	**Total Agriculture Capital Cost**	**Annualized Cost**	**Pumping Facility Maintenance**	**Agriculture Share of Pumping Maintenance**	**Total Agriculture O&M**	**Total Agriculture Annualized Cost**
No Action					$370,000	$370,000	$370,000	
4-month Improved Ladder	$69,100,000	$32,891,600	$32,891,600	$2,000,739	$466,460	$222,035	$222,035	$2,222,774
4-month Bypass Channel	$69,100,000	$32,891,600	$32,891,600	$2,000,739	$466,460	$222,035	$222,035	$2,222,774
2-month Improved Ladder	$79,000,000	$32,891,600	$32,891,600	$2,000,739	$406,189	$193,346	$193,346	$2,194,085
2-month with Existing Ladders	$79,000,000	$32,891,600	$32,891,600	$2,000,739	$406,189	$193,346	$193,346	$2,194,085
Gates-out	$88,000,000	$32,891,600	$32,891,600	$2,000,739	$359,875	$171,301	$171,301	$2,172,039

Note: Allocation of pumping costs to fish includes 600 cfs for Stony Creek, 165 cfs for fish ladder pumps, and the pumping difference between gate operations.

set costs for pumping facilities for each alternative. Column B shows the distribution of the costs for pumping facilities, as allocated to fish passage and agriculture[1]. The cost of pumping facilities allocated to agriculture is the same for all alternatives, but the cost difference among alternatives is allocated to fish passage. Column C shows the total capital costs for each alternative. Column C, Total Fish Capital Cost, totals the fish passage facility costs plus the fish passage share of pumping facilities. Column C, Total Agriculture Capital Cost, shows that the capital costs for agriculture are limited to the agriculture share of pumping facilities. Column D shows the total capital costs for fish passage and agriculture, annualized at 6.125 percent for 50 years.

Columns E, F, and G show O&M costs for each alternative, as allocated to fish passage and agriculture. Column H shows total annualized costs (capital and O&M) for each alternative as allocated to fish passage and agriculture.

Table A-12, uses the fish passage scores from Fishtastic! (shown in Tables A-7 through A-9) plus the total fish passage annualized costs (Column H in Table A-11) to achieve a cost-benefit analysis of fish passage for each alternative. Table A-12 shows the number of units of fish per million dollars for each alternative for adult and juvenile focus species.

As shown above, the alternative that provides the greatest cost benefit for fish passage is the Gates-out Alternative, with 57.91 units of fish per million dollars. The 2-month with Existing Ladders Alternative follows with 50.33 units of fish per million dollars, and the 2-month Improved Ladder Alternative is third with 39.85 units of fish per million dollars. The 4-month Improved Ladder and 4-month Bypass Channel alternatives provide the lowest cost benefit for fish passage, with 5.92 and 4.29 units of fish per million dollars, respectively.

There is some disagreement among parties about how pumping costs should be allocated. Because of this disagreement, the above analysis was repeated where only the cost of the pumping difference between gate operations is allocated to fish passage; all other pumping costs are allocated to agriculture. Table A-13 illustrates the breakdown of capital and O&M costs into fish passage costs and agriculture costs under this scenario. All other factors remain as described previously.

Table A-14 uses the fish passage scores from Fishtastic! (shown in Tables A-7 through A-9) plus the total fish passage annualized costs (Column H in Table A-13) to achieve a cost-benefit analysis of fish passage for each alternative under this revised cost allocation scenario. Table A-14 shows the number of units of fish per million dollars for each alternative for adult and juvenile focus species.

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[1] Under Existing Conditions, 240 cfs comes from RPP, 165 cfs from the right fish ladder, and 600 cfs from Stony Creek, for 1,005 cfs during the gates-out period. Under the No Action Alternative, the pumping capacity at RPP would be increased to 320 cfs, and the Stony Creek pumping would be eliminated, for 485 cfs during the gates-out period. Under the two 4-month gates-in alternatives, 320 cfs would come from RPP, and 1,380 cfs would come from the Mill Site, for a total of 1,700 cfs during the gates-out period. Under the two 2-month gates-in alternatives, 320 cfs would come from RPP, and 1,680 cfs would come from the Mill Site, for a total of 2,000 cfs during the gates-out period. Under the 0-month gates-in alternative, 320 cfs would come from RPP, and 2,180 would come from the Mill Site, for a total of 2,500 cfs during the gates-out period.

To allocate pumping facilities costs to fish passage and agriculture, fish passage was assigned the cost of 600 cfs from Stony Creek, 165 cfs from the right fish ladder, and the pumping difference between gate operations. Agriculture was assigned the cost of the difference between pumping 240 cfs at RPP under Existing Conditions and pumping 320 cfs at RPP under all alternatives plus the remainder of pumping capacity required. The allocation of costs is illustrated in Table A-13.

TABLE A-12
Unit Adult and Juvenile Focus Species per Million Dollars Annualized Cost

	Alternatives				
	4-month Improved Ladder	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Adult Focus Species					
Winter-run salmon	0.30	0.27	2.03	2.65	2.82
Spring-run salmon	2.66	1.34	10.66	13.58	13.56
Fall-run salmon	0.89	0.54	2.03	1.99	4.80
Late-fall-run salmon	--	--	--	--	--
Rainbow trout	1.48	0.80	4.57	5.63	7.63
Steelhead	0.59	0.27	2.03	2.32	3.11
Green sturgeon	--	1.07	8.88	11.59	9.89
Total	**5.92**	**4.29**	**30.20**	**37.75**	**41.81**
Juvenile Focus Species					
Winter-run salmon	--	--	0.76	0.99	1.13
Spring-run salmon	--	--	0.25	0.33	0.28
Fall-run salmon	--	--	0.51	0.66	0.85
Late-fall-run salmon	--	--	1.02	1.32	1.69
Rainbow trout	--	--	1.52	1.99	2.26
Steelhead	--	--	1.78	2.32	2.26
Green sturgeon	--	--	3.81	4.97	7.64
Total	**--**	**--**	**9.64**	**14.67**	**16.10**
Combined Total	**5.92**	**4.29**	**39.85**	**50.33**	**57.91**

As shown above, the alternative that provides the greatest cost benefit for fish passage as indicated by the revised cost allocation scenario is the 2-month with Existing Ladders Alternative with 185.37 units of fish per million dollars. The Gates-out Alternative follows with 152.99 units of fish per million dollars, and the 2-month Improved Ladder Alternative is third with 89.71 units of fish per million dollars. The 4-month Improved Ladder and 4-month Bypass Channel alternatives provide the lowest cost benefit for fish passage, with 16.95 and 10.46 units of fish per million dollars, respectively.

TABLE A-13
Alternatives Cost Comparison Allocated to Fish Passage and Agriculture (Revised Cost Allocation Scenario)

	Capital Costs				O&M Costs			
	A	B	C	D	E	F	G	H
Alternative	**Fish Passage**	**Fish Share of Pumping**	**Total Fish Capital Cost**	**Annualized Cost**	**Passage Facility Maintenance**	**Fish Share of Pumping Maintenance**	**Total Fish O&M**	**Total Fish Passage Annualized Cost**
No Action								
4-month Improved Ladder	$15,400,000		$15,400,000	$936,755		$244,425	$244,425	$1,181,180
4-month Bypass Channel	$21,100,000		$21,100,000	$1,283,476		$244,425	$244,425	$1,527,901
2-month Improved Ladder	$15,400,000	$9,900,000	$25,300,000	$1,583,955		$212,843	$212,843	$1,751,798
2-month with Existing Ladders		$9,900,000	$9,900,000	$602,200		$212,843	$212,843	$815,043
Gates-out		$18,900,000	$18,900,000	$1,149,654		$188,575	$188,575	$1,338,228
	Pumping Facilities	**Agriculture Share of Pumping Facilities**	**Total Agriculture Capital Cost**	**Annualized Cost**	**Pumping Facility Maintenance**	**Agriculture Share of Pumping Maintenance**	**Total Agriculture O&M**	**Total Agriculture Annualized Cost**
No Action					$370,000	$370,000	$370,000	
4-month Improved Ladder	$69,100,000	$69,100,000	$69,100,000	$4,203,232	$466,460	$222,035	$222,035	$4,425,267
4-month Bypass Channel	$69,100,000	$69,100,000	$69,100,000	$4,203,232	$466,460	$222,035	$222,035	$4,425,267
2-month Improved Ladder	$79,000,000	$69,100,000	$69,100,000	$4,203,232	$406,189	$193,346	$193,346	$4,396,578
2-month with Existing Ladders	$79,000,000	$69,100,000	$69,100,000	$4,203,232	$406,189	$193,346	$193,346	$4,396,578
Gates-out	$88,000,000	$69,100,000	$69,100,000	$4,203,232	$359,875	$171,301	$171,301	$4,374,533

Note: Allocation of pumping costs to fish includes only the pumping difference between gate operations.

TABLE A-14
Unit Adult and Juvenile Focus Species per Million Dollars Annualized Cost (Revised Cost Allocation Scenario)

	Alternatives				
	4-Month Improved Ladder	**4-Month Bypass Channel**	**2-Month Improved Ladder**	**2-Month with Existing Ladders**	**Gates-out**
Adult Focus Species					
Winter-run salmon	0.85	0.65	4.57	9.76	7.46
Spring-run salmon	7.63	3.27	24.00	50.00	35.82
Fall-run salmon	2.54	1.31	4.57	7.32	12.69
Late-fall-run salmon	--	--	--	--	--
Rainbow trout	4.24	1.96	10.29	20.73	20.15
Steelhead	1.69	0.65	4.57	8.54	8.21
Green sturgeon	--	2.61	20.00	42.68	26.12
Total	**16.95**	**10.46**	**68.00**	**139.02**	**110.45**
Juvenile Focus Species					
Winter-run salmon	--	--	1.71	3.66	2.99
Spring-run salmon	--	--	0.57	1.22	0.75
Fall-run salmon	--	--	1.14	2.44	2.24
Late-fall-run salmon	--	--	2.29	4.88	4.48
Rainbow trout	--	--	3.43	7.32	5.97
Steelhead	--	--	4.00	8.54	5.97
Green sturgeon	--	--	4.00	8.54	5.97
Total	**--**	**--**	**21.71**	**46.34**	**42.54**
Combined Total	**16.95**	**10.46**	**89.71**	**185.37**	**152.99**

Conclusion

The two separate cost allocations described in Tables A-11 and A-13 cover a range of reasonable cost allocations between agricultural and fish “shares” of project cost. It is important to note that the two allocations arrive at different conclusions regarding the most efficient allocation of dollars. Using the allocation described in Table A-11 results in the Gates-out Alternative being the most economically efficient use of money (Table A-12). Using Table A-13 results in the 2-month with Existing Ladders Alternative as the most efficient (Table A-14). However, it is important to note that the other alternatives maintain the same order; that is, they are notably less efficient in the use of money than either the Gates-out or 2-month with Existing Ladders alternatives. Further, under both allocations, these two alternatives are within 20 percent of each other, indicating that the alternatives are certainly comparable under both analyses.

Therefore, because both cost allocation methods are reasonable, both the Gates-out and 2-month with Existing Ladders alternatives result in fairly similar outcomes. Assuming that the range of potential allocations is between those described above, the results should also vary between the results presented in Tables A-12 and A-14. In simple terms, the greater share of the project allocated toward fish, the more economical the Gates-out Alternative becomes. If agriculture bears the bulk of the project cost, then the 2-month with Existing Ladders Alternative is more economical.

Agricultural Water Supply Benefit Analysis

Similar to the analysis provided for fish passage, an analysis was conducted to compare the ability of the alternatives to provide water reliability in meeting agricultural water demand. For this portion of the analysis, only three action alternatives are considered: 4-month Gates-in, 2-month Gates-in, and 0-month Gates-in. Sub-alternatives relating to fish passage facilities do not affect the physical ability of various alternatives to supply water to TCCA. However, consideration of effects on fish is still an important parameter for agricultural supply as it relates to the risk that future conditions might require reductions in gates-in operations. An evaluation of such risk is considered beyond the scope of this analysis.

General Approach

For the years 1989 through 1999, records of actual daily water delivery, including deliveries to Glenn-Colusa Irrigation District (GCID), were reviewed. For the same time period, both the average and the maximum amount of water delivered on each day between May and September was also determined. These calculations help establish the historical range of deliveries accommodated by TCCA over the 1989 to 1999 period.

As a second step, reference evapotranspiration was calculated for the combined member districts of TCCA, excluding GCID. Reference evapotranspiration is used to calculate crop water consumption for both agricultural and natural vegetation. This analysis used the modified Pennman-Monteith method for calculating reference evapotranspiration. The modified Pennman-Monteith method is endorsed by the Food and Agriculture Organization of the United Nations as a preferred method for evaluating crop water requirements. The method uses a number of parameters, including solar radiation, air temperature, air humidity and wind speed, crop growth, and other factors in assessing the evaporation process. For the period of record, average monthly climatological data were used.

For the TCCA districts, excluding GCID, average crop mix as determined by USBR needs assessment was used as a representative crop variety over the period of record. The percentage of specific crops was pro-rated against the recorded acres irrigated in each year between 1989 and 1999. The acreage of each crop in each year in conjunction with average monthly climate data was used to derive a monthly water demand for the 1989 to 1999 period. Daily water demand was assumed to follow a pattern similar to the daily water deliveries. Using daily water deliveries, the monthly crop demands were disaggregated into daily demands to give a sense of variability within months. Average and maximum daily crop demand was then determined similar to those reported for water delivery. In most cases crop demand far outpaces actual water deliveries. Periods where water deliveries are in excess of crop demand are representative of large deliveries to GCID, which was not included in the crop demand analysis.

GCID was excluded from the crop demand analysis because its primary source of water is the GCID canal, not the TC Canal. Including crop demand within GCID would have yielded a much higher crop demand, but would not have been representative of the crop demands served by TCCA. However, it is important to note that water is regularly conveyed to GCID by TCCA. These GCID demands are episodic in nature and have been as high as 1,125 cfs, which is the maximum capacity of the intertie facilities between TCCA and GCID. Such demands are reflected in TCCA water deliveries, but not in the modeled crop demand.

Average daily water delivery is used to show the typical water delivery to TCCA member districts. Maximum water delivery is used to show the upper variability of water demand of TCCA member districts on any given day. Average modeled crop demand reflects the water needs of crops grown by TCCA member districts based on acres in production, water requirements of different crops, and weather conditions, averaged over the 11-year study period. The difference between crop demand and water delivery is likely accounted for by water reuse, groundwater pumping, and precipitation. Maximum modeled crop demand is simply the maximum calculated crop demand for each day of the period of record. These average and maximum water deliveries and average and maximum crop demands were then compared to the delivery capability from RBDD under each of the project alternatives.

Each of the alternatives includes various assumptions about the amount of capacity available to divert water into the TCCA system, and the time periods that capacity is available. For example, the gates-in period allows for maximum diversion from the Sacramento River; however, when gates are raised, capacity is limited to the facilities that are not dependent on gravity diversion from the Sacramento River. These facilities are primarily pumps, but also include diversions from Stony Creek. All of the alternatives, including the No Action Alternative, have the capacity to divert water far in excess of the contractual entitlements of TCCA member districts. None of the alternatives would change the total volume of water TCCA was contractually entitled to, although they would change the time periods under which TCCA districts could reasonably assume to call upon water deliveries.

Thus, the maximum potential diversion under each alternative is a measure of the water supply reliability of the alternative. The difference between the No Action Alternative and the various alternatives is a measure of the addition or reduction in total water supply reliability of the action alternatives. Further, by comparing the alternatives to the actual water deliveries and the modeled crop demand, it is possible to assess how the alternatives might constrain crop selection. Crops that are likely to require water during low capacity periods would be less desirable than crops that do not. Of course, other factors such as soil types, existing investment, and market conditions will also play important roles in future crop selection. Table A-15 outlines the maximum diversion capacity of the various alternatives over the May 1 through September 30 time period. Maximum diversion capacity is defined as the amount of water that could be diverted if the alternative operated at its maximum diversion rate every day of the period. Table A-16 presents the change in maximum diversion capacity compared to the No Action Alternative.

TABLE A-15
Comparison of Diversion Capacity and Maximum Diversion of Alternatives

	Alternatives							
	No Action		4-month Gates-in		2-month Gates-in		0-month Gates-in	
Time period	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)
May 1 through May 14	485	14,405	1,700	50,490	2,000	59,400	2,500	74,250
May 16 through May 31	2,500	79,200	2,500	79,200	2,000	63,360	2,500	79,200
June 1 through June 30	2,500	148,500	2,500	148,500	2,000	118,800	2,500	148,500
July 1 through August 31	2,500	306,900	2,500	306,900	2,500	306,900	2,500	306,900
September 1 through 15	2,500	74,250	2,500	74,250	2,000	59,400	2,500	74,250
September 16 through 30	485	14,405	1,700	50,490	2,000	59,400	2,500	74,250
Total		**637,659**		**709,830**		**667,260**		**757,350**

Note: Total maximum diversion would not change the cumulative CVP water service contract held by TCCA member districts

TABLE A-16
Action Alternatives Difference from No Action

	Alternatives					
	4-month Gates-in		2-month Gates-in		0-month Gates-in	
Time period	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)
May 1 through May 14	1,215	36,086	1,515	44,996	2,015	59,846
May 16 through May 31	0	0	(500)	(15,840)	0	0
June 1 through June 30	0	0	(500)	(29,700)	0	0
July 1 through August 31	0	0	0	0	0	0
September 1 through 15	0	0	(500)	(14,850)	0	0
September 16 through 30	1,215	36,086	1,515	44,996	2,015	59,846
Total		**72,171**		**29,601**		**119,691**

Figure A-5 illustrates the average and maximum water delivery and average and maximum modeled crop demand compared to the No Action and 4-month Gates-in alternatives. Figure A-5 shows that for the period of May 1 through May 14, average and maximum water deliveries and average and maximum crop demand exceed the ability of the No Action Alternative to deliver water. For the same time period, the maximum water delivery exceeds the ability of the 4-month Gates-in alternatives to deliver water. For the period of September 16 through September 30, average and maximum crop demand exceed the ability of the No Action Alternative to deliver water, but the ability of the 4-month Gates-in Alternatives to deliver water are not exceeded. For the majority of the irrigation season, May 15 through September 14, both the No Action and the 4-month Gates-in alternatives can meet the water needs defined by average and maximum water delivery and average and maximum crop demand. On whole, the 4-month Alternative increases the reliability of water diversion by increasing capacity in the May 1 to 15 and September 1 to 15 periods over the No Action Alternative.

Figure A-6 illustrates the average and maximum water delivery and average and maximum modeled crop demand compared to the No Action and 2-month Gates-in alternatives. For the period of May 15 through July 14, maximum modeled crop demand exceeds the ability of the 2-month Gates-in Alternatives, as does a portion of the maximum water delivery. For the remainder of the irrigation season, July 15 through September 30, the 2-month Gates-in Alternatives can meet average and maximum water delivery and average and maximum crop demand. The No Action Alternative is the same as described for Figure A-5. It is important to note that the 2-month Alternative reduces the reliability of water diversion during the May 15 through June 30 and September 1 through 15 periods compared to the No Action Alternative. On whole, however, because of increased capacity in the May 1 through 14 and September 16 through 30 periods, this alternative would increase the reliability of water diversion over the No Action Alternative.

Figure A-7 illustrates the average and maximum water delivery and average and maximum modeled crop demand compared to the No Action and 0-month Gates-in alternatives. Figure A-7 shows that the water delivery ability of the 0-month Gates-in Alternative satisfies the average and maximum water deliveries and average and maximum crop demand for the entire irrigation season, with the exception of a single day where maximum modeled crop demand is not met. The No Action Alternative is the same as described for Figure A-5. On whole, the 0-month Alternative increases the reliability of water diversion by increasing capacity in the May 1 through 14 and September 1 through 15 periods over the No Action Alternative.

Conclusion

Although the alternatives were designed to be similar in terms of water supply reliability, there are important differences to note. The 0-month Alternative provides the greatest water supply reliability because it can divert a full 2,500 cfs at any time during the irrigation season. The 4-month Alternative does not provide as much water supply reliability as the 0-month alternative because of reduction in capacity from 2,500 cfs during the gates-in period, to 1,700 cfs during the gates-out period. The 2-month Alternative provides the least water supply reliability because of the reduction in capacity during the May 15 through June 30 and September 1 through 15 periods compared to No Action. The comparative reliability is summarized in Table A-16.

As noted in the Fish Passage Benefit Analysis (specifically Tables A-11 and A-13), there is currently some debate regarding the proper allocation of costs between fish and agriculture. However, under all potential allocations, the costs assigned to agriculture are static across alternatives. Therefore, it is possible to rank the action alternatives in terms of economic efficiency because the relative costs are all the same. Using that approach, the 0-month

Alternative provides the most economically efficient benefits, followed in order by the 4-month Alternative and the 2-month Alternative.

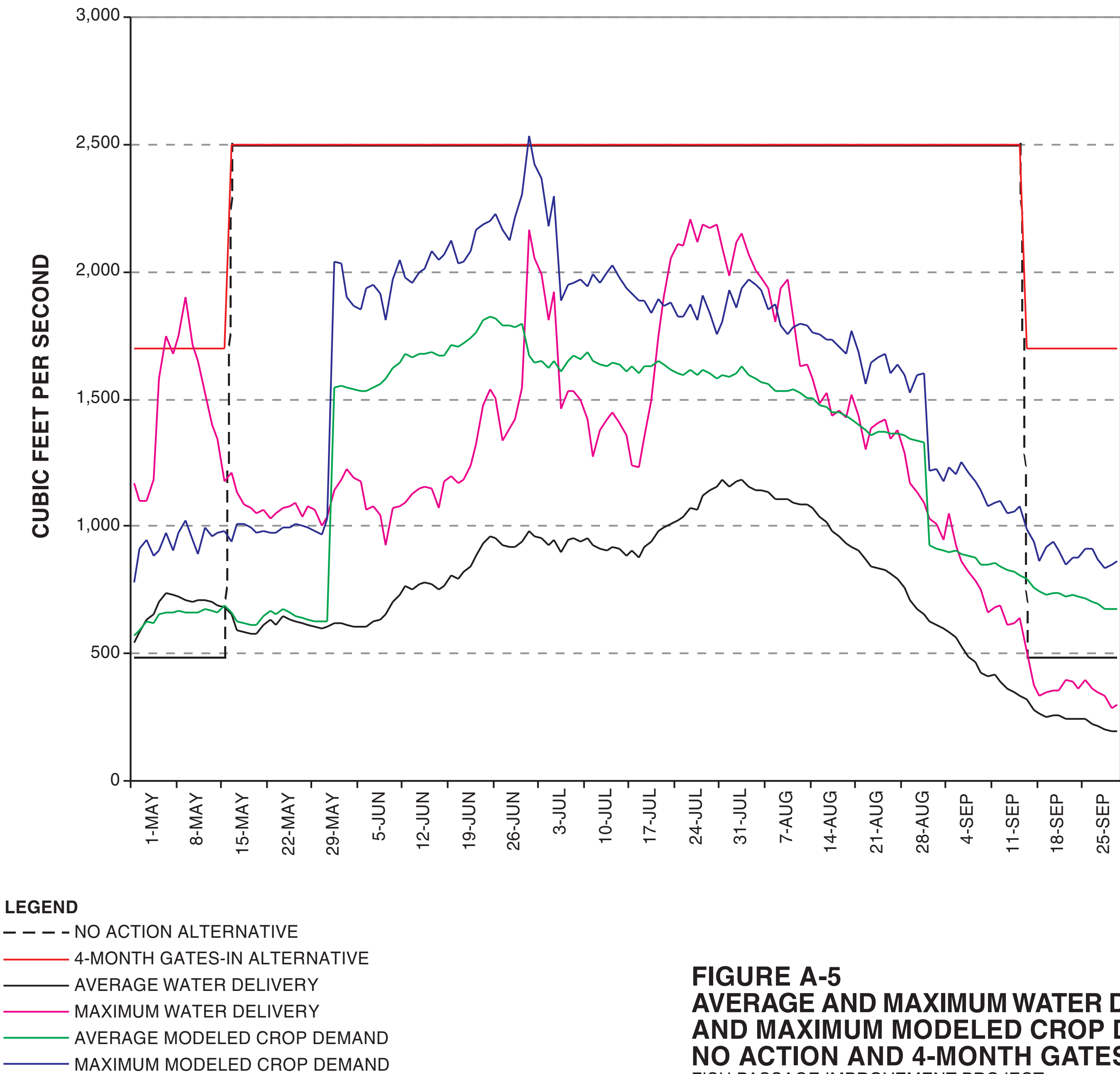

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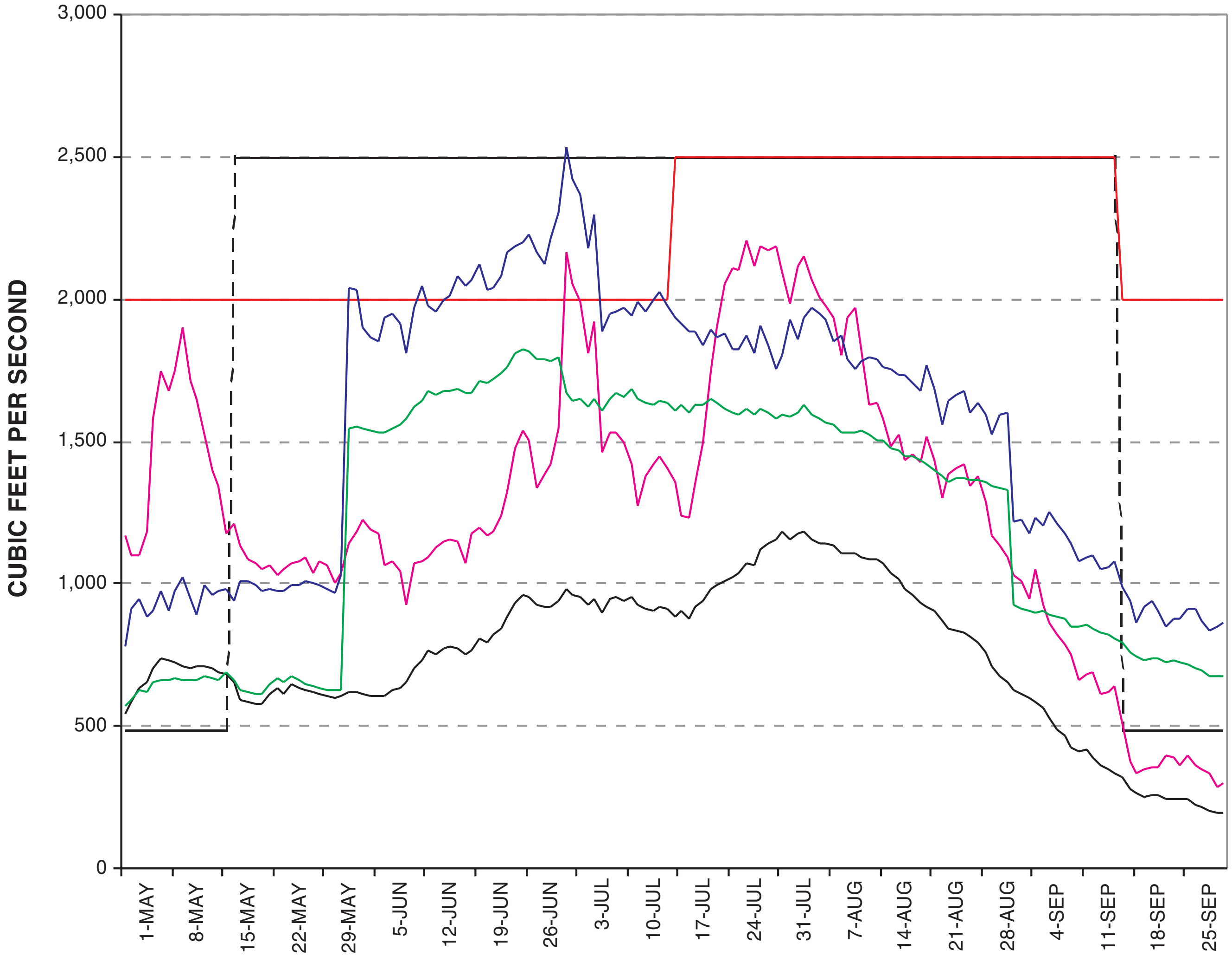
FIGURE A-5
AVERAGE AND MAXIMUM WATER DELIVERY AND AVERAGE AND MAXIMUM MODELED CROP DEMAND COMPARED TO NO ACTION AND 4-MONTH GATES-IN ALTERNATIVES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

CH2MHILL



LEGEND

- NO ACTION ALTERNATIVE
- 4-MONTH GATES-IN ALTERNATIVE
- AVERAGE WATER DELIVERY
- MAXIMUM WATER DELIVERY
- AVERAGE MODELED CROP DEMAND
- MAXIMUM MODELED CROP DEMAND

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FIGURE A-6
AVERAGE AND MAXIMUM WATER DELIVERY AND AVERAGE AND MAXIMUM MODELED CROP DEMAND COMPARED TO NO ACTION AND 2-MONTH GATES-IN ALTERNATIVES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

CH2MHILL

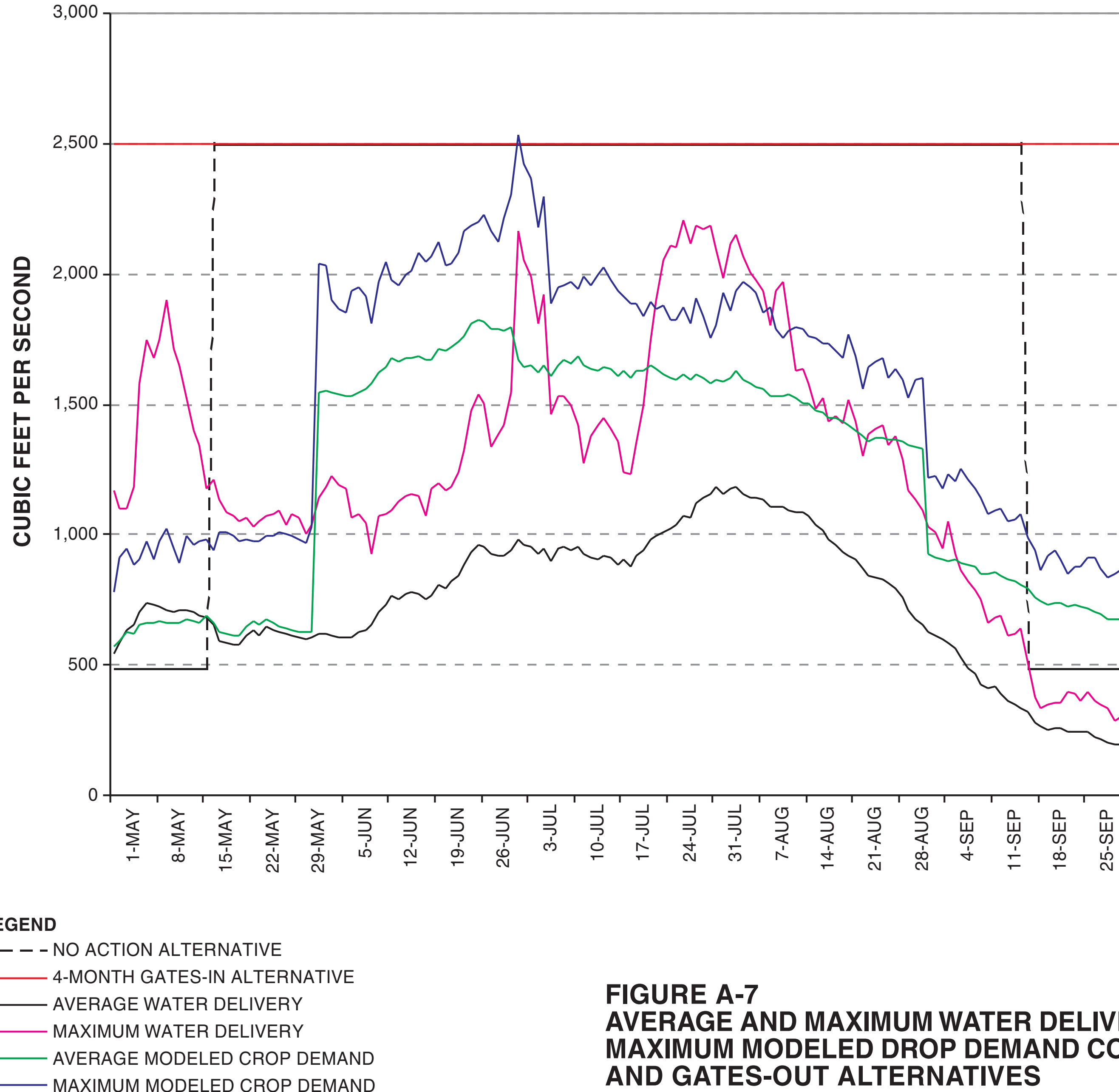

FIGURE A-7
AVERAGE AND MAXIMUM WATER DELIVERY AND AVERAGE AND MAXIMUM MODELED DROP DEMAND COMPARED TO NO ACTION AND GATES-OUT ALTERNATIVES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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