United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Southwest Region
2800 Cottage Way, Room W-2606
Sacramento, California 95825-1846

In Reply Refer To:
08FBDT00-2016-F-0247

JUN 2 3 2017

Memorandum

To: Regional Director, U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, California

From: Regional Director, U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California

Subject: Biological Opinion for the California WaterFix

This memorandum is in response to the U.S. Bureau of Reclamation's (Reclamation) July 29, 2016 letter requesting consultation with the U.S. Fish and Wildlife Service (Service) on the effects of the California WaterFix (CWF) on species listed and critical habitat designated under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*; [Act]). Reclamation was designated as lead action agency and the U.S. Army Corps of Engineers is an additional Federal action agency for this consultation.

A *Biological Assessment for the California WaterFix* (BA), dated July 2016, accompanied the request. In a memorandum dated September 15, 2016 to Reclamation, the Service agreed that formal consultation could be initiated. An Administrative Draft Biological Opinion (BiOp) was provided to the action agencies and applicant on January 19, 2017. The attached Final BiOp incorporates relevant information provided by the action agencies and applicant, including comments, changes, and additions to the CWF provided since consultation was initiated.

The Service has prepared a mixed programmatic BiOp on the CWF. This BiOp represents the culmination of consultation on a mix of standard-level and programmatic-level project elements. An analysis and conclusion of whether or not the entire CWF action is likely to jeopardize each listed species or destroy or adversely modify designated critical habitat is included in this BiOp. All activities addressed programmatically will be subject to a subsequent consultation on future Federal actions in order to proceed.

The following activities analyzed as a standard consultation are: (1) construction of the tunnels; (2) expansions and other modifications of Clifton Court Forebay; (3) associated infrastructure; (4) geotechnical explorations, (5) compensatory mitigation associated with construction except the North Delta Diversions (NDD), Head of Old River Gate (HORG), and Contra Costa Water District (CCWD) settlement agreement facilities; and (6) specific construction-related conservation measures including preconstruction surveys for listed terrestrial species.

Where incidental take of threatened or endangered species is reasonably certain to occur, an Incidental Take Statement for these activities is included with this BiOp.

The following activities requiring future Federal approvals and therefore addressed programmatically are: (1) construction of the NDD and associated structures; (2) construction of the HORG; (3) construction of the CCWD settlement agreement facilities; (4) operations of new and existing CVP and SWP water facilities under dual conveyance; (5) future maintenance; (5) future monitoring; (6) compensatory mitigation associated with construction of the NDD, HORG, and CCWD settlement agreement facilities; and (7) the CWF Adaptive Management Program. In order to ensure that future actions developed for the CWF are consistent with this analysis, Reclamation and DWR have proposed a framework consisting of Guiding Principles that are analyzed as part of this BiOp. One or more subsequent consultations will be needed to address activities associated with future approvals. No Incidental Take Statement is included for activities addressed programmatically because those subsequent consultations will address incidental take associated with those activities.

The Service has analyzed the operational scenario for CWF included in the BA. The agencies recognize this operational scenario will change between now and the time that the CWF facilities are operational. Changes to the operational scenario will be analyzed in subsequent consultation.

The attached BiOp addresses effects of the CWF to 16 federally-listed species and designated critical habitat. Appendix A of the BiOp includes justifications for the species and critical habitat that were determined not likely to be adversely affected. Effects to the remainder of the species and critical habitat are addressed in the BiOp. The Service has determined that the CWF is not likely to jeopardize the continued existence of any of these species, and is not likely to destroy or adversely modify designated critical habitat.

The Service appreciates Reclamation's efforts to complete this consultation. We look forward to further coordination on the CWF. If you have any questions on this consultation, please contact Kaylee Allen, Field Supervisor, San Francisco Bay-Delta Fish and Wildlife Office at kaylee_allen@fws.gov or (916) 930-5603.

Attachment

cc: Barry Thom, National Marine Fisheries Service, Portland, OR
Maria Rea, National Marine Fisheries Service, Sacramento, CA
Michael Jewell, U.S. Army Corps of Engineers, Sacramento, CA
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BIOLOGICAL OPINION
For the California WaterFix

Service File No. 08FBDT00-2016-F-0247

U.S. Fish and Wildlife Service
San Francisco Bay-Delta Fish and Wildlife Office
Sacramento, California

____________________________________ Signed: June 23, 2017

Regional Director, Pacific Southwest

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LIST OF ACRONYMS

Act	Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et* seq.)
af	acre feet
AFRP	Anadromous Fish Restoration Program
AG	agricultural
AMM	Avoidance and Minimization Measure
AMP	Adaptive Management Program
AN	above normal
BA	Biological Assessment
BCDC	Bay Conservation and Development Commission
BDFWO	San Francisco Bay-Delta Fish and Wildlife Office
BiOp	Biological Opinion
BMP	Best Management Practice
BN	below normal
C	critical
CCF	Clifton Court Forebay
CCPP	Clifton Court Pumping Plant
CDFW	California Department of Fish and Wildlife
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHNSR	spring-run Chinook salmon
CHNWR	winter-run Chinook salmon
CIDH	cast-in-drilled-hole
CNDDB	California Natural Diversity Database
CNOR	Candidate Notice of Review
COA	Coordinated Operation Agreement
Corps	U.S. Army Corps of Engineers
CSAMP	Collaborative Science and Adaptive Management Program
CVFPB	Central Valley Flood Protection Board
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVRWQCB	Central Valley Regional Water Quality Control Board
CVTRT	Central Valley Technical Recovery Team
CWF	California WaterFix
cy	cubic yards
dB	decibel
dBA	A-weighted decibel
D	dry
DCC	Delta Cross Channel
DEIR	Draft Environmental Impact Report
DEIS	Draft Environmental Impact Statement
DHCCP	Delta Habitat and Conservation Conveyance Program
DJFMP	Delta Juvenile Fish Monitoring Program

DOI	Department of the Interior
DRERIP	Delta Regional Ecosystem Restoration Implementation Plan
DSM2	Delta Simulation Model II
DSOD	Division of Safety of Dams
DSP	Delta Science Program
DWR	Department of Water Resources
E/I	[Delta] export/inflow
EC	electrical conductivity
ECOS	Environmental Conservation Online System
EDSM	Enhanced Delta Smelt Monitoring
ELT	Early Long-Term
EPA	Environmental Protection Agency
ERP	Ecosystem Restoration Program
ESA	Endangered Species Act
FCCL	Fish Conservation and Culture Laboratory
FL	fork length
FFTT	Fish Facilities Technical Team
FFWT	Fish Facilities Working Team
FMWT	Fall Midwater Trawl
ft	feet or foot
FR	Federal Register
H	horizontal
ha	hectares
HCP	habitat conservation plan
HOR	Head of Old River
HORG	Head of Old River Gate
I/E	[San Joaquin River] inflow/export
IEP	Interagency Ecological Program
IF	Intermediate Forebay
IICG	Interagency Implementation and Coordination Group
ITP	Incidental Take Permit
ITS	Incidental Take Statement
kV	kilovolt
LFWO	Lodi Fish and Wildlife Office
LSNFH	Livingston Stone National Fish Hatchery
LSZ	low-salinity zone
m	meter
MIDS	Morrow Island Distribution System
MHHW	Mean High High Water
MLLW	Mean Low Low Water
MI	municipal and industrial
mg/L	milligrams per liter
mm	millimeter
m^3/s	cubic meters per second

NAA	No Action Alternative
NCCF	North Clifton Court Forebay
NCCP	Natural Community Conservation Planning
NDD	North Delta Diversions
NDDTT	North Delta Diversion Technical Team
NDOI	Net Delta Outflow Index
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
No.	number
NPDES	National Pollutant Discharge Elimination System
NRDC	Natural Resources Defense Council
OMR	Old and Middle river
PA	Proposed Action
PCE	Primary Constituent Elements
PG&E	Pacific Gas and Electric
PP	pumping plant
ppt	parts per thousand
Reclamation	U.S. Bureau of Reclamation
RI	River Index
RIT	Recovery Implementation Team
RM	river mile
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RRDS	Roaring River Distribution System
RTM	Reusable Tunnel Material
RTO	real-time operations
SBFNC	Suisun Bay Federal Navigation Channels
SCCF	South Clifton Court Forebay
SDWSC	Stockton Deep Water Ship Channel
Secretary	Secretary of the Interior
SEL	sound exposure level
SERP	Small Erosion Repair Program
Service	U.S. Fish and Wildlife Service
SKT	Spring Kodiak Trawl
SLC	California State Lands Commission
SMSCG	Suisun Marsh Salinity Control Gates
SMUD	Sacramento Municipal Utility District
SPL	sound pressure level
sq	square feet
SR	State Route
SRDWSC	Sacramento River Deep Water Ship Channel
SRWTP	Sacramento Regional Wastewater Treatment Plant
Strategy	Delta Smelt Resiliency Strategy
SWP	State Water Project

SWPPP	Stormwater Pollution Prevention Plan
SWRCB	California State Water Resources Control Board
TAF	thousand acre feet
TBM	Tunnel Boring Machine
TNS	[Summer] Townet Survey
TOT	Technical Oversight Team
U.S.	United States
U.S.C.	United States Code
V	vertical
W	wet
Western	Western Area Power Administration
WREM	Water Resources Engineering Memorandum
WQCP	Water Quality Control Plan
WSE	Water Surface Elevation
WY	water year

1.0 INTRODUCTION

The California Department of Water Resources (DWR) proposes to: (1) construct, operate, and maintain new water conveyance facilities in the Sacramento–San Joaquin Delta, including three intakes, two tunnels, associated facilities, and a permanent Head of Old River Gate (HORG), (2) operate existing State Water Project (SWP) Delta facilities in coordination with the new facilities, (3) maintain the newly-constructed and existing facilities, (4) implement and uphold new and existing conservation measures, and (5) implement and assist in an ongoing monitoring and a new adaptive management program.

The United States (U.S.) Department of the Interior (DOI), Bureau of Reclamation (Reclamation), as the Federal lead agency for the Endangered Species Act (Act) section 7 consultation [acknowledging the U.S. Army Corps of Engineers (Corps) as an additional Federal action agency], proposes to coordinate Central Valley Project (CVP) operations with DWR, the applicant, using the new and existing facilities. The Corps proposes to issue permits to DWR pursuant to Rivers and Harbors Act Section 10, Clean Water Act Section 404, and 33 United States Code (U.S.C.) 408.

DWR is the entity undertaking all construction-related activities including those related to the intakes, the associated tunnels, and their associated structures. When referring to DWR throughout this BiOp as the entity carrying out construction, operation, or maintenance of the CWF, it includes DWR's agents and those under DWR's supervision (6/13/2017 email from Kenneth Bogdan, DWR). The in-water construction activities associated with the intakes, tunnels, and associated structures, as well as the change in SWP Delta operations, requires a combination of Rivers and Harbors Act Section 10, Clean Water Act Section 404, and 33 U.S.C. 408 approvals from the Corps. DWR and/or its designees will operate and maintain the facilities, and Reclamation will adjust its operation of the CVP to utilize the dual water conveyance system.

DWR's operation of the proposed facilities, referred to as "California WaterFix," would modify operation of SWP, which is operated in coordination with the CVP. Reclamation is responsible for operation and maintenance of the CVP and DWR is responsible for the operation and maintenance of the SWP. The proposed new facilities would operate in coordination with the existing Delta facilities, including the Clifton Court Forebay (CCF), located in San Joaquin County, California. The three proposed intakes, comprising the new proposed North Delta Diversions (NDD), would be located on the east bank of the Sacramento River near Clarksburg, in Sacramento County, California, and connected to the CCF by two underground tunnels and a new pumping plant, which would be sited at an expanded CCF. The proposed new facilities would provide water for intake at the Banks Pumping Station and the South Bay Pumping Plant, which are existing SWP facilities that draw water from the CCF for distribution through existing SWP facilities.

2.0 PURPOSE OF THIS CONSULTATION

The Service concurs with Reclamation's likely to adversely affect determinations. Therefore, this consultation examines whether the California WaterFix (CWF) Proposed Action (PA) is likely to jeopardize the continued existence of the threatened California red-legged frog (*Rana draytonii*), threatened California tiger salamander (Central California Distinct Population Segment; *Ambystoma californiense*), threatened delta smelt (*Hypomesus transpacificus*), threatened giant garter snake (*Thamnophis gigas*), endangered Least bell's vireo (*Vireo bellii pusillus*), endangered San Joaquin kit fox (*Vulpes macrotis mutica*), threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), threatened vernal pool fairy shrimp (*Branchinecta lynchi*), endangered vernal pool tadpole shrimp (*Lepidurus packardi*), and threatened western yellow-billed cuckoo (*Coccyzus americanus occidentalis*). Additionally, this consultation addresses whether the CWF PA is likely to destroy or adversely modify delta smelt critical habitat.

3.0 SPECIES' AND CRITICAL HABITAT NOT LIKELY TO BE ADVERSELY AFFECTED

The Service concurs with Reclamation's determination that the PA may affect, but is not likely to adversely affect the endangered California clapper rail (*Rallus longirostris obsoletus*), endangered California least tern (*Sternula antillarum browni*), California red-legged frog designated critical habitat, endangered riparian brush rabbit (*Sylvilagus bachmani riparius*), endangered salt marsh harvest mouse (*Sternula antillarum browni*), endangered soft bird's-beak (*Cordylanthus mollis ssp. mollis*), and endangered Suisun thistle (*Cirsium hydrophilium*). While critical habitat is designated within the action area for the soft bird's-beak and Suisun thistle, the critical habitat is not likely to be adversely affected by the PA and will not be addressed further. Reclamation determined that critical habitat for vernal pool fairy shrimp and vernal pool tadpole shrimp was likely to be adversely affected. However, upon review, the Service has determined that critical habitat for both species is not likely to be adversely affected. The avoidance and minimization measures (AMMs) identified in the *Description of the Proposed Action* support these not likely to adversely affect species' and critical habitat determinations. Refer to *Appendix A* for further justifications related to these determinations.

Recent genetic analyses of rail species resulted in a change in the common name and taxonomy of the large, "clapper-type" rails (*Rallus longirostris*) of the west coast of North America to Ridgway's rail (*Rallus obsoletus*) (Maley and Brumfield 2013; Chesser *et al.* 2014). Thus, the California clapper rail (*Rallus longirostris obsoletus*) is now referred to in the scientific community as the California Ridgway's rail (*Rallus obsoletus obsoletus*). The change in the common name and taxonomy of the California clapper rail does not change the listing status of the species under the Act and is referred to by the original name in this biological opinion (BiOp).

4.0 CONSULTATION HISTORY

This consultation is the most recent in a long history of activities regarding the CVP and SWP operations. A detailed discussion of the history leading up to this consultation can be found in the Service's 2005 *Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues* and 2008 *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP).* Additional information on the consultation history can be found in Chapter 2 of the July 2016 *Biological Assessment for the California WaterFix* (BA) that documents the technical assistance provided by the Service during the development of the CWF BA.

July, 2006	Several State and private parties enter into a memorandum of agreement (MOA) that sets out the financial commitments of the parties to carry out actions to satisfy existing regulatory requirements related to operation of the CVP and SWP and develop a habitat conservation plan (HCP) for the Delta that would support new regulatory authorizations under State and Federal endangered species laws for current and future activities related to the CVP and SWP. This plan comes to be called the Bay Delta Conservation Plan (BDCP). DWR unites the MOA parties into a BDCP Steering Committee, which commences regular meetings that continue until November 18, 2010.
December 15, 2008	The Service issues a BiOp for the *Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP)* (Service 2008), portions of which address operation and management of CVP and SWP facilities in the Delta. Reclamation provisionally accepts and then implements the BiOp including the Reasonable and Prudent Alternative (RPA).
June 4, 2009	NMFS issues a BiOp for the *Long-Term Operations of the Central Valley Project and State Water Project* (NMFS 2009), portions of which address operation and management of CVP and SWP facilities in the Delta. Reclamation provisionally accepts the BiOp, including the RPA, on June 4, 2009, and then implements the BiOp including the RPA.
September, 2010	The Service issues a BiOp, analyzing the effects of proposed geotechnical explorations to inform the BDCP and preliminary engineering studies for the Delta Habitat Conservation and Conveyance Program (DHCCP).
December, 2010	The BDCP steering committee is dissolved and DWR continues the BDCP planning process as the principal applicant for the BDCP, which is intended to serve as an HCP for the purposes of compliance with the Act

and as a natural community conservation plan (NCCP) for the purposes of Natural Community Conservation Planning Act (NCCPA) compliance. The BDCP at this stage includes, in a preliminary form, the proposed new facilities and water operations subsequently incorporated into the PA for the CWF. DWR and its contractors meet regularly with Reclamation, CDFW, NMFS, and Service staff members to discuss issues related to development of the HCP and NCCP; these meetings continue until release of the draft BDCP in December 2013.

April 7, 2011	NMFS issues amendments to the RPA of its 2009 BiOp (NMFS 2009). Subsequent references in this BiOp to the 2009 NMFS BiOp should be interpreted to include reference to these 2011 amendments, as applicable.
July 15, 2011	The Service participates in a 5-agency effort to provide recommendations to agency management on the intake location, size, design, and configuration in the north Delta. After a series of meetings, the Fish Facilities Technical Team (FFTT) produces a Technical Memorandum on July 15, 2011. The Technical Memorandum includes in the appendix the previous August 2008 recommendations from the FFTT.
July 28, 2013	As a follow-up to the July 15, 2011 FFTT Technical Memorandum, the Service participates in a series of meetings to develop a Work Plan which focuses on initial scope, schedule, and cost estimates for the 22 technical studies identified in the Technical Memorandum related to the NDD.
December 13, 2013-July 29, 2014	DWR issues draft BDCP, files an application for an Incidental Take Permit (ITP) under section 10 of the Act, and together with Reclamation, NMFS, and Service, issues a Draft Environmental Impact Report/Draft Environmental Impact Statement (DEIR/DEIS), evaluating the BDCP and 12 other alternatives. Public comment period on the plan and EIR/EIS extends through July 29, 2014.
January 9, 2015	Reclamation reinitiates consultation with the Service on the 2008 Service BiOp and Conveyance of Revised Incidental Take for the 2015 Water Year (WY).
February, 2015	Reclamation and DWR decide to pursue a section 7 consultation instead of a HCP as a pathway for incidental take authorization for the construction and operation of the water facilities formerly proposed under BDCP.
March 25, 2015 - July 19, 2016	The Service and CDFW participate in the Terrestrial Technical Team (TTT) with Reclamation, Corps, DWR, and ICF International, which consisted of conference calls and in-person meetings up to

	multiple times per week as necessary to discuss species lists, species and critical habitat determinations, avoidance and minimization measures, conservation measures, and effects to State and federally listed terrestrial species and their critical habitats. The Service reviews and comments numerous iterations of biological assessment components as part of the TTT.
April 2, 2015	The Corps Sacramento District designates Reclamation as lead Federal agency for the section 7 consultation on the CWF.
June 30, 2015 - June 30, 2016	The BDCP/CWF Partially Recirculated DEIR/Supplemental DEIS is made available for public review and comment.
October 1, 2015	Reclamation transmits a draft CWF BA to the Service and NMFS for review.
October 30, 2015	Reclamation transmits additional components of the draft CWF BA to the Service and NMFS for review.
November 2015	The Service and NMFS provide comments on the draft CWF BA to Reclamation in the context of a series of meetings and emails.
April 5-6, 2016	The Delta Science Program (DSP) conducts a 2-day meeting related to an independent scientific evaluation of the methods and approaches for developing the biological assessments for the section 7 consultations and analyses prepared for the CDFW 2081 (b) ITP application for the CWF.
May 12, 2016	The Service receives the final report *Independent Review Panel Report for the 2016 California WaterFix Aquatic Science Peer Review* of the Phase 1 independent science review. The final report is available at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/BDCP/ca_waterfix_aq_sci_review_report_final_may12.pdf
July 26, 2016	The Service receives a letter from Natural Resources Defense Council (NRDC), which includes scientific information relevant to the consultation.
July 29, 2016	The Service receives electronic copy of Reclamation's initiation letter requesting consultation with the Service on the effects of the CWF accompanied by a biological assessment titled *Biological Assessment for the California WaterFix*, dated July 2016.
August 2, 2016	The Service receives a letter from Reclamation and DWR requesting to initiate reinitiation of consultation on the 2008 Service BiOp. The

	reinitiation was based on new information related to multiple years of drought and recent data demonstrating a low delta smelt population and new information available and expected to become available as a result of the ongoing work through collaborative science processes.
August 3, 2016	The Service sends a response to Reclamation and DWR acknowledging the receipt of the August 2, 2017 reinitiation request. The letter acknowledged that a Consultation Agreement would be developed by the fall outlining the tasks, process and schedule to complete a BA and BiOp.
September - December 13, 2016	The Service, NMFS, and CDFW participate in conference calls, email exchanges, and in-person meetings with DWR, Reclamation, Corps, and consultants to provide comments and receive responses on additional information requests resulting in the *BiOp Resolution Log*.
September 23, 2016	The Service receives a memorandum from ICF International which includes clarifications to comments and questions on the CWF BA. The memo addresses the following species: San Joaquin kit fox, giant garter snake, California red-legged frog, California tiger salamander, and valley elderberry longhorn beetle.
November 4, 2016	The Service and NMFS receive an email transmittal from Reclamation adding the Contra Costa Water District Settlement Agreement actions to the CWF project description.
November 7, 2016	The Service and NMFS receive an email transmittal from Reclamation adding restoration timing commitments and revisions of spring outflow criteria to the CWF project description.
November 29, 2016	The Service receives a memo from Reclamation with the subject: *California WaterFix (CWF): Endangered Species Act (ESA) Section 7 Consultation – Scope of Current and Future Federal Actions.*
December 13, 2016	The Service and NMFS receive the *BiOp Resolution Log*, which documents comments and responses between the Service, NMFS, CDFW, DWR, Reclamation, Corps, and consultants.
December 23, 2016	The Service transmits the Draft Partial CWF BiOp to the Delta Stewardship Council for independent peer review. NMFS posts online at http://www.westcoast.fisheries.noaa.gov/central_valley/WaterFix/WaterFixPeerReview2BMaterials.html.
December 23, 2016- January 19, 2017	The Service, NMFS, CDFW participate in conference calls, emails, and in person meetings with DWR, Reclamation, Corps, and consultants

regarding partial draft BiOps.

January 19, 2017	The Service transmits the administrative draft of the CWF BiOp to Reclamation with copies to the Corps, NMFS, and CDFW.
January 19, 2017	The Service and NMFS received an email from Reclamation describing commitments related to long-term operations of the CWF.
January 19-May 12, 2017	The Service, NMFS, CDFW participate in conference calls, emails, and in person meetings with DWR, Reclamation, Corps, public water agencies, and consultants to resolve comments received on the Service's administrative draft of the CWF BiOp.
January 23-24, 2017	The Delta Science Program (DSP) conducts a 2-day meeting related to an independent scientific evaluation of the methods and analyses in the draft aquatic sections of the BiOps.
January 26, 2017	The Service receives Reclamation's comments on the December 23, 2016 Draft Partial CWF BiOp via email.
February 21-22, 2017	The Service receives Reclamation and DWR's comments on the January 19, 2017 administrative draft of the CWF BiOp.
February 24, 2017	The Service receives a letter from NRDC, Defenders of Wildlife, and the Bay Institute outlining concerns about the draft CWF BiOp.
March 8, 2017	The Service receives final reports for the *Independent Review Panel Report for the 2016-2017 California WaterFix Aquatic Science Peer Review Phase 2A* and *Independent Review Panel Report for the 2016-2017 California WaterFix Aquatic Science Peer Review Phase 2B* from the DSP. As appropriate, the recommendations from the independent peer review panel's final reports were addressed and incorporated into this BiOp. The Phase 2A final report is available at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/CAWaterFix/Peer%20Review%202A/ca.waterfix.phase2a.version2017mar07_final_to_dsp.pdf. The Phase 2B final report is available at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/CAWaterFix/Peer%20Review%202B/ca.waterfix.phase2b.version2017mar07_final_to_dsp.pdf
May 5, 2017	The Service receives from DWR revisions to the project description including Guiding Principles for CWF actions and subsequent consultations, changes to operations of the NDD and pulse flow protections for salmonids, changes to south Delta operations in October

and November, and changes to delta smelt compensatory mitigation along with a new long-term sensitivity analysis simulation of the PA which included some of the changes.

May 19, 2017	The Service receives a request from Kern County Water Agency, San Luis & Delta-Mendota Water Authority, Santa Clara Valley Water District and Westlands Water District requesting to review Draft CWF BiOp.
May 23, 2017	The Service provides the Draft CWF BiOp to representatives from Kern County Water Agency, San Luis & Delta-Mendota Water Authority, Santa Clara Valley Water District, Westlands Water District and Metropolitan Water District.
May 24, 2017	The Service receives from Reclamation and DWR modifications to the project description, *BiOp Resolution Log, Adaptive Management Framework* and funding assurances.
May 26, 2017	The Service meets with DWR to receive additional comments on the Draft CWF BiOp.
May 26, 2017	The Service receives joint written comments from Kern County Water Agency, San Luis & Delta-Mendota Water Authority, Santa Clara Valley Water District and Westlands Water District.
May 26, 2017	The Service receives written comments from Grasslands Water District concerning the possibility of reduced allocation to CVP contractors, including south-of-Delta wildlife refuges, which receive CVP water on a priority basis and provide wetland habitat for a number of threatened and endangered species, and that any reduced south Delta diversions would require further mitigation to ensure no harm to critical refuge water deliveries.
May 30, 2017	The Service receives an email from DWR with written clarifications to the longfin spring outflow criteria.
June 6, 2017	The Service receives written comments from Kern County Water Agency.
June 7, 2017	The Service receives an email from NRDC which includes scientific information and analysis related to abundance and survival of delta smelt.

5.0 CONSULTATION APPROACH

The purpose of this section 7 consultation is to evaluate the effects of the CWF on listed species and designated critical habitat. After reviewing the CWF as proposed by Reclamation and the Corps and the Corps' permitting schedule, the Service has determined that CWF presents a mixed programmatic action, as defined in 50 CFR 402.02. The Service's consultation includes a mix of standard consultation (which includes an Incidental Take Statement [ITS]) and programmatic consultation (which can include an ITS or defer the ITS to a later time associated with subsequent Federal actions). An analysis and conclusion of whether or not the entire CWF action as described in the PA is likely to jeopardize listed species or destroy or adversely modify critical habitat is included in this BiOp. All activities addressed programmatically will be subject to a subsequent consultation in order to proceed. Additionally, some project elements and their effects on listed species or critical habitat will change as DWR continues to develop the PA and may require reinitiation.

Some of the project elements are described at a site-specific level for near-term implementation with no future Federal action required. For other project elements, the PA provides a framework for the development of future Federal actions that will be authorized, funded, or carried out at a later time. This BiOp uses a programmatic approach to evaluate the elements of the PA that will be subject to future project-specific consultations because of subsequent Federal approvals. Table 5.0-1 describes the approach we took for each project element. In addition, a schematic explaining this approach and phase maps are included in Appendix C. The analysis in this BiOp allows for a broad-scale examination of the potential impacts on listed species and their designated critical habitats, and examines how the parameters of the CWF align with the survival and recovery needs of listed species occurring in the action area. The remainder of the project elements not addressed programmatically are addressed as a standard, project-level consultation because they are not subject to future Federal approvals. For framework programmatic actions, an incidental take statement is not required at the program (framework) level for those actions falling within the definition of framework programmatic action (50 CFR 402.02). Therefore, this BiOp contains an ITS for those standard, project-level consultation elements for which incidental take is reasonably certain to occur.

For other project elements lacking the necessary specificity at this time but not requiring future Federal approvals, reinitiation of this consultation may be required when additional information is available. This approach is consistent with the requirement for the action agency to reinitiate consultation under certain circumstances. 50 CFR 402.16 outlines the circumstances that require reinitiation of consultation, which apply to the PA. In addition, this BiOp describes some additional specific conditions under which consultation will need to be reinitiated. These are included by species in the *Effects of the Proposed Action* sections and *Reinitiation-Closing Statement*.

Programmatic portions of the PA will require separate section 7 consultations as part of the subsequent approval. These portions of the PA are not authorized to commence until these separate consultations are completed. This document provides a framework analysis for subsequent CWF consultations, which includes principles that will be used to guide how CWF is implemented (see the *Guiding Principles for the Framework Programmatic Consultation* section below). The Service anticipates the subsequent consultations will be initiated by either Reclamation or the Corps (depending on the specific project element) and will provide sufficient information as outlined in 50 CFR 402.12(f).

Portions of the PA that require future approvals and are therefore addressed programmatically herein, are: (1) construction of the NDD and associated structures, (2) construction of the HORG, (3) construction of the CCWD settlement agreement facilities, (4) operations of new and existing CVP and SWP water facilities under dual conveyance, (5) future maintenance, (6) future monitoring, and (7) compensatory mitigation associated with construction of the NDD, HORG, and CCWD settlement agreement facilities. Portions of the PA that are addressed as a standard consultation are: (1) construction of the tunnels, (2) expansions and other modifications of CCF, (3) associated infrastructure, (4) geotechnical explorations, (5) compensatory mitigation associated with construction except the NDD, HORG, and CCWD settlement agreement facilities, and (6) specific construction-related conservation measures including preconstruction surveys for listed terrestrial species. As noted above, some of these actions may require reinitiation in the future. We have organized the *Description of the Proposed Action* into programmatic and standard actions for purposes of this consultation (Table 5.0-1).

Table 5.0-1 Components of the mixed programmatic approach.

	Standard consultation w/ITS	Framework programmatic consultation w/no ITS
Pre-construction (geotechnical borings, surveys)	✓	
Construction (Corps Phase 1: access, staging areas, tunnels, CCF)	✓	
Construction (Corps Phase 2: HORG, NDD, CCWD settlement agreement facilities)		✓
Future Project Operations		✓
Monitoring associated with Corps Phase 1 activities	✓	
Monitoring associated with Corps Phase 2 activities		✓
Mitigation/restoration associated with Corps Phase 1 activities	✓	
Mitigation/restoration associated with Corps Phase 2 activities		✓
Maintenance of Corps Phase 1 facilities	✓	
Maintenance of Corps Phase 2 facilities		✓
Adaptive Management related to Corps Phase 1 activities	✓	
Adaptive Management related to Corps Phase 2 activities		✓

6.0 DESCRIPTION OF THE PROPOSED ACTION

The PA includes: (1) construction of the new water conveyance facility including preconstruction geotechnical surveys, (2) new conveyance facility operation in coordination with operation of existing CVP and SWP Delta facilities, (3) maintenance of the existing facilities and newly constructed facilities, (4) Contra Costa Water District (CCWD) Settlement Agreement facilities construction and operation, (5) implementation and maintenance of conservation measures including preconstruction surveys for listed species, and (6) required monitoring of pre- and post-construction and adaptive management activities.

The Service has summarized this description of the PA from the CWF BA and incorporated the BA and appendices by reference. We also incorporated information that resulted from exchanges between the agencies during early technical assistance and consultation and made minor changes for clarity. The *BiOp Resolution Log* articulates these changes and is included as an appendix to this BiOp. Portions of Chapter 3 in the CWF BA that articulate or summarize existing actions that have been previously analyzed, permitted, or authorized under the Act will not be included in our summary of the PA. However, these items may be discussed in the *Environmental Baseline* section of this BiOp.

DWR is the entity undertaking all construction-related activities including those related to the intakes, the associated tunnels, and their associated infrastructure. The in-water construction activities associated with the intakes, tunnels, and associated infrastructure, as well as the change in SWP Delta operations, requires a combination of Rivers and Harbors Act Section 10, Clean Water Act Section 404, and 33 U.S.C. 408 (408) approvals from the Corps. The Corps has divided the Clean Water Act Section 404, Section 10 of the Rivers and Harbors Act, and 408 permit approvals into two phases. The first phase will involve permit decisions for the construction of tunnels, Intermediate Forebay (IF), CCF modifications, and associated infrastructure. The second phase will involve permit decisions for the NDD and the HORG. DWR and/or its designees will operate and maintain the facilities, and Reclamation will adjust operation of the CVP to utilize the dual conveyance.

Effects resulting from operations, maintenance and monitoring of the new conveyance facilities are addressed at a programmatic-level in this BiOp. Reclamation and the Corps have proposed to prepare future project-specific BAs when subsequent Federal actions occur for these activities. Either Reclamation or the Corps will be the lead Federal action agency for these future consultations (Reclamation 2016a), depending on the triggers and processes for each activity and those agencies' discretionary authority over the action and effects to listed species and critical habitat.

As described in Chapter 1 of the CWF BA, for section 7 consultation under the Act, Reclamation is the lead Federal Agency and Action Agency for coordinated operation of the CVP and SWP ("Operations") and the Corps is the Action Agency for construction. DWR is the applicant. Reclamation has requested consultation on the CWF on behalf of both agencies as the lead Federal Agency.

6.1 Programmatic Actions

Guiding Principles for the Framework Programmatic Consultation

Future CWF actions subject to subsequent Federal decisions or approvals include construction and related actions (including maintenance, mitigation, and monitoring) of the NDD intakes and HORG, and operations of the new CWF facilities. It is anticipated that the construction-related actions subject to future Federal approvals will be consulted upon as part of the Corps' Phase 2 permitting for CWF. Phase 2 permitting will be preceded by the reinitiated consultation on the 2008 Service BiOp and 2009 NMFS BiOp. Agency decisions related to identifying the final

CWF operational criteria will be made in a subsequent consultation, and Reclamation and DWR have committed to analyze and further address species effects from CWF operations at that time.

The following Guiding Principles are proposed by Reclamation and DWR to establish a framework in this consultation under which the future CWF actions will be developed to ensure both that future consultations related to CWF actions build upon the analysis in this document as described in the *Consultation Approach* section above and that the CWF is constructed and operated in a manner that promotes the co-equal goals articulated in California's Delta Reform Act. The principles are intended to promote (1) ecological conditions suitable for all life stages of delta smelt, and (2) water supply reliability. The Guiding Principles are as follows:

1. Improving habitat conditions for rearing juvenile delta smelt, which may include locating the low-salinity zone (LSZ) in suitable areas of the estuary.
2. Operating CVP and SWP water exports in the south Delta to minimize entrainment of migrating and spawning adult delta smelt and larval/young juvenile delta smelt.
3. Promoting increased turbidity in geographical areas and during temporal windows that may be expected to increase the extent and quality of delta smelt habitat through implementation of sediment management plan referenced in the 2017 CWF PA and through actions described in the Delta Smelt Resiliency Strategy.
4. Restoring, creating, or enhancing spawning habitat conditions through use of mitigation commitments made by Reclamation and DWR in the 2017 CWF PA and through actions described in the Delta Smelt Resiliency Strategy.
5. Promoting food production and transport into areas where habitat conditions are suitable for delta smelt.
6. Improving population-level delta smelt habitat conditions through reductions in non-native invasive species.
7. Coordinating operations of the south Delta and NDD water facilities to limit effects to the delta smelt population from cyanobacteria blooms.
8. Implementing all actions in a manner that limits, to the maximum extent practicable, impacts to water supply and provides opportunities to recover water supplies consistent with protection of listed species.

These principles are subject to change over time where the best available scientific information indicates that such change is appropriate. In such event, the agencies will evaluate whether the change triggers the requirement to reinitiate consultation.

Adaptive Management

Reclamation, DWR, the Service, NMFS, CDFW, and the public water agencies have agreed to develop a program of collaborative science, monitoring, and adaptive management in support of CWF (refer to CWF BA *Agreement for Implementation of an Adaptive Management Program for Project Operations, Adaptive Management Program* and *BiOp Resolution Log*). This Agreement and Adaptive Management Program outline a collaborative process for assessing and adapting to effects to listed species stemming from the ongoing operation of the CVP and SWP, including future implementation and operation of the CWF. Under the adaptive management program, new information developed during the course of implementation is expected to inform operational decisions and conservation tactics. DWR and Reclamation commit to implementing the Adaptive Management Program (AMP), consistent with the *Agreement for Implementation of an Adaptive Management Program for Project Operations.* The AMP includes a cost estimate and DWR and Reclamation commit to implementing the categories of actions described in the cost estimate. However, final determination of the specific actions, implementation plans, and costs associated with implementation of those actions will be determined through the Interagency Implementation and Coordination Group (IICG).

North Delta Diversions

Intakes

The PA includes construction of three intakes (Intake 2, Intake 3, and Intake 5 of the original five proposed in the BDCP) on the east bank of the Sacramento River between Clarksburg and Courtland, in Sacramento County, California. Each intake will divert a maximum of 3,000 cubic feet per second (cfs) of Sacramento River water. Each intake will consist of an intake structure fitted with on-bank fish screens, gravity collector box conduits extending through the levee to convey diverted water to a sedimentation system(consisting of sedimentation basins to capture sand-sized sediment and drying lagoons to dry and consolidate the sediment); a sedimentation afterbay providing the transition from the sedimentation basins to a shaft that will discharge into a tunnel leading to the IF; and an access road, vehicle parking area, electrical service, and fencing. Intake 2 will be located at river mile (RM) 41.1 and will be 1,969 feet (ft) in length, Intake 3 will be located at RM 39.4 and will be 1,497 ft in length, and Intake 5 will be located at RM 36.8 and will be 1,901 ft in length along the Sacramento River's east bank. Text in Section 3.2.2.1 of the CWF BA refers to Appendices 3.A-C for renderings, drawings, and components of the intakes. At the conclusion of construction, the intake facilities will be landscaped, fenced, and provided with security lighting.

Fish Screen Design

Each intake will include fish screens designed to minimize the risk that fish or larvae will be entrained into the intakes or injured by impingement on the fish screens. A general description is provided in Section 3.2.2.2 and references CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, but final design is not complete. Final design is subject to review and approval by the fish and wildlife agencies (*i.e.*, Service, NMFS, and CDFW). DWR will evaluate screen design using recommendations from the FFTT and has described the process to be subject to extensive collaborative discussions with the fish agencies. Additionally a variety of preconstruction studies are proposed to aid in refinement of the fish screen design and are listed in Table 3.4-17 items 1-8 in the CWF BA, as required prior to final intake design.

Levee Work

Levee modifications will be needed to construct the intakes and must provide continual flood management while construction occurs and after it is finished. The levee modifications are described in CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Section 15 *Levees*, and in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Drawings 6, 10 to 17, 19, 44, and 45. Additional information on cofferdam construction (one element of the levee work) appears in CWF BA Appendix 3.B, Section 6.2.1, *General Constructability Considerations*. The Sacramento River levees are Federal Flood Control Project levees under the jurisdiction of the Corps and the Central Valley Flood Protection Board, and specific requirements are applicable to the penetrations of these levees that are needed to move Sacramento River water into the proposed conveyance tunnels. Authorizations for this work have not yet been issued. All construction on these levees will be performed in accordance with conditions and requirements set forth in the Corps permit authorizing the work.

Principal levee modifications necessary for conveyance construction are summarized here. See the referenced text in CWF BA Appendices 3.B and 3.C, *Conceptual Engineering Report, Volumes 1 and 2*, respectively, for detailed descriptions of the work. CWF BA Appendix 3.B, Section 15.2, *Sequence of Construction at the Levee*, includes a table detailing the sequence of construction activities in levee work.

New facilities interfacing with the levee at each intake site will include the following elements:

<u>Levee Widening</u>

Levees near the intakes will be widened on the land-side to increase the crest width, facilitate intake construction, provide a pad for sediment handling, and accommodate a realignment of State Route (SR) 160. Levee widening is done by placing low permeability levee fill material on the land-side of the levee. The material is compacted in lifts and keyed into the existing levee and ground. The levee will be widened by about 250 ft at each intake site. The widened levee sections will allow for construction of the intake cofferdams, associated diaphragm walls, and levee cutoff walls within the existing levee prism while preserving a robust levee section to remain in place during construction.

SR 160 will be impacted by construction activities at each of the three intake sites. During the levee widening, the highway will be permanently relocated from its current alignment along the top of the river levee to a new alignment established on top of the widened levee aligned approximately 220 ft east of the river. The location of the new permanent SR 160 alignment is shown in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Drawings 13, 14, 15 and 16.

On-Bank Intake Structure, Cofferdam, and Cutoff Walls

The intake structure and a portion of the box conduits will be constructed inside a dual sheet pile cofferdam installed within the levee prism on the river-side (CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2,* Drawings 15, 16, 17 and 19; construction techniques are described in CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1,* Sections 6.2.1, General Constructability Considerations; 15.1, Configuration of Facilities in the Levee; and 15.2, Sequence of Construction at the Levee. See CWF BA Section 3.2.2.5, *Pile Installation for Intake Construction,* for detail on the pile placement required for cofferdam construction). The intake structure foundation will use a combination of ground improvement and steel-cased driven piles or drilled piers. The cofferdams will project from 10 to 35 ft into the river, relative to the final location of the intake screens, dewatering up to 5 acres of channel at each intake site. The river width varies from 475 ft at Intake 3 to 615 ft at Intake 5, so this represents 1.6% to 7.4% of the channel width.

The back wall of each cofferdam along the levee crest will be a deep slurry diaphragm cutoff wall designed for dual duty as a structural component of the cofferdam that will also minimize water seepage through and under the levee; thus the cofferdam sheet piles will become permanent structural components of the intake facility. The diaphragm wall will extend along the levee crest upstream and downstream of the cofferdam and the fill pad on the land-side of the levee, which will allow for a future tie-in with levee seepage cutoffs that are not part of the PA. The other three sides of each cofferdam, including a center divider wall, will be sheet pile walls. The cofferdam will include a permanent, 5-ft-thick tremie concrete seal in the bottom to aid dewatering and construction within the enclosed work area.

In conjunction with the diaphragm wall, a slurry cutoff wall (soil, bentonite, and cement slurry) will be constructed around the perimeter of the construction area for the land-side facilities. This slurry wall will be tied into the diaphragm wall at the levee by short sections of diaphragm wall perpendicular to the levee. The slurry cutoff wall will overlap for approximately 150 ft along the diaphragm wall at the points of tie-in. The slurry wall is intended to help prevent river water from seeping through or under the levee during periods when deep excavations and associated dewatering are required on the land-side. By using the slurry wall in conjunction with the diaphragm wall, the open cut excavation portion of the work on the land-side will be completely surrounded by cutoff walls. These walls will minimize induced seepage from the river through the levee, both at the site and immediately adjacent to the site, and serve as long-term seepage control behind the levee.

Once each cofferdam is completed and the tremie seal has been poured and has cured, the enclosed area will be dewatered and any stranded fish will be rescued in accordance with a fish rescue plan that will be developed by DWR or its contractors and approved by CDFW, NMFS, and the Service. Following full dewatering, areas within the cofferdam will be excavated to the level of design using a clam shell or long-reach backhoe. Then, ground improvements (jet grouting and deep soil mixing) will be made to enable installation of foundation piles that will support the intakes and fish screens.

At the upstream and downstream ends of each intake structure, a sheet pile training wall will transition from the concrete intake structure into the river-side of the levee. Riprap will be placed on the river-side slope upstream and downstream of the training walls to prevent erosion that could result from anomalies in the river created by the structure. Riprap will also be placed along the face of the structure at the river bottom to resist scour.

After intake construction is complete the cofferdammed area will be flooded and underwater divers using torches or plasma cutters will trim the sheet piles at the finished grade/top of structural slab. A portion of the cofferdam will remain in place after intake construction is complete to facilitate dewatering as necessary for maintenance and repairs, as shown in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2,* Drawing 16.

Box Conduits

Large gravity collector box conduits (12 conduits at each intake) will lead from the intake structure through the levee to the land-side facilities. The box conduits will be constructed by open-cut methods after the intake portion of the cofferdam is backfilled. Backfill above the box conduits and reconstruction of the disturbed portion of the levee prism will be accomplished using low-permeability levee material in accordance with Corps specifications.

Pile Installation for Intake Construction

Table 6.1-1 summarizes proposed pile driving at the intake sites, including the type, size, and number of piles required to build the cofferdams and structural reinforcements of the intakes. Table 6.1-1 also shows the number of piles anticipated to be driven per day, the number of impact strikes per pile, and whether piles will be driven in-water or on land. CWF BA Table 3.2-7 specifies 42-inch steel piles for the intake foundations; however, depending on the findings of the geotechnical exploration, it may be feasible to replace some or all of those steel piles with cast-in-drilled-hole (CIDH) foundation piles. The CIDH piles are installed by drilling a shaft, installing rebar, and filling the shaft with concrete. No pile driving is necessary with CIDH methods. If concrete-filled steel piles are required, their installation will involve vibratory or impact pile driving to set hollow steel piles deep into the sediment, so they can then be filled with concrete. CWF BA Table 3.2-7 assumes that all piles will be driven using impact pile driving, but the design intent is to use impact pile driving only for the piles supporting the foundations of the intakes. All other piles (*e.g.*, cofferdams) will be initially driven into the river bottom using vibratory pile driving but may require impact pile driving to reach design depths. Based on experience during construction of the Freeport diversion facility, it is expected that approximately 70% of the length of each pile can be placed using vibratory pile driving, so in an equivalent situation, impact driving would be needed for the other 30%. In-water pile driving will be subject to abatement (*e.g.*, use of a bubble curtain), hydroacoustic monitoring, and compliance with timing limitations as described in CWF BA Appendix 3.F.

Table 6.1-1. Pile driving for intake construction.

Feature	On-land or In-water	Pile Type/ Sizes	Total Piles	Number of Pile Drivers in Concurrent Use	Piles/ Day	Strikes/ Pile	Strikes/ Day
Intake Cofferdam – Intakes 2, 3, and 5	In-water	Sheet pile	2,500	4	60	210	12,600
Intake Structure Foundation – Intake 2	In-water	42-inch diameter steel	1,120	4	60	1,500	90,000
Intake Structure Foundation – Intake 3	In-water	42-inch diameter steel	850	4	60	1,500	90,000
Intake Structure Foundation – Intake 5	In-water	42-inch diameter steel	1,120	4	60	1,500	90,000
SR-160 Bridge (Realignment) at Intake	On-land	42-inch diameter steel	150	2	30	1,200	36,000
Control Structure at Intake	On-land	42-inch diameter steel	650	4	60	1,200	72,000
Pumping Plant and Concrete Sedimentation Basins at Intake	On-land	42-inch diameter steel	1,650	4	60	1,200	72,000

Sheet pile placement for cofferdam installation will be performed by a barge-mounted crane equipped with vibratory and impact pile driving rigs. Foundation pile placement within the cofferdammed area may be done before or after the cofferdammed area is dewatered. If it is done after the area is dewatered and the site is dry, a crane equipped with pile driving rig will be used within the cofferdam. If done before the cofferdam is dewatered, pile driving will be performed by a barge-mounted crane positioned outside of the cofferdam or a crane mounted on a deck on top of the cofferdam.

Construction Overview for North Delta Diversions

The NDD construction timeline is presented in CWF BA Appendix 3.D, *Construction Schedule for the Proposed Action*. The schedule is complex, with work simultaneously occurring at all major facilities for a period of years. During construction, the sequence of activities and duration of each schedule element will depend on the contractor's available means and methods, definition and variation of the design, departure from expected conditions, and perhaps other variable factors.

Each intake has its own construction duration projected to take approximately 4 to 5 years. Early phase tasks to facilitate construction will include mobilization, site work, and establishing concrete batch plants, pug mills, and cement storage areas. During mobilization the contractors will bring materials and equipment to construction sites, set up work areas, locate offices, staging and laydown areas, and secure temporary electrical power. Staging, storage, and construction zone preparation areas for each intake site will cover approximately 5 to 10 acres. Barges, which will be used as construction platforms for drilling rigs, cranes, etc., will be present throughout the construction period at each intake facility.

Site work consists of clearing and grubbing vegetation, constructing site work pads, building construction access roads, and building barge access sites. Before site work commences, the contractor will implement erosion and sediment controls in accordance with the Stormwater Pollution Prevention Plan (SWPPP). Specific plans for site clearing and grubbing and site access to stockpile locations have not yet been developed, but will be subject to erosion and dust control measures as specified in the SWPPP and other permit authorizations.

Although DWR plans to use existing roads to the greatest extent possible, some new roads will be constructed to expedite construction and to minimize impacts to residents, commuters and the environment. Access roads and environmental controls will be maintained consistent with best management practices (BMPs) and other requirements of the SWPPP and permit documents.

Substantial amounts of engineered fill will be placed landward of the levee, amounting to approximately 2 million cubic yards at each intake site. This fill material will be used primarily to widen the levee, build construction pads for the fills, and other land work needed to ensure that the permanent facilities are at an elevation above the design flood stage (*i.e.,* a 200-year flood with additional allowance for sea level rise). The required engineered fill material will preferably be sourced onsite from locations within the permanent impact footprint, for instance from excavations to construct the sedimentation basins, but may also need to be sourced from off-site locations.

Head of Old River Gate

In the CWF BA, DWR recognizes that design of the HORG is in the early stages. As such, DWR proposes to convene a CCF Technical Team with representatives from DWR, Reclamation, NMFS, CDFW, and the Service upon initiation of formal consultation for the PA. The team will meet periodically until DWR completes final design for the proposed gate (expected to be at least two years). The general concepts and construction components are summarized below and reference the CWF BA where appropriate.

An operable gate will be constructed at the Head of Old River (HOR) to replace the existing barrier at this channel junction. The existing seasonal rock barrier will remain in use until the HORG is complete. The gate will be located at the divergence of the HOR and the San Joaquin River, within the confines of the existing Old River channel, with no levee relocation, as shown in CWF BA Appendix 3.A, *Map Book for the Proposed Action*, Sheet 16. The proposed location is approximately 300 ft west of the temporary rock barrier that is annually installed and removed under current conditions. Preliminary design of the HORG specifies that it will be 210 ft long and 30 ft wide, with a top elevation of +15 ft (CWF BA Appendix 3.C, *Conceptual Engineering*

Report, Volume 2, Sheets 95 and 96). Design and construction are further detailed in CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Section 17, *Operable Barrier.*

The proposed HORG will include seven bottom-hinged gates, totaling approximately 125 ft in length. Other components include a fish passage structure, a boat lock, a control building, a boat lock operator's building, and a communications antenna. Appurtenant components include floating and pile-supported warning signs, water level recorders, and navigation lights. The facility will also have a permanent storage area (180 by 60 ft) for equipment and operator parking. Fencing and gates will control access to the structure. A propane tank will supply emergency power.

The boat lock will be 20 ft wide and 70 ft long. The final design of the associated fish passage structure will be established with input from NMFS and the Service, but is proposed to be 40 ft long and 10 ft wide, and constructed with reinforced concrete. Stop logs will be used to close the fish passage structure when it is not in use to protect it from damage. When the HORG is partially closed, flow will pass through a series of baffles in the fish passage structure. The fish passage structure is designed to maintain a 1-ft-maximum head differential across each set of baffles. The historical maximum head differential across the rock barrier is 4 ft, so it is anticipated that four sets of baffles will be required. The vertical slot fish passage structure will be entirely self-regulating and will operate without mechanical adjustments to maintain an equal head drop through each set of baffles regardless of varying upstream and downstream water surface elevations.

Construction

The HORG will be constructed using cofferdam construction techniques, which will create a dewatered construction area for ease of access and egress. To ensure the stability of the Old River levees, sheet pile retaining walls will be installed in the levees where the operable barrier connects to them. Construction will occur in two phases. The first phase will include construction of half of the operable barrier, masonry control building, operator's building, and boat lock. The second phase will include construction of the second half of the operable barrier, the equipment storage area, and the remaining fixtures, including the communications antenna and fish passage structure. The construction period is estimated to be up to 32 months, with a maximum construction crew of 80 people. A temporary work area of up to 15 acres will be sited in the vicinity of the barrier for such uses as storage of materials, fabrication of concrete forms or gate panels, placing of stockpiles, office trailers, shops, and the maintenance of construction equipment. The operable barrier construction site, including the temporary work area, has for many years been used for seasonal construction and removal of the temporary rock barrier, and all proposed work will occur within the area that is currently seasonally disturbed for temporary rock barrier construction (and deconstruction). Site access roads and staging areas used in the past for rock barrier installation and removal will be used for construction, staging, and other construction support facilities.

All in-water work, including the construction of cofferdams, sheet pile walls and pile foundations, and riprapping, will occur during the proposed in-water work windows to minimize effects on fish. Bubble/sound barrier (with acoustic monitoring to verify reduction in sound field) will be used when impact hammers are used. All land-based construction will take place from a barge or from the levee crown and will occur throughout the year.

The construction of the cofferdam and the foundation for the HORG will require in-water pile driving. The installation of the cofferdams will require approximately 550 sheet piles (275 per season). Approximately 15 piles, a maximum of 50 ft long and driven to a depth of 13.5 to 15 ft, will be set per day with an estimated 210 strikes per pile over a period of approximately 18 days per season. Sheet piles will be installed starting with a vibratory hammer, which may then switch to an impact hammer if the target depth cannot be achieved using the vibratory hammer. The foundation for the operable barrier will require 100 14-inch steel pipe or H-piles (50 per season) which will be set with 1 pile driver located on site. Approximately 15 piles, a maximum of 50 ft long and driven to a depth of 13.5 to 15 ft, will be set per day with an estimated 1,050 strikes per pile over a period of approximately 3 days per season. Foundation pile driving may be done in the dry or in the wet. It is possible that CIDH concrete foundation piles will be used, in which case pile driving of foundation piles will not be required, but that determination awaits results of geotechnical analysis and further design work.

The first construction phase involves installing a cofferdam in half of the channel and then dewatering the cordoned-off area. The cofferdam will remain in the water until the completion of half of the gate. The cofferdam will then be flooded, and removed or cut off at the required depth. Then, a new cofferdam will be installed in the other half of the channel. In the second phase, the gate will be constructed using the same methods; again when finished, the cofferdam will either be removed or cut off at the foundation. Cofferdam construction will in both phases begin in August and last approximately 18 days. Construction has been designed so that the rock barrier used at this site can continue to be installed and removed until the permanent gates are fully operable.

Dredging

Dredging to prepare the channel for gate construction will occur along 500 ft of the Old River channel, from 150 ft upstream to 350 ft downstream of the proposed barrier. A total of up to 1,500 cubic yards of material will be dredged. Dredging will last approximately 15 days, and like other aspects of HORG construction, will be performed during the in-water work window. Dredging may use either a hydraulic or a sealed clamshell dredge, in either case the dredge will be operated from a barge in the channel. Dredging for the HORG is proposed to deviate from the procedure described in AMM 6 in CWF BA Appendix 3.F, *General Avoidance and Minimization Measures,* in one respect. If local landowners are interested and appropriate review authorities determine the plan to be acceptable, then DWR proposes to spread dredged sediment onto adjacent agricultural fields in a layer approximately 1-foot thick. If this plan is not acceptable and DWR is required to use an existing dredged material disposal site, the site currently used for dredged material disposal for the temporary rock barrier placement and removal will be used.

Dual Conveyance Operations of the CVP and SWP

This BiOp analyzes the BAs operational scenario at a programmatic-level and identifies potential effects to delta smelt and its designated critical habitat from the operational scenario described. Our effects analysis considers the framework provided by the Guiding Principles as described above and in the PA and includes the effects of the Guiding Principles in the analysis.

Implementation

Implementation of the PA will include operations of both new and existing water conveyance facilities once the new NDD facilities are completed and become operational. Most existing facilities will continue to be operated consistent with existing regulatory authorizations, including the Service (2008) and NMFS (2009) BiOps or subsequent BiOps.
See CWF BA Table 3.1-1 for a complete summary of facilities and actions included in the PA. The PA also includes operational criteria for Delta outflow during the spring (March through May; hereafter termed "spring outflow") and minimum flow criteria at Rio Vista for the months of January through August that will apply when the proposed NDD becomes operational. The NDD and the HORG are new facilities for the SWP and will be operated consistent with the PA criteria presented in CWF BA for these facilities and any new flow criteria stemming from the Water Quality Control Plan (WQCP) update or long-term operations BiOps.

Criteria

The CWF BA attempts to describe the temporal scale at which some of the operational criteria will be implemented (*e.g.*, north Delta bypass flow requirements and Old and Middle river [OMR] requirements). The CalSim II modeling cannot perfectly represent all of the operational decisions associated with real-time operations (RTO) of the PA (see Table 6.1-2). A detailed operations plan will be developed by Reclamation and DWR in coordination with CDFW, NMFS and the Service prior to the new facilities becoming operational, which will detail implementation of the criteria presented in Table 6.1-2 and 6.1-3.

Additionally DWR collaborated with CDFW to develop spring outflow criteria for longfin smelt. As described in Table 6.1-3, protective outflows from March 1 through May 31 every year will be determined by the use of a lookup table derived from a linear relationship between the 50% exceedance forecast for the current month's 8RI and recent historic Delta outflow (1980 – 2016).

RTO of the NDD are intended to allow for the project objective of water diversion while also providing for the protection of migrating and rearing salmonids. RTO will be a key component of NDD operations, and will likely govern operations for the majority of the December through June salmonid migration period. Under RTO, the NDD would be operated within the range of pulse protection, and Levels 1, 2, and 3, depending on risk to fish and with consideration for other factors such as water supply and other Delta conditions, and by implementing pulse protection periods when primary juvenile winter-run and spring-run Chinook salmon migration is occurring. Post-pulse bypass flow operations may remain at Level 1 pumping depending on fish presence, abundance, and movement in the north Delta; however, the exact levels will be determined through initial operating studies evaluating the level of protection provided at various levels of pumping. The specific criteria for transitioning between and among pulse protection and post-pulse bypass flow operations will be based on real-time fish monitoring and hydrologic/behavioral cues upstream of and in the Delta that will be studied as part of the PA's AMP (CWF BA Section 3.4.6). Based on the outcome of the studies listed in Section 3.4.6, information about appropriate triggers, off-ramps, and other RTO management of NDD operations will be integrated into the operations of the PA. RTO will be used to support the successful migration of salmonids past the NDD and through the Delta, in combination with other operational components of the PA.

The following operational framework serves as an example that is based on the recommended NDD RTO process (Marcinkevage and Kundargi 2016). A 5-agency technical team co-chaired by NMFS and CDFW will incorporate results from ongoing monitoring and studies to revise specific fish triggers and may further refine the RTO process based on the amount of time it takes to make the RTO change in pumping rates and a science plan developed through the collaborative science process and finalized through the adaptive management process prior to commencement of actual operations of the NDD.

Table 6.1-2. New and existing water operations flow criteria and relationship to assumptions in CalSim II modeling.

Parameter	Criteria	Summary of CalSim II Modeling Assumptions
New Criteria Included in the PA		
North Delta bypass flows[1]	• Bypass Flow Criteria (specifies bypass flow required to remain downstream of the NDD): • October, November: Minimum flow of 7,000 cfs required in river after diverting at the NDD. • December through June: Post-pulse bypass flow operations will not exceed Level 1 pumping unless specific criteria have been met to increase to Level 2 or Level 3. If those criteria are met, operations can proceed as defined in CWF BA Table 3.3-2. The specific criteria for	• Initial Pulse Protection: o Low-level pumping of up to 6% of total Sacramento River flow such that bypass flow never falls below 5,000 cfs. No more than 300 cfs can be diverted at any one intake. o If the initial pulse begins and ends before December 1, criteria for the appropriate month (October–November) go into effect after the pulse

[1] Sacramento River flow upstream of the intakes to be measured flow at Freeport. Bypass flow is the Sacramento River flow quantified downstream of the Intake 5. Sub-daily NDD operations will maintain fish screen approach and sweeping velocity criteria.

	transitioning between and among pulse protection, Level 1, Level 2, and/or Level 3 operations, will be developed and based on real-time fish monitoring and hydrologic/ behavioral cues upstream of and in the Delta. During operations, adjustments are expected to be made to improve water supply and/or migratory conditions for fish by making real-time adjustments to the pumping levels at the NDD. These adjustments will be managed under RTO as described below. • July, August, September: Minimum flow of 5,000 cfs required in river after diverting at the NDD. • Pulse Protection: • Low-level pumping of up to 6% of total Sacramento River flow at Freeport such that bypass flow never falls below 5,000 cfs. No more than 300 cfs can be diverted at any one intake. • Low level pumping maintained during the pulse protection period. • Pulse is determined based on real-time monitoring of juvenile fish movement as described in CWF BA Section 3.3.3.1 *North Delta Diversion*. • If the initial pulse begins and ends before Dec 1, the bypass flow criteria for the month (Oct-Nov) when the pulse occurred would take effect. On Dec 1, the Level 1 rules defined below apply unless a second pulse occurs. Post-pulse Criteria (specifies bypass flow required to remain downstream of the NDD): • December through June: once the pulse protection ends, post-pulse bypass flow operations will not exceed Level 1 pumping unless specific criteria have been met to increase to Level 2 or Level 3. If those criteria are met, operations can proceed as defined in CWF BA Table 3.3-2. Allowable diversion will be greater of the low-level pumping or the diversion allowed by the post-pulse bypass flow rules in CWF BA Table 3.3-2. The specific criteria for transitioning between and among pulse protection, Level 1, Level 2, and/or Level 3 operations, will be developed and based on real-time fish monitoring and hydrologic/behavioral cues upstream of and in the Delta as discussed in CWF BA Section 3.3.3.1, *North Delta Diversion*. During operations, adjustments to the default allowable diversion level specified in CWF BA Table 3.3-2 are expected to be made to improve water supply and/or migratory	until December 1. On December 1, the Level 1 rules defined in CWF BA Table 3.3-2 apply until a second pulse, as defined in CWF BA Table 3.3-3 occurs. The second pulse will have the same protective operation as the first pulse.

	conditions for fish by making real-time adjustments to the diversion levels at the NDD. These adjustments are expected to fall within the operational bounds analyzed for the CWF BA and will be managed under RTO.	
South Delta operations[2,3]	• October, November: To be determined based on real time operations and protection of the D-1641 San Joaquin River 2-week pulse • December: OMR flows will not be more negative than an average of -5,000 cfs when the Sacramento River at Wilkins Slough pulse (same as NDD bypass flow pulse defined in CWF BA Table 3.3-2) triggers[4], and no more negative than an average of -2,000 cfs when the 2008 Service BiOp action 1 triggers. No OMR flow restriction prior to the Sacramento River pulse or 2008 Service BiOp action 1 triggers. • January, February: OMR flows will not be more negative than a 3-day average of 0 cfs during wet years, –3,500 cfs during above-normal years, or –4,000 cfs during below-normal to critical years, except –5,000 in January of dry and critical years. • March[5]: OMR flows will not be more negative than a 3-day average of 0 cfs during wet or above- normal years or –3,500 cfs during below-normal and dry year and -3,000 cfs	• December: –5,000 cfs only when the Sacramento River pulse based on the Wilkins Slough flow (same as the pulse for the NDD) occurs. If the 2008 Service BiOp Action 1 is triggered,–2,000 cfs requirement for 14 days is assumed. Remaining December days were assumed to have an allowable OMR of -8,000 cfs to compute a composite monthly allowable OMR level. • April, May: OMR requirement for the Vernalis flows between 5,000 cfs and 30,000 cfs were determined by linear interpolation. For example, when Vernalis flow is between 5,000 cfs and 6,000 cfs, OMR requirement is determined by linearly interpolating between –2,000 cfs and +1,000 cfs.

[2] The criteria do not fully reflect the complexities of CVP and SWP operations, dynamic hydrology, or spatial and temporal variation in the distribution of aquatic species. As a result, the criteria will be achieved by operating within an initial range of real time operational criteria from January through March and in June. This initial range, including operational triggers, will be determined through future discussion, including a starting point of -1,250 to -5,000 cfs based on a 14-day running average, and will be informed by the AMP, including real time monitoring. Further, the 3-day averaging period may be modified through future discussion. Modifications to the 3-day average period and the range of operating criteria may be needed, in part, because: (1) the WY type is forecasted in February but not finalized until May, and (2) 0 cfs, or positive, OMR in wet and above normal years may be attained coincident with unimpaired flows.

[3] OMR measured through the currently proposed index-method (Hutton 2008) with a 14-day averaging period consistent with the current operations (Reclamation 2014).

[4] December Sacramento River pulse determined by flow increases at Wilkins Slough of greater than 45% within 5-day period and exceeding 12,000 cfs at the end of 5-day period, and real-time monitoring of juvenile fish movement. Reclamation and DWR will require lead time. Preliminary discussions with engineers indicates ramping down can begin within an hour of no less than 3 days to change operations in response to the pulse trigger and full ramp down could be complete within approximately 12 hours. The Wilkins Slough trigger will be reviewed through future discussion, which will be informed by the AMP, including real time monitoring.

[5] WY type as described in the above footnote.

	during critical years. • April, May[6]: Allowable OMR flows depend on gaged flow measured at Vernalis, and will be determined by a linear relationship. If Vernalis flow is below 5,000 cfs, OMR flows will not be more negative than -2000 cfs. If Vernalis is 6,000 cfs, OMR flows will not be less than +1000 cfs. If Vernalis is 10,000 cfs, OMR flows will not be less than +2,000 cfs. If Vernalis is 15,000 cfs, OMR flows will not be less than +3,000 cfs. If Vernalis is at or exceeds 30,000 cfs, OMR flows will not be less than 6,000 cfs. • June: Similar to April and May, allowable flows depend on gaged flow measured at Vernalis (except without interpolation). If Vernalis is less than 3,500 cfs, OMR flows will not be more negative than –3,500 cfs. If Vernalis exceeds 3,500 cfs up to 10,000 cfs, OMR flows will not be less than 0 cfs. If Vernalis exceeds 10,000 cfs up to 15,000 cfs, OMR flows will not be less than +1,000 cfs. If Vernalis exceeds 15,000 cfs, OMR flows will not be less than +2,000 cfs. • July, August, September: No OMR flow constraints[7]. • OMR criteria under 2008 Service and 2009 NMFS BiOps or the above, whichever results in more positive, or less negative OMR flows, will be applicable[8].	• January–March and June–September: Same as the criteria • New OMR criteria modeled as monthly average values.
HORG operations	• October 1- November 30: RTO management – with the current expectation being that the HORG will be operated to protect the D-1641 pulse flow. • January-March 31, and June 1-15: RTO will determine exact operations to protect salmon fry when migrating. During this migration, operation will be to close the gate subject to RTO for purposes of water quality, stage, and flood control considerations. • April-May: Initial operating criterion will be to close the gate 100% of the time subject to RTO	• Assumed 50% open from January 1 to June 15 and during days in October prior to the D-1641 San Joaquin River pulse. Closed during the pulse. 100% open in the remaining months.

[6] When OMR target is based on Vernalis flow, will be a function of 5-day average measured flow.

[7] The PA operations include a preference for south Delta pumping in July through September months to provide limited flushing flows to manage water quality in the south Delta.

[8] Change in CVP and SWP pumping from the south Delta will occur to comply with OMR targets and will be achieved to the extent exports can control the flow. The OMR targets would not be achieved through releases from CVP and SWP reservoirs. The combined CVP and SWP export rates from the proposed NDD and the existing south Delta intakes will not be required to drop below 1,500 cfs to provide water supply for health and safety needs, critical refuge supplies, and obligation to senior water rights holders.

	for purposes of water quality, stage, and flood control considerations (CWF BA Section 3.3.3, *Real-Time Operational Decision-Making Process*). Reclamation, DWR, NMFS, Service, and CDFW will actively explore the implementation of reliable juvenile salmonid tracking technology that may enable shifting to a more flexible real time operating criterion based on the presence/absence of listed fishes. • June 16 to September 30, December: Operable gates will be open.	
Spring Outflow	March, April, May: Initial operations will maintain the March–May delta outflows that maintain longfin smelt habitat quality and quantity at levels consistent with recent conditions (1980-2016).[9]	• 2011 NMFS RPA for San Joaquin River I/E ratio constraint is the primary driver for the Apr-May Delta outflow under the NAA, this criterion was used to constrain Apr-May total Delta exports under the PA to meet Mar-May Delta outflow targets.
Rio Vista minimum flow standard[10]	• September through December: flows per D-1641	• Same as PA criteria
Key Existing Delta Criteria Included in Modeling[11]		
Fall Outflow	• No change. September, October, November: implement the Service 2008 BO Fall X2 requirements in wet and above normal WY types.	• September, October, November: implement the 2008 Service BiOp "Action 4: Estuarine Habitat During Fall" (Fall X2) requirements (Service 2008).
Winter and summer outflow	• No change. Flow constraints established under D-1641 will be followed if not superseded by criteria listed above.	• State Water Resources Control 's (SWRCB) D-1641 Delta outflow and February – June X2 criteria.
Delta Cross Channel Gates	• Operating criteria as required by 2009 NMFS BiOp Action IV.1 and D-1641, and Delta Cross Channel (DCC) closure for downstream flood control will be based on Sacramento River flow at Freeport, upstream of the NDD facilities.	• DCC gates are closed for a certain number of days during October 1 through December 14 based on the Wilkins Slough flow, and the gates may be opened if the D-1641 Rock Slough salinity standard is violated because of the gate

[9] See targets in spring outflow table below: *Spring Outflow Criteria, Upon initiation of the Test Period and throughout the CDFW permit term, average Delta outflow for Longfin Smelt based on the 50% exceedance forecast for the current month's Early Long-Term (ELT) 8 River Index (8RI).*

[10] Rio Vista minimum monthly average flow in cfs (7-day average flow not be less than 1,000 below monthly minimum), consistent with the SWRCB D-1641.

[11] All the CalSim II modeling assumptions are described in CWF BA Appendix 5.A, *CALSIM Methods and Results.*

		closure. DCC gates are assumed to be closed during December 15 through January 31. February 1 through June 15, DCC gates are operated based on D-1641 requirements.
Suisun Marsh Salinity Control Gates	• No change. Gates will continue to be closed up to 20 days per year from October through May.	• For the DSM2 modeling, used generalized seasonal and tidal operations for the gates. • Seasonal operation: The radial gates are operational from October to February if Martinez electrical conductivity (EC) is higher than 20,000, and for remaining months they remain open. • Tidal operations when gates are operational: Gates close when: downstream channel flow is < 0.1 (onset of flood tide); Gates open when: upstream to downstream stage difference is greater than 0.3 ft (onset of ebb tide).
Export to inflow ratio	• Operational criteria are the same as defined under D-1641, and applied as a maximum 3-day running average. • The D-1641 export/inflow (E/I) ratio calculation was largely designed to protect fish from south Delta entrainment. For the PA, Reclamation and DWR propose that the NDD be excluded from the E/I ratio calculation. In other words, Sacramento River inflow is defined as flows downstream of the NDD and only south Delta exports are included for the export component of the criteria.	• Combined export rate is defined as the diversion rate of the Banks and Jones Pumping Plant (PP) from the south Delta channels. • Delta inflow is defined as the sum of the Sacramento River flow downstream of the proposed NDD, Yolo Bypass flow, Mokelumne River flow, Cosumnes River flow, Calaveras River flow, San Joaquin River flow at Vernalis, and other miscellaneous in-Delta flows.
[a] See CWF BA Table 3.3-2 for PA CalSim II Modeling Assumptions		

Table 6.1-3. PA CalSim II criteria and modeling assumptions.

Dual Conveyance Scenario with 9,000 cfs NDD (includes Intakes 2, 3 and 5 with a maximum diversion capacity of 3,000 cfs at each intake)

1. North Delta Diversion Bypass Flows

These parameters define the criteria for modeling purposes and provide the real-time operational criteria levels as operations move between and among the levels. Actual operations will be based on real-time monitoring of hydrologic conditions and fish presence/movement as described in CWF BA Section 3.3.3.1, *North Delta Diversions.*

Low-Level Pumping (December-June)

Diversions of up to 6% of total Sacramento River flow such that bypass flow never falls below 5,000 cfs. No more than 3,000 cfs can be diverted at any one intake.

Initial Pulse Protection

Low level pumping as described in CWF BA Table 3.3-1will be maintained through the initial pulse period. For modeling, the initiation of the pulse is defined by the following criteria: (1) Sacramento River flow at Wilkins Slough increasing by more than 45% within a five-day period, and (2) flow on the fifth day greater than 12,000 cfs.

The pulse (and low-level pumping) continues until either (1) Sacramento River flow at Wilkins Slough returns to pre-pulse flow level (flow on first day of pulse period), (2) Sacramento River flow at Wilkins Slough decreases for 5 consecutive days, or (3) Sacramento River flow at Wilkins Slough is greater than 20,000 cfs for 10 consecutive days.

After pulse period has ended, operations will return to the bypass flow table (Sub-Table A).

If the initial pulse period begins and ends before December 1st in the modeling, then any second pulse that may occur before the end of June will receive the same protection, *i.e.,* low level pumping as described in CWF BA Table 3.3-1.

Post-Pulse Operations

After initial pulse(s), allowable diversion will go to Level I Post-Pulse Operations (see Sub-Table A) until 15 total days of bypass flows above 20,000 cfs occur. Then allowable diversion will go to the Level II Post-Pulse Operations until 30 total days of bypass flows above 20,000 cfs occur. Then allowable diversion will go to the Level III Post-Pulse Operations.

Sub-Table A. Post-Pulse Operations for NDD Bypass Flows

Implement following bypass flow requirements sufficient to minimize any increase in the upstream tidal transport at two points of control: (1) Sacramento River upstream of Sutter Slough, and (2) Sacramento River downstream of Georgiana Slough. These points are used to minimize any increase in upstream transport toward the proposed intakes or into Georgiana Slough. Allowable diversion will be greater of the low-level pumping or the diversion allowed by the following bypass flow rules.

Level I Post-Pulse Operations			**Level II Post-Pulse Operations**			**Level III Post Pulse Operations**		
If Sacramento River flow is over...	**But not over...**	**The bypass is...**	**If Sacramento River flow is over...**	**But not over...**	**The bypass is...**	**If Sacramento River flow is over...**	**But not over...**	**The bypass is...**
December–April								
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining	5,000 cfs	11,000 cfs	Flows remaining	5,000 cfs	9,000 cfs	Flows remaining after constant

		after constant low level pumping			after constant low level pumping			low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 80% of the amount over 15,000 cfs	11,000 cfs	15,00 0 cfs	11,000 cfs plus 60% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 50% of the amount over 9,000 cfs
17,000 cfs	20,000 cfs	16,600 cfs plus 60% of the amount over 17,000 cfs	15,000 cfs	20,00 0 cfs	13,400 cfs plus 50% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	12,000 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	18,400 cfs plus 30% of the amount over 20,000 cfs	20,000 cfs	no limit	15,900 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	13,000 cfs plus 0% of the amount over 20,000 cfs
May								
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	11,00 0 cfs	Flows remaining after constant low level pumping	5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 70% of the amount over 15,000 cfs	11,000 cfs	15,00 0 cfs	11,000 cfs plus 50% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 40% of the amount over 9,000 cfs
17,000 cfs	20,000 cfs	16,400 cfs plus 50% of the amount over 17,000 cfs	15,000 cfs	20,00 0 cfs	13,000 cfs plus 35% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	11,400 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	17,900 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	14,750 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	12,400 cfs plus 0% of the amount over 20,000 cfs

June								
0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs	0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	15,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	11,000 cfs	Flows remaining after constant low level pumping	5,000 cfs	9,000 cfs	Flows remaining after constant low level pumping
15,000 cfs	17,000 cfs	15,000 cfs plus 60% of the amount over 15,000 cfs	11,000 cfs	15,000 cfs	11,000 cfs plus 40% of the amount over 11,000 cfs	9,000 cfs	15,000 cfs	9,000 cfs plus 30% of the amount over 9,000 cfs
17,000 cfs	20,000 cfs	16,200 cfs plus 40% of the amount over 17,000 cfs	15,000 cfs	20,000 cfs	12,600 cfs plus 20% of the amount over 15,000 cfs	15,000 cfs	20,000 cfs	10,800 cfs plus 20% of the amount over 15,000 cfs
20,000 cfs	no limit	17,400 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	13,600 cfs plus 20% of the amount over 20,000 cfs	20,000 cfs	no limit	11,800 cfs plus 0% of the amount over 20,000 cfs

Bypass flow requirements in other months:		
If Sacramento River flow is over...	**But not over...**	**The bypass is...**
July–September		
0 cfs	5,000 cfs	100% of the amount over 0 cfs
5,000 cfs	No limit	A minimum of 5,000 cfs
October–November		
0 cfs	7,000 cfs	100% of the amount over 0 cfs
7,000 cfs	No limit	A minimum of 7,000 cfs

2. South Delta Channel Flows

<u>OMR Flows</u>

All of the baseline model logic and input used in the NAA as a surrogate for the OMR criteria required by the various fish protection triggers (density, calendar, turbidity and flow based triggers) described in the 2008 Service and the 2009 NMFS BiOps were incorporated into the modeling of the PA except for NMFS BiOp Action IV.2.1 – San Joaquin River inflow/export (I/E) ratio. The PA includes the proposed operational criteria, as well. Whenever the BiOps' triggers require OMR be less negative or more positive than those shown below, those OMR requirements will be met. These newly proposed OMR criteria (and associated HORG operations) are in response to expected changes under the PA, and only applicable after the proposed NDD becomes operational. Until the NDD becomes operational, only the OMR criteria under the 2008 Service and 2009 NMFS BiOps apply to CVP

and SWP operations.
Combined OMR flows must be no less than values below[a] (cfs)
(WY type classification based Sacramento River 40-30-30 index)

Month	W	AN	BN	D	C
Jan	0	-3,500	-4,000	-5,000	-5,000
Feb	0	-3,500	-4,000	-4,000	-4,000
Mar	0	0	-3,500	-3,500	-3,000
Apr	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
May	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
Jun	varies[b]	varies[b]	varies[b]	varies[b]	varies[b]
Jul	N/A	N/A	N/A	N/A	N/A
Aug	N/A	N/A	N/A	N/A	N/A
Sep	N/A	N/A	N/A	N/A	N/A
Oct	varies[c]	varies[c]	varies[c]	varies[c]	varies[c]
Nov	varies[c]	varies[c]	varies[c]	varies[c]	varies[c]
Dec	-5,000[d]	-5,000[d]	-5,000[d]	-5,000[d]	-5,000[d]

[a] Values are monthly averages for use in modeling. The model compares these minimum allowable OMR values to 2008 Service BiOp RPA OMR requirements and uses the less negative flow requirement.

[b] Based on San Joaquin inflow relationship to OMR provided below in Sub-Table B.

[c] Two weeks before the D-1641 pulse (assumed to occur October 16-31 in the modeling), No OMR restrictions (for modeling purposes an OMR requirement of -5,000 cfs was assumed during this 2 week period).
Two weeks during the D-1641 pulse, no south Delta exports.
Two weeks after the D-1641 pulse, -5,000 cfs OMR requirement (through November).

[d] OMR restriction of -5,000 cfs for Sacramento River winter-run Chinook salmon when North Delta initial pulse flows are triggered or OMR restriction of -2,000 cfs for delta smelt when triggered. For modeling purposes (to compute a composite Dec allowable OMR), remaining days were assumed to have an allowable OMR of -8000 cfs.

Head of Old River Operable Gate Operations/Modeling assumptions (% OPEN)

MONTH	HORG[a]	MONTH	HORG[a]
Oct	50% (except during the pulse)[b]	May	50%
Nov	100% (except during the post-pulse period)[b]	Jun 1–15	50%
Dec	100%	Jun 16–30	100%
Jan	50%[c]	Jul	100%
Feb	50%	Aug	100%
Mar	50%	Sep	100%
April	50%		

[a] Percent of time the HORG is open. Agricultural barriers are in and operated consistent with current practices. HORG will be open 100% whenever flows are greater than 10,000 cfs at Vernalis.
HORG operation is triggered based upon SWRCB D-1641 pulse trigger. For modeling assumptions only, two weeks before the D-1641 pulse, it is assumed that the HORG will be open 50%.

[b] During the D-1641 pulse (assumed to occur October 16-31 in the modeling), it is assumed the HORG will be closed.
For two weeks following the D-1641 pulse, it was assumed that the HORG will be open 50%.
Exact timing of the action will be based on hydrologic conditions. See CWF BA Table 3.3-1 for HOR gate operations under the PA.

[c] The HORG becomes operational at 50% when salmon fry are migrating (based on real time monitoring). This generally occurs when flood flow releases are being made. For the purposes of modeling, it was assumed that salmon fry are migrating starting on January 1.

In the CalSim II modeling, the "HORG open percentage" specified above is modeled as the percent of time within a month that HORG is open. In the Delta Simulation Model II (DSM2) modeling, HORG is assumed to operate such that the above-specified percent of "the flow that would have entered the Old River if the HORG were fully open" would enter the Old River.

Sub-Table B. San Joaquin Inflow Relationship to OMR			
April and May		**June**	
If San Joaquin flow at Vernalis is the following	Average OMR flows would be at least the following (interpolated linearly between values)	If San Joaquin flow at Vernalis is the following	Average OMR flows would be at least the following (no interpolation)
≤ 5,000 cfs	-2,000 cfs	≤ 3,500 cfs	-3,500 cfs
6,000 cfs	+1,000 cfs	3,501 to 10,000 cfs	0 cfs
10,000 cfs	+2,000 cfs		
15,000 cfs	+3,000 cfs	10,001 to 15,000 cfs	+1,000 cfs
≥30,000 cfs	+6,000 cfs	>15,000 cfs	+2,000 cfs

3. Delta Cross Channel Gate Operations

Assumptions

Per SWRCB D-1641 with additional days closed from October 1 – January 31 based on 2009 NMFS BiOp Action IV.1.2 (closed during flushing flows from October 1 – December 14 unless adverse water quality conditions). This criterion is consistent with the NAA.

4. Rio Vista Minimum Instream Flows

Assumptions

September–December: Per D-1641; January-August: Minimum of 3,000 cfs.

5. Delta Outflow

Delta Outflow

SWRCB D-1641 requirements, or outflow per requirements noted below, whichever is greater.

Months	Delta Outflow Requirement
Spring (Mar–May):	Additional spring outflow requirement
Fall (September–November):	Implement 2008 Service BiOp Fall X2 requirement

Notes: Protective outflows from March through May every year shall be determined by the use of a lookup table derived from a linear relationship between the 50% exceedance forecast for the current month's 8RI and recent historic Delta outflow (1980 – 2016). Operators shall utilize Net Delta Outflow Index (NDOI) data to confirm that the average Delta outflow target was met during each 30 day period from March – May. Operators shall provide daily NDOI data quantifying daily Delta outflow in each 30 day period to CDFW on or before April 20, May 21, and June 20 every year. Reduction in exports down to minimum health and safety requirements established in D-1641 (currently 1,500 cfs) may be necessary. These targets are intended to be provided through the acquisition of water from willing sellers and through operations of the CVP and SWP. Operators shall achieve Delta outflow targets through shared export allocations between the NDD and south Delta. If the target average Delta outflow is greater than 44,500 cfs operators shall consult with CDFW to determine how to allocate exports between the NDD and the south Delta.

Spring Outflow Criteria

As a condition of the 2081(b) ITP, CDFW is requiring DWR, upon initiation of the Test Period and throughout operation of the PA, to provide average Delta outflow for longfin smelt based on the 50% exceedance forecast of the current month's Eight River Index (8RI).

February ELT 8RI (TAF)	March 1 – March 15 Average Delta Outflow Target (cfs)	March ELT 8RI (TAF)	March 16 – April 15 Average Delta Outflow Target (cfs)	April ELT 8RI (TAF)	April 16 – May 15 Average Delta Outflow Target (cfs)	May ELT 8RI (TAF)	May 16 – May 31 Average Delta Outflow Target (cfs)
0	0	0	0	0	0	0	0
450	7100	450	7100	450	7100	250	4000
900	7100	1000	7100	1000	7100	850	4000

1000	9100	1625	7100	1500	7100	1545	4000
1100	11000	1700	8700	1855	7100	1600	4700
1200	13000	1800	10900	1900	8100	1700	6000
1300	14900	1900	13000	2000	10300	1800	7300
1400	16900	2000	15200	2100	12500	1900	8600
1500	18800	2100	17400	2200	14700	2000	9900
1600	20800	2200	19500	2300	16900	2100	11300
1700	22700	2300	21700	2400	19100	2200	12600
1800	24700	2400	23800	2500	21300	2300	13900
1900	26600	2500	26000	2600	23500	2400	15200
2000	28600	2600	28100	2700	25700	2500	16500
2100	30500	2700	30300	2800	27900	2600	17800
2200	32500	2800	32400	2900	30100	2700	19100
2300	34400	2900	34600	3000	32300	2800	20400
2400	36400	3000	36800	3100	34500	2900	21700
2500	38300	3100	38900	3200	36700	3000	23000
2600	40300	3200	41100	3300	38900	3100	24300
2700	42200	3300	43200	3400	41200	3200	25600
2815	44500	3360	44500	3500	43400	3300	26900
> 2815	44500	> 3360	44500	3550	44500	3400	28300
				> 3550	44500	3500	29600
						3600	30900
						3700	32200
						3800	33500
						3900	34800
						4000	36100
						4100	37400
						4200	38700
						4300	40000
						4400	41300
						4500	42600
						4600	44000
						4650	44500
						> 4650	44500

6. Operations for Delta Water Quality and Residence Time

Assumptions

July–September: Prefer south delta intake up to total pumping of 3,000 cfs; no specific intake preference beyond 3,000 cfs.

October–June: Prefer NDD (real-time operational flexibility).

7. In-Delta Agricultural and Municipal & Industrial Water Quality Requirements

Assumptions

Existing D-1641 agricultural and municipal & industrial (AG and MI) standards.

8. D-1641 E/I Ratio Computation

Assumptions

In computing the Delta E/I ratio in the CalSim II model, the NDD is not included in the export term, and the Sacramento River inflow is as modeled downstream of the NDD.

Pulse-Protection

- A fish pulse is defined as combined catch of X_p[12] winter-run and spring-run sized Chinook salmon in a single day at specified locations.
- Upon initiation of fish pulse, operations must reduce to low-level pumping.
- Pumping may not exceed low-level pumping for the duration of fish pulse. However, additional pumping above low-level may be allowed as long as a minimum of 35,000 cfs[13] bypass flow is maintained during the period of pulse protection. A fish pulse is considered over after X[14] consecutive days with daily combined catch of winter- and spring run-sized Chinook salmon less than X_p[14] at or just downstream of the new intakes.
- Post-pulse bypass flow operations will be determined through initial operating studies evaluating the level of protection provided at various levels of pumping.
- All subsequent pulses of winter- and spring-run Chinook salmon will be afforded the same level of protection as the first pulse (see Footnotes below).
- Unlimited fish pulses are protected in any given year.

Flow criteria are applied seasonally (month by month) and according to the following five WY types. Under the observed hydrologic conditions over the 82-year period (1922–2003), the number of years of each WY type is listed below. The WY type classification, unless otherwise noted, is based on the Sacramento Valley 40-30-30 WY Index defined under Revised D-1641.

- Wet (W) water-year: the wettest 26 years of the 82-year hydrologic data record, or 32% of years.
- Above-normal (AN) water-year: 12 years of 82, or 15%.

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[12] Preliminary evaluation of the effects of the proposed operations will use triggers developed from data provided by existing monitoring stations. The values and monitoring location would depend upon operation of a new/additional station, the method used to identify winter- and spring-run Chinook salmon, collection of sufficient data, and the time of year. The PA includes a condition related to pulse protection which triggers a pulse based on a Knights Landing catch index (X_p) greater than or equal to 5 winter-run-sized and spring-run-sized fish.

[13] Preliminary evaluation of the effects of the proposed operations will use a minimum off-ramp bypass flow developed from existing data. The off-ramp bypass flow required will be determined based on pre-construction studies identified in CWF BA Section 3.4.7.3.

[14] Preliminary evaluation of the effects of the proposed operations will use triggers developed from data provided by existing monitoring stations. The values and monitoring location would depend upon operation of a new/additional station, the method used to identify winter- and spring-run Chinook salmon, collection of sufficient data, and the time of year. The PA includes a condition related to pulse protection which considers a pulse to be over when Knights Landing catch index (X_p) is less than 5 for a duration (X) of 5 days.

- Below-normal (BN) water-year: 14 years of 82, or 17%.
- Dry (D) water-year: 18 years of 82, or 22%.
- Critical (C) water-year: 12 years of 82, or 15%.

The above noted frequencies are expected to change slightly under projected climate conditions at year 2030. The number of years of each WY type per D-1641 Sacramento Valley 40-30-30 WY Index under the projected climate condition assumed for the CWF BA, over the 82-year period (1922–2003) is provided below. CWF BA Appendix 5.A, Section 5.A.3, *Climate Change and Sea Level Rise*, provides more information on the assumed climate change projection at year 2030.

- Wet WY: the wettest 26 years of the 82-year hydrologic data record, or 32% of years.
- Above-normal WY: 13 years of 82, or 16%.
- Below-normal WY: 11 years of 82, or 13%.
- Dry WY: 20 years of 82, or 24%.
- Critical WY: 12 years of 82, or 15%.

Refer to the CWF BA and appendices for further discussion of the operational criteria and assumptions, the RTO Decision-Making Process, the CSAMP, and future drought procedures.

Table 6.1-4. Modeled March longfin smelt outflow criteria: Monthly Net Delta Outflow Index in relation to Eight River Index.

Eight River Index[15] (March), TAF	Monthly Net Delta Outflow Index (March), cfs
0	0
545	6,200
1,488	8,800
1,911	12,700
2,140	17,100
2,421	20,000
2,575	25,200
3,104	35,000
3,492	43,700
≥4,217	44,500
Note: Net Delta Outflow Index targets are linearly interpolated for 8RI values falling between those shown on the table. This approach is based on the 90% forecast.	

Maintenance of the Facilities

The PA includes the maintenance of the proposed NDD, tunnels, IF, CCF and Pumping Plant, connections to Banks and Jones Pumping Plants, power supply and grid connections, HORG, and the south Delta facilities. Refer to the *BiOp Resolution Log* for additional detail on the frequency of the maintenance activities.

[15] The 8RI refers to the sum of the unimpaired runoff for the following locations: Sacramento River flow at Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River flow at Smartville; American River, total inflow to Folsom Reservoir; Stanislaus River, total inflow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total inflow to Exchequer Reservoir; and San Joaquin River, total inflow to Millerton Lake.

North Delta Diversions

CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1,* Section 6.3, *Maintenance Considerations*, discusses maintenance needs at the NDD intakes. These include intake dewatering, sediment removal, debris removal, control of biofouling, corrosion, and equipment needs.

Intake Dewatering

The intake structure on the land side of each screen bay group (*i.e.*, a group of 6 fish screens) will be dewatered by closing the slide gates on the back wall of the intake structure, installing bulkheads into guides at the front of the structure, and pumping out the water with a submersible pump; see CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Drawings 15, 16, 17, 19, and 22, for illustrations of this structure. The intake collector box conduits can be dewatered by closing the gates on either side of the conduits and pumping out the water between the gates. Dewatering may occur to remove accumulated sediment (described below) or to repair the fish screens.

The water removed for intake maintenance would likely be disposed by discharge to the conveyance tunnels. Any discharge to surface water (the Sacramento River) would occur in accordance with the terms and conditions of a valid National Pollutant Discharge Elimination System (NPDES) permit and any other applicable Central Valley Regional Water Quality Control Board (CVRWQCB) requirements.

Sediment Removal

Maintenance sediment removal activities include activities that will occur on both the river side and land side of the fish screens. Anticipated maintenance activities include suction dredging around the intake structure, and mechanical excavation around intake structures using track-mounted equipment and a clamshell dragline. Mechanical excavation will occur behind a floating turbidity control curtain. These maintenance activities will occur on an approximately annual basis, depending upon the rates of sediment accumulation.

Sediment will also be annually dredged from within the sedimentation basins using a barge mounted suction dredge, and will periodically be removed from other piping and conduits within the facility by dewatering them. Lastly, sediment will be annually removed from the sediment drying lagoons using equipment such as a front-end loader. The accumulated sediment will be tested and disposed in accordance with the materials reuse provisions of AMM6.

Maintenance dredging will occur only during DWR's proposed in-water work windows. Subsequent regulatory authorizations for the dredging work typically include a permit for in-water work from the Corps and a water quality certification from the CVRWQCB.

Debris Removal

After high-to-extreme flow conditions, the intake structures will be visually inspected for debris. If a large amount of debris has accumulated, the debris must be removed. The intake screens will be maintained by continuous traveling cleaning mechanisms, or other screen cleaning technology. Cleaning frequency will depend on the debris load.

A log boom system will be aligned within the river alongside the intake structure to protect the fish screens and fish screen cleaning systems from being damaged by large floating debris. Spare parts for vulnerable portions of the intake structure will be housed onsite to minimize downtime, should repairs be needed.

Biofouling

Biofouling, the accumulation of algae and other sessile biological organisms, could occlude the fish screens and impair function. A key design provision for intake facilities is that all mechanical elements can be moved to the water surface for inspection, cleaning, and repairs. The intake facilities will have top-side gantry crane systems for removal and insertion of screen panels, and tuning baffle assemblies and bulkheads. All panels will require periodic removal for pressure washing. Additionally, screen bay groups will require periodic dewatering (as described above) for inspection and assessment of biofouling rates. With the prospective invasion of quagga and zebra mussels into inland waters, screen and bay washing could become more frequent. Coatings and other deterrents to reduce the need for such maintenance will be investigated during further facility design. In-water work is not expected to be necessary to address biofouling, as the potentially affected equipment is designed for ready removal from the water as described above. However, if needed, in-water work would be performed consistent with DWR's proposed in-water work windows.

Corrosion

Materials for the intake screens and baffles will consist of plastics and austenitic stainless steels. Other systems will be constructed of mild steel, provided with protective coatings to preserve the condition of those buried and submerged metals and thereby extend their service lives. Passive (galvanic) anode systems can also be used for submerged steel elements. Maintenance consists of repainting coated surfaces and replacing sacrificial (zinc) anodes at multi-year intervals.

Equipment Needs

Operation and maintenance equipment for the intake facilities include the following: (1) a self-contained portable high-pressure washer unit to clean fish screen and solid panels, concrete surfaces, and other surfaces, (2) submersible pumps for dewatering, (3) a floating work platform for accessing, inspecting, and maintaining the river side of the facility, (4) a hydraulic suction dredge, and (5) a man basket or bridge inspection rig to safely access the front of the intake structure from the upper deck.

Sedimentation Basins and Drying Lagoons

The sedimentation system at each intake will consist of a jetting system in the intake structure that will resuspend accumulated river sediment through the box conduits to two unlined earthen sedimentation basins where it will settle out, and then on to four drying lagoons (CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2,* Sheets 10-13, 18-21, and 28-30; see also Appendix 3.B, *Conceptual Engineering Report, Volume 1,* Section 6.1.2, *Sedimentation System General Arrangement*, for detailed description of the sedimentation system). Sediment particles larger than 0.002 mm are expected to be retained (settle out) in the sedimentation basins, while particles smaller than 0.002 mm (*i.e.,* colloidal particles) will flow through to the tunnel system to the IF.

At each intake, a barge-mounted suction dredge will hydraulically dredge the sedimentation basins through a dedicated dredge discharge pipeline to 4 drying lagoons. Dredging will occur annually. Dredged material will be disposed at an approved upland site.

Tunnels

Maintenance requirements for the tunnels have not yet been finalized. Some of the critical considerations include evaluating whether the tunnels need to be taken out of service for inspection and, if so, how frequently. Typically, new water conveyance tunnels are inspected at least every 10 years for the first 50 years and more frequently thereafter. In addition, the equipment that the facility owner must put into the tunnel for maintenance needs to be assessed so that the size of the tunnel access structures can be finalized. Equipment such as trolleys, boats, harnesses, camera equipment, and communication equipment will need to be described prior to finalizing shaft design, as will ventilation requirements. As described above, it is anticipated that, following construction, large-diameter construction shafts will be modified to approximately 20-ft diameter access shafts.

Intermediate Forebay

The IF embankments will be maintained to control vegetation and rodents. Embankments will be repaired when they show signs of erosion. Maintenance of control structures could include repairs to roller gates, radial gates, and stop logs. Maintenance requirements for the spillway will include the removal and disposal of any debris blocking the outlet culverts.

The majority of easily settled sediments are removed at the sedimentation basins at each intake facility. The IF provides additional opportunity to settle sediment. It is anticipated that over a 50-year period, sediments will accumulate to a depth of approximately 4.1 ft, which is less than one-half the height of the overflow weir at the outlet of the IF. Thus maintenance dredging of the IF is not expected to be necessary at the time of this consultation.

Clifton Court Forebay and Pumping Plant

The existing CCF is proposed to be expanded and partitioned into a North Clifton Court Forebay (NCCF) and South Clifton Court Forebay (SCCF). The NCCF and SCCF embankments and grounds, including the area around the consolidated pumping plants, will all be maintained to control vegetation and rodents. They will also be subject to embankment repairs in the event of erosion. Maintenance of forebay control structures could include repairs to roller gates, radial gates, and stop logs. Maintenance requirements for the spillway will include the removal and disposal of any debris blocking the structure. Riprap slope protection on the water-sides of the embankments will require periodic maintenance to monitor and repair any sloughing. In-water work, if needed (*e.g.*, to maintain riprap below the ordinary high-water mark), would be performed during DWR's proposed in-water work window.

The small fraction of sediment passing through the IF will be transported through the tunnels to NCCF. Given the upstream sediment removal and the large storage available in the forebay, sediment accumulation at NCCF is expected to be minimal over a 50-year period, and no maintenance dredging is expected to be needed during the life of the facility.

Connections to Banks and Jones Pumping Plants

Maintenance requirements for the canal will include erosion control, control of vegetation and rodents, embankment repairs in the event of erosion, and monitoring of seepage flows. Sediment traps may be constructed by deepening portions of the channel upstream of the structures where the flow rate will be reduced to allow suspended sediment to settle at a controlled location. The sediment traps will be periodically dredged to remove the trapped sediment.

Power Supply and Grid Connections

Three utility grids could supply power to the PA conveyance facilities: Pacific Gas and Electric Company (PG&E) (under the control of the California Independent System Operator), the Western Area Power Administration (Western), and/or the Sacramento Municipal Utility District (SMUD). The electrical power needed for the conveyance facilities will be procured in time to support construction and operation of the facilities. Purchased energy may be supplied by existing generation, or by new generation constructed to support the overall energy portfolio requirements of the western electric grid. It is unlikely that any new generation will be constructed solely to provide power to the PA conveyance facilities. It is anticipated the providers of the three utility grids that supply power to the PA will continue to maintain their facilities.

Head of Old River Gate

For the operable barrier proposed under the PA, maintenance of the gates will occur every 5 to 10 years. Maintenance of the motors, compressors, and control systems will occur annually and require a service truck.

Each miter or radial gate bay will include stop log guides and pockets for stop log posts to facilitate the dewatering of individual bays for inspection and maintenance. Each gate bay will be inspected annually at the end of the wet season (April) for sediment accumulation. Maintenance dredging around the gate will be necessary to clear out sediment deposits. Dredging around the gates will be conducted using a sealed clamshell dredge. Depending on the rate of sedimentation, maintenance dredging is likely to occur at intervals of 3 to 5 years, removing no more than 25% of the original amount of sediment dredged from the Old River channel to build the structure. The timing and duration of maintenance dredging will comply with the proposed in-water work windows. Spoils will be dried in the areas adjacent to the gate site. A formal dredging plan with further details on specific maintenance dredging activities will be developed prior to dredging. Guidelines related to dredging are given in CWF BA Appendix 3.F, *General Avoidance and Minimization Measures,* AMM6, *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material.* AMM6 requires preparation of a sampling and analysis plan; compliance with relevant NPDES and SWRCB requirements; compliance with proposed in-water work windows; and other measures intended to minimize adverse effects to listed species.

Existing South Delta Export Facilities

The PA includes maintenance of CVP and SWP facilities in the south Delta after the proposed intakes become operational. Maintenance means those activities that maintain the capacity and operational features of the CVP and SWP water diversions and conveyance facilities. Maintenance activities include maintenance of electrical power supply facilities; maintenance as needed to ensure continued operations; replacement of facility or system components when necessary to maintain system capacity and operational capabilities; and upgrades and technological improvements of facilities to maintain system capacity and operational capabilities, improve system efficiencies, and reduce operations and maintenance costs.

Monitoring

Monitoring activities will occur prior to operations and after operations commence. Monitoring and studies of listed fish species will be focused on the effects of construction and operation of the dual conveyance facilities. This monitoring will begin with baseline data collection needed to compare to similar results post-construction. While a detailed effort has been made regarding proposed monitoring for the NDD, monitoring prior to operations will be required throughout the action area. DWR has committed to working with the Service and other agencies to develop the specifics (including timeframes) of monitoring using various technical teams. A Service-approved monitoring plan will be developed, and construction cannot begin until it has been approved by the Service.

Monitoring and studies related to operations that must occur after dual conveyance has commenced consist of four types: monitoring addressing the operation of the proposed new facilities, monitoring related to species condition and habitat that may be influenced by operations of the new facilities, monitoring to evaluate the effectiveness of the proposed facilities, and monitoring addressing the performance of the habitat protection and restoration sites.

If monitoring activities may affect listed species or critical habitat and are not subject to future section 7 consultation or approvals (*i.e.*, the Corps' Phase 1 permit), reinitiation of this consultation is required to address those effects. Monitoring activities associated with all other aspects of the PA will require future approvals and will be subject to future consultations if those activities may affect listed species or critical habitat.

Prior to Dual Conveyance Operations

Monitoring and studies related to operation of the proposed new facilities, that must occur prior to operation of the new facilities, is focused on the conveyance facilities and their potential effects on listed fish species. This monitoring begins with gathering baseline data to compare with post-construction monitoring and studies. A more detailed effort has already been made regarding monitoring for the NDD. DWR has committed to working with the Service, NMFS, and CDFW to develop the specifics of that monitoring, which will be a key charge of both the CCF Technical Team and HORG Technical Team.

For the NDD, specific monitoring studies will be developed in collaboration with the Service, NMFS, and CDFW that are focused on preconstruction conditions and on design of the diversions. These monitoring efforts prior to operations will build off the work done by the FFTT (FFTT 2011), which identified monitoring associated with the NDD and their effects. The preconstruction studies identified by this group were focused on specific key questions rather than general monitoring needs and are listed in Table 6.1-5. Monitoring studies focused on the NDD were developed during the BDCP process and include items 7 and 8 as listed in Table 6.1-6. These studies and their projected timeframes will be revisited as the final monitoring plan is developed.

Table 6.1-5. Preconstruction studies at the North Delta Diversions.

Potential Research Action[1]	Key Uncertainty Addressed	Timeframe
1. This action includes preconstruction study 1, *Site Locations Lab Study*, as described by the Fish Facilities Working Team (FFWT 2013). The purpose of this study is to develop physical hydraulic models to optimize hydraulics and sediment transport at the selected diversion sites.	What is the relationship between proposed north Delta intake design features and expected intake performance relative to minimization of entrainment and impingement risks?	Ten months to perform study; must be complete prior to final intake design.
2. This action includes preconstruction study 2, *Site Locations Numerical Study*, as described by the Fish Facilities Working Team (FWTT 2013). The purpose of this study is to develop site-specific numerical studies (mathematical models) to characterize the tidal and river hydraulics and the interaction with the intakes under all proposed design operating conditions.	How do tides and diversion rates affect flow conditions at the north Delta intake screens and at the Georgiana Slough junction?	Eight months to perform study; must be complete prior to final intake design.

3. This action includes preconstruction study 3, *Refugia Lab Study*, as described by the Fish Facilities Working Team (FFWT 2013). The purpose of this study is to test and optimize the final recommendations for fish refugia that will be incorporated in the design of the NDD.	How should north Delta intake refugia be designed in principle to achieve desired biological function?	Nine months to perform study; must be complete prior to final intake design.
4. This action includes preconstruction study 4, *Refugia Field Study*, as described by the Fish Facilities Working Team (FFWT 2013). The purpose of this study is to evaluate the effectiveness of using refugia as part of NDD design for the purpose of providing areas for juvenile fish passing the screen to hold and recover from swimming fatigue and to avoid exposure to predatory fish.	How do alternative NDD refugia designs perform with regard to desired biological function?	Two years to perform study; must be complete prior to final intake design.
5. This action includes preconstruction study 5, *Predator Habitat Locations*, as described by the Fish Facilities Working Team (FFWT 2013). The purpose of this study is to perform field evaluation of similar facilities (*e.g.*, Freeport, RD108, Sutter Mutual, Patterson Irrigation District, and Glenn Colusa Irrigation District) and identify predator habitat areas at those facilities.	Where is predation likely to occur near the new NDD?	One to two years to perform study; must be complete prior to final intake design.
6. This action includes preconstruction study 6, *Baseline Fish Surveys*, as described by the Fish Facilities Working Team (FFWT 2013), somewhat modified based on discussions with NMFS during 2014. The purpose of this study is to perform literature search and potentially field evaluations at similar facilities (*e.g.*, Freeport, RD108, Sutter Mutual, Patterson Irrigation District, and Glenn Colusa Irrigation District), to determine if these techniques also take listed species of fish, and to assess ways to reduce such by-catch, if necessary.	What are the best predator reduction techniques, *i.e.*, which techniques are feasible, most effective, and best minimize potential impacts on listed species?	Two years to perform study; must be complete prior to final intake design.
7. This action includes preconstruction study 7, *Flow Profiling Field Study*, as described by the Fish Facilities Working Team (FFWT 2013). The purpose of this study is to characterize the water velocity distribution at river transects within the proposed diversion reaches for differing flow conditions. Water velocity distributions in intake reaches will identify how hydraulics change with flow rate and tidal cycle, and this information will be used in fish screen final design and in model-based testing of fish screen performance (preconstruction study 8, below).	What is the water velocity distribution at river transects within the proposed intake reaches, for differing river flow conditions?	One year to perform study; must be complete prior to final intake design.
8. This action includes preconstruction study 8, *Deep Water Screens Study*, as described by the Fish Facilities Working Team (FFWT 2013). The purpose of this study is to use a computational fluid dynamics model to identify the hydraulic characteristics of deep fish screen panels.	What are the effects of fish screens on hydraulic performance?	Nine months to perform study; must be complete prior to final intake design.
9. This action includes preconstruction study 9, *Predator Density and Distribution*, as described by the Fish Facilities Working Team (FFWT 2013); and includes post-construction study 9, *Predator Density and Distribution*, as described by the FFTT (FFTT 2011). The purpose of this study is to use an appropriate technology (to be identified in the detailed study plan) at two to three proposed screen	What are predator density and distribution in the NDD reaches of the Sacramento river?	Start in 2016 to collect multiple annual datasets before construction begins. The post-construction

locations; the study will also perform velocity evaluation of eddy zones, if needed. The study will also collect baseline predator density and location data prior to facility operations, compare that to density and location of predators near the operational facility; and identify ways to reduce predation at the facilities.		study will cover at least 3 years, sampling during varied river flows and diversion rates.
10. This action includes preconstruction study 10, *Reach-Specific Baseline Juvenile Salmonid Survival Rates*, as described by the Fish Facilities Working Team (FFWT 2013); and includes post-construction study 10, *Post-Construction Juvenile Salmon Survival Rates*, as described by the FFTT (FFTT 2011). The purpose of this study is to determine baseline rates of survival for juvenile Chinook salmon and steelhead within the Sacramento River near proposed NDD sites for comparison to post-project survival in the same area, with sufficient statistical power to detect a 5% difference in survival. Following initiation of project operations, the study will continue, using the same methodology and same locations. The study will identify the change in survival rates due to construction/operation of the intakes.	How will the new NDD affect survival of juvenile salmonids in the affected reach of the Sacramento River?	The preconstruction study will cover at least 3 years and must be completed before construction begins. The post-construction study will cover at least 3 years, sampling during varied river flows and diversion rates.
11. This action includes preconstruction study 11, *Baseline Fish Surveys*, as described by the Fish Facilities Working Team (FFWT 2013) and includes post-construction study 11, *Post-Construction Fish Surveys*, as described by the Fish Facilities Technical Team (FFTT 2011). The purpose of this study is to determine baseline densities and seasonal and geographic distribution of all life stages of delta and longfin smelt inhabiting reaches of the lower Sacramento River where the NDD will be sited. Following initiation of diversion operations, the study will continue sampling using the same methods and at the same locations. The results will be compared to baseline catch data to identify potential changes due to intake operations.	How will the new NDD affect delta and longfin smelt density and distribution in the affected reach of the Sacramento River?	Preconstruction study will cover at least 3 years. Post-construction study will be performed for duration of project operations (or delisting of species), with timing and frequency to be determined.

Notes
[1] All research actions listed in this table are part of the PA. For all proposed research actions, a detailed study design must be developed prior to implementation. The study design must be reviewed and approved by CDFW, NMFS, and the Service prior to implementation.

Table 6.1-6. Monitoring actions for listed species of fish for the North Delta Diversions.

Monitoring Action(s)	Action Description[1]	Timing and Duration
1. Fish screen hydraulic effectiveness	This action includes post-construction study 2, *Long-term Hydraulic Screen Evaluations*, combined with post-construction study 4, *Velocity Measurement Evaluations*, as described by the Fish Facilities Technical Team (FFTT 2011). The purpose of this monitoring is to confirm screen operation produces approach and sweeping velocities consistent with design criteria, and to measure flow velocities within constructed refugia. Results of this monitoring will be used to "tune" baffles and other components of the screen system to consistently achieve compliance with design criteria.	Approximately 6 months beginning with initial facility operations.

2. Fish screen cleaning	This action includes post-construction study 3, *Periodic Visual Inspections*, as described by the Fish Facilities Technical Team (FFTT 2011). The purpose of this monitoring is to perform visual inspections to evaluate screen integrity and the effectiveness of the cleaning mechanism, and to determine whether cleaning mechanism is effective at protecting the structural integrity of the screen and maintaining uniform flow distribution through the screen. Results of this monitoring will be used to adjust cleaning intervals as needed to meet requirements.	Initial study to occur during first year of facility operation with periodic re-evaluation over life of project.
3. Refugia effectiveness	This action includes post-construction study 5, *Refugia Effectiveness*, as described by the FFTT (FFTT 2011). The purpose is to monitor refugia to evaluate their effectiveness relative to design expectations. This includes evaluating refugia operation at a range of river stages and with regard to effects on target species or agreed proxies. Results of this monitoring will be used to "tune" the screen system to consistently achieve compliance with design criteria.	Approximately 6 months beginning with initial facility operations.
4. Fish screen biological effectiveness	This action includes post-construction study 7, *Evaluation of Screen Impingement*, as described by the FFTT (FFTT 2011). The purpose of this monitoring is to observe fish activity at the screen face (using technology to be identified in the detailed study plan) and use an appropriate methodology (to be identified in the detailed study plan) to evaluate impingement injury rate. Results of this monitoring are to be used to assess facility performance relative to take allowances, and otherwise as deemed useful via the collaborative adaptive management process.	Study to be performed at varied river stages and diversion rates, during first 2 years of facility operation.
5. Fish screen entrainment	This action includes post-construction study 8, *Screen Entrainment*, as described by the FFTT (FFTT 2011). The purpose of this monitoring is to measure entrainment rates at screens using fyke nets located behind screens, and to identify the species and size of entrained organisms. Results of this monitoring are to be used to assess facility performance relative to take allowances, and otherwise as deemed useful via the collaborative adaptive management process.	Study to be performed at varied river stages and diversion rates, during first 2 years of facility operation.
6. Fish screen calibration	Perform hydraulic field evaluations to measure velocities over a designated grid in front of each screen panel. This monitoring will be conducted at diversion rates close to maximum diversion rate. Results of this monitoring will be used to set initial baffle positions and confirm compliance with design criteria.	Initial studies require approximately 3 months beginning with initial facility operations.
7. Fish screen construction	Document NDD design and construction compliance with fish screen design criteria (note, this is simple compliance monitoring).	Prior to construction and as-built.
8. Operations independent measurement	Document NDD compliance with operational criteria, with reference to existing environmental monitoring programs including (1) Interagency Ecological Program Environmental Monitoring Program: Continuous Multi-parameter Monitoring, Discrete Physical/Chemical Water Quality Sampling, (2) Reclamation and DWR: Continuous Recorder Sites, (3) CVRWQCB: NPDES Self- Monitoring Program, and (4) U.S. Geological Survey Delta Flows Network and National Water	Start prior to construction of water diversion facilities and continue for the duration of the PA.

	Quality Assessment Program. The purpose of this monitoring is to ensure compliance and consistency with other relevant monitoring programs, and to ensure that this information is provided to CDFW, NMFS, and the Service in association with other monitoring reporting.	
9. Operations measurement and modeling	Document NDD compliance with the operational criteria using flow monitoring and models implemented by DWR. The purpose of this monitoring is to ensure and demonstrate that the intakes are operated consistent with authorized flow criteria.	Start prior to completion of water diversion facilities and continue for the duration of the permit term.
10. North Delta intake reach salmonid survivorship	Determine the overall impact on survival of juvenile salmonids through the diversion reach, related to the operation of the new north Delta intakes. Use mark/recapture and acoustic telemetry studies (or other technology to be identified in the detailed study plan) to evaluate effects of facility operations on juvenile salmonids, under various pumping rates and flow conditions. Results of this monitoring are to be used to assess whether survival objectives for juvenile salmonids traversing the diversion reach are being met, to determine whether take allowances are exceeded, and otherwise as deemed useful via the collaborative adaptive management process.	Study to be performed at varied river flows and diversion rates, during first 2 to 5 years of facility operation.

Notes
[1] All monitoring actions are part of the PA. For all proposed monitoring actions, a detailed study design must be developed prior to implementation. The study design must be reviewed and approved by CDFW, NMFS, and the Service prior to implementation.

Monitoring after Dual Conveyance Operations Commence

Monitoring and studies related to CVP and SWP Delta operations, that must occur after operation of the new facilities has commenced, broadly consists of four types of monitoring, performed to assess system state and effects on listed species: monitoring addressing the operation of the proposed new facilities, monitoring related to species condition and habitat that may be influenced by operations of the new facilities, monitoring to evaluate the effectiveness of the proposed facilities, and monitoring addressing the habitat protection and restoration sites.

6.2 Standard (Non-programmatic) Actions

As stated in the *Consultation Approach* section above, some of the project elements are not subject to subsequent consultation and, therefore, must be addressed under standard (non-programmatic) consultation in this BiOp. Effects and any "reasonably certain to occur" incidental take are addressed in this BiOp. Additionally, sections *9.2.4 Project-level Reinitiation Triggers and Programmatic Approach with Subsequent Consultation* and the species-specific *Reinitiation Triggers* sections describes some additional specific conditions under which consultation will need to be reinitiated.

Geotechnical Explorations

DWR will perform a series of geotechnical investigations along the selected water conveyance alignment, at locations proposed for facilities, and at material borrow areas. The proposed exploration is designed as a two-part program (referred to as Phases 2a and 2b) to collect geotechnical data. The land-based portion will occur at approximately 1,380 locations and will be active for a period ranging from a few hours to 12 work days per site, depending on exploration type and target depth. The overwater portion will occur at approximately 90 to 100 locations. DWR will conduct overwater drilling only during August 1 through October 31 depending on location and will only work between the hours of sunrise and sunset. Duration of drilling at each location will vary depending on the number and depth of the holes, drill rate, and weather conditions, but activities are not expected to exceed 60 days at any one location. Total duration for land-based explorations will require approximately 24 months and will typically occur from April through November. Total duration of overwater explorations will require approximately 14 months, using two drill rigs operating concurrently for 6 days per week from June through November depending on location. The schedule for geotechnical explorations is not included in CWF BA Appendix 3.D, *Construction Schedule for the Proposed Action.*

Refer to Section 3.2.1 of the CWF BA for DWR's description of the geotechnical explorations. Section 3.2.1 references CWF BA Appendix 3.G, *Geotechnical Exploration Plan—Phase 2*, a draft 2014 document for DHCCP.

Conveyance Tunnels

Design

The conveyance tunnels will extend from the proposed intake facilities to the NCCF. The tunneled conveyance includes the north tunnels, which consist of three reaches that connect the intakes to the IF; and two parallel main tunnels, connecting the IF to the NCCF. Final surface conveyance connecting the NCCF to the existing export facilities is described in Section 3.2.6, *Connections to the Banks and Jones Pumping Plants*, of the CWF BA. The water conveyance tunnels will be operated with a gravity feed system, delivering to a pumping station located at the NCCF.

Each tunnel segment will be excavated by a tunnel boring machine (TBM), which is a very large and heavy electrically-powered machine that will be launched from the bottom of a launch shaft, and will tunnel continuously underground to a reception shaft. For a detailed explanation of the tunneling work, see the CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Sections 3.1, *Proposed Alignment and Key Components*, 3.2, *Reach Descriptions*, and 11.0, *Tunnels;* Sections 11.2.5, *Tunnel Excavation Methods*, and 11.2.6, *Tunnel Support*, in particular, detail the process of tunneling. The cutterhead of the TBM will be hydrostatically isolated from the remainder of the machine, so that the inside of the tunnel will be dry and at atmospheric pressure. As the TBM proceeds, precast concrete tunnel lining sections will be assembled within the TBM to produce a rigid, watertight tunnel lining. Typically very little dewatering will be needed to keep the interior of the tunnel dry. An electrically-powered conveyor will carry excavated material from the TBM back to the launch shaft, where a vertical conveyor will carry the material to the surface for disposal. A narrow-gauge railway may be installed in the tunnel with a diesel locomotive, or rubber wheeled diesel engine trucks may be used to carry workers, tunnel lining segments, and other materials from the launch shaft to the TBM.

The TBM launch facilities will be relatively large and active construction sites because they are continuously active during a TBM tunnel drive, as they will provide the only surface access to the tunnel. Thus they will require stockpiles of materials used by the TBM. They will provide access to the TBM for its operation and maintenance, and will receive all materials excavated by the TBM. Conversely, TBM reception facilities will be used to recover the TBM at the end of its drive, and these will have smaller footprints and a more limited operating scope than the launch facilities. Table 6.2-1 summarizes all of the proposed tunnel drives, identifying launch and reception shafts, tunnel lengths, and tunnel diameters. CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Figure 11-1, shows this information on a map. Note that Bouldin Island and the IF will be the primary tunneling launch sites (Table 6.2-1).

Refer to the map book for the tunnel drives presented in the CWF BA Appendix 3.A, *Map Book for the Proposed Action*. Design drawings showing tunnel routing, design of the shaft structures, and layout of the surface facilities at launch and reception sites appear in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*; see Drawings 44 to 54, showing the tunnel routing and all associated areas of surface activity. A detailed project schedule, showing periods of tunneling and associated activities, is given in CWF BA Appendix 3.D, *Construction Schedule for the Proposed Action*. Each TBM launch or retrieval shaft will require barge access for equipment and materials. AMMs to be implemented during construction work at all surface facilities supporting the tunneling work appear in CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*.

Table 6.2-1. Tunnel drive summary.

Reach	Launch Shaft	Reception Shaft	Inside Diameter (ft)	Length (miles)
1	Intake 2	Intake 3 junction structure	28	1.99
2	IF inlet	Intake 3 junction structure	40	6.74
3	IF inlet	Intake 5	28	4.77
4 (west tunnel)	IF	Staten Island	40	9.17
4 (east tunnel)	IF	Staten Island	40	9.17
5 (west tunnel)	Bouldin Island	Staten Island	40	3.83
5 (east tunnel)	Bouldin Island	Staten Island	40	3.83
6 (west tunnel)	Bouldin Island	Bacon Island	40	8.86
6 (east tunnel)	Bouldin Island	Bacon Island	40	8.86
7 (west tunnel)	NCCF	Bacon Island	40	8.29
7 (east tunnel)	NCCF	Bacon Island	40	8.29

Tunnel Construction Components

Shaft Site Facilities

Facilities at launch shaft sites will include a concrete batch plant and construction work areas including offices, parking, shop, short-term segment storage, fan line storage, crane, dry houses, settling ponds, daily spoils piles, temporary reusable tunnel material (RTM) storage, electrical power supplies, air, water treatment, and other requirements. There will also be space for slurry ponds at sites where slurry wall construction is required. Work areas for RTM handling and permanent spoils disposal will also be necessary. Facilities at reception shafts will be similar but more limited, as there will be no need for a concrete batch plant or for RTM storage.

Shaft Site Preparation

Shaft site preparation is detailed in CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Section 11.2.1, *Advance Works Contracts*. During shaft site preparation, vehicular access will be established and electrical service will be provided via temporary transmission line. The shafts will be located on pads elevated to above the 200-year flood elevation; fill will be placed to construct these pads. The site will be fenced for security and made ready for full construction mobilization. Due to the pervasive nature of these activities, all surface disturbance associated with construction at each shaft site will occur very early during the period of activity at each site; the entire site footprint will be disturbed and will remain so for the duration of construction.

The number of shafts that will be required is not known precisely at this time (Table 6.2-2). Final determination of the number and siting of shaft locations will depend upon determinations by the tunnel construction contractor(s). Table 6.2-2 shows the number of safe haven interventions expected to be associated with each tunnel, based upon current understanding of site conditions.

Access Routes

Access routes for each shaft site are shown in CWF BA Appendix 3.A, *Map Book for the Proposed Action*, and in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Drawings 44 to 54. These sources also depict the footprint for new permanent access roads, which will be a feature of every shaft site. SR 160 provides access to the intakes and their associated shafts, but for all other shafts (including atmospheric safe haven access shafts), access roads will be constructed. Those roads will be permanent features except at atmospheric safe haven access shafts, where they will be temporary.

Fill Pads

Permanent conveyance facilities (intakes, permanent shaft sites, IF, and CCF facilities) will require fill pads with a top surface elevation of approximately 25 ft to 35 ft, depending upon location (CWF BA 2016, Appendix 3.B, Table 3-4). These sites are currently near or below sea level, so substantial fill material volumes will be needed and will be sourced by borrow sites, the placement of which will cause consolidation settlement of underlying delta soils at the construction sites. The shafts at the IF are an exception; these will initially be constructed at near existing site grades, and final site grades will be established in conjunction with final IF inlet and outlet facilities. The permanent elevated pad perimeters are assumed to extend to 75 ft from the outside of the shafts to facilitate heavy equipment access for maintenance and inspection. As the existing ground elevations are significantly lower than the final planned elevations, the pad fills will slope down to the adjacent existing site grades at an inclination of between 3 horizontal to 1 vertical (3H to 1V) to 5H to 1V.

Due to the soft ground conditions expected at the construction sites, it will also be necessary to improve existing sites to support heavy construction equipment, switchyards, transformers, concrete and grout plants, cranes and hoists, TBMs, and water treatment plants.

Pad construction will precede other work at the shaft site; at the IF, for instance, earthwork will begin 2.5 years prior to a 9-month period of ground improvement before the sites will be ready for mobilization of construction equipment needed to build the pads.

Shaft Construction

Shaft construction procedures are described in CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Section 11.2.3, *Shaft Construction*. Shafts are circular in plan with a 100-ft diameter for 28-ft tunnels and a 113-ft diameter for 40-ft tunnels. These are minimum sizes; larger diameter shafts may be needed to launch and retrieve the TBM from the bottom of the shaft.

Final design of shafts is not complete, but the basic objective is to use concrete construction methods to create a watertight shaft sufficiently strong to resist the hydrostatic pressure created by tunneling down into the Delta sediments. This will be done by constructing a concrete cylinder prior to removing the sediment from the shafts. Potential construction methods include overlapping concrete caisson walls, panel walls, jet-grout column walls, secant piles walls, slurry walls, precast sunken caissons, and potentially other technologies. In the areas where TBMs enter and exit, a special break-in/break-out section will be constructed as an integral part of the shaft.

Shaft bottoms will be stabilized to resist uplift associated with external hydrostatic pressure, during both excavation and operation. It may be necessary to pretreat the ground at the shaft area from the surface to the bottom of the shaft to control blowouts during excavation of the shaft. Concrete working slabs capable of withstanding uplift will be required at all shaft locations to provide a stable bottom and a suitable working environment. To place the bottom slab, the shaft will be excavated to approximately 30 to 50 ft below the invert level of the tunnel, and a concrete base will be placed underwater using tremie techniques. It is expected that this base will be a large concrete plug to withstand ground water pressure, with optional relief wells to relieve uplift pressure during tunnel construction. Large openings need to be created in the shaft walls to launch and retrieve the TBMs. To maintain structural stability around the launch and retrieval openings, it will be necessary to provide additional structural support (*e.g.*, reinforced concrete buttresses or frame structures within the shaft). Dewatering will be required during shaft construction and operation. Dewatering of sediments surrounding the shaft may be needed during construction, depending upon the construction method selected. Dewatering will also be needed during excavation within the shaft, following placement of the tremie seal, and continuously thereafter until the shaft is completely constructed.

Tunnel Excavation

The tunnel excavation procedure is described in CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Sections 11.2.5, *Tunnel Excavation Methods*, to 11.2.8, *Logistics*. Tunnel excavation will occur entirely underground and thus will entail no surface impacts, apart from those associated with the TBM launch and reception shafts and the construction access shafts. Tunnel dewatering needs will be minor, compared to those associated with shaft construction.

Intermediate Tunnel Access

In the event that maintenance, inspection, or repair of the TBM cutterhead is needed, contractors will be able to access their equipment either from inside the TBM or from the surface using construction access shafts. Such access points are termed "safe havens" because they constitute points where humans can work on the outside of the TBM in conditions of comparative safety.

Access to the cutterhead from inside the TBM will occur at a "pressurized safe haven intervention." Pressurized safe haven interventions will be constructed by injecting grout from the surface to a point in front of the TBM, or by using other ground improvement techniques such as ground freezing. Once the ground has been stabilized by one of these techniques, the

TBM will then bore into the treated area. Surface equipment required to construct the safe haven intervention site will include a small drill rig and grout mixing and injection equipment, and facilities to control runoff from dewatering. Disturbance at the site is expected to be limited to an area of approximately 100 ft by 100 ft. The surface drilling and treatment operation will typically take about 8 weeks to complete. Once complete, all equipment will be removed and the surface features reestablished. To the greatest extent possible, established roadways will be used to access the intervention sites. If access is not readily available, temporary access roads will be built.

Access to the cutterhead from the surface, referred to as an "atmospheric safe haven interventions," will require construction of a shaft. These construction access shafts will not require pad construction to elevate the top of the shaft to above the 200-year flood level. At these sites, a shaft roughly equal to the diameter of the TBM cutterhead will be excavated to tunnel depth. Approximately 3 acres will be required at each of these locations to set up equipment, construct flood protection facilities, excavate/construct the shafts, and set up and maintain the equipment necessary for the TBM maintenance work. It is anticipated that all work associated with developing and maintaining these shafts will occur over approximately 9 to 12 months. At the completion of the TBM maintenance at these sites, the TBM will mine forward, and the shaft location will be backfilled. Dewatering at construction access shafts may be required. Drilling muds or other materials required for drilling and grouting will be confined on the work site and such materials will be disposed of off-site at a permitted facility. Disturbed areas will be returned to preconstruction conditions by grading and appropriate revegetation.

Table 6.2-2. Expected safe haven interventions.

Reach	Length (miles)	Number of Safe Haven Interventions	
		Pressurized	Atmospheric
1	1.99	1	1
2	6.74	5	1 to 3
3	4.77	3	1 to 2
4 (twin tunnel)	9.17	7	1 to 4
5 (twin tunnel)	3.83	2	1
6 (twin tunnel)	8.86	7	1 to 4
7 (twin tunnel)	8.29	6	1 to 3

The tunnel construction timeline is presented in CWF BA Appendix 3.D, *Construction Schedule for the Proposed Action.* The TBM launch shafts will be most active, producing RTM on a nearly continuous basis, for the following time periods:

- CCF: May 2020 to February 2025
- Bouldin Island: October 2020 to May 2025
- IF: May 2021 to October 2026
- Intake 2: October 2021 to July 2025

Overall, the peak period of activity will be from October 2020 to April 2025. Considering the time required to prepare each site, as well as time required to stabilize and restore RTM storage areas, each site will remain active throughout essentially the whole period of construction (2018 to 2030). Since the CCF, IF, and Intake 2 are essential components of the conveyance system, these sites will remain permanently active. The Bouldin Island site, however, will close following revegetation and restoration for the RTM storage areas; only a small permanent tunnel access shaft will remain.

During mobilization, construction personnel, stockpiles of materials, and needed equipment will be stationed at the construction sites. The construction phase at both permanent and temporary shaft sites will conclude with landscaping and the installation of safety lighting and security fencing.

Intermediate Forebay

The IF, located on Glanville Tract, will receive water from the three NDD and discharge it to the twin tunneled conveyance to CCF. The IF will store water between the proposed intake and conveyance facilities and the main tunnel conveyance segment.

The IF will provide an atmospheric break in the deep tunnel system and act as a buffer for CVP and SWP exports between the NDD and the Banks Pumping Plant. This buffer provides make-up water and storage volume to mitigate transient interruptions in water diversions resulting from planned or unplanned adjustments of system pumping rates. The IF also facilitates isolating segments of the tunnel system, while maintaining operational flexibility. Thus each tunnel, into and out of the IF, can be hydraulically isolated for maintenance, while maintaining partial system capacity.

Design

CWF BA Appendix 3.A, *Map Book for the Proposed Action*, Sheet 5, shows the IF, access routes, and related facilities in the area. CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Drawings 55 to 68, show an artist's concept of the completed forebay, as well as drawings showing the complete forebay and various design details. CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Section 14, *Forebays*, provides detail on the design, construction and operations of the IF; see particularly Sections 14.1. (description and site plan), 14.2. (construction methodology), 14.2.4 (embankment completion), 14.2.6 (spillway), and 14.2.8 (inlet and outlet structures). CWF BA Section 5.3.1, *Intermediate Forebay Size Evaluation*, describes the basis for design sizing of the IF.

The IF will have a capacity of 750 acre feet (af) and an embankment crest elevation of +32.2 ft, which meets DHCCP flood protection standards (*i.e.*, a 200-year flood with provision for sea level rise). Current ground surface elevation at the site averages +0 ft. The water surface elevation (WSE) varies between a maximum elevation of +25 ft and a minimum elevation of -20 ft. The IF will include an emergency spillway and emergency inundation area to prevent the forebay from overtopping. This spillway will divert water during high flow periods to an approximately 131-acre emergency inundation area adjacent to and surrounding the IF. From the IF, water will be conveyed by a gravity bypass system through an outlet control structure into a dual-bore 40-ft-diameter tunnel that runs south to the CCF. The IF will serve to enhance water supply operational flexibility by using forebay storage capacity to regulate flows from the intakes to the CCF. The IF footprint will have a water surface area of 54 acres at maximum water elevation.

Construction

Construction of the IF entails first excavating the embankment areas down to suitable material (Table 6.2-3). A slurry cutoff wall is then placed to a depth of -50 ft to eliminate the potential for piping or seepage beneath the embankment. The embankment is then constructed of compacted fill material. Inlet and outlet shafts (which also serve as TBM launch shafts) will then be constructed. Next, the interior basin will be excavated to design depth (-20 ft), and the spillway will be constructed. All excavations are expected to require dewatering, and dewatering is expected to be continuous throughout construction of the IF. Ground improvement may be needed beneath structures, depending upon the outcomes of the geotechnical explorations.

The IF will have a surface footprint of 243 acres, all of which is permanent (under 2016 conditions, the area is a vineyard). Approximately 1 million cubic yards (cy) of excavation and 2.3 million cy of fill material will be required to complete the IF embankments. Much of the excavated material is expected to be high in organics and unsuitable for use in embankment construction and will therefore require off-site disposal. However, fill material may be sourced onsite from locations within the permanent impact footprint. Material sourced from off-site will be obtained as described in the Borrow Fill section of the CWF BA. The construction phase at the IF will conclude with landscaping and the installation of safety lighting and security fencing.

Table 6.2-3. Summary construction schedule for the Intermediate Forebay.

Description	Start[a]	End[a]	Duration
Contract management, supervision, administration, temporary facility operations, and delivery of construction supplies	7/1/2026	7/11/2031	61 months
Earthworks	7/1/2026	12/25/2029	42 months
Inlet & outlet ground improvements	12/28/2028	10/12/2030	23 months
Inlet & outlet site work	9/27/2029	4/12/2030	8 months
Operate concrete batch plant; inlet & outlet concrete work	3/27/2030	4/11/2031	13 months
Inlet & outlet gates, mechanical & electrical work	12/25/2030	7/11/2031	7 months

[a] Dates given in this table assume a Record of Decision date of 1/1/2018 and a construction end date of 7/11/2031.

Clifton Court Forebay

Design

In the CWF BA, DWR recognizes that design of the modifications and expansion of CCF are in early stages. As such, DWR proposes to convene a CCF Technical Team upon initiation of formal consultation for the PA and will meet periodically until DWR completes final design for the proposed CCF modifications (a time period expected to be at least two years). The general concepts and construction components are summarized below and reference the CWF BA where appropriate.

The CCF will be divided into two separate but contiguous forebays: NCCF and SCCF. The NCCF will receive screened water from the new Sacramento River intakes while the SCCF will continue to receive flows from the existing Old River intake gate. The NCCF will be sized to meet the hydraulic needs of balancing water entry from the NDD with discharge via the CVP and SWP export pumps. The SCCF will continue to meet the needs of SWP export pumps taking in south Delta water; as such it will function as a replacement for the current CCF, and thus must be enlarged to the south in order to maintain its current size while still accommodating the creation of the NCCF. SCCF will consist of the southern portion of the existing CCF, with expansion to the south into Byron Tract 2.

The CCF will be expanded by approximately 590 acres to the southeast. The existing CCF will be dredged, and the expansion area excavated, to design depths of -8 ft for the NCCF and -10 ft for the SCCF. A new embankment will be constructed around the perimeter of the entire forebay complex, and another embankment will separate the NCCF from the SCCF. The tunnels from the Sacramento River intakes will enter the Clifton Court Pumping Plant (CCPP) at the northeastern end of the NCCF, immediately south of Victoria Island, and flows will typically be pumped into the NCCF.

An emergency spillway will be constructed in the NCCF east side embankment, south of the CCPP fill pad. The spillway will be sized to carry emergency overflow (9,000 cfs, the maximum inflow from the NDD) to the Old River, so a containment area will not be necessary. The shallow foundation beneath this structure must be improved to prevent it from failing. The ground improvement will be to elevation -50.0 ft both within the footprint of the structure and beyond it by a distance of approximately 25 ft. The work will be performed within the sheet pile installed to build the in-water portion of the eastern embankment.

Detailed information on design of the proposed facilities at CCF is given in CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Sections 4.4.6, *Clifton Court Forebay Pump Plant (CCFPP) Operations*; 4.4.7, *North Clifton Court Forebay Operations*. Section 7, *CCF Pumping Plant*, describes the design and construction of the CCF pumping plant, while the north and south CCF and their construction methodology are described in Sections 14.1.2, *North Clifton Court Forebay*; 14.1.3, *South Clifton Court Forebay*; 14.2.2, *General Excavation for the NCCF and SCCF*; 14.2.3, *General Excavation for the Existing South Embankment of Clifton*

Court Forebay; 14.2.5, *New Clifton Court Forebay Embankment*; 14.2.6, *New Spillway and Stilling Basin*; and 14.2.8, *New Forebay Structures*.

Per the CWF BA, Appendix 3.A, *Map Book for the Proposed Action*, Sheet 13, shows the CCF, access routes, and related facilities in the area. CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Drawing 2, provides an overview of the CCF facilities in relation to the rest of the conveyance facilities, and Drawing 54 provides a site-scale view of the proposed facilities at CCF. Drawing 74 shows an artist's concept of the completed CCF pumping plant, and Drawings 75 to 78 show details of the proposed pumping plant. Drawing 82 is a detailed overall CCF site plan, and Drawings 85 to 87 provide sectional views of the proposed embankments that contain the CCF. Drawings 90 and 91 provide plan and section views of the proposed spillway from the NCCF into Old River.

The NCCF will be designed to accommodate hydraulic surges and transitions related to short-term (typically less than 24 hours) differences in the rate of water delivery to NCCF and the rate of export by the CVP and SWP pumps. The NCCF will also be the site for a pump station, the operations of which form the primary control and constraints on the rate of water diversion through the NDD intakes (although that rate is also subject to control at the river intakes). Collective operations of these facilities will be coordinated through an operations center sited at the NCCF pump station. The SCCF will continue to operate as under current conditions. The proposed size of the CCF and its appurtenant facilities have been optimized consistent with the overall design goal of the PA to achieve diversion rates at the NDD not exceeding 9,000 cfs, and to achieve overall CVP and SWP water export rates consistent with existing authorizations for those facilities, subject to operational and regulatory constraints detailed in Section 3.3, *Operations and Maintenance of the New and Existing Facilities*.

Construction

Due to the duration and complexity of the proposed work at CCF, a phased work schedule is planned and described further in the CWF BA and *BiOp Resolution Log*. The phases include the following activities:

- Construct embankment needed for forebay expansion on the south in the dry.
- Construct sheet pile channel in existing Clifton Court south embankment.
- Remove existing embankment on the south.
- Install sheet piles required for construction during the proposed in-water work window.
- Dewater and complete fish salvage operation in the CCF north cell. Prior to the start of construction, a fish salvage plan will be prepared in coordination with the State and Federal fisheries agencies.
- Construct divider embankment between CCF north cell and south cell.
- Continue construction activities in the CCF north cell in the dry.
- Dredge the central part of CCF south cell between the divider wall and the existing south embankment. Dredging activities in the CCF south cell will be limited to the in-water work window and are expected to continue for up to five years.

- Construct remainder of the CCF south cell embankments on the east and west.

The overall schedule for activities at CCF is shown in the *BiOp Resolution Log and* CWF BA Appendix 3.D, *Construction Schedule for the Proposed Action*; see drawings in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, for locations of the referenced structures. Four major elements of the proposed construction will occur in the CCF area: tunneling, the construction of a CCPP, the modifications to the current CCF to create the NCCF and SCCF, and connections to the Banks and Jones pumping plants.

- Tunneling (Reach 7) will start from the CCPP construction site and will excavate north to Bacon Island, as described in CWF BA Section 3.2.3, *Tunneled Conveyance*; RTM from the tunnels will be disposed near CCF as described in Section 3.2.10.6, *Dispose Spoils*. Tunneling activity will begin 47 months after project start (scheduled to occur in January; the start year depends upon the date of project authorization and the time needed to prepare contract specifications and issue contracts) and will proceed continuously for 61 months.
- The CCPP will be constructed at the northeast corner of the CCF complex and includes the shafts used to launch the TBMs. Construction will start at the CCPP beginning 36 months after project start and will proceed continuously for 100 months.
- CCF work will occur throughout the site, and will be continuously active from 84 months after project start for 63 months, for an expected completion at 147 months after project start. Apart from startup activities (access improvement, mobilization, etc.), embankment and canal work will continue from 90 months to 130 months after project start. Work on control structures and spillways will take 36 months, occurring from 108 months to 144 months after project start.

Clifton Court Pumping Plant

Design

Each of the two units at CCPP will have a design pumping capacity of 4,500 cfs and will include 4 large pumps (1,125 cfs capacity) and 2 smaller pumps (563 cfs capacity). One large pump at each plant will be a spare. Each pumping plant will be housed within a building and will have an associated electrical building. The pumping plant buildings will be circular structures with a diameter of 182 ft and each will be equipped with a bridge crane that will rotate around the building and allow for access to the main floor for pump removal and installation. The total site for the pumping plants, electrical buildings, substation, spillway, access roads, and construction staging areas is approximately 95 acres. The main floor of the pumping plants and appurtenant permanent facilities will be constructed at a minimum elevation of 25 ft to provide flood protection. The bottom of the pump shafts will be at an elevation of approximately -163 ft, though a concrete base slab, shaft lining, and diaphragm wall will be constructed to deeper levels (to an elevation of -275 ft). A control room within an electrical building at the pumping facility site will be responsible for controlling and monitoring the communication between the intakes, pumping plants, and the Delta Field Division Operations and Maintenance Center, DWR Headquarters, and the Joint Operations Center.

The CCPP shafts will be larger in inside diameter (150 ft instead of 113 ft) than most shafts serving 40-ft tunnel bores due to the design needs of the pumping plant. As shown in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume* 2, Drawings 75 and 76, the appurtenant facilities will be more extensive than at most tunnel shaft sites, including a permanent electrical substation, two electrical buildings, and an office/storage building, as well as temporary facilities for storage, staging, construction electrical, and water treatment (for stormwater). All of these facilities will be sited on the CCF embankment, at the design flood elevation (*i.e.*, a 200-year flood with provision for sea level rise) of 25 ft.

A 230 kilovolt (kV) transmission line and associated 230Kv–115kV substation used during construction will be repurposed and used to power the pumping plants at the CCF location. The repurposed substation will provide power to a new substation that will convert power from 115kV to 13.8kV. This substation will then include 13.8 kV feeder lines to a proposed electrical building to distribute the power to the major loads including the main pumps, dewatering pumps, and 13.8kV to 480V transformers.

Clifton Court Pumping Plant Construction Components

A detailed account of CCPP construction appears in CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Section 7.2, *Construction Methodology*.

Site Access

Vehicular site access during construction will use existing roads: from the east, from Byron Highway via Clifton Court Road and the Italian Slough levee crest road or the NCCF embankment crest road. Access from the south will be from the Byron Highway via NCCF embankment crest road and West Canal levee crest road. Barge access will also be needed, for transport of heavy TBM sections and other very large equipment and materials, and possibly for transport of bulk materials (fill material or excavated material). Barge access will be from the West Canal using a proposed barge unloading facility.

Cofferdam and Fill Work

A sheet pile cofferdam will be placed to enclose the portion of the CCPP fill pad adjoined by water (CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2,* Drawings 75 and 83). Note that, the design has been modified to dewater NCCF prior to CCPP construction. Thus, no sheet pile cofferdam will be placed in the portions of the CCPP fill pad adjoining the NCCF. Sheet pile placement for cofferdam installation will be performed by a barge-mounted crane and/or a crane mounted on the existing levee, equipped with vibratory and impact pile driving rigs. Fill pad construction will then proceed within the dewatered area, including fill placement, compaction, and ground improvement.

Dewatering

Extensive dewatering will be required during construction of the CCPP shafts.

Connections to Banks and Jones Pumping Plants

Construction at CCF will also include connections to the existing Banks and Jones pumping plants. The new system configuration will allow both the Banks PP and the Jones PP to draw water from existing sources and from the NCCF.

The new system configuration will require canals and control structures and two new siphons, shown in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Sheets 83 and 84. One siphon will convey NCCF water beneath the SCCF outlet canal. The second siphon will convey NCCF water to the Banks PP underneath the Byron Highway and the adjacent Southern Pacific Railroad line. Each siphon will have a control structure fitted with radial gates at the inlet, to regulate upstream WSE and flow through the siphons. In order to isolate a siphon for repairs and inspections, stop logs will also be provided at the downstream end of the siphon barrel. Control structures, fitted with radial gates, will also be located at the end of the new approach channels to control the amount of flow delivered to Jones PP and Banks PP. Refer to the CWF BA for further description and construction details for the canals, siphons and control structures.

Power Supply and Grid Connections

During construction, the PA will rely primarily upon electrical power sourced from the grid via temporary transmission lines to serve the TBMs and other project components. Use of diesel generators or other portable electrical power sources will be minimized due to the adverse air quality impacts of onsite power generation. Once operational, the largest power consumption will be for the pumping plant at CCF, where a grid connection will be available nearby. The intakes and IF will have relatively low operational power demands, which will be met via relatively short and lower-voltage connections to nearby grid sources.

Electric power will be required for intakes, pumping plants, operable barriers, boat locks, and gate control structures throughout the proposed conveyance alignment. Temporary power will also be required during construction of water conveyance facilities. New temporary electrical transmission lines to power construction activities will be built prior to construction of permanent transmission lines to power conveyance facilities. These lines will extend existing power infrastructure (lines and substations) to construction areas, generally providing electrical capacity of 12 kV at work sites. Main shafts for the construction of deep tunnel segments will require the construction of 69 kV temporary electrical transmission lines. Both temporary and permanent electrical transmission lines serving the PA are shown in CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Sheet 94. Temporary and permanent transmission lines are also shown in the map book, CWF BA Appendix 3.A, *Map Book for the Proposed Action*, Sheets 1 to 15.

Transmission lines to construct and operate the water conveyance facilities will connect to the existing grid in two different locations. The northern point of interconnection will be located north of Lambert Road and west of Highway 99 (CWF BA Appendix 3.A, *Map Book for the Proposed Action*, Sheet 4). From here, a new 230 kV transmission line will run west, along Lambert Road, where one segment will run south to the IF on Glanville Tract, and one segment will run north to connect to a substation where 69 kV lines will connect to the three Sacramento River intakes. At the southern end of the conveyance alignment, the point of interconnection will be in one of two possible locations: southeast of Brentwood near Brentwood Boulevard (CWF BA Appendix 3.A, Sheet 15) or adjacent to the Jones Pumping Plant (CWF BA Appendix 3.A, Sheet 13). A 230 kV line will extend from one of these locations to a tunnel shaft northwest of CCF, and will then continue north, following tunnel shaft locations, to Bouldin Island. Lower voltage lines (CWF BA Appendix 3.C, *Conceptual Engineering Report, Volume 2*, Sheet 94) will be used to power intermediate and reception shaft sites between the main drive shafts. Because the power required during operation of the water conveyance facilities will be much less than that required during construction, and because it will largely be limited to the pumping plants, all of the new electrical transmission lines between the IF and the CCF will be temporary.

An existing 500kV line, which crosses the area proposed for expansion of the CCF, will be relocated to the southern end of the expanded forebay in order to avoid disruption of existing power facilities. No interconnection to this existing line is proposed.

Temporary substations will be constructed at each intake, at the IF, and at each of the launch shaft locations. To serve permanent pumping loads, a permanent substation will be constructed adjacent to the pumping plants at CCF, where electrical power will be transformed from 230 kV to appropriate voltages for the pumps and other facilities at the pumping plant site. For operation of the three intake facilities and IF, existing distribution lines will be used to power gate operations, lighting, and auxiliary equipment at these facilities.

Utility interconnections are planned for completion in time to support most construction activities, but for some activities that need to occur early in the construction sequence (*e.g.*, constructing raised pads at shaft locations and excavating the shafts), onsite generation may be required on an interim basis. As soon as the connection to associated utility grid power is completed, electricity from the interim onsite generators will no longer be used.
Temporary lines will be constructed from existing facilities to each worksite where power will be necessary for construction. Construction of new transmission lines will require three phases: site preparation, tower or pole construction, and line stringing. For 12 kV and 69 kV lines, cranes will be used during the line stringing phase. For stringing transmission lines between 230 kV towers, cranes and helicopters will be used. Helicopters may fly as low as the top of the transmission towers, which may be as low as 60 feet. They will take-off and land in the right of ways obtained for transmission line construction, within the corridor identified on the construction footprint, or on other property obtained for the project, and identified on the project construction footprint, or designated existing helicopter pads (airstrips). They will not be allowed to land in sensitive habitat.

Construction of 230 kV and 69 kV transmission lines will require a corridor width of 100 ft and, at each tower or pole, a 100- by 50-ft area will be required for construction laydown, trailers, and trucks. Towers or poles will be located at intervals of 450 ft for 69kV lines (*i.e.*, 11 to 12 towers per mile), and 750 ft for 230kV lines (*i.e.*, 7 towers per mile). Construction will also require about 350 ft along the corridor (measured from the base of the tower or pole) at conductor pulling locations, which includes any turns greater than 15 degrees and/or every 2 miles of line. Construction will also require vehicular access to each tower or pole location. Vehicular access routes have not yet been determined.

For construction of 12 kV lines (when not sharing a 69 kV line), a corridor width of 25 to 40 ft will be necessary along the entire span, with a 50-ft width (25 ft in each direction) required at each pole. The construction of the pulling locations will require additional space; 200 ft along the corridor itself (measured from the base of the pole) and an additional 50-ft-wide area at conductor pulling locations. For a pole-mounted 12 kV/480 volt transformer, the work area will only be that normally used by a utility to service the pole (typically about 20 by 30 ft adjacent to pole). For pad-mounted transformers, the work area will be approximately 20 by 30 ft adjacent to the pad (for construction vehicle access). Construction of 12kV lines will also require vehicular access to each tower or pole location and routes have not yet been determined.

Temporary Access and Work Areas

Temporary access and work areas are defined for this project as areas or structures that will be removed, and not the duration of the activity. Construction work areas for the conveyance facilities will include areas for construction equipment and worker parking, field offices, a warehouse, maintenance shops, equipment and materials laydown and storage, and stockpiled topsoil strippings saved for reuse in landscaping.

Surface vehicular access will be needed for construction of all water conveyance facilities. Geotechnical exploration sites on water or on agricultural lands can be accessed by suitable vehicles, but all other construction sites will require road access. All-weather roads (asphalt paved) will be needed for year-round construction at all facilities, while dry-weather roads (minimum 12 inch thick gravel or asphalt paved) can be used for construction activities restricted to the dry season. Heavy construction equipment, such as diesel-powered dozers, excavators, rollers, dump trucks, fuel trucks, and water trucks will be used during excavation, grading, and construction of access/haul roads. Detour roads will be needed for all intakes and for traffic circulation around the work areas. Temporary barge unloading facilities will be constructed, used, and decommissioned.

Temporary concrete batch plants will be needed due to the large amount of concrete required for construction and the schedule demands of the PA. A temporary batch plant is proposed for each TBM launch shaft and TBM retrieval shaft location. Since there is no TBM launch shaft or TBM retrieval shaft at the site of the HORG, no concrete batch plant will be sited at the HORG. The area required for these plants will be within the construction footprint for these facilities but precise facility siting within the construction site has not yet been determined. Other facilities to be co-located with concrete batch plants within the construction site footprints will include fuel stations, pug mills, soil mixing facilities, cement storage, and fine and coarse aggregate storage. Fuel stations will be needed for construction equipment. Pug mills will be needed for generating processed soil materials used at the various sites. Soil mixing facilities will be needed for some of the muck disposal and for ground improvement activities. Cement and required admixtures will be stored at each site to support concrete, slurry walls, ground improvement, soil mixing, and other similar needs. TBM launch sites may also contain facilities that produce precast tunnel segments. If constructed, these will be located adjacent to concrete plants, and will also be within the construction site footprint. It is likely that each precast segment plant would require approximately 10 acres for offices, concrete plant, materials storage, and casting facilities.

All storage and processing areas will be properly contained as required for environmental and regulatory compliance. In addition, work at all sites will be required to comply with terms of all applicable AMMs.

Common Construction-Related Activities

Clearing

Essentially all lands within the temporary and permanent impact footprint are assumed to be cleared; the only exceptions are lands that are underlain by a structure (TBM-excavated tunnels), or that are beneath a structure (electrical transmission line wires, between the towers), or that are underwater (in association with the Delta intakes, the CCF, the Banks and Jones connections, and the HORG). Grading will be performed where required by the project design. Clearing and grading will be performed using standard equipment such as bulldozers. Topsoil from cleared areas will be stockpiled and reused at the close of construction.

Site Work

Site work will occur within previously cleared areas. It will include construction of site access, establishment of stockpiles and staging and storage areas, site fencing, onsite electric (such as a substation), and erection of temporary construction buildings (primarily offices and storage). Equipment used during site work mainly will include large vehicles and vehicle-mounted equipment such as cranes, which have the potential to elevate noise and light levels. Performance of site work will entail the risk of spills associated with vehicles and with materials transport, and the potential for localized erosion or stormwater dispersal of fuel, motor oil, etc. leaked from equipment.

Ground Improvement

Ground improvement will occur within previously cleared areas. Ground improvement serves to improve existing substrates at a site so that they can bear heavy loads and otherwise support the design of the proposed construction. Activities performed in ground improvement will include drilling, and injection of materials. Ground improvement commonly will occur in association with grading and dewatering. Improved ground will remain in place for the duration of the PA and thereafter. Equipment used in ground improvement will include large vehicle-mounted drilling and injection equipment with potential to create noise and light comparable to other construction equipment. Performance of ground improvement will entail the risk of spills associated with vehicles and with materials transport.

Borrow Fill

The total amount of borrow material for engineered fill used in all aspects of the PA will be approximately 21 million cy (as bank cubic yards). This total amount will include approximately 3 million cy for tunnel shaft pads, 6.5 million cy for the CCF embankments, 2 million cy for the IF embankments, 6.7 million cy at the three intake sites (approximately 2 million cy each), and 2.6 million cy at the CCPP site. Source locations for this borrow material will generally be within the work area footprint shown in CWF BA Appendix 3.A, *Map Book for the Proposed Action*. CWF BA Appendix 3.B, *Conceptual Engineering Report, Volume 1*, Section 21, *Borrow Sites*, describes the criteria for selection of borrow sites and identifies suitable geological materials that could be used as sources of borrow material. Apart from engineering specifications, the criteria for selection of borrow sites will include the following: (1) borrow material should not require post-excavation processing (other than wetting), (2) borrow material should be exposed at surface and require no, or very limited, overburden removal, and (3) borrow areas should be selected to minimize the impact or encroachment on existing surface and subsurface development and environmentally sensitive areas as much as possible.

Fill to Flood Height

Permanent levees, embankments, and fills on which structures are sited at the intakes, the IF, the CCPP, and the Banks and Jones connections, will be filled to the design flood height, which is the level of the 0.5% annual exceedance flood (*i.e.*, the 200-year flood), plus an 18-inch allowance for sea level rise. Since current ground elevations at most of the construction sites are at or slightly below sea level, substantial volumes of material will be needed to construct these fills, and the weight of this material will cause substantial compaction and settling in the underlying ground. Compaction and settling will be addressed by ground improvement and dewatering wells, which are used to reduce hydraulic pressure within the sediments and accelerate the rate of compaction.

Fills to flood height will occur at sites that have previously been cleared. The fill material will be sourced from borrow sites and transported using conventional earthmoving equipment, or possibly conveyors if the distances involved are short and are entirely within the area cleared for facility construction. Performance of this work will entail the risk of spills associated with vehicles and with materials transport, and the potential for erosion or stormwater effects associated with cleared areas.

Dispose Spoils

Spoils will include materials removed from the construction area and placed for nonstructural purposes. The principal sources of spoils will be materials removed during excavation of tunnels (RTM) and dredging of the CCF. Secondary sources will include structural excavations during facilities construction. Table 6.2-4 provides key construction information on spoils and reusable tunnel material storage.

RTM is the by-product of tunnel excavation using a TBM. The RTM will be a plasticized mix consisting of soil cuttings, air, water, and may also include soil conditioning agents. Soil conditioning agents such as foams, polymers, and bentonite may be used to make soils more suitable for excavation by a TBM. Soil conditioners are non-toxic and biodegradable. During tunnel construction the daily volume of RTM withdrawn at any one shaft location will vary, with an average volume of approximately 6,000 cubic yards per day. It is expected that the transport of the RTM out of the tunnels and to the RTM storage areas will be nearly continuous during mining or advancement of the TBM. The RTM will be carried on a conveyor belt from the TBM to the base of the launch shaft. The RTM will be withdrawn from the tunnel shaft with a vertical conveyor and placed directly into the RTM work area using another conveyor belt system. From the RTM work area, the RTM will be roughly segregated for transport to RTM storage and water treatment (if required) areas as appropriate. CWF BA Appendix 3.A, *Map Book for the Proposed Action*, Sheets 1–5 and 7–15 show conveyor belt and RTM storage area locations.

RTM must be dewatered in order to stabilize it for long-term placement in a storage area. Atmospheric drying by tilling and rotating the material, combined with subsurface collection of excess liquids will typically be sufficient to render the material dry and suitable for long-term storage or reuse. Leachate will drain from ponds to a leachate collection system, then be pumped to leachate treatment ponds for possible additional treatment. Disposal of the RTM decant liquids will require permitting in accordance with NPDES and Regional Water Quality Control Board regulations. A retaining dike and underdrain liquid collection system (composed of a berm of compacted soil, gravel and collection piping, as described below), will be built at each RTM storage area. The purpose of this berm and collection system will be to contain any liquid runoff from the drying material. The dewatering process will consist of surface evaporation and draining through a drainage blanket consisting of rock, gravel, or other porous drain material. The drainage system will be designed per applicable permit requirements. Treatment of liquids (primarily water) extracted from the material could be done in several ways, including conditioning, flocculation, settlement/sedimentation, and/or processing at a package treatment plant to ensure compliance with discharge requirements.

Designated spoils storage areas are shown in the map book, CWF BA Appendix 3.A, *Map Book for the Proposed Action*. RTM will be the largest source of this material, and disposition of that material will be, on an acreage basis, one of the largest impacts of the PA (see Table 6.2-5). Dredged material from the CCF will be the second largest source of spoils.

Table 6.2-4. Spoils and Reusable Tunnel Material storage: key construction information.

• Final locations for storage of spoils, RTM, and dredged material will be selected based on the guidelines presented in *AMM6 Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material* (CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*). • Conventional earthmoving equipment, such as bulldozers and graders, would be used to place the spoil. Some spoil, with the exception of RTM, may be placed on the land-side toes of canal embankments and/or setback levees. • Spoils may temporarily be placed in borrow pits or temporary spoil laydown areas pending completion of embankment or levee construction. Borrow pits created for this project will be the preferred spoil location. • RTM that may have potential for re-use in the PA (such as levee reinforcement, embankment or fill construction) will be stockpiled. The process for testing and reuse of this material is described further in *AMM6 Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material* (CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*). • A berm of compacted imported soil will be built around the perimeter of the RTM storage area to ensure containment. The berm will conform to Corps guidelines for levee design and construction. • RTM will be stacked to an average depth of 10 ft; precise stacking depth will vary across disposal sites. • Maximum capacity of RTM storage ponds will be less than 50 af. • RTM areas may be subdivided by a grid of interior earthen berms in RTM ponds for dewatering. • Dewatering will involve evaporation and a drainage blanket of 2 ft-thick pea gravel or similar material placed over an impervious liner. • Leachate will drain from ponds to a leachate collection system, then be pumped to leachate ponds for possible additional treatment. • Transfer of RTM solids to disposal areas may be handled by conveyor, wheeled haul equipment, or barges, at the contractor's discretion. • Where feasible, the invert of RTM ponds will be a minimum of 5 ft above seasonal high groundwater table. • An impervious liner will be placed on the invert and along interior slopes of berms, to prevent groundwater contamination. • RTM will not be compacted. • Spoil placed in disposal areas will be placed in 12-inch lifts, with nominal compaction. • The maximum height for placement of spoil is expected to be 6 ft above preconstruction grade (10 ft above preconstruction grade for sites adjacent to CCF), and have side slopes of 5H:1V or flatter. • After final grading of spoil is complete, the area will be restored based on site-specific conditions following project restoration guidelines.

Table 6.2-5. Spoils disposition, volumes and acreages.

Disposal Site	Volume (cy)	Disposal Area (acres)
RTM and dredged material disposal site near Intake 2	1,020,000	45.6
RTM disposal sites near IF	9,060,000	404.7
RTM disposal site on Bouldin Island	8,340,000	1,208.8
RTM and dredged material disposal sites near CCF	5,370,000 (RTM) 7,000,000 (dredged)	899.6
TOTAL	**30,790,000**	**2,558.7**

RTM is expected to be reusable tunnel material, suitable as engineered fill for varied applications, and also suitable for restoration work such as tidal habitat restoration. However, end uses for that material have not yet been identified. It is likely that the material will remain in designated storage areas for a period of years before a suitable end use is identified, and any such use will be subject to environmental evaluation and permitting independent of the PA. Therefore disposition of RTM is assumed to be permanent, and future reuse of this material is not part of the PA.

Materials removed during surface excavation and dredging, or from clearing of the sedimentation basins, may also be reusable. As with RTM, no end uses for this material have yet been identified, such use is not part of the PA, and the material will be permanently disposed in the designated RTM and dredged material storage areas. The exception to this statement is topsoil removed during clearing for construction. Topsoil is not classified as spoils; it will be stockpiled and reused for landscaping and restoration.

Dewatering

Due to the generally high groundwater table in the Delta, the location of much of the construction alignment at below-sea-level elevations, and the extensive construction of below-grade structures, dewatering will be needed for nearly all components of conveyance construction. "Dewatering" as used in this document refers to the removal of water from a work area or from excavated materials, and discharge of the removed water to surface waters in accordance with the terms and conditions of a valid NPDES permit and any other applicable CVRWQCB requirements.

Dewatering will generally be accomplished using electrically powered pumps, which will either dewater via groundwater wells (thereby drawing down the water table to minimize the amount of water entering a work area) or by direct removal of water from an excavation or other work area (such as pumping water out of a cofferdam or the bottom of a tunnel access shaft). Dewatering of excavated materials would be accomplished in a similar manner, by stockpiling the material and allowing the water to infiltrate to an impervious layer such as a liner or the bottom of a storage tank, and then pumping or draining it prior to treatment or discharge. At most conveyance facilities, dewatering will be an ongoing activity throughout most of the period of construction activity.

The water removed during dewatering is subject to contamination. These waters will be stored in sedimentation tanks; tested for contaminants and treated in accordance with permit requirements before being discharged to surface waterways. Treatment needs for pumped groundwater have not yet been determined and could include conditioning, flocculation, settlement/sedimentation, and/or processing at a package treatment plant. Velocity dissipation structures, such as rock or grouted riprap, will be used to prevent scour where treated water is discharged back to the Delta. Location of dewatering discharge points will be determined at time of filing for coverage under the NPDES general permit or before start-up of discharge as appropriate. Additional information will be developed during design and the contractor will be required to comply with permit requirements.

Dredging and Riprap Placement

For the purposes of this consultation, dredging and riprap placement are defined to be activities that occur in fish-bearing waters. This definition thus excludes, for instance, dredging that occurs in the sedimentation basins at the intakes, or riprap placement that occurs in a dewatered area. Dredging is subject to constraints imposed by the Federal permit for the activity. Riprap placement would also comply with relevant NPDES and SWRCB requirements; and with the proposed in-water work windows.

Barge Landing Construction and Barge Traffic

Contractors will use barges to deliver TBM components to TBM launch sites, and may also use barges to deliver other heavy or bulky equipment or materials to those sites, or to haul such materials from those sites. This activity will include the construction of barge landings, barge operations in the river, tug operations, and the eventual removal of the barge landings when construction is completed. Barge landings will be needed at these seven locations:

- Snodgrass Slough north of Twin Cities Road (adjacent to proposed IF)
- Little Potato Slough (Bouldin Island south)
- San Joaquin River (Venice Island south)
- San Joaquin River (Mandeville Island east at junction with Middle River)
- Middle River (Bacon Island north)
- Middle River (Victoria Island northwest)
- Old River (junction with West Canal at CCF)

Locations of the barge landings are shown in CWF BA Appendix 3.A, *Map Book for the Proposed Action*, CWF BA Chapter 6 page 6-22, and item no. 101 of the *BiOp Resolution Log* (CWF 2016). The *BiOp Resolution Log* also provides additional information related to barge traffic routes, including frequency and duration of travels. Locations are approximate; precise siting and dimensions of these docks are to be determined by DWR's construction contractors. To minimize potential effects to fish species, plans will be developed for materials that can be transported by truck or rail to launch and retrieval points along the proposed tunnel alignment. This includes investigating the potential of using rail to deliver materials and components to the Stockton and the CCF locations. See the CWF BA for further points characterizing the barge landings and barge uses.

Landscaping and Associated Activities

The construction phase at most conveyance facilities will conclude with landscaping. Revegetation of disturbed areas will be determined in accordance with guidance given by DWR's Water Resources Engineering Memorandum (WREM) Number (No.) 30a, Architectural Motif, State Water Project and through coordination with local agencies through an architectural review process. Landscaping in cleared areas will reuse topsoil stockpiled at the time of site clearing. Site revegetation plans will be developed for restoration of areas disturbed by PA activities.

Other activities occurring at the conclusion of construction will include site cleanup, installation of operational lighting, and installation of security fencing. Site cleanup will consist of removal of all construction equipment, materials, and debris from the site. Construction debris will be disposed at a regional facility authorized to receive such materials. The Sacramento River intakes, the IF, the consolidated pumping plant at CFF, and the HORG will be provided with security fencing to prevent unauthorized public access.

Operational lighting will be needed at the intakes, the IF, the consolidated pumping plant at CCF, at the HORG, and at the control structures associated with the Banks and Jones connections; operational lighting will also continue to be provided at the existing CVP and SWP facilities. Lighting for the proposed facilities will be designed in accordance with guidance given by DWR's WREM No. 30a, Architectural Motif, State Water Project and through coordination with local agencies through an architectural review process.

Pile Driving

Sheet pile and tubular steel pile driving will be required for intake construction, barge landing construction, embankment work at CCF, the Banks and Jones connections, and construction of the HORG. Both vibratory and impact pile driving are expected to occur at each of these locations, as structural requirements call for impact pile driving to refusal.

For all sheet pile cofferdams proposed at the Delta intakes, CCF, and HORG, it is assumed that approximately 70% of the length of each pile can be placed using vibratory pile driving, with impact driving used to finalize pile placement. Piles will be installed using vibratory methods or other non-impact driving methods for the intakes, wherever feasible, to minimize adverse effects on fish and other aquatic organisms. However, the degree to which vibratory driving can be performed effectively is unknown at this time due to as yet undetermined geologic conditions at the construction sites. The remaining pile driving would be conducted using an impact pile driver. Once constructed, if the foundation design for either the Delta intakes or HORG requires pile driving, such work would be conducted from within the cofferdam; it is still undetermined if the foundation would use piles or concrete-in-drilled-hole methods, which does not require pile driving. If driven foundation piles are included in the design, DWR will require contractors to isolate pile driving activities within dewatered cofferdams.

The barge landings would require pile driving of 24-inch tubular steel piles in the water. DWR will work with contractors to minimize pile driving, particularly impact pile driving. If dock piles for barge landings cannot be installed using vibratory methods, the construction contractor will use a bubble curtain or other attenuation device to minimize underwater noise.

Table 6.2-6 shows the approximate channel widths, timing, and duration of pile driving for each facility or structure where pile driving is proposed to occur in open water or on land within 200 ft of open water.

Table 6.2-6. Pile driving sites and durations.

Facility or Structure	Average Width of Water Body (ft)	Year of Construction	Duration of Pile Driving (days)[1]
Intake 2 Cofferdam	700	Year 8	42
Intake 2 Foundation	700	Year 9	19
Intake 3 Cofferdam	500	Year 7	42
Intake 3 Foundation	500	Year 8	14
Intake 5 Cofferdam	600	Year 5	42
Intake 5 Foundation	600	Year 6	19
Barge Landings	265 – 1,030	Year 1 - 3[2]	2
CCF Cofferdams	10,500	Year 9 - 10	85
NCCF Siphon	10,500	Year 6 - 7	36
HORG Cofferdams	150	Year 3 - 4	19
HORG Foundation	150	Year 3 - 4	4

Notes
[1] Indicates number of days required for one pile driver. Work may be completed more quickly if multiple pile driving rigs operate concurrently.
[2] Two years of pile driving per site; three years to complete pile driving at all facilities.

Contra Costa Water District Settlement Agreement Facility Construction and Operation

DWR and CCWD entered into the Agreement for Mitigation of Impacts to CCWD from Construction and Operation of the BDCP/CWF (Agreement) effective March 24, 2016. The mitigation measures required as part of the agreement include the conveyance of water to CCWD that meets specified water quality requirements, in quantities and on a schedule defined in the Agreement. The Agreement ensures that the quality of the water CCWD delivers to its customers is not impacted as a result of the BDCP/CWF. The Agreement does not increase the total amount of water that CCWD would otherwise divert, nor does it change the operational criteria presented in section 3.3 of the CWF BA, or the permitted operational criteria of the Freeport intake.

The water associated with the agreement would be conveyed to CCWD in one of two ways: (1) the primary method of conveying the water, when capacity is available, would be through the existing Freeport Regional Water Authority Intake (Freeport Intake) and the existing interconnection between East Bay Municipal Utility District's Mokelumne Aqueduct and CCWD's Los Vaqueros Pipeline, and (2) the secondary method of conveying the water, triggered under certain conditions, would be through a new Interconnection Facility between the CWF water conveyance facilities and existing CCWD facilities. Two different options for the new Interconnection Facility are being considered: either on Victoria Island between the water conveyance facilities and the existing CCWD Middle River pipeline; or at CCF between the CCF and the CCWD Los Vaqueros pipeline. No new facilities are required for the East Bay Municipal

Utility District/Freeport Intake conveyance method.

The Interconnection Facility on Victoria Island would consist of the following components: (1) a direct connection to the water conveyance facility, pumping station and appurtenant facilities (Victoria Island Interconnection Pump Station) with capacity to convey water at a normal operating capacity of up to 250 cfs, and with sufficient pressure for the water to reach CCWD's existing Transfer Pump Station while the Old River Pipeline is operating at a total flow rate of up to 320 cfs, (2) a pipeline and appurtenant facilities with a normal operating capacity of up to 250 cfs to convey water from the Interconnection Pump Station on Victoria Island to CCWD's existing Middle River Pipeline (Victoria Island Interconnection Pipeline), (3) a valve between the Interconnection Pipeline and CCWD's Middle River Pipeline (Victoria Island Interconnection Valve), and (4) all instrumentation and communication equipment needed for CCWD to remotely monitor all Interconnection Facility.

The Interconnection Facility from CCF would consist of the following components: (1) a direct connection to the CCF, pumping station and appurtenant facilities (Clifton Court Interconnection Pump Station) with capacity to convey water to CCWD's Old River Pipeline at a normal operating capacity of up to 250 cfs, and with sufficient pressure for the water to reach CCWD's existing Transfer Pump Station while the Old River Pipeline is operating at a total flow rate of up to 320 cfs, (2) a pipeline and appurtenant facilities with a normal operating capacity of up to 250 cfs to convey water from the Interconnection Pump Station at CCF to CCWD's existing Transfer Pump Station (Clifton Court Interconnection Pipeline), (3) a valve between the Interconnection Pump Stations and the Interconnection Pipeline (Clifton Court Interconnection Valve), and (4) all instrumentation and communication equipment needed for CCWD to remotely monitor the Interconnection Facility.

The Agreement does not increase the total amount of water that CCWD would otherwise divert, nor does it change the operational criteria presented in section 3.3 of the BA, or the permitted operational criteria of the Freeport intake. Under the Agreement, CCWD would take the same quantity of water that it would take absent the agreement, but the location and timing of diversions would change. Annual average diversions of Agreement water would be on the order of 30 TAF, far smaller than the total diversions through the new water conveyance facility, and the maximum rate of diversion of the Agreement water would be 250 cfs, far smaller than the diversion capacity of the new conveyance facility.

Conservation Measures

This section is intended to articulate the general construction and species-specific AMMs during construction. DWR will ground-truth impact areas prior to initiating proposed actions to determine the extent of suitable habitat present. After work is complete, DWR will field-verify the impacts that have actually occurred with implementation of AMMs. DWR will track predicted and actual impacts at each project site and provide that information in annual compliance reporting (outlined in Chapter 3, Section 3.7.4.2 of the CWF BA).

General Avoidance and Minimization Measures

CWF BA Appendix 3.4 describes the general AMMs to reduce or avoid adverse effects to listed species that may result from the PA. Table 6.2-7 briefly summarizes the measures below. Refer to CWF BA Appendix 3.F for detailed descriptions.

Table 6.2-7. Summary of the general Avoidance and Minimization Measures.

Number	Title	Summary
AMM1	Worker Awareness Training	Includes procedures and training requirements to educate construction personnel on the applicable environmental rules and regulations, the types of sensitive resources in the project area, and the measures required to avoid and minimize effects on these resources. All attendees will sign an attendance sheet along with their printed name, company or agency, email address, and telephone number. The original sign-in sheet will be sent to the Service within 7 calendar days of the completion of the training.
AMM2	Construction Best Management Practices and Monitoring	Standard practices and measures that will be implemented prior to, during, and after construction to avoid or minimize effects of construction activities on sensitive resources (*e.g.*, species, habitat), and monitoring protocols for verifying the protection provided by the implemented measures.
AMM3	Stormwater Pollution Prevention Plan	Includes measures that will be implemented to minimize pollutants in stormwater discharges during and after construction, and that will be incorporated into a stormwater pollution prevention plan to prevent water quality degradation related to project area runoff to receiving waters.
AMM4	Erosion and Sediment Control Plan	Includes measures that will be implemented for ground-disturbing activities to control short-term and long-term erosion and sedimentation effects and to restore soils and vegetation in areas affected by construction activities, and that will be incorporated into plans developed and implemented as part of the NPDES permitting process for covered activities.
AMM5	Spill Prevention, Containment, and Countermeasure Plan	Includes measures to prevent and respond to spills of hazardous material that could affect navigable waters, as well as emergency notification procedures.
AMM6	Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material	Includes measures for handling, storage, and disposal of excavation or dredge spoils and reusable tunnel material, including procedures for the chemical characterization of this material or the decant water to comply with permit requirements, and reducing potential effects on aquatic habitat, as well as specific measures to avoid and minimize effects on species in the areas where reusable tunnel material would be used or disposed.
AMM7	Barge Operations Plan	Includes measures to avoid or minimize effects on aquatic species and habitat related to barge operations by establishing specific protocols for the operation of all project-related vessels at the construction and/or barge landing sites. Also includes monitoring protocols to verify

		compliance with the plan and procedures for contingency plans.
AMM8	Fish Rescue and Salvage Plan	Includes measures that detail procedures for fish rescue and salvage to avoid and minimize the number of Chinook salmon, steelhead, green sturgeon, and other listed species of fish stranded during construction activities, especially during the placement and removal of cofferdams at the intake construction sites.
AMM9	Underwater Sound Control and Abatement Plan	Includes measures to minimize the effects of underwater construction noise on fish, particularly from impact pile driving activities. Potential effects of pile driving will be minimized by restricting work to the least sensitive period of the year and by controlling or abating underwater noise generated during pile driving.[16]
AMM10	Methylmercury Management	Design and construct wetland mitigation sites to minimize ecological risks of methylmercury production.
AMM11	Design Standards and Building Codes	Ensure that the standards, guidelines, and codes, which establish minimum design criteria and construction requirements for project facilities, will be followed. Follow any other standards, guidelines, and code requirements that are promulgated during the detailed design and construction phases and during operation of the conveyance facilities.
AMM12	Transmission Line Design and Alignment Guidelines	Design the alignment of proposed transmission lines to minimize impacts on sensitive terrestrial and aquatic habitats when siting poles and towers. Restore disturbed areas to preconstruction conditions. In agricultural areas, implement additional BMPs. Site transmission lines to avoid greater sandhill crane roost sites or, for temporary roost sites, relocate roost sites prior to construction if needed. Site transmission lines to minimize bird strike risk.
AMM13	Noise Abatement	Develop and implement a plan to avoid or reduce the potential in-air noise impacts related to construction, maintenance, and operations.
AMM14	Hazardous Material Management	Develop and implement site-specific plans that will provide detailed information on the types of hazardous materials used or stored at all sites associated with the water conveyance facilities and required emergency-response procedures in case of a spill. Before construction activities begin, establish a specific protocol for the proper handling and disposal

[16] Proposed in-water work windows vary within the Delta: June 1 through October 31 at the NDD, July 1 through November 30 at the CCF, and August 1 through November 30 at the HORG and October 31 at the barge landings. Specific in-water work windows for pile driving are below. NDD work window for pile installation using impact hammers: June 15 through September 15, with ability to extend based on success of bubble curtain and robust real-time monitoring for fish presence. Mobilization and demobilization are not included within the work window. Impact pile installation could continue between June 1 through June 15 and September 16 through October 31 in the dewatered cofferdam outside the above shortened work window with in-channel acoustic monitoring required to verify that generated sound thresholds do not exceed the behavioral criteria thresholds. Except impact pile driving, all other work including drilled shaft (also known as cast-in-drilled hole piles) construction could continue in the dewatered cofferdam outside the above referenced work windows. Any extension/reduction of work windows would focus on half-month increments. Impact pile driving window at barge landing sites: July 1 through August 3. Pile driving window at CCF: July 1 through October 31; however, mobilization and demobilization could continue to occur outside this window.

		of hazardous materials.
AMM15	Construction Site Security	Provide all security personnel with environmental training similar to that of onsite construction workers, so that they understand the environmental conditions and issues associated with the various areas for which they are responsible at a given time.
AMM16	Fugitive Dust Control	Implement basic and enhanced control measures at all construction and staging areas to reduce construction-related fugitive dust and ensure the project commitments are appropriately implemented before and during construction, and that proper documentation procedures are followed.
AMM17	Notification of Activities in Waterways	Before in-water construction or maintenance activities begin, notify appropriate agency representatives when these activities could affect water quality or aquatic species.

Delta Smelt

DWR proposes to implement varying in-water work windows for components of the PA. Table 6.2-8 provides a breakdown of the proposed timing for in-water work for the various preconstruction and construction phases.

Table 6.2-8. Proposed timing for in-water work during the preconstruction and construction phases.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CWF Conveyance System Components												
Geotechnical Explorations								■	■	■		
Barge Landings							■	■				
North Delta Diversions*						■	■	■	■	■		
Tunneled Conveyance	No proposed in-water work											
Intermediate Forebay	No proposed in-water work											
Clifton Court Forebay							■	■	■	■		
Connections to the Jones Pumping Plant							■	■	■	■		
Power Supply and Grid Connections	No proposed in-water work											
Head of Old River Gate								■	■	■		
Temporary Access and Work Areas	No proposed in-water work											

* Impact pile driving will be restricted to June 15 to September 15, with the ability to extend (up to October 31) based on success of bubble curtain and robust real-time monitoring for fish presence.

Riparian Brush Rabbit

1. DWR will implement the following measures to avoid and minimize noise and lighting related effects on riparian brush rabbit:
   a. Establish a 1,200-ft no disturbance buffer between any project activities and suitable habitat.
   b. Establish a 1,400-ft buffer between any lighting and pile driving and suitable habitat.
   c. Screen all lights and direct them down toward work activities away from potential occupied habitat. A Service-approved biologist will ensure that lights are properly directed at all times.
   d. Operate portable lights at the lowest allowable wattage and height, while in accordance with the National Cooperative Highway Research Program's *Report 498: Illumination Guidelines for Nighttime Highway Work.*
   e. Limit construction during nighttime hours (10:00 p.m. to 7:00 a.m.) such that construction noise levels do not exceed 50 dBA (A-weighted decibel) L_{max} at the nearest residential land uses.
   f. Limit pile driving to daytime hours (7:00 a.m. to 6:00 p.m.).

2. Geotechnical exploration for the PA will not occur in or near riparian brush rabbit suitable riparian habitat.

3. Power supply and grid connections for the PA will not occur within or near riparian brush rabbit suitable riparian habitat.

4. Restoration activities for the PA will not occur within riparian brush rabbit suitable riparian habitat, or within 100 ft of such habitat.

San Joaquin Kit Fox

Conservation Measures for Geotechnical Explorations

1. Geotechnical work in and within 200 ft of San Joaquin kit fox habitat will be limited to daytime hours.

2. Vehicles will access the work site following the shortest possible route from the levee road. All site access and staging shall limit disturbance to the riverbank or levee as much as possible and avoid sensitive habitats. When possible, existing ingress and egress points shall be used. The Service-approved biologist for San Joaquin kit fox will survey the sites for San Joaquin kit fox no less than 14 days and no more than 30 days prior to beginning of geotechnical exploration activities.

3. Project activities will not take place at night when San Joaquin kit foxes are most active.

4. Off-road traffic outside of designated project areas will be prohibited.

5. A Service-approved biologist will be stationed near the work areas to assist the construction crew with environmental issues as necessary. If San Joaquin kit foxes are encountered by a Service-approved biological monitor during construction, activities shall cease until appropriate corrective measures have been completed or it has been determined that the species will not be harmed.

6. To prevent inadvertent entrapment of San Joaquin kit foxes or other animals during the construction phase of a project, all excavated, steep-walled holes or trenches more than 2 ft (0.6 m) deep will be covered at the close of each working day by plywood or similar materials, or provided with one or more escape ramps constructed of earth fill or wooden planks. Before such holes or trenches are filled, they will be thoroughly inspected for trapped animals.

7. All construction pipes, culverts, or similar structures with a diameter of 4 inches (10 cm) or greater that are stored at a construction site for one or more overnight periods should be thoroughly inspected for San Joaquin kit foxes before the pipe is used or moved in any way. If a San Joaquin kit fox is discovered inside a pipe, construction activities will be halted and that section of pipe will not be moved until the Service-approved biologist monitoring the project construction site has contacted the Service. Once the Service has given the construction monitor instructions on how to proceed or the San Joaquin kit fox has escaped on its own volition, the pipe may be moved.

8. No firearms will be allowed at the worksite except for those carried by authorized security personnel, or local, State, or Federal law enforcement officials.

9. Noise will be minimized to the extent possible at the work site to avoid disturbing San Joaquin kit foxes.

10. To prevent harassment, mortality of San Joaquin kit foxes or damage of dens by dogs or cats, no pets are permitted on project sites.

11. Rodenticides and herbicides will not be used during geotechnical exploration.

12. If a San Joaquin kit fox is incidentally injured or killed or entrapped, the Service-approved biological monitor shall immediately report the incident to the Service. Notification must include the date, time, and location of the incident or of the finding of a dead or injured animal and any other pertinent information.

Conservation Measures for Construction Activities

13. Within 14 to 30 days prior to ground disturbance related to PA activities, a Service-approved biologist with experience surveying for and observing the species will conduct preconstruction surveys in those areas identified as having suitable habitat per the habitat model described in Section 4.A.6.6, *Suitable Habitat Definition*, of the CWF BA or per the recommendation of the Service-approved biologist. The Service-approved biologist will survey the worksite footprint and the area within 200 ft beyond the footprint to

identify known or potential San Joaquin kit fox dens. Adjacent parcels under different land ownership will not be surveyed unless access is granted within the 200-ft radius of the construction activity. The Service-approved biologists will conduct these searches by systematically walking 30- to 100-ft-wide transects throughout the survey area; transect width will be adjusted based on vegetation height and topography (Service 1999). The Service-approved biologist will conduct walking transects such that 100% visual coverage of the worksite footprint is achieved. Dens will be classified in one of the following four den status categories outlined in the *Standardized Recommendations for Protection of the Endangered San Joaquin Kit Fox Prior to or During Ground Disturbance*[17]. Written results of the surveys will be submitted to Service within five calendar days of the completion of surveys and prior to the beginning of ground disturbance and/or construction activities in San Joaquin kit fox modeled habitat. Also, the Service-approved biologist will flag all potential small mammal burrows within 50 ft of the worksite to alert biological and work crews of their presence.

a. Potential den - Any subterranean hole within the species' range that has entrances of appropriate dimensions for which available evidence is sufficient to conclude that it is being used or has been used by a San Joaquin kit fox. Potential dens comprise any suitable subterranean hole or any den or burrow of another species (*e.g.*, coyote, badger, red fox, or ground squirrel) that otherwise has appropriate characteristics for San Joaquin kit fox use. If a potential den is found, the Service-approved biologist will establish a 50-ft buffer using flagging.

b. Known den - Any existing natural den or artificial structure that is used or has been used at any time in the past by a San Joaquin kit fox. Evidence of use may include historical records; past or current radio telemetry or spotlighting data; San Joaquin kit fox sign such as tracks, scat, and/or prey remains; or other reasonable proof that a given den is being or has been used by a San Joaquin kit fox. If there is a known den in the action area, the Service-approved biologist will establish a 100-ft buffer using fencing.

c. Natal or pupping den - Any den used by San Joaquin kit foxes to whelp and/or rear their pups. Natal/ pupping dens may be larger with more numerous entrances than dens occupied exclusively by adults. These dens typically have more San Joaquin kit fox tracks, scat, and prey remains near the den and may have a broader apron of matted dirt and/or vegetation at one or more entrances. A natal den, defined as a den in which San Joaquin kit fox pups are actually whelped but not necessarily reared, is a more restrictive version of the pupping den. In practice, however, it is difficult to distinguish between the two; therefore, for

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[17] The guidelines can be accessed at: https://www.fws.gov/sacramento/es/survey-protocols-guidelines/Documents/kitfox_standard_rec_2011.pdf

purposes of this definition, either term applies. If a natal den is discovered, a buffer of at least 200 ft will be established using fencing.

d. Atypical den - Any artificial structure that has been or is being occupied by a San Joaquin kit fox. Atypical dens may include pipes, culverts, and diggings beneath concrete slabs and buildings. If an atypical den is discovered, the Service-approved biologist will establish a 50-ft buffer using flagging.

14. If an atypical, natal, known or potential San Joaquin kit fox den is discovered at the worksite, the den will be monitored for three days by a Service-approved biologist using a tracking medium or an infrared beam camera to determine if the den is currently being used.

15. Unoccupied potential, known, or atypical dens will be destroyed immediately to prevent subsequent use. The den will be fully excavated by hand, filled with dirt, and compacted to ensure that San Joaquin kit foxes cannot re-enter or use the den during the construction period.

16. If an active natal or pupping den is found, the Service will be notified immediately. The den will not be destroyed until the pups and adults have vacated and then only after further coordination with Service. All known dens will have at least a 100-ft buffer established using fencing.

17. If San Joaquin kit fox activity is observed at the potential, known, or atypical den during the preconstruction surveys, den use will be actively discouraged, as described below, and monitoring will continue for an additional five consecutive days from the time of the first observation to allow any resident animals to move to another den. For dens other than natal or pupping dens, use of the den can be discouraged by partially plugging the entrance with soil such that any resident animal can easily escape. Once the den is determined to be unoccupied, it may be excavated under the direction of the Service-approved biologist. Alternatively, if the animal is still present after five or more consecutive days of plugging and monitoring, the den may have to be excavated by hand when, in the judgment of a Service-approved biologist, it is temporarily vacant (*i.e.*, during the animal's normal foraging activities). If at any point during excavation a San Joaquin kit fox is discovered inside the den, the excavation activity will cease immediately and monitoring of the den, as described above, will be resumed. Collapsing of the den may be completed when, in the judgment of the Service-approved biologist, the animal has escaped from the partially destroyed den.

18. Construction and operational requirements from *Standardized Recommendations for Protection of the San Joaquin Kit Fox prior to or during Ground Disturbance* or the latest guidelines will be implemented. The guidelines can be accessed at: https://www.fws.gov/sacramento/es/survey-protocols-guidelines/Documents/kitfox_standard_rec_2011.pdf

19. If potential, known, atypical, or natal or pupping dens are identified at the worksite or within a 200-ft buffer, exclusion zones around each den entrance or cluster of entrances will be demarcated. The configuration of exclusion zones will be circular, with a radius measured outward from the den entrance(s). No activities will occur within the exclusion zones. Exclusion zone radii for atypical dens and suitable dens will be at least 50 ft and will be demarcated with four to five flagged stakes. Exclusion zone radii for known dens will be at least 100 ft and will be demarcated with fencing that encircle each den or cluster of dens but do not prevent access to the den by the foxes.

20. Vehicles will observe a daytime speed limit of 20-mph throughout the worksite, where it is practical and safe to do so, except on county roads and State and Federal highways; vehicles will observe a nighttime speed limit of 10-mph throughout the worksite; this is particularly important at night when San Joaquin kit foxes are most active. Nighttime construction in or adjacent to San Joaquin kit fox habitat will be minimized to the greatest extent practicable.

21. To prevent inadvertent entrapment of kit foxes or other animals during construction, all excavated, steep-walled holes or trenches more than 2 ft deep will be covered at the close of each working day by plywood or similar materials. If the trenches cannot be closed, one or more escape ramps constructed of earthen-fill or wooden planks will be installed. Before such holes or trenches are filled, they will be thoroughly inspected for trapped animals. If at any time a trapped or injured kit fox is discovered, the Service will be contacted.

22. San Joaquin kit foxes are attracted to den-like structures such as pipes and may enter stored pipes and become trapped or injured. All construction pipes, culverts, or similar structures with a diameter of 4 inches or greater that are stored at a construction site within suitable San Joaquin kit fox habitat for one or more overnight periods will be thoroughly inspected for San Joaquin kit foxes before the pipe is subsequently buried, capped, or otherwise used or moved in any way. If a San Joaquin kit fox is discovered inside a pipe, that section of pipe will not be moved until the Service has been consulted. If necessary, and under the direct supervision of the Service-approved biologist, the pipe may be moved only once to remove it from the path of construction activity until the fox has escaped.

23. All food-related trash items such as wrappers, cans, bottles, and food scraps will be disposed of in securely closed containers and removed at least once a week from a construction site in suitable kit fox habitat.

24. No firearms will be allowed at the worksite except for those carried by authorized security personnel, or local, State, or Federal law enforcement officials

25. No pets, such as dogs or cats, will be permitted at worksites to prevent harassment, mortality of kit foxes, or loss of dens.

26. Use of rodenticides and herbicides in areas that are in modeled San Joaquin kit fox habitat will be prohibited.

27. The Service-approved biologist for San Joaquin kit fox will be the contact source for any employee or contractor who might incidentally kill or injure a San Joaquin kit fox or who finds a dead, injured, or entrapped San Joaquin kit fox.

28. An employee education program (AMM1, *Worker Awareness Training*) will be conducted for any activities that will be conducted in San Joaquin kit fox habitat. The program will consist of a brief presentation by the Service-approved biologist for San Joaquin kit fox to explain endangered species concerns to all personnel who will be working in the construction area. The program will include the following: A description of the San Joaquin kit fox and its habitat needs; a report of the occurrence of San Joaquin kit fox at the worksite; an explanation of the status of the species and its protection under the Endangered Species Act; and a list of measures being taken to reduce impacts on the species during construction and operations. A fact sheet conveying this information will be prepared for distribution to all worksite personnel.

29. Upon completion of construction at a worksite, all areas subject to temporary ground disturbances will be re-contoured if necessary, and revegetated to promote restoration of the area to preconstruction conditions. An area subject to "temporary" disturbance means any area that is disturbed during construction, but after construction will be revegetated. Appropriate methods and plant species used to revegetate such areas will be determined on a site-specific basis in consultation with the Service.

30. Any personnel who are responsible for incidentally killing or injuring a San Joaquin kit fox will immediately report the incident to the Service-approved biologist. The Service-approved biologist will contact the Service immediately in the case of a dead, injured, or entrapped San Joaquin kit fox. The Service contact is the Assistant Field Supervisor of Endangered Species, at Bay-Delta Fish & Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814, (916) 930-5603. Notification must include the date, time, and location of the incident or of the finding of a dead or injured animal and any other pertinent information.

31. New sightings of San Joaquin kit fox will be reported to the California Natural Diversity Database (CNDDB). A copy of the reporting form and a topographic map clearly marked with the location of where the San Joaquin kit fox was observed will also be provided to Service at the address below.

32. Following completion of CCF modifications, the area to be operated and maintained within suitable San Joaquin kit fox habitat will be fenced with chain link fencing that prevents entry of San Joaquin kit fox. The fencing will be inspected annually to ensure there are no holes or gaps in the fencing that would allow San Joaquin kit foxes to enter.

33. Prior to final design for the transmission line alignments, a Service-approved biologist will survey potential transmission line locations where suitable San Joaquin kit fox habitat is present. These surveys will be conducted as described above, except that the surveys will be conducted early enough to inform the final transmission line design but no less than 14 days and no more than 30 days prior to beginning of PA activities. Therefore, multiple surveys may be required. If any occupied dens are found, the Service will be immediately contacted and the project will be designed to avoid the occupied dens by 200 ft. After the final transmission line alignment has been determined, the construction conservation measures will be applied.

California Least Tern

1. If suitable nesting habitat for California least tern (flat, unvegetated areas near aquatic foraging habitat) is identified during planning-level surveys, at least three preconstruction surveys for this species will be conducted during the nesting season by a Service-approved biologist with experience observing the species and its nests. Projects will be designed to avoid loss of California least tern nesting colonies. No construction will take place within 200 ft of a California least tern nest during the nesting season (April 15 to August 15, or as determined through surveys).

2. Only inspection, maintenance, research, or monitoring activities may be performed during the least tern breeding season in occupied least tern nesting habitat with Service and CDFW approval under the supervision of a qualified biologist.

3. Safe havens, RTM, and transmission lines will fully avoid California least tern foraging habitat. Transmission lines may cross waterways, but must avoid disturbance of open water habitat.

Western Yellow-Billed Cuckoo

Measures for Activities with Fixed Locations

1. Prior to construction, all suitable western yellow-billed cuckoo habitat in the construction area will be surveyed, with surveys performed in accordance with any required Service survey protocols and permits applicable at the time of construction.

2. If surveys find western yellow-billed cuckoos in the area where vegetation will be removed, vegetation removal will be done when western yellow-billed cuckoos are not present.

3. If an activity is to occur within 1,200 ft of western yellow-billed cuckoo habitat (or within 2,000 ft if pile driving will occur) during the period of from June 15 through September 1, the following measures will be implemented to avoid noise effects on migrating western yellow-billed cuckoos.

4. Prior to the construction, a noise expert will create a noise contour map showing the 60 dBA noise contour specific to the type and location of construction to occur in the area

5. During the period between June 15 and September 1, a Service-approved biologist will survey any suitable migratory habitat for yellow-billed cuckoos within the 60 dBA noise contour on a daily basis during a two-week period prior to construction. While construction is occurring within this work window, the Service-approved biologist will conduct daily surveys in any suitable habitat where construction-related noise levels could exceed 60 dBA L_{eq} (1 hour). If a yellow-billed cuckoo is found, sound will be limited to 60 dBA in the habitat being used until the Service-approved biologist has confirmed that the bird has left the area.

6. Limit pile driving to daytime hours (7:00 a.m. to 7:00 p.m.).

7. Locate, store, and maintain portable and stationary equipment as far as possible from suitable western yellow-billed cuckoo habitat.

8. Employ preventive maintenance including practicable methods and devices to control, prevent, and minimize noise.

9. Route truck traffic in order to reduce construction noise impacts and traffic noise levels within 1,200 ft of suitable western yellow-billed cuckoo migratory habitat during migration periods.

10. Limit trucking activities (*e.g.*, deliveries, export of materials) to the hours of 7:00 a.m. to 10:00 p.m.

11. Screen all lights and direct them down toward work activities away from migratory habitat. A Service-approved biologist will ensure that lights are properly directed at all times.

12. Operate portable lights at the lowest allowable wattage and height, while in accordance with the National Cooperative Highway Research Program's *Report 498: Illumination Guidelines for Nighttime Highway Work.*

Measures for Activities with Fixed Locations

Geotechnical Explorations

1. During geotechnical activities, a Service-approved biologist will be onsite to avoid the loss or degradation of suitable western yellow-billed cuckoo habitat by exploration activities.

Safe Haven Work Areas

2. During the siting phase of safe haven construction, a Service-approved biologist will work with the engineers to avoid loss or degradation of suitable western yellow-billed cuckoo migratory habitat. This includes ensuring that safe haven work areas are not sited in western yellow-billed cuckoo habitat. This also includes ensuring noise from safe haven work areas does not exceed 60 dBA at nearby western yellow-billed cuckoo migratory habitat.

Power Supply and Grid Connections

3. The final transmission line alignment will be designed to minimize removal of western yellow-billed cuckoo migratory habitat by removing no more than four acres of the habitat. To minimize the chance of western yellow-billed cuckoo bird strikes at transmission lines, bird strike diverters will be installed on project and existing transmission lines in a configuration that research indicates will reduce bird strike risk by at least 60% or more. Bird strike diverters placed on new and existing lines will be periodically inspected and replaced as needed until or unless the project or existing line is removed. The most effective and appropriate diverter for minimizing strikes on the market according to best available science will be selected.

Safe Havens

4. Safe haven sites will avoid western yellow-billed cuckoo migratory habitat. All work associated with safe haven sites will be conducted during daylight hours, and will not require any lighting.

<u>*Giant Garter Snake*</u>

Ground-Truthed Habitat Assessment and Giant Garter Snake Surveys

1. When each site is available for surveys, a giant garter snake expert, approved by the Service and CDFW, will then delineate giant garter snake habitat at each project site, based on the definition of suitable habitat, including both aquatic and upland habitat.

2. Once habitat has been delineated, the giant garter snake expert may use giant garter snake surveys performed using a method approved by the Service to determine presence/absence of the species on the project site to enable further determination of mitigation requirements.

3. For sites where such surveys are performed, the surveys will conform to protocol and reporting need per a plan to be jointly developed by DWR, CDFW, and the Service to provide population and occurrence data for the species in the Delta.

4. To the greatest extent possible, identified and delineated habitat will be completely avoided.

Measures for Activities with Fixed Locations

5. Initiate construction and clear suitable habitat, between May 1 and September 30, and avoid giant garter snake habitat during periods of brumation (between October 1 and April 30). Suitability of aquatic and upland habitat characteristics will be determined by the Service-approved biologist consistent with the Service habitat description. Once a construction site has been cleared and exclusionary fencing is in place, work within the cleared area can occur between October 1 and April 30.

6. To the extent practicable, conduct all activities within paved roads, farm roads, road shoulders, and similarly disturbed and compacted areas; confine ground disturbance and habitat removal to the minimal area necessary to facilitate construction activities.

7. For construction activities, dredging, and any conveyance facility maintenance involving heavy equipment, giant garter snake aquatic and upland habitat that can be avoided will be clearly delineated on the work site, with exclusionary fencing and signage identifying these areas as sensitive. The exclusionary fencing will be installed during the active period for giant garter snake (May 1–September 30) and will consist of 3-ft-tall, non-monofilament silt fencing extending to 6 inches below ground level.

8. For activities requiring exclusionary fencing, the Service-approved biological monitor and construction supervisor will be responsible for checking the exclusionary fences around the work areas daily to ensure that they are intact and upright. Any necessary repairs will be immediately addressed. The exclusionary fencing will remain in place for the duration of construction.

9. The Service-approved biologist will also survey suitable aquatic and upland habitat in the entire work site for the presence of giant garter snakes, as well as 50 ft outside the work site exclusion fencing in suitable habitat.

10. If exclusionary fencing is found to be compromised, a survey of the exclusion fencing and the area inside the fencing will be conducted immediately preceding construction activity that occurs in delineated giant garter snake habitat or in advance of any activity that may result in take of the species. The Service-approved biologist will search along exclusionary fences, in pipes, and beneath vehicles before they are moved. Any giant garter snake found will be captured and relocated to suitable habitat a minimum of 200 ft outside of the work area in a location that is approved by the Service and CDFW prior to resumption of construction activity.

11. All construction personnel, and personnel involved in operations and maintenance in or near giant garter snake habitat, will attend worker environmental awareness. This training

will include instructions to workers on how to recognize giant garter snakes, their habitat(s), and the nature and purpose of protection measures.

12. Within 24 hours prior to construction activities, dredging, or maintenance activities requiring heavy equipment, a Service-approved biologist will survey all of the activity area not protected by exclusionary fencing where giant garter snake could be present. This survey of the work area will be repeated if a lapse in construction or dredging activity of two weeks or greater occurs during the brumation period (October 1 through April 30) or if the lapse in construction activity is more than 12 hours during active season (May 1–September 30). If a giant garter snake is encountered during surveys or construction, cease activities until appropriate corrective measures have been completed, it has been determined that the giant garter snake will not be harmed, or the giant garter snake has left the work area.

13. The Service-approved biological monitor will help guide access and construction work around wetlands, active rice fields, and other sensitive habitats capable of supporting giant garter snake, to minimize habitat disturbance and risk of injuring or killing giant garter snakes.

14. Report all observations of giant garter snakes to the Service-approved biological monitor.

15. Maintain all construction and operations and maintenance equipment to prevent leaks of fuel, lubricants, and other fluids and use extreme caution when handling and or storing chemicals (such as fuel and hydraulic fluid) near waterways, and abide by all applicable laws and regulations. Follow all applicable hazardous waste BMPs and keep appropriate materials on site to contain, manage, and clean up any spills as described in CWF BA Appendix 3.F.

16. Conduct service and refueling procedures in uplands in staging areas and at least 200 ft away from giant garter snake upland habitat and waterways when practicable. See also CWF BA Appendix 3.F.

17. During construction and operation and maintenance activities in and near giant garter snake habitat, employ erosion (non-monofilament silt fence), sediment, material stockpile, and dust control (BMPs on site). Avoid fill or runoff into wetland areas or waterways to the extent practicable.

18. Return temporary work areas to pre-existing contours and conditions upon completion of work. Where re-vegetation and soil stabilization are necessary in non-agricultural habitats, revegetate with appropriate non-invasive native plants at a density and structure similar to that of preconstruction conditions.

19. Properly contain and remove from the worksite all trash and waste items generated by construction and crew activities to prevent the encouragement of predators such as raccoons and coyotes from occupying the site.

20. No firearms will be allowed at the worksite except for those carried by authorized security personnel, or local, State, or Federal law enforcement officials.

21. Store equipment in designated staging areas at least 200 ft away from giant garter snake aquatic habitat to the extent practicable.

22. Confine any vegetation clearing to the minimum area necessary to facilitate construction activities.

23. Limit vehicle speed to 10 miles per hour (mph) on access routes (except for public roads and highways) and within work areas that are within 200 ft of giant garter snake aquatic habitat that are not protected by exclusion fencing to avoid running over giant garter snakes.

24. Visually check for giant garter snakes under vehicles and equipment prior to moving them. Cap all materials onsite (conduits, pipe, etc.), precluding wildlife from becoming entrapped. Check any crevices or cavities in the work area where individuals may be present including stockpiles that have been left for more than 24 hours where cracks/crevices may have formed.

For activities that will occur within the giant garter snake inactive season (October 1 through April 30), and will last more than two weeks, DWR will implement the following additional avoidance and minimization measures.

25. If there are proposed activities that will occur within suitable aquatic giant garter snake habitat during the giant garter snake active season (May 1 through September 30), prior to proposed construction activities that will commence during the inactive period, and when unavoidable, all aquatic giant garter snake habitat will be dewatered for at least 14 days prior to excavating or filling the dewatered habitat. Dewatering is necessary because aquatic habitat provides prey and cover for giant garter snake; dewatering serves to remove the attractant, and increase the likelihood that giant garter snake will move to other available habitat. Any deviation from this measure will be done in coordination with, and with approval of, the Service.

26. Following dewatering of aquatic habitat, all potential impact areas that provide suitable aquatic or upland giant garter snake habitat will be surveyed for giant garter snake by the Service-approved biologist. If giant garter snakes are observed, they will be passively allowed to leave the potential impact area, or the Service will be consulted to determine the appropriate course of action for removing giant garter snake from the potential impact area.

27. Once habitat is deemed giant garter snake-free, exclusion fencing will be constructed around the construction site so no snakes may re-enter prior to or during construction.

The following avoidance and minimization measures will be applied to maintenance activities in suitable aquatic habitat, as delineated by a Service- approved biologist, and uplands within 200 ft of suitable aquatic habitat, to minimize effects on the giant garter snake.

28. Vegetation control will take place during the active period (May 1 through September 30) when snakes are able to move out of areas of activity.

29. Trapping or hunting methods will be used for rodent control, rather than poison bait. All rodent control methods will be approved by the Service. If trapping or other non-poison methods are ineffective, the Service will be consulted to determine the best course of action.

30. Movement of heavy equipment will be confined to outside 200 ft of the banks of giant garter snake aquatic habitat to minimize habitat disturbance.

31. All construction personnel, and personnel involved in operations and maintenance in or near giant garter snake habitat, will attend worker environmental awareness training as described in CWF BA Appendix 3.F. This training will include instructions to workers on how to recognize giant garter snakes, their habitat(s), and the nature and purpose of protection measures.

Measures for Activities with Flexible Locations

Geotechnical Activities

32. Geotechnical activities will avoid giant garter snake aquatic habitat.

33. Geotechnical activity in giant garter snake upland habitat will be confined to the giant garter snake's active period (May 1 through September 30).

34. Movement of heavy equipment will be confined to existing roads as much as possible, and will avoid suitable upland giant garter snake habitat.

35. Construction personnel will receive Service-approved worker environmental awareness training instructing workers to recognize giant garter snakes and their habitat.

Safe Haven Work Areas

36. Safe haven work areas will avoid giant garter snake aquatic and upland habitat.

Power Lines and Grid Connections

37. Giant garter snake avoidance and minimization measures for transmission lines will be the same as described in *Measures for Activities with Fixed Locations.* These power lines and grid connections will be designed to avoid giant garter snake aquatic habitat.

The following avoidance and minimization measures will be applied to maintenance activities in suitable aquatic habitat, as delineated by a Service-approved biologist, and uplands within 200 ft of suitable aquatic habitat, to minimize effects on the giant garter snake.

38. Vegetation control will take place during the active period (May 1 through September 30) when snakes are able to move out of areas of activity.

39. Trapping or hunting methods will be used for rodent control, rather than poison bait. All rodent control methods will be approved by the Service. If trapping or other non-poison methods are ineffective, the Service will be consulted to determine the best course of action.

40. Movement of heavy equipment will be confined to outside 200 ft of the banks of potential giant garter snake habitat to minimize habitat disturbance.

41. Construction personnel will receive Service-approved worker environmental awareness training instructing workers to recognize giant garter snakes and their habitat.

<u>*California Red-Legged Frog*</u>

1. A Service-approved biologist will conduct a field evaluation of the California red-legged frog modeled habitat to ascertain the distribution of suitable upland and aquatic habitat in the worksite vicinity. Surveys within suitable upland habitat will identify suitable aquatic features that may not have been identified during the habitat modeling.

Measures for Activities with Fixed Locations

2. If aquatic habitat cannot be avoided, aquatic habitats in potential work areas, will be surveyed for tadpoles and egg masses. If California red-legged frog tadpoles or egg masses are found, and the aquatic habitat cannot be avoided, the Service will be contacted, and if determined to be appropriate, measures will be developed to relocate tadpoles and eggs to the nearest suitable aquatic habitat, as determined by the Service-approved biologist.

3. The Service-approved biologist will conduct employee education training for employees working on earthmoving and/or construction activities. Personnel will be required to attend the presentation that will describe the California red-legged-frog avoidance, minimization, and conservation measures, legal protection of the animal, and other

related issues. All attendees will sign an attendance sheet along with their printed name, company or agency, email address, and telephone number. The original sign-in sheet will be sent to the Service within seven (7) calendar days of the completion of the training.

4. Preconstruction surveys will be implemented after the planning phase and prior to any ground-disturbing activity.

5. The Service-approved biologist and construction supervisor will be responsible for checking the exclusion fences around the work areas daily to ensure that they are intact and upright. This will be especially critical during rain events, when flowing water can easily dislodge the fencing. Any necessary repairs will be immediately addressed. The amphibian exclusion fencing will remain in place for the duration of construction.

6. If the exclusion fence is found to be compromised at any time, a survey will be conducted immediately preceding construction activity that occurs in designated California red-legged frog habitat or in advance of any activity that may result in take of the species. The Service-approved biologist will search along exclusion fences, in pipes, and beneath vehicles before they are moved. The survey will include a careful inspection of all potential hiding spots, such as along exclusion fencing, large downed woody debris, and the perimeter of ponds, wetlands, and riparian areas. Any California red-legged frogs found will be captured and relocated to suitable habitat, a minimum of 300 ft outside of the work area that has been identified in the relocation plan (described below) and approved by a Service-approved biologist prior to commencement of construction.

7. Initial ground-disturbing activities will not be conducted between November 1 and March 31 in areas identified during the planning stages as providing suitable California red-legged frog habitat, to avoid the period when they are most likely to be moving through upland areas. Once the initial ground disturbance has occurred, the area has been cleared, and exclusionary fencing is in place, work within the disturbed area can occur outside the construction window.

8. Surface-disturbing activities will be designed to minimize or eliminate effects on rodent burrows that may provide suitable cover habitat for California red-legged frog. Surface-disturbing activities will avoid areas with a high concentration of burrows to the greatest extent practicable. In addition, when a concentration of burrows is present in a worksite, the area will be staked or flagged to ensure that work crews are aware of their location and to facilitate avoidance of the area.

9. No initial clearing activities will occur during rain events, or within 24 hours following a rain event, prior to clearing a site and installing exclusionary fencing. A Service-approved biologist will check the exclusion fencing daily to ensure it is intact, and if there are any breaches in the fencing, the Service-approved biologist will survey the work area for California red-legged frogs. If the species is found, the Service-approved biologist will relocate the frog consistent with an approved relocation plan.

10. To the maximum extent practicable, nighttime construction will be minimized or avoided when working in suitable California red-legged frog habitat. Because dusk and dawn are often the times when the California red-legged frog is most actively moving and foraging, to the greatest extent practicable, earthmoving and construction activities will cease no less than 30 minutes before sunset and will not begin again prior to no less than 30 minutes after sunrise. Except when necessary for driver or pedestrian safety, artificial lighting at a worksite will be prohibited during the hours of darkness when working in suitable California red-legged frog habitat. No more than 24 hours prior to any ground disturbance that could affect potential California red-legged frog habitat, preconstruction surveys for California red-legged frog will be conducted by a Service-approved biologist. These surveys will consist of walking the worksite limits. The Service-approved biologist will investigate all potential areas that could be used by the California red-legged frog for feeding, breeding, sheltering, movement or other essential behaviors. This includes an adequate examination of mammal burrows, such as California ground squirrels or gophers. If any adults, subadults, juveniles, tadpoles, or eggs are found, the Service-approved biologist will contact the Service to determine if moving any of the individuals to a pre-approved location within the relocation plan is appropriate. If the Service approves moving animals, the Service-approved biologist will be given sufficient time to move the animals from the work site before ground disturbance is initiated. Only Service-approved biologists will capture, handle, and monitor the California red-legged frog.

11. If work must be conducted at night, all lighting will be directed away and shielded from California red-legged frog habitat outside the construction area to minimize light spillover to the greatest extent possible. If light spillover into adjacent California red-legged frog habitat occurs, a Service-approved biologist will be present during night work to survey for burrows and emerging California red-legged frogs in areas illuminated by construction lighting. If a California red-legged frog is found above-ground the Service-approved biologist has the authority to terminate the project activities until the light is directed away from the burrows, the California red-legged frog moves out of the illuminated area, or the California red-legged frog is relocated out of the illuminated area by the Service-approved biologist.

12. At least 15 days prior to any ground disturbance activities in suitable California red-legged frog habitats, DWR will prepare and submit a relocation plan for the Service's written approval. The relocation plan will contain the name(s) of the Service-approved biologist(s) to relocate California red-legged frogs, the method of relocation (if different than described), a map and description of the proposed release site(s) within 300 ft of the work area or at a distance otherwise agreed to by the Service, and written permission from the landowner to use their land as a relocation site.

13. Aquatic habitats within the areas that will be permanently affected by the PA will be surveyed for California red-legged frog adults and metamorphs. Any California red-legged frog adults or metamorphs that are found will be captured and held for a minimum

amount of time necessary to relocate the animal(s) to suitable habitat a minimum of 300 ft outside of the work area. Prior to and after handling frogs, the Service-approved biologist will observe the appropriate decontamination procedures to ensure against spread of chytrid fungus or other pathogens.

14. If construction activities will occur in streams or ditches, temporary aquatic barriers such as hardware cloth will be installed both up and downstream of the stream crossing, and animals will be relocated and excluded from the work area. The Service-approved biologists will establish an adequate buffer on both sides of creeks and ditches and around potential aquatic habitat and will restrict entry during the construction period.

15. The Service-approved biologist(s) will kill any aquatic exotic wildlife species, such as bullfrogs and crayfish, found on the worksite, to the greatest extent practicable.

16. Each encounter with the California red-legged frog will be treated on a case-by-case basis in coordination with the Service, but the procedure will follow the pre-approved Relocation Plan and will be conducted as follows: (1) the animal will not be disturbed if it is not in danger, or (2) the animal will be moved to a secure location if it is in any danger. These procedures are further described below:

    a. When a California red-legged frog is encountered, all activities that have the potential to result in the harassment, injury, or death of an individual will cease immediately and the Onsite Project Manager and Service-approved biologist will be notified. The Service-approved biologist will then assess the situation and select a course of action to avoid or minimize adverse effects to the animal. To the maximum extent possible, contact with the frog will be avoided to allow it to move out of the potentially hazardous situation to a secure location on its own volition. This procedure applies to situations where a California red-legged frog is encountered while it is moving to another location. It does not apply to animals that are uncovered or otherwise exposed or in areas where there is not sufficient adjacent habitat to support the species should the individual move away from the hazardous location.

    b. California red-legged frogs that are at risk of being injured or killed will be relocated and released by the Service-approved biologist outside the construction area, but within the same riparian area or watershed. If such relocation is not feasible (*e.g.*, there are too many individuals observed per day), the Service-approved biologist will relocate the animals to a location previously approved by the Service. Prior to the initial ground disturbance DWR will obtain approval of the relocation plan from the Service in the event that a California red-legged frog is encountered and needs to be moved away from the worksite. Under no circumstances will a California red-legged frog be released on a site unless the written permission of the landowner has been obtained.

c. The Service-approved biologist will limit the duration of the handling and captivity of the California red-legged frog to the minimum amount of time necessary to complete the task. If the animal must be held in captivity, it will be kept in a cool, dark, moist, aerated environment, such as a clean and disinfected bucket or plastic container with a damp sponge and a cover which air can freely pass through. The container used for holding or transporting the individual will not contain any standing water.

d. The Service will be immediately notified once the California red-legged frog and the site are secure. The Service contact is the Assistant Field Supervisor of Endangered Species, at Bay-Delta Fish & Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814, (916) 930-5603.

17. For onsite storage of pipes, conduits and other materials that could provide shelter for California red-legged frogs, an open-top trailer will be used to elevate the materials above ground. This is intended to reduce the potential for animals to climb into the conduits and other materials.

18. Plastic monofilament netting (erosion control matting), loosely woven netting, or similar material in any form will not be used at the worksite because California red-legged frogs can become entangled and trapped in such materials. Any such material found on site will be immediately removed by the Service-approved biologist or construction personnel. Materials utilizing fixed weaves (strands cannot move), polypropylene, polymer or other synthetic materials will not be used.

19. Dust control measures will be implemented during construction, or when necessary in the opinion of the Service-approved biologist, Service, or their authorized agent. These measures will consist of regular truck watering of construction access areas and disturbed soil areas with water or organic soil stabilizers to minimize airborne dust and soil particles generated from graded areas. Regular truck watering will be a requirement of the construction contract. Guidelines for truck watering will be established to avoid any excessive runoff that may flow into contiguous or adjacent areas containing potential habitat for the California red-legged frog.

20. Trenches or pits 1 ft or deeper that are going to be left unfilled for more than 48 hours will be securely covered with boards or other material to prevent California red-legged frogs from falling into them. If this is not possible, wooden ramps or other structures of suitable surface that provide adequate footing for the California red-legged frog will be placed in the trench or pit to allow for their unaided escape. Auger holes or fence post holes that are greater than 0.10 inch in diameter will be immediately filled or securely covered so they do not become pitfall traps for the California red-legged frog. The Service-approved biologist will inspect the trenches, pits, or holes prior to their being filled to ensure there are no California red-legged frogs in them. The trench, pit, or hole also will be examined by the Service-approved biologist each workday morning at least

one hour prior to initiation of work and in the late afternoon no more than one hour after work has ceased to ascertain whether any individuals have become trapped. If the escape ramps fail to allow the animal to escape, the Service-approved biologist will remove and transport it to a safe location, or contact the Service for guidance.

21. To minimize harassment, injury, death, and harm in the form of temporary habitat disturbances, all vehicle traffic related to the PA will be restricted to established roads, construction areas, equipment staging, and storage, parking, and stockpile areas. These areas will be included in preconstruction surveys and, to the maximum extent possible, established in locations disturbed by previous activities to prevent further adverse effects.

22. All vehicles will observe a 20-mile per hour speed limit within construction areas where it is safe and feasible to do so, except on County roads, and State and Federal highways. Off-road traffic outside of designated and fenced work areas will be prohibited.

23. If a work site is to be temporarily dewatered by pumping, the pump intakes shall be completely screened with wire mesh not larger than five millimeters to prevent California red-legged frogs from entering the pump system. Water shall be released or pumped downstream at an appropriate rate to maintain downstream flows during construction. Upon completion of construction activities, any barriers to streamflow shall be removed in a manner that would allow flow to resume with the least disturbance (scour) to the substrate.

24. Uneaten human food and trash attracts crows, ravens, coyotes, and other predators of the California red-legged frog. A litter control program will be instituted at each worksite. All workers will ensure their food scraps, paper wrappers, food containers, cans, bottles, and other trash are deposited in covered or closed trash containers. The trash containers will be removed from the worksite at the end of each working day.

25. All grindings and asphaltic-concrete waste may be temporally stored within previously disturbed areas absent of habitat and at a minimum of 150 ft from any culvert, pond, creek, stream crossing, or other waterbody. On or before the completion of work at the site, the waste will be transported to an approved disposal site.

26. Loss of soil from runoff or erosion will be prevented with straw bales, straw wattles, or similar means provided they do not entangle, or block escape or dispersal routes of the California red-legged frog.

27. Insecticides or herbicides will not be applied at the worksite during construction or long-term operational maintenance where there is the potential for these chemical agents to enter creeks, streams, waterbodies, or uplands that contain potential habitat for the California red-legged frog.

28. No pets will be permitted at the worksite, to avoid and minimize the potential for harassment, injury, and death of the California red-legged frog. No firearms will be allowed at the worksite except for those carried by authorized security personnel, or local, State, or Federal law enforcement officials to avoid and minimize the potential for harassment, injury, and death of the California red-legged frog.

Measures for Activities with Flexible Locations

Geotechnical Exploration

29. Geotechnical exploration will be sited outside of California red-legged aquatic habitat.

30. To the extent practicable, all activities will avoid impacts to California red-legged frog suitable habitat that possesses cracks or burrows that could be occupied by California red-legged frogs.

31. Preconstruction surveys will be conducted by a Service-approved biologist. A Service-approved biological monitor will be present during all drilling activities in California red-legged frog upland habitat to ensure there are no significant impacts to California red-legged frog.

32. Work will be done outside the wet season and measures, such as having vehicles follow shortest possible routes from levee road to the drill or CPT sites, will be taken to minimize the overall project footprint.

Power Lines and Grid Connections

33. The final transmission line alignments will be designed to avoid California red-legged frog aquatic habitat, and to minimize effects on upland habitat. The transmission lines will be sited at least 300 ft from occupied California red-legged frog aquatic habitat as determined through protocol-level surveys of any suitable aquatic habitat in the potential transmission line alignment. Occupancy may be assumed, in order to forego the need for protocol-level surveys. After the final transmission line alignment has been determined, the AMMs described above will be followed.

California Tiger Salamander

1. A Service-approved biologist familiar with the species and its habitat will conduct a field evaluation of suitable upland or aquatic habitat for California tiger salamander for all activities in the PA that occur within modeled habitat, or within areas of suitable habitat located by a Service-approved biologist during the field evaluation.

Measures for Activities with Fixed Locations

2. No aquatic habitat for California tiger salamander will be affected.

Site Preparation

3. The perimeter of construction sites will be fenced with amphibian exclusion fencing by no more than 14 days prior to the start of construction. The Onsite Project Manager and the Service-approved biologist (in cooperation with Service) will determine where exclusion fencing will be installed to protect California tiger salamander habitat adjacent to the defined site footprint and to minimize the potential for California tiger salamanders to enter the construction work area. The locations of exclusion fencing will be determined, in part, by the locations of suitable habitat for the species. A conceptual fencing plan will be submitted to the Service prior to the start of construction and the California tiger salamander exclusion fencing will be shown on the final construction plans. DWR will include the amphibian exclusion fence specifications including installation and maintenance criteria in the bid solicitation package special provisions. The amphibian exclusion fencing will remain in place for the duration of construction and will be regularly inspected and fully maintained. The Service-approved biological monitor and construction supervisor will be responsible for checking the exclusion fencing around the work areas daily to ensure that they are intact and upright. This will be especially critical during rain events, when flowing water can easily dislodge the fencing. Repairs to the amphibian exclusion fence will be made within 24 hours of discovery. Where construction access is necessary, gates will be installed with the exclusion fence.

4. At least 15 days prior to any ground disturbance activities, DWR will prepare and submit a Relocation Plan for Service's written approval. The Relocation Plan will contain the name(s) of the Service-approved biologist(s) to relocate California tiger salamanders, the method of relocation (if different than described), a map, and a description of the proposed release site(s) within 300 ft of the work area or at a distance otherwise agreed to by Service, and written permission from the landowner to use their land as a relocation site.

5. Preconstruction surveys will be conducted by a Service-approved biologist immediately prior to the initiation of any ground-disturbing activities or vegetation clearing in areas identified as having suitable California tiger salamander habitat. Prior to initiating surveys, water trucks will spray the work area to encourage emergence. Watering will occur at dusk, trucks will make a single pass, and the Service-approved biologist(s) will survey the watered area for one hour following the spraying. If California tiger salamanders are found, they will be relocated consistent with the Relocation Plan described above.

Initial Clearance/Ground Disturbance

6. Except for limited vegetation clearing necessary to minimize effects to nesting birds, initial suitable habitat clearance and disturbance will be confined to the dry season, generally July 15 through October 15. All initial clearing will be limited to periods of no or low rainfall (less than 0.08 inches per 24-hour period and less than 40% chance of rain). Clearing activities within California tiger salamander habitat will cease 24 hours prior to a 40% or greater forecast of rain from the closest National Weather Service (NWS) weather station. Clearing may continue 24 hours after the rain ceases, if no precipitation is in the 24-hour forecast. If clearing must continue when rain is forecast (greater than 40% chance of rain), a Service-approved biologist will survey the worksite before clearing begins each day rain is forecast. If rain exceeds 0.5 inches during a 24-hour period, clearing will cease until the NWS forecasts no further rain. Modifications to this timing may be approved by Service based on site conditions and expected risks to California tiger salamanders. Once the ground has been cleared and perimeter fencing is in place, these restrictions do not apply.

During Construction

7. The Service-approved biologist shall conduct clearance surveys at the beginning of each day and regularly throughout the workday when construction activities are occurring that may result in take of California tiger salamander. These surveys will consist of walking surveys within the worksites and investigating suitable aquatic and upland habitat including refugia habitat such as small woody debris, refuse, burrow entries, etc. All mammal burrows within the worksite limits that cannot be avoided will be hand-excavated and collapsed so that they do not attract California tiger salamanders during construction.

8. If the exclusion fence is compromised during the rainy season, when California tiger salamanders are likely to be active, a survey will be conducted immediately preceding construction activity that occurs in modeled or suitable California tiger salamander habitat, as determined by a Service-approved biologist, or in advance of any activity that may result in take of the species. The Service-approved biologist will search along exclusion fences, in pipes, and beneath vehicles each morning before they are moved. The survey will include a careful inspection of all potential hiding spots, such as along exclusion fencing, large downed woody debris, and the perimeter of ponds, wetlands, and riparian areas. Any tiger salamanders found will be captured and relocated to suitable habitat with an active rodent burrow system at a location predetermined prior to commencement of construction in the Relocation Plan.

9. To avoid entrapment of animals during construction, pipes or similar structures will be capped if stored overnight. Excavated holes and trenches will have escape ramps, and any open holes and trenches more than 6 inches deep will be closed with plywood at the end of each workday. The Service-approved biologist will inspect all holes and trenches at the

beginning of each workday and before the holes and trenches are filled. All pipes, culverts, or similar structures stored in the work area overnight will be inspected before they are subsequently moved, capped, and/or buried. If a California tiger salamander is discovered, the Onsite Project Manager and Service-approved biologist will be notified immediately, and the Service-approved biologist will move the animal to a safe nearby location (as described by the species observation and handling protocol below) and monitor it until it is determined that it is not imperiled by predators, or other dangers.

10. If verbally requested before, during, or upon completion of ground disturbance and construction activities where suitable California tiger salamander habitat is present, DWR will ensure that the Service can immediately access and inspect the worksite for compliance with the description of the PA, including its AMMs, and to evaluate effects on the California tiger salamander and its habitat. A Service-approved biologist will be onsite during all activities that may result in take of California tiger salamander. The Service-approved biologist will carry a working mobile phone whose number will be provided to Service prior to the start of construction and ground disturbance.

11. The Service-approved biologist will have the authority to stop activities at the worksite if they determine that any of the AMMs are not being fulfilled.

12. The Service-approved biologist will maintain monitoring records that include (1) the beginning and ending time of each day's monitoring effort, (2) a statement identifying the covered species encountered, including the time and location of the observation, (3) the time the specimen was identified and by whom and its condition, (4) the capture and release locations of each individual, (5) photographs and measurements (snout to vent and total length) of each individual, and (6) a description of any actions taken. The Service-approved biologist will maintain complete records in their possession while conducting monitoring activities and will immediately provide records to the Service upon request. If requested, all monitoring records will be provided to the Service within 30 days of the completion of monitoring work.

13. To the extent possible, earthmoving and construction activities will cease no less than 30 minutes before sunset and will not begin again until no less than 30 minutes after sunrise within 300 ft of California tiger salamander habitat. Except when necessary for driver or pedestrian safety, to the greatest extent practicable, artificial lighting at a worksite will be prohibited during the hours of darkness.

14. If work must be conducted at night within 300 ft of California tiger salamander habitat, all lighting will be directed away and shielded from California tiger salamander habitat outside the construction area to minimize light spillover to the greatest extent possible. If light spillover into adjacent California tiger salamander habitat occurs, a Service-approved biologist will be present during night work to survey for burrows and emerging California tiger salamanders in areas illuminated by construction lighting. If California tiger salamander is found above-ground the Service-approved biologist has the authority

to terminate the project activities until the light is directed away from the burrows, the California tiger salamander moves out of the illuminated area, or the California tiger salamander is relocated out of the illuminated area by the Service-approved biologist.

15. No rodenticides will be used during construction or long-term operational maintenance in areas that support suitable upland habitat for California tiger salamander.

16. To prevent California tiger salamander from becoming entangled, trapped, or injured by erosion control structures, erosion control measures that use plastic or synthetic monofilament netting will not be used within areas designated to have suitable California tiger salamander habitat. This includes products that use photodegradable or biodegradable synthetic netting, which can take several months to decompose. Acceptable materials include natural fibers such as jute, coconut, twine, or other similar fibers. Following site restoration, erosion control materials, such as straw wattles, will be placed in a manner that will not block movement of the California tiger salamander.

Species Observation and Handling Protocol

17. If a California tiger salamander is observed, the Service-approved biologist will implement the following species observation and handling protocol. Only Service-approved biologists will participate in activities associated with the capture, handling, and monitoring of California tiger salamanders. If a California tiger salamander is encountered in a construction area, activities within 50 ft of the individual will cease immediately and the Onsite Project Manager and Service-approved biologist will be notified. Based on the professional judgment of the Service-approved biologist, if activities at the worksite can be conducted without harming or injuring the California tiger salamander, it may be left at the location of discovery and monitored by the Service-approved biologist. All personnel on site will be notified of the finding and at no time will work occur within 50 ft of the California tiger salamander without a Service-approved biologist present. If it is determined by the Service-approved biologist that relocating the California tiger salamander is necessary, the following steps will be followed:

    a. Prior to handling and relocation, the Service-approved biologist will take precautions to prevent introduction of amphibian diseases in accordance with the Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the California Tiger Salamander (Service 2003). Disinfecting equipment and clothing is especially important when Service-approved biologists are coming to the action area to handle amphibians after working in other aquatic habitats. California tiger salamanders will also be handled and assessed according to the Restraint and Handling of Live Amphibians. The Handling of Live Amphibians standard operating procedures can be accessed at:

https://www.nwhc.usgs.gov/publications/amphibian_research_procedures/handling_and_restraint.jsp

b. California tiger salamanders will be captured by hand, dipnet, or other Service-approved methodology, transported, and relocated to nearby suitable habitat outside of the work area and released as soon as practicable the same day of capture. Individuals will be relocated no greater than 300 ft outside of the work area to areas with an active rodent burrow or burrow system (unless otherwise approved by Service). Holding/transporting containers and dipnets will be thoroughly cleaned, disinfected, and rinsed with freshwater prior to use within the action area. The Service will be notified within 24 hours of all capture, handling, and relocation efforts. The Service-approved biologists will not use soaps, oils, creams, lotions, repellents, or solvents of any sort on their hands within two hours before and during periods when they are capturing and relocating individuals. To avoid transferring disease or pathogens when handling the amphibians, Service-approved biologists will follow the Declining Amphibian Populations Task Force's "Code of Practice." The "Code of Practice" can be accessed on the internet at: https://www.fws.gov/ventura/docs/species/protocols/DAFTA.pdf

c. If an injured California tiger salamander is encountered and the Service--approved biologist determines the injury is minor or healing and the salamander is likely to survive, the salamander will be released immediately, consistent with the pre-approved Relocation Plan as described above. The California tiger salamander will be monitored until it is determined that it is not imperiled by predators or other dangers.

d. If the Service-approved biologist determines that the California tiger salamander has major or serious injuries because of activities at the worksite, the Service-approved biologist, or designee, will immediately take it to a Service-approved facility. If taken into captivity, the individual will not be released into the wild unless it has been kept in quarantine and the release is authorized by the Service. DWR will bear any costs associated with the care or treatment of such injured California tiger salamanders. The circumstances of the injury, the procedure followed and the final disposition of the injured animal will be documented in a written incident report. Notification to the Service of an injured or dead California tiger salamander in the action area will be made as described under the Reporting Requirements measure, and reported whether or not its condition resulted from activities related to the PA. In addition, the Service-approved biologist will follow up with the Service in writing within two calendar days of the finding. Written notification to the Service will include the following information: the species, number of animals taken or injured, sex (if known), date, time, location of the incident or of the finding of a dead or injured animal, how the individual was taken, photographs of the specific animal, the names of the persons who observe the take and/or found the animal, and any other pertinent information. Dead specimens will be preserved, as appropriate, and held in a secure location until instructions are received from the Service regarding the disposition of the specimen.

Measures for Activities with Flexible Locations

Geotechnical Explorations

18. Geotechnical exploration will be sited outside of California tiger salamander aquatic habitat.

19. To the extent practicable, all project activities within California tiger salamander suitable habitat will avoid impacts to areas that possess cracks or burrows that could be occupied by California tiger salamanders.

20. Preconstruction surveys will be conducted by a Service-approved biologist. A Service-approved biological monitor will be present during all drilling activities to ensure there are no significant impacts to California tiger salamander.

21. Work will be done during the dry season (July 15 through October 31) and measures, such as having vehicles follow shortest possible routes from levee road to the drill or CPT sites, will be taken to minimize the overall project footprint.

22. Geotechnical exploration activities will cease no less than 30 minutes before sunset and will not begin again until no less than 30 minutes after sunrise within 300 ft of California tiger salamander habitat.

Safe Havens

23. Safe havens will avoid suitable California tiger salamander habitat.

Power Supply and Grid Connections

24. The final transmission line alignments will be sited to avoid California tiger salamander aquatic habitat, and to minimize effects on upland habitat. The transmission lines will be sited at least 300 ft from occupied California tiger salamander aquatic habitat as determined through protocol-level surveys of any suitable aquatic habitat within the potential transmission line alignment. Occupancy may be assumed, in order to forego the need for protocol-level surveys. After the final transmission line alignment has been determined, the avoidance and minimization measures described in Activities with Fixed Locations, will be followed, with the following exception: Transmission line construction activities will cease no less than 30 minutes before sunset and will not begin again until no less than 30 minutes after sunrise within 300 ft of California tiger salamander habitat.

Valley Elderberry Longhorn Beetle

Measures for Activities with Fixed Locations

1. Preconstruction surveys for elderberry shrubs will be conducted within all facility footprints and all areas within 100 ft of facility footprints. The preconstruction surveys will be conducted by a Service-approved biologist familiar with the appearance of valley elderberry longhorn beetle exit holes in elderberry shrubs. Preconstruction surveys will be conducted in the calendar year prior to construction and will follow the guidance of Service's Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999), hereafter referred to as the 1999 Valley Elderberry Longhorn Beetle Conservation Guidelines. The results of preconstruction surveys will be reported to the Service. Elderberry shrubs will be avoided to the greatest extent practicable. Complete avoidance (*i.e.*, no adverse effects) may be assumed when a buffer of at least 100 ft is established and maintained around elderberry plants containing stems measuring 1 inch or greater in diameter at ground level. Firebreaks may not be included in the buffer zone. The Service will be consulted before any disturbances, including construction, within the 100-ft buffer area are considered. Any damaged area within the buffer zones will be restored following the conclusion of construction in the work area.

   Elderberry shrubs that must be removed will be transplanted to Service-approved Conservation Areas (the areas where plantings will occur to offset impacts). Transplanting, avoidance measures, and associated compensation will follow the 1999 Valley Elderberry Longhorn Beetle Conservation Guidelines except where modified with site specificity as stated herein. Avoidance measures for shrubs not directly affected by construction but within 100 ft of ground-disturbing activities will follow the guidance outlined in the 1999 Valley Elderberry Longhorn Beetle Conservation Guidelines as well.

2. For shrubs not directly affected by construction but that occur between 20 ft and 100 ft from ground-disturbing activities, the following measures will be implemented.

   a. Fence and flag areas to be avoided during construction activities. In areas where encroachment on the 100-ft buffer has been approved by the Service, provide a minimum setback of at least 20 ft from the dripline of each elderberry plant.

   b. To the greatest extent practicable, construction will be limited during the valley elderberry longhorn beetle active season, March 15th through June 15th.

   c. Brief contractors on the need to avoid damaging the elderberry plants and the possible penalties for not complying with these requirements.

   d. Erect signs every 50 ft along the edge of the avoidance area with the following information: "This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the

Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment." The signs will be clearly readable from a distance of 20 ft, and must be maintained for the duration of construction.

e. Instruct work crews about the status of the beetle and the need to protect its elderberry host plant.

f. During construction activities, no insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the 100-ft buffer area.

g. To the greatest extent practicable, nighttime construction will be minimized or avoided between March 15th and June 15th where valley elderberry longhorn beetle is likely to be present. Because there is potential for valley elderberry valley longhorn beetles to be attracted to nighttime light and thus increase the potential for predation, activities will cease no less than 30 minutes before sunset and will not begin again prior to no less than 30 minutes after sunrise. Except when necessary for driver or pedestrian safety, to the greatest extent practicable, artificial lighting at a construction site will be prohibited during the hours of darkness where valley elderberry longhorn beetle is likely to be present.

h. Night lighting of valley elderberry longhorn beetle habitat will be minimized to the extent practicable. If night lighting is to be used, to the greatest extent possible it will be pointed toward work areas and away from riparian, other sensitive habitats, and other areas that contain elderberry shrubs.

i. Restore any damage done to the buffer area (area within 100 ft of elderberry plants) during construction. Provide erosion control and re-vegetate with appropriate native plants.

j. For those parts of the water conveyance facility that will require ongoing maintenance (*e.g.*, intake facilities, pump facilities at CCF, in rights-of-way around permanent transmission lines, around vent shafts, etc.), buffer areas must continue to be maintained for the protection of the species after construction with measures such as fencing, signs, weeding, and trash removal as appropriate.

k. A written description of how the buffer areas are to be restored and maintained for the protection of the species will be provided to the Service.

l. To prevent fugitive dust from drifting into adjacent habitat, all clearing, grubbing, scraping, excavation, land leveling, grading, cut and fill, demolition activities, or other dust generating activities will be effectively controlled for fugitive dust emissions utilizing application of water or by presoaking work areas.

3. For shrubs directly affected by construction, and within 20 ft of disturbance activities if this area is also disturbed, the following measures will be followed for transplantation.

    a. A Service-approved biologist must be onsite for the duration of the transplanting of the elderberry plants to ensure that no unauthorized take of the valley elderberry longhorn beetle occurs. If unauthorized take occurs, the monitor has the authority to stop work until corrective measures have been completed. The monitor must immediately report any unauthorized take of the beetle or its habitat to the Service and to the CDFW.

    b. Elderberry shrubs will be transplanted during their dormant season, which occurs from November, after they have lost their leaves, through the first two weeks in February. If transplantation occurs during the growing season, increased compensation ratios will apply. Compensation ratios could be up to three times the standard compensation ratios as determined in consultation with Service staff.

    c. Transplantation procedure will be as specified in the 1999 Valley Elderberry Longhorn Beetle Conservation Guidelines.

    d. Elderberry shrubs will be transplanted into the area where plantings will occur to offset impacts referred to in the 1999 Valley Elderberry Longhorn Beetle Conservation Guidelines as the Conservation Area.

    e. If a plant appears to be unlikely to survive transplantation, then transplantation is not required, but a higher compensation ratio may be applied. In this instance, the Service will be contacted to determine the appropriate action.

Measures for Activities with Flexible Locations

4. During the planning phase, for these not fully sited activities, preconstruction surveys for elderberry shrubs will be conducted in potential work areas by a Service-approved biologist familiar with the appearance of valley elderberry longhorn beetle exit holes in elderberry shrubs. Preconstruction surveys will be conducted in accordance with the protocol provided in the 1999 Valley Elderberry Longhorn Beetle Conservation Guidelines, and survey results will be reported to the Service. Elderberry shrubs will be avoided to the greatest extent practicable. Complete avoidance (*i.e.*, no adverse effects) may be assumed when a buffer of at least 100 ft is established and maintained around elderberry plants containing stems measuring 1 inch or greater in diameter at ground level. Firebreaks may not be included in the buffer zone. The Service will be consulted before any disturbances, including construction, within the 100-ft buffer area are considered. Any damaged area within the buffer zones will be restored following the conclusion of construction in work areas.

Geotechnical Activities

5. Geotechnical exploration activities for the PA will fully avoid effects on valley elderberry longhorn beetle and its habitat.

Safe Haven Work Areas

6. Workers will confine ground disturbance and habitat removal to the minimal area necessary to facilitate construction activities. In addition, AMMs for safe haven interventions will be the same as described in Activities with Fixed Locations.

Power Lines and Grid Connections

7. Based on the planning level surveys, the siting of transmission towers and poles will avoid elderberry shrubs to the extent practicable. Valley elderberry longhorn beetle avoidance and minimization measures for transmission lines will be the same as described in Activities with Fixed Locations.

<u>*Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp*</u>

Activities with Known Locations

1. Staging areas will be designed so that they are more than 250 ft from vernal pool fairy shrimp or vernal pool tadpole shrimp habitat. All vehicles will access the work site following the shortest possible route from the levee road. All site access and staging shall limit disturbance to the riverbank, or levee as much as possible and avoid sensitive habitats. When possible, existing ingress and egress points shall be used.

2. A vehicle inspection and fueling area will be established at least 250 ft away from any vernal pools or seasonal wetlands to reduce the potential for chemical pollution such as oil, diesel, or hydraulic fluid. An inspection and fueling plan will be developed and construction workers trained so that any contamination is minimized. An emergency spill response plan will be completed and all workers will be trained on how to respond to emergency spills of chemicals.

3. If habitat is avoided (preserved) at the site, a Service-approved biologist will inspect any construction-related activities at the activity site to ensure that no unnecessary take of listed species or loss of their habitat occurs. The Service-approved biologist will have the authority to stop all activities that may result in take or loss of habitat until appropriate corrective measures have been completed. The Service-approved biologist also will be required to immediately report any unauthorized impacts to the Service.

4. Topographic depressions that are likely to serve as seasonal vernal pools will be flagged and avoided where possible.

5. Silt fencing will be installed wherever activities occur within 250 ft of vernal pool type seasonal wetlands. To avoid additional soil disturbances caused by silt fence installation, the bottom portion of the fence will be secured by waddles rather than buried.

6. All onsite construction personnel will receive instruction regarding the presence of listed species and the importance of avoiding impacts on the species and their habitat.

7. All activities that are inconsistent with the maintenance of the suitability of remaining habitat and associated onsite watersheds that support vernal pool fairy shrimp or vernal pool tadpole shrimp habitat are prohibited. This includes, but is not limited to: (1) alteration of existing topography or any other alteration or uses for any purposes, (2) placement of any new structures on these parcels, (3) dumping, burning, and/or burying of rubbish, garbage, or any other wastes or fill materials, (4) building of any new roads or trails, (5) killing, removal, alteration, or replacement of any existing native vegetation, (6) placement of storm water drains, (7) fire protection activities not required to protect existing structures at the site, and (8) use of pesticides or other toxic chemicals.

Activities with Uncertain Locations

8. Geotechnical exploration activities, the construction and operation and maintenance of transmission lines, and restoration activities for the PA will fully avoid effects on vernal pool fairy shrimp and vernal pool tadpole shrimp and their habitat. Full avoidance requires a minimum 250-ft, no-disturbance buffer around all vernal pools and other aquatic features potentially supporting vernal pool fairy shrimp or vernal pool tadpole shrimp.

Least Bell's Vireo

1. Prior to disturbing an area potentially supporting habitat for the species, a Service-approved biologist will evaluate the area to identify suitable habitat.

Measures for Activities with Fixed Locations

2. Prior to construction, all suitable least Bell's vireo habitat in the construction area will be surveyed, with surveys performed in accordance with any required Service survey protocols and permits applicable at the time of construction.

3. If surveys find least Bell's vireos in the area where vegetation will be removed, vegetation removal will be done when the birds are not present.

4. If an activity is to occur within 1,200 ft of least Bell's vireo habitat (or within 2,000 ft if pile driving will occur) during the breeding period for least Bell's vireos, the following measures will be implemented to avoid noise effects on least Bell's vireo.

a. Prior to the construction, a noise expert will create a noise contour map showing the 60 dBA noise contour specific to the type and location of construction to occur in the area.

b. During the breeding period for least Bell's vireo, a Service-approved biologist will survey any suitable habitat for least Bell's vireo within the 60 dBA noise contour on a daily basis during a two-week period prior to construction. While construction is occurring within this work window, the Service-approved biologist will conduct daily surveys in any suitable habitat where construction-related noise levels could exceed 60 dBA (A-weighted decibel) Leq (1 hour). If a least Bell's vireo is found, sound will be limited to 60 dBA in the habitat being used until the Service-approved biologist has confirmed that the bird has left the area.

5. Limit pile driving to daytime hours (7:00 a.m. to 7:00 p.m.).

6. Locate, store, and maintain portable and stationary equipment as far as possible from suitable least Bell's vireo habitat.

7. Employ preventive maintenance including practicable methods and devices to control, prevent, and minimize noise.

8. Route truck traffic in order to reduce construction noise impacts and traffic noise levels within 1,200 ft of suitable least Bell's vireo habitat during migration periods.

9. Limit trucking activities (*e.g.*, deliveries, export of materials) to the hours of 7:00 a.m. to 10:00 p.m.

10. Screen all lights and direct them down toward work activities and away from migratory habitat. A Service-approved biologist will ensure that lights are properly directed at all times.

11. Operate portable lights at the lowest allowable wattage and height, while in accordance with the National Cooperative Highway Research Program's Report 498: Illumination Guidelines for Nighttime Highway Work (Ellis *et al.* 2003).

Measures for Activities with Flexible Locations

Geotechnical Explorations

12. During geotechnical activities, a Service-approved biologist will be onsite to avoid the loss or degradation of suitable least Bell's vireo habitat by geotechnical exploration activities.

Safe Haven Work Areas

13. During the siting phase of safe haven construction, a Service-approved biologist will work with the engineers to avoid loss or degradation of suitable least Bell's vireo habitat. This includes ensuring that safe haven work areas are not sited in least Bell's vireo habitat. This also includes ensuring noise from safe haven work areas do not exceed 60 dBA at nearby least Bell's vireo habitat.

Power Supply and Grid Connections

14. The final transmission line alignment will be designed to minimize removal of least Bell's vireo habitat by removing no more than three acres of this habitat. To minimize the chance of least Bell's vireo bird strikes at transmission lines, bird strike diverters will be installed on project and existing transmission lines in a configuration that research indicates will reduce bird strike risk by at least 60% or more. Bird strike diverters placed on new and existing lines will be periodically inspected and replaced as needed until or unless the project or existing line is removed. The most effective and appropriate diverter for minimizing strikes on the market according to best available science will be selected.

Safe Havens

15. Safe haven sites will avoid least Bell's vireo habitat. All work associated with safe haven sites will be conducted during daylight hours, and will not require any lighting.

6.3 Compensatory Mitigation – Programmatic and Standard Actions

This section summarizes the proposed mitigation. As part of compensatory mitigation for impacts to listed species from the PA, DWR has proposed the following options: (1) restoration with protection in perpetuity, (2) enhancement with protection in perpetuity, (3) purchasing credits at an approved conservation bank, (4) creating and establishing a conservation bank, and (5) protection in perpetuity without restoration or enhancement. DWR has proposed to develop and implement management plans for restoration and protection sites but has not identified specific sites. The action agencies proposed that compensatory mitigation will be constructed and protected prior to PA impacts. All mitigation ratios below reflect protected habitat: lost habitat.

The PA includes a commitment that all lands protected and restored for compensation of effects on listed species will be protected and managed in perpetuity, and DWR will ensure adequate funding for this perpetual management. DWR will dedicate an endowment fund or other Service-approved perpetual funding mechanism for this purpose, and designate the party or entity that will be responsible for long-term management of these lands. Further, the endowment or other Service-approved financial assurance will designate the party or entity that will be responsible for the long-term management of these lands and associated waterways as applicable. The Service will be provided with written documentation that funding and management of mitigation lands will be provided in perpetuity. Habitat compensation will occur prior to the impact being compensated for. The compensatory mitigation strategy is further detailed in the *BiOp Resolution Log*.

For activities under the Corps' Phase 1 permitting process, if it is determined that listed species or critical habitat are present and may be affected as a result of the compensatory mitigation, the Corps is required to reinitiate this consultation to address these effects. Effects of the compensatory mitigation associated with the Corps Phase 2 and Reclamation's actions will be addressed in subsequent consultations. Phase 2 compensatory mitigation activities will be subject to approvals by either Reclamation or the Corps, depending on the nature of the activities and authority and oversight over the activities. Therefore, subsequent consultations with either of these agencies will occur in order to assess the effects of Phase 2 compensatory mitigation. The mitigation approach for the construction of the CCWD Settlement Agreement will be consistent with mitigation approach for effects to species from other CWF construction activities.

NMFS Species

The PA includes restoration of 154.8 acres of tidal perennial habitat suitable for NMFS species and 4.3 miles of channel margin habitat to mitigate for permanent and temporary losses of migration and rearing habitat. Refer to the CWF BA for further discussion.

As a condition of approval of the ITP under Section 2081(b) of the California Fish & Game Code (2081(b) ITP), CDFW is requiring that, upon issuance of a final water right order by the SWRCB that approves the changes in point of diversion for the project, DWR will provide funds to implement multiple restoration actions necessary and sufficient to minimize effects of the project on listed salmonids. DWR will provide up to $4,000,000 annually to benefit spring-run Chinook salmon (CHNSR) and winter-run Chinook salmon (CHNWR) and steelhead in the Sacramento River watershed.

As a condition of the 2081(b) ITP, CDFW is requiring DWR to improve spawning and rearing habitat for CHNSR, CHNWR and steelhead, and contribute to establishment of additional populations of winter run, support adult spawning, egg incubation and juvenile production. The funding described above will be used specifically to establish a new population of CHNWR through introduction and reintroduction of fish into Sacramento River tributaries (which may include Battle Creek and/or upstream of Shasta Reservoir) and to support that population with associated habitat restoration and other measures within ten years of order issuance. Consistent with the 2081(b) ITP, the goal of this action is to establish a new CHNWR population in the Sacramento River watershed within the term of this permit that meets the low extinction risk criteria identified by the Central Valley Technical Recovery Team (CVTRT) (Lindley *et al.*

2007).As a condition of the 2081(b) ITP, DWR will fully fund and implement reintroduction and restoration action effectiveness monitoring and extinction risk monitoring to ensure that the goal is met. Additionally, the 2081(b) ITP requires that funding commitments will be sufficient to support creation and enhancement of Sacramento River spawning and instream and/or off-channel rearing habitat and measurable expansion of salmonid habitat capacity. Consistent with the 2081(b) ITP, the goal of this effort is to contribute to the quantity, quality, and diversity of important rearing habitat along the Sacramento River corridor for CHNWR, CHNSR, and steelhead, and may include use of mitigation bank(s) as appropriate.

DWR and Reclamation commit to improve and expand the diversity, quantity, and quality of rearing and refuge habitat in the tidal portions of the Delta and Suisun Marsh. DWR will restore at least 1,800 acres of tidal habitat, consistent with the multi-species benefits that exist with restoration associated with the delta smelt conservation measures described below, that will contribute to improved growth, survival, and migratory success of juvenile CHNWR, CHNSR, and steelhead, including potential use of mitigation banks as deemed appropriate. This amount is in addition to the 9,000 acres of restoration currently being implemented through EcoRestore.

Additional tidal restoration, provided in part through the funding described above, will be considered if necessary to address potential undesirable hydrodynamic effects of NDD operations (*e.g.*, reverse flows) as well as climate change and sea-level rise. DWR and Reclamation commit to ongoing analytical efforts as part of the AMP to better understand what restoration (*e.g.*, location and amount), in combination with other changes to baseline would be necessary to address the effect of reverse flows caused by NDD operations. Furthermore, DWR and Reclamation commit as part of the AMP to a monitoring program to assess the performance of these actions and modify the mitigation approach as necessary to offset the effects of the project as they are better understood.

As a condition of the 2081(b) ITP, CDFW is requiring DWR to operate the SWP to achieve pre-project juvenile CHNWR and CHNSR survival rates at Chipps Island (as established by Pre-construction Study 12 in Table 6.1-5 of Section 6.1 *Description of the Proposed Action*).If alternative migratory routes and/or other CWF mitigation efforts are able to increase the number of juvenile CHNSR and CHNWR successfully passing Chipps Island or improve downstream survival rates offsetting through-Delta loss associated with NDD operations, CDFW will consider it as a potential mechanism to meet this criterion. As a condition of the 2081(b) ITP, CDFW is requiring that the Test Period and Full Project Operations survival rates shall be determined by Post-Construction Study 12 (Table 6.1-5 of Section 6.1 *Description of the Proposed Action*). CDFW is requiring that survival estimates be provided to CDFW, the Technical Oversight Team (TOT) and the North Delta Diversion Technical Team (NDDTT) on an annual basis and used in the AMP to determine if criterions are being achieved.

Delta Smelt

Restoration of 1,827.7 acres of habitat suitable for delta smelt is proposed, of which 74.7 acres is intended to minimize construction impacts from the HORG and barge landings, and 1,753 acres is intended to minimize effects from permanent loss of shallow water habitat in the vicinity and upstream of the NDD.

The proposed habitat restoration will minimize effects on delta smelt spawning, rearing, and migration habitat. Restoration will be performed at a site(s) in the vicinity of west Delta, central Delta, north Delta, Cache Slough, and/or other Service-approved site. Within these broader regions, examples of site-specific areas include, but are not limited to: Sherman Island, lower San Joaquin River (such as San Andreas Shoal and Prisoners Point area), Sutter and Steamboat Sloughs, and waterways within the Cache Slough Complex.

The 1,753 acres of compensatory mitigation from restricted upstream access will include spawning habitat, as deemed appropriate by the Service and CDFW during the site-specific design based on criteria including salinity, velocity, substrate, and locations necessary to support delta smelt spawning. The focus for spawning habitat will be on restoring or creating sandy shoals, islands, and/or channel bar augmentation. Noting that the characteristics of desirable spawning habitat for delta smelt are not well understood, these criteria will be informed by studies DWR and Reclamation will fund to monitor and research habitat preferences. DWR and Reclamation will fund monitoring and research to: (1) determine the existing use of the area at and upstream of the NDD, (2) perform studies (*e.g.*, field-based mesocosms in actual Sacramento River habitat) to determine spawning habitat characteristics, and based on this information, (3) refine existing conceptual models, in coordination with the Service and CDFW, to better define the characteristics that would be included in the site-specific restoration design to ensure that the restored sites offer high functioning spawning habitat to delta smelt.

DWR and Reclamation will develop a sediment reintroduction plan, described in concept in the CWF BA, to specifically address spawning habitat needs for delta smelt, including the potential for a recurring sediment placement program to maintain sites for the duration of the PA's long-term effects.

San Joaquin Kit Fox

DWR will compensate for loss of habitat by protecting San Joaquin kit fox habitat at a ratio of 3:1 at a location subject to Service approval, adjacent to other modeled San Joaquin kit fox habitat to provide a large, contiguous habitat block. San Joaquin kit fox habitat protection will be accomplished either through the purchase of mitigation credits through an existing, Service-approved conservation bank or will be purchased in fee-title by DWR or a DWR partner organization with approval from the Service. If purchased in fee-title, a permanent, Service-approved conservation easement will be placed on the property. Suitable San Joaquin kit fox habitat will be acquired for protection in the Byron Hills area, subject to Service approval, where there is connectivity to existing protected habitat and to other adjoining San Joaquin kit fox habitat. Grassland protection will focus in particular on acquiring the largest remaining contiguous patches of unprotected grassland habitat, which are located south of State Route (SR)

4. This area connects to over 620 acres of existing habitat that was protected under the East Contra Costa County Habitat Conservation Plan (HCP)/ Natural Community Conservation Plan (NCCP) (East Contra Costa County Habitat Conservancy 2006). Refer to the CWF BA for siting details.

Western Yellow-Billed Cuckoo

DWR will offset the loss of 32 acres of western yellow-billed cuckoo migratory habitat through the creation or restoration at a 2:1 ratio, for a total of 64 acres of migratory riparian habitat creation or restoration in the action area. DWR will develop a riparian restoration plan that will identify the location and methods for riparian creation or restoration, and this plan will be subject to Service approval. Refer to the CWF BA for further discussion.

Giant Garter Snake

Where identified and delineated giant garter snake habitat cannot be avoided, compensation for the loss of the habitat will occur at a ratio of 3:1 for each, aquatic and upland habitat. An estimated 775 acres of giant garter snake habitat will be affected; therefore, approximately 2,325 acres of giant garter snake habitat will be protected or restored. Insofar as mitigation is created/protected in a Service agreed-to high-priority conservation area, such as the eastern protection area between Caldoni Marsh and Stone Lakes, a mitigation ratio of 2:1 for each, aquatic and upland habitat type, will apply which may lower the above example to 1,550 acres of mitigation. This ratio and locations will be reviewed and approved by the Service.

Giant garter snake upland mitigation will be placed and protected adjacent to aquatic habitat protected for giant garter snake. The upland habitat will not exceed 200 ft from protected aquatic habitat (unless research shows a larger distance is appropriate and the Service agrees).

Incidental injury and/or mortality of giant garter snakes within protected and restored habitat will be avoided or minimized by establishing 200-ft buffers between protected giant garter snake habitat and roads (other than those roads primarily used to support adjacent cultivated lands and levees). Protected and restored giant garter snake habitat will be at least 2,500 ft from urban areas or areas zoned for urban development.

Characteristics of restored and protected habitat may change from the above descriptors if new information and best available science indicate greater benefits as agreed to by the Service. Specific mitigation locations have not been proposed at this time. Siting criteria as described in the CWF BA are still in discussion between DWR, the Service, and CDFW.

California Red-legged Frog

California red-legged frog aquatic and upland habitat will be protected at a ratio of 3:1 within the East San Francisco Bay core recovery area, at locations subject to Service approval. Three acres of aquatic habitat and 153 acres of upland cover and dispersal habitat will be protected. The compensation ratios apply only if protection occurs prior to or concurrent with the impact. If protection occurs after an impact, the ratio will increase. Refer to the CWF BA for further discussion.

California Tiger Salamander

DWR will protect California tiger salamander habitat at a ratio of 3:1 at locations subject to Service approval, adjacent to or near occupied, protected upland habitat, with a management plan and endowment, or similar funding mechanism, to direct and fund management in perpetuity. California tiger salamander habitat protection will be located in the Byron Hills area, west of the worksite. Grasslands targeted for protection will be located near important areas for conservation that were identified in the East Contra Costa County HCP/NCCP (East Contra Costa County Habitat Conservancy 2006) (not all of which will be acquired by that plan) and will include appropriate upland and aquatic features, *e.g.*, rodent burrows, stock ponds, intermittent drainages, and other aquatic features, etc. An estimated 150 acres of habitat will be protected. Refer to the CWF BA for further discussion.

Valley Elderberry Longhorn Beetle

DWR will mitigate impacts to valley elderberry longhorn beetle habitat by either creating valley elderberry longhorn beetle habitat or by purchasing the equivalent credits at a Service-approved conservation bank with a service area that overlaps with the action area consistent with the 1999 Valley Elderberry Longhorn Beetle Conservation Guidelines. These guidelines require replacement of each impacted valley elderberry bush stem measuring one inch or greater in diameter at ground level, in the Conservation Area, with valley elderberry seedlings or cuttings at a ratio ranging from 1:1 to 8:1 (new plantings to affected stems), and planting of associated native riparian plants. These ratios will apply if compensation occurs prior to or concurrent with the impacts. If compensation occurs after the impacts, a higher ratio may be required by the Service. The planting area will provide at a minimum 1,800 square feet (sf) for each transplanted valley elderberry shrub. As many as five additional valley elderberry plantings (cuttings or seedlings) and up to five associated native species plantings may also be planted within the 1,800 square ft area with the transplant. An additional 1,800 sf will be provided for every additional 10 conservation plants. Refer to the CWF BA for further discussion.

Vernal Pool Fairy Shrimp and Tadpole Fairy Shrimp

For every acre of habitat directly or indirectly affected, at least two vernal pool credits will be purchased within a Service-approved ecosystem preservation bank. Alternatively, based on Service evaluation of site-specific conservation values, three acres of vernal pool habitat may be preserved at the affected site or on another non-bank site as approved by the Service. For every acre of habitat directly affected, at least one vernal pool creation credit will be dedicated within a

Service-approved habitat conservation bank, or, based on Service evaluation of site-specific conservation values, two acres of vernal pool habitat will be created and monitored at the affected site or on another non-bank site as approved by the Service.

Compensation ratios for non-bank compensation may be adjusted if the Service considers the conservation value of the non-bank compensation area to approach that of Service-approved conservation banks. If protection occurs outside a Service-approved conservation bank, protection will be prioritized in the Livermore recovery unit, which is one of the core recovery areas identified in the Vernal Pool Recovery Plan (Service 2005) and is adjacent to an existing protected vernal pool complex. Protected sites will be prioritized within the affected critical habitat unit for vernal pool fairy shrimp, unless an adequate rationale is provided to the Service for lands to be protected outside of the critical habitat unit. Protected sites will include the surrounding upland watershed necessary to sustain the vernal pool functions (*e.g.*, hydrology, uplands to provide for pollinators, etc.).

If vernal pool restoration is conducted outside of a Service-approved conservation bank, the restoration sites will meet the following site selection criteria: (1) the site has evidence of historical vernal pools based on soils, remnant topography, remnant vegetation, historical aerial photos, or other historical or site-specific data, (2) the site supports suitable soils and landforms for vernal pool restoration, (3) the adjacent land use is compatible with restoration and long-term management to maintain natural community functions (*e.g.*, not adjacent to urban or rural residential areas), and (4) ensure sufficient land is available for protection (vernal pool features and surrounding grasslands) to ensure the local watershed can sustain vernal pool hydrology, with a vernal pool density representative of intact vernal pool complex in the vicinity of the restoration site.

Acquisition of vernal pool restoration sites will be prioritized based on the following criteria: (1) the site will contribute to establishment of a large, interconnected vernal pool and alkali seasonal wetland complex reserve system (*e.g.*, adjacent to an existing protected vernal pool complex or alkali seasonal wetland complex) and (2) the site is close to known populations of vernal pool fairy shrimp or vernal pool tadpole shrimp. Refer to the CWF BA for further discussion.

Least Bell's Vireo

DWR will mitigate the loss of 32 acres of least Bell's vireo habitat through the creation or restoration at a 2:1 ratio, for a total of 64 acres of riparian habitat creation or restoration in the action area. DWR will develop a riparian restoration plan that will identify the location and methods for riparian creation or restoration, and this plan will be subject to Service approval.

Sacramento River Sediment Reintroduction

Sacramento River sediment removed from the water column at the intake sedimentation basins will be reused. To the maximum extent practicable, the first and preferred disposition of this material will be to reintroduce it to the water column in order to maintain Delta water quality (specifically, turbidity, as a component of delta smelt critical habitat). DWR will collaborate with the Service and CDFW to develop and implement a sediment reintroduction plan that provides the desired beneficial habitat effects of maintained turbidity while addressing related permitting concerns (the proposed sediment reintroduction is expected to require permits from the Central Valley Regional Water Quality Control Board and the Corps). The Service and NMFS will have approval authority for this plan and for monitoring measures, to be specified in the plan, to assess its effectiveness. Current conceptual design for the plan suggests that it will incorporate placement of sediment during low flow periods at a seasonally inundated location along the mainstem river, such as a bench constructed for the purpose. The sediment would then be remobilized and carried downstream following inundation during seasonal high flows (generally, the winter and spring months). The sediment reintroduction would be designed for consistency with CVRWQCB's Basin Plan objectives for turbidity, namely, "For Delta waters, the general objectives for turbidity apply subject to the following: except for periods of storm runoff, the turbidity of Delta waters shall not exceed 50 NTUs (Nephelometric Turbidity Units) in the waters of the central Delta and 150 NTUs in other Delta waters. Exceptions to the Delta specific objectives will be considered when a dredging operation can cause an increase in turbidity. In this case, an allowable zone of dilution within which turbidity in excess of limits can be tolerated will be defined for the operation and prescribed in a discharge permit" (Central Valley Water Board 1998).

7.0 DESCRIPTION OF THE ACTION AREA

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for this consultation encompasses the entire legal Delta, Suisun Marsh, Suisun Bay, and Byron Hills; and extends upstream within the channels of the Sacramento and American rivers to Keswick and Nimbus Dams. See Figure 7.0-1 and 7.0-2. Byron Hills is 13,156 acres south of Highway 4, east of Los Vaqueros Reservoir, north of the Contra Costa/Alameda county line, and west of the Byron Highway.

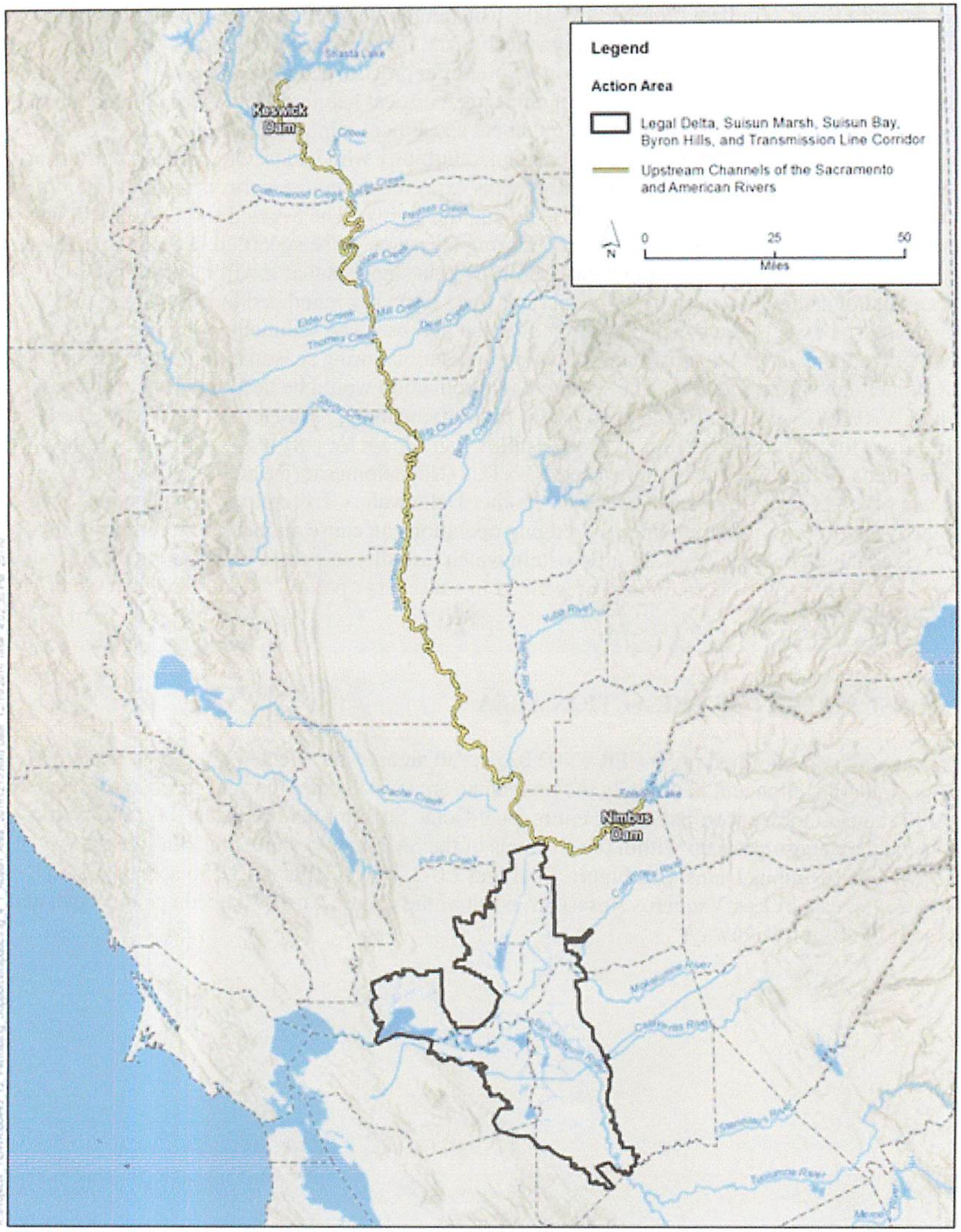

Figure 7.0-1. Map of CWF Action Area.

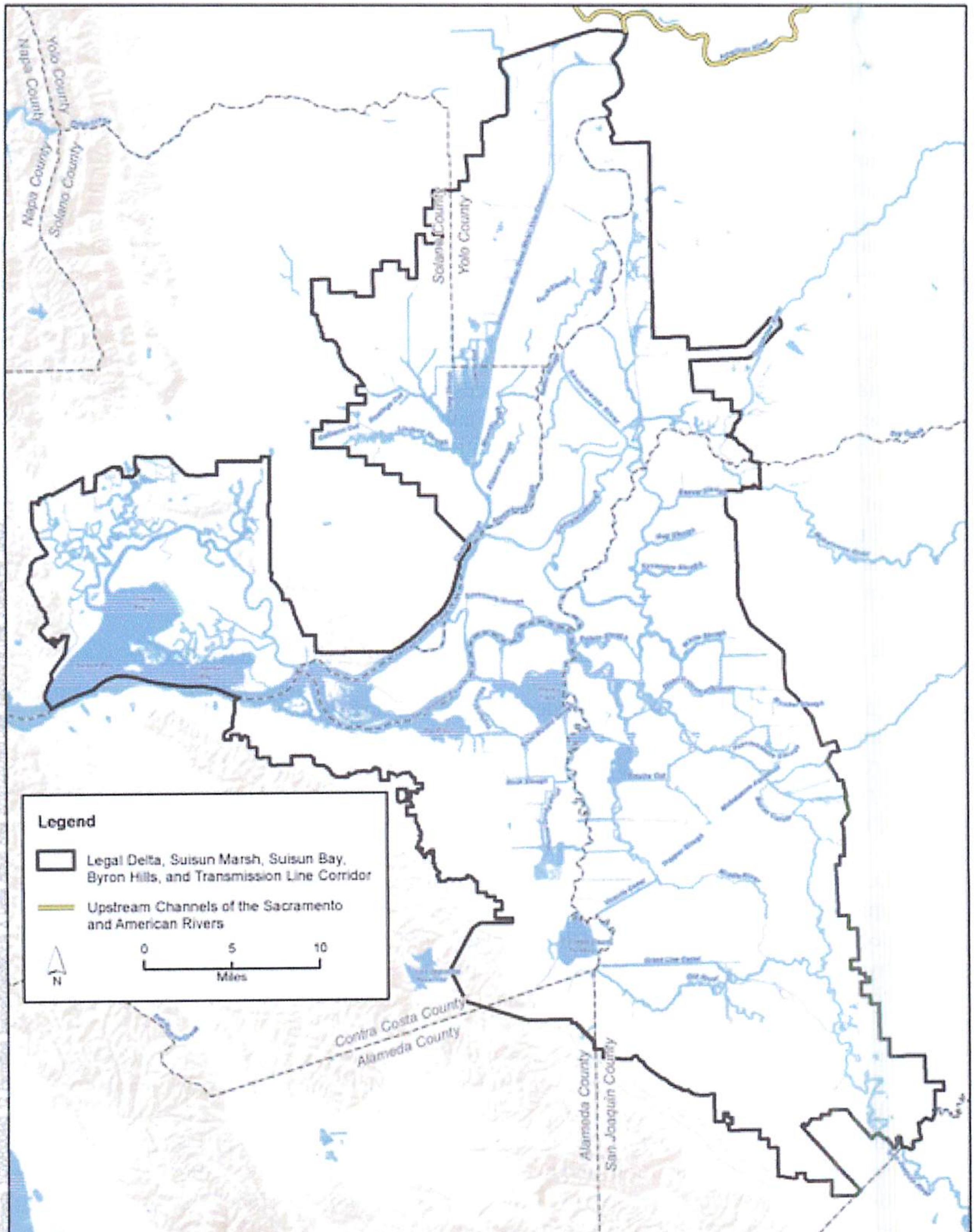

Figure 7.0-2. Detailed map of CWF Action Area.

8.0 ANALYTICAL FRAMEWORK

8.1 Analytical Framework for the Jeopardy Determination

Section 7(a)(2) of the Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02).

The jeopardy analysis in this BiOp considers the effects of the proposed Federal action, and any cumulative effects, on the range-wide survival and recovery of the listed species. It relies on four components: (1) the *Status of the Species*, which describes the range-wide condition of the species, the factors responsible for that condition, and its survival and recovery needs, (2) the *Environmental Baseline*, which analyzes the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species, (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species, and (4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the species.

8.2 Analytical Framework for the Adverse Modification Determination

Section 7(a)(2) of the Act requires that Federal agencies insure that any action they authorize, fund, or carry out is not likely to destroy or to adversely modify designated critical habitat. A final rule revising the regulatory definition of "destruction or adverse modification" was published on February 11, 2016 (81 FR 7214). The final rule became effective on March 14, 2016. The revised definition states:

> "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features."

The destruction or adverse modification analysis in this BiOp relies on four components: (1) the *Status of Critical Habitat*, which describes the range-wide condition of the critical habitat in terms of the key components (*i.e.*, essential habitat features, primary constituent elements, or physical and biological features) that provide for the conservation of the listed species, the factors responsible for that condition, and the intended value of the critical habitat overall for the conservation/recovery of the listed species, (2) the *Environmental Baseline*, which analyzes the condition of the critical habitat in the action area, the factors responsible for that condition, and the value of the critical habitat in the action area for the conservation/recovery of the listed species, (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated and interdependent activities on the key components of critical habitat that provide for the conservation of the listed species, and how those impacts are likely to influence the conservation value of the affected critical habitat, and (4) *Cumulative Effects*, which evaluate the effects of future non-Federal activities that are reasonably certain to occur in the action area on the key components of critical habitat that provide for the conservation of the listed species and how those impacts are likely to influence the conservation value of the affected critical habitat.

For purposes of making the destruction or adverse modification determination, the Service evaluates if the effects of the proposed Federal action, taken together with cumulative effects, are likely to impair or preclude the capacity of critical habitat in the action area to serve its intended conservation function to an extent that appreciably diminishes the range-wide value of critical habitat for the conservation of the listed species. The key to making that finding is understanding the value (*i.e.*, the role) of the critical habitat in the action area for the conservation/recovery of the listed species based on the *Environmental Baseline* analysis.

9.0 SPECIES ANALYSES

9.1 Considerations Applicable to All Species

The PA includes activities at various stages of development, for which little or no information exists at this time regarding effects to listed species or critical habitat. These activities include compensatory mitigation, maintenance of the proposed facilities, monitoring, and adaptive management of several aspects of the PA. Pursuant to the *Consultation Approach* section above, Reclamation or the Corps will ensure that effects to species or critical habitat are addressed by either reinitiating this consultation or initiating subsequent consultations, depending on the triggers and processes associated with each activity.

Compensatory Mitigation

DWR proposes to provide species-specific compensatory mitigation prior to construction, operations, and other activities at the ratios or acreages identified in the *Description of the Proposed Action* for each species. DWR has proposed to use one or more of the following options to implement the species-specific mitigation: (1) restoration with protection in perpetuity, (2) enhancement with protection in perpetuity, (3) purchasing credits at an approved conservation bank, (4) creating and establishing a conservation bank, and (5) protection in perpetuity without restoration or enhancement. We anticipate that this compensatory mitigation will minimize effects to each species by replacing the function of the habitat lost, altered, or degraded as a result of construction, maintenance, and operations of the existing and proposed CVP and SWP facilities in the action area, unless otherwise specifically identified in the species-specific effects sections. DWR has proposed to develop and implement management plans for the mitigation lands, but has not yet identified specific sites. The CWF BA does not identify or analyze effects to listed species or critical habitat from implementation of the compensatory mitigation because, the mitigation sites have not been chosen. Without the site-specific information will mitigation will be located, we don't have sufficient information to determine if mitigation will have species effects or the extent of those effects.

All compensatory mitigation activities will be subject to approvals by either Reclamation or the Corps (as described in the *Description of the Proposed Action*), depending on the nature of the activity and which agency has authority and oversight. Therefore, either reinitiation of this consultation or subsequent consultations with either of these agencies will occur so that the Service can assess the effects of each compensatory mitigation project.

For activities under the Corps' Phase 1 permitting process, if it is determined that listed species or critical habitat are present and may be affected as a result of the compensatory mitigation, the Corps will reinitiate this consultation to address these effects. Effects of the compensatory mitigation associated with the Corps Phase 2 and Reclamation's actions will be addressed in subsequent consultations.

The action agencies and DWR have committed in the PA to protecting and managing mitigation sites in perpetuity and ensuring adequate funding for the perpetual management of all compensatory mitigation. Management plans will be developed for each compensatory mitigation site with a conservation easement or other Service-approved conservation mechanism that is held by a third party approved by the Service. DWR will secure an endowment or other Service-approved financial assurance that will be sufficient to fund any monitoring, operations, maintenance, and adaptive management of the restoration site. Further, the endowment or other Service-approved financial assurance will designate the party or entity that will be responsible for the long-term management of these lands and associated waterways as applicable. The Service will be provided with written documentation that funding and management of mitigation lands will be provided in perpetuity.

Therefore, based on these commitments and assurances provided by DWR described in the CWF BA, we anticipate that the proposed compensatory mitigation will minimize the adverse effects of PA activities to each species by replacing the function of the habitat that will be lost, altered, or degraded as a result of implementing the PA. Where appropriate, the proposed species-specific habitat ratios or acreages are described within our analysis of each species.

Maintenance

As described in the *Description of the Proposed Action*, future maintenance of the project facilities will be necessary. Table 9.1-1 describes some of the anticipated maintenance activities and their assumed frequencies once the facilities are built. Little information is known at the time of this consultation about when, how, and, in some cases, where these maintenance activities will be implemented; therefore, no analysis was provided in the CWF BA as to how or if these activities would affect listed species or critical habitat. Addressing effects resulting from future maintenance activities would be speculative at this time. If maintenance activities may affect listed species or critical habitat and are not subject to future approvals (*i.e.,* the Corps' Phase 1 permit), reinitiation of this consultation is required to address those effects. Maintenance activities associated with all other aspects of the PA will require future approvals as described in the *Description of the Proposed Action* and will be subject to future consultations if those activities may affect listed species or critical habitat.

Table 9.1-1. Potential maintenance activities and assumed frequency associated with elements of the PA as described in the CWF BA.

North Delta Diversions

Activity	Assumed Frequency	
	Basic	Major
Dredging within sedimentation basins in areas isolated from river	Annually	
Dredging on river side of intake screen	Every 3-5 years (routine maintenance dredging)	Every 10-15 years based on frequency of flow events (>100,000 cfs)
Levee maintenance (responsibility transferred to Corps or Central Valley Flood Protection Board [CVFPB])	-Inspections: 4x/year (no more than 90 days apart) -Vegetation control: 2x/year -Approx. 20 days/year total -Assume maintenance occurs within 100 ft distance from intake structure	Dependent on major erosion or other stability issues
Fish screen and bay maintenance activities in areas isolated from river	Weekly inspections for normal operation of screens and cleaning system	Annual maintenance of fish screen (pressure washing) and bays (dewatering, sediment/debris removal, and mechanical maintenance)
Cleaning brush replacement	Annual inspections	Replacement (typically every 3 years)
Baffle adjustment	Tuning to achieve uniform approach velocity across screen face annually	As needed to comply with design/screening criteria
Debris removal (log boom, screen face) on river side of intake screen	Annually or as needed	
Inspection, maintenance, and monitoring of screen	Keep maintenance log	

Clifton Court Forebay

Activity	Assumed Frequency	
	Basic	Major
Dredging of SCCF	Minimum of every 15 years	Unanticipated; potential dredging to address shoaling/scouring affecting gate operations
Embankment maintenance (per Division of Safety of Dams [DSOD] requirements)	-Inspections: 4x/year -Vegetation control: 2x/year -Approx. 20 days/year total	Frequency of repairs dependent on major erosion/stability issues
Vegetation control	Annually in summer (2-3 days per treatment)	
Predator control	Boat electrofishing: 3x/week (Jan-May)	
Labyrinth weir debris removal	None if not used	Periodically as weir is used for emergency overflow
Siphon	Debris removal annually or as needed	Sediment removal in siphon
Debris removal (roller gates, radial gates, stop logs)	Annually or as needed	

Barge Landings

Activity	Assumed Frequency	
	Basic	Major
Dredging	Every 3-5 years after initial dredging (depending on lifespan of landing)	Spot dredging as needed to address potential grounding issues
Barge route dredging	Every 3-5 years after initial dredging (depending on duration of barge operations)	Spot dredging as needed to address potential grounding issues
Aquatic vegetation control	Annual inspections; spot treat annually or as needed	

Head of Old River Gate

Activity	Assumed Frequency	
	Basic	Major
Dredging	Every 3-5 years (routine maintenance dredging)	-Removal of accumulated sediment after major flow events: Every 5-10 years based on Vernalis flows > 30,000 cfs -Spot dredging as needed to address potential grounding issues
Mechanical maintenance (motors, compressors, control systems)	-Annual inspections; servicing/repairs as needed	
Gate maintenance (Obermeyer-type gate assumed)	-Annual inspections; servicing/repairs as needed -Monthly testing of gate mechanism -Sediment/debris removal: Annually or as needed	Dewatering and repairs: Every 5-10 years
Boat lock maintenance	-Annual inspections; servicing/repairs as needed -Monthly testing of gate mechanism -Sediment/debris removal: Annually or as needed -Aquatic vegetation control: Annual inspections and treatment as needed	Dewatering and repairs: Every 5-10 years
Fish ladder maintenance	Maintain water surface elevation levels when the gate is in operation	-Annually or as needed (more frequent during winter months) -Sediment/debris removal after major flow events

Compensatory Mitigation Sites

Activity	Assumed Frequency	
	Basic	Major
Levee maintenance (responsibility transferred to local maintenance agencies)	Inspections: 4x/year Vegetation control: 2x/year Approx. 20 days/year total	
Riparian plantings (replantings, watering, non-native removal)	Watering: 2x/week (summer) and 2x/month (growing season) for 2-3 years Non-native removal: 1x/2 months for 3-5 years	Annual inspections and applied treatments as necessary
Post-project habitat monitoring	After success criteria are achieved, inspections conducted once every 3-5 years to verify functionality and compliance with performance standards	Once per month for first 2 years
Aquatic species and water quality monitoring	Once per month for species of interest for years 1-3	Annually for years 4-10
Terrestrial species and delta smelt monitoring	Future Service-approved long-term management and monitoring plan with future identified performance standards	

Monitoring

Monitoring activities will occur prior to operations and after operations commence. Monitoring and studies of listed fish species will be focused on the construction and operation of conveyance facilities. This monitoring will begin with baseline data collection needed to compare with similar post-construction findings. While a detailed effort has been made regarding proposed monitoring for the NDD, monitoring prior to operations will be required throughout the action area. DWR has committed to working with the Service and other agencies to develop the specifics (including timeframes) of monitoring using various technical teams. Monitoring and studies related to operations that must occur after operation of the new facilities has commenced consist of four types: monitoring addressing the operation of the proposed new facilities, monitoring related to species condition and habitat that may be influenced by operations of the new facilities, monitoring to evaluate the effectiveness of the proposed facilities, and monitoring addressing the performance of the habitat protection and restoration sites.

Little information is known at the time about when, where, and how monitoring will be implemented; therefore, no analysis was provided in the CWF BA as to how these activities would affect listed species or critical habitat. Addressing effects resulting from monitoring activities would be speculative at this time. If monitoring activities that are not subject to future section 7 consultation or approvals (*i.e.,* the Corps' Phase 1 permit) may affect listed species or critical habitat, reinitiation of this consultation is required to address those effects. Monitoring activities associated with all other aspects of the PA will require future approvals as described in the *Description of the Proposed Action* and will be subject to future consultations if those activities may affect listed species or critical habitat.

Adaptive Management

Reclamation, DWR, the Service, NMFS, CDFW, and the public water agencies have agreed to develop a program of collaborative science, monitoring, and adaptive management in support of CWF (CWF BA 2016, Appendix 3.H). The AMP outlines a collaborative process for assessing and adapting to effects to listed species stemming from the ongoing operation of the CVP and SWP, including future implementation and operation of the CWF. Under the AMP, new information developed during the course of implementation is expected to inform operational decisions and conservation tactics. New information will be developed through scientific research to understand the ecological changes that the CWF and other cumulative effects will have on the Bay-Delta ecosystem, including delta smelt. However, currently little information is known about what, when, where, and how these effects will be adaptively managed, much less how they will be implemented. Therefore, no analysis was provided in the CWF BA as to how or if activities associated with adaptive management would affect listed species or critical habitat. Addressing effects resulting from the implementation of the adaptive management plan would be speculative at this time. If activities that are identified as part of the framework are not subject to future approvals (*i.e.,* the Corps' Phase 1 permit) and may affect listed species or critical habitat, reinitiation of this consultation is required to address those effects. Activities associated with all other aspects of the PA will require future approvals as described in the *Description of the Proposed Action* and will be subject to future consultations if those activities may affect listed species or critical habitat.

9.2 Delta Smelt and its Critical Habitat

9.2.1 Status of the Species and Critical Habitat/Environmental Baseline

The CWF action area encompasses almost the entire species range and the critical habitat designation. The Napa River is outside of the CWF action area, but delta smelt do occur in that river. However, this small area is on the fringe of the species range. For the purposes of this BiOp, the Status of the Species, Status of the Critical Habitat, and Environmental Baseline are combined.

The Environmental Baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of State or private actions, which are contemporaneous with the consultation in process (50 CFR 402.02). The key purpose of the Environmental Baseline is to describe the condition of the listed species/critical habitat that exist in the action area in the absence of the action subject to this consultation. Sections 9.2.1.2 and 9.2.1.4 describe in more detail the conditions in the action area and a description of previous actions that have contributed to these current conditions.

9.2.1.1 Status of the Species

Legal Status

The Service proposed to list the delta smelt (*Hypomesus transpacificus*) as threatened with proposed critical habitat on October 3, 1991 (Service 1991). The Service listed the delta smelt as threatened on March 5, 1993 (Service 1993), and designated critical habitat for the species on December 19, 1994 (Service 1994). The delta smelt was one of eight fish species addressed in the *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (Service 1996), and a revision addressing delta smelt is currently underway. A 5-year status review of the delta smelt was completed on March 31, 2004 (Service 2004). The 2004 review concluded that delta smelt remained a threatened species. A subsequent 5-year status review recommended uplisting delta smelt from threatened to endangered (Service 2010a). A 12-month finding on a petition to reclassify the delta smelt as an endangered species was completed on April 7, 2010 (Service 2010b). After reviewing all available scientific and commercial information, the Service determined that re-classifying the delta smelt from a threatened to an endangered species was warranted but precluded by other higher priority listing actions (Service 2010c). The Service annually reviews the status and uplisting recommendation for delta smelt during its Candidate Notice of Review (CNOR) process. Each year, the CNOR has recommended the uplisting from threatened to endangered. Electronic copies of these documents are available at http://ecos.fws.gov/docs/five_year_review/doc3570.pdf and http://www.gpo.gov/fdsys/pkg/FR-2013-11-22/pdf/2013-27391.pdf (Service 2010a; Service 2010b).

Description and Life Cycle

The delta smelt is a small fish of the family Osmeridae. It is endemic to the San Francisco Bay-Delta where it primarily occupies open-water habitats in Suisun Bay and marsh and the Sacramento-San Joaquin Delta. The delta smelt is primarily an annual species, meaning that it completes its life cycle in one year which typically occurs from April to the following April plus or minus one or two months. In captivity delta smelt can survive to spawn at two years of age (Lindberg *et al.* 2013), but this appears to be rare in the wild (Bennett 2005). Very few individuals reach lengths over 3.5 inches (90 mm).

Population Numbers

The spawning stock of delta smelt in WY 2017 appears to be at its second lowest abundance on record, the lowest having been recorded during WY 2016 (Table 9.2.1.1-1). The 2016 Fall Midwater Trawl (FMWT) Index was 7, the second lowest on record. The CDFW Spring Kodiak Trawl (SKT) monitors the adult spawning stock of delta smelt and serves as an indication for the relative number and distribution of spawners in the system. The 2017 SKT Abundance Index is 3.8, the second lowest on record. The Service calculated an absolute abundance estimate[18] for adult delta spawners in WY 2017, using January and February SKT data. This absolute abundance estimate is also the second lowest on record (Table 9.2.1.1-1). The population size of adult delta smelt January through February 2017 was estimated to be between 22,000 and 92,000 fish with a point estimate of 47,786. The January through February, 2016 point estimates were the lowest values since 2002 and suggested delta smelt experienced increased mortality during the extreme drought conditions occurring during 2013-2015. While 2017 estimates likely represent an increase in recruitment and survival from the prior year, the continued low parental stock of delta smelt relative to historical numbers suggest the population will continue to be vulnerable to stochastic events and operational changes that may occur in response until successive years of increased population growth results in a substantial increase in abundance.

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[18] The Service completed a revised adult delta smelt abundance estimation procedure based on CDFW's SKT data for January and February (see Table 9.2.1.1-1). This procedure has recently been updated from that used in 2016. While these estimates likely represent a minimum population size due to the method reliance on survey data, this is our current best estimate of the annual population size.

Table 9.2.1.1-1. Three indicators of adult delta smelt status for WYs 2002-2017. Column 2 is the CDFW FMT Index by WY (*i.e.*, the indices for calendar years 20012016). Column 3 is the CDFW SKT Index. Column 4 is an estimate of adult delta smelt abundance during January and February that the Service calculates from the SKT survey. The SKT Index will not be available until June 2017.

WY	FMWT Index (unitless)	SKT Index (unitless)	January and February SKT Abundance Estimate (number of delta smelt) [Lower; Upper Confidence Interval]
2002	603	N/A	739,877 [506,889; 1,043,891]
2003	139	N/A	634,000 [340,811; 1,081,388]
2004	210	99.7	654,492 [370,200; 1,074,662]
2005	74	52.9	477,775 [308,015; 708,388]
2006	26	18.2	186,797 [133,663; 254,133]
2007	41	32.5	291,964 [155,148; 502,239]
2008	28	24.1	325,333 [147,533; 626,188]
2009	23	43.8	365,946 [151,439; 748,841]
2010	17	27.4	169,417 [106,837; 255,665]
2011	29	18.8	290,792 [99,502; 670,574]
2012	343	130.2	772,311 [420,904; 1,303,955]
2013	42	20.4	212,504 [95,804; 410,659]
2014	18	30.1	207,595 [110,373; 356,969]
2015	9	13.8	139,310 [66,314; 259,301]
2016	7	1.8	16,159 [7,403; 30,886]
2017	8	3.8	47,786 [21,709; 91,864]

In addition to these abundance estimates, the CDFW conducts four fish surveys from which it develops indices of delta smelt's relative abundance (Figures 9.2.1.1-1 and 9.2.1.1-2). Each survey has variable and unquantified capture efficiency, and in each, the frequency of zero catches of delta smelt is very high, largely due to the species' rarity (*e.g.,* Latour 2016; Polansky *et al.* in press). The [summer] Townet Survey (TNS) is the longest running indicator of delta smelt relative abundance; it has been conducted since 1959. Although this survey was designed to index the relative abundance of metamorphosing juvenile striped bass (*Morone saxatilis*) (Turner and Chadwick 1972), delta smelt have been collected incidentally; most of the delta smelt captured are age-0 and about 20-40 mm in length (Miller 2000). The FMWT is the second longest running indicator of delta smelt relative abundance; it has been conducted since 1967. This survey was also designed to index the relative abundance of age-0 striped bass (Stevens 1977), but as with the TNS, delta smelt are collected incidentally (Stevens and Miller 1983). Most of the delta smelt captured by the FMWT are age-0 "subadults" and are about 50-70 mm in length (Sweetnam 1999). The 20-mm Survey is the third longest running indicator of delta smelt relative abundance; it has been conducted since 1995. This survey was designed to monitor the distribution of late larval or metamorphosing juvenile delta smelt to assess their distribution and risk of entrainment into the large water export diversions of the CVP and SWP (Dege and Brown 2004). As its name suggests, most of the delta smelt collected by the 20-mm Survey are about 10-30 mm in length, with a peak catch of fish just under 20 mm (Kimmerer 2008). The newest indicator of delta smelt relative abundance is the SKT Survey, which has been conducted since 2002. This survey was designed to monitor the distribution of pre-spawn and spawning adult delta smelt to assess their distribution and risk of entrainment. Most of the delta smelt captured in the SKT are 60-80 mm in length (Bennett 2005).

The TNS and FMWT abundance indices for delta smelt have documented the species' long-term decline, while the newer 20-mm and SKT abundance indices have generally confirmed the recent portions of the trends implied by the older surveys (Figures 9.2.1.1-1 and 9.2.1.1-2). During the period of record, juvenile delta smelt relative abundance has declined from peak levels observed during the latter 1970s (Figure 9.2.1.1-1), while subadult relative abundance was at its highest in 1970, and similarly high in 1980 (Figure 9.2.1.1-2). Juvenile and subadult abundance indices both declined rapidly during the early 1980s, increased somewhat during the 1990s, and then collapsed in the early 2000s. Since 2005, the TNS and the FMWT have produced indices that reflect less year to year variation than their 20-mm and SKT analogs, but overall, the trends in both sets of indices are similar. During the past decade, each index has frequently reached new record low levels. The TNS index was 0.0 in 2015 and 2016, and the 2015 FMWT index and subsequent 2016 SKT index were record lows (about one half of one percent of the relative abundance recorded in 1970-1971).

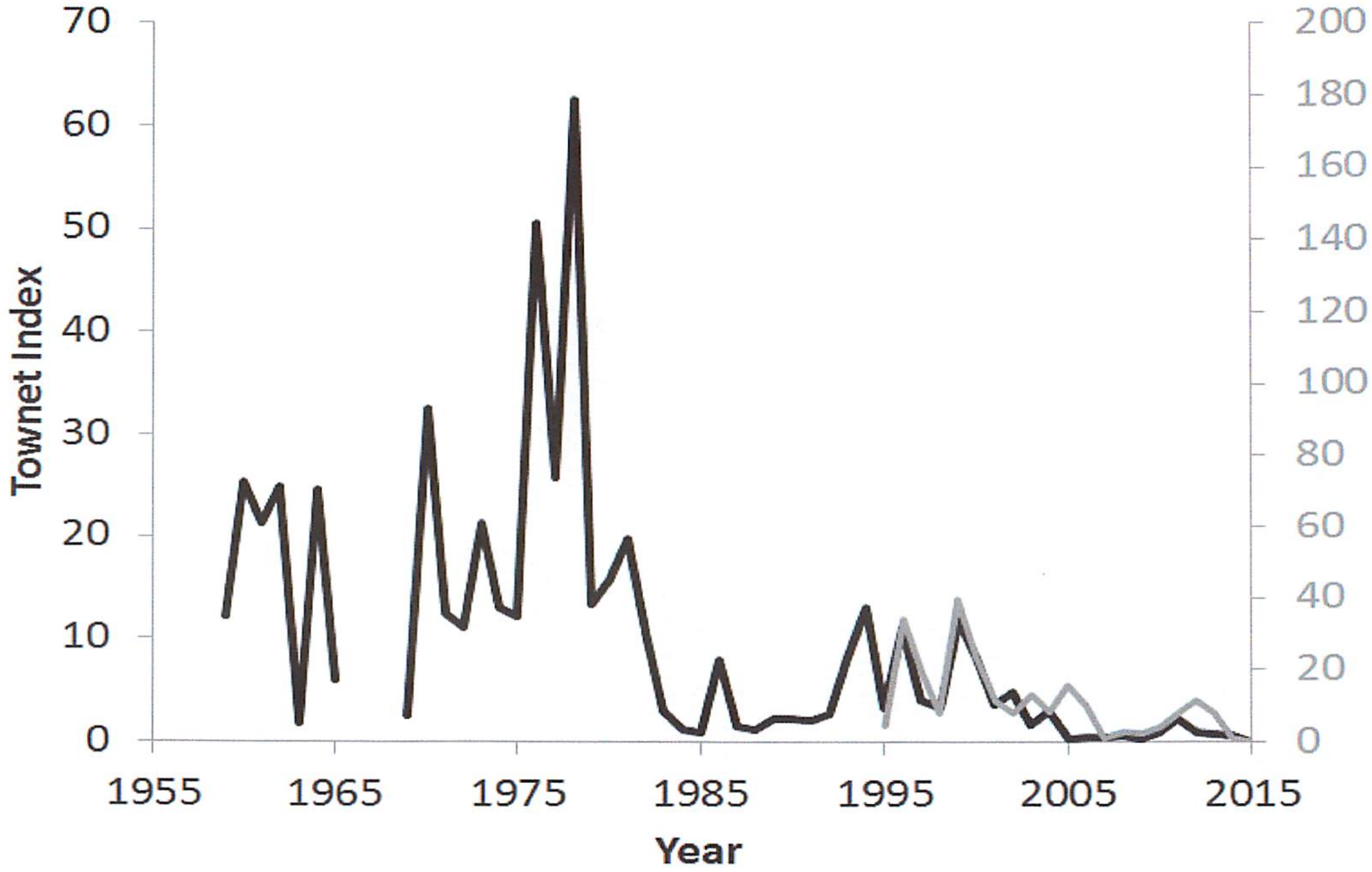

Figure 9.2.1.1-1. Time series of the CDFW's summer TNS (black line; primary y-axis) and 20-mm Survey (gray line; secondary y-axis) abundance indices for delta smelt.

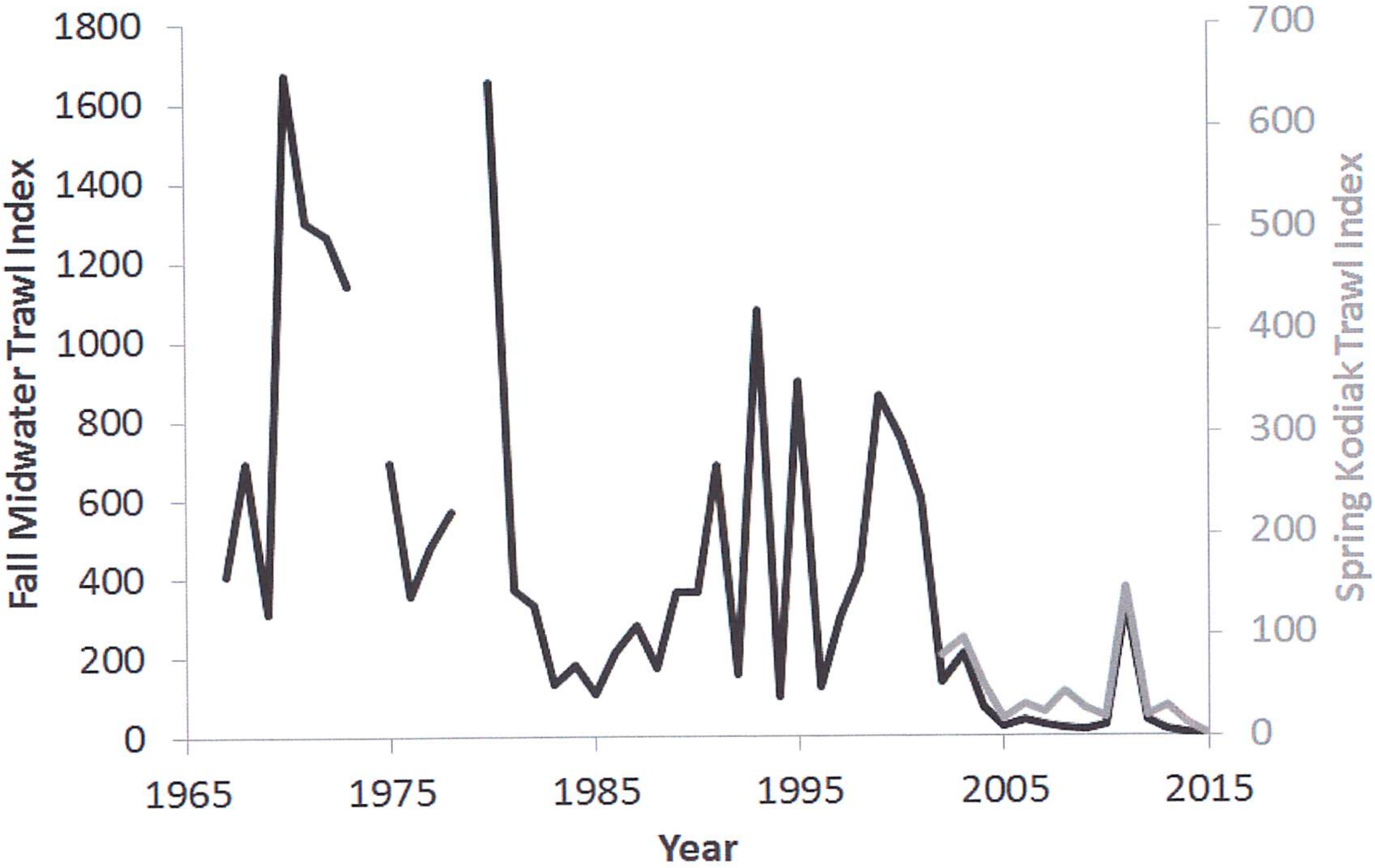

Figure 9.2.1.1-2. Time series of the CDFW's FMWT (black line; primary y-axis) and SKT (gray line; secondary y-axis) abundance indices for delta smelt.

The abundance of adult delta smelt may have exceeded twenty million in 1980-1981 (Rose *et al.* 2013b). This may sound like a large number – and it is compared to the contemporary estimates listed in Table 9.2.1.1-1. However, decades of monitoring by CDFW has shown that the delta smelt has usually not been very abundant when compared to other pelagic (meaning offshore-oriented or open-water) fishes (Figure 9.2.1.1-3). In the TNS, delta smelt catches have usually been lower than age-0 striped bass, and in recent years, also lower than gobies and threadfin shad. In the FMWT, delta smelt catches have been persistently lower than at least five other species. Research and monitoring in shallower habitats like Suisun Marsh (Moyle *et al.* 1986; Matern *et al.* 2002), Delta beaches (Nobriga *et al.* 2005), and small tidal marshes in the upper estuary (Gewant and Bollens 2012) have reported even lower relative abundances of delta smelt. In each of the studies cited, the catches of delta smelt represented less than one percent of the total fish catch and there were usually more than a dozen more abundant fish species.

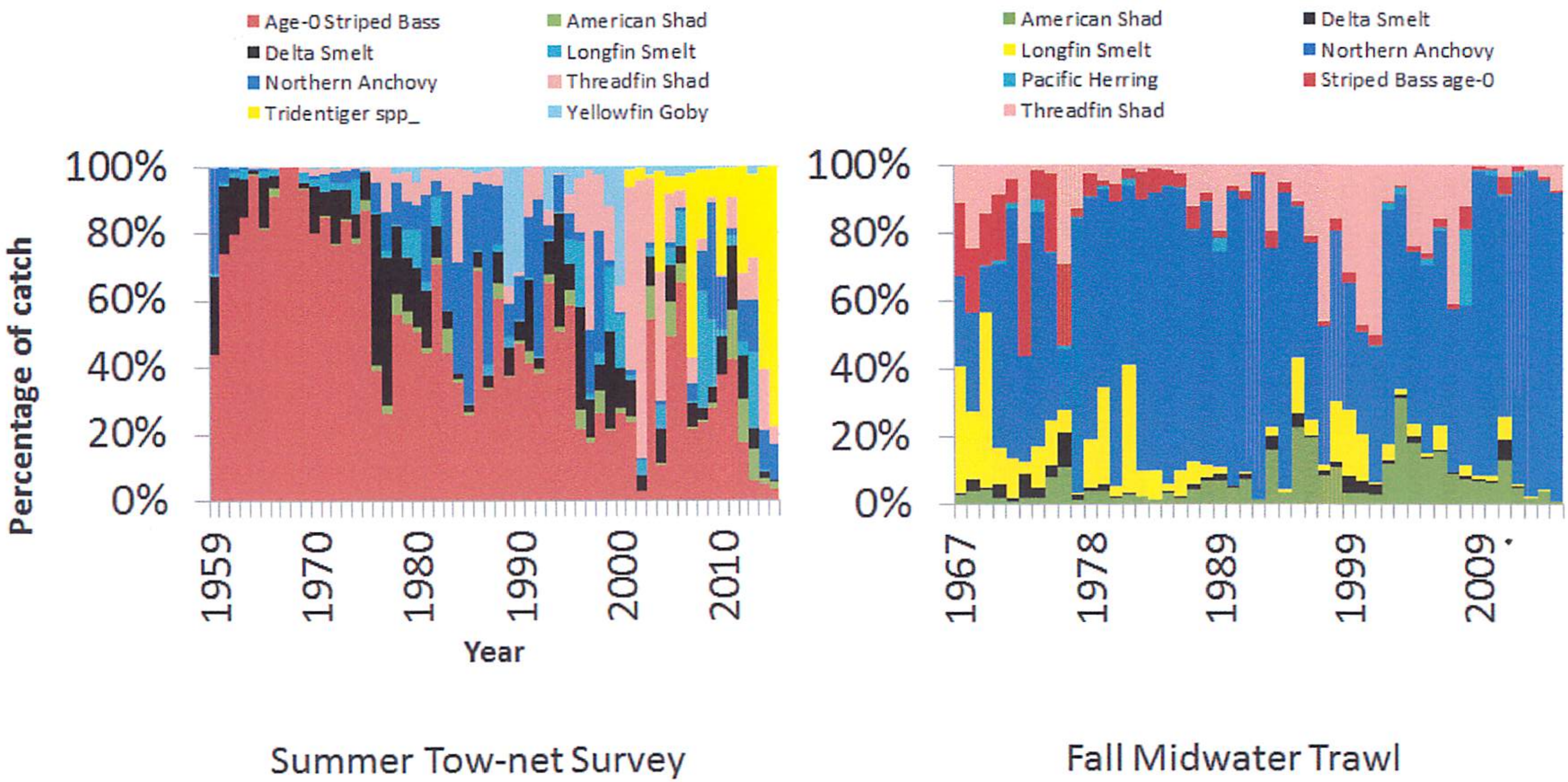

Figure 9.2.1.1-3. Fractional compositions of the eight most frequently collected fish species in the CDFW's summer TNS (1959-2015), and the seven most frequently collected fish species in the FMWT (1967-2015).

The long-term rarity of the delta smelt has had a consequence for understanding the reasons for their population decline, which generates uncertainty about how resource managers should intervene. Some pelagic fishes have shown long-term relationships between Delta inflow, Delta outflow, or X2 and their abundance or survival (Stevens and Miller 1983; Jassby *et al.* 1995; Kimmerer 2002b; Kimmerer *et al.* 2009). There does seem to be some difference in the likelihood of whether the delta smelt population will increase or decrease in abundance from one year to the next based on hydrology (Figure 9.2.1.1-4), but there has never been any predictable relationship linking freshwater flow conditions to the relative abundance of delta smelt (Stevens and Miller 1983; Jassby *et al.* 1995; Kimmerer 2002b; Kimmerer *et al.* 2009). Recently, several teams of researchers have built several varieties of conceptual (IEP 2015) and mathematical (Thomson *et al.* 2010; Maunder and Deriso 2011; Miller *et al.* 2012; Rose *et al.* 2013a) life cycle models for the delta smelt that attempt to describe the reasons the population has declined. Some of these models have been able to recreate the trend observed in abundance indices very well (Figure 9.2.1.1-5), but they have all done so using different approaches and different variables to do so. Collectively, these modeling efforts have been helpful in that they generally support water temperature and changes in the estuary's food web as 'universally supported' factors affecting delta smelt. However, they have also come to very different conclusions about the conservation value of more readily manageable factors like water project operations.

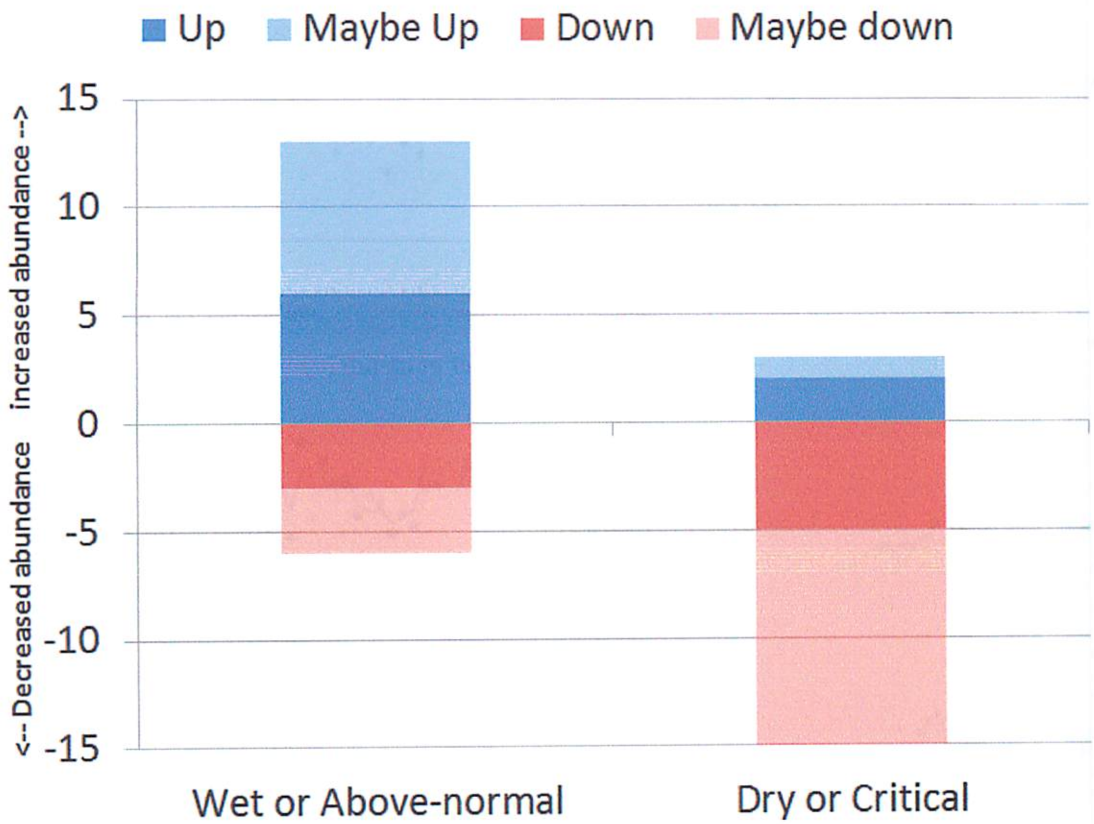

Figure 9.2.1.1-4. Frequencies of delta smelt population increases or decreases (red colored portions of each bar occurring below zero) based on the CDFW's FMWT Survey, 1967-2015. A population increase reflects an increase in relative abundance over the prior year's index and a population decrease reflects a decrease in relative abundance compared to the prior year's index. The Service performed bootstrap resampling on each year's catch per tow to generate a mean catch per tow with 95 percent confidence intervals. This resulted in four possible outcomes: (1) a statistically significant increase in relative abundance from one year to the next in which the confidence intervals of the two years did not overlap ("Up"; solid blue bar segments), (2) a statistically non-significant increase in relative abundance from one year to the next in which the confidence intervals of the two years overlapped ("Maybe Up"; lighter blue bar segments), (3) a statistically significant decrease in relative abundance from one year to the next in which the confidence intervals of the two years did not overlap ("Down"; solid red bar segments), or (4) a statistically non-significant decrease in relative abundance from one year to the next in which the confidence intervals of the two years overlapped ("Maybe Down"; lighter red bar segments). The counts in each of the four categories were combined by Sacramento Valley WY types except that below-normal years were not plotted. The frequencies of population decline were converted into a negative number so that population increases would count up from the zero line on the y-axis and population decreases would count down from the zero line.

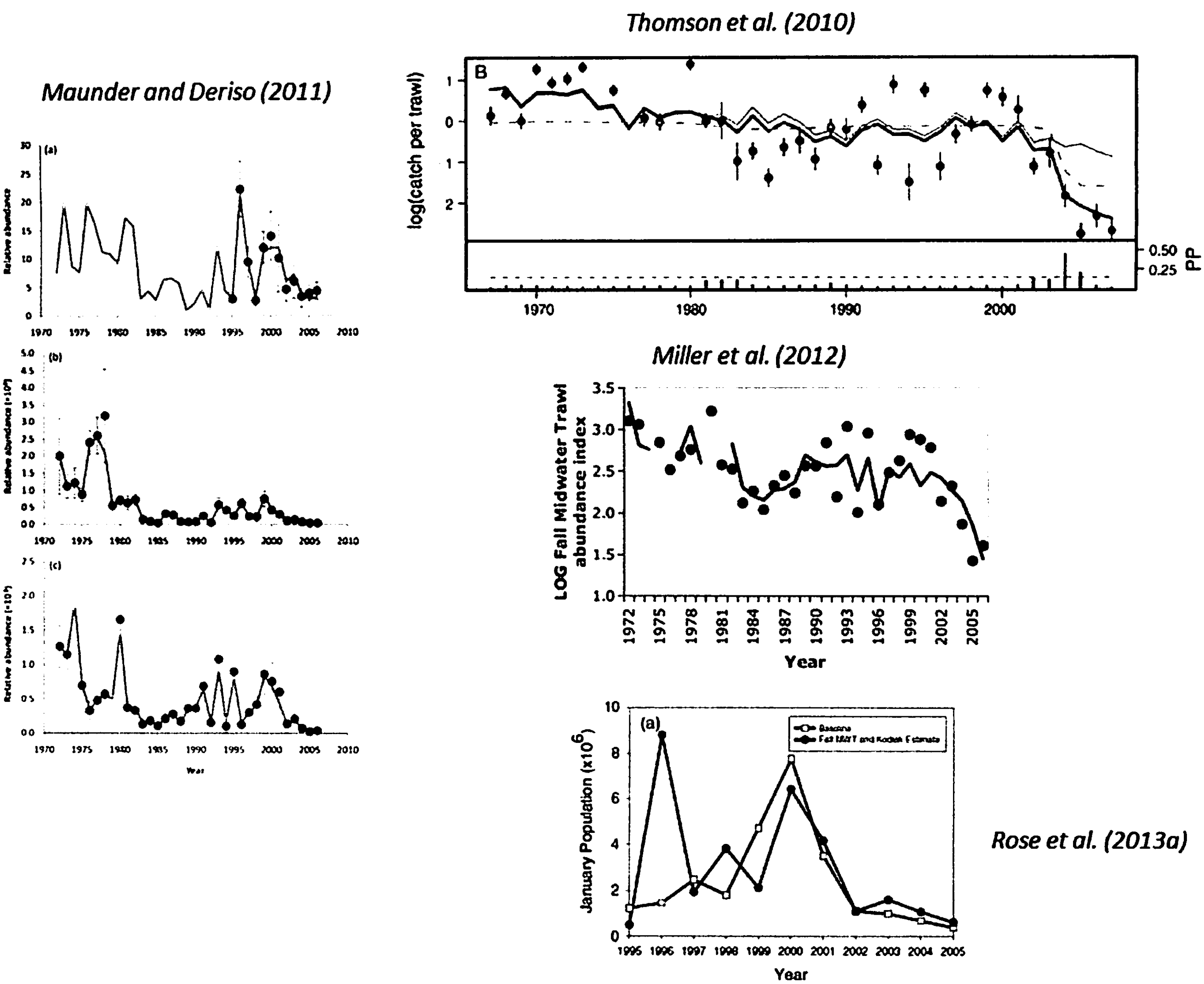

Figure 9.2.1.1-5. Examples of recent published model fits to time series of delta smelt relative abundance data. The source of each is referenced above or alongside each time series. In each plot, observed catches are depicted as black dots and model predictions of the data as gray or black lines. Model predictions from Rose *et al.* (2013a) are a black line with open symbols. In Maunder and Deriso (2011), the three panels represent the 20-mm Survey, summer TNS, and FMWT Survey from top to bottom, respectively. The other three studies are fit to estimates of adult delta smelt relative abundance (FMWT catch in Thomson *et al.* 2010 and the FMWT index in Miller *et al.* 2012) or absolute abundance (Rose *et al.* 2013a). See each study for further details on Methods, Results, and the authors' interpretations of their results.

Habitat and Distribution

Because the delta smelt only lives in part of one comprehensively monitored estuary, its general distribution is well understood (Moyle *et al.* 1992; Bennett 2005; Hobbs *et al.* 2006, 2007; Feyrer *et al.* 2007; Nobriga *et al.* 2008; Kimmerer *et al.* 2009; Merz *et al.* 2011; Murphy and Hamilton 2013; Sommer and Mejia 2013). There are both location-based (*e.g.*, Sacramento River around Decker Island) and conditions-based (low-salinity zone) habitats that delta smelt permanently occupy. There are habitats that delta smelt occupy seasonally (*e.g.*, for spawning), and there are habitats that delta smelt occupy transiently, which we define here as occasional seasonal use. These include distribution extremes from which delta smelt are not collected every year or even in most years.

Most delta smelt complete their entire life cycle within or immediately upstream of the estuary's low-salinity zone. The low-salinity zone is frequently defined as waters with a salinity range of about 0.5 to 6 parts per thousand (ppt) (Kimmerer 2004). The 0.5 to 6 ppt and similar salinity ranges reported by different authors were chosen based on analyses of historical peaks in phytoplankton and zooplankton abundance, but recent physiological and molecular biological research has indicated that the salinities that typify the low-salinity zone are also optimal for delta smelt (Komoroske *et al.* 2016). The low-salinity zone is a dynamic habitat with size and location that respond rapidly to changes in tidal and river flows. The U.S. Environmental Protection Agency (EPA) recently finished a comprehensive set of maps that show how the low-salinity zone changes in size and shape when freshwater flows change the location of X2[19]. The low-salinity zone expands and moves downstream when river flows into the estuary are high, placing low-salinity water over a larger and more diverse set of nominal habitat types than occurs under low flow conditions. During periods of low outflow, the low-salinity zone contracts and moves upstream. Due to its historical importance as a fish nursery habitat, there is a long research history into the physics and biology of the San Francisco Estuary's low-salinity zone (Kimmerer 2004).

The ecological function of the low-salinity zone also varies depending mainly on freshwater flow (Jassby *et al.* 1995; Kimmerer 2002a; Kimmerer 2004). Low outflow can decrease the capacity of the low-salinity zone and adjacent habitats to support the production of delta smelt by reducing habitat diversity and concentrating the fish with their predators and competitors (Service 1993, 1994). During the past four decades, the low-salinity zone ecosystem has undergone substantial changes in turbidity (Schoellhamer 2011) and food web function (Winder and Jassby 2011) that cannot be undone solely by increasing Delta outflow. These habitat changes, which extend into parts of the Delta where water is fresher than 0.5 ppt, have also decreased the ability of the low-salinity zone and adjacent habitats to support the production of delta smelt (Thomson *et al.* 2010; Rose *et al.* 2013b; IEP 2015).

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[19]http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_Delta/docs/cmnt081712/karen_schwinn.pdf

Delta smelt have been observed as far west as San Francisco Bay, as far north as Knights Landing on the Sacramento River, as far east as Woodbridge on the Mokelumne River and Stockton on the Calaveras River, and as far south as Mossdale on the San Joaquin River (Figure 9.2.1.1-6). This distribution represents a range of salinity from essentially zero ppt up to about 20 ppt, which represents a salinity range well beyond definitions of the low-salinity zone or mixing zone near a salinity of 2 ppt emphasized in the critical habitat rule (Service 1994). It is also well beyond the geographic extent of the critical habitat rule (described below). However, most delta smelt that have been collected in the extensively surveyed San Francisco Estuary have been collected from locations within the bounds defined in the critical habitat rule. In addition, all habitats known to be occupied year-around by delta smelt occur within the bounds defined in the critical habitat rule.

Figure 9.2.1.1-6. Delta smelt range map. Waterways colored in purple depict the delta smelt distribution described by Merz *et al.* (2011). The Service has used newer information to expand the transient range of delta smelt further up the Napa and Sacramento rivers than indicated by Merz *et al.* (2011). The red polygon depicts the designated critical habitat for the delta smelt.

Delta smelt permanently occupy the Cache Slough 'Complex', including Liberty Island and the adjacent reach of the Sacramento Deepwater Shipping Channel (Sommer and Mejia 2013), Cache Slough to its confluence with the Sacramento River and the Sacramento River from that confluence downstream to Chipps Island, Honker Bay, and the eastern part of Montezuma Slough (Figure 9.2.1.1-7). The reasons delta smelt are believed to permanently occupy this part of the estuary are the year-round presence of fresh- to low-salinity water that is comparatively turbid and of a tolerable water temperature. These appropriate water quality conditions overlap an underwater landscape featuring variation in depth, tidal current velocities, edge habitats, and food production (Sweetnam 1999; Nobriga *et al.* 2008; Feyrer *et al.* 2011; Murphy and Hamilton 2013; Hammock *et al.* 2015; Bever *et al.* 2016). Field observations are increasingly supported by laboratory research that explains how delta smelt respond physiologically to variation in salinity, turbidity, water temperature, and other aspects of their habitat that can vary with changes in climate, freshwater flow and estuarine bathymetry (Hasenbein *et al.* 2014; 2016; Komoroske *et al.* 2014; 2016).

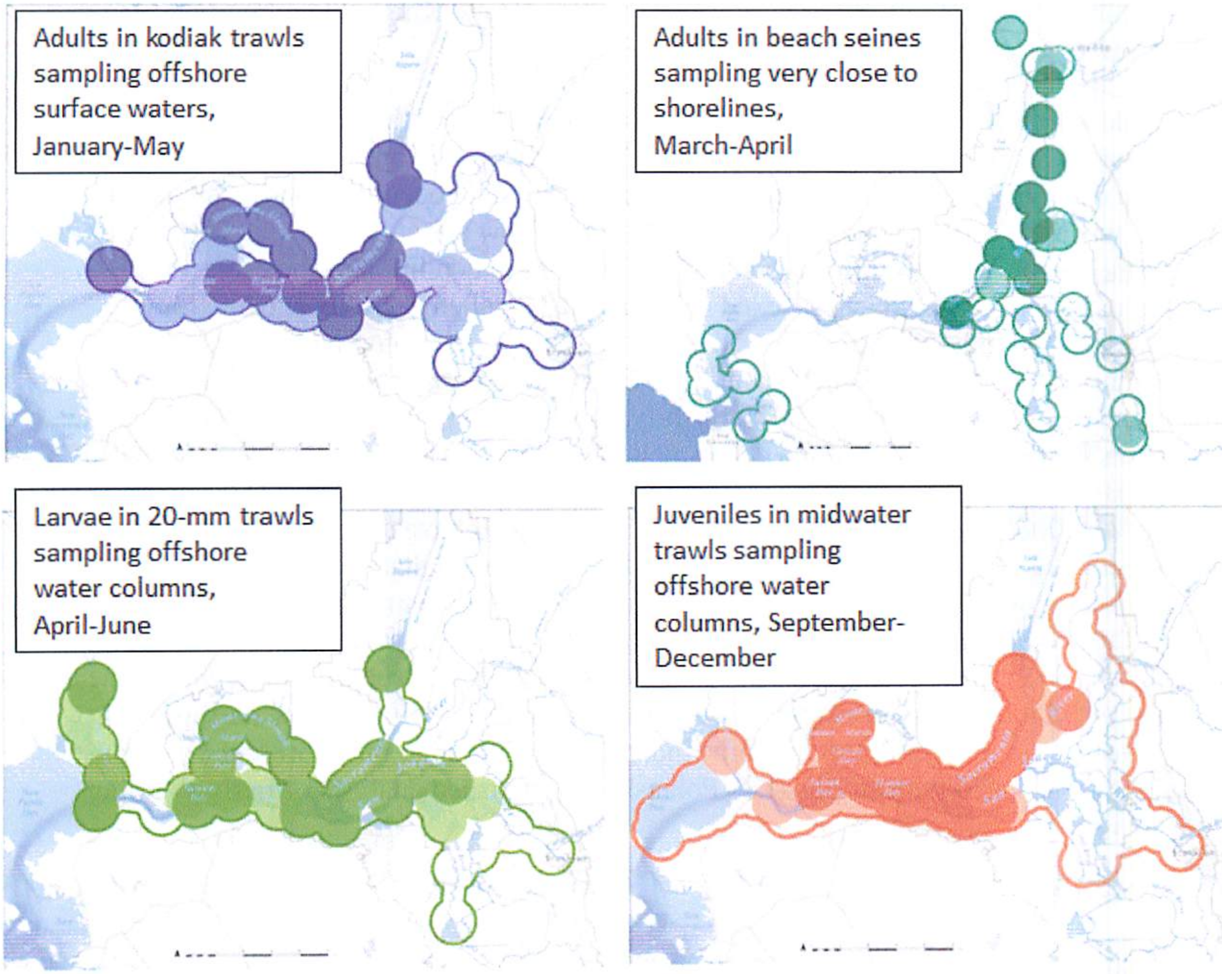

Figure 9.2.1.1-7. Maps of multi-year average distributions of delta smelt collected in four monitoring programs. The sampling regions covered by each survey are outlined. The areas with dark shading surround sampling stations in which 90 percent of the delta smelt collections occurred, the areas with light shading surround sampling stations in which the next 9 percent of delta smelt collections occurred. Source: Murphy and Hamilton (2013).

Each year, the distribution of delta smelt seasonally expands when adults disperse in response to winter flow increases that also coincide with seasonal increases in turbidity and decreases in water temperature (Figure 9.2.1.1-7). The annual range expansion of adult delta smelt extends up the Sacramento River to about Garcia Bend in the Pocket neighborhood of Sacramento, up the San Joaquin River from Antioch to areas near Stockton, up the lower Mokelumne River system, and west throughout Suisun Bay and Suisun Marsh. Some delta smelt seasonally and transiently occupy Old and Middle river in the south Delta each year, but face a high risk of entrainment when they do (Grimaldo *et al.* 2009).

The distribution of delta smelt occasionally expands beyond this area (Figure 9.2.1.1-6). For instance, during high outflow winters, adult delta smelt also disperse west into San Pablo Bay and up into the Napa River (Hobbs *et al.* 2007). Similarly, delta smelt have occasionally been reported from the Sacramento River north of Garcia Bend up to Knights Landing (*e.g.*, Merz *et al.* 2011; Vincik and Julienne 2012).

The expanded adult distribution initially affects the distribution of the next generation because delta smelt eggs are adhesive and not believed to be highly mobile once they are spawned. The distribution of larvae reflects a combination of where spawning occurred and freshwater flow conditions when the eggs hatched. Variation in Delta outflow affects the spatial distribution of the delta smelt population for most of its life. The ecological condition of the estuary's low-salinity zone has historically been indexed using a statistic called X2, a local name for the geographic location of 2 ppt salinity near the bottom of the water column (Jassby *et al.* 1995). During spring, larval delta smelt have centers of distribution in freshwater, typically 20-40 km upstream of X2 (Dege and Brown 2004). By July, as water temperatures in the Delta reach annual peaks, post-larval and juvenile delta smelt have centers of distribution very close to X2 (Dege and Brown 2004), but the fish are broadly distributed around that peak (Sweetnam 1999; Nobriga *et al.* 2008). During the fall, subadult delta smelt still have a center of distribution near X2 (Sommer *et al.* 2011), and remain broadly distributed around that peak (Feyrer *et al.* 2007; 2011). During the winter, maturing adult delta smelt disperse in connection with winter storms following the spread of turbid freshwater (Grimaldo *et al.* 2009; Sommer *et al.* 2011; Murphy and Hamilton 2013). Recent analyses suggest that after an initial dispersal in December, the adult delta smelt population does not respond strongly to variation in Delta outflow during January to May (Polansky *et al.* in press), though some individuals continue to move around in response to flow changes associated with storms (Leo Polansky, unpublished analysis of Early Warning Survey data set).

Food

At all life stages, numerous small planktonic crustaceans, especially a group called calanoid copepods, make up most of the delta smelt diet (Nobriga 2002; Slater and Baxter 2014). Small crustaceans are ubiquitously distributed throughout the estuary, but which prey species are present at particular times and locations has changed dramatically over time (Winder and Jassby 2011; Kratina *et al.* 2014). This has likely affected delta smelt feeding success, particularly during Central California's warm summers.

Reproductive Strategy

The reproductive behavior of delta smelt is only known from captive specimens spawned in artificial environments and most of the information has never been published. Spawning likely occurs mainly at night with several males attending a female that broadcasts her eggs onto bottom substrate (Bennett 2005). Although preferred spawning substrate is unknown, spawning habits of delta smelt's closest relative, the surf smelt (*Hypomesus pretiosus*), as well as unpublished experimental trials, suggest that sand may be the preferred substrate (Bennett 2005). Hatching success peaks at temperatures of 15-16°C (59-61°F) and decreases at cooler and warmer temperatures. Hatching success nears zero percent as water temperatures exceed 20°C (68°F) (Bennett 2005). Water temperatures suitable for spawning occur most frequently during the months of March-May, but ripe female delta smelt have been observed as early as January and larvae have been collected as late as July.

Delta smelt spawn in the estuary and have one spawning season for each generation, which makes the timing and duration of the spawning season important every year. As stated above, delta smelt are believed to spawn on sandy substrates in fresh and possibly low-salinity water (Bennett 2005). Therefore, freshwater flow affects how much of the estuary is available for delta smelt to spawn (Hobbs *et al.* 2007).

Delta smelt can start spawning when water temperatures reach about 10°C (50°F) and can continue until temperatures reach about 20°C (Bennett 2005). The ideal spawning condition occurs when water temperatures remain cool throughout the spring (*e.g.*, March-May). Few delta smelt ≤ 55 mm in length are sexually mature and 50% of delta smelt reach sexual maturity at 60 to 65 mm in length (Rose *et al.* 2013b). Thus, if water temperatures rise much above 10°C in the winter, the "spawning season" can start before most individuals are mature enough to actually spawn. If temperatures continue to warm rapidly toward 20°C in early spring, that can end the spawning season with only a small fraction of 'adult' fish having had an opportunity to spawn. Delta smelt were initially believed to spawn only once before dying (Moyle *et al.* 1992). It has since been confirmed that like many other ecologically similar forage fishes (Winemiller and Rose 1992), individual delta smelt can spawn more than once if water temperatures remain suitable for a sufficient length of time, and if the adults find enough food to support the production of another batch of eggs (Lindberg *et al.* 2013; Kurobe *et al.* 2016). As a result, the longer water temperatures remain cool, the more fish have time to mature and the more times individual fish can spawn.

Although adult delta smelt can spawn more than once, mortality is high during the spawning season and most adults die by May (Polansky *et al.* in press). The egg stage averages about 10 days before the embryos hatch into larvae. The larval stage averages about 30 days. Metamorphosing "post-larvae" appear in monitoring surveys from April into July of most years. By July, most delta smelt have reached the juvenile life stage. Delta smelt collected during the fall are called "subadults", a stage which lasts until winter when fish disperse toward spawning habitats. This winter dispersal usually precedes sexual maturity (Sommer *et al.* 2011).

Recovery and Management

Following Moyle *et al.* (1992), the Service (1993) indicated that SWP and CVP exports were the primary factors contributing to the decline of delta smelt due to entrainment of larvae and juveniles and the effects of low flow on the location and function of the estuary mixing zone (now called the low-salinity zone). In addition, prolonged drought during 1987-1992, in-Delta water diversions, reduction in food supplies by nonindigenous aquatic species, specifically overbite clam and nonnative copepods, and toxicity due to agricultural and industrial chemicals were also factors considered to be threatening the delta smelt. In the 2008 Service BiOp, the Service's Reasonable and Prudent Alternative required protection of delta smelt from entrainment in December through June and augmentation of Delta outflow during the fall of Wet or Above-Normal years as classified by the State of California (Service 2008). The expansion of entrainment protection for delta smelt in the 2008 Service BiOp was in response to large increases in juvenile and adult salvage in the early 2000s (Kimmerer 2008). The fall X2 requirement was in response to increased fall exports that had resulted in greatly reduced variability in Delta outflow during the fall months (Feyrer *et al.* 2011).

Consistent with the 2008 Service BiOp, the Service's (2010c) recommendation to uplist delta smelt from threatened to endangered included reservoir operations and water diversions upstream of the estuary as mechanisms interacting with exports to restrict the low-salinity zone and concentrate delta smelt with competing fish species. In addition, Brazilian waterweed (*Egeria densa*) and increasing water transparency were considered new detrimental habitat changes. Predation was considered a low-level threat linked to increasing waterweed abundance and increasing water transparency. Additional threats considered potentially significant by the Service in 2010 were entrainment into power plant diversions, contaminants, and reproductive problems that can stem from small population sizes. Conservation recommendations included: establish Delta outflows proportionate to unimpaired flows to set outflow targets as fractions of runoff in the Central Valley watersheds; minimize reverse flows in Old and Middle river; and, establish a genetic management plan with the goals of minimizing the loss of genetic diversity and limiting risk of extinction caused by unpredictable catastrophic events. The Service (2012b) added climate change to the list of threats to the delta smelt.

Continued protection of the delta smelt from excessive entrainment, improving the estuary's flow regime, suppression of nonnative species, increasing zooplankton abundance, and improving water quality are among the actions needed to recover the delta smelt.

Climate Change

Climate projections for the San Francisco Bay-Delta and its watershed indicate that temperature and precipitation changes will diminish snowpack in the Sierra-Nevada, changing the timing and availability of natural water supplies (Knowles and Cayan 2002; Dettinger 2005). Warming may result in more precipitation falling as rain which will mean less water stored in spring snowpacks. This would increase the frequency of rain-on-snow events and increase winter runoff with an associated decrease in runoff for the remainder of the year (Hayhoe *et al.* 2004). Overall, these and other storm track changes may lead to increased frequency of flood and drought cycles during the 21st century (Dettinger *et al.* 2015). Thus far, the 21st century has been substantially drier than the 20th century (Figure 9.2.1.1-8) to which the frequency of WY type classifications are compared.

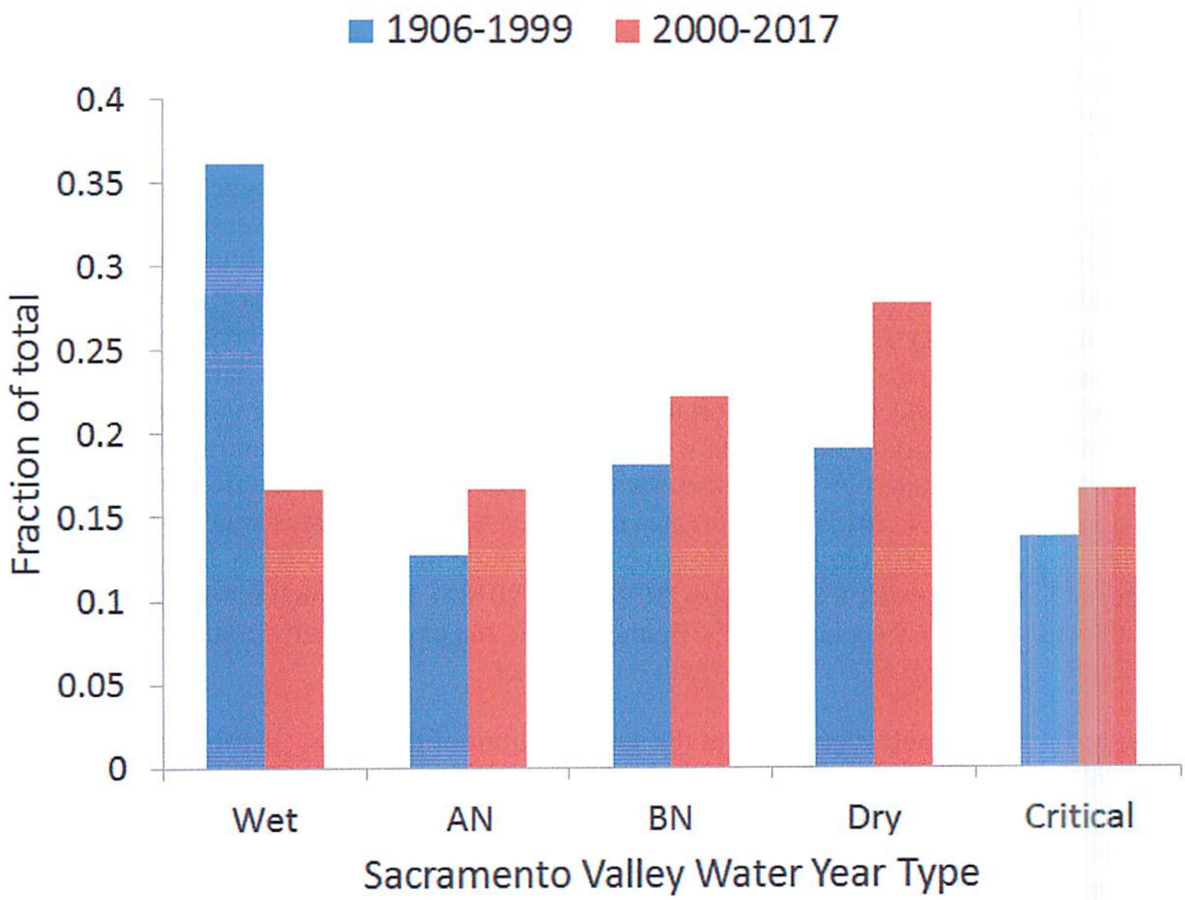

Figure 9.2.1.1-8. Frequency distribution of Sacramento Valley WY types for: blue=1906-1999 and red=2000-2017.

Sea level rise is also anticipated as a consequence of a warming global climate and if it is not mitigated, sea level rise will likely influence saltwater intrusion into the Bay-Delta. Salinity within the northern San Francisco Bay is projected to rise by 4.5 ppt by the end of the century (Cloern *et al.* 2011). Elevated salinity could push X2 further eastward in the estuary if outflows are not increased to compensate. Fall X2 mean values are projected to increase by about 7 km to the area near the City of Antioch approximately 90 km from the Golden Gate Bridge by 2100 (Brown *et al.* 2013). This projected change in the location of X2 in the fall is expected to decrease suitable physical habitat if current levees and channel structures are maintained.

Central California's warm summers are already a source of energetic stress for delta smelt and warm springs already severely compress the duration of their spawning season (Rose *et al.* 2013a,b). Central California's climate is anticipated to get warmer (Dettinger 2005). We expect warmer estuary temperatures to present a significant conservation challenge for delta smelt. Mean annual water temperatures within the Delta are expected to increase steadily during the second half of this century (Cloern *et al.* 2011). Warmer water temperatures could further reduce delta smelt spawning opportunities, decrease juvenile growth during the warmest months, and increase mortality via several food web pathways including: increased vulnerability to predators, increased vulnerability to toxins, and decreased capacity for delta smelt to successfully compete in an estuary that is energetically more optimal for warm-water tolerant fishes.

Recent research into the ecological effects of warming water temperatures suggests that delta smelt, depending on location, may be forced to spawn an average of ten to twenty-five days earlier in the season (Brown *et al.* 2013). The number of high mortality days (cumulative number of days of daily average water temperature >25°C (77°F) is expected to increase (Brown *et al.* 2013). The number of physiologically stressful days (cumulative number of days of daily average water temperature >20°C (68°F) is expected to be stable or decrease partly because many stressful days will become high mortality days. Thus, current modeling indicates that delta smelt will likely face a shorter maturation window and reduced habitat availability due to increased water temperatures. A shorter maturation window will likely have effects on reproduction (Brown *et al.* 2013). Growth rates have been shown to slow as water temperatures increase above 20°C (68°F), requiring delta smelt to consume more food to reach growth rates that are normal at lower water temperatures (Rose *et al.* 2013a). Delta smelt are smaller, on average, than in the past (Sweetnam 1999; Bennett 2005) and expected temperature increases due to climate change will likely slow growth rates further.

In summary, the delta smelt is currently at the southern limit of the inland distribution of the family Osmeridae along the Pacific coast of North America. Thus, increased temperatures associated with climate change may present a significant conservation challenge if they result in a Bay-Delta that is outside of the delta smelt's competitive limits. For the time being however, water temperatures are cool enough in the delta smelt's range for the species to complete its life cycle.

Summary of the Status of Delta Smelt

The relative abundance of delta smelt has reached very low numbers for a small forage fish in an ecosystem the size of the San Francisco Estuary. The extremely low recent relative abundance reflects decades of habitat change and marginalization by non-native species that prey on and out-compete delta smelt. The anticipated effects of climate change on the San Francisco Estuary and watershed such as warmer water temperatures, greater salinity intrusion, lower snowpack contribution to spring outflows from the Delta, and the potential for frequent extreme drought, which has been experienced for the 21st century thus far (Figure 9.2.1.1-8) indicate challenges to delta smelt survival will increase. A rebound in relative abundance during the very wet and cool conditions during 2011 indicated that delta smelt retained some population resilience (IEP 2015). However, since 2012, declines to record low population estimates (Table 9.2.1.1-1) have been broadly associated with the remarkably dry hydrology occurring from 2012 to 2016.

9.2.1.2 Status of the Species at Proposed Action Area Preconstruction and Construction Sites

The following sections provide additional detail about habitat conditions in specific areas where CWF proposes construction activities. The status of the delta smelt at these proposed construction areas is dependent on the species' range-wide status because the CWF construction is all proposed to occur in seasonally or transiently used habitats that will be occupied and used by fish in general proportion to their overall range-wide abundance.

Sacramento River from I Street Bridge in Sacramento to its Confluence with Cache Slough at Grand Island and the Primary Distributary Channels Steamboat Slough, Georgiana Slough, and the Delta Cross Channel

The adjacent land use along most of this river reach has been urban (Sacramento) or agricultural since the 1860s-1890s (Whipple *et al.* 2012; Figure 9.2.1.2-1). Major changes include deforestation of the natural levees, disconnection of the river from its flanking floodplains, extensive levee reinforcement with riprap, and an initial increase in sediment, followed by a long-term decrease that has changed the tidal prism of this river reach. Reclamation constructed the Delta Cross Channel (DCC) in 1944 from the Sacramento River at Walnut Grove to the North Fork Mokelumne River to increase the flow of Sacramento River water across the Delta. When the DCC gates are opened, Sacramento River water flows into the North Fork of the Mokelumne River, which then flows into the San Joaquin River between Bouldin and Andrus islands.

Historically, the Sacramento River and its distributary sloughs had a well-developed riparian corridor along large natural levees that separated this river segment from its flanking floodplains (Whipple *et al.* 2012). The fringing riparian forest varied from several hundred feet wide to about one mile wide depending on location. The river did not meander here. Rather, floodwaters flowed into the Yolo basin at Knights Landing Ridge and into the Sacramento basin at the confluence of the American River. The Sacramento basin connection has been severed to develop and protect the greater Sacramento urban area. The Yolo basin connection has been muted by Fremont and Sacramento weirs, and levees that separate the Yolo Bypass from adjacent land areas, but the connection is not completely severed. The Yolo Bypass continues to route flood flows away from the Sacramento urban area (Sommer *et al.* 2001).

Presently, urban and agricultural land uses encroach to the landside of the existing reinforced levee system and little riparian habitat remains (Figures 9.2.1.2-2 and 9.2.1.2-3). This reach of the Sacramento River also includes a 286 cfs capacity water diversion operated by the Freeport Regional Water Authority, and the outfall for the Sacramento Regional Wastewater Treatment Plant. The positive barrier fish screens on the Freeport diversion preclude post larval fishes from being entrained. Larval fish sampling behind the Freeport fish screens was conducted from 2012-2014; no delta smelt larvae were found, though a small number of wakasagi larvae were collected (CWF BA 2016). The only significant natural habitat area adjacent to this river reach is the Stone Lakes National Wildlife Refuge near the City of Elk Grove. However, the refuge has no natural connection to the river and therefore provides no habitat value to delta smelt.

Hydraulic mining made this reach of the Sacramento River much shallower (and non-tidal) during the late 19th and early 20th centuries, but the sediment has dispersed over time and the river has regained its tidal influence (Whipple *et al.* 2012). Although under tidal influence, this reach of the Sacramento River is a major CVP and SWP water conveyance channel. Thus, flows are almost always high enough such that net flow is downstream even during flood tides (CWF BA 2016). The sediment supply carried into the estuary via the Sacramento River declined by 50% from the latter 1950s to the early 2000s (Wright and Schoellhamer 2004). Most of the sediment currently delivered to the estuary from this and other sources occurs during periods of high flow because sediment delivery rates steepen as inflows increase (Wright and Schoellhamer 2005).

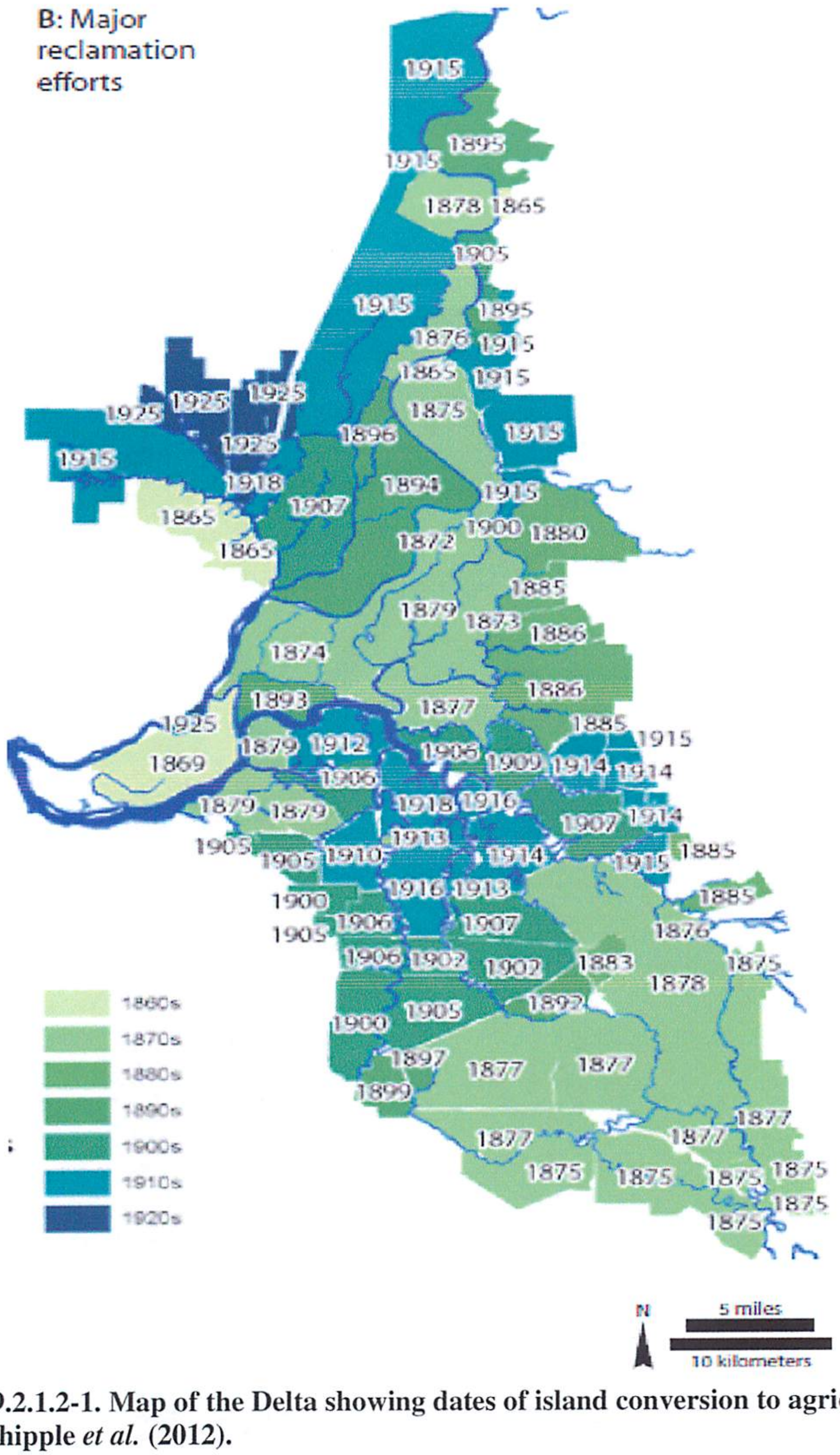

Figure 9.2.1.2-1. Map of the Delta showing dates of island conversion to agriculture. Taken from Whipple *et al.* (2012).

Figure 9.2.1.2-2. National Agriculture Imagery Program (2016) aerial image of the Sacramento River in the vicinity of Isleton.

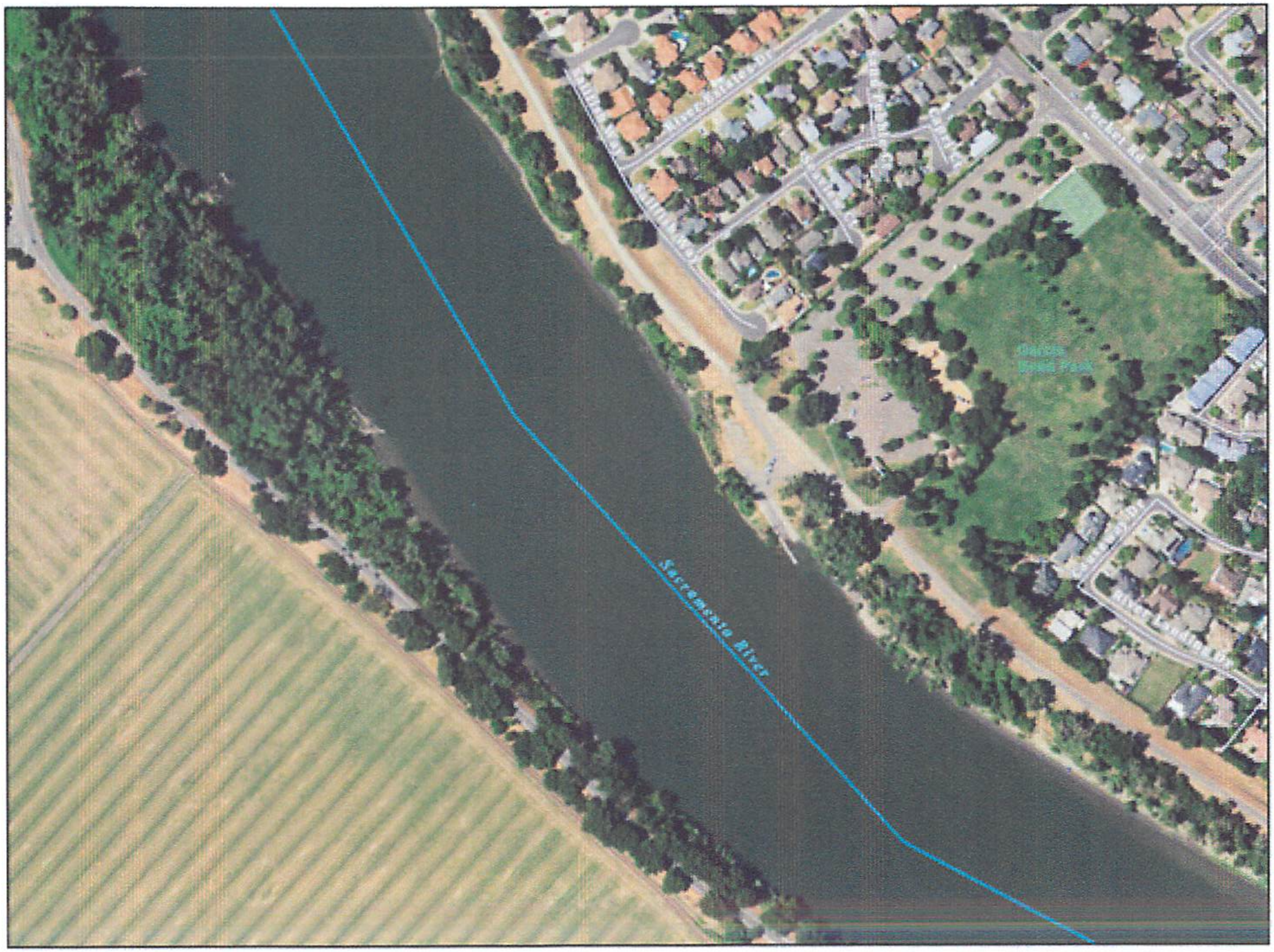

Figure 9.2.1.2-3. National Agriculture Imagery Program (2016) aerial image of the Sacramento River in the vicinity of Garcia Bend.

Food web: The Sacramento River from Sacramento to Isleton and its primary distributaries are low productivity channels and have been for several decades (Orsi and Mecum 1986). This may be due to the canal shape of these channels and the rapid conveyance of river water into the Delta. However, there are also water chemistry-related reasons for this area's low productivity. For instance, chlorophyll concentrations in the Sacramento River decline rapidly as it flows past the City of Sacramento, suggesting a toxic effect on primary productivity (Parker *et al.* 2012). Parker *et al.* (2012) proposed ammonium inhibition of phytoplankton growth as the mechanism generating this pattern. In addition, toxicity to invertebrates related to urban pesticide runoff has been observed in the American River, which flows into the Sacramento River in the city limits (Weston *et al.* 2012). Thus, this river reach is not presently a major source of immediately available zooplankton production for delta smelt to prey on.

Adult migration and spawning: The results of DSM-2 PTM modeling show that there is no measurable probability tide-surfing particles intended to represent dispersing adult delta smelt could ascend the Sacramento River to the proposed NDD sites using only open off-channel habitats (CWF BA 2016). This makes intuitive sense for two reasons. First, the tidal energy extending up into Cache Slough is much greater than the tidal energy extending into the comparatively narrow mainstem channel of the Sacramento River so most particles that can move upstream move into Cache Slough. Second, both flood and ebb tide flows are usually moving downstream in the Sacramento River where the proposed NDD would be built. Once the tides stop flowing in two directions, the standard tide-surfing mechanisms, vertical and lateral changes in distribution during flood versus ebb tides, would no longer work to move fish upstream. However, adult delta smelt do ascend the Sacramento River (Merz *et al.* 2011), in one robustly documented instance, even reaching Knights Landing, which is well beyond the reach of tidal influence (Vincik and Julienne 2012). The most parsimonious explanation for how delta smelt can accomplish this against water velocities that exceed their sustained swimming speeds in mid-channel is to do something they do less frequently further downstream, which is to remain near the shoreline throughout the tidal cycle because near the shoreline, water velocities are slower.

If this hypothesis about migration tactics is correct, then we would expect to see low catches in trawls from this reach of the Sacramento River and relatively higher catches in nearshore beach seines. The available data support this hypothesis. The estimated densities of adult delta smelt in this river reach based on the CDFW SKT (station 724 at Ryde) are zero, although delta smelt have been collected in Service Kodiak trawling at Sherwood Harbor during January–March (detection in 5 years from 2002–2016). In contrast, detection frequencies based on the Service's Delta Juvenile Fishes Monitoring Program beach seine surveys are fairly high (Table 9.2.1.2-1).

Table 9.2.1.2-1. Summary of adult delta smelt detections (capture of at least one delta smelt in a beach seine) at sixteen sites along a transect of the Sacramento River and its primary distributaries from Decker Island to Verona. The sites SR012 and SR014 are downstream of the Sacramento River confluence with Cache Slough and reflect a permanently occupied baseline or background detection rate for this sampling program (86 to 90 percent; see far right column). The other sampling sites are seasonally or transiently occupied habitats that can be compared against SR012 and SR014. Green cells represent detections during January-June from 1994-2014, gray cells represent non-detections, yellow cells represent autumn detections, which were only reported a few times in relatively upstream locations and thus may represent misidentified wakasagi[20]. Data source: Delta Juvenile Fishes Monitoring Program, 1994-2014 (https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm).

Location	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Frequency
SR012	green		green	green	green	green	green	green	green	green	green		green		green	green	green	green	green	green	green	0.86
SR014	green	green	green	green	green	green	green	green	green	green	green		green	green	green	green		green	green	green	green	0.90
SR017 (Isleton)		green	green		green			green			green	green	green				green					0.38
SR024 (Koket)		green	green	green	green	green		green	green	green	green		green				green	green	green			0.62
XC001 (DCC)	green																					0.05
GS010 (Georgiana Slough)							green			green							green		green			0.19
SS011 (Steamboat Slough)		green	green		green		green	green			green	green	green						green			0.43
SR043 (Clarksburg)		green		green	green	green	green	green		green	green	green	green			green	green	green	green		green	0.71
SR049 (Garcia Bend)		green	green		green	green	green		green	green	green	green	green	green	green	green	green		green		green	0.76
SR055 (Sherwood)	yellow																		yellow			0.00
SR057 (Miller Park)	green			green																		0.10
SR060 (Disco Park 1)	yellow		green	yellow	yellow					green								green			green	0.19
AM001 (Disco Park 2)												green										0.05
SR062 (Sand Cove)	yellow	green																			green	0.10
SR071 (Elkhorn)				green						green												0.10
SR080 (Verona)									green						green							0.10

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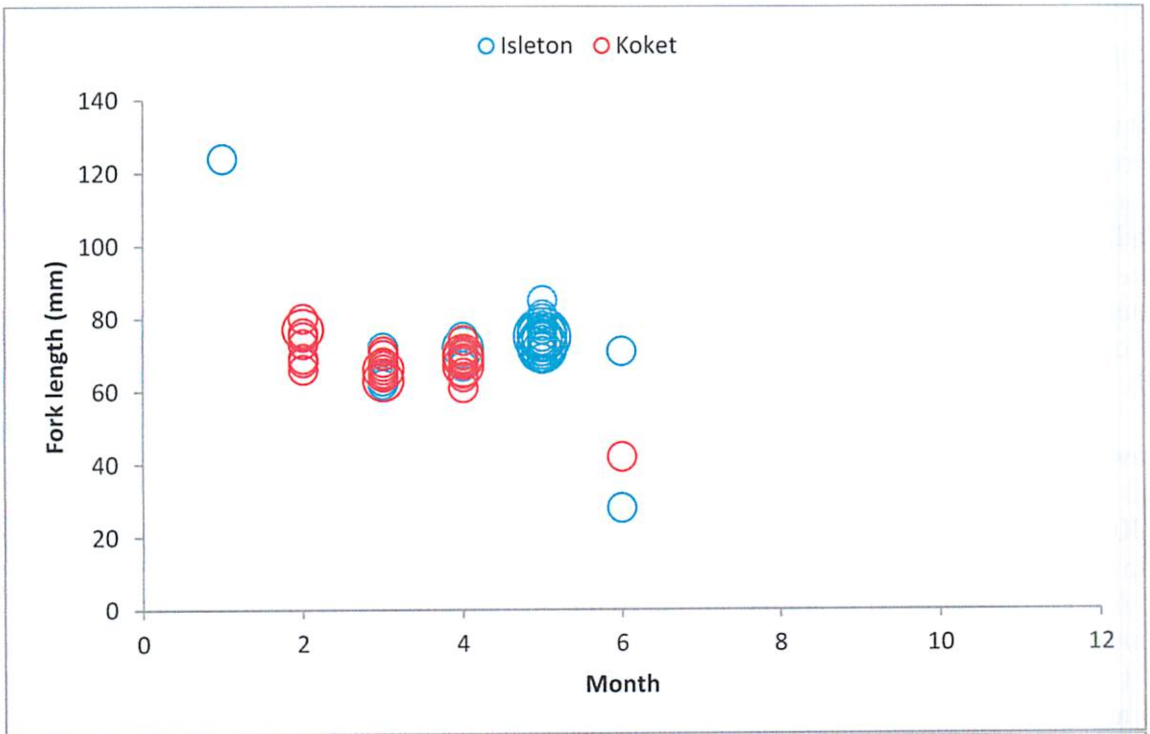
[20] The raw catches and densities of fish collected using different gear types cannot be quantitatively compared unless studies have been conducted to calibrate the methods. The monitoring studies designed to target the delta smelt have been based on trawling techniques, but delta smelt have been incidentally collected using other gears from monitoring studies designed to target other species. For instance, the DJFMP beach seine survey was developed to monitor the distribution and relative density of Chinook salmon fry, but a few delta smelt are incidentally collected each year. There is no calibration information available to quantitatively compare the catches of delta smelt in trawl surveys to the catches in the DJFMP beach seine survey. Therefore, we have limited our analysis of the beach seine information to presence-absence in an effort to avoid misleading quantitative raw catch or density comparisons.

The beach seine data suggest that delta smelt use the Sacramento River between Isleton and Sacramento, and its primary distributaries, as a migratory corridor and spawning habitat. We conclude this because the vast majority of individuals collected are adult-sized fish during February-May (Figure 9.2.1.2-4). These recent observations of timing and location are consistent with a somewhat older study by Stevens (1963): "Evidently freshwater smelt leave the Courtland-Freeport area soon after their spawning period. Most specimens present in the stomachs of bass caught in this area had ripe ovaries or testes and only three were found after June 25."

Larval transport and juvenile rearing: Delta Smelt larvae that hatch in the Sacramento River above its confluence with Cache Slough typically encounter swift downstream currents that would rapidly transport them below the confluence with Cache Slough into larger channels with tidal flows that move upstream and downstream twice a day. Larvae can use this stronger tidal influence to help them maintain position in the estuary (Bennett *et al.* 2002). Larvae that hatch in Steamboat and Georgiana sloughs would likewise be rapidly moved downstream; however, larvae that hatch in Steamboat Slough would be transported to the same areas as larvae hatched in the Sacramento River whereas larvae hatching in Georgiana Slough would be transported to the San Joaquin River.

Juvenile delta smelt catches along the Sacramento River and its distributaries are rare above Cache Slough. During 1994-2014, only three were collected from Courtland and Garcia Bend, the two sampling sites nearest the proposed NDD locations (Figure 9.2.1.2-4). Thus, this part of the action area is for the most part, not a juvenile rearing habitat.



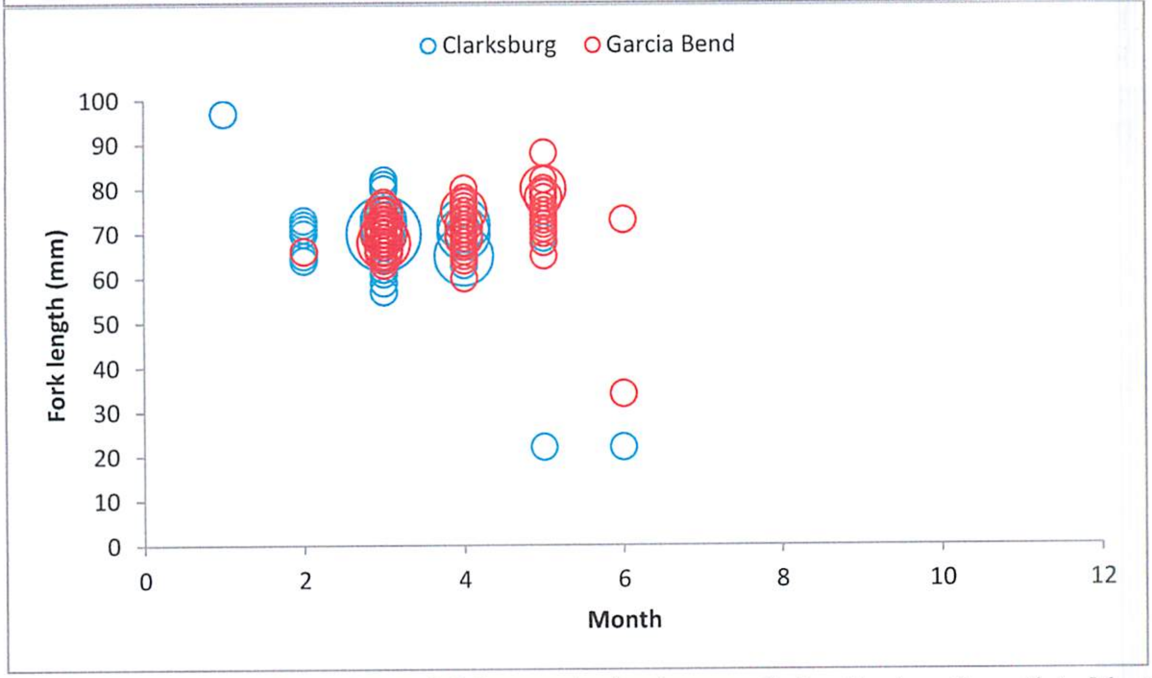


Figure 9.2.1.2-4. Scatterplots of delta smelt size by month for the locations listed in the captions. Delta smelt larger than 50 mm in length are adults. The smallest data points reflect one fish collected at the plotted length, the larger the data point, the more fish of that length were collected. Data source: DJFMP beach seine survey, 1994-2014. Waterways to the east of the Sacramento River in the vicinity of Locke and Walnut Grove: Snodgrass Slough, Lost Slough, the lower Cosumnes River, and the North and South forks of the Mokelumne River adjacent to Staten Island

The adjacent land use along most of this river reach was converted to agriculture around 1915 (Whipple *et al.* 2012; Figure 9.2.1.2-1). Before reclamation, the region was largely riverine though it was under tidal influence as it is today (Florsheim and Mount 2002). Major changes include deforestation of the natural levees, channelization and disconnection of the river from its flanking floodplains and extensive levee reinforcement with riprap. Presently, agriculture is the dominant adjacent land use; however, there are a few natural habitat areas including stands of riparian forest and parcels of freshwater wetlands that are more frequently separated from the river channels by levees than not (Figure 9.2.1.2-5). Since the 1990s, there has been some restoration of the Cosumnes River floodplain at the edge of the Delta's tidal influence (Swenson *et al.* 2003).

Routine trawl-based monitoring programs by CDFW that sample this part of the Delta like the FMWT and the SKT have seldom collected delta smelt (< 1% of the catch; Murphy and Hamilton 2013). The Service's beach seine monitoring program has occasionally collected delta smelt (57 individuals in 21 years) from the few sampling sites it has in this region (Figure 9.2.1.2-6). All 57 collections were adults; similar to the Sacramento River, the collections occurred during the spawning season with observations as late in the year as June 1 in 1999 (Table 9.2.1.2-2). Delta smelt have occasionally been collected from several other locations within this area and up the Mokelumne River as far as Woodbridge Dam (Merz *et al.* 2011; Figure 9.2.1.1-6). No delta smelt were collected during a three-year study of fishes in the Cosumnes River basin during 1999-2001 (Moyle *et al.* 2003). Furthermore, no delta smelt larvae were collected during larval fish surveys of the Cosumnes floodplain restoration areas (Crain *et al.* 2004). The Service concludes this is a transiently used spawning habitat area for delta smelt.

Figure 9.2.1.2-5. National Agriculture Imagery Program (2016) aerial image of the Delta east of Walnut Grove, showing the Mokelumne River system from the Delta Cross Channel to the Cosumnes River floodplain.

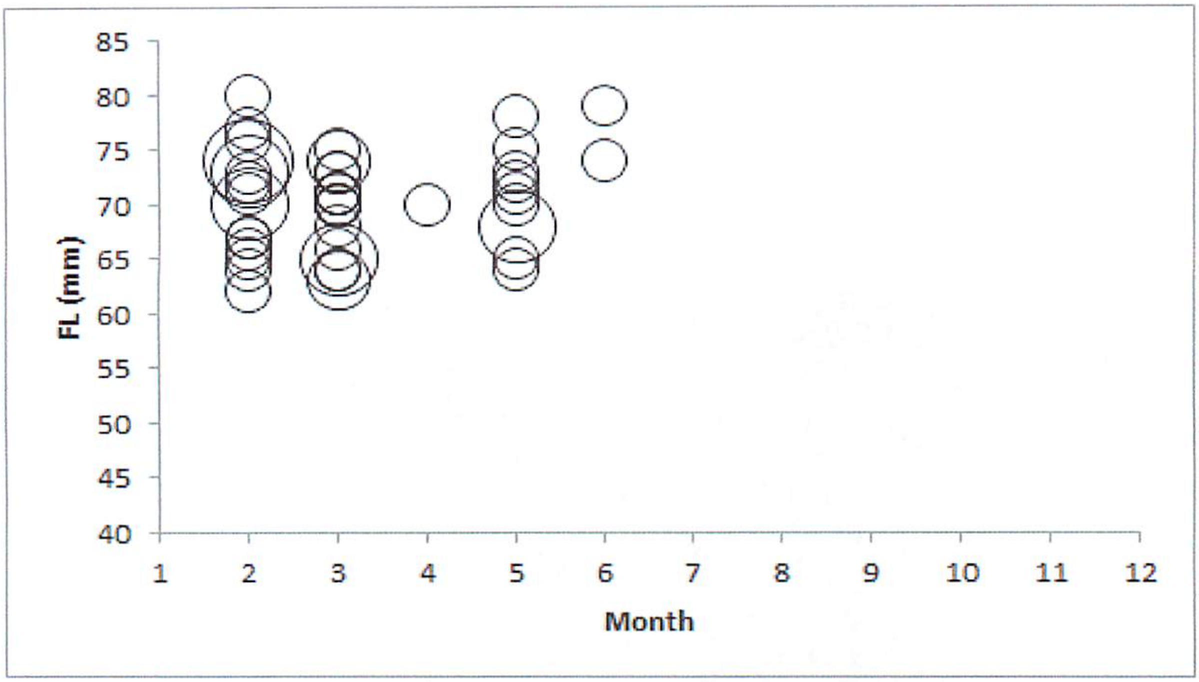


Figure 9.2.1.2-6. Timing and fork lengths of delta smelt collected by Service beach seine surveys at Mokelumne River sites. Delta smelt larger than 50 mm in length are adults, so only adults have been collected in these surveys. The smallest data points reflect one fish collected at the plotted length, the larger the data point, the more fish of that length were collected. Data source: DJFMP beach seine survey, 1994-2014.

Table 9.2.1.2-2. Years in which beach seine surveys conducted by DJFMP have collected delta smelt from Mokelumne River sites.

Location	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Frequency
SF014E (Wimpy's)																						0.29
LP003E (Terminous)																						0.19
MK004W (B&W Marina)																						0.00

Waterways near Prisoners Point

The forks of the Mokelumne River and Georgiana Slough flow into the San Joaquin River along the north and west sides of Bouldin Island. The proposed tunnel alignment crosses under the San Joaquin River at Venice Island just east of Prisoners Point (CWF BA 2016). Historically, this reach of the San Joaquin River system was part of the central Delta's vast 300,000-acre tidal marsh system with a complex, sinuous channel network (Whipple *et al.* 2012). The historical vegetation was dominated by tules. The surrounding landscape was converted to agriculture between 1906 and 1916 (Figure 9.2.1.2-1).

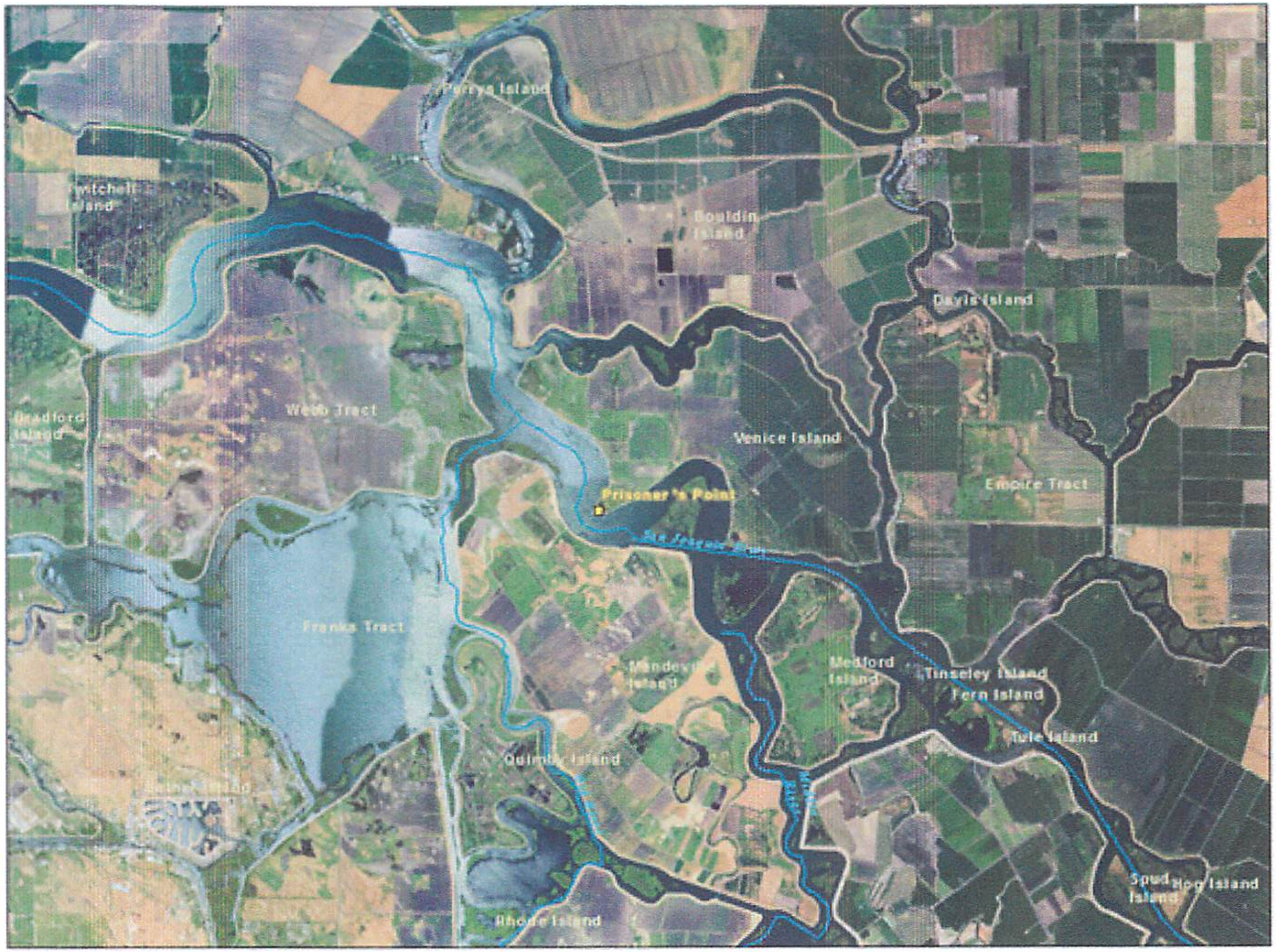


Figure 9.2.1.2-7. National Agriculture Imagery Program (2016) aerial image of the central Delta, including the San Joaquin River region around Prisoners Point.

The major landscape change in this region is the disconnection of the Delta islands from the river channel network and the conversion of the tule marsh plains into agriculture (Whipple *et al.* 2012). The tule peat was burned and otherwise oxidized away over the previous 100 years, leaving the surrounding islands well below sea level (Mount and Twiss 2005). These subsided islands are protected from flooding by riprapped levees. Generally the levees along the north bank of the San Joaquin River are extensively riprapped and as a consequence, largely denuded of vegetation, while the southern bank retains greater amounts of riparian and marsh vegetation.

There are numerous in-channel islands in Potato Slough along the north side of Venice Island and in the San Joaquin River upstream of Prisoners Point (Figure 9.2.1.2-7). The channel edges and remnant wetland complexes in this reach are heavily infested with submerged aquatic vegetation (Durand *et al.* 2016) and slow moving sloughs and smaller channels can have seasonal infestations of water hyacinth as well (Toft *et al.* 2003). These aquatic plants, largely comprised of invasive species, create highly productive microhabitats (Lucas *et al.* 2002; Nobriga *et al.* 2005; Grimaldo *et al.* 2009), but they degrade habitat quality for delta smelt by increasing water transparency (Nobriga *et al.* 2008; Hestir *et al.* 2016) and harboring predatory fishes (Ferrari *et al.* 2014; Conrad *et al.* 2016).

Unlike the proposed construction areas to the north, this region has been monitored more intensively and has been a region of significant fish biological research as well (*e.g.*, Toft *et al.* 2003; Grimaldo *et al.* 2004; Nobriga *et al.* 2005; 2008; Grimaldo *et al.* 2009; 2012). Thus, delta smelt's use of the area is more mechanistically understood here. Each winter, some delta smelt move up the San Joaquin River to spawn. This has been confirmed over the past decade and a half by the CDFW's SKT Survey (http://www.dfg.ca.gov/delta/data/skt/DisplayMaps.asp) and more recently, the Service's Early Warning Surveys (https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm). These fish presumably find spawning habitats along sandy beach areas. Grimaldo *et al.* (2004) generally found higher densities of delta smelt larvae in the river channels around Venice Island than the remnant marshes associated with the in-channel islands. The CDFW's 20-mm Survey, which samples channel habitats, has collected larval and small juvenile delta smelt from this region every year of its 21-year history (http://www.dfg.ca.gov/delta/data/20mm/CPUE_map3.asp). However, larvae collected in the San Joaquin River could have either been spawned in the San Joaquin River or have been transported from the Sacramento and Mokelumne systems, which are hydrodynamically connected to the San Joaquin River near Prisoners Point (Kimmerer and Nobriga 2008). The abundance of larval delta smelt in the central Delta usually drops below 20-mm survey detection limits by the end of June and below south Delta diversion fish facilities detection limits about a month later (Figure 9.2.1.2-8). As abundance has decreased, these detection thresholds have shifted earlier in the year because both trawl nets and the fish facilities have minimum densities of fish they can reliably detect, and perhaps because water operations changes initiated under the Service and NMFS BiOps have better enabled larval delta smelt to move seaward during the spring.

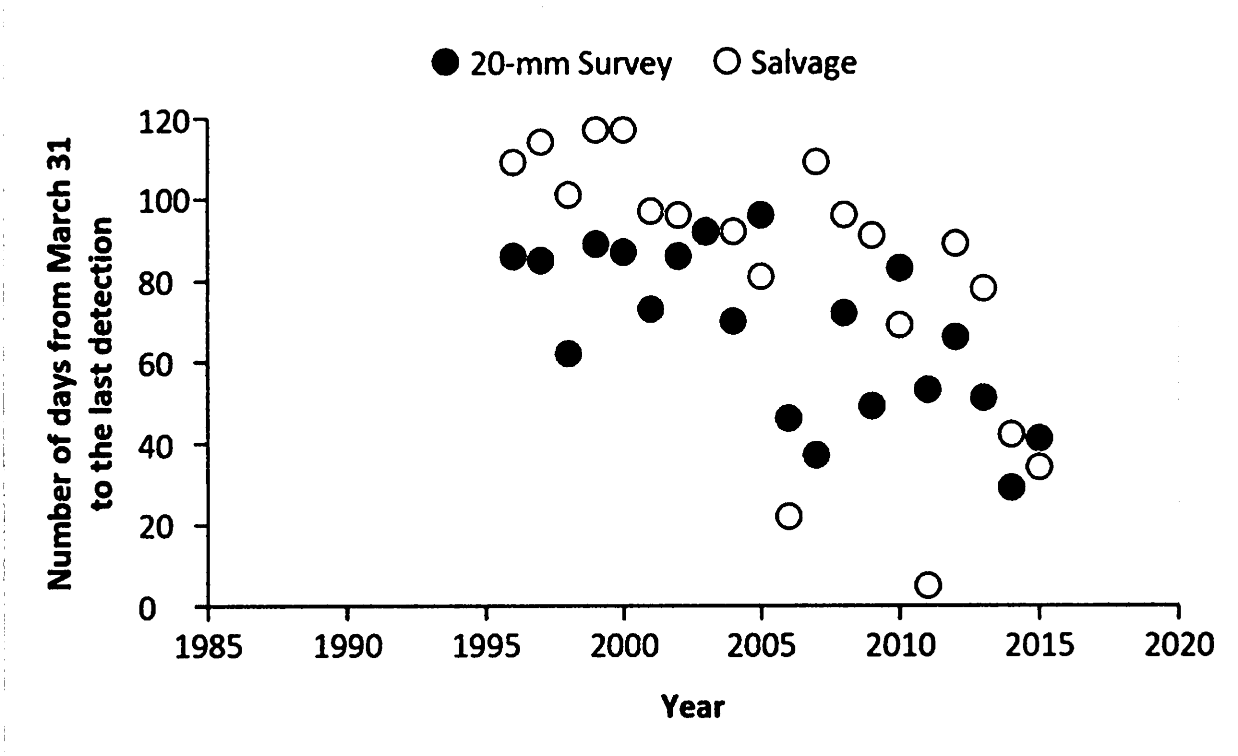


Figure 9.2.1.2-8. Time series of the day of last detection of delta smelt upstream of Jersey Point in the 20-mm Survey and at the CVP or SWP fish facilities. On the y-axis, day 1 is April 1, and day 120 is July 29.

Head of Old River and Other Waterways along the Proposed Tunnel Alignment South of the San Joaquin River Main Stem

The CDFW's striped bass and delta smelt monitoring surveys do not sample in the San Joaquin River upstream of Rough and Ready Island in Stockton (Figure 9.2.1.1-7). Delta smelt have been collected as far up the San Joaquin River as Mossdale (Figure 9.2.1.1-6) and the Service's DJFMP beach seine program has occasionally collected delta smelt in the vicinity of the HOR (Figure 9.2.1.1.7). The Service considers delta smelt that ascend this far up the San Joaquin River to be entrained and as such not functionally contributing to the next generation of fish. Not all entrained delta smelt die in water diversions because many are eaten by predators or otherwise perish in the poor quality habitats of the southern Delta's flooded islands (Franks Tract, Mildred Island) and canals with net reverse flows (Old and Middle river) before they reach the fish facilities. Some of these 'entrained' fish may even have the opportunity to spawn, but PTM shows their larvae would seldom have a hydrodynamic opportunity to escape the south Delta (Kimmerer and Nobriga 2008). In addition, most delta smelt that reach the CVP and SWP intakes are eaten by predators before they can be salvaged (Castillo *et al.* 2012). Delta smelt are seldom collected anywhere in the southern Delta beyond June due to entrainment, increasing water temperature (Kimmerer 2008; Service 2008), and increasing sensitivity to high transparency water as they metamorphose into juveniles (Nobriga *et al.* 2008).

The major landscape change in this region is the disconnection of the Delta islands from the river channel network and the conversion of the tule marsh plains into agriculture (Whipple *et al.* 2012). The tule peat was burned and otherwise oxidized away over the previous 100 years, leaving the surrounding islands well below sea level (Mount and Twiss 2005). These subsided islands are protected from flooding by riprapped levees. Generally the levees along the north bank of the San Joaquin River are extensively riprapped and as a consequence, largely denuded of vegetation, while the southern bank retains greater amounts of riparian and marsh vegetation.

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9.2.1.3 Status of the Critical Habitat

Legal Status

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code) (Service 1994). The entire designated critical habitat for delta smelt is encompassed by the action area for the PA, and the action area encompasses almost the entire range of the delta smelt. Therefore, we combined the *Status of Critical Habitat* and the *Environmental Baseline/Status of Critical Habitat in the Action Area* into one section.

Conservation Role of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful completion of the life cycle, including spawning, larval and juvenile transport, rearing, and adult migration back to spawning sites. Delta smelt are endemic to the Bay-Delta and the vast majority only live one year. Thus, regardless of annual hydrology, the Bay-Delta estuary must provide suitable habitat all year, every year. The primary constituent elements essential to the conservation of the delta smelt are physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (Service 1994). The Service recommended in its designation of critical habitat for the delta smelt that salinity in Suisun Bay should vary according to WY type. For the months of February through June, this element was codified by the State Water Resources Control Board's "X2 standard" described in D-1641 and the Board's current WQCP.

Description of the Primary Constituent Elements

The original descriptions of the primary constituent elements are compared and contrasted with current scientific understanding in Table 9.2.1.3-1.

Table 9.2.1.3-1. Comparison of delta smelt primary constituent elements of critical habitat between the 1994 publication of the rule and the present.

Primary Constituent Element	1994 critical habitat rule	2016 state of scientific understanding
Spawning Habitat	Shallow fresh or slightly brackish edgewaters.	No change.
	Backwater sloughs.	Possible, never confirmed. Most likely spawning sites have sandy substrates and need not occur in sloughs. Backwater sloughs in particular tend to have silty substrates that would suffocate eggs.
	Low concentrations of pollutants.	No change.
	Submerged tree roots, branches, emergent vegetation (tules).	Not likely. Unpublished observations of spawning by captive delta smelt suggest spawning on substrates oriented horizontally and a preference for gravel or sand that is more consistent with observations of other osmerid fishes.
	Key spawning locations: Sacramento River "in the Delta", Barker Slough, Lindsey Slough, Cache Slough, Prospect Slough, Georgiana Slough, Beaver Slough, Hog Slough, Sycamore Slough, Suisun Marsh.	All of the locations listed in 1994 may be suitable for spawning, but based on better monitoring from the Spring Kodiak Trawl Survey, most adult fish have since been observed to aggregate around Grizzly Island, Sherman Island, and in the Cache Slough complex including the subsequently flooded Liberty Island.
	Adults could spawn from December-July.	Adults are virtually never fully ripe and ready to spawn before February and most spawning is completed by May (warm years) or June (cool years).

Larval and juvenile transport	Larvae require adequate river flows to transport them from spawning habitats in backwater sloughs to rearing habitats in the open waters of the LSZ.	Not likely. Most delta smelt that survive to the juvenile life stage do eventually inhabit water that is in the 0.5 to 6 ppt range, due to either or both of downstream movement or decreasing outflow. However, delta smelt larvae can feed in the same habitats they were hatched in and juvenile fish can rear in water less than 0.5 ppt salinity.
	Larvae require adequate flow to prevent entrainment.	No change.
	Larval and juvenile transport needs to be protected from physical disturbances like sand and gravel mining, diking, dredging, riprapping.	No change, but seems likely to have more impact on spawning habitat than larval transport.
	2 ppt isohaline (X2) must be west of the Sacramento-San Joaquin River confluence to support sufficient larval and juvenile transport.	No change. X2 is generally west of the confluence during February-June due to State Water Resources Control Board X2 standard; however, the standard does have a drought off-ramp.
	Maturation must not be impaired by pollutant concentrations.	No change.
	Additional flows might be required in the July-August period to protect delta smelt that were present in the south and central Delta from being entrained in export pumps.	July-August outflow augmentations may be helpful, but not to mitigate entrainment. Habitat changes in the central and south Delta have rendered it seasonally unsuitable to delta smelt during the summer; entrainment is seldom observed past June.
Rearing habitat	2 ppt isohaline (X2) should remain between Carquinez Strait in the west, Three-Mile Slough on the Sacramento River and Big Break on the San Joaquin River in the east. This was determined to be a range for 2 ppt salinity (including its tidal time scale excursion into the Delta).	No change. X2 generally in this area during February-June due to State Water Resources Control Board X2 standard; however the standard does have a drought off-ramp. Most juvenile delta smelt still rear in this area but it is now recognized that a few remain in the Cache Slough complex as well.

Adult migration	Adults require unrestricted access to spawning habitat from December-July.	Adults disperse faster than was recognized in 1994; most of it is finished by the time Spring Kodiak Trawls start in January, though local movements and possibly rapid longer distance dispersal occurs throughout the spawning season, which as mentioned above is usually February-June or a subset of those months.
	Unrestricted access results from adequate flow, suitable water quality, and protection from physical disturbance.	No change.

Primary Constituent Element 1: "Physical habitat" is defined as the structural components of habitat (Service 1994). The ancestral Delta was a large tidal marsh-floodplain habitat totaling approximately 300,000 acres. During the late 1800s and early 1900s, most of the wetlands were diked and reclaimed for agriculture or other human use (Figure 9.2.1.2-1). The physical habitat modifications of the Delta and Suisun Bay were mostly due to land reclamation and urbanization. Water conveyance projects and river channelization have had some influence on the regional physical habitat by armoring levees with riprap, building conveyance channels like the Delta Cross Channel, storage reservoirs like CCF, and by building and operating temporary barriers in the south Delta and permanent gates and water distribution systems in Suisun Marsh.

During the 1930s to 1960's, the shipping channels were dredged deeper (~12 m) to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the Sacramento-San Joaquin River confluence region as the largest and most depth-varying places in the typical range of the low-salinity zone. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle *et al.* 1992; Jassby *et al.* 1995). However, the deeper landscape created to support shipping and flood control requires more freshwater outflow to maintain the low-salinity zone in the large Suisun Bay/river confluence region than was once required. The shipping itself has historically provided a source of non-native organisms, that along with depleted flows and deep channelization, have contributed to the changing ecology of the upper estuary (Winder and Jassby 2011; Kratina *et al.* 2014).

Although the delta smelt is a generally pelagic or open-water fish, depth variation of open-water habitats is an important habitat attribute (Moyle *et al.* 1992; Hobbs *et al.* 2006). In the wild, delta smelt are most frequently collected in water that is somewhat shallow (4-15 ft deep) where turbidity is often elevated and tidal currents exist but are not excessive (Moyle *et al.* 1992; Bever *et al.* 2016). In Suisun Bay, the deep shipping channels are poor quality habitat because tidal velocity is very high (Bever *et al.* 2016), but in the north Delta where tidal velocity is slower, the Sacramento Deepwater Shipping Channel is used to a greater extent, particularly for spawning and by larval fish (CDFW unpublished data). Adult delta smelt also use edge habitats as tidal current refuges and corridors to spawning habitats (Bennett and Burau 2015).

Primary Constituent Element 2: "Water" is defined as water of suitable quality to support various delta smelt life stages that allow for survival and reproduction (Service 1994). Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt and are discussed in detail below. Contaminant exposure can degrade this primary constituent element even when the basic habitat components of water quality are otherwise suitable (Hammock *et al.* 2015).

Turbidity: Delta smelt require turbidity. Even in captivity, clear water is a source of physiological stress (Lindberg *et al.* 2013; Hasenbein *et al.* 2016). The small plankton that delta smelt larvae eat are nearly invisible in clear water. The sediment (or algal) particles that make turbid water turbid, provide a dark background that helps delta smelt larvae see their translucent prey (Baskerville-Bridges *et al.* 2004). Older delta smelt are less reliant on turbidity to see their prey, but older fish still feed more effectively in water of moderate turbidity (Hasenbein *et al.*

2013; 2016) and probably need turbid water to help disguise themselves from predators (Ferrari *et al.* 2014). The turbidity of the Delta and Suisun Bay has been declining for a long time due to dams and riprapped levees, both of which cut off sources of sediment from rivers flowing into the estuary (Arthur *et al.* 1996; Wright and Schoellhamer 2004), and due to the spread of Brazilian waterweed (Hestir *et al.* 2016) which filters the water, increasing clarity. Water exports from the south Delta may also have contributed to the trend toward clearer water by removing resuspended sediment in the exported water (Arthur *et al.* 1996). The primary turbid areas that remain in the upper estuary are the semi-shallow embayments in northern Suisun Bay (Bever *et al.* 2016) and the lower Yolo Bypass region that includes Liberty Island and the upper reach of the Sacramento Deepwater Shipping Channel (Morgan-King and Schoellhamer 2013). Both tidal and river flows, as well as wind speed, affect turbidity in these locations. Many of the estuary's deeper channels tend to have somewhat lower turbidity because water velocity and wind cannot resuspend sediment that sinks into deep water (Ruhl and Schoellhamer 2004).

Water temperature: Water temperature is the primary driver of the timing and duration of the delta smelt spawning season (Bennett 2005). Water temperature also affects delta smelt's growth rate which in turn can affect their readiness to spawn (Rose *et al.* 2013a). Water temperature is not strongly affected by variation in Delta outflow; the primary driver of water temperature variation in the delta smelt critical habitat is air temperature (Wagner *et al.* 2011). Very high flows can transiently cool the upper estuary (*e.g.*, flows in the upper 10th percentile, Kimmerer 2004), but the system rapidly re-equilibrates once air temperatures begin to warm.

Older laboratory based research suggested an upper water temperature limit for delta smelt of about 25°C, or 77°F (Swanson *et al.* 2000). Newer laboratory research suggests delta smelt temperature tolerance decreases as the fish age, but is a little higher than previously reported, up to 28°C or 82°F in the juvenile life stage (Komoroske *et al.* 2014). It should be kept in mind that these are upper *acute* water temperature limits, meaning temperatures in this range will kill, on the average, one of every two fish.

In the laboratory and the wild, delta smelt appear to have a physiological optimum temperature near 20°C or 68°F (Nobriga *et al.* 2008; Rose *et al.* 2013a; Jeffries *et al.* 2016); most of the upper estuary exceeds this water temperature from June through September (Wagner *et al.* 2011). Thus, many parts of the estuary are energetically costly and stress delta smelt. Generally speaking, spring and summer water temperatures are cooler to the west and warmer to the east due to the differences in overlying air temperatures between the Bay Area and the warmer Central Valley (Kimmerer 2004). In addition, there is a strong water temperature gradient across the Delta with cooler water in the north and warmer water in the south. The higher flows from the Sacramento River probably explain this north-south gradient. Note that water temperatures in the north Delta near Liberty Island and the lower Yolo Bypass are also typically warmer than they are along the Sacramento River (Sommer *et al.* 2001; Nobriga *et al.* 2005).

Food: Food and water temperature are strongly interacting components of delta smelt health and habitat because the warmer the water, the more food delta smelt require (Rose *et al.* 2013a). If the water gets too warm, then no amount of food is sufficient. The more food delta smelt eat (or must try to eat) the more they will be exposed to predators and contaminants. Water exports can limit the flux of phytoplankton production from the Delta into Suisun Bay (Jassby and Cloern 2000), but the effect of water exports on phytoplankton production appears to be lower than grazing by clams (Jassby *et al.* 2002) and ammonium inhibition of phytoplankton growth from Sacramento's urban wastewater inputs (Dugdale *et al.* 2012).

Historically, prey production occurred when the low-salinity zone was positioned over the shoals of Suisun Bay during late spring through the summer, but this function has been depleted due to grazing by overbite clams (Kimmerer and Thompson 2014), high ammonium concentrations in critical habitat (Dugdale *et al.* 2012; 2016), and water diversions (Jassby and Cloern 2000). Recent research suggests delta smelt occupying Suisun Bay may experience poor nutritional health (Hammock *et al.* 2015). Delta smelt occupying the Cache Slough region in the north Delta are in better nutritional health, but have shown evidence of relatively high contaminant impacts. The southern Delta is among the more productive areas remaining in the upper estuary (Nobriga *et al.* 2005), but delta smelt cannot remain in this habitat during the warmer months of the year (Nobriga *et al.* 2008) and may face a high risk of entrainment when they occupy it during cooler months (Kimmerer 2008; Grimaldo *et al.* 2009). Extensive blooms of the toxin-producing cyanobacteria *Microcystis* in the central and southern Delta became abundant around 1999 and depending on flow, and temperature, blooms can extend westward into the low-salinity zone where delta smelt are rearing (Brooks *et al.* 2011). However, in general delta smelt that occupy Suisun Marsh fare better both in terms of nutrition and in experiencing a lower level of contaminant impacts (Hammock *et al.* 2015).

Primary Constituent Element 3: "River flow" was originally defined as transport flow to facilitate spawning migrations and transport offspring to low-salinity zone rearing habitats (Service 1994). River flow includes both "inflow to" and "outflow from" the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflows, outflows, and Old and Middle river flows influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at the Banks and Jones facilities (Grimaldo *et al.* 2009).

The spawning microhabitats of delta smelt are not known, but whatever they are, it is likely there is more available suitable spawning habitat when Delta outflow is high during spawning than when it is low because more of the estuary is covered in fresh- and low-salinity water when outflow is high (Jassby *et al.* 1995). Most spawning occurs between February and May. Delta outflow during February through May is mainly driven by the climatic effect on the amount and form of precipitation in the watershed, the storage and diversion of water upstream of the Delta, and CVP and SWP water operations in the Delta (Jassby *et al.* 1995; Kimmerer 2002a). Thus far, the 21st century has tended to be pretty dry (Figure 9.2.1.1-8) and that could have resulted in some chronic reduction in spawning habitat availability or suitability.

Primary Constituent Element 4: "Salinity" helps define nursery habitat (Service 1994). Older laboratory research suggested that delta smelt have an upper acute salinity tolerance of about 20 ppt (Swanson *et al.* 2000) which is about 60% of seawater's salt concentration of 32-33 ppt. Newer laboratory-based research suggests that some individuals can acclimate to seawater, but that comes at a high energetic cost that is lethal to about one in four individuals (Komoroske *et al.* 2014; 2016). In the wild, delta smelt are nearly always collected at very low salinities, which recent laboratory research has confirmed is nearer to the physiological optimum (Komoroske *et al.* 2016). Few individuals are collected at salinities higher than 6 ppt (about 20% of seawater salt concentration) and very few are collected at salinities higher than 10 ppt (about 30% of seawater salt concentration) (Bennett 2005). This well documented association with fresh to low salinity water is a reason for the scientific emphasis on X2 as a delta smelt habitat indicator (Dege and Brown 2004; Feyrer *et al.* 2011). Recent research combining long-term monitoring data with three-dimensional hydrodynamic modeling shows that the spatial overlap of several of the key habitat attributes described above increases as Delta outflow increases (Bever *et al.* 2016). This means that higher outflow, which lowers the salinity of Suisun Bay and Suisun Marsh, increases the suitability of habitat in the estuary by increasing the overlap of some, but not necessarily all, needed elements. Lower outflows provide less overlap and in fewer places.

Summary of Status of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful completion of the life cycle, including spawning, larval and juvenile transport, rearing, and adult migration back to spawning sites. Since the implementation of the RPA in the Service's 2008 BiOp, there has been a lower likelihood of water operations that are highly detrimental to the spawning migration of adult delta smelt, the spawners themselves, or larval transport. Further, recent research suggests that the movement of adult delta smelt to nominal spawning locations is quite similar among years (Polansky *et al.* in press).

There are very few locations that consistently provide all the needed habitat attributes for larval and juvenile rearing at the same times and in the same places (Table 9.2.1.3-2; IEP 2015). Larval and juvenile rearing remains most impacted by ecological changes in the estuary since the delta smelt's listing under the Act. As described above, those changes have stemmed from changes in outflow, species invasions and associated changes in how the upper estuary food web functions, declining prey availability, high water temperatures, declining water turbidity, summertime blooms of *Microcystis aeruginosa*, proliferation of submerged aquatic plants, and localized contaminant accumulation by delta smelt.

ry of habitat attribute conditions for delta smelt in six regions of the estuary that are permanently or nost years.

Landscape	Turbidity	Salinity	Temperature	Food
Appropriate	Appropriate	Appropriate *when outflow is sufficient*	Usually appropriate	Appropriate
›ropriate except in ıipping channel	Appropriate, but declining	Appropriate *when outflow is sufficient*	Usually appropriate	Depleted
d area 4 to 15 ft deep	marginal, declining	Appropriate	Can be too high during summer	Depleted
Appropriate	Appropriate	Appropriate	Can be too high during summer	Appropriate, but associated with elevated contaminant impacts
l area 4 to 15 ft deep; swift currents	Marginal except during high flows, declining	Appropriate	Usually appropriate	Likely low due to swift currents and wastewater inputs
ropriate except too uch coverage by ıbmerged plants	Too low	Appropriate	Too high in the summer	Appropriate

9.2.1.4 Existing Conditions and Previous Consultations in the Action Area

9.2.1.4.1 Consultation of the Coordinated Long-Term Operations of the CVP and SWP

Background

The CVP and SWP are California's two largest water storage and delivery systems. The CVP and SWP include major reservoirs north and south of the Delta; both projects transport water via natural watercourses and canal systems to areas throughout much of California. For both the CVP and the SWP, the primary north to south transfer point is the Delta where water is exported to the south from the C.W. "Bill" Jones and Harvey O. Banks pumping plants into the Delta-Mendota Canal and the California Aqueduct, respectively. Additionally, CVP water is also exported from the Delta via the Contra Costa Water District facilities to the Bay Area and SWP water is also exported from the Delta via the Barker Slough Pumping Plant.

The California State Water Resources Control Board (SWRCB) permits the CVP and SWP to store, release, and divert water and to divert natural runoff. The CVP and SWP operate pursuant to water rights permits and licenses issued by the SWRCB. As conditions of their water rights permits and licenses, the SWRCB requires the CVP and SWP to meet specific water quality, quantity, and operational criteria within the Delta. Reclamation and the DWR closely coordinate the CVP and SWP operations to meet these obligations.

2008 Service BiOp on the Coordinated Operations of the CVP and SWP

In 2008, the Service issued a BiOp that concluded that the continued long-term operation of the CVP and SWP was likely to jeopardize the continued existence of delta smelt and destroy or adversely modify its critical habitat. The Service included a RPA to avoid jeopardy and adverse modification. Reclamation provisionally accepted the RPA and began implementing the BiOp and the RPA in December 2008. This BiOp is currently in effect.

Key elements of the Service's RPA in the 2008 BiOp are:

RPA Component 1: The objective of Component 1 (comprised of Actions 1 and 2) is to reduce entrainment of pre-spawning adults by controlling OMR flows during periods of elevated entrainment risk. Action 1 is designed to protect migrating delta smelt. Action 2 is designed to protect adult delta smelt that are residing in the Delta prior to spawning. Overall, RPA Component 1 increases the suitability of spawning habitat for delta smelt by decreasing the amount of Delta habitat affected by the CVP and SWP export pumping plants' operations prior to, and during, the critical spawning period;

RPA Component 2: The objective of Component 2 is to limit entrainment of larval and juvenile delta smelt by reducing net negative flow conditions in the central and south Delta, so that larval and juvenile delta smelt can successfully rear in the Delta and move downstream when appropriate;

RPA Component 3: The objective of Component 3 is to improve fall habitat conditions for delta smelt by increasing Delta outflow during fall of Wet and Above-normal years to re-establish variability in habitat conditions during this time of year;

RPA Component 4: The objective of Component 4 is to restore a minimum of 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh to increase prey production for delta smelt; and

RPA Component 5: Component 5 provides for monitoring and reporting. Reclamation and DWR shall ensure that information is gathered and reported to ensure: (1) proper implementation of the restoration actions, (2) that the physical results of the restoration actions are achieved, and (3) that information is gathered to evaluate the effectiveness of these actions on the targeted life stages of delta smelt so that the actions can be refined, if needed.

For more information, the 2008 Service BiOp can be found at:
https://www.fws.gov/sfbaydelta/documents/SWP-CVP_OPs_BO_12-15_final_signed.pdf

2009 NMFS BiOp on the Coordinated Operations of the CVP and SWP

NMFS issued its current coordinated operations of the CVP and SWP BiOp on June 4, 2009. The NMFS BiOp covers: Central California Coast steelhead and its critical habitat; Sacramento River winter-run Chinook salmon; Central Valley spring-run Chinook salmon; Central Valley steelhead; Southern Distinct Population Segment (DPS) of Northern American green sturgeon; and Southern resident DPS of killer whales. NMFS determined that the action was likely to jeopardize these species and destroy or adversely modify their critical habitat, except the Central California Coast steelhead, and included an RPA.

Key elements of the NMFS RPA in the 2009 BiOp are:

- A new temperature management program for Shasta Reservoir and the Sacramento River below Keswick Dam;
- Long-term passage prescriptions at Shasta Dam to allow re-introduction of listed salmonids;
- Flow and temperature criteria in Clear Creek below Whiskeytown Dam;
- A new screened pumping plant in Red Bluff to replace the Red Bluff Diversion Dam (completed in 2012);
- Improved juvenile salmonid fish rearing habitat in the lower Sacramento River and Delta;
- Delta Cross Channel gate closure beyond the mandates of D-1641;
- An OMR flow limit of -5000 cfs from January 1 through June 30 with salvage-based triggers that can limit OMR flow to less negative values;
- A limit on the ratio of exports to San Joaquin River inflow during April and May;
- Required studies of acoustic tagged steelhead in the San Joaquin Basin to evaluate the effectiveness of the RPA and refinements as necessary;

- New flow management standard, temperature management plan, additional technological fixes to temperature control structures, and long-term fish passage above Folsom Dam for steelhead on the American River;
- New minimum flow regime for steelhead in the Stanislaus River and long-term fish passage evaluations above Goodwin, Tulloch, and New Melones Dam; and
- A hatchery genetics management plan for Nimbus Hatchery for steelhead and fall-run Chinook salmon (which is an important prey base for listed Southern Resident DPS killer whale).

For more information, the 2009 NMFS BiOp can be found at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/nmfs_biological_and_conference_opinion_on_the_long-term_operations_of_the_cvp_and_swp.pdf.

Existing Water Facilities

Below is a summary of the existing CVP and SWP water facilities. For additional information on CVP and SWP water service contracts, allocations, deliveries, and project facilities operational considerations that the SWP and CVP are obligated to comply with, see the Service 2008 and NMFS 2009 BiOps.

Central Valley Project (CVP) Re-authorization

The CVP is the largest Federal Reclamation project and was originally authorized by the Rivers and Harbors Act of 1935. The CVP was reauthorized by the Rivers and Harbors Act of 1937 for the purposes of "improving navigation, regulating the flow of the San Joaquin River and the Sacramento River, controlling floods, providing for storage and for the delivery of the stored waters thereof, for construction under the provisions of the Federal Reclamation Laws of such distribution systems as the Secretary of the Interior (Secretary) deems necessary in connection with lands for which said stored waters are to be delivered, for the reclamation of arid and semiarid lands and lands of Indian reservations, and other beneficial uses, and for the generation and sale of electric energy as a means of financially aiding and assisting such undertakings and in order to permit the full utilization of the works constructed." This Act provided that the dams and reservoirs of the CVP "shall be used, first, for river regulation, improvement of navigation and flood control; second, for irrigation and domestic uses; and, third, for power." The CVP was reauthorized in 1992 through the Central Valley Project Improvement Act (CVPIA) (Public Law 102-575, Title 34) adding mitigation, protection, and restoration of fish and wildlife as a project purpose. Further, the CVPIA specified that the dams and reservoirs of the CVP should now be used "first, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses and fish and wildlife mitigation, protection and restoration purposes; and, third, for power and fish and wildlife enhancement."

The CVPIA includes actions to benefit fish and wildlife. Specifically, Section 3406(b)(1) is implemented through the Anadromous Fish Restoration Program (AFRP). The AFRP objectives, as they relate to operations, are further explained below. CVPIA Section 3406(b)(1) provides for modification of the CVP operations to meet the fishery restoration goals of the CVPIA, so long as the operations are not in conflict with the fulfillment of the Secretary's contractual obligations to provide CVP water for other authorized purposes. The DOI decision on Implementation of Section 3406(b)(2) of the CVPIA, dated May 9, 2003, provides for the dedication and management of 800,000 af of CVP-water yield annually. This (b)(2) water has been used to augment flows below CVP dams and to reduce CVP exports from the Delta. DOI manages and accounts for (b)(2) water pursuant to its May 9, 2003 decision and court decisions, including the Ninth Circuit Court of Appeals' decision in *Bay Institute of San Francisco v. United States*, 66 Fed. Appx. 734 (9^{th} Cir. 2003), as amended, 87 Fed. Appx. 637 (2004). Additionally, DOI is authorized to acquire water to supplement (b)(2) water, pursuant to Section 3406(b)(3).

State Water Project (SWP)

DWR was established in 1956 as the successor to the Department of Public Works for authority over water resources and dams within California. DWR was also given the authority to apply for the appropriation of water on behalf of the State (Stats. 1956, First Ex. Sess., Ch. 52; see also Wat. Code Sec. 123) and currently holds water rights permits used by the SWP. DWR's authority to construct State water facilities or projects is derived from the Central Valley Project Act (CVPA) (Wat. Code Sec. 11100 et seq.), the Burns-Porter Act (California Water Resources Development Bond Act) (Wat. Code Sec. 12930-12944), the State Contract Act (Pub. Contract Code Sec. 10100 et seq.), the Davis-Dolwig Act (Wat. Code Sec. 11900-11925), and special acts of the State Legislature. The CVPA described specific facilities that have been built by DWR, including the Feather River Project and California Aqueduct (Wat. Code Sec. 11260), Silverwood Lake (Wat. Code Sec. 11261), and the North Bay Aqueduct (Wat. Code Sec. 11270). The CVPA allows DWR to administratively add other units (Wat. Code Sec. 11290) and develop power facilities (Wat. Code Sec. 11295).

The Burns-Porter Act which was approved by California voters in November 1960 (Wat. Code Sec. 12930-12944), authorized the issuance of bonds for construction of the SWP. The principal facilities of the SWP are Oroville Reservoir and related facilities in the Feather River, the San Luis Dam and related facilities, two pumping plants in the Delta, the California Aqueduct including its terminal reservoirs, and the North and South Bay Aqueducts. DWR is required to plan for recreational and fish and wildlife uses of water in connection with State-constructed water projects and the agency can acquire land for those uses (Wat. Code Sec. 233, 345, 346, 12582). The Davis-Dolwig Act (Wat. Code Sec. 11900-11925) established the policy that preservation of fish and wildlife is part of State costs to be paid by water supply contractors, and recreation and enhancement of fish and wildlife are to be provided by appropriations from the General Fund.

DWR holds contracts with 29 public agencies in northern, central, and southern California for water supplies from the SWP. Water stored in Lake Oroville and the Thermalito Complex along with water available in the Delta (consistent with applicable regulations) is conveyed to SWP contractors via the Barker Slough and Banks Pumping Plants.

The SWP is operated to provide flood control and water for agricultural, municipal, industrial, recreational, and environmental purposes. A large portion of the water stored in Oroville Reservoir is provided to three Feather River area contractors, two contractors served from the North Bay Aqueduct, and 24 contractors south of the Delta. In addition to pumping water released from Oroville Reservoir, both the Barker Slough and Banks Pumping Plants pump water entering the Delta from other managed and unmanaged sources of inflow.

Coordinated Operations of the CVP and SWP

Coordinated Operation Agreement

The Coordinated Operation Agreement (COA) between the United States and the State of California to operate the CVP and SWP was signed in November, 1986. Congress, through Public Law 99-546, authorized and directed the Secretary to execute and implement the COA. The COA defines the rights and responsibilities of the CVP and SWP with respect to in-basin water needs and project exports and provides a mechanism to account for those rights and responsibilities.

Under the COA, Reclamation and DWR agree to operate the CVP and SWP under balanced conditions in a manner that meets Sacramento Valley and Delta needs while maintaining each project's annual water supplies. Balanced conditions are defined as periods when the two projects agree that releases from upstream reservoirs, plus unregulated flow, approximately equal water supply needed to meet Sacramento Valley in-basin uses and project exports. Coordination between the CVP and the SWP is facilitated by an accounting procedure based on the sharing principles outlined in the COA. During balanced conditions in the Delta when water must be withdrawn from storage to meet Sacramento Valley and Delta requirements, 75% of the responsibility to withdraw from storage is borne by the CVP and 25% by the SWP. The COA also provides that during balanced conditions when unstored water is available for export, 55% of the sum of stored water and the unstored water for export is allocated to the CVP, and 45% is allocated to the SWP. Although the principles were intended to cover a broad range of conditions, changes made subsequent to the COA, including the 2000 Trinity Record of Decision, recent BiOps, the SWRCB WQCP, and the CVPIA were not specifically addressed by the COA. However, these variances have been addressed by Reclamation and DWR through mutual, informal agreements.

1995 SWRCB Water Quality Control Plan

The SWRCB adopted the 1995 Bay-Delta WQCP (SWRCB 1995) on May 22, 1995, which became the basis of SWRCB Decision 1641 (D-1641) in 2000. The SWRCB continues to hold workshops and receive information regarding processes on specific areas of the 1995 WQCP. The SWRCB amended the WQCP in 2006, but to date, the SWRCB has made no significant changes to the 1995 WQCP framework.

SWRCB Decision 1641 and Revised D-1641

The SWRCB has issued numerous orders and decisions regarding water quality and water right requirements for the Bay-Delta including multiple operational responsibilities on the CVP and SWP to meet the flow objectives in D-1641 (issued December 29, 1999) and its subsequent revision (Revised D-1641, dated March 15, 2000). The SWRCB objectives set forth in the WQCP are intended to protect beneficial uses of water in the Delta. The SWRCB is currently considering a petition to change points of diversion in support of CWF and an update to the WQCP that could change the operational assumptions reflected in the CWF BA. Operation of the CWF will need to be consistent with decisions of the Board in both the WQCP and point of diversion petition processes.

The various flow objectives and export limits in D-1641 are designed to protect the estuary ecosystem, in-Delta agriculture and regional municipal water quality. These objectives include salinity requirements throughout the year, and export to inflow ratio limits in February through June. The water quality objectives vary within and between years according to the Sacramento Valley 40-30-30 WY Index: Wet, Above-normal, Below-normal, Dry, and Critically Dry. These flow and water quality objectives are subject to revision per petition process or every 3–5 year revision process set by the SWRCB.

2006 SWRCB Revised Water Quality Control Plan

The SWRCB undertook a proceeding under its water quality authority to amend the WQCP. Prior to commencing this proceeding, the SWRCB conducted a series of workshops in 2004 and 2005 to receive information on specific topics addressed in the WQCP.

The SWRCB adopted a revised WQCP on December 13, 2006. There were no changes to the Beneficial Uses from the 1995 WQCP to the 2006 WQCP, nor were any new water quality objectives adopted in the 2006 WQCP. A number of changes were made for readability. Consistency changes were also made to assure that sections of the 2006 plan reflected the current physical condition of the estuary and regulations existing at that time.

Current Water Quality Control Plan Process

The SWRCB is currently in the process of developing and implementing updates to its 2006 WQCP. The update has been broken into four phases, some of which are proceeding concurrently. Phase 1 of this work, currently in progress, involves updating San Joaquin River flow and southern Delta water quality requirements for inclusion in the WQCP. Phase 2 will involve comprehensive changes to the WQCP to protect beneficial uses not addressed in Phase 1, focusing on the Sacramento River basin and the Delta. Phase 3 will involve implementation of Phases 1 and 2 through changes to water rights and other measures. This phase will require a series of hearings to determine the appropriate allocation of responsibility between water rights holders within the scope of the Phase 1 and Phase 2 plans. Phase 4 will involve developing and implementing flow objectives for priority Delta tributaries upstream of the Delta.

Annual/Seasonal Temperature Management Upstream of the Delta

Reclamation is required to control water temperature in the Sacramento River pursuant to

SWRCB Order WR 90-5 and Action Suite I.2 of the RPA in the NMFS 2009 BiOp. Reclamation is required to develop and implement an annual Temperature Management Plan by May 15 each year to manage the cold water supply within Shasta Reservoir and make cold water releases from Shasta Reservoir, and Trinity Reservoir through the Spring Creek Tunnel, to provide suitable temperatures for winter-run Chinook salmon, and, when feasible, fall-run Chinook salmon, which supports an important commercial fishery and a prey base for listed Southern Resident DPS killer whale.

NMFS has been working with Reclamation to amend the RPA Action Suite I.2. The amendment is being made pursuant to the 2009 NMFS BiOp Section 11.2.1.2. Research and Adaptive Management, which states "After completion of the annual review, NMFS may initiate a process to amend specific measures in this RPA to reflect new information, provided that the amendment is consistent with the Opinion's underlying analysis and conclusions and does not limit the effectiveness of the RPA in avoiding jeopardy to listed species or adverse modification of critical habitat." The basis for the proposed RPA amendment included recent, multiple years of drought conditions, new science and modeling, and data demonstrating the low population levels of endangered Sacramento River winter-run Chinook salmon and threatened Central Valley spring-run Chinook salmon. This process resulted in a one year pilot study to the existing seasonal temperature management processes to evaluate the proposed amendments to Shasta operations, which include temperature dependent mortality biological objectives, spring Shasta Reservoir storage targets, and revised temperature compliance criteria. It remains to be seen whether the revised RPA Action Suite I.2 will affect inflows to the Delta.

Drought Operations and Management

Drought Contingency Plan and Temporary Urgency Change Petitions

The exceptionally dry conditions in 2014, 2015, and 2016 resulted in low reservoir storages which created a challenge to deliver water supplies, provide adequate cold water for instream fisheries resources, and comply with D-1641 standards. During 2014, 2015 and 2016, Reclamation and DWR petitioned the SWRCB on several occasions to temporarily modify the terms of their water rights permits for operation of the CVP and SWP. The SWRCB Executive Director approved Orders for temporary urgency changes to D-1641 standards to help Reclamation and DWR deliver minimum water supplies. The granted requests and information related to the drought workshops can be found online at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml.

West False River Temporary Emergency Drought Barrier

An emergency drought barrier was installed at West False River between Jersey and Bradford Islands in May and June 2015 to prevent tidal pumping of saltwater into the central Delta during a period of extremely low Delta outflow. The 750-foot rock barrier allowed the CVP and SWP water facilities to meet relaxed salinity standards while conserving limited water supply in the Projects' reservoirs. The barrier was removed in the fall of 2015. The barrier was installed near the end of the delta smelt's spawning season. The barrier prevented delta smelt from utilizing that corridor as a path for migration or dispersal, possibly increasing the risk of predation if fish were dispersed into Franks Tract. These types of drought operation could be considered in the future if exceptionally dry conditions are repeated.

9.2.1.4.2 Other Existing Conditions and Consultations in the Action Area

The following past and ongoing actions affect the current and future status of delta smelt and its critical habitat in the action area.

Freeport Regional Water Project

The Freeport Regional Water Project (FRWP) is an on-bank intake with a diversion capacity of 286 cubic feet per second (cfs) and a fish screen of approximately 175 ft in length (http://www.freeportproject.org/nodes/aboutfrwa/). The facility is located along the Sacramento River near Freeport and supplies water to Sacramento County and East Bay Municipal Utility District (EBMUD). EBMUD diverts water pursuant to its amended contract with Reclamation. Sacramento County diverts water pursuant to its water right and its CVP contract. This facility was not in the 1986 COA, but is considered an in basin use under COA. A BiOp for the construction, operation, and maintenance of the facility was issued in 2004 (Service 2004) and the water exports associated with the Freeport Intake were addressed in the 2008 Service BiOp (Service 2008) and previously the 2004 Operations Criteria and Plan (OCAP BiOp) (Service 2004).

The FRWP has a design capacity of 286 cfs (185 millions of gallons per day [mgd]). Up to 132 cfs (85 mgd) is diverted under Sacramento County's existing Reclamation water service contract and other anticipated water entitlements and up to 155 cfs (100 mgd) of water is diverted under EBMUD's amended Reclamation water service contract. To date, average annual deliveries to EBMUD have been approximately 23,000 AF. Thus far, maximum annual delivery has been approximately 99,000 AF.

The FRWP intake is within critical habitat and resulted in the loss of delta smelt spawning habitat. The adverse effects of entrainment and impingement on delta smelt were minimized by the construction of a fish screen designed to meet CDFW and NMFS criteria and recommendations provided by the Service. The intake screens were built and operate to a 0.2 feet per second (fps) approach velocity for the protection of delta smelt.

South Delta Temporary Barriers Project

The South Delta Temporary Barriers Project began as a test project in 1991 and was extended for five years in 1996 and again for seven years in 2001. The project consists of four rock barriers across south Delta channels (see Figure 9.2.1.4.2-1). Three of the four rock barriers are in place from April 15 to September 30 each year to maintain water levels needed by local irrigators. The fourth, the HOR rock barrier, serves as a fish barrier that has been seasonally installed most years since 1963 between September 15 and November 30. Beginning in 1992, it is also frequently installed in the spring. Since 2008, the HOR rock barrier has been installed in the spring in 2012, 2014, 2015, and 2016 and fall of 2014 and 2015.

Objectives of the project are to:

- Increase water levels, circulation, and water quality in the southern Delta area for local agricultural diversions, and
- Incentivize salmonid fishes to stay in the mainstem of the San Joaquin River.

The PA proposes to continue the temporary barriers project but to replace the HOR rock barrier with a permanent operable gate, the HORG.

Prior to explicit limits on OMR flows, the installation of the HOR barrier during spring could create rapid changes in south Delta hydrodynamics that were associated with spikes in juvenile delta smelt salvage because the barrier increased net negative flow in Old and Middle river if exports were not simultaneously reduced. The OMR flow limits in the Service's 2008 BiOp help minimize the entrainment risk associated with barrier placement.

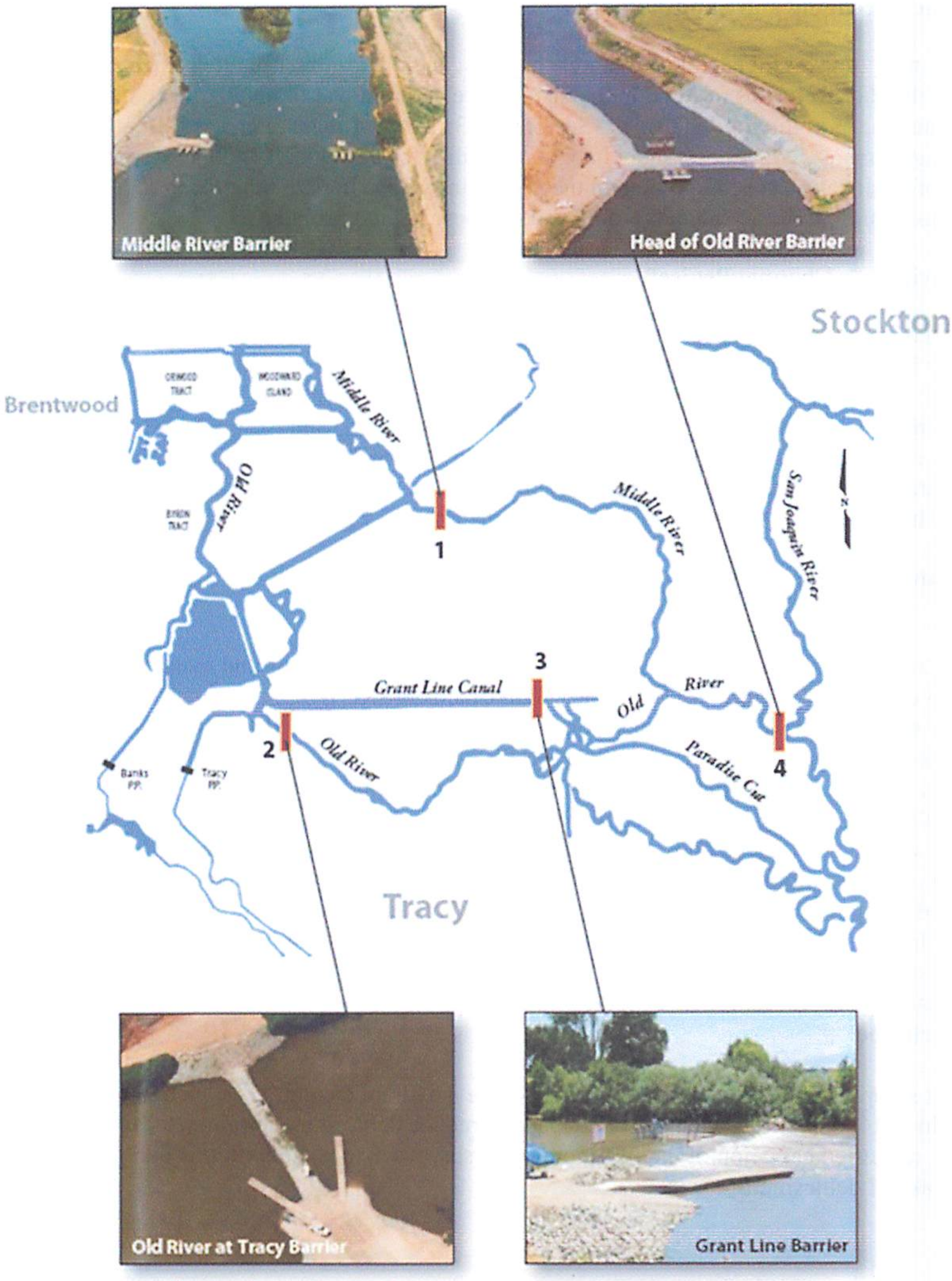

Figure 9.2.1.4.2-1. Location of the South Delta Temporary Barriers Project (Service 2012a).

Maintenance Dredging and Sand-mining

The maintaining of levees, Federal navigation channels, and other infrastructure projects throughout the Bay-Delta has resulted in the disturbance and removal of habitat, in addition to the harassment or mortality of delta smelt (Service 1993; 1994). The maintenance of these levees and shipping channels reduces nearshore habitat suitability for delta smelt and increases the quantities of freshwater needed to maintain the low-salinity zone in particular locations. The proposed deepening of these channels would worsen these habitat problems.

Suisun Navigation Channel Project

The Corps consulted with the Service to conduct their annual maintenance dredging in the Suisun Bay Federal Navigation Channels (SBFNC). The SBFNC includes several reaches, from west to east: Bulls Head Channel, Suisun Bay Main Channel (comprised of Point Edith Crossing, Preston Point Reach, Roe Island Channel, and Port Chicago Reach) and New York Slough. Maintenance activities have included the use of hydraulic suction dredging and mechanical clamshell dredging equipment. Delta smelt have been entrained with the hydraulic suction dredging. The Corps used clamshell dredging equipment in 2015 and 2016 to minimize effects.

Stockton and Sacramento Deep Water Ship Channel Dredging and Bank Stabilization Project

The Corps has consulted with the Service to conduct its annual operations and maintenance dredging in the Sacramento River Deep Water Ship Channel (SRDWSC) and Stockton Deep Water Ship Channel (SDWSC). All sites along the SRDWSC and SDWSC are dredged to maintain the current navigational depths. The SRDWSC begins in the city of West Sacramento and extends southwest to Collinsville. The SDWSC extends from New York Slough near Pittsburg to Stockton along the San Joaquin River. The SRDWSC varies in width from 200 to 400 ft. The ship channel was proposed to be deepened and widened as authorized under the Water Resources Development Act of 1986 (Public Law 99-662). The channel was proposed to be deepened along its entire length and widened to bottom widths ranging from 250 to 400 ft. Due to funding and other constraints, the PA was not completed. As of the beginning of 2014, only the upstream most 8 miles, RM 35 to the turning basin, of the ship channel have been deepened and the only widening that occurred was that necessary to maintain a 1:3 side slope for the deeper channel.

The current shipping channel maintenance projects use a hydraulic cutter head suction dredge for dredging. In 2016, operational changes were made to reduce delta smelt entrainment. In 2015, the Service requested cessation of the fish monitoring surveys associated with this dredging to minimize take of delta smelt.

Jerico Products, Hanson Marine Operations, and Suisun Associates Marine Sand-mining Project

Jerico Products, Hanson Marine Operations, and their joint-venture partnership Suisun Associates are commercial sand mining companies that have leases in Suisun Bay and the western Delta to harvest sand for construction-related material using hydraulic dredging methods. The Corps consulted with the Service in 2014 on their ten-year marine sand-mining lease project proposal.

The amount and seasonal timing of mining volumes are largely dictated by demand for sand and the weather. Generally, sand mining peaks in the summer and early fall when commercial and residential construction is also at its annual peak. Mining activity in the period from July – October historically makes up over 43% of the total annual volume.

Permit requirements, such as prohibiting mining near the shoreline and in shallow areas, help protect delta smelt spawning habitat and fringing marsh habitats. Bathymetric surveys are also proposed as part of the project to provide a basis for routinely monitoring subtidal conditions within areas where mining takes place and to detect and assess biologically significant changes in subtidal benthic habitat. Monitoring of each individual sand mining event and bathymetric monitoring is required as part of the Corps permit. Tracking mining locations serves to ensure that mining occurs only within designated lease areas and that mining avoids sensitive subtidal habitat located outside of a lease area.

Suisun Marsh Managed Wetland Operations and Maintenance

The Service issued a BiOp for the *Suisun Marsh Habitat Management, Preservation, and Restoration Plan* (Suisun Marsh Plan) on June 10, 2013 for the continued operation and maintenance of managed wetlands in the Suisun Marsh that are an important component of the Pacific Flyway. Also included are: new managed wetland activities; dredging; installing alternative bank protection; placing new riprap; and installing fish screens. The BiOp also consisted of a programmatic-level restoration plan for restoring 5,000 to 7,000 acres of natural tidal marsh in the Suisun Marsh (see Suisun Marsh Plan in 9.2.1.4.4 *Regional Conservation Efforts* below). Details of the project-level activities associated with the managed wetland activities can be found online at: https://www.fws.gov/sfbaydelta/documents/2012-F-0602-2_Suisun_Marsh_Solano_County_Corps_programmatic.pdf.

Aquatic Weed Control Program

The Division of Boating and Waterways (DBW) is the lead agency to cooperate with other State, local, and Federal agencies in controlling aquatic weeds in the Delta, its tributaries, and the Suisun Marsh. This includes controlling water hyacinth, the Brazilian water weed (*Egeria densa*), curly-leaf pondweed and Spongeplant. These programs are not intended to eradicate the species, but to control their spread. Thus far, they have not been successful. Spraying treatments in the Delta are restricted to March 1 through November 30. DBW is permitted to treat 3,500 acres in the following areas: west up to and including Sherman Island at the confluence of the

San Joaquin and Sacramento rivers, north to the confluence of the Sacramento River through the Sacramento Deep Water Channel, plus Lake Natomas, south along the San Joaquin River to Mendota, and all the tributaries to the San Joaquin, Tuolumne, Merced and Stanislaus rivers.

Wallace Weir Modification Project

The Wallace Weir Modification Project began construction in winter of 2016. Wallace Weir is a permanent, operable structure that provides year-round operational control of the weir's hydraulics. Modifications include replacement of the seasonal earthen dam with an operable weir. The project will also include a fish rescue facility that would return fish back to the Sacramento River. Wallace Weir has been treated as a common element to the larger habitat restoration and fish passage projects included in the 2009 NMFS BiOp. The project will serve primarily as an anadromous fish passage improvement action that will prevent adult salmonids and sturgeon from getting into the Colusa Basin Drain. Operational control of water levels would also provide greater flexibility for managing water releases for agriculture and managed wetlands. Management and operations of the Yolo bypass have the potential to influence food supply contributions downstream into the Cache Slough Complex and connecting waterways. The Cache Slough Complex has been documented for delta smelt rearing, making food supply availability, quality, and quantity important factors to those rearing individuals.

Sacramento Area Levees

In March of 2015, the Corps completed a draft general reevaluation study of the American River Common Features project for the City of Sacramento and surrounding areas. This study addresses the flood risk management system for the American and Sacramento Rivers and five other smaller channels. The study is located in the general vicinity of the confluence of the Sacramento and American rivers, and includes the City of Sacramento and surrounding areas including the American River downstream of Folsom Dam, the Natomas Basin, the east bank of the Sacramento River and areas surrounding five other smaller waterways which are sources of potential flooding. Some of these areas overlap the action area for the PA. This project will remediate levee seepage problems along approximately 22 miles of the American River. It will also strengthen and raise 12 miles of Sacramento River levee in Natomas. Lastly, the authorization includes seepage remediation and higher levees along four stretches of the American River and 5 miles of the Natomas Cross Canal levee.

Small Erosion Repair Program

The Small Erosion Repair Program (SERP) provides a streamlined process for DWR to identify, obtain regulatory authorization for, and construct small levee repairs on levees maintained by DWR within the Sacramento River Flood Control Project area. The initial focus of SERP covers approximately 300 miles of levees and represents an initial five-year effort. After the first phase, the Interagency Flood Management Collaborative Program Group will evaluate the program's success and, if warranted, SERP may be expanded to include sites repaired by local agencies throughout the Sacramento-San Joaquin drainage. Similar to previous initiatives, these small levee repairs will slowly increase levee riprapping along the Sacramento River, further degrading the quality of habitat for delta smelt.

9.2.1.4.3 Existing Monitoring and Research Programs

Monitoring surveys targeting delta smelt and other fishes and invertebrates are conducted throughout the year under the auspices of the Interagency Ecological Program (IEP) (Hartman, CDFW, personal communication; Figure 9.2.1.4.3-1 through 9.2.1.4.3-6). Historically, take in survey collections was low compared to estimated abundances (Bennett 2005); however, given the combination of recent population decline and substantial increase in survey effort, scientific take may be reaching a relevant fraction of the delta smelt population in some seasons. Because of low abundance and a high level of sampling mortality, some survey methods have been modified to limit incidental catches of delta smelt when delta smelt is not the target species (*e.g.*, the Service's Chipps Island trawl, which targets the recapture of tagged Chinook salmon).

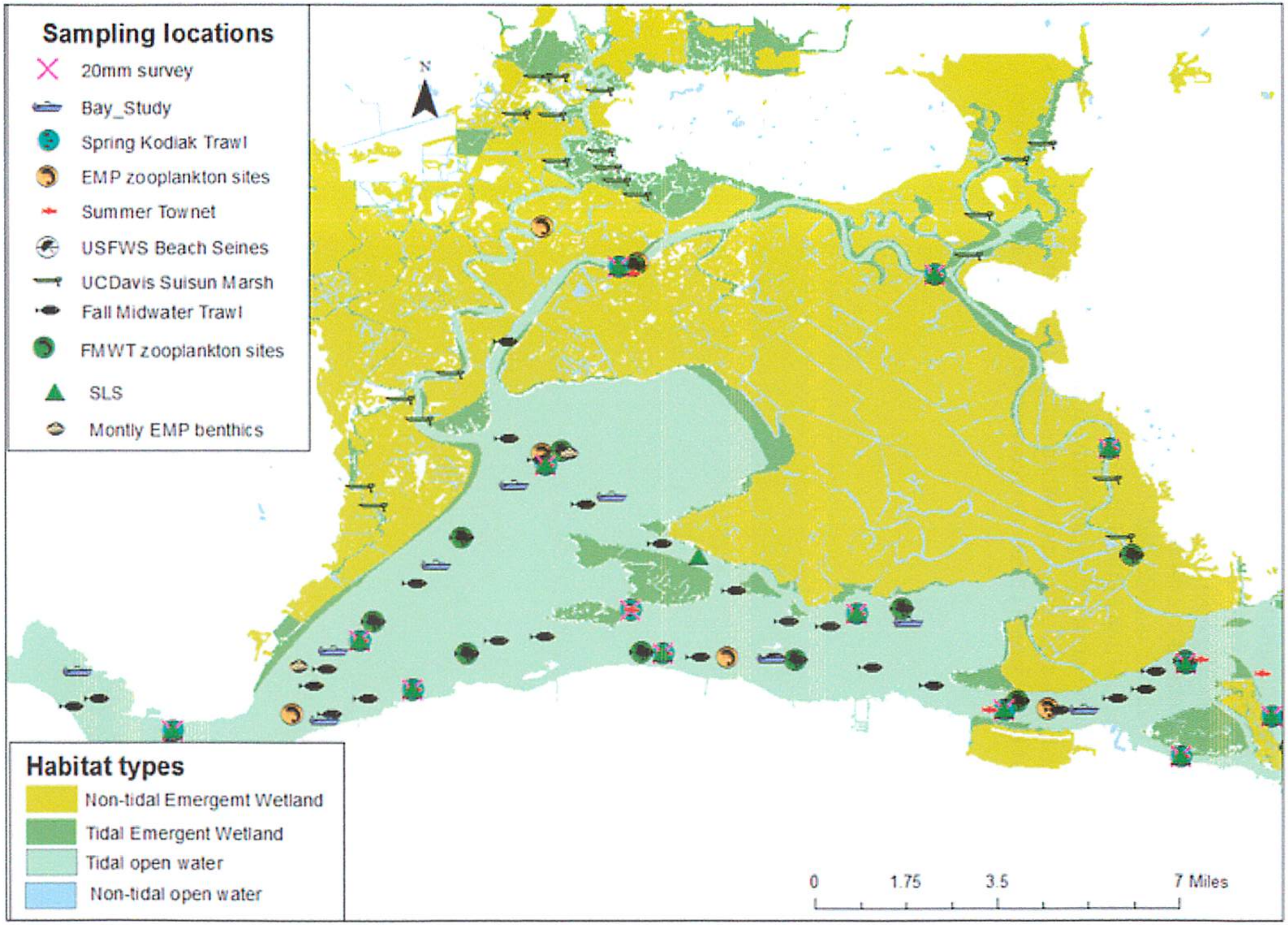

Figure 9.2.1.4.3-1. Sampling locations in the Suisun Marsh for invertebrates and fish.

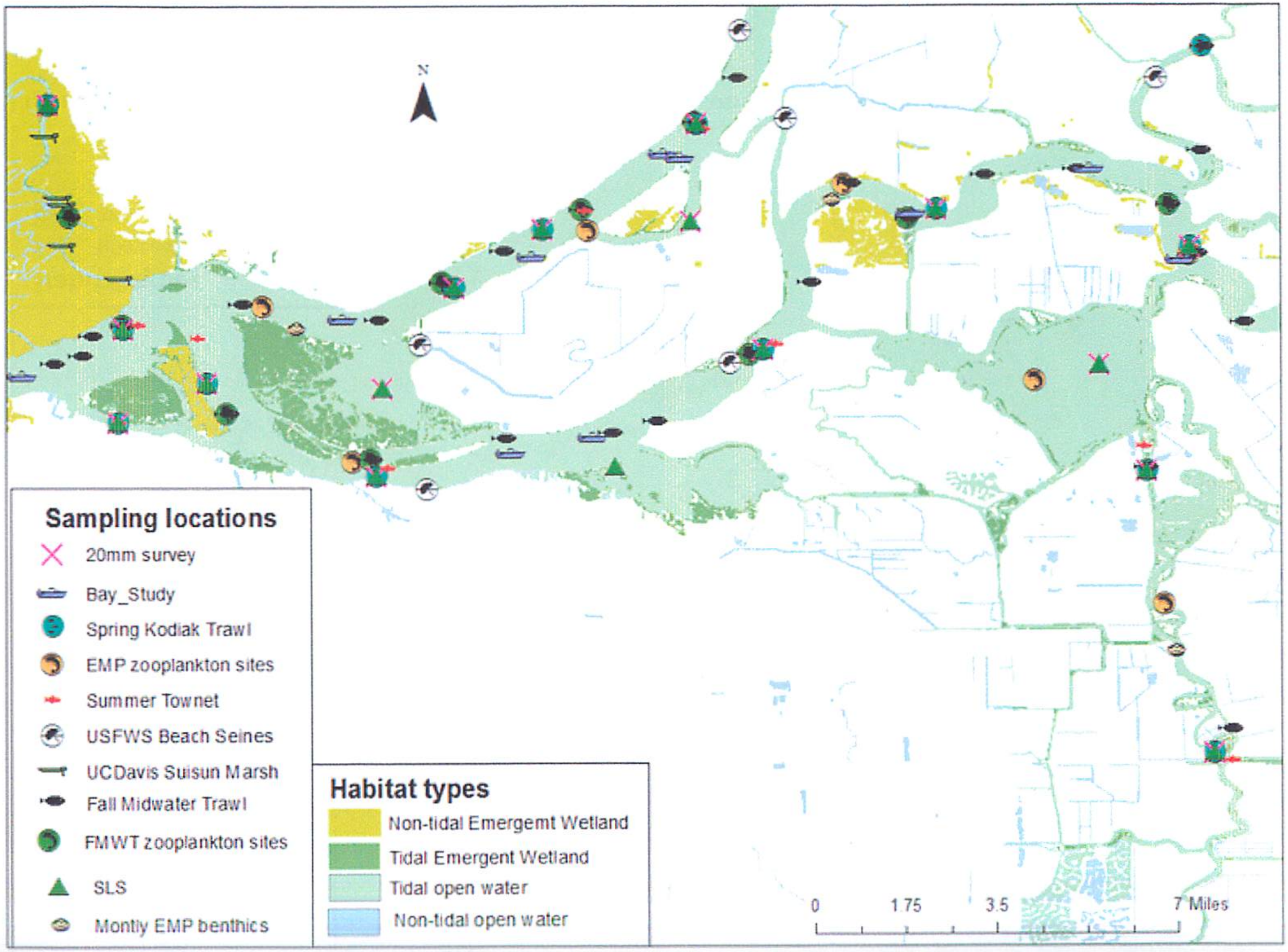

Figure 9.2.1.4.3-2. Sampling locations in the west Delta for invertebrates and fish.

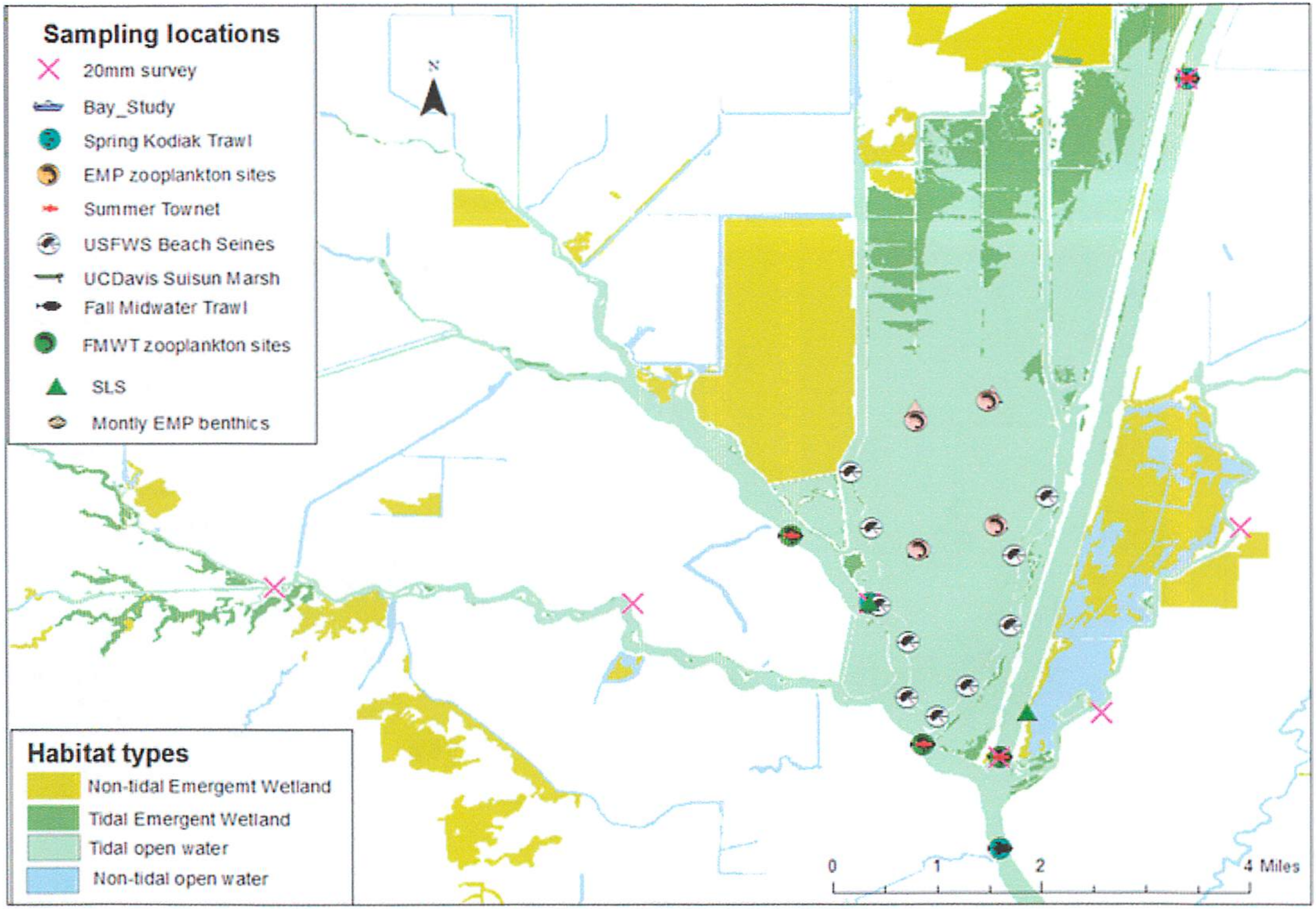

Figure 9.2.1.4.3-3. Sampling locations in the Cache Slough Complex for invertebrates and fish.

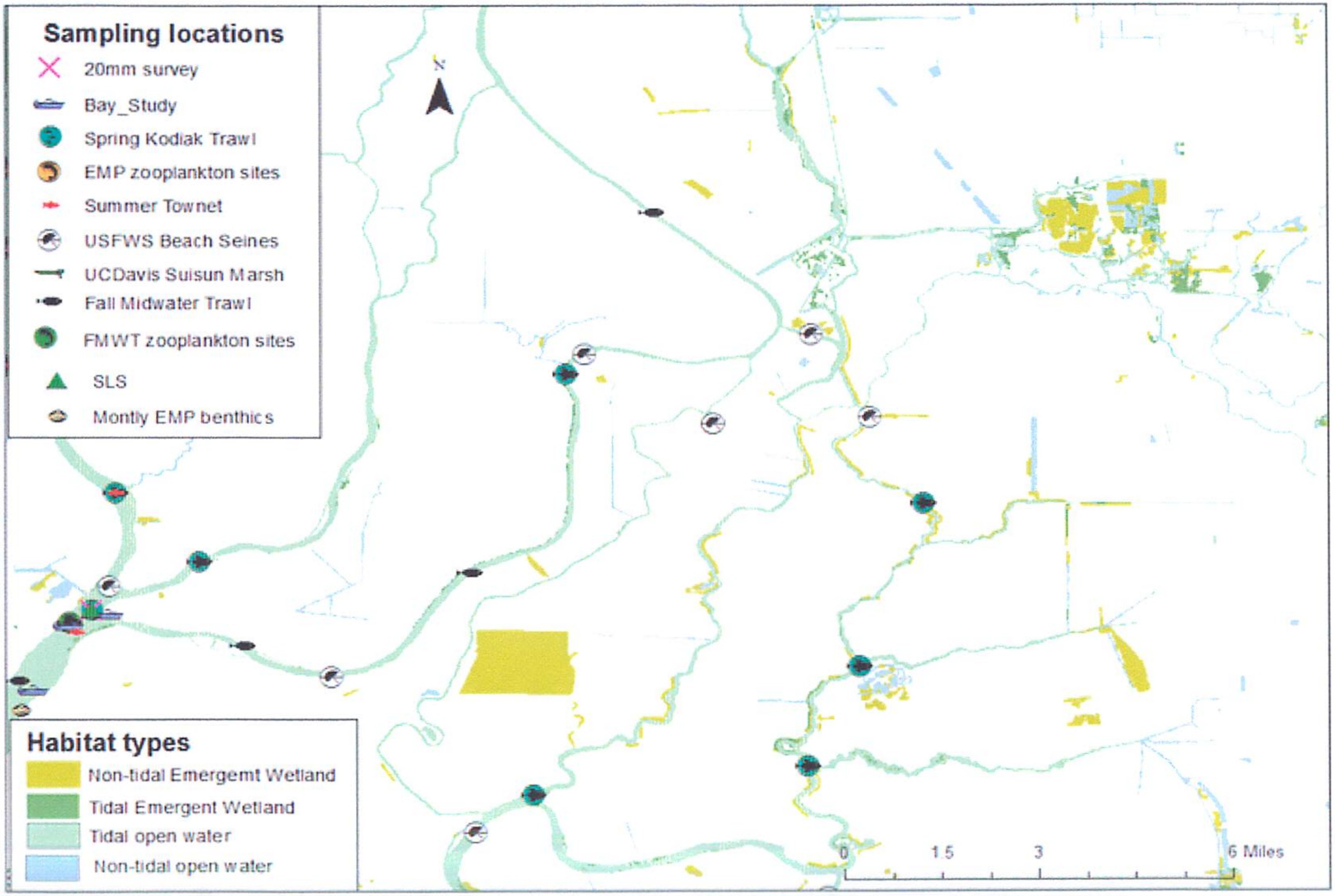

Figure 9.2.1.4.3-4. Sampling locations in the north Delta for invertebrates and fish.

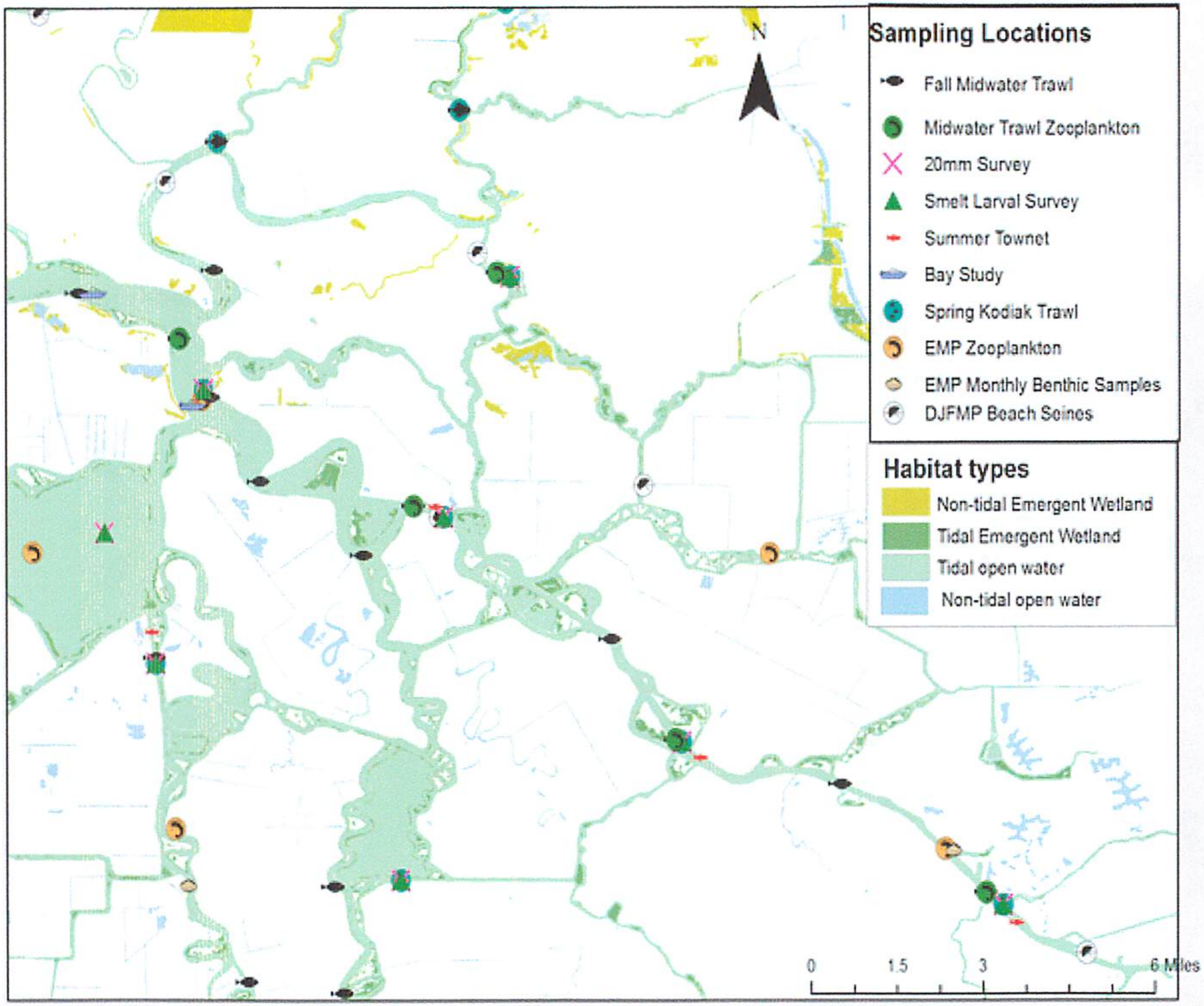

Figure 9.2.1.4.3-5. Sampling locations in the east Delta for invertebrates and fish.

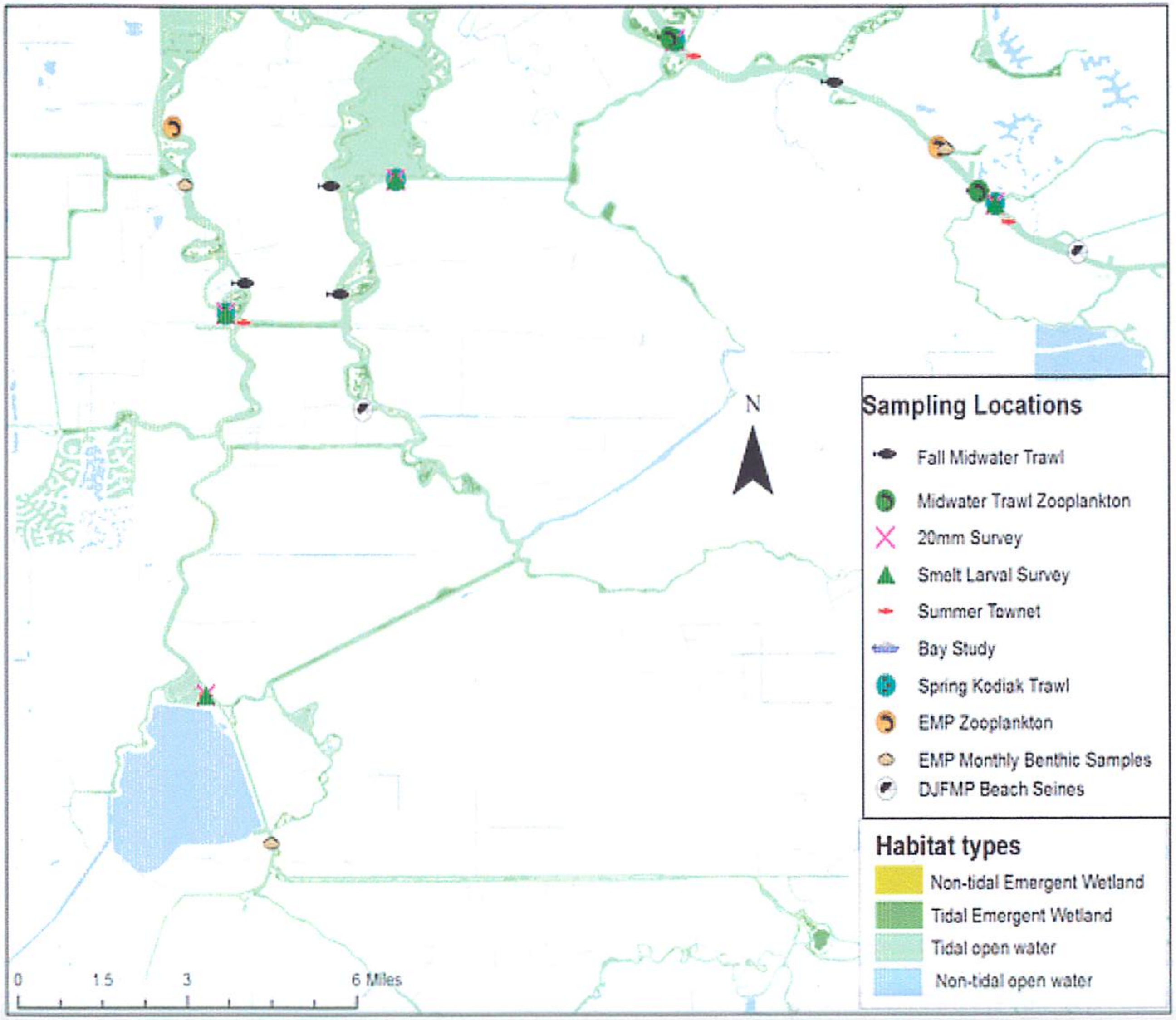

Figure 9.2.1.4.3-6. Sampling locations in the south Delta for invertebrates and fish.

Interagency Ecological Program for the San Francisco Estuary

The mission of the IEP is, in collaboration with others, to provide ecological information and scientific leadership for use in management of the San Francisco Estuary. The goals of IEP are to: describe the status and trends of aquatic ecological factors of interest in the estuary, develop an understanding of environmental factors that influence observed aquatic ecological status and trends, use knowledge of the above information in a collaboration process to support natural resource planning, management, and regulatory activities in the estuary, continually reassess and enhance long-term monitoring and research activities that demonstrate scientific excellence, and to provide scientific information about the estuary that is accurate, accessible, reliable, and released in a timely manner. Since its inception in 1972, IEP has been the principal entity coordinating ecological investigations, science collaboration and fish monitoring in the Bay-Delta.

Most research and monitoring of fish populations in the Bay-Delta is coordinated through the IEP. The IEP is a cooperative effort led by State and Federal agencies with university and private partners (http://www.water.ca.gov/iep/). Several of the IEP's monitoring programs capture delta smelt. However, only four sample efficiently enough for delta smelt to be commonly used to index the species' abundance or distribution, and only three (Spring Kodiak Trawl Survey, 20-mm Survey, and Enhanced Delta Smelt Monitoring) are designed specifically to target delta smelt.

A summary of the number of individuals that were reported from IEP studies from 2005 through 2016 is presented in Tables 9.2.1.4.3-1, 9.2.1.4.3-2, and 9.2.1.4.3-3.

Table 9.2.1.4.3-1. Number or larvae delta smelt individuals captured from 2005-2016 from IEP studies.

Larvae (<20 mm FL)

Survey	Year											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fall Midwater Trawl	0	0	0	0	10	0	0	0	0	0	0	0
Townet Survey			10	82	49	198	470	246	171	75	0	0
SF Bay Study	0	0	0	0	0	0	0	0	0	0	0	1
South Delta fish investigations	8		277									
20-mm*	644	978	135	274	435	833	1162	1076	1125	256	99	126
Yolo Bypass	0	0	0	0	0	0	0	0	0	0	0	0
Delta Juvenile Fish Monitoring	14										0	0
Directed Fish Collections			2									
Upper estuary zooplankton			2	17		10	3	3	5	1	0	0
Investigation of Antioch and Pittsburg Power Plants				17	10	1	1					
Spring Kodiak Trawl	26					1		1	2	53	3	26
Morrow Island Distribution			1									
UCD Suisun Marsh										2	0	0
Smelt Larva Survey		79	274	0	0	6	3	238	118	24	6	8
Mossdale Spring Trawl											0	0
Fish Community Monitoring				22								
Pilot Mark-recap to Estimate Pre-screen Loss and Salvage Efficiency					111							
Gear Efficiency Evaluation in Support of Delta Smelt Modeling									85	147	0	0
FRP Tidal Wetland Monitoring Study											0	0
USGS Early Warning											0	0
USGS Physical and Biological Drivers												0
TOTAL	692	1057	701	412	615	1049	1639	1564	1506	558	108	161

*20mm Study reports larvae and juveniles together (age-0). Age-1+ reported as adults.

Table 9.2.1.4.3-2. Number of juvenile and adult delta smelt individuals captured from 2005-2016 for IEP studies.

Juveniles and Adults (>=20 mm FL)

Survey	Year											
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fall Midwater Trawl	28	39	27	21	32	54	344	47	21	11	7	7
Townet Survey	120	83	45	0	0	2	318	28	0	1	23	6
SF Bay Study	85	21	64	45	20	49	181	95	77	43	51	6
20-mm	15	0	2	1	2	5	8	63	9	1	0	2
Yolo Bypass	4	17	4	26	88	19	31	133	134	46	50	18
Broodstock Collections (FCCL)	2297	2418		70	23	80		2	198			
Delta Juvenile Fish Monitoring	761	954	245	119	136	445	956	710	464	301	245	103
New Technologies and Release Sites, Element 2 (Electrofishing)				2								
Indicators to Predict Adverse Effects to Salvaged Delta Smelt	64											
Fish Predation in the CHTR Phase	19											
Acute Mortality Associated with CHTR		28										
Directed Fish Collections	5	371	4									
Upper estuary zooplankton						1	2	2	0	1	0	0
Investigation of Antioch and Pittsburg Power Plants				2	14		0					
Spring Kodiak Trawl	1311	473	708	339	671	659	445	1204	339	356	107	260
Morrow Island Distribution	2	1										
UCD Suisun Marsh	2	1	3	1	4	2	22	10	6	7	3	0
Smelt Larva Survey		1	0	0	2	0	2	10	4	0	2	0
Mossdale Spring Trawl						1			0	0	0	0
Fish Community Monitoring			3	3	8		9					
Effects of Largemouth Bass on Delta Ecosystem						5						
Pilot Mark-recap to Estimate Pre-screen Loss and Salvage Efficiency				189	10							
Smelt Migration Study (AKA First Flush)**						659		822				
Gear Efficiency Evaluation in Support of Delta Smelt Modeling								721	863	890	185	0
FRP Tidal Wetland Monitoring Study											0	2
USGS Early Warning											0	42
USGS Physical and Biological Drivers												1
TOTAL	4713	4407	1105	818	1010	1981	2318	3847	2115	1657	673	447

*Smelt Migration sampling in year 2010 includes one day of sampling in 2011

Table 9.2.1.4.3-3. Number of adult delta smelt individuals for all life stages reported from 2005-2016 for IEP studies.

All life stages combined

	Year											
Survey	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fall Midwater Trawl	28	39	27	21	42	54	344	47	21	11	7	7
Townet Survey	120	83	55	82	49	200	788	274	171	76	23	6
SF Bay Study	85	21	64	45	20	49	181	95	77	43	51	7
South Delta Fish Investigations	8	0	277									
20-mm	659	978	137	275	437	838	1170	1139	1134	257	99	128
Yolo Bypass	4	17	4	26	88	19	31	133	134	46	50	18
Broodstock Collections	2297	2418		70	23	80		2	198			
Delta Juvenile Fish Monitoring	775	954	245	119	136	445	956	710	464	301	245	103
New Technologies and Release Sites, Element 2 (Electrofishing)	0			2								
Indicators to Predict Adverse Effects to Salvaged Delta Smelt	64											
Fish Predation in the CHTR Phase	19											
Acute Mortality Associated with CHTR	0	28										
Directed Fish Collections	5	371	6									
Upper estuary zooplankton	0		2	17		11	5	5	5	2	0	0
Investigation of Antioch and Pittsburg Power Plants				19	24	1	1					
Spring Kodiak Trawl	1337	473	708	339	671	660	445	1205	341	409	110	286
Morrow Island Distribution	2	1	1									
UCD Suisun Marsh	2	1	3	1	4	2	22	10	6	9	3	0
Smelt Larva Survey		80	274		2	6	5	248	122	24	8	8
Mossdale Spring Trawl	0					1				0	0	0
Fish Community Monitoring			3	25	8	0	9					
Effects of Largemouth Bass on Delta Ecosystem						5						
Pilot Mark-recap to Estimate Pre-screen Loss and Salvage Efficiency				189	121							
Smelt Migration Experiment (AKA First Flush)						659		822				
Gear Efficiency Evaluation in Support of Delta Smelt Modeling								721	948	1037	185	0
FRP Tidal Wetland Monitoring Study											0	2
USGS Early Warning											0	42
USGS Physical and Biological Drivers												1
TOTAL	5405	5464	1806	1230	1625	3030	3957	5411	3621	2215	781	608

Enhanced Delta Smelt Monitoring

The objective of the Service's Enhanced Delta Smelt Monitoring (EDSM) is to provide data for calculating life stage-specific estimates of abundance, spatial distribution, and proportion at risk of entrainment for selected life stages and times of year. The monitoring program aims to collect data that will yield estimates with greater precision and less selection bias than estimates based on catches from existing surveys, namely, the SKTS, 20mm, TNS, and FMWT Surveys. There are three key differences between EDSM and existing surveys: (1) the most efficient gear for each life stage will be used, (2) for each sampling occasion, trawling locations will be chosen at random using a spatially representative selection procedure such as Generalized Random Tesselation Stratified sampling or Balance Acceptance Sampling, and (3) sampling is done up to four times per week at approximately 24 randomly selected locations throughout the range occupied by the relevant delta smelt life stage, and multiple tows will be taken at each sample location.

Other Delta Smelt Research

Liberty Island

In 2009, the Stockton Fish and Wildlife Office (now Lodi Fish and Wildlife Office (LFWO) served a critical role in developing and facilitating a collaborative interdisciplinary study known as Breach III to assess the effects of restoration on aquatic biota inhabiting the tidally influenced freshwater wetlands at Liberty Island and Little Holland Tract in Yolo County, California. The goals of the Breach III project are to provide a predictive level of understanding about (1) how restoration activities influence local flooding and levee erosion, and (2) how abiotic and biotic factors control aquatic vegetation, fish, and wildlife distributions. The study was designed to simultaneously address the macroinvertebrate and fish response portions of the study at Liberty Island and evaluate the use of a restoring wetland complex by specific life stages of delta smelt, longfin smelt, Chinook salmon, striped bass, threadfin shad, and Sacramento splittail.

This program documented year-around occurrence of delta smelt in Liberty Island and confirmed that some individuals used the tidal marsh edge in northern Liberty Island as foraging habitat. This study provided the Service with greater certainty that wetland restoration in this part of the Delta will provide benefits to delta smelt.

The Arc Project: Suisun Marsh, Sherman Lake, and the North Delta

This project aims to provide a better understanding of how land and vegetation in the Delta interact with river flow and tides to create habitat favored by native fishes. Scientists, engineers and resource managers expect to use this information to identify areas and conditions of high potential for habitat improvement throughout the Delta. The investigation focuses on regions in the north Delta where contemporary fish surveys have shown relatively high populations of native fishes - regions including Suisun Marsh, the flooded Sherman Island and the Cache and Lindsey sloughs. The areas together form an arc, inspiring the project name "North Delta Arc of Native Fishes."

9.2.1.4.4 Regional Conservation Efforts

Fish Conservation and Culture Lab and Livingston Stone National Fish Hatchery Refugial Populations

The Fish Conservation and Culture Laboratory (FCCL) has been operated by the University of California, Davis since 1996 (FCCL 2016) and contains a refugial population of delta smelt. In 2007, CDFW and the Service began holding the second refugial population at the Service's Livingston Stone National Fish Hatchery (LSNFH). The goal of both refugial populations (FCCL and LSNFH) is to maintain a population in captivity that is very close to the wild population both in terms of phenotype and genotype to serve as a safeguard against extinction. The delta smelt culture techniques have been continuously improved over the years and the survival rate of cultured delta smelt at the FCCL is high (Lindberg *et al.* 2013). Approximately 260-300 families of delta smelt are maintained at the FCCL annually; delta smelt from the wild contribute to each new generation and are currently required to avoid genetic drift (Fisch *et al.* 2012).

Tidal Marsh Recovery Plan

This California coast-wide, multi-species recovery plan, published in 2013, includes conservation needs for the San Francisco Estuary, with a focus on the following listed plant and terrestrial species: *Cirsium hydrophilum var. hydrophilum* (Suisun thistle), *Cordylanthus mollis ssp. Mollis* (soft bird's beak), *Suaeda californica* (California sea-blite), California clapper rail (*Rallus longirostris obsoletus*), and salt marsh harvest mouse (*Reithrodontomys raviventris*). The Tidal Marsh Recovery Implementation Team (RIT) was formed in 2015 and has been meeting quarterly. Restoration efforts from this plan are identified in its implementation table online at: https://www.fws.gov/sfbaydelta/es/tidal_marsh_recovery.htm.The RIT is working collaboratively with the San Francisco Bay Joint Venture and other partners to prioritize science, research, and restoration needs. The RIT is also currently developing an action item system by soliciting priorities by species from the clapper rail, salt marsh harvest mouse and plants groups to be presented at the next San Francisco Bay Joint Venture Conservation Delivery Committee meeting. This updated priority list will be used to leverage funding from traditional sources and Measure AA funding. A portion of tidal marsh restoration actions are to take place in the Suisun Marsh and Bay areas where the delta smelt resides (See Suisun Marsh Habitat Management, Preservation and Restoration Plan below). Actions taken are expected to have ecosystem-wide benefits and could positively impact delta smelt.

Suisun Marsh Habitat Management, Preservation and Restoration Plan (The Suisun Marsh Plan)

The Suisun Marsh Plan, signed in 2014, was developed to balance the goals and objectives of the Bay-Delta Program, Suisun Marsh Preservation Agreement and other management and restoration programs within Suisun Marsh. The Suisun Marsh Plan provides for simultaneous protection and enhancement of Pacific Flyway and existing wildlife values in managed wetlands, endangered species recovery, and water quality. The plan's tidal wetland restoration program could benefit delta smelt via contribution to the Suisun Marsh food web. The first tidal marsh restoration project to fall under the Suisun Marsh Plan was the Tule Red Tidal Restoration Project that started interior construction in late fall of 2016. The project will convert approximately 420 acres of managed wetlands for waterfowl, by breaching a habitat berm allowing for tides to reclaim the land. The project is anticipated to breach in 2017. Once the breach has occurred, food web production is expected to be exported into Grizzly Bay where delta smelt are known to occur.

Ecosystem Restoration Program

The State of California funds several initiatives to improve the estuary for fish and wildlife. The Ecosystem Restoration Program (ERP) was created to improve and increase aquatic and terrestrial habitats and ecological function in the Delta and its tributaries. Additionally, created in 2014, California EcoRestore Prop1 provides funding to facilitate regional water management while reducing reliance on water from the Delta. California EcoRestore also seeks to protect and restore important ecosystems.

The CDFW program seeks to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse plant and animal species. The Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) is one of four regional plans intended to implement the ERP. The DRERIP is an ongoing effort that has produced a series of conceptual models to inform agencies about processes, habitats, species, and stressors of the Bay-Delta (http://www.dfg.ca.gov/ERP/conceptual_models.asp). CDFW and the DWR are continuing to implement and plan for ecosystem restoration projects begun under the CALFED Bay-Delta Program located in Suisun Marsh, at Dutch Slough, at Cache Slough, in the Yolo Bypass, and at the Cosumnes River Preserve's North Delta project. Between 1994 and 2004, the program expended 700 million dollars on 500 restoration projects in the Estuary and its tributary rivers. This includes enhancement or restoration of over 19 miles of riparian and shaded riverine, instream riverine, saline emergent wetland and freshwater emergent wetland, and in-channel island habitat within the delta smelt's range. The program had also funded research on control and prevention of non-native species through the development of an ecological flow tool used to understand the relationship between flow and fish habitat needs in the Estuary. More information on the Ecosystem Restoration Program can be found online at: http://www.dfg.ca.gov/erp/.

California EcoRestore

This initiative by the State of California is implemented in coordination with State and Federal agencies to advance the restoration of at least 30,000 acres of Sacramento-San Joaquin Delta (Delta) habitat by 2020. California EcoRestore will pursue habitat restoration projects including tidal wetlands, floodplain, upland, riparian, fish passage improvements and others. Planned restoration projects include the 8,000 acres of tidal habitat required under the 2008 Service BiOp.

To date, one tidal marsh restoration project has begun construction: the Tule Red Restoration Project, located in Suisun Marsh, which broke ground in September 2016. The project will restore 420 acres of managed wetlands into tidal and subtidal wetlands designed to provide food web benefits to delta smelt. In addition, Proposition 1 funds will be providing grant money towards ecosystem restoration and water quality improvement projects which may also benefit delta smelt. Although projects have been chosen to receive funding, no projects have been completed to date.

Habitat Conservation Plans and National Community Conservation Plans

Under Section 10(a)(1)(B) of the Endangered Species Act, several Habitat Conservation Plans have been completed and are being implemented in the action area to provide long-term conservation planning in coordination with human development, while other Habitat Conservation Plans are still under development and in the planning stage. Of those completed, there is one that has delta smelt as a covered species. The San Joaquin County Multi-Species Habitat Conservation and Open Space Plan was completed in 2000. The HCP allows for urban development and includes compensatory mitigation for the loss of up to 371 acres of shallow water habitat and 3 acres of submerged aquatic habitat at a 3:1 ratio.

Conservation Banks

The Service has approved two delta smelt conservation banks within the action area: North Delta Fish Conservation Bank and Liberty Island Conservation Bank.

North Delta Fish Conservation Bank

Wildlands worked in partnership with the landowners, The Trust for Public Land and Reclamation District 2093, to establish the 811-acre conservation bank located within the northern portion of Liberty Island and southern end of the Yolo Bypass. The conservation bank was approved in 2013 and will provide habitat benefits to delta smelt by enhancing 657 acres of tidal marsh wetlands, including emergent marsh, seasonal wetland, riparian, and shallow open water habitats, in addition to 68 acres of tidal channel enhancement, and over 32 acres of tidal emergent marsh creation through the removal of levees and lowering a portion of the existing floodplain habitat.

Liberty Island Conservation Bank

Liberty Island Conservation Bank is a 186-acre habitat restoration project in Yolo County, California. It is a mosaic of tidal aquatic habitats intended to benefit Delta native fish species, including delta smelt. The construction included creating open water channels, tidal emergent marsh, seasonally inundated floodplain habitats and removing levees which impeded tidal and flood flow. In all over 190,000 cubic yards of material was moved to complete the project. The conservation bank will preserve 19.3 acres of tidal channel in Liberty Cut and Shag Slough and restore or create 47.9 acres of emergent marsh and tidal channels for delta smelt.

Delta Smelt Resiliency Strategy

The Delta Smelt Resiliency Strategy (Strategy) was proposed by the State of California in 2016. It proposes to address both immediate and longer term needs of the delta smelt, promote their resilience to drought as well as future variations in habitat conditions caused by climate change, future floods and droughts, CVP and SWP operations, and several other stressors. The proposed actions in the Strategy include habitat improvement projects like: aquatic weed control; north Delta food web adaptive management projects; outflow augmentation; reoperation of the Suisun Marsh Salinity Control Gates; sediment supplementation in the low-salinity zone; spawning habitat augmentation; Roaring River distribution system food production; and coordinated managed wetland flood and drain operations in Suisun Marsh. It proposes a variety of other actions intended to improve the status of delta smelt including cessation of salvage of nonnative fishes in the summer and fall; planning for improved stormwater discharge management; building the Rio Vista Research Station and Fish Technology Center; accelerating tidal marsh habitat restoration; and exploring the feasibility of restoring Franks Tract into a tidal marsh.

A subset of EcoRestore habitat restoration projects that overlap with the 8,000 acres of tidal marsh and associated subtidal habitat requirement previously described above in 2008 Service BiOp within RPA Component 4 is also described in the Strategy.

Of the actions proposed, the following action has occurred:

North Delta Food Web Adaptive Management Projects

DWR augmented flow in the Yolo Bypass by closing Knights Landing Outfall Gates and routed water from Colusa Basin into Yolo Bypass in July 2016 to promote food production and export into areas where delta smelt are known to occur.

Summary of Environmental Baseline

Much of the action area has been altered or degraded from its historical state. Loss of shallow water edge habitat along the Sacramento River and its tributaries has occurred over time from riprapping and will be likely maintained in the future. Loss and degradation of suitable habitat continues to pose the largest threat to delta smelt. Efforts by DWR and Reclamation are currently being made through the Delta Smelt Resiliency Strategy to improve baseline habitat conditions and therefore abundance of the population (DWR 2016). Other recovery actions include the future development of an estuarine research station and fish technology center.

Sources of injury/mortality to delta smelt and habitat loss include dredging, sand-mining, wastewater treatment plants, aquatic weed control, managed wetland activities, research and monitoring efforts, and small projects, such as boat docks. The Service has collaborated with other State, Federal, and private entities to significantly reduce monitoring and research efforts that result in lethal take in parallel with the observed change in status of the species. Although greatly reduced, existing monitoring and research programs still take delta smelt in the hundreds annually across all life stages. In addition to existing IEP monitoring efforts, additional efforts are anticipated to continue into the near-term, such as the EDSM. Thus far, EDSM, as implemented, has taken considerably fewer delta smelt than originally estimated. The EDSM, for example, could greatly improve our understanding of the life history of the species, which will inform future conservation actions. The EDSM is also designed to inform CVP and SWP operations to minimize risk of entrainment.

9.2.2 Effects to Delta Smelt from the Proposed Action

This BiOp includes a mixture of project- and program-level analyses for the different CWF components as described above. Preconstruction and construction-related activities have been analyzed and described in the CWF BA and supplemental documentation (*BiOp Resolution Log*) at the site-specific level for near-term implementation with no future Federal action required, except for the NDD, HORG, and CCWD settlement agreement facilities construction, which will have subsequent Federal approvals. The CWF BA supplemental material, provided to the Service on November 7, 2016, identified no in-water work and no effects to delta smelt and its critical habitat from the construction of the CCWD settlement agreement facilities. Effects to delta smelt and its critical habitat for all preconstruction and construction components of the PA have been analyzed herein at a project-level and include a jeopardy/adverse modification analysis; however, the ITS only includes take resulting from the preconstruction and construction components of the PA which will not have subsequent Federal approvals (*i.e.*, the NDD, HORG components, and CCWD settlement agreement facilities components are part of the framework programmatic action and are not included in the ITS). Effects to delta smelt and its critical habitat from operations of the new and existing CVP and SWP water facilities have been analyzed at a programmatic-level based on the framework programmatic approach of this consultation with a jeopardy/adverse modification analysis for dual conveyance operations. As described in Section 9.2.2.2, the ITS for delta smelt does not include take resulting from operations.

What has been referred to in Figure 9.2.2-1 as the NAA, No Action Alternative, has been provided to the Service in the CWF BA as a basis for comparison when discussing effects of implementing the PA, primarily for assessing effects from operations on delta smelt and its habitat. The NAA is intended to represent the projected conditions under existing regulatory requirements without the PA. The NAA is a representation of the base CVP and SWP operations and physical conditions at year 2030. The NAA and the PA simulations include assumptions about climate change including sea level rise, and water demands of a larger human population in California. Refer to CWF BA Appendix 5.A, *CalSim II Modeling and Results*, for more detail on the CalSim II modeling assumptions for the NAA and the PA. The NAA modeling does not fully represent baseline conditions, since only some of the components of the existing conditions were quantified in the computer simulations. Others are discussed qualitatively; for instance, the restoration of 8,000 acres of tidal marsh habitat identified in the 2008 Service BiOp RPA Habitat Component 4 that is required to be completed by 2018 was not directly simulated because the locations of most of the restoration have not been chosen. See *Status of the Species* for delta smelt and *Existing Conditions and Consultations in the Action Area* for more details.

The information presented here is based directly on CalSim II modeling that is described in the CWF BA Appendix 5.A, *CalSim II Modeling and Results*, sections 5.A.4.1 and 5.A.4.5. The

CalSim II model is a mathematical water planning tool developed by DWR and Reclamation. It estimates operational responses of the system, including CVP and SWP management, to variable hydrology on a monthly time step for an assumed level of development and an assumed regulatory environment using 82 years of historical data as model input (WYs 1922-2003). In a simple sense, the CalSim II model simulates how much water is stored and/or released from reservoirs and how much water is diverted and/or returned to the rivers, given a set of assumptions regarding infrastructure, demands and regulations. This series of steps is repeated one month at a time for 82 years, generating 82 years times 12 months equals 984 monthly estimates of any hydrologic quantity of interest. Thus, the model can produce very large amounts of information. The hundreds of graphical representations of CalSim II results in Appendix 5.A are but a small portion of the model's output.

Because CalSim II is a planning tool applied to hypothetical conditions, it is not intended to recreate the past. Rather, it is used to estimate what might happen in the future under specified conditions, *e.g.*, alternative water quality standards and other environmental regulations. The CalSim II model has been a standard part of CVP and SWP water operations consultations for more than a decade because it provides a way to quantitatively compare how things like reservoir storages, river flows, diversions from Central Valley rivers, Delta exports, and X2 locations are expected to vary given different sets of operating rules. In the BA, a proposed operational change (the PA) was compared to a simulation representing the existing regulatory regime (the NAA).

On page 5.A-6, the authors of Appendix 5.A noted that "The CalSim II model is most appropriately applied for comparing one alternative to another and drawing comparisons between the results." However, CalSim II is a quantitative model that is not strictly a relative comparison model because the absolute values of outputs like exports, reservoir storages, OMR flows, and X2 locations are intended to at least approximate what the real-world conditions would be under a particular set of assumptions (CWF BA, Appendix 5.A, *CalSim II Modeling and Results*, page 5.A-12). This is reflected on page 5.A-5 of CWF BA Appendix 5.A, as the authors noted that "The ANN[21] [footnote inserted by the Service] is implemented in CalSim II to ensure the operations of upstream reservoirs and the Delta export pumps satisfy particular salinity requirements in the Delta."

The Service was provided CalSim II output data and we generated graphs from those data for this BiOp. Some of our graphics plot the differences in X2 in the PA relative to the NAA. Some of our other graphics pick particular X2 and OMR values and compare the number of times the PA met that target relative to the NAA. We have used bar charts rather than continuous line charts to reflect CalSim II's discrete monthly time step. We have not relied on singular values (a particular month's results of an individual year) anywhere in the *Effects to Delta Smelt from the*

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[21] The ANN referred to in this sentence is an acronym for artificial neural network, a complex statistical tool that has been added to the CalSim II model to predict salinity in the Bay-Delta based on the model's flow predictions. See BA Appendix 5.A, CalSim II Modeling and Results section 5.A.4.1 for additional details.

Proposed Action or *Effects to Delta Smelt Critical Habitat from the Proposed Action* sections. Rather, we have limited our interpretation of the CalSim II results to trends that are obvious from visual inspection of the graphed data sets.

The Service has received various modeling outputs throughout the duration of the PA development. For the purposes of this BiOp, CalSim II modeling presented throughout the *Effects to Delta Smelt from the Proposed Action* and *Effects to Delta Smelt Critical Habitat from the Proposed Action* sections is based on data the Service received on May 5, 2017 of model runs dated April 28, 2017 (refer to *Consultation History* and CWF BA). However, the step-down analyses from CalSim II modeling using the Delta Simulation Model II (DSM2), such as DSM2-QUAL, DSM2-PTM, DSM2 hydraulic residence time, and DSM2 fingerprinting outputs, were derived using modeling runs dated April 8, 2015 for the NAA and June 1, 2015 for the PA (refer to *Consultation History* and CWF BA). The DSM2 outputs described above were provided to the Service from Reclamation, DWR, and the consultants in 2015, prior to PA modifications that occurred in late 2016 and early 2017, such as the enhanced longfin smelt outflow criteria, OMR October and November criteria modifications, and NDD RTO for post-pulse flow operations. In the *Effects to Delta Smelt from the Proposed Action, Effects to Habitat* section related to water temperature, turbidity, entrainment of food materials, *Microcystis*, and selenium, the analyses rely upon the 2015 DSM2 results. CalSim II and the subsequent step-down analyses were not modeled to capture future decisions during RTO based on fish presence for the NDD post-pulse protections.

The PA, as described in the *Description of the Proposed Action*, has been deconstructed into individual activities (Figure 9.2.2-1) and analyzed for effects to delta smelt.

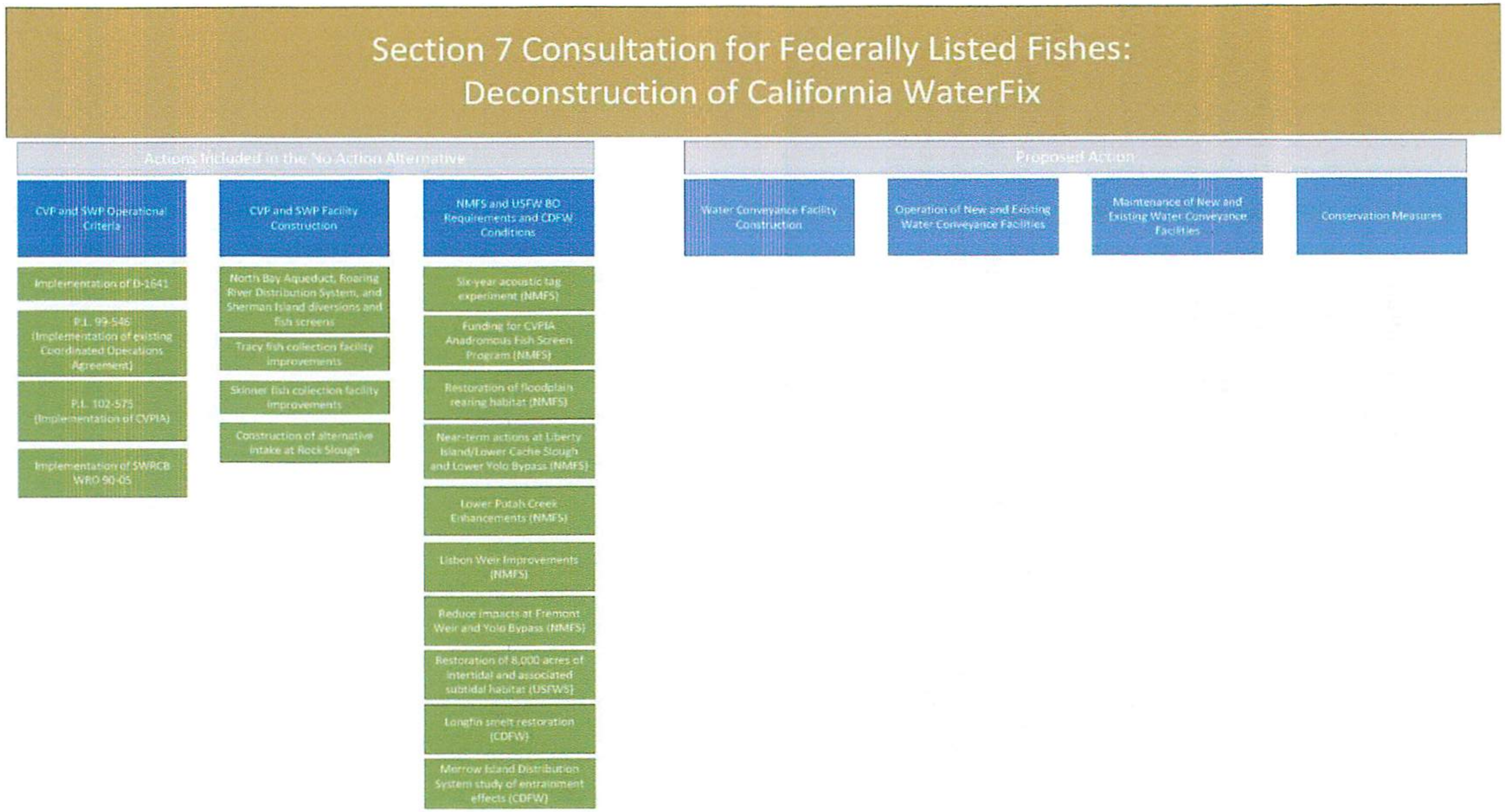

Figure 9.2.2-1. Deconstruction of the existing and projected conditions (referred to as the NAA or No Action Alternative above) and PA (Proposed Action).

9.2.2.1 Preconstruction and Construction

Preconstruction activities include land-based and overwater geotechnical explorations. Construction activities are proposed to occur throughout the proposed footprint over 13 years (CWF BA Appendix 3.D *Assumed Construction Schedule for the Proposed Action*). Common construction-related activities among all water facilities construction include: clearing, site work, ground improvements, borrow fill, fill to flood height, dispose soils, dewatering, dredging and riprap placement, barge traffic, landscaping and associated activities, drilling, and pile driving. See Figure 9.2.2.1-2 below for the deconstruction.

Some components of the PA do not propose any in-water work (*e.g.*, land-based geotechnical explorations, temporary access and work areas, power supply and grid connections, and IF and conveyance tunnel construction). These components are judged to have no effect to delta smelt or its habitat, except in the event of an accidental spill or in the event where noise levels on land reach adverse levels to delta smelt. Effects to delta smelt and its habitat from accidental spills are addressed below. The remainder of the effects analysis is associated with components of the PA that include in-water work and noise effects. If the land-based components change as the PA is refined to include in-water work, reinitiation is required to analyze any new effects not analyzed in this opinion.

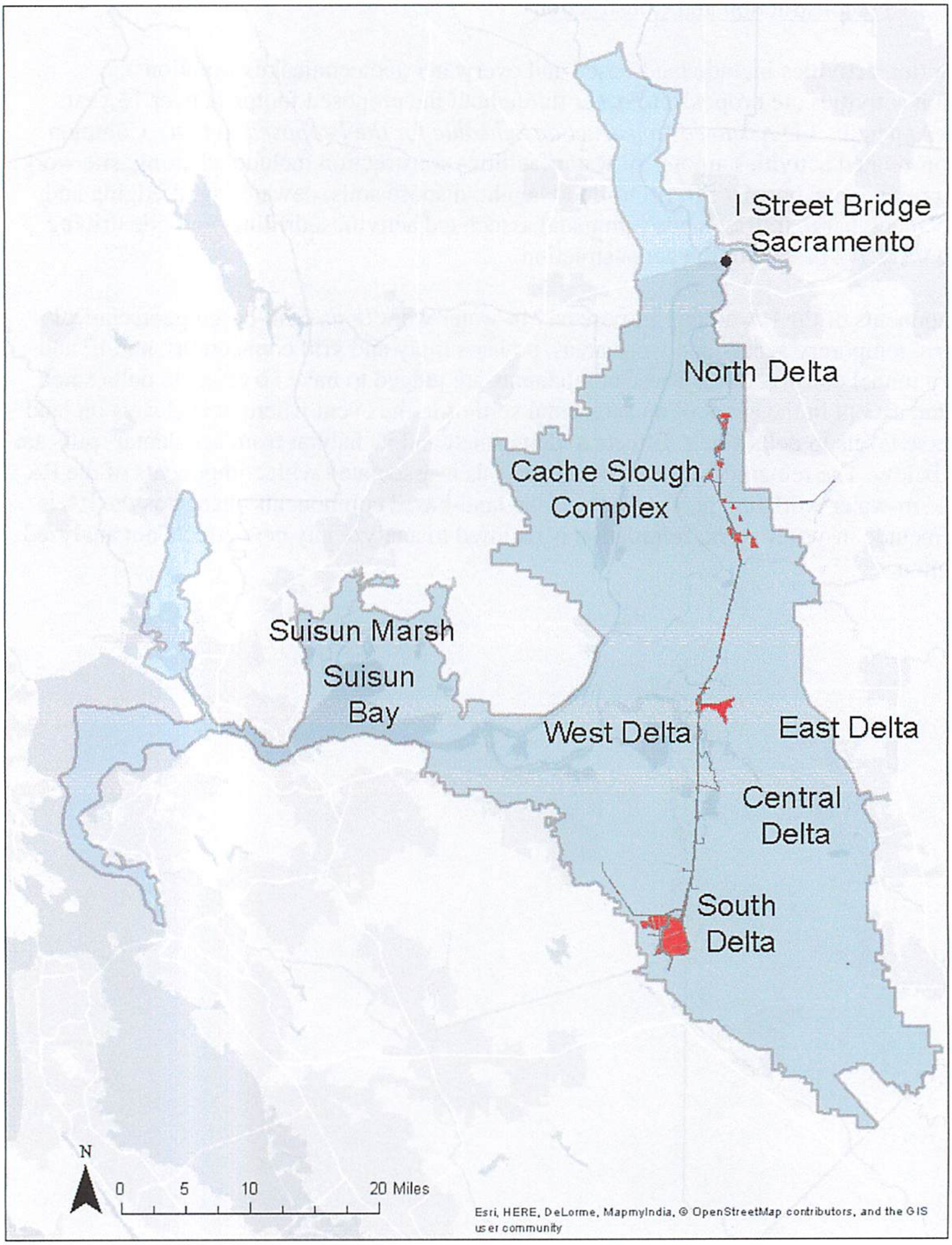

Figure 9.2.2.1-1. Map of the CWF PA footprint (in red) in context to the delta smelt critical habitat (grey) and the range (light grey). The map provides general locations of surrounding geographical regions for orientation.

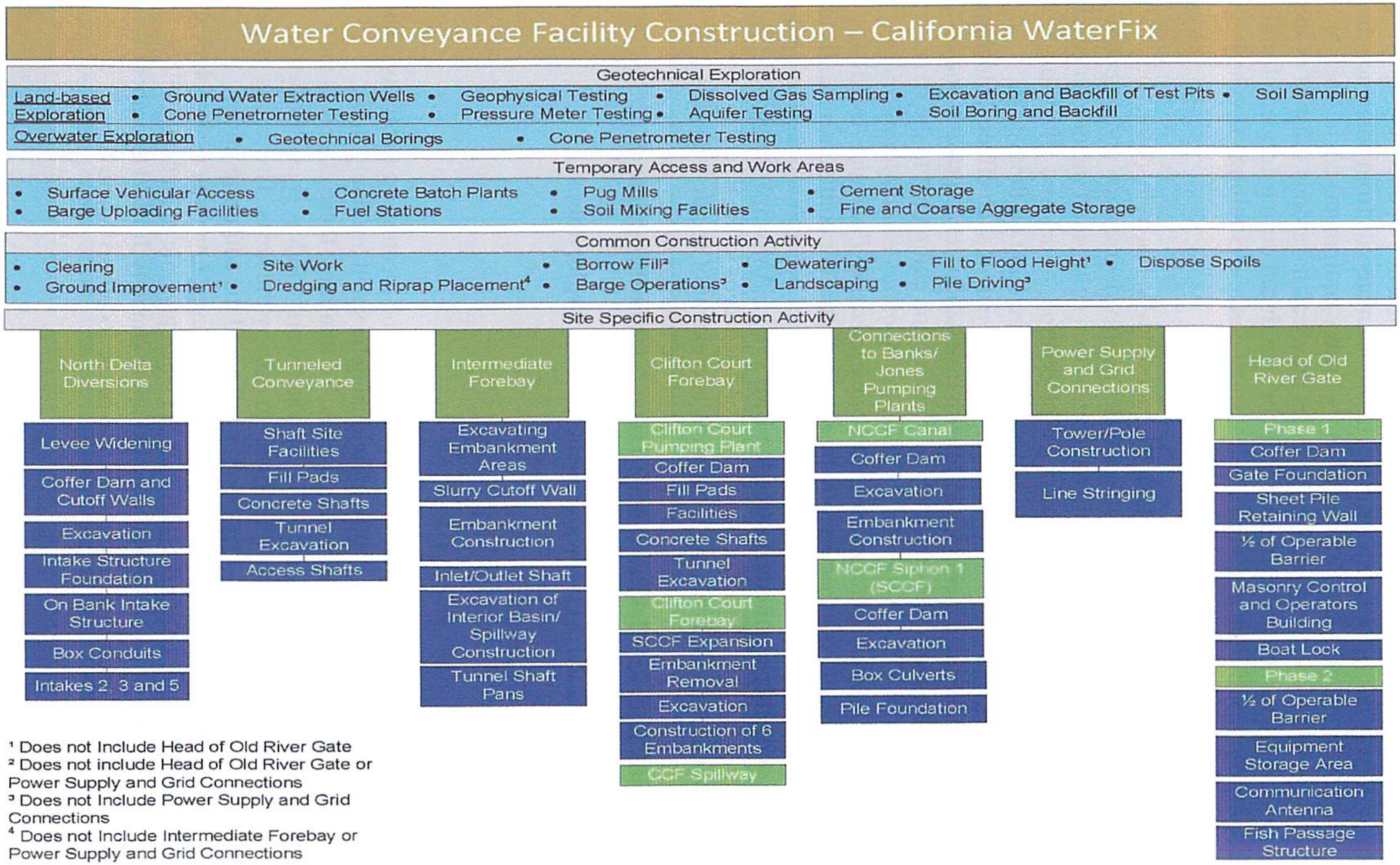

Figure 9.2.2.1-2. Deconstruction of the PA by construction activities, including preconstruction studies (*i.e.*, geotechnical explorations).

Accidental Spills

Land-side proposed construction activities could result in the introduction of chemical contaminants to the waterway and adjacent shorelines. Hazardous materials from construction equipment, barges and towing vessels, and other machinery (heavy equipment) could leach or wash into the water or the soil along the shoreline. Vehicles may leak hazardous substances such as motor oil and antifreeze. A variety of substances could be introduced during accidental spills of materials. Such spills can result from leaks in vehicles, small containers falling off vehicles, or from accidents resulting in loads being spilled.

Accidental spills of contaminants, including oil, fuel, hydraulic fluids, concrete, paint, and other construction-related materials could result in localized water quality degradation and potential adverse effects on delta smelt. Potential effects of contaminants on delta smelt include physical injury and mortality (*e.g.*, damage to gill tissue causing asphyxiation) or delayed effects on growth and survival (*e.g.*, increased stress or reduced feeding), depending on the type of contaminant, extent of the spill, and exposure concentrations. The risk of such effects is highest during in-water construction activities, including cofferdam installation, levee grading and armoring, and barge traffic, because of the proximity of construction equipment to the river. However, implementation of CWF BA Appendix 3.F, *General Avoidance and Minimization Measures,* AMM5, *Spill Prevention, Containment, and Countermeasure Plan*, and AMM14, *Hazardous Materials Management*, is expected to reduce the potential for contaminant spills and guide rapid and effective response in the case of inadvertent spills of hazardous materials. With implementation of these and other required construction BMPs (*e.g.,* AMM3, *Stormwater Pollution Prevention Plan*), the risk of contaminant spills or discharges to the river from in-water or upland sources will be minimized. The nature, quantity, and extent of accidental spills associated with implementation of the PA are unknown until the time of the event occurs. In the event of an accidental spill, refer to 9.2.4 *Reinitiation Triggers* for further guidance.

9.2.2.1.1 Overwater Geotechnical Explorations

Effects to Individuals and the Population

Individual-level

Due to the duration of the geotechnical explorations (to occur at one location up to 60 days) and quantity of in-water borings (approximately 100), individual delta smelt are likely to be adversely affected by in-water work construction activities. To minimize these effects to the delta smelt, work windows will be implemented. The in-water work window is established to allow in-water work when the delta smelt are least likely to occupy the areas. The timing of the in-water construction activities (August 1 – October 31) will avoid the adult migration, spawning, incubation (*i.e.,* eggs/embryos), and larval transport phases. Overwater geotechnical explorations are scheduled to occur (August 1–October 31) when juvenile delta smelt will be rearing near the LSZ during the summer and fall months (approximately July – December). However, given the delta smelt's seasonal to transient use of the locations where the geotechnical explorations will occur, it is expected that few rearing juveniles will be in the identified areas, resulting in an overall low number of individuals injured or killed.

Adverse effects to delta smelt will be difficult to detect due to their small size, low numbers, and rarity. However, effects are expected to be minimal given the low occupancy and low probability of effects to occur. For delta smelt present during the geotechnical explorations, adverse effects are likely to occur to individuals from disturbance from heavy equipment or materials, increased turbidity and suspended sediment, exposure to contaminants, disturbance of contaminated sediments, and disturbance or alteration to rearing and spawning habitat.

Increased Turbidity and Suspended Sediment

Delta smelt are adapted to turbid waters, where they presumably benefit from increased feeding efficiency and avoidance of sight-feeding predators. Laboratory experiments suggest that if turbidity gets higher than 250 NTU, then there is the potential for a strong decline in feeding (Hasenbein *et al.* 2013). However, the geotechnical explorations are not expected to create turbidity that reaches this threshold to adversely affect individuals from increases in turbidity.

Exposure to Contaminants and Disturbance of Contaminated Sediment

Suspension of sediments and contaminants will alter the localized conditions for rearing juveniles exposed to in-water work activities. Delta smelt using these areas could be exposed to contaminants that are present at the site. Exposure pathways could include respiration, dermal contact, direct ingestion, or ingestion of contaminated prey. Exposure to contaminants could result in lethal or sublethal effects, possibly resulting in reduced productivity or mortality of exposed individuals. Carcinogenic substances could cause genetic or organ damage resulting in sterility, reduced productivity, or reduced fitness among progeny. Little information is available on the effects of contaminants on delta smelt (Brooks *et al.* 2012) and the effects may be difficult to detect. DWR proposes to minimize risks by implementing BMPs and a Spill Response Plan as stated in the AMMs.

Underwater Noise and Vibrations

Construction noise, vibration, and increased human activity may interfere with normal behavior, including feeding, sheltering, and other essential behaviors of delta smelt. Intolerable levels of disturbance may force individuals from suitable habitat cover and subject them to predation that otherwise would not occur. However, given the delta smelt's seasonal to transient use of the locations where the geotechnical explorations will occur, it is expected that rearing juveniles will be in low numbers in the identified areas, resulting in an overall low number of individuals injured or killed.

Disturbance or Alteration to Rearing and Spawning Habitat

Geotechnical exploration activities in open water may affect habitat through suspension and deposition of sediment throughout the water column and onto nearby spawning substrates, primarily when installing and removing the casing. As a result, potential spawning substrates may be buried or altered by suspended sediment. It is not yet known whether any of the geotechnical boring sites will occur over spawning habitat. For sites that will occur within spawning habitat, effects are expected to be low based on the small disturbance footprints and nature of disturbance resulting from installation and removal of the casings, and the general lack of sandy substrates at the proposed geotechnical exploration sites.

Population-level

Due to the anticipated low numbers of individuals that will be exposed to the geotechnical explorations due to the in-water work restrictions and the locations of the sites, it is expected that there will be very low effects to the overall population.

9.2.2.1.2 Barge Landings and Barge Trips

Effects to Individuals and the Population

Individual-level

The overall exposure of delta smelt to activities related to construction of the barge landings is expected to be minimal. Adverse effects to delta smelt will be difficult to detect due to the delta smelt's small size and rarity. Work has been proposed to be conducted during an in-water work window intended to minimize exposure and avoid the seasonal and transient use by delta smelt of the locations where barge landing locations are identified.

Injury or Mortality from Heavy Equipment

To minimize the adverse effects to delta smelt, the timing of the in-water construction activities, including barge landing construction (July 1 – August 31), will avoid direct effects to migrating adults, incubation (*i.e.*, eggs/embryos), and larval transport phases. During the in-water work window, juvenile delta smelt will be rearing in the action area during the summer and fall months (approximately July – December). However, historical survey data indicate that most of the delta smelt population is distributed away from the proposed construction sites during the proposed July through August work window. Since juvenile delta smelt typically rear downstream of the proposed barge landing locations in the summer and fall, it is expected that there will be a low probability of delta smelt being injured or killed by in-water construction activities, such as pile driving or riprapping. Additionally, there is no scientific evidence that delta smelt have been injured or killed by propeller strikes from barge traffic, presumably due to their small body size and use of various depths within the water column. Water displacement caused by the boat hulls is going to move individuals away from the back of the barges where the propellers are located.

Increased Turbidity and Suspended Sediment

Pile driving, barge operations, and riprapping will be the principal sources of turbidity and suspended sediment during construction of the barge landings. These activities will result in disturbance of the channel bed and banks, resulting in periodic increases in turbidity and suspended sediment in the adjacent waterways. In-water vibratory and impact driving of the sheet piles are expected to generate turbidity plumes that could extend beyond the immediate vicinity of the source piles depending on the direction and velocity of tidal flows. Pile driving will be restricted to the in-water construction window (July 1 – August 31) to avoid the primary periods of delta smelt occurrence near the barge landing sites. Localized increases in turbidity are unlikely to harm delta smelt unless they reach sustained concentrations on the order of 250 NTU.

DWR proposes to develop and implement AMM7, *Barge Operations Plan*, which includes specific measures to minimize bed scour, bank erosion, loss of submerged and emergent vegetation, and disturbance of benthic communities (CWF BA 2016, Appendix 3.F, *General Avoidance and Minimization Measures*). Other AMMs that are proposed to avoid or minimize potential turbidity, suspended sediment, and other water quality effects include AMM1, *Worker Awareness Training*; AMM2, *Construction Best Management Practices and Monitoring*; AMM3, *Stormwater Pollution Prevention Plan;* AMM4, *Erosion and Sediment Control Plan*; AMM5, *Spill Prevention, Containment, and Countermeasure Plan*; AMM14, *Hazardous Material Management Plan*; and AMM6, *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material* (CWF BA 2016, Appendix 3.F).

Exposure to Contaminants and Disturbance of Contaminated Sediments

Work has been proposed to be conducted during an in-water work window intended to minimize exposure to contaminants. Contaminants may enter the aquatic environment through disturbance, resuspension, or discharge of contaminated soil and sediments from construction sites. Because the barge landings will be constructed on Delta waterways adjacent to major agricultural islands, these sites are more likely to contain agricultural-related toxins such as copper and organochlorine pesticides. Sediments act as a source of contaminant exposure to delta smelt both directly and indirectly through contamination of prey. The resuspension of contaminated sediments may have adverse effects on delta smelt that encounter sediment plumes or come into contact with deposited or newly exposed sediment from contaminant exposure.

Delta smelt using these areas could be exposed to contaminants that are present at the site. Exposure pathways could include respiration, dermal contact, direct ingestion, or ingestion of contaminated food source. Exposure to contaminants could cause short- or long-term morbidity, possibly resulting in mortality or reduced fitness. Little information is available on the effects of contaminants on delta smelt and the effects may be difficult to detect (Brooks *et al.* 2012). DWR proposes to minimize these risks by implementing BMPs and a Spill Response Plan as stated in the AMMs.

The potential for introduction of contaminants from disturbed sediments will be addressed through the implementation of specific measures addressing containment, handling, storage, and disposal of contaminated sediments, as described under CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*, AMM6, *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material.* These measures include the preparation and implementation of a preconstruction sampling and analysis plan to characterize contaminants and determine appropriate BMPs to minimize or avoid mobilization of contaminated sediments during in-water construction activities. Because potential mobilization of contaminants is closely linked to sediment disturbance and associated increases in turbidity and suspended sediment, turbidity monitoring and control measures (*e.g.*, silt curtains) to achieve compliance with existing Basin Plan objectives will be important measures for limiting dispersal of contaminated sediments during dredging and other in-water construction activities.

Underwater Noise and Vibrations

Impact pile driving at the barge landing sites will potentially produce underwater noise levels of sufficient intensity and duration to cause injury to delta smelt. Currently, it is estimated that each barge landing will require vibratory and/or impact driving of 107 steel pipe piles (24-inch diameter) to construct the dock and mooring facilities. Based on the concurrent operation of 4 impact pile drivers at each site and an estimated installation rate of 60 piles per day, pile driving noise is expected to occur over a period of 2 days at each barge landing.

Based on the general timing and abundance of delta smelt in the north, east, and south Delta, restriction of pile driving activities to July 1 – August 31 will essentially eliminate the potential for exposure of delta smelt to pile driving noise during barge landing construction. In addition, DWR will develop and implement an underwater sound control and abatement plan outlining specific measures that will be implemented to avoid and minimize the effects of underwater construction noise on listed fish species (CWF BA 2016, Appendix 3.F, *General Avoidance and Minimization Measures*, AMM9, *Underwater Sound Control and Abatement Plan*). These measures include the use of vibratory and other non-impact driving methods as well as other physical and operational measures to limit the intensity and duration of underwater noise levels when delta smelt may be present. Where impact pile driving is required, hydroacoustic monitoring will be performed to determine compliance with established objectives (*e.g.*, distances to cumulative noise thresholds) and corrective actions that will be taken should the thresholds be exceeded. These measures will be reviewed and approved by the Service to ensure the measures will minimize adverse effects to delta smelt.

Increased Risk of Predation

Larvae, juveniles, and adults may be subjected to an elevated risk of predation as they pass the barge landing sites, because of the presence of in-water and overwater structures and the loss of overall channel complexity caused by the removal of shallow, low-velocity nearshore areas. The presence of in-water and overwater structures (sheet pile wall, floating docks, piles, and vessels) provides shade and cover that may attract certain predatory fish species (*e.g.*, silversides, striped bass, largemouth bass, Sacramento pikeminnow) and increase their ability to ambush prey, such as delta smelt. These structures may also increase predation opportunities on delta smelt for piscivorous birds (*e.g.*, gulls, terns, cormorants) by providing perch sites immediately adjacent to open water. Although it is believed that low numbers of delta smelt are currently using this area and therefore, low numbers of individuals would be exposed to increased risk of predation that may result in injury or mortality.

Loss or Degradation of Habitat

Construction of the barge landings will result in temporary to permanent losses or alteration of aquatic habitat in several locations: Snodgrass Slough north of Twin Cities Road (adjacent to proposed IF), Little Potato Slough (Bouldin Island south), San Joaquin River (Venice Island south), San Joaquin River (Mandeville Island east at junction with Middle River), Middle River (Bacon Island north), Middle River (Victoria Island northwest), and Old River (junction with West Canal at CCF). Permanent effects will occur to shallow water habitat and, depending on exact location, associated riparian and wetland habitats that may be used during adult migration or by larvae during the spring.

With implementation of the proposed water quality and sound abatement and control AMMs, in-water construction activities will result in temporary, localized increases in turbidity, suspended sediment, noise, and vibrations in the vicinity of construction sites, but these parameters are expected to return to baseline levels following cessation of construction activities and will not result in long-term effects on aquatic habitat or water quality. Historical survey data indicate that juveniles rear downstream of the proposed barge landing locations in the summer and fall; therefore, juveniles are not expected to be affected by temporary alterations to water quality and noise during construction.

Effects to loss of physical habitat can be measured in acres. The Service has defined the shallow water habitat of delta smelt habitat as all water between Mean High High Water (MHHW) and 3-meters below Mean Low Low Water (MLLW). Construction of the barge landings will result in permanent loss of approximately 22.4 acres of shallow water habitat (approximately 3.2 acres per landing) used by delta smelt at various life stages. Because the barge landings will likely be sited in areas with steep, riprapped levees and deep nearshore areas, the habitat potential of these sites for spawning and other ecological functions is low. Consequently, permanent losses or alteration of nearshore habitat resulting from construction of the barge landings will not likely have a significant effect on spawning habitat or its use by spawning adults. During construction, and continuing during operation of the barge landings, the channel banks, bed, and waters adjacent to the dock will be periodically disturbed by propeller wash and scour from barges and tidal action, resulting in minor changes to water depths, benthic substrates, and loss of submerged and emergent vegetation. The effects of the loss of 22.4 acres of delta smelt habitat will be minimized through on-site and/or off-site mitigation.

During construction activities, DWR will implement AMM2, *Construction Best Management Practices and Monitoring*, to minimize effects to delta smelt and its habitat (CWF BA 2016, Appendix 3.F, *General Avoidance and Minimization Measures*). These BMPs include a number of measures to limit the extent of disturbance of aquatic and riparian habitat during construction, and, following construction, to restore disturbed areas to preconstruction conditions. All construction and site restoration BMPs will be subject to an approved construction and post-construction monitoring plan to ensure their effectiveness. To further minimize adverse effects to aquatic habitat associated with barge traffic, DWR also proposes to implement a *Barge Operations Plan*, which includes specific measures to minimize bed scour, bank erosion, loss of submerged and emergent vegetation, and disturbance of benthic communities (CWF BA 2016, Appendix 3.F, *General Avoidance and Minimization Measures*).

Population-level

Historical survey data indicate the delta smelt population is distributed near the LSZ and in the Cache Slough Complex during the proposed in-water work window. Thus, we do not expect there to be any population-level effects to delta smelt as a result of exposure to in-water construction activities of barge landings. Once the barge landings are constructed, there will be a risk of increased predation at the sites that could potentially result in increased mortality of adult delta smelt or their progeny. Although, this effect is likely to be low based on the number of delta smelt present near the barge landing locations from historical survey data and the relative small footprint of the barge landings relative to open water areas in the affected region of the Delta.

Summary

Delta smelt exposure to the in-water work activities will be avoided with the proposed in-water work window. Based on historical survey data, we expect delta smelt to be distributed near the LSZ during construction. From the start of construction to the completion and until the barge landings are removed, increased predation is likely to occur from in-water structures. Construction of the barge landings will result in permanent effects to approximately 22.4 acres of shallow water habitat that includes the footprint of the docks and mooring structures. Implementation of Guiding Principles 3 and 4, as stated in Section 6.1 within *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, are intended to promote turbidity and restore, create, or enhance spawning habitat conditions through commitments made in the CWF PA and through actions described in the Delta Smelt Resiliency Strategy. These Guiding Principles are intended to minimize adverse effects to delta smelt from barge landing construction and other CWF activities. Reclamation and DWR have proposed to mitigate for the permanent loss of shallow water habitat due to construction by restoring 1,827.7 acres of shallow water habitat. Reclamation and DWR have also proposed to develop a sediment reintroduction plan, as described in the CWF BA, to specifically address spawning habitat needs for delta smelt, including the potential for a recurring sediment placement program to maintain sites for the duration of the PA's long-term effects.

9.2.2.1.3 North Delta Diversions

Construction activities that could potentially affect delta smelt include the following in-water activities: cofferdam installation and removal, levee clearing and grubbing, riprap placement, dredging, and barge traffic. In-water construction or work activities are defined here as activities occurring within the active channel of the river (*e.g.*, at waterline, in water column, on riverbed, or along river shoreline). All other sediment-disturbing activities associated with construction of the NDD and associated facilities, including construction of the sedimentation basins, will be isolated from the Sacramento River and will use appropriate BMPs and AMMs to avoid or minimize the discharge of sediment to the river. DWR has proposed to minimize effects to delta smelt by conducting all in-water work between June 1 and October 31, whereas pile driving will be limited to June 15 through September 15 within that broader work window. Implementation of Guiding Principles 3 and 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, are intended to promote turbidity and restore, create, or enhance spawning habitat conditions. These Guiding Principles are intended to minimize adverse effects to delta smelt from NDD construction and other CWF activities and establish a framework for developing future actions consistent with this BiOp.

Effects to Individuals and the Population

Individual-level

In-water construction activities (June 1 – October 31) will avoid the adult migration season and minimize exposure to the adult spawning, incubation (*i.e.*, eggs/embryos), and larval transport phases. Infrequent detection of larger juveniles in beach seine surveys suggests that the Sacramento River serves as a spawning ground and not as a nursery ground (see *Status of the Species at Proposed Action Area Preconstruction and Construction Sites*). Therefore, since juveniles nearly always rear downstream of the proposed intake sites in the summer and fall, few if any will be exposed to the proposed in-water work activities.

Contact with Heavy Equipment or Materials

Adult Spawners (February – June)

In years when air temperatures are cool during the spring, water temperatures likewise remain cool allowing longer spawning seasons (*e.g.*, June instead of May). Given the in-water work window proposed (June 1 – October 31), localized spawning may be impaired depending on what temperature conditions are like when the first year of construction occurs. As previously stated above, very low numbers of delta smelt will be exposed to the in-water work. Although adults are expected to move away from active construction areas, it is assumed there is a potential for injury or mortality whenever heavy equipment or materials are operated or placed in open water.

Eggs and Embryos (Spring: ~ March – June)

Spawning habitat within the footprint of the three intakes is degraded and of low quality. Much of the edge habitat has been riprapped and contains only a sparse amount of sandy beaches. Based on the lack of extensive sandy beaches and expected low use and avoidance behavior by spawning adults during in-water construction activities, there is little risk of injury or mortality to eggs or embryos. However, any eggs or embryos that remain on the east river bank at the construction sites would not be able to escape once construction work commences.

Transport of Larvae and Young Juveniles (Spring: ~ March – June)

During the first year of NDD construction, there is potential for adult delta smelt to migrate upstream of the proposed construction areas prior to construction and spawn upstream of where construction work will commence. If that occurs, late spawned larvae or young juveniles being transported downstream could be exposed to in-water work activities. Although the potential for exposure is low, delta smelt larvae and young juveniles may be particularly vulnerable to injury or mortality because their small size limits their ability to escape and their need to pass downstream to survive could make them vulnerable to in-water noise if pile driving occurs during June of that first year of NDD construction. For those years following the cofferdam installation, the Service anticipates that very few or no delta smelt will be able to ascend the river beyond the construction sites. As a result, there should no longer be impacts to offspring. Future Service-approved monitoring studies will investigate the degree to which the NDD construction sites and fish screens act as a migration impediment to delta smelt.

Increased Turbidity and Suspended Sediment

Construction activities within the footprint of the NDD that disturb the riverbed and banks may temporarily increase turbidity and suspended sediment levels in the Sacramento River. These activities include: cofferdam installation and removal; levee clearing and grading; riprap placement; dredging; and barge traffic. These activities will be restricted to the proposed in-water construction window of June 1 through October 31, when delta smelt are least likely to be present in the area. In addition to minimizing effects to delta smelt by limiting activities to occurring within the in-water work window, additional AMMs are proposed to avoid or minimize effects due to increases in turbidity and suspended sediment levels on water quality and direct and indirect effects to delta smelt resulting from sediment-disturbing activities. Those AMMs include the following: AMM1, *Worker Awareness Training*; AMM2, *Construction Best Management Practices and Monitoring*; AMM3, *Stormwater Pollution Prevention Plan*; AMM4, *Erosion and Sediment Control Plan*; AMM5, *Spill Prevention, Containment, and Countermeasure Plan*; AMM14, *Hazardous Material Management Plan*; AMM6, *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material*; and AMM7, *Barge Operations Plan* (CWF BA 2016, Appendix 3.F, *General Avoidance and Minimization Measures*).

Any delta smelt present could be harassed, harmed, or killed by construction equipment, noise, or siltation and impaired water quality. The use of silt trapping devices during all in-water work, where feasible, could minimize the effects on delta smelt caused by siltation and impaired water quality. All other sediment-disturbing activities associated with construction of the NDD, including construction of the sedimentation basins, will be isolated from the Sacramento River and will not result in the discharge of sediment to the river with implementation of the proposed AMMs and BMPs related to off-bank (land-based) construction activities. There is a potential for increased erosion and mobilization of sediment runoff from disturbed levee surfaces; however, with the implementation of the proposed erosion and sediment control measures (AMM4) and other BMPs to ensure the effectiveness of these measures (AMM2, *Construction Best Management Practices and Monitoring*), no adverse water quality effects are anticipated to delta smelt and its habitat from these land-based activities.

Adult Spawners (February – June)

During cofferdam installation, levee clearing and grubbing, riprap placement, and barge traffic, turbidity and suspended sediment levels in the river are anticipated to exceed ambient levels in the immediate vicinity of these activities. Increases in turbidity and suspended sediment levels will be temporary and localized sediment plumes are unlikely to reach levels causing direct injury or mortality to delta smelt.

Turbidity plumes may extend several hundred feet downstream of construction activities. NMFS (2008) reviewed observations of turbidity plumes during installation of riprap for bank protection projects along the Sacramento River and concluded that visible plumes are expected to be limited to only a portion of the channel width, extend no more than 1,000 ft downstream, and dissipate within hours of cessation of in-water activities. Based on these observations, NMFS concluded that such activities could result in turbidity levels exceeding 25–75 NTUs. Turbidity in this range is in the feeding and physiological optimum for delta smelt (Hasenbein *et al.* 2013, 2016) and therefore should not cause harm to individuals. However, under the assumption that there could be some effect to the substrate of habitat up to 1,000 ft downstream from each intake, this will result in 1.9 acres of impact to shallow water habitat (which is included in the overall 5.6 acres of shallow water habitat impact from the NDD footprint).

Increases in suspended sediment during in-water construction activities may result in localized sediment deposition in the vicinity of the proposed intakes, degrading potential spawning habitat of delta smelt by burying suitable spawning substrates. The Sacramento River in the vicinity of the proposed intake sites consists of mostly low quality spawning habitat due to levees that are dominated by steep slopes, existing riprap, and a lack of sandy substrates. The effects of the permanent loss of downstream shallow water habitat from multiple years of daily in-water construction will be mitigated by the preservation, creation, or restoration of shallow water habitat lost at the amount identified in the *Description of the Proposed Action* and CWF BA *BiOp Resolution Log*, prior to impact, in accordance with the proposed conservation measure by DWR.

Eggs and Embryos (Spring: ~ March – June)

Delta smelt eggs and embryos are demersal and adhesive, attaching to substrates with an adhesive stalk formed by the outer layer of the egg (Bennett 2005). Although the potential for exposure is very low, individual eggs could be subject to burial by the deposition of suspended sediment generated by in-water construction activities. However, only eggs and embryos from late spawners would be subject to burial.

Transport of Larvae and Young Juveniles (Spring: ~ March – June)

During the first year of NDD construction, delta smelt larvae and young juveniles may still be in the vicinity of the in-water construction activities during their downstream transport. However, implementation of the proposed pollution prevention, erosion and sediment control, and barge traffic AMMs will prevent local turbidity from reaching harmful levels (*i.e.*, > 80 to 100 NTUs).

Exposure to Contaminants and Disturbance of Contaminated Sediments

Contaminants may enter the aquatic environment through disturbance, resuspension, or discharge of contaminated soil and sediments from the installation and subsequent partial removal of the sheet pile cofferdams. Sediments act as a sink or source of contaminant exposure depending on local hydrologic conditions, habitat type, and frequency of disturbance. Persistent chemicals that have been introduced into the aquatic environment will often bind to sediment particles, with most organic and inorganic anthropogenic chemicals and waste materials accumulating in sediment (Ingersoll *et al.* 1995). Thus, resuspension of contaminated sediments may impact delta smelt that encounter sediment plumes or come into contact with deposited or newly exposed sediment. Suspended sediment can also adversely affect delta smelt by causing localized increases in chemical oxygen demand in waters in or near plumes. These toxins could have an immediate or delayed lethal or sub-lethal effect on various life stages of delta smelt and may also affect the reproductive success. Submerged aquatic vegetation may also be negatively affected by the use of persistent herbicides. The use of silt trapping devices during the in-water work, where feasible, will minimize the effects on delta smelt caused by toxic sediments.

The proposed intake sites are downstream of the City of Sacramento where sediments have been affected by historical and current urban discharges from the city. No information on sediment contaminants at these sites is currently available. Metals, polychlorinated biphenyls (PCBs), and hydrocarbons (typically oil and grease) are common urban contaminants that are introduced to aquatic systems via nonpoint-source stormwater drainage, industrial discharges, and municipal wastewater discharges. Many of these contaminants readily adhere to sediment particles and tend to settle out of solution relatively close to the primary source of contaminants. PCBs are persistent, adsorb to soil and organic matter, and accumulate in the food web. Lead and other metals also will adhere to particulates and can bioaccumulate to levels sufficient to cause adverse biological effects. Mercury is also present in the Sacramento River system and could be sequestered in riverbed sediments. Hydrocarbons biodegrade over time in an aqueous environment and do not tend to bioaccumulate or persist in aquatic systems.

Like pile driving, dredging also has the potential to release contaminants from disturbed sediments into the water column during construction and maintenance dredging at the proposed intakes. Current estimates indicate the total dredging and channel disturbance will affect 12.1 acres of the riverbed adjacent to the cofferdams at the NDD. Measured sediment plumes from hydraulic dredging operations (Hayes *et al.* 2000) suggest that less than 0.1% of disturbed sediments and associated contaminants will likely be re-suspended during cutterhead dredging operations. In sediments, only a small fraction of the total amount of heavy metals and organic contaminants are dissolved. In the case of heavy metals, releases during dredging may be largely due to the resuspension of fine particles from which the contaminants may be desorbed, and in the case of organic contaminants, most of the chemicals released into the dissolved phase will be bound to dissolved organic matter.

The potential for introduction of contaminants from disturbed sediments will be addressed through the implementation of specific measures addressing containment, handling, storage, and disposal of contaminated sediments, as described under AMM6, *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*, in CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*. These measures include the preparation and implementation of a preconstruction sampling and analysis plan to characterize contaminants and determine appropriate BMPs to minimize or avoid mobilization of contaminated sediments during in-water construction activities. Because potential mobilization of contaminants is closely linked to sediment disturbance and associated increases in turbidity and suspended sediment, turbidity monitoring and control measures (*e.g.*, silt curtains) to achieve compliance with existing Basin Plan objectives will be important measures for limiting dispersal of contaminated sediments during dredging and other in-water construction activities.

Adult Spawners (February – June)

Exposure of delta smelt to contaminants as a result of spills or sediment disturbance can cause effects that range from physiological stress, potentially resulting in delayed effects on growth, survival, and reproductive success to direct mortality (acute toxicity) depending on the concentration, toxicity, solubility, bioavailability, and duration of exposure, as well as the sensitivity of the exposed organisms (Connon *et al.* 2009; Connon *et al.* 2011a, b; Jeffries *et al.* 2015).

Based on the timing of in-water construction activities (June 1 – October 31), late spawning adults in the vicinity of the NDD in June may be subject to direct exposure from a potential contaminant spill or sediment-borne contaminants (*i.e.*, through exposure to turbidity plumes). Such an exposure may or may not be of a magnitude that causes harm. Further, implementation of the proposed pollution prevention and erosion and sediment control AMMs will minimize contaminant exposure risks.

Eggs and Embryos (Spring: ~ March – June)

Delta smelt eggs and embryos are demersal and adhesive, attaching to substrates with an adhesive stalk formed by the outer layer of the egg (Bennett 2005). Although exposure of eggs or embryos is expected to be minimal, individual eggs could be damaged or die if directly exposed to contaminant spills or sediment-borne contaminants during construction. Implementation of the proposed pollution prevention and erosion and sediment control AMMs will minimize this risk throughout the construction period.

Transport of Larvae and Young Juveniles (Spring: ~ March – June)

Individual larvae and young juveniles may be injured or killed by direct exposure to contaminant spills or sediment-borne contaminants during construction of the intakes during the downstream migration. It is believed that low numbers of delta smelt are currently using this area and therefore, low numbers of individuals would be exposed to increased contaminant levels that may result in injury or mortality. However, implementation of the proposed pollution prevention and erosion and sediment control AMMs will minimize this risk throughout the construction period.

Underwater Noise and Vibrations

During construction of the NDD, activities that are likely to generate underwater noise include pile driving, riprap placement, dredging, and barge traffic. Pile driving poses the greatest risk to delta smelt, because the levels of underwater noise produced by impulsive types of sounds often reach levels of sufficient intensity to injure or kill fish within a certain radius of the source piles (Popper and Hastings 2009). Therefore, DWR has proposed to further minimize effects to delta smelt by limiting pile driving in-water work to June 15 through September 15 within that broader work window of June 1 to October 31. Other activities such as riprap placement, dredging, and barge traffic generally produce more continuous, lower energy sounds below the thresholds associated with direct injury, but may cause avoidance behavior (*i.e.*, cause delta smelt to detour from the area) or temporary hearing loss or physiological stress if avoidance is not possible or exposure is prolonged (Popper and Hastings 2009).

During NDD construction, underwater noise levels of sufficient intensity to cause direct injury or mortality of fish could occur over a period of 12-42 days during the proposed in-water work period (June 15-September 15) for up to 2 years at each intake location. Restriction of pile driving activities in or near open water in the Sacramento River from June 15 through September 15 will minimize the exposure of delta smelt to potentially harmful underwater noise because most individuals will have left the area by June (see Figure 9.2.1.2-4). In addition, DWR will develop and implement an underwater sound control and abatement plan outlining specific measures that will be implemented to avoid and minimize the effects of underwater construction noise on listed fish species (see CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*, AMM9, *Underwater Sound Control and Abatement Plan*). These measures include the use of vibratory methods or other non-impact driving methods (*e.g.*, drill-shaft methods) whenever possible, to install the cofferdam sheet piles and foundation piles. The degree to which vibratory and non-impact driving methods can be performed is uncertain at this time (due to uncertain geologic conditions at the proposed intake sites) although reasonable assumptions are applied to sheet pile installation in the following analysis. If impact pile driving is required, DWR, in coordination with the Service, NMFS, and CDFW, will evaluate the feasibility of other protective measures including dewatering, physical devices (*e.g.*, bubble curtains), and operational measures (*e.g.*, restricting pile driving to specific times of the day) to limit the intensity and duration of underwater noise levels when delta smelt and/or other listed fish species may be present. Coordination, implementation, and monitoring of these measures will be performed in accordance with the underwater sound control and abatement plan, which includes hydroacoustic monitoring to determine compliance with established objectives (*e.g.*, distances to cumulative noise thresholds) and corrective actions to be taken should the thresholds be exceeded. These measures may include additional physical or operational measures to further limit the magnitude and/or duration of underwater noise levels.

Adult Spawners (February – June)

Restricting pile driving to June 15 – September 15 will avoid most of the delta smelt spawning season, although there is potential for exposure of late spawning adults in June. In general, the effects of pile driving noise on fish may cause fish to swim away from the construction site, may cause physiological stress, or in more extreme cases temporary or permanent hearing loss, organ tissue damage, or mortality of any fish located near a pile strike. Factors that influence the magnitude of these potential effects include life stage and size of fish; type and size of pile and hammer; frequency and duration of pile driving; site characteristics (*e.g.*, depth); and distance of fish from the source. In delta smelt and most other teleost fish, the presence of a swim bladder to maintain buoyancy increases their vulnerability to underwater noise (Hastings and Popper 2005). Sublethal effects of elevated noise include damage to hearing organs that may temporarily affect a delta smelt's swimming ability and hearing sensitivity, which in turn may reduce their ability to detect predators. Non-injurious levels of underwater noise may also startle the fish which can increase vulnerability to predation or attract fish into disturbed areas from suspended prey items in with the sediment.

To quantify the level of sound expected to cause harassment and harm, the Fisheries Hydroacoustic Working Group, an interagency working group that includes the Service, has established interim criteria for evaluating underwater noise effects from pile driving on fish. These criteria are defined in the document entitled "*Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities*", dated June 12, 2008 (Fisheries Hydroacoustic Working Group 2008). This agreement identifies dual interim criteria that represent the acoustic thresholds associated with the onset of physiological impairment in fish that is suggestive of injury resulting from pile driving noise (Fisheries Hydroacoustic Working Group 2008). The dual criteria for impact pile driving are (1) 206 decibels (dB) for peak sound pressure level (SPL), and (2) 187 dB for cumulative sound exposure level (SEL) for fish larger than 2 grams, and 183 dB SEL for fish smaller than 2 grams (Table 9.2.2.1.3-1). The peak SPL threshold is considered the maximum sound pressure level a fish can receive from a single strike without injury. The cumulative SEL threshold is considered the total amount of acoustic energy that a fish can receive from single or multiple strikes without injury. The cumulative SEL threshold is based on the total daily exposure of a fish to noise from sources that are discontinuous (in this case, noise that occurs up to 12 hours a day, with 12 hours between exposures). This assumes that a fish is able to recover from any previously incurred effects during this 12-hour period. These criteria relate to impact pile driving only. Vibratory pile driving is generally accepted as an effective measure for minimizing or eliminating injury of fish from pile driving. Although there has been no formal agreement on a "behavioral" threshold, NMFS uses 150 dB-root mean square (rms) as their threshold for adverse effects on fish behavior.

Table 9.2.2.1.3-1. Interim criteria for injury to fish from pile driving activities.

Interim Criteria	Agreement in Principle
Peak Sound Pressure Level (SPL)	206 dB re: 1μPa (for all sizes of fish)
Cumulative Sound Exposure Level (SEL)	187 dB re: 1μPa^2-sec—for fish size ≥ 2 grams 183 dB re: 1μPa^2-sec—for fish size < 2 grams

Fish smaller than 2 grams are more sensitive to underwater noise than larger individuals (Table 9.2.2.1.3-1). Larvae and young juvenile delta smelt are generally smaller than 2 grams, while adults average 2 to 3 grams (Foott and Bigelow 2010). Because some adults are less than 2 grams, the lower injury threshold (183 dB) was applied to all life stages. The interim criteria were set to be conservatively protective of delta smelt and NMFS species.

The potential for injury of fish from exposure to pile driving sounds was evaluated using a spreadsheet model developed by NMFS to calculate the distances from a pile that the peak and cumulative sound criteria travel (available at: http://www.dot.ca.gov/hq/env/bio/files/NMFS%20Pile%20Driving%20Calculations.xls). These distances define the area in which the criteria are expected to be exceeded as a result of impact pile driving. The NMFS spreadsheet calculates these distances based on estimates of the single-strike sound levels for each pile type (measured at 10 meters from the pile) and the rate at which sound attenuates with distance. In the following analysis, the standard sound attenuation rate of 4.5 dB per doubling of distance was used in the absence of other data. To account for the exposure of fish to multiple pile driving strikes, the model computes a cumulative SEL for multiple strikes based on the single-strike SEL and the number of strikes per day or pile driving event. The NMFS spreadsheet also employs the concept of "effective quiet". This assumes that cumulative exposure of fish to pile driving sounds of less than 150 dB SEL does not result in injury.

Other sources of in-water noise include generator and engine vibration transmitted through the hulls of work barges and associated vessels, and dredge equipment. Noise levels produced by these sources typically are less than those associated with vibratory pile driving and are likely to be comparable to ambient noise conditions in the vicinity of the intakes caused by traffic, boats, water skiers, etc. For routine vessel traffic, these noise levels typically range from peak levels of 160 to 190 dB at a range of 10 meters, depending on vessel size (Thomsen *et al.* 2009). Vessels will be traveling along haul routes from established barge landings in Stockton, Antioch, and San Francisco to the newly constructed barge landing locations identified in the *BiOp Resolution Log*. Dredge equipment noise will vary depending on equipment type. For example, a hydraulic cutterhead dredge working in the SDWSC produced noise levels of around 152 to 157 dB at 1 meter from the source (Reine and Dickerson 2014). Removal of pilings or other underwater structures could involve use of vibratory methods. This could generate sounds that could cause avoidance behavior of any delta smelt present. However, the noise levels generated by vibratory driving do not approach the peak or cumulative sound criteria outlined above.

Insufficient data are currently available to support the establishment of a noise threshold that stresses fish enough to change their behavior in a deleterious way (Popper *et al.* 2006). NMFS generally assumes that a noise level of 150 dB root mean square (RMS) is an appropriate threshold. NMFS acknowledges this threshold is uncertain, but believes 150 dB root mean square (RMS) is effective in minimizing effects.

Table 9.2.2.1.3-2 reports the estimates of the extent, timing, and duration of pile driving noise levels predicted to exceed the interim injury and behavioral thresholds based on application of the NMFS spreadsheet model and the assumptions presented in CWF BA Appendix 3.E, *Pile Driving Assumptions for the Proposed Action*. This analysis considers only those pile driving activities that could generate noise levels high enough to exceed the interim injury thresholds. These activities include impact pile driving in open water, inside cofferdams adjacent to open water, or on land within 200 ft of open water. For cofferdam sheet piles, it is assumed that approximately 70% of the length of each pile can be driven using vibratory pile driving, with impact driving used to finalize pile placement. For the intake structure foundation piles, the current design assumes the use of impact pile driving only. However, some degree of attenuation is expected assuming that the cofferdams can be fully dewatered. Therefore, predictions are shown for two scenarios, one in which dewatering results in a 5 dB reduction in reference noise levels, and one in which no attenuation is possible (no dewatering or other forms of attenuation). All computed distances over which pile driving sounds are expected to exceed the injury and behavioral thresholds assume an unimpeded sound propagation path. However, site conditions such as major channel bends and other in-water structures can reduce these distances by impeding the propagation of underwater sound waves.

Table 9.2.2.1.3-2. Extent, timing, and duration of pile driving noise levels predicted to exceed the interim injury and behavioral thresholds from NDD construction-related activities.

Facility or Structure	Distance to 206 dB SPL Injury Threshold (ft)	Distance to Cumulative 187 dB SEL Injury Threshold[1, 2] (ft)	Distance to 150 dB RMS Behavioral Threshold[2] (ft)	Construction Season	Timing of Pile Driving	Duration of Pile Driving (days)
Intake 2						
Cofferdam	30	2,814	13,058	Year 8	Jun–Oct	42
Foundation (no attenuation)	46	3,280	32,800	Year 9	Jun–Oct	19
Foundation (with attenuation)	20	1,522	15,226	Year 9	June-Oct	19
Intake 3						
Cofferdam	30	2,814	13,058	Year 7	Jun–Oct	42
Foundation (no attenuation)	46	3,280	32,800	Year 8	Jun–Oct	14
Foundation (with attenuation)	20	1,522	15,226	Year 8	June-Oct	14
Intake 5						
Cofferdam	30	2,814	13,058	Year 5	Jun–Oct	42
Foundation (no attenuation)	46	3,280	32,800	Year 6	Jun–Oct	19
Foundation (with attenuation)	20	1,522	15,226	Year 6	June-Oct	19

[1] Computed distances to injury thresholds are governed by the distance to "effective quiet" (150 dB SEL). Calculation assumes that single strike SELs <150 dB do not accumulate to cause injury. Accordingly, once the distance to the cumulative injury threshold exceeds the distance to effective quiet, increasing the number of strikes does not increase the presumed injury distance.

[2] Distance to injury and behavioral thresholds assume an attenuation rate of 4.5 dB per doubling of distance and an unimpeded propagation path; on-land pile driving, non-impact driving methods, dewatering of cofferdams, and the presence of major river bends or other channel features can impede sound propagation and limit the extent of underwater sounds exceeding the injury and behavioral thresholds.

Sound monitoring data collected during similar types of pile driving operations indicate that single-strike peak SPLs exceeding the interim injury thresholds are expected to be limited to areas within 30 ft of the cofferdam sheet piles and 20-46 ft of the intake foundation piles, depending on whether cofferdams can be dewatered (Table 9.2.2.1.3-2).

Based on a cumulative (daily) threshold of 187 dB SEL, the risk of injury is calculated to extend up to 5,628 ft (2,814 x 2)[22] during installation of the cofferdams and 6,560 ft (3,280 x 2[1]) during

[22] The radius was doubled to determine the diameter of noise effects to delta smelt.

installation of the foundation piles (3,044 ft if the cofferdams can be dewatered) assuming an unimpeded propagation path.[23] It is likely that bends in the river will attenuate sound faster than these predictions indicate, so these estimates likely reflect maximum potential for impacts. The predictions in Table 9.2.2.1.3-2 apply to one intake location; the current construction schedule indicates that pile driving will occur at only one intake in a given year, except for Year 8 in which cofferdam installation at Intake 2 may coincide with foundation pile installation at intake 3 (CWF BA 2016, Appendix 3.D, *Construction Schedule for the Proposed Action*). In this case, there will be no overlap in the potential noise impact areas, although delta smelt moving through the action area could be exposed to pile driving noise over two reaches totaling 12,188 feet. Based on the duration of pile driving, such conditions could occur for up to 14 days based on the duration of foundation pile installation.

The potential for behavioral effects will exist beyond the distances associated with potential injury. Based on a threshold of 150 dB RMS, the potential for behavioral effects is calculated to extend up to 13,058 ft (2.5 miles) from the cofferdam sheet pile installation, and 32,800 ft (6.2 miles) from the intake foundation pile installation (15,226 ft or 2.9 miles away if the cofferdams can be dewatered). These estimates assume an unimpeded propagation path. However, the extent of noise levels exceeding the injury and behavioral thresholds will be constrained to varying degrees by major channel bends that range from approximately 1,500 to 12,000 ft away from each intake facility. Although it is believed that low numbers of delta smelt are currently using this area and therefore, low numbers of individuals would be exposed to elevated noise levels that may result in injury or mortality.

For each intake facility, the current construction schedule indicates that cofferdam sheet piles will be installed over a period of 42 days at each intake location within the proposed in-water construction season followed by installation of the intake foundation piles over a period of 14 to 19 days during the following season.

<u>Eggs and Embryos (Spring: ~ March – June)</u>

Delta smelt eggs and embryos are demersal and adhesive, attaching to substrates with an adhesive stalk formed by the outer layer of the egg (Bennett 2005). There is limited research on effects of noise on delta smelt eggs; however, the potential for exposure is low due to the work window. Prolonged exposure to pile driving noise may reduce survival, development, or viability of any individual eggs in the vicinity of the intake sites (Banner and Hyatt 1973).

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[23] Based on the estimated number of pile strikes per day, the computed distances to the injury thresholds are governed by the distance to "effective quiet" (150 dB SEL).

Transport of Larvae and Young Juveniles (Spring: ~ March – June)

During June of the first year of construction, delta smelt larvae and young juveniles originating from upstream spawning areas may encounter pile driving noise during downstream movement to estuarine rearing areas. Although the exposure potential is low, any larval delta smelt passing the intakes during impact pile driving will be unable to avoid exposure to pile driving noise and therefore could be injured or killed depending on their proximity to the source piles and the duration of exposure.

Stranding

If present, delta smelt could be harassed, displaced, or die during construction of the riprap and sheet pile cofferdam. Installation of cofferdams to isolate the construction areas for the proposed intake sites has the potential to strand delta smelt, resulting in direct mortality from dewatering, dredging, and pile driving within the enclosed areas of the channel. Adults are at less risk than younger delta smelt, which are more vulnerable to stranding due to their limited ability to swim away and are more susceptible to being entrained.

To minimize entrapment risk and the number of delta smelt subject to capture and handling during fish rescue and salvage operations, cofferdam construction will be limited to the proposed in-water construction period (June 1–October 31) with pile driving proposed to occur June 15-September 15 of that broader work window) to avoid the peak abundance of adults, larvae, and young juveniles in the north Delta. The effect of stranding on delta smelt will be minimized by rescuing/salvaging any delta smelt stranded behind the cofferdam prior to dewatering. DWR will prepare and submit a fish rescue and salvage plan[24] (see CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*, AMM8, *Fish Rescue and Salvage Plan*) to the fish and wildlife agencies (NMFS, Service, CDFW) for review and approval prior to implementation. Due to the delta smelt's sensitive nature, it is likely that any delta smelt salvaged from behind the cofferdam will die from the fish capture methods and handling. Therefore, the efficacy of this minimization measure is considered low. The proposed in-water work window is the most effective measure to reduce stranding.

Adult Spawners (February – June)

Although present in very low numbers, spawning adults may be present in the vicinity of the NDD in June and subject to stranding behind the cofferdams. Adults are expected to move away

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[24] The fish rescue and salvage plan will include detailed procedures for fish rescue and salvage, including collection, holding, handling, and release, that will apply to all in-water activities with the potential to entrap delta smelt. All fish rescue and salvage operations will be conducted under the guidance of a qualified Service-approved fish biologist. The Service-approved biologist, in consultation with CDFW and NMFS, will determine the appropriate fish collection and relocation methods based on site-specific conditions and construction methods. Collection methods may include seines, dip nets, and electrofishing if Service-approved.

from active construction occurring, but some risk of stranding will exist as long as the interior of the cofferdam is accessible to delta smelt. Fish rescue and salvage activities using typical fish collection methods can result in injury or mortality to delta smelt. Given the appropriate training, some level of survival is possible. However, injury or mortality may still occur because of varying degrees of effectiveness with the collection methods and potential stress and injury associated with various capture and handling methods.

Eggs and Embryos

Based on the low utilization and expected avoidance of the intake sites by spawning adults, there is low to no risk of stranding delta smelt eggs or embryos.

Transport of Larvae and Young Juveniles (Spring: ~ March – June)

Although the potential for exposure is very low, delta smelt larvae and young juveniles may be particularly vulnerable to stranding because of their limited swimming abilities and potential entrainment in open cofferdams. In addition, conventional fish collection methods are less effective and more likely to cause injury or death of these life stages compared to larger juveniles or adults. Therefore, it is likely that most if not all of any larvae and young juveniles present will die as a result of stranding.

Increased Risk of Predation

Changes in hydrology will occur due to the placement of the cofferdams, the fish screens, and rock revetment around the new intakes. This could change how delta smelt are able to use this reach of the Sacramento River, blocking migrants and limiting access to the already narrow shoals in this river reach. Riprap and eddies created upstream and downstream of structures like the sheet pile cofferdams or the fish screens are known to attract predatory fish that may prey upon the delta smelt. The creation of deeper, higher-velocity zones adjacent to the cofferdams, additional riprap and fish screens may increase predator ambush habitat, although this will only affect individuals that migrate to the NDD locations. Although it is believed that low numbers of delta smelt are currently using this area and therefore, low numbers of individuals would be exposed to an increased risk of injury or mortality from predation. Additionally, implementation of Guiding Principle 6, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to improve population-level delta smelt habitat conditions through reductions in non-native invasive species. This Guiding Principle will ensure that as future development of the NDD occurs, minimization of entrainment of predators and other effects of the structures will be incorporated.

Loss, Alteration, and Restricted Access to Habitat

NDD construction will result in permanent loss, alteration, and accessibility of shallow water and open water habitat to migrating and spawning adults, eggs and embryos, and transport of larval and young juveniles. The effects of construction activities on water quality, including turbidity and suspended sediment, and contaminants, were previously discussed above. Implementation of

Guiding Principles 3 and 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, are intended to promote turbidity and restore, create, or enhance spawning habitat conditions through commitments made in the CWF PA and through actions described in the Delta Smelt Resiliency Strategy. These Guiding Principles are intended to minimize adverse effects to delta smelt from NDD construction and other CWF activities and establish a framework for developing future actions consistent with this BiOp. DWR has proposed to mitigate effects prior to the impact (see *Description of the Proposed Action*) within their mitigation proposal to restore 1,827.7 acres of shallow water habitat. Reclamation and DWR have also proposed to develop a sediment reintroduction plan, as described in the CWF BA, to specifically address spawning habitat needs for delta smelt, including the potential for a recurring sediment placement program to maintain sites for the duration of the PA's long-term effects.

During construction activities, DWR will implement AMM2, *Construction Best Management Practices and Monitoring*, to minimize effects to delta smelt (see CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*). These BMPs include a number of measures to limit the extent of disturbance to aquatic habitat during construction, and, following construction, to restore temporarily disturbed areas to preconstruction conditions. All construction and site restoration BMPs will be subject to a Service-, CDFW-, and NMFS-approved construction and post-construction monitoring plan to ensure their effectiveness. DWR proposes to offset unavoidable, permanent habitat loss from the construction of the proposed intake sites through yet-to-be developed shallow water habitat mitigation, with specific spawning habitat features.

The range of delta smelt extends north of the City of Sacramento; however, recent monitoring suggests that delta smelt only occasionally migrate beyond the extent of designated critical habitat (I Street Bridge; see *Status of the Species*). As a supplement to the CWF BA, the *BiOp Resolution Log* quantified effects (in number of acres) of the restricted access to habitat to the extent of its range (Knights Landing). The Service anticipates that construction of the NDD will result in a contraction of the delta smelt's range precluding access to habitats between Clarksburg and Knights Landing that might otherwise be used more frequently and in greater numbers in the future, especially given the potential for salinity intrusion from current climate change projections or under drought conditions.

<u>Migrating Adults (December – March)</u>

Delta smelt ascending the Sacramento River beyond its confluence with Cache Slough cannot swim against mid-channel velocities for an extended time and use low velocity paths to migrate upstream while also avoiding predation (CWF BA 2016). In downstream locations, vertical and lateral distribution changes have been observed that help fish both move and maintain geographic positions (Bennett *et al.* 2002; Feyrer *et al.* 2013; Bennett and Burau 2015), but these previous studies provide no evidence that delta smelt show affinity to one side of the river or the other when they move on and off shore. The Sacramento River makes 6 major bends between Isleton and Freeport shunting the highest velocity parts of the river cross section back and forth across the channel. In addition to this shifting high velocity water, it seems unlikely that delta smelt could keep swimming up one bank of the river from Isleton to areas upstream because they would eventually need to avoid a predator or be displaced off the shoreline at night when they lose visual reference and become less active. Both of these phenomena would tend to mix migrating smelt across the shorelines from day to day. Thus, in-water structures of the length proposed by the PA are likely to delay, impede or entirely block upstream migration.

Once constructed, each intake will be a permanent vertical wall extending 1,030-1,404 ft along the east bank of the Sacramento River, creating an impediment to fish passage. During February-May, data indicate that small numbers of adult delta smelt move upstream along the river reach where the intake will be constructed (see *Status of the Species at Proposed Action Area Preconstruction and Construction Sites).* The PTM modeling in the CWF BA suggests that these migrating adults could not ascend the Sacramento River this far changing only their depth in the water column (CWF BA 2016). Therefore, these individuals must consistently remain in lower velocity water near the shore. The anticipated water velocities along the cofferdam faces, and later the fish screens, will be faster than delta smelt can swim against for extended periods of time. Without an immediately adjacent shoreline to provide a velocity refuge, the Service believes this will create an impediment that will prevent individuals from migrating beyond the NDD.

Using December – June Freeport velocity data, the probability that an individual migrating adult delta smelt will successfully pass the lowermost cofferdam or intake structure was estimated to range from 0.071 to 0.072 (CWF BA 2016, Appendix 6A.2). The probability that an individual will pass all three intakes is estimated to be 0.0004[25]. This analysis suggests that river velocities will almost always be too high for delta smelt to swim the required distance upstream. However, as discussed on page 24 of the *Independent Review Panel Report for the 2016-2017 California WaterFix Aquatic Science Peer Review Phase 2B*, this calculation assumes that any delta smelt surviving past the first fish screen (intake 5) has an undiminished chance of getting past the second fish screen (intake 3), and likewise for the third fish screen (intake 2). Furthermore, the effort that a delta smelt must expend to make its way past any one fish screen will very likely reduce its chance to getting past subsequent fish screens. Thus, the probability of passing the second fish screen is likely to be less than 7.1 or 7.2%, conditional on passing the first fish screen. And the probability of passing the third fish screen, conditional on having to pass the first and second fish screen, is likely to be even smaller. So, the overall probability of passing all three fish screens is almost certainly less than 0.04%, approaching zero. The probability of fish passage past the fish screens could increase when considering the possibility of utilizing both sides of the river bank; however, based on the geography of the river, the bends will force most delta smelt towards the eastern bank where the NDD will be. Also, during high flow periods, the river velocities are higher than the dry year velocities used in the calculations above, which further substantiates that the NDD will create a restriction for upstream migration and spawning.

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[25] If the probability of passing one intake is approximately 0.07, then the probability of an individual adult delta smelt passing all three intakes is 0.0004 (0.07*0.07*0.07) if it remains oriented toward the east river bank.

Adaptive management efforts include monitoring and research which should further inform the effects of the NDD to delta smelt passage (refer to the *Adaptive Management Program*).

The CWF BA analysis of the ability of migrating adult delta smelt to pass the most downstream intake if occurring near the east bank suggested that only a very small percentage (4%) of fish would be expected to do so. If successfully passing one intake and remaining near the east bank, the remaining delta smelt would encounter the other intakes and have to decide whether to try to pass them, with a similarly low probability of success. Whether a delta smelt could migrate upstream past the three intakes would depend on its ability to use lower velocity habitat on the west bank of the river, near the channel bottom, or within the refugia along the intakes. Pre-construction studies are expected to further investigate the potential use of the refugia screen panels by delta smelt. However, at this time we do not consider it likely that delta smelt will intentionally enter the refugia because this is an open water species that does not seek cave-like structures in the wild and is stressed by confined spaces in captivity. In addition, predators (*e.g.*, striped bass, largemouth bass, and catfish) are also likely to use the refuge to escape the high water velocities along the fish screens.

Delta smelt detections along the reach of the proposed intake locations are consistent, but low in shallow water surveys (*e.g.*, beach seines) and even lower for mid-channel trawls. The presence of the intake structures will likely prevent migrating adult delta smelt from continuing past the NDD and result in injury or mortality due to impingement when individuals try to pass them. Few or no individuals may attempt to keep moving upstream along the east bank once they encounter elevated velocities associated with the first diversion. However, delta smelt can currently ascend the river along its east bank. Thus, the loss of low-velocity shoreline and increase in shoreline water velocity along the river's east bank that will occur as a result of installing a cofferdam and constructing the NDD will permanently remove or restrict habitat accessibility because it will alter the capacity of delta smelt to ascend the river. However, low numbers of delta smelt are believed to migrate this far upstream, and therefore NDD construction is only expected to affect a small proportion of the population.

During the in-water construction period, a total of approximately 5.6 acres of shallow water habitat will be permanently removed within the NDD construction footprint. This includes 0.4 acres that will be altered by dredging and barge traffic through changes in channel depths, benthic habitat, cover, and temporary in-water and overwater structure (barges, spud piles) within active work areas adjacent to the proposed intake structure and levee slope. The footprint of the three intake structures, transition walls, and bank protection will result in the permanent loss of approximately 3.2 acres of shallow water habitat. In addition, the 5.6-acre estimate includes potential suspended sediment effects to habitat 1,000 ft downstream of each intake (a total of 1.9 acres of shallow water habitat). Permanent modifications of nearshore habitat due to the presence of these structures will encompass a total of 5,367 ft (1.02 miles) of shoreline. At each intake, between 1.6 and 3.1 acres of open water habitat will be located within the cofferdams during construction.

Table 9.2.2.1.3-3 provides an account of the habitat acres estimated in the *BiOp Resolution Log* to be permanently affected from the permanent removal, alteration, or restricted access by delta smelt from NDD construction. Construction of the NDD will result in restricted access to 250.6 acres of adult migration and spawning habitat from Intake 5 to the I Street Bridge and another approximately 250 acres to Knights Landing, which is the northern extent of their range.

Table 9.2.2.1.3-3. Quantity of habitat acres[26] calculated to be permanently lost from removal, alteration, or restricted access by delta smelt from NDD construction.

Reach	Open Water Habitat	Shallow Water Habitat	Area of Sandy Beach	Sandy Beach Shallow Water Habitat	Designated Delta Smelt Critical Habitat
NDD Intake 5 to I Street Bridge	1,540 acres	250.6 acres	50 acres	36 acres	Yes
I Street Bridge to Knights Landing	1,562 acres	~ 250 acres[27]	58.5 acres	~ 42 acres[28]	No

This BiOp provides a programmatic analysis of the NDD construction, operations, maintenance, monitoring, and adaptive management. Information on the substrate type and vegetation within the footprints are unknown at this time, but is expected to be developed during subsequent consultation during Phase 2 of the Corps permitting when more information on the final siting and design of the NDD is available. As currently provided, the CWF BA does not provide the full quantity of sandy substrate within the shallow water habitat footprint expected to be affected, except for the area of habitat lost to upstream access. This was estimated through aerial imagery[29] (due to low vegetation in the area covering the substrate an estimate was feasible) that is expected to be refined when additional information is available to the Service, prior to impact.

DWR has proposed to mitigate the loss of delta smelt migratory and spawning habitat from NDD construction through a commitment to restore 1,753 acres of shallow water habitat. DWR has proposed to provide mitigation prior to the impact. The compensatory mitigation will consist of newly created or restored sandy beaches of high quality in areas where delta smelt are known to occur, such as Sherman Island, Cache Slough, north Delta, or other areas approved by the Service and CDFW. Mitigation sites within or upstream of the NDD will not be considered

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[26] Values within the NDD Intake 5 to I Street Bridge reach include the NDD footprints.
[27] Estimated from the observed shallow water to open water ratio from NDD Intake 5 to I Street Bridge (*i.e.*, 250:1,540).
[28] Estimated from the observed shallow water sandy beach to sandy beach ratio from NDD Intake 5 to I Street Bridge (*i.e.*, 36:50).
[29] Based on Google Earth Pro aerial imagery from 4/16/2015 with Freeport flow = 5,490 cfs [DAYFLOW] (refer to *California WaterFix Revised Mitigation Proposal Informing Service Final Biological Opinion* memorandum transmitted from Reclamation and DWR on 05/05/2017 in the *BiOp Resolution Log*).

appropriate for mitigating effects to habitat. DWR proposes to provide shallow water habitat that will be of higher quality and in areas closer to core areas of occurrence (*i.e.,* the 'North Arc'). The sandy beaches will have appropriate water velocities and depths to maintain the habitat and be accessible to delta smelt for direct use. Water quality conditions must also be suitable for delta smelt (*e.g.,* lack high density aquatic invasive plants that could serve as predator habitat, non-lethal levels of contaminants, and suitable salinity levels). Examples of site-specific areas include, but are not limited to: Sherman Island, lower San Joaquin River (such as San Andreas Shoal and Prisoners Point area), Sutter and Steamboat Sloughs, and waterways within the Cache Slough Complex.

Overall, these changes to the Sacramento River in the vicinity of the proposed intakes will block, delay, or impede adult passage, elevate risk of predation from an increase in predator habitat, and constrain the width of the channel. The Service anticipates that with mitigation included in the PA, effects to migrating adults will be minimized by creation of additional spawning habitat in areas that remain accessible to delta smelt. Additionally, implementation of Guiding Principle 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*, is intended to restore, create, or enhance spawning habitat conditions through mitigation commitments made by the CWF BA and through actions described in the Delta Smelt Resiliency Strategy. This Guiding Principle is intended to minimize adverse effects to spawning habitat and establish a framework for developing future actions consistent with this BiOp.

<u>Adult Spawners (February – June)</u>

Within the footprint of the proposed intake locations, there appears to be little or no sandy substrates that are thought to be preferred by delta smelt for spawning habitat (see *Status of the Species at Proposed Action Area Preconstruction and Construction Sites*). During the site selection process, DWR proposed the placement of the intakes in areas, avoiding, where feasible, large stands of riparian shaded riverine habitat for NMFS species and spawning substrates for delta smelt (BDCP 2013). The proposed intake locations are dominated by steep levee slopes, existing riprap and low quantities of riparian and aquatic vegetation. The permanent loss of nearshore habitat will block, delay, or impede access to upstream sandy beaches and remove low quality spawning habitat. As a result, delta smelt that would have otherwise used this habitat for spawning may seek suitable spawning habitats downstream.

It is unknown if there will be an effect to the spawning success of those individuals that migrate up the Sacramento River and have to redistribute downstream to avoid the construction areas. Predation rates are higher for those individuals that travel further looking for suitable places to spawn. Spawning habitat is not thought to be a limiting factor for delta smelt within the action area, although spawning habitat is limited along the Sacramento River due to historical habitat conversions (*e.g.,* riprapping). These reductions in spawning habitat and changes to spawning behavior will occur in approximately 15 RMs of edgewater with intermittent spawning habitat, typically thought to be areas with sandy substrates with suitable water velocities, from just below the southernmost diversion northward to the I Street Bridge.

Additionally, the three permanent structures will redefine the northern limit of the delta smelt spawning distribution, reducing the northern extent of its range (see *Status of the Species* Figure 9.2.1.1-6), which extends beyond the I Street Bridge. As stated above, NDD construction will block or impede access to 78 acres of spawning habitat from the lowermost NDD to the northern extent of its range along the Sacramento River and its tributaries (see Table 9.2.2.1.3-3 above). Implementation of Guiding Principles 3 and 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, are intended to promote turbidity and restore, create, or enhance spawning habitat conditions through commitments made in the CWF PA and through actions described in the Delta Smelt Resiliency Strategy. These Guiding Principles are intended to minimize adverse effects to delta smelt from NDD construction and other CWF activities.

<u>Eggs and Embryos (Spring: ~ March – June)</u>

Available data suggest that currently few individuals utilize the habitats in the vicinity of the proposed NDD for spawning. It is unknown if there will be an effect to the spawning success of delta smelt that migrate up the Sacramento River to spawn and are forced to move back downstream to avoid the high velocity conditions discussed above.

<u>Transport of Larvae and Young Juveniles (Spring: ~ March – June)</u>

At this life stage, delta smelt may be subject to predation along the intake sites where construction is proposed to occur. Once installation of the three cofferdams has occurred, it is expected that adult delta smelt will experience restricted access to areas above the cofferdams to spawn. With the anticipated reduction in delta smelt spawning at and north of the cofferdams, it is expected that fewer larval and juvenile offspring will pass back downstream. Overall, there will be a loss in edge water and open water habitat available to larvae and young juveniles for transport in these areas, similarly as it is for migrating adults, adult spawners, and eggs and embryos.

<u>Rearing Juveniles (Summer/Fall: ~ July – December)</u>

Juvenile delta smelt rear downstream of the proposed intakes in the summer and fall and therefore are unlikely to be affected by losses or alteration of habitat in the vicinity of the Sacramento River where the proposed intakes are located.

<u>Population-level</u>

Survey data indicate that most of the delta smelt population is distributed downstream of the proposed intake sites. Adults and larvae have been reported to occur in the north Delta and one adult has been collected as far upstream as Knights Landing (Vincik and Julienne 2012). The results from various surveys and general life history information suggest that the proportion of the population moving through or occupying the area that will be affected by construction of the NDD is low. Further, most individuals use this river reach during the winter and spring migration and spawning periods, rather than during the proposed in-water work period. For example, the mean densities of delta smelt larvae collected in the vicinity of the proposed intakes during 1991-1994 egg and larval surveys was 4-6% of the mean densities collected downstream of these locations during April and May. The low catches of migrating adults near the proposed intake sites during the construction window are also supported by the DJFMP beach seine data. With the expected low use near the intakes by spawning adults and low contribution to the overall spawning habitat available, there is a low risk on egg and embryo production or survival.

Due to current low population estimates and record low detections of delta smelt in recent years, the individuals remaining in the population are more valuable and susceptible to further reductions in the population. It is possible that the reduction in available migratory and spawning habitat from loss and restricted upstream access will have effects to the overall viable population size. However, the Service has no information on the relative value of individuals originating from or returning to the Sacramento River between Clarksburg and areas upstream to the overall population. Implementation of the proposed future Service-approved monitoring plan as described in the CWF BA and the *Adaptive Management Program* may provide information to better quantify and assess the consequences of restricted upstream passage (CWF BA 2016; *Adaptive Management Program*).

Summary

Delta smelt presence has been established in the Sacramento River where construction is proposed to occur. Only 3 adult delta smelt have been observed during DJFMP beach seine surveys during the in-water work window of June 1 through October 31. This supports our conclusion that there is a low likelihood of exposure to in-water work activities because there are relatively few adult delta smelt using this area.

DWR proposes to construct cofferdams to minimize effects to delta smelt by isolating work areas from fish in the river. If present during the first year of construction of the cofferdams, individual delta smelt (adults, eggs/embryos, larvae, and young juveniles) may experience: direct physical injury or mortality from riprapping and sheet piling, exposure to contaminants from accidental spills and disturbed contaminated sediments, underwater noise, and increased risk of predation. Thereafter, habitat loss becomes an additional effect; once the installation of the cofferdams has been completed, the altered hydrology will impair the upstream migration of delta smelt to upstream spawning habitat, constricting their overall range. The cofferdams will reduce the width of the river channel and eliminate some of the already limited amount of shallow, low-velocity nearshore zone along the east bank of the river.

Construction of the NDD is expected to block, delay, or impede delta smelt access to spawning habitat from the intakes to the northern extent of their range. However, low numbers of delta smelt are believed to migrate this far upstream, and therefore NDD construction is only expected to affect a small proportion of the population. In addition, DWR has proposed compensatory mitigation for the loss of this habitat. We anticipate this habitat restoration will minimize effects to delta smelt from NDD construction.

9.2.2.1.4 Head of Old River Gate

Effects to Individuals and the Population

Individual-level

The timing of the in-water HORG construction activities (August 1 – October 31) will avoid adverse effects to migratory and spawning adults, incubation (*i.e.*, eggs/embryos), and larval transport phases because these life stages do not occur during this time of year. HORG construction is scheduled to occur (August 1–October 31) during juvenile delta smelt rearing (approximately July – December). However, conditions at the HORG are not suitable for juvenile rearing at this time of the year because the water is too warm so we do not expect any individuals to be present at the construction site during the work window. Water temperature will cool during the work window, but delta smelt will not re-occupy this site until after the first winter rains occur in December or January. This seasonal change in the distribution of delta smelt is also addressed in RPA Component 2 of the 2008 Service BiOp, where the action ends June 30th or when the 3-day mean water temperature at CCF reaches 25 degrees Celsius, whichever occurs earlier (Service 2008; see *Status of the Species* and *Status of the Species at Proposed Action Area Preconstruction and Construction Sites*). Therefore, we do not expect there to be any exposure to delta smelt from in-water work activities occurring at the HORG during August 1-October 31.

Increased Risk of Predation

As analyzed in the 2008 Service BiOp, delta smelt and their offspring that migrate into the south Delta within the entrainment footprint are functionally lost to the population due to reverse flows, entrainment and salvage, predation, and degraded habitat conditions, except during the wettest years in the San Joaquin Basin. With the installation of the HORG, there will be an increased risk of predation during the earlier months of the year when delta smelt are present. The cofferdam will constrict the flow to half the channel's width which will increase water velocities. The presence of in-channel cofferdams and the HORG may increase the amount of predatory fish habitat and create hydraulic conditions that improve a predator's ability to prey on delta smelt as they migrate past the site. In its current state, the south Delta almost always has an annual installation of a temporary spring and sometimes fall HOR rock barrier, which poses similar predation concerns. However, the HORG will be a permanent in-water structure. Reclamation and DWR have committed to further engagement with the Service, NMFS, and CDFW during finalization of the design to develop measures to minimize predation and other effects of the structure. Additionally, implementation of Guiding Principle 6, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to improve population-level delta smelt habitat conditions through reductions in non-native invasive species. This Guiding Principle will ensure that as future development of the HORG occurs, minimization of entrainment of predators and other effects of the structure will be incorporated.

Loss or Alteration of Habitat

Construction of the HORG will result in permanent impacts to approximately 2.9 acres of shallow water habitat including the footprint of the gate and the channel segments upstream and downstream of the structure that will be affected by dredging. DWR proposes to mitigate unavoidable impacts to delta smelt habitat from construction of the HORG with 8.7 acres of habitat.

<u>Migrating Adults (December – March)</u>

Historically, delta smelt more frequently utilized portions of the San Joaquin River upstream as far south as the City of Mossdale; however, they no longer occur in large numbers at the HOR due primarily to poor water quality and increased temperature, high entrainment risk, and perhaps high predation risk associated with the aquatic weed infestations present throughout much of the south Delta. We base this conclusion on the recent lack of detections in the Mossdale Kodiak trawls, nearby DJFMP beach seines, annual ongoing disturbance from installing a temporary HOR rock barrier, riprapped levees, and denuded habitat.

DWR has proposed to mitigate effects to shallow water habitat from construction of the HORG as described in the *Description of the Proposed Action.* Location of the mitigation is important to the function of the habitat for delta smelt. DWR has proposed to mitigate in areas such as, Sherman Island, Cache Slough, or the north Delta, where we observe higher abundances of delta smelt. The habitat will have the appropriate water velocities and depths to maintain the habitat and be accessible to delta smelt for direct use. In addition, it will have the appropriate water quality conditions in order to be suitable for delta smelt (*e.g.,* lack of man-made predator habitat, non-lethal levels of contaminants, and suitable salinity levels). Given the degraded condition of the habitat within the area of the HORG footprint, habitat being mitigated for at a 3:1 ratio, in areas that are of higher value and quality to delta smelt, will provide an overall greater conservation value to delta smelt in comparison to the habitat that will be disturbed or removed by HORG construction.

<u>*Adult Spawners (February – June)*</u>

Loss or alteration of aquatic habitat within the footprints of the cofferdams, riprapped banks, and dredged channel areas may reduce the amount of shallow water habitat potentially available to spawning adults. However, this portion of the Old River channel is frequently disturbed by the annual installation of a temporary rock barrier and is dominated by steep levee slopes, riprap, and low quantities of sandy substrates, riparian, and aquatic vegetation (see *Existing Conditions and Previous Consultations in the Action Area*).

<u>Eggs and Embryos (Spring: ~ March – June)</u>

Based on the lack of spawning habitat for delta smelt, the potential for injury or mortality of eggs and embryos is negligible. The footprint of the HORG has experienced annual disturbances since the conception of the rock barriers in 1963 (see *Existing Conditions and Previous Consultations in the Action Area*) and lacks suitable habitat for spawning adults and their spawn.

Transport of Larvae and Young Juveniles (Spring: ~ March – June)

Any delta smelt larvae that hatch in the area surrounding the proposed HORG are likely to be entrained or eaten and thus will not contribute to the population. This conclusion is based on extensive hydrodynamic modeling that shows extremely low probability of water and by extension, planktonic animals like fish larvae, being transported away from the south Delta export pumps except in very wet years in the San Joaquin basin.

Rearing Juveniles (Summer/Fall: ~ July – December)

The southern Delta does not support delta smelt rearing during the summer. Delta smelt densities decline below 20-mm Survey detection limits by the end of June and typically fall below the much more sensitive detection limits of the south Delta fish facilities during June or July.

Population-level

Delta smelt have been found as far upstream on the San Joaquin River as the City of Mossdale, which is upstream of the HOR, but delta smelt that migrate into the south Delta are faced with high risk of entrainment and predation. As a result, most of the delta smelt population is distributed downstream of the proposed HORG. Available monitoring data suggest that adult delta smelt occur in very low numbers near the HORG. Over 2,300 beach seine samples in the San Joaquin River between Dos Reis (RM 51) and Weatherbee (RM 58) between 1994 and 2016 yielded four delta smelt (all in February–April) (Service 2016). Nearly 30,000 trawl samples at Mossdale from 1994 to 2016 resulted in the capture of 44 delta smelt, principally in March-June (Service 2016).

The low abundance of delta smelt and low quality of potential spawning habitat in the vicinity of the HORG indicates that impacts from construction will have undetectable population-level effects. Based on the low abundance of delta smelt in the San Joaquin River in the vicinity of HORG, potential adverse effects on migration and survival of migrating adults will likely be limited to a small proportion of the population.

Summary

The proposed HORG construction work window is expected to avoid affecting delta smelt because they are not expected to be present in this location at this time of year (August 1-October 31). Habitat within the footprint of the HORG has become heavily altered and disturbed with the annual installation of the temporary HOR rock barrier that is installed most years in the spring and fall (see *Existing Conditions and Previous Consultations in the Action Area*). By permanently installing an operable gate within that footprint there will be a loss of 2.9 acres of shallow water habitat that is proposed to be mitigated for as described in the *Description of the*

Proposed Action. That mitigation will provide a greater overall conservation value to the delta smelt than the habitat that is being lost due to construction of the HORG.

9.2.2.1.5 Clifton Court Forebay, Clifton Court Forebay Pumping Plant, and Connections to Banks and Jones Pumping Plants

Effects to Individuals and the Population

Individual-level

Construction activities at CCF that may affect delta smelt include expansion and dredging of SCCF, construction of divider wall and east/west embankments, dewatering and excavation of NCCF, construction of NCCF outlet canals and siphons, and construction of a SSCF intake structure and NCCF emergency spillway. Of those identified activities, effects to delta smelt and its critical habitat have previously been addressed for some components of the PA in prior consultation with the Service in the 2008 Service BiOp. Delta smelt can only occur within the CCF by operation of the SWP. Therefore, this BiOp addresses those additional affects to delta smelt and its critical habitat outside of the previously analyzed footprint in the 2008 Service BiOp. Construction within and near the CCF may alter (increase or decrease) the number of delta smelt salvaged at the existing CVP and SWP pumping facilities when compared to what has been described in the 2008 Service BiOp incidental take statement. However, there are limitations to the delta smelt effects analyses based on the information provided to the Service in the CWF BA and best available information; it is too speculative to determine how salvage estimates of the existing CVP and SWP pumping facilities will be affected by the implementation of the PA. Effects to individuals from exposure to in-water work activities at CCF exposure that have previously been accounted for in the 2008 Service BiOp incidental take statement are described below.

Contact with Heavy Equipment or Material

Delta smelt could be injured or killed by contact with equipment or materials during in-water construction activities in CCF and the adjacent Old River channel. In addition to the proposed in-water work window, DWR proposes to implement a number of AMMs to minimize the potential for impacts on delta smelt, including AMM1, *Worker Awareness Training*; AMM4, *Erosion and Sediment Control Plan*; AMM6, *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*; AMM7, *Barge Operations Plan*; AMM9, *Underwater Sound Control and Abatement Plan*; and AMM8, *Fish Rescue and Salvage Plan* (CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*).

Increased Turbidity and Suspended Sediment

In-water construction activities at CCF will result in elevated turbidity and suspended sediment levels in CCF and Old River. The principal sources of increased turbidity and suspended sediment are dredging and cofferdam construction (sheet pile installation and removal). Minor increases in turbidity and suspended sediment in CCF and Old River are also expected during construction of the CCPP, outlet canals and siphons, SSCF intake structure, and North CCF (NCCF) emergency spillway. All other sediment-disturbing activities within cofferdams, upland areas, or forebays pose little or no risk to water quality.

The potential for elevated turbidity and suspended sediment to affect delta smelt will be minimized by restricting all in-water construction activities to July 1-October 31 (when delta smelt are least likely to be entrained by operations), limiting the duration of these activities to the extent practicable, and implementing the AMMs described in CWF BA Appendix 3.F, *General Avoidance and Minimization Measures.*

Dredging could cause extensive, long-term effects on turbidity and suspended sediment within CCF. Potential secondary effects include potential increases in chemical and biological oxygen demand associated with the decomposition of vegetation and organic material in disturbed sediments. In addition to implementing the AMMs listed above, DWR proposes to limit the potential exposure of listed species to water quality impacts by restricting the timing, extent, and frequency of major sediment-disturbing events. For example, DWR proposes to limit the extent of dredging impacts in CCF by restricting daily operations to two dredges operating for 10-hour periods (daylight hours) within 200-acre cells enclosed by silt curtains (representing approximately 10% of total surface area of CCF). In addition, dredging will be monitored and regulated through the implementation of the *Disposal and Reuse of Spoils, Reusable Tunnel Material, and Dredged Material Plan*, which includes preparation of a sampling and analysis plan, compliance with NPDES and SWRCB water quality requirements during dredging activities, and compliance with proposed in-water work windows.

Exposure to Contaminants and Disturbance of Contaminated Sediments

Contaminated sediments can adversely affect fish through direct exposure from mobilized sediment or indirect exposure through accumulation of contaminants in the food web. Consequently, dredging, excavation, and expansion of CCF pose a substantial short-term and long-term risk of exposure of delta smelt and other aquatic organisms to elevated concentrations of contaminants. Current estimates indicate the dredging will affect up to 1,932 acres of CCF while expansion of the SCCF will create an additional 590 acres of newly exposed sediment. The proximity of the south Delta to agricultural, industrial, and municipal sources indicates that a broad range of contaminants that are toxic to fish and other aquatic biota, including metals (*e.g.*, copper, mercury), hydrocarbons, pesticides, and ammonia, could be present. Mud and silt in south Delta waterways have been shown to contain elevated concentrations of contaminants, including mercury, pesticides (chlorpyrifos, diazinon, DDT), and other toxic substances (California State Water Resources Control Board 2010). Impairments in Delta waterways also include heavy metals such as selenium, cadmium, and nickel (G. Fred Lee & Associates 2004). Thus, exposure and resuspension of sediments during in-water construction could lead to degradation of water quality and adverse effects on fish or their food resources in the action area.

The potential for introduction of contaminants from disturbed sediments will be addressed through the implementation of specific measures addressing containment, handling, storage, and disposal of contaminated sediments, as described under AMM6, *Disposal of Spoils, Reusable Tunnel Material, and Dredged Material*, in CWF BA Appendix 3.F, *General Avoidance and Minimization Measures*. These measures include the preparation and implementation of a preconstruction sampling and analysis plan to characterize contaminants and determine appropriate BMPs to minimize or avoid mobilization of contaminated sediments during in-water construction activities. Because potential mobilization of contaminants is closely linked to sediment disturbance and associated increases in turbidity and suspended sediment, turbidity monitoring and control measures (*e.g.*, silt curtains) to achieve compliance with existing Basin Plan objectives will be important measures for limiting dispersal of contaminated sediments during dredging and other in-water construction activities.

Underwater Noise and Vibrations

During construction of the CCF water conveyance facilities, activities that are likely to generate underwater noise include in-water pile driving, riprap placement, dredging, and barge traffic. Pile driving conducted in or near open water poses the greatest risk to delta smelt because the levels of underwater noise produced by impulsive types of sounds often reach levels of sufficient intensity to injure or kill fish within a certain radius of the source piles (Popper and Hastings 2009). Other activities such as riprap placement, dredging, and barge operations generally produce more continuous, lower energy sounds below the thresholds associated with direct injury but may cause harm and harassment to individuals resulting in avoidance behavior or temporary hearing loss or physiological stress if avoidance is not possible or exposure is prolonged (Popper and Hastings 2009).

Pile driving conducted in or near open water can produce underwater noise of sufficient intensity to injure or kill fish within a certain radius of the source piles. Pile driving information for CCF is available for the embankments, divider wall, siphon at NCCF outlet, and siphon at Byron Highway (CWF BA 2016, Appendix 3.E, *Pile Driving Assumptions for the Proposed Action*). Pile driving operations include the installation of an estimated 19,294 temporary sheet piles to construct the cofferdams for the embankments and divider wall, and 2,160 14-inch diameter concrete or steel pipe piles to construct the siphon at the NCCF outlet. Pile driving for the siphon under Byron Highway is not addressed in the following analysis because all pile driving will be conducted on land and more than 200 ft from water potentially containing listed fish species. A total of 4 construction seasons will likely be required to complete pile driving operations based on the estimated duration of pile installation (CWF BA 2016, Appendix 3.D, *Construction Schedule for the Proposed Action*).

DWR proposes to minimize the potential exposure of delta smelt to pile driving noise by conducting all in-water construction activities between July 1 and November 30 (when delta smelt are least likely to be entrained by operations). In addition, DWR will develop and implement an underwater sound control and abatement plan outlining specific measures that will be implemented to avoid and minimize the effects of underwater construction noise on listed fish species (CWF BA 2016, Appendix 3.F, *General Avoidance and Minimization Measures*, AMM9, *Underwater Sound Control and Abatement Plan*). These measures include the use of vibratory and other non-impact driving methods as well as other physical and operational measures to limit the intensity and duration of underwater noise levels when delta smelt may be present. Where impact pile driving is required, hydroacoustic monitoring will be performed to determine compliance with established objectives (*e.g.*, distances to cumulative noise thresholds) and identify corrective actions to be taken should the thresholds be exceeded.

Table 9.2.2.1.5-1 presents the extent, timing, and duration of pile driving noise levels predicted to exceed the interim injury and behavioral thresholds during installation of cofferdam sheet piles for the embankments and divider wall, and the structural piles for the NCCF siphon based on application of the NMFS spreadsheet model and the assumptions presented in CWF BA CWF BA Appendix 3.E, *Pile Driving Assumptions for the Proposed Action*. For cofferdam sheet piles, it is assumed that approximately 70% of the length of each pile can be driven using vibratory pile driving, with impact driving used to finalize pile placement. For the NCCF siphon piles, the current design assumes the use of impact pile driving only. However, some degree of attenuation is expected assuming that the cofferdams can be fully dewatered. Therefore, predictions are shown for two scenarios, one in which dewatering results in a 5 dB reduction in reference noise levels, and one in which no attenuation is possible.

Table 9.2.2.1.5-1. Extent, Timing, and Duration of Pile Driving Noise Levels Predicted to Exceed the Interim Injury and Behavioral Thresholds at CCF.

Facility	Distance to 206 dB SPL Injury Threshold (ft)	Distance to Cumulative 187 dB SEL Injury Threshold[1, 2] (ft)	Distance to 150 dB RMS Behavioral Threshold[2] (ft)	Number and Timing of Construction Seasons	Timing of Pile Driving	Duration of Pile Driving (days)
Clifton Court Forebay						
Embankment Cofferdams	30	2,814	13,058	1 (Year 5)	Jul–Nov	85
Divider Wall	30	2,814	13,058	1 (Year 4)	Jul–Nov	86
NCCF Siphon (no attenuation)	46	1,774	9,607	2 (Years 2-3)	Jul–Nov	72
NCCF Siphon (with attenuation)	20	823	4,458	2 (Years 2-3)	Jul–Nov	72

[1] Computed distances to injury thresholds are governed by the distance to "effective quiet" (150 dB SEL). Calculation assumes that single strike SELs <150 dB do not accumulate to cause injury. Accordingly, once the distance to the cumulative injury threshold exceeds the distance to effective quiet, increasing the number of strikes does not increase the presumed injury distance.

[2] Distance to injury and behavioral thresholds assume an attenuation rate of 4.5 dB per doubling of distance and an unimpeded propagation path; on-land pile driving, vibratory driving or other non-impact driving methods, dewatering of cofferdams, and the presence of major river bends or other channel features can impede sound propagation and limit the extent of underwater sounds exceeding the injury and behavioral thresholds.

Sound monitoring data collected during similar types of pile driving operations indicate that single-strike peak SPLs exceeding the interim injury thresholds are expected to be limited to areas within 30 ft of the cofferdam sheet piles and 20-46 ft of the NCCF siphon piles (Table 9.2.2.1.5-1). Based on a cumulative (daily) threshold of 187 dB, the risk of injury is calculated to extend 2,814 ft away from the source piles during installation of cofferdam sheet piles and 1,774 ft during installation of the NCCF siphon piles (823 ft if the cofferdams can be dewatered).[30] Based on a threshold of 150 dB RMS, the potential for behavioral effects is calculated to extend 13,058 and 9,607 ft (4,458 if the cofferdams can be dewatered), respectively. Such exposures will occur over a period of up to 72 days (36 days per season) during installation of the NCCF siphon piles (second and third years of construction activities at CCF), 86 days during cofferdam construction for the divider wall (year 4), and 85 days during cofferdam construction for the embankments (year 5).

Stranding

Installation of cofferdams to isolate construction areas in CCF and the adjacent Old River channel has the potential to strand fish, resulting in direct injury and mortality of fish that become trapped inside the cofferdams. To minimize potential stranding losses, DWR will implement a fish rescue and salvage plan (CWF BA 2016, Appendix 3.F, *General Avoidance and Minimization* Measures, AMM8, *Fish Rescue and Salvage Plan*[31]). This plan will be submitted to the fish and wildlife agencies (NMFS, Service, CDFW) for review and approval prior to implementation.

Disturbance and Alteration to Habitat

Construction of the new water conveyance facilities at CCF will result in temporary and permanent losses or alteration of aquatic habitat in CCF and, near the new SCCF intake and the NCCF emergency spillway, in the Old River. Effects of construction activities on water quality, including turbidity and suspended sediment, underwater noise, and contaminants, were previously discussed. The following analysis focuses on permanent impacts on physical habitat associated with construction activities. Cofferdam installation, dredging, embankment construction, and construction of CCPP, NCCF emergency spillway, and SCCF intake, and NCCF canal and siphons will affect an estimated 1,932 acres of shallow water habitat (see CWF BA Mapbook M3.A) through changes in water depths, vegetation, and substrate. Permanent impacts on aquatic habitat encompass an estimated 258 acres of shallow water habitat in CCF that will be replaced by permanent fill and structures associated with the new CCPP, embankments, canals and siphons, and intake structure and spillway.

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[30] In this case, the distance to the injury thresholds are governed by the distance to "effective quiet" (150 dB SEL).

[31] The plan will include detailed procedures for fish rescue and salvage, including collection, holding, handling, and release, that will apply to all in-water activities with the potential to entrap fish. All fish rescue and salvage operations will be conducted under the guidance of a Service-approved fish biologist. The biologist, in consultation with a designated agency biologist, will determine the appropriate fish collection and relocation methods based on site-specific conditions and construction methods. Collection methods may include seines, dip nets, and electrofishing as approved by the Service, CDFW, and NMFS.

During construction activities, DWR will implement AMM2, *Construction Best Management Practices and Monitoring*, to protect listed fish, wildlife, and plant species, their designated critical habitat, and other sensitive natural communities (CWF BA 2016, Appendix 3.F, *General Avoidance and Minimization Measures*). These BMPs include a number of measures to limit the extent of disturbance of aquatic and riparian habitat during construction, and following construction, to restore any disturbed areas to preconstruction conditions. All construction and site restoration BMPs will be subject to an approved construction and post-construction monitoring plan to ensure their effectiveness. DWR is not proposing to mitigate for permanent effects to aquatic habitat in CCF due to the unfavorable conditions within the forebay as previously analyzed and characterized in the 2008 Service BiOp (see *Status of the Species at Proposed Action Area Preconstruction and Construction Sites* and *Existing Conditions and Previous Consultations in the Action Area*).

<u>Population-level</u>

Delta smelt within the CCF have been entrained and effectively lost to the population in terms of successful reproduction and contribution to future generations as previously analyzed in the 2008 Service BiOp. Construction within and near the CCF may alter the number of delta smelt salvaged at the existing CVP and SWP pumping facilities. There is considerable uncertainty as to how delta smelt salvage within the existing CVP and SWP pumping facilities will be affected by the implementation of the PA. However, the construction in-water work window is scheduled to occur when typically low salvage is observed. Salvage records indicate that adults and larvae may be present in June and July but abundance is low and declining in these months, especially in July as water temperatures typically exceed the upper tolerance levels for successful reproduction. This is recognized in the RPA Component 2 of the 2008 Service BiOp, where the action ends June 30th or when the 3-day mean water temperature at CCF reaches 25 degrees Celsius, whichever occurs earlier (Service 2008).

Summary

Construction within CCF will result in changes to 258 acres of shallow water habitat and affect an estimated 1,932 acres of shallow water habitat from cofferdam installation, dredging, embankment construction, and construction of CCPP, NCCF emergency spillway, and SCCF intake, and NCCF canal and siphons. Salvage estimates may be altered from the proposed in-water work activities. Given uncertainty, and limitations in information provided to the Service within the CWF BA, and available information, it is too speculative to determine how those estimates of the existing CVP and SWP pumping facilities will be affected by the implementation of the CWF BA. It is acknowledged that low salvage numbers and detections are expected to occur during the overlap in action RPA Component 2 and the in-water work activities (*i.e.*, during the in-water work window) and therefore are anticipated to have a small effect on salvage.

9.2.2.1.6 Summary of Preconstruction and Construction-related Effects on Delta Smelt Reproduction, Numbers, and Distribution

Activities associated with the preconstruction and construction of the water conveyance facilities are likely to affect individual delta smelt through harassment, injury, mortality, and loss of suitable habitat. Details related to maintenance, monitoring, adaptive management, and implementation of the compensatory mitigation are too uncertain to describe effects to individuals from implementation of these actions at this time; however, effects will be assessed during subsequent future consultations (*i.e.,* Corps Phase 2 permitting) when information related to final design of the NDD, HORG, CCWD settlement agreement facilities, and restoration locations is available.

We expect the risk of exposure to individuals and injury or mortality to be low from preconstruction and construction activities for the following reasons: (1) work has been proposed to be conducted during work restriction windows (CWF BA Appendix 3.F *General Avoidance and Minimization Measures*), (2) the record low abundance of delta smelt will translate into even lower numbers of delta smelt at the construction sites, and (3) the seasonal and transient use of the locations where the in-water work has been identified to occur will limit delta smelt presence. Therefore, it is expected that overall adverse effects to individuals will be low, resulting in a minimal reduction in the delta smelt population over the approximately 13 years of proposed in-water construction activities (see CWF BA Appendix 3.D *Assumed Construction Schedule for the Proposed Action*). Implementation of Guiding Principles 3, 4, and 6, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, are intended to be protective of all delta smelt life stages through commitments made in the CWF PA and through actions described in the Delta Smelt Resiliency Strategy. These Guiding Principles are intended to minimize adverse effects to delta smelt from construction activities.

The most significant adverse effect to delta smelt from the PA is the permanent contraction in available habitat to delta smelt that presently supports some migration, spawning, transport, and rearing processes that are necessary for reproduction and survival of the species. The construction of the NDD is expected to result in restricted access to migratory and spawning habitat from the southernmost intake to the northern extent of the species' range. However, low numbers of delta smelt are believed to migrate this far upstream, and therefore NDD construction is only expected to affect a small proportion of the population. Reclamation and DWR have proposed to mitigate for the effects to delta smelt by restoring spawning, rearing, and migration habitat prior to impacts. Restoration will be performed at a site or sites that will provide the most benefit for delta smelt into the future, such as in the vicinity of west Delta, central Delta, north Delta, or Cache Slough. The proposed compensatory mitigation will likely provide habitat conditions to improve the functions necessary to support all life stages of delta smelt. Implementation of Guiding Principle 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to restore, create, or enhance spawning habitat conditions through commitments made in the CWF

PA and through actions described in the Delta Smelt Resiliency Strategy. This Guiding Principle is intended to minimize adverse effects to delta smelt from the CWF by ensuring that future actions consider appropriate restoration, creation, and enhancement of habitat during development and implementation. Based on the mitigation proposed and the framework to guide future actions associated with CWF, we believe the adverse effects of habitat loss resulting from construction will be minimized.

9.2.2.2 Operations

The BA analysis includes a comparison to two sets of hypothetical future water operations, one with the PA and one without (the NAA). Prior to the NDD facilities becoming operational, the existing CVP and SWP facilities will continue to be operated consistent with the Service's (2008) and NMFS' (2009) BiOps or new BiOps developed during the reinitiation process. The reinitiation of the 2008 Service BiOp, reinitiation of the 2009 NMFS BiOp, and the update of the SWRCB's WQCP will change the criteria upon which the provided CWF PA and NAA operational modeling was based. It is anticipated that as part of the reinitiation of the 2008 Service BiOp, Reclamation and DWR will propose project operations that avoid jeopardizing delta smelt or destroying or adversely modifying its critical habitat. Reclamation has indicated the scope of this reinitiation of consultation is expected to include the operation of existing facilities with CWF facilities (1/19/2017 email from Brooke White, Reclamation). In that case, the reinitiation of the 2008 BiOp would constitute a subsequent consultation on CWF operations. This section summarizes the effects from operations as they are proposed in the CWF BA. This is considered a programmatic-level analysis with the understanding that the operations proposed in the CWF BA are likely to change based on the uncertainties described below.

The proposed suite of operations has been deconstructed into the following sections identified in Figure 9.2.2.2-1, which interact to form the new and existing CVP and SWP water conveyance facilities operations. These include: NDD; south Delta Water Facilities; HORG; DCC; Suisun Marsh Facilities, including the Suisun Marsh Salinity Control Gates, Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall; NBA Intake; and other facilities, including Contra Costa Water District Facilities, Freeport Intake, and the CCF Aquatic Weed Control Program.

Figure 9.2.2.2-1. Deconstruction of the new and existing water conveyance facilities.

The following effects analysis addresses the three general categories of potential effects that may be caused by the addition of CWF operations to the operation of existing CVP and SWP water facilities in the Delta. The first category of effects are those that can typically result from the operation of large water diversions such as entrainment, impingement, and injury of delta smelt that come in contact with the fish facility as water is being diverted (*i.e.*, salvage). The second category includes those impacts that may result from the simple existence of large concrete and steel structures in the river, such as increased predation and loss of shoreline habitat features. The third category of impacts are those associated with the actual diversion of large quantities of water from the river, which can affect flow patterns, hydrodynamics, and resulting habitat features and ecological processes that vary with changes in river flows into the estuary.

Entrainment, impingement, and fish screen contact are used to assess direct injury or loss of delta smelt from diversions. Entrainment can occur whenever delta smelt are present in river water that is diverted (or exported), creating the opportunity for delta smelt and/or their food supply to follow the flow of diverted water and become entrained (*i.e.*, lost from the Bay-Delta ecosystem). The entrainment footprint in the south Delta can extend beyond the CCF into adjacent waterbodies. Comparatively, entrainment for the NDD refers to those individuals or food supply that passes through the fish screen. Screen contact is defined as any contact along the face of the fish screen. Impingement occurs when delta smelt that have contacted a fish screen are trapped or pinned by the force of the flow of water against the intake screens at the entrance of a diversion.

The analyses of the potential effects of water exports on delta smelt that are presented in the sections below address direct effects of water exports (such as entrainment and impingement) and indirect effects (such as predation and habitat impacts). Effects to habitat resulting from the operation of the CVP and SWP water facilities with CWF included are combined in the analysis below because the effects cannot be separated out by facility. There is the potential for near-field habitat effects to occur from the operations of each water project, such as near-field habitat alterations and localized scouring. However, those habitat alterations were analyzed in the previous construction sections. Future modeling, monitoring, and laboratory studies associated with preconstruction monitoring efforts are expected to inform localized [downstream, upstream, or adjacent] effects from water exports (FFTT 2011; CWF BA Table 6.1-5). This information will inform final design of the NDD, HORG, and the future project-level consultations.

9.2.2.2.1 Framework for Programmatic Consultation

As described in the *Consultation Approach* section above, some of the actions in this consultation are being analyzed using a framework programmatic approach. Future CWF actions subject to subsequent Federal decisions or approvals include construction and related actions (including maintenance, mitigation, and monitoring) of the NDD intakes and HORG, and operations of the new CWF facilities.

It is anticipated that the construction-related actions subject to future Federal approvals will be consulted upon as part of the Corps' Phase 2 permitting for CWF. Phase 2 permitting will be preceded by the reinitiated consultation on the 2008 Service BiOp and 2009 NMFS BiOp. Agency decisions related to identifying the final CWF operational criteria will be made in a subsequent consultation, and Reclamation and DWR have committed to analyze and further address species effects from CWF operations at that time.

The following Guiding Principles are proposed to establish a framework in this consultation under which the future CWF actions will be developed to ensure both that future consultations related to CWF actions build upon the analysis in this document as described in the *Consultation Approach* section above and that the CWF is constructed and operated in a manner that promotes the co-equal goals articulated in California's Delta Reform Act. The principles are intended to promote (1) ecological conditions suitable for all life stages of delta smelt, and (2) water supply reliability. The Guiding Principles are as follows:

1. Improving habitat conditions for rearing juvenile delta smelt, which may include locating the LSZ in suitable areas of the estuary.
2. Operating CVP and SWP water exports in the south Delta to minimize entrainment of migrating and spawning adult delta smelt and larval/young juvenile delta smelt.
3. Promoting increased turbidity in geographical areas and during temporal windows that may be expected to increase the extent and quality of delta smelt habitat through implementation of sediment management plan referenced in the 2017 CWF PA and through actions described in the Delta Smelt Resiliency Strategy.
4. Restoring, creating, or enhancing spawning habitat conditions through use of mitigation commitments made by Reclamation and DWR in the 2017 CWF PA and through actions described in the Delta Smelt Resiliency Strategy.
5. Promoting food production and transport into areas where habitat conditions are suitable for delta smelt.
6. Improving population-level delta smelt habitat conditions through reductions in non-native invasive species.
7. Coordinating operations of the south Delta and NDD water facilities to limit effects to delta smelt populations from cyanobacteria blooms.
8. Implementing all actions in a manner that limits, to the maximum extent practicable, impacts to water supply and provides opportunities to recover water supplies consistent with protection of listed species.

These principles are subject to change over time where the best available scientific information indicates that such change is appropriate. In such event, the agencies will evaluate whether the change triggers the requirement to reinitiate consultation.

9.2.2.2.2 Operational Uncertainties and the Collaborative Scientific Process

With respect to operations, Reclamation and DWR have described and analyzed in the BA one scenario for the CWF, which presents operational criteria. The criteria were largely formed, in consultation with the Service, NMFS, and CDFW, at the time in the development of the PA when the NDD was proposed at a capacity of 15,000 cfs and when the PA included a 50-year Habitat Conservation Plan and Natural Communities Conservation Plan covering both listed and non-listed species. Thus, the operational criteria required to satisfy regulatory requirements for the CWF at the time operations commence are likely to be different from those presented in the BA.

Additionally, some of the criteria and some of the outcomes in the effects analysis are based upon precautionary assumptions, whereas other outcomes are based upon a greater degree of certainty. The analysis of the effects of the PA on fish and aquatic resources is influenced by numerous factors related to the complexity of the ecosystem, changes within the system (*e.g.*, climate change and species population trends), and the imprecision of operational controls and resolution in modeling tools. These factors are further complicated by the scientific uncertainty about some fundamental aspects of the life histories of the listed fish species and how these species respond to changes in the system, as well as sometimes competing points of view on the interpretation of biological and physical data within the scientific community. Some of the criteria of the PA have been conservatively estimated based on professional judgment. In this context, uncertainty in some of the criteria was resolved in a manner to provide greater protection of species and these criteria may not be required to avoid jeopardy or adverse modification of critical habitat.

This CWF BiOp analyzes the BA's operational scenario at a programmatic-level and identifies potential effects to delta smelt and designated critical habitat from the operational scenario described; however, all identified potential effects must also be considered within the framework provided by the Guiding Principles as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation.*

As noted above, the operational criteria described in the BA are very likely to change not only for the reasons described above but also based on other processes. Future CVP and SWP operations with CWF and species needs will be informed by these other processes, including the State Water Board process to update the Bay Delta WQCP, reinitiation of consultation on the 2008 Service BiOp, reinitiation of consultation on the 2009 NMFS BiOp, the Collaborative Science and Adaptive Management Program (CSAMP), implementation of the CWF AMP, California EcoRestore, implementation of the Delta Smelt Resiliency Strategy, implementation of the Salmonid Resiliency Strategy, the Delta Smelt Recovery Plan update, and other actions that are likely to cause physical, chemical, and biological changes within the watershed. The CWF operations will be developed consistent with the framework provided by the Guiding Principles articulated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation.*

The outcomes of the processes described above, as well as consideration of Delta conditions and relevant regulatory obligations existing at the time, will be considered in determining how CWF will be operated. Some of the criteria identified in the PA may have substantial water supply effects while providing limited ability to minimize effects to species. As a result, operational criteria identified in the CWF PA may be modified, relaxed, or removed and may no longer apply to an operation with CWF, while other operational criteria not currently identified in this CWF consultation or those already identified may be included or modified. Therefore, the operational criteria that are described in the CWF BA and in this BiOp will change between now and when CWF becomes operational.

The Service is committed to working with other agencies and stakeholders through the CWF AMP, CSAMP, and other processes to undertake additional focused research and analyses to improve scientific understanding concerning the tools used to analyze species and critical habitat effects and the impact of the facilities' operations on listed species and their habitat, as well as the scientific understanding concerning the benefits of other actions (*e.g.*, habitat restoration) on listed species and their habitats.

The CWF includes a robust adaptive management program that incorporates a collaborative science process to further refine, during the subsequent consultations, what ultimately will be defined as the initial operating criteria for the CWF project. The adaptive management program will continue to refine CWF operations over time. The AMP described in Section 6.1, will collect and analyze data for the purpose of evaluating the propriety of the anticipated operations in light of the evolving science and changing circumstances in the Delta, in the context of the consultation provisions set out in Section 7 of the ESA.

Operating criteria applicable to CWF that are in addition to the criteria that govern CVP and SWP operations without CWF will only take effect once the NDD facilities become operational. Reclamation will propose, and the Service will use the best scientific and commercial data available, including data collected and analysis conducted through the CWF AMP, to determine through a section 7 consultation the specific criteria required to comply with section 7 when the NDD facilities become operational.

9.2.2.2.3 North Delta Diversions

Once the NDD are operational, the diversion of water will generate an approach velocity that can increase fish impingement above what may be caused just by the high near-screen water velocities. The adverse effects from construction of the NDD are elevated by operation of the NDD due to impingement (*i.e.*, screen contact), and from predation, further worsening conditions for those delta smelt that migrate into the reach of the river in the vicinity of the intakes. In the effects of the NDD construction section, we analyzed how construction of the diversions and fish screens would increase the nearshore water velocities that delta smelt would experience if attempting to migrate upstream along the east bank of the Sacramento River. Based on historical and recent sampling detections, the reach of the proposed intake locations has few observations of delta smelt in beach seines and fewer from trawling methods.

Entrainment

Based on delta smelt body depth to body length ratios and using the screening effectiveness analysis described in the CWF BA Appendix 6.A *Quantitative Methods for Biological Assessment of Delta Smelt*, Section 6.A.2.2, the proposed NDD screen mesh of 1.75 mm would prevent delta smelt greater than standard length of around 20-21 mm from being entrained through the fish screens. Therefore, delta smelt older than approximately 90 days (Hobbs *et al.* 2007) would not be entrained through the NDD fish screens. All adult delta smelt exceed 90 days of age and 21 mm in length. Based on fish screen exclusion, it is not expected that migrating or spawning adults or even juveniles will be entrained by the NDD operations. Additionally, eggs and embryos are demersal (associated with substrates) and adhesive, attaching to substrates with an adhesive stalk formed by the outer layer of the egg (Bennett 2005). Therefore, eggs and embryos should not be subject to entrainment or impingement. Only delta smelt larvae could potentially be at risk of entrainment based on their open water habitat use and their less than 20-mm body size.

The CWF BA provided estimates of larval delta smelt entrainment using estimates of the percentage of flow diverted from NDD operations (CWF BA 2016, Chapter 6). However, based on results presented in Section 9.2.2.1.3 of this BiOp, we expect the NDD structures to block, delay, or impede upstream migration of adult delta smelt. Since no spawning is expected to occur upstream of the NDD, no larvae will be present to move downstream past the NDD. With the reduction in delta smelt spawning north of the diversions, it is expected that few or no larvae and juvenile offspring will be produced from that area, reducing the number of offspring that migrate downstream to rearing habitat. Thus, entrainment of larvae is expected to have minimal or no population effect.

Impingement and Screen Contact

Migrating adults will be at risk of impingement if they migrate up the eastern bank of the Sacramento River to the location of the NDD and try to pass them along the screen faces. The primary reason that delta smelt will face a high risk of impingement is that the expected sweeping velocities along the fish screens will usually be flowing faster than the fish can swim for sustained periods (CWF BA). This effect was discussed in the construction section. The operation of the NDD will create a second current flowing into the fish screens called an approach velocity. This current will be much less than the sweeping velocity, but nonetheless can affect fish screen contact and injury (Swanson et al. 2005; White et al. 2007; Young et al. 2010).

As noted in CWF BA Chapter 3 and the *Description of the Proposed Action* of this BiOp, the NDD would be operated such that approach velocity would be limited to 0.2 fps as a minimization measure for delta smelt. It is expected that the NDD FFTT, as part of the final design process, will investigate and assess various approach and sweeping velocity operational criteria intended to minimize effects of screened water exports on delta smelt. There remains the potential that delta smelt larger than the minimum screenable size of approximately 20-21 mm could contact the NDD screens and be injured or die. This potential exists for several reasons: (1)

even at 0.2-fps approach velocity, delta smelt were injured from screen contact in an experimental flume (White *et al.* 2007), (2) the sweeping flow velocity at which it was assumed that NDD diversions could commence (0.4 fps; see Section 5.A.5.2.4.9, *North Delta Diversion Bypass Flows*, in CWF BA Appendix 5.A *CALSIM Methods and Results*, and Section 5.B.2.3.5, *North Delta Diversion Operations*, in CWF BA Appendix 5.B *DSM2 Modeling and Results*) is within the velocity range at which captive delta smelt switched swimming modes from a non-continuous stroke and glide behavior to continuous swimming, resulting in swimming failure because of inability to swim steadily (Swanson *et al.* 1998), and (3) the proposed fish screens are long requiring delta smelt to swim continuously against strong current for lengthy periods to pass the screens. The behavior-based PTM analysis (see Section 6.1.3.2.2.1.2, *Population-Level Effects* of the CWF BA) supports the hypothesis that adult delta smelt migrating upstream in the vicinity of the NDD need to use the lower velocity periphery of the channel to swim upstream against unidirectional flow during periods when the NDD would be operating (*i.e.,* the typical tidal surfing behavioral conceptual model [Bennett and Burau 2015] would not move fish this far upstream). As a result, individuals that do migrate this far upstream may face a higher risk of contact with the screens if they migrated along the east bank of the river where the NDD would be located. Injury and mortality of juveniles and adults have been found to occur following screen contact in laboratory experiments conducted at the UC Davis Fish Treadmill Facility (Swanson *et al.* 2005; White *et al.* 2007), and stress (measured as plasma cortisol) is positively correlated with screen contact in adult delta smelt (Young *et al.* 2010).

The published studies on delta smelt from the UC Davis Fish Treadmill Facility (cited above in the previous paragraphs) were used to assess the potential for screen contact, screen passage, and mortality. As described in CWF BA Appendix 6.A *Quantitative Methods for Biological Assessment of Delta Smelt*, Section 6.A.2.3, two of the methods (CWF BA 2016, Section 6.A.2.3.1.1 *Adult Delta Smelt (Number of Screen Contacts)*; Section 6.A.2.3.1.2 *Juvenile and Adult Delta Smelt (Percentage Mortality)* were based on an assessment methodology undertaken as part of the FFTT planning effort. From these analyses, it is estimated the adult delta smelt passing one of the NDD screens—moving against the flow in an upstream direction, based on the laboratory studies—would contact the screen 3 to 5 times, and that there would be little variation in this estimate across a wide range of sweeping velocity (Figure 9.2.2.2.3-1).

In addition, application of the relationships from the laboratory studies estimated that mortality would be 1% or less for fish encountering one of the intakes when sweeping velocity is low (0.2–0.3 fps), possibly increasing to 4–6% at sweeping velocity above 1.5 fps if the fish screen was encountered at night (Figure 9.2.2.2.3-2). A third analysis (CWF BA 2016, Section 6.A.2.3.1.3 *Adult Delta Smelt (Screen Passage and Survival)* was adapted from an analysis provided by the Service. This analysis focuses on the ability of delta smelt moving upstream near the east bank of the river to pass the lowermost NDD fish screen, given historic dry year Sacramento River velocities at Freeport. Using December-June Freeport velocity information, the probability that an individual adult delta smelt would successfully pass the lowermost NDD fish screen was estimated to range from 7.3% to 7.5% (or 0.04% probability past three intakes[32]). The survival estimates for fish that actually pass the screen were relatively high and had low variability: mean ± standard deviation = 92% plus or minus < 1%, but the survival estimates had little influence on passage (*P*) because river velocity is almost always too high for delta smelt to swim the required distance upstream. As described in the CWF BA Section 3.2.2.2, *Fish Screen Design*, 22-ft-wide refugia could be provided between each of the six screen bay groups at the three intakes, which, are intended to provide resting areas and refuge from predators. However, the efficacy of the refugia to provide cover and protection to delta smelt is unknown at this time.

At this time we do not consider it likely that delta smelt will intentionally enter the refugia because delta smelt is an open water species that does not seek cave-like structures in the wild and in captivity is stressed by confined spaces. In addition, the refugia will also be places that small predators (*e.g.*, striped bass, largemouth bass, catfish) can escape the high water velocities along the fish screens. For these reasons, these analyses ignored the proposed refugia in the fish screens (*i.e.*, assumed that delta smelt would not use them).

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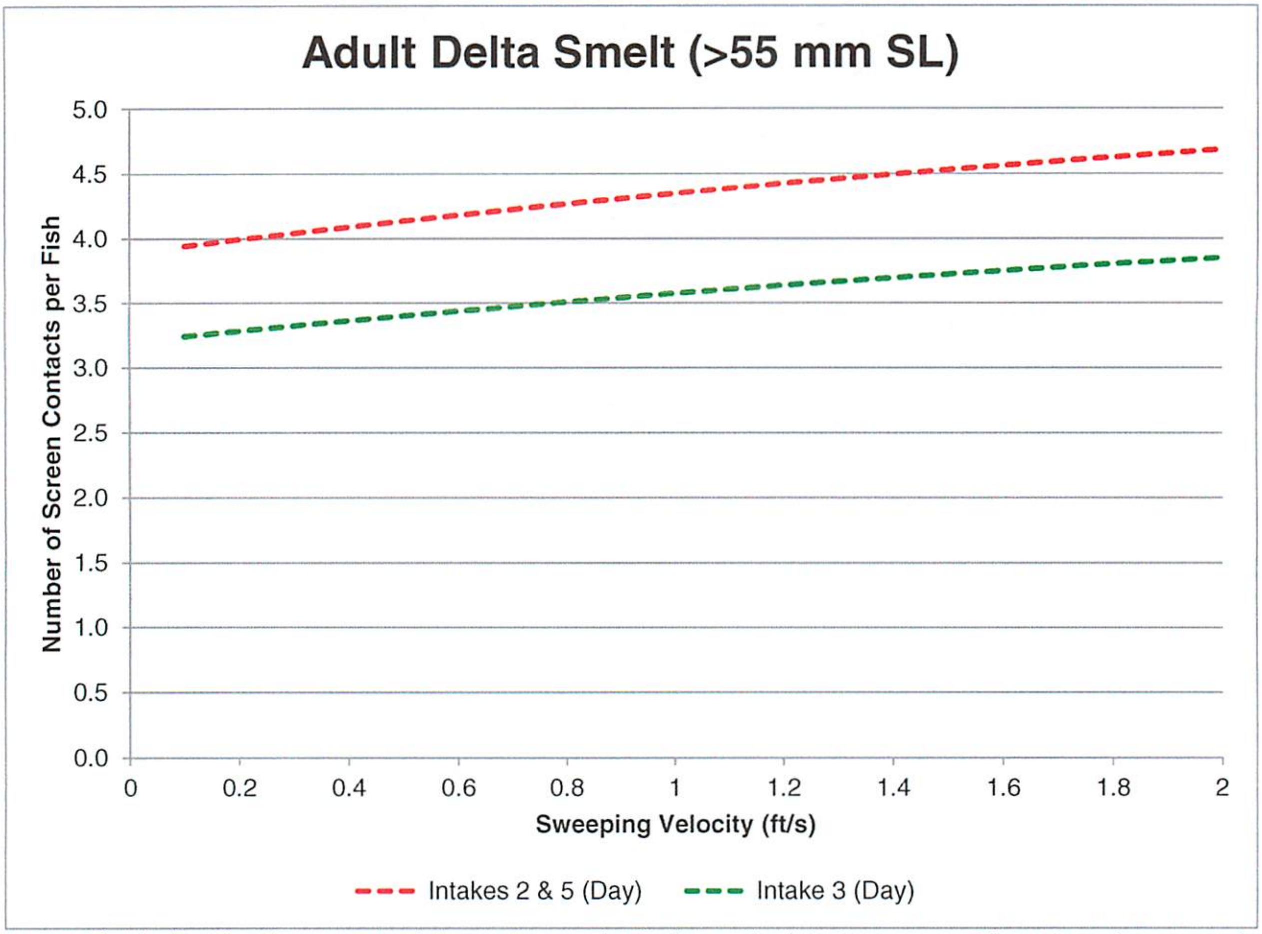
[32] The estimated chance of passing one diversion is approximately 7.3%, so the chance of passing all three is 7.3% times 7.3% times 7.3% = 0.04%.

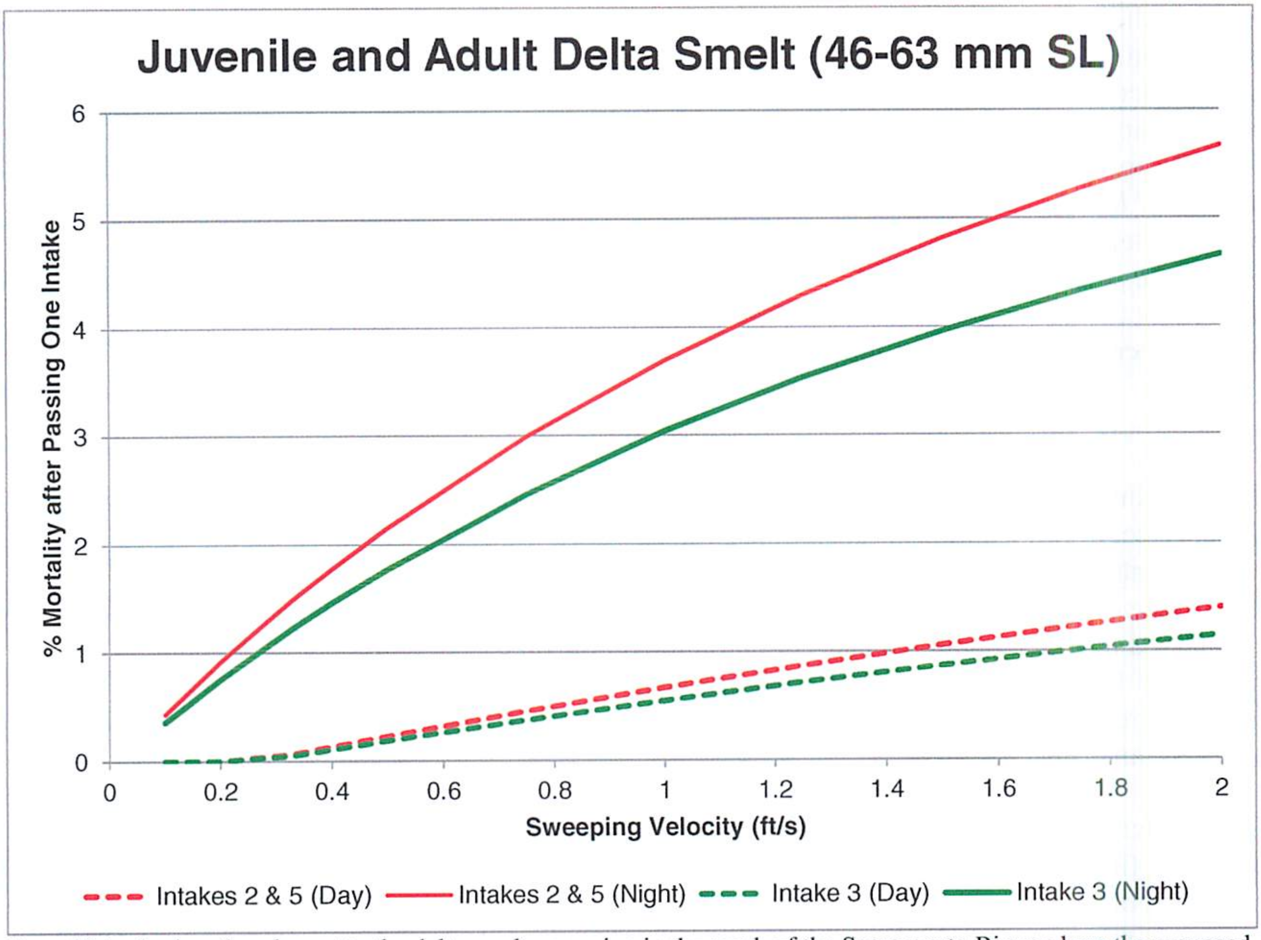


Note: This plot is only relevant to the delta smelt occurring in the reach of the Sacramento River where the proposed NDD would be situated, and of those, only the ones encountering the intake screens at the river margins where the on-bank intakes would be sited. Plot only includes mean responses and does not consider model uncertainty.

Figure 9.2.2.2.3-1. Estimated number of screen contacts of adult delta smelt encountering fish screens the length of intakes 2 and 5 (1,350 ft) and intake 3 (1,110 ft) at an approach velocity of 0.2 fps during the day.

Overall, the UC Davis Fish Treadmill studies indicate that there is potential for lethal and non-lethal effects to juvenile and adult delta smelt from screen contact and impingement for the subset of the population occurring in the reach of the river where the NDD would be located (Figure 9.2.2.2.3-2). However, low numbers of delta smelt are believed to migrate this far upstream, and therefore NDD construction is only expected to affect a small proportion of the population. Although shorter and smaller in size, we can infer from the Freeport intake facility potential lessons learned and extent by which the NDD might cause similar effects to delta smelt from their operations at a larger scale. Monitoring efforts conducted at the Freeport intake to evaluate impingement impacts, using sonar cameras and diver surveys, did not reveal any impinged fish (eggs, larvae, or later life stages) in 2014 (or in 2011–2013), and there was no significant debris accumulation on screen panels (which can affect screen performance). A hydraulic evaluation of the Freeport intake in 2014 showed that approach velocity ranged from 0.09 fps to 0.27 fps and that 70% of approach velocity measurements did not exceed the target design approach velocity of 0.2 fps, although the facility was operating at 85% of capacity (ICF International 2015b).

It is expected that the FFTT, as part of the final design process, will assess various techniques to measuring approach and sweeping velocities in an attempt to get velocity readings that represent the face of the screen. This will allow for operators to respond to changes in approach and sweeping velocities in real-time in order to be more protective of listed species.



Note: This plot is only relevant to the delta smelt occurring in the reach of the Sacramento River where the proposed NDD would be situated, and of those, only the ones encountering the intake screens at the river margins where the on-bank intakes would be sited. Plot only includes mean responses and does not consider model uncertainty.

Figure 9.2.2.2.3-2. Estimated 48-hour mortality of juvenile and adult delta smelt encountering fish screens the length of intakes 2 and 5 (1,350 ft) and intake 3 (1,110 ft) at an approach velocity of 0.2 fps during the day and night.

Predation Risk

The likelihood of delta smelt presence by life stage in the vicinity of the NDD was previously discussed above in Section 9.2.2.1.3 of this BiOp. It is uncertain to what extent the predation rate in front of an operable fish screen will differ from the predation rate that would otherwise occur in this reach without the NDD present because there are no data available to estimate predation rates on delta smelt in this reach. A hydroacoustic survey as part of Freeport intake monitoring in 2014 (when diversions were over 130 cfs) found that predator-sized fish (*i.e.*, 12 inches long [305 mm long] and larger) density at the intake was similar or less than the density in upstream and downstream control reaches (ICF International 2015a), although only four surveys were undertaken[33]. As discussed in the CWF BA Section 6.1.1.3, *Water Facilities Construction*, riprap used in association with the intakes could result in increased predator habitat and predation risk. Various substrates and material types will be assessed for inclusion as part of convening the FFTT in the future to develop a final design and minimize effects to delta smelt from predation. In addition, the implementation of localized predatory fish reduction through adaptive management under the PA may limit predation risk, but there is uncertainty in the effectiveness of this adaptive management measure given that the area is open to immigration and emigration of predators and turnover may be appreciable in a relatively short period of time (refer to the *Adaptive Management Program*; Cavallo *et al.* 2013). The efficacy of this minimization measure will be researched during the pre-construction phase, when the predator baseline is established as part of the pre-construction studies that have been identified during the FFTT. Additionally, fish injured by contact with the fish screen will likely have a slower escape response from predators thereby increasing the risk of predation.

9.2.2.2.4 South Delta Water Facilities

The entrainment of delta smelt into the south Delta by the Banks and Jones pumping plants is a direct effect of SWP and CVP operations. Salvage has historically been used as an indicator of entrainment resulting from CVP and SWP export operations from the south Delta, but as the abundance of delta smelt has continued to decline, salvage has also declined and is currently not considered to be a reliable indicator of entrainment. Salvage is an extrapolated estimate of the number of fish at each Project's fish facility and subsequently returned to the Delta through a truck and release operation. See Brown *et al.* (1996) for a description of fish salvage operations at the Skinner Fish Facility.

Even under the best of conditions, the salvage estimates are indices of entrainment - most entrained fish are not observed (Table 9.2.2.2.4-1), so most of the fish are not salvaged and do not survive (Castillo *et al.* 2012). Bennett (2005) suggested that many, if not most, of the delta smelt that reach the fish facilities likely die due to handling stress and predation; however, recent studies suggest there may be relatively high survival of adult delta smelt during collection, handling, transport, and release when they are salvaged during cool temperature conditions (Morinaka 2013). There is no data on the survival on these fish post release. Pre-screen loss due to predation near and within the CVP and SWP fish facilities is an additional cause of mortality

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[33] NMFS also has been conducting hydroacoustic surveys of predator-sized fish near the Freeport intake; these data were not yet available for inclusion in this effects analysis.

for delta smelt. In one study, pre-screen loss of captive-reared delta smelt released into CCF ranged from about 90% to 100% for adults and nearly 100% for juveniles (Castillo *et al.* 2012).

Under a dual conveyance system, modeled south Delta exports were reduced from baseline conditions under existing regulatory rules. This was a result of the flexibility to utilize the dual conveyance system. Reductions in south Delta water exports are predicted to reduce the entrainment of individual delta smelt from the south Delta during the spawning migration and larval transport phases. Further, reduced exports are anticipated to increase the capacity for delta smelt to successfully use the San Joaquin River for spawning by allowing their offspring to escape entrainment from locations farther up the river than is presently possible much of the time. The Service sees the potential for reductions in entrainment and increased habitat availability in the San Joaquin River by operating a dual conveyance facility to reduce reliance on south Delta exports from current operations.

Presently, the Service considers delta smelt to almost always be entrained (and therefore lost to the population) if they enter Old or Middle rivers except under extremely wet San Joaquin Basin conditions. As mentioned above, the salvage of delta smelt does not return meaningful numbers of fish back into the Delta (Castillo *et al.* 2012). Thus, the source of mortality of delta smelt in the south Delta is not especially important like it is for fishes that are more effectively salvaged (*e.g.*, Chinook salmon and steelhead). Most delta smelt that enter the southern Delta via Old and Middle river are assumed to be eaten before they reach the water facilities and the Service does not expect that dual conveyance will change that assumption. However, lower south Delta exports are expected to reduce the entrainment of delta smelt into Old and Middle river by reducing the entrainment footprint of the export facilities. Generally speaking, decreases in entrainment translate into lower mortality of individuals from predation.

Table 9.2.2.2.4-1. Factors affecting delta smelt entrainment and salvage.

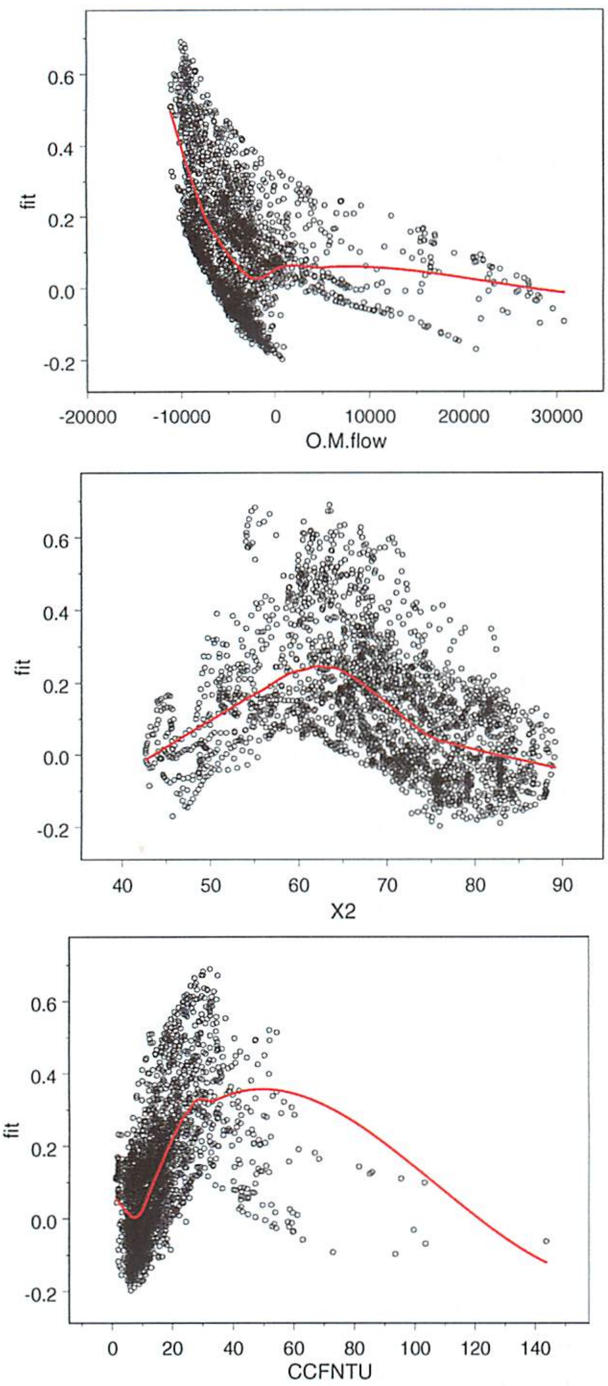
Factor	Adults	Larvae < 20 mm	Larvae >20 mm and Juveniles	Source
Pre-screen loss (predation prior to encountering fish salvage facilities)	CVP: unquantified; SWP: 89.9–100%	Unquantified	CVP: unquantified; SWP: 99.9%	SWP: (Castillo *et al.* (2012
Fish facility efficiency	CVP: 13%; SWP: 43–89%	~0%	CVP: likely < 13% at all sizes, << 13% below 30 mm (based on adult data); SWP: 24–30%	CVP (Kimmerer 2008; adults only), SWP: (Castillo *et al.* 2012)
Collection screens efficiency	~100%	~0%	<100% until at least 30 mm	(Service 2011)
Identification protocols	Identified from subsamples, then expanded in salvage estimates	Not identified	Identified from subsamples, then expanded in salvage estimates	(Service 2011)
Collection and handling	48-hour experimental mean survival of 93.5% (not statistically different from control) in 2005; 88.3% in 2006 (significantly less than 99.8% of control)	Unquantified	48-hour experimental mean survival of 61.3% in 2005 and 50.9% in 2006 (both significantly less than mean control survival of 82.0–85.9%)	(Morinaka 2013)
Trucking and release (excluding post-release predation)	No significant additional mortality beyond collection and handling (above)	Unquantified	No significant additional mortality than collection and handling (above), although mean survival was 37.4% in 2005	(Morinaka 2013)

Entrainment and Salvage

Larval, juvenile, and adult delta smelt are entrained into the south Delta by the export facilities during the migration, spawning, and transport periods of their life cycle (Kimmerer 2008; 2011; Grimaldo *et al.* 2009; Sommer *et al.* 2011). Delta smelt were previously considered 'semi-anadromous' and assumed to make a somewhat coordinated and generally eastward spawning migration into the Delta (Service 1993; Bennett 2005; Sommer *et al.* 2011). Newer research suggests that rather than a "migration", the fish spread out in multiple directions during winter storms (Murphy and Hamilton 2013; Polansky *et al.* in press). During winter dispersal is when adult delta smelt show up in fish salvage counts. Salvage of adults has mainly occurred from late December through March (Kimmerer 2008; Grimaldo *et al.* 2009).

For adults, the risk of entrainment is influenced by net negative flow (stronger flood tides than ebb tides) and turbidity in the south Delta (Grimaldo *et al.* 2009). Project pumping (*i.e.,* the export of water from the Delta) can cause the tidally filtered or "net" flows in Old and Middle river and other south Delta channels to move "upstream". This occurs when water removed by Banks and Jones, along with other diversions in the area, is back-filled by tidal and Sacramento River flows. This phenomenon is mathematically depicted as negative flow. Negative OMR flows and higher turbidity are often associated with adult delta smelt entrainment when delta smelt are present in the zone of entrainment, but no particular OMR flow assures entrainment will or will not occur. The net OMR flows indicate how strongly the tidally averaged flows in these channels are moving toward Banks and Jones pumping plants. It is possible the net flows themselves are the mechanism that increases entrainment risk for young delta smelt. However, high exports can also lead to strong tidal asymmetry in Old and Middle river where flood tides toward the pumps become much stronger than the ebb tides away from the pumps (Service 2008), so altered tidal flows are a second, covarying, mechanism that could increase risk of entrainment particularly of adult delta smelt if they are using tide-surfing behaviors to move. The real-time management of adult delta smelt entrainment risk is based on OMR flow and turbidity management.

The empirical shape of the associations between estuarine salinity distribution (X2), OMR, turbidity and adult delta smelt salvage normalized by the FMWT is shown in Figure 9.2.2.2.4-3. Normalized delta smelt salvage is correlated in a nonlinear way with X2. An interpretation of this is that the intermediate river flow or X2 conditions are associated with the highest salvage because flows are sufficient to disperse turbidity around the Delta, but not so high that most delta smelt are distributed seaward of the Delta. Figure 9.2.2.2.4-3 shows that even when X2 and south Delta turbidity are accounted for, there is no OMR flow that assures delta smelt entrainment will or will not occur. The predicted relationship is a smooth, accelerating function with increasing normalized salvage as OMR flow becomes more negative (Figure 9.2.2.2.4-3).



Note: The scatter in each panel is caused by the interacting effects of the other two variables.

Figure 9.2.2.2.4-3. Empirical trends in predictions of adult delta smelt salvage (y-axis) during December–March, 1993–2013, as a function of OMR flow (cfs), X2 (km from Golden Gate Bridge), and turbidity at CCF (CCFNTU, NTU).

Adult entrainment risk, related to exports from the south Delta, is expected to decrease as a result of the shift in exports to the NDD during the migration period. For the south Delta, OMR flows more positive than -2000 cfs are expected to be protective of a high fraction of adults because Sacramento River water flowing into the mainstem of the San Joaquin River is not being rapidly drawn into Old and Middle river.

In the PA, average OMR flows are less negative than current operations in January, February, and March. During adult spawning migration, OMR flows in the PA are expected to be more positive than -2000 cfs 40% of the time during January, 50% of the time in February, and 60% of the time during March (CWF BA 2016).

In December, flows will be similar to projected conditions under existing regulations without the PA (CWF BA 2016). OMR flow under current conditions is always more negative than -2000 cfs in December, unless Action 1 of the 2008 Service BiOp is in effect.

The shift in Delta exports from the south to the north during larval and juvenile transport period is expected to maintain or improve transport flow function and decrease entrainment of larval and juvenile delta smelt in the south. OMR flows more positive than -2000 cfs are expected to provide appropriate transport flows for larval and juvenile smelt from spawning locations in the San Joaquin River and eastern Delta to the LSZ. OMR flows more positive than -5000 cfs are expected to provide appropriate transport flows for larvae and juveniles being transported through Three-Mile Slough and the lower San Joaquin River between Antioch and Jersey Point. Modeled OMR flows are more positive for the PA than the modeled projected baseline conditions in March and June and are similar in April and May. OMR will not be more negative than -5000 cfs during the months of March to June (CWF BA 2016).

Juvenile delta smelt can be entrained at the south Delta export facilities after June, but patterns of salvage suggest that entrainment loss is very low after June (see Figure 3 of Kimmerer 2008). Recognizing this, the 2008 Service BiOp established June 30 as the latest date to which restrictions on south Delta export pumping are presently applied to limit entrainment of larval/young juvenile delta smelt. The restrictions can end earlier than this if the daily mean water temperature at Clifton Court Forebay reaches 25°C for 3 consecutive days, because this indicates that conditions are no longer conducive to smelt survival (Service 2008), consistent with broad-scale observations on distribution (Nobriga *et al.* 2008).

Under the PA, south Delta exports are reduced from the projected conditions under existing regulations without the PA. This is due to the flexibility to utilize the dual conveyance system. Observed reductions in south Delta water exports thereby reduce the entrainment risk of individuals in the south Delta during the spawning migration and larval transport phases and will increase the potential for delta smelt to use the San Joaquin River for spawning and their offspring to escape entrainment.

As described in CWF BA Section 3.3.2.2 *Operational Criteria for South Delta CVP/SWP Export Facilities*, the OMR flow requirements would be governed by the existing 2008 Service BiOp and 2009 NMFS BiOp (near-term) until they are replaced by the new long-term operations and/or subsequent CWF consultations. As described in the CWF BA, the proposed operational criteria would generally improve OMR flows in wetter years compared to the existing BiOps (CWF BA 2016). Real-time management of entrainment risk would also occur, as needed, in a manner similar to the existing determination process or may be modified in the reinitiation process (see *Existing Conditions and Previous Consultations in the Action Area*).

During the months of December through June, additional protections may be implemented during RTO to protect pulses of Chinook salmon migrating down the mainstem of the Sacramento River, which will result in a reduction in water exports at the NDD (refer to the revised May 5, 2017 *BiOp Resolution Log*). CalSim II and the subsequent step-down analyses were not modeled to capture these changes in future decisions during RTO based on fish presence. During RTO, there is a potential for there to be a shift in exports between the CVP and SWP facilities (NDD and south Delta) that could increase south Delta water exports in such a way that would reduce the minimized risk of entrainment footprint expected to occur in the south Delta.

Subsequent consultation will occur related to those CWF activities subject to future Federal approvals, such as the dual conveyance operations, in which Reclamation and DWR have committed to analyze and further address species effects from CWF operations at that time (refer to the *Consultation Approach* section of this BiOp). Additionally, implementation of Guiding Principle 2, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to facilitate operating CWF in coordination with the CVP and SWP water exports in the south Delta to minimize entrainment of migrating and spawning delta smelt and larval/juvenile delta smelt. This Guiding Principle will ensure that as future development of operational criteria occurs, minimization of entrainment of delta smelt during these critical life stages will be incorporated.

Predation Risk

Predation probably kills a large proportion of adult delta smelt before they reach the fish facilities or the export pumps (Castillo *et al.* 2012), reducing the number of delta smelt salvaged at the facilities. To the extent that the adaptive management measure of localized reduction of predatory fishes through electrofishing reduces predator abundance in CCF, predation risk to adult delta smelt could be reduced under the PA (refer to *Adaptive Management Program*). However, there is uncertainty in the efficacy of localized reduction of predatory fishes, given that previous efforts did not yield measurable changes in predator population size within the Forebay (Brown *et al.* 1996). Predatory fish removal in CCF has the potential to increase the number of entrained delta smelt that show up in salvage.

Operations of the new facilities within and near the CCF may increase or decrease the number of delta smelt salvaged at the existing CVP and SWP pumping facilities by way of changes in predation rates in the CCF. There are limitations to this delta smelt effects analysis based on the information provided to the Service in the CWF BA, along with best available scientific information not being sufficient to determine how salvage estimates or predation rates in the

CCF of the existing CVP and SWP pumping facilities will be affected by the implementation of the PA.

9.2.2.2.5 Head of Old River Gate

HORG operations will be managed in real-time to balance water level needs of south Delta farmers, water quality and circulation patterns in the south Delta, and to increase operational flexibility of the CVP and SWP to improve the survival of federally-listed salmonid fishes. The HORG will replace the annual installation and removal of the rock barrier used to guide the emigration of salmon and steelhead. Depending on timing of the operations, there is the potential to influence entrainment of delta smelt larvae, but this effect will be minimized by the OMR flows described in the BA (CWF BA 2016). The potential effects of the HORG are similar to effects analyzed previously by the Service for the south Delta Temporary Barriers Project. Unlike the rock barrier, HORG operations would occur in the context of real-time changes in gate position concurrent with north and south Delta exports to meet the OMR flows specified in the BA. Effects to delta smelt will be minimized through the real-time management of OMR flows and HORG operations that will limit the entrainment of adult, larval, and young juvenile delta smelt into the south Delta.

Entrainment and Predation Risk

As previously noted by the Service (2008), there is potential for negative effects to delta smelt from operation of the HORG. A HOR barrier or gate does not alter total Delta outflow, or the position of X2. However, it would cause changes in the hydraulics of the interior Delta, which may affect delta smelt. The barrier/gate prevents San Joaquin River water from flowing into Old River at the HOR junction. This increases the flow toward Banks and Jones from Turner and Columbia cuts, which can result in more negative OMR flows and increase the predicted entrainment risk for particles (simulating larvae) in the east and central Delta by up to about 10% (Kimmerer and Nobriga 2008). The directional flow towards Banks and Jones increases the vulnerability of delta smelt to entrainment. Larval and juvenile delta smelt are especially susceptible to these flow changes.

There is the potential for the HORG to result in short-term negative effects to delta smelt by influencing the hydraulics of Old and Middle river (Service 2008). However, the general improvements to OMR flows resulting from lower proposed south Delta exports, combined with the flexibility to manage the proposed HORG in real time would limit the potential for adverse effects. If necessary, opening and closing of the HORG could be done in consideration of fish distribution and simulation (*e.g.*, PTM) modeling; adjustments to south Delta exports could then be implemented to avoid short-term increases in entrainment.

In addition to broad-scale effects of the HORG on south Delta hydrodynamics, there may be localized effects on migrating adult delta smelt that are further described in Section 9.2.2.1.4 of this BiOp. Studies of the rock barrier installed at the HOR in 2012 suggested the structure created eddies that could have resulted in elevated predation on juvenile salmonids (DWR

2015a); we deduce that similar effects could also occur to delta smelt as a result of HORG operations.

9.2.2.2.6 Delta Cross Channel

The DCC gates are used to increase the flow of Sacramento River water toward the south Delta pumping plants. This improves water quality in the southern Delta (*i.e.*, it lowers salinity elevated by agricultural return flow in the San Joaquin River). The DCC has operable gates that are closed to limit flooding during periods of high river flow and more recently to limit the entrainment of juvenile salmonid fishes into the San Joaquin River and south Delta (per D-1641 and 2009 NMFS BiOp). The entrainment of salmonid fishes into the DCC and points south increases their migration path length, which is thought to increase the cumulative predation loss experienced by smolts (CWF BA). It also increases entrainment in the south Delta if exports are sufficiently high (Kimmerer 2008).

It is unknown what, if any, direct impacts occur to delta smelt as a result of opening or closing the DCC gates. Delta smelt move into the area surrounding the DCC during the winter (Figure 9.2.1.2-7), but based on limited collections (Figure 9.2.1.2-6), the Service considers this region a transiently used habitat. It is possible that opening or closing the DCC gates changes the migration path of some delta smelt, but it is not known whether there is a consequence, such as a change in predation risk or likelihood of successful spawning.

The PA proposed no changes to DCC gate operations relative to what was analyzed in the 2008 Service BiOp and 2009 NMFS BiOp (see *Description of the Proposed Action*). The DCC gates are closed for a majority of the period when delta smelt have historically been observed in the vicinity of the DCC (*i.e.*, during winter dispersal/migration and springtime spawning). Local predation impacts in the Sacramento River, Georgiana Slough and Mokelumne River branches are anticipated to be similar to existing conditions that were analyzed in the 2008 Service BiOp.

Entrainment and Predation Risk

Given that the main effect of DCC operations would be to manage the quantity of Sacramento River flow entering the interior (central and south) Delta, there will be minimal effects to delta smelt when present due to the proposed gate closure schedule for fishery protection. Closures of the DCC for juvenile salmonid protection are likely to create more natural hydrologies in the Delta, by keeping Sacramento River flows in the Sacramento River and Georgiana Slough, which provide flow cues for migrating adult delta smelt (Service 2008). Closure of the DCC would occur during most, if not all, of the December-March upstream migration period of adult delta smelt, and essentially would not differ between the projected conditions under existing regulations and the PA (see Table 5.A.6-31 in CWF BA Appendix 5.A *CALSIM Methods and Results*). DCC closure for downstream flood control will be based on Sacramento River flow at Freeport upstream of the NDD facilities.

The effects of the DCC on Delta hydrodynamics are included in the CalSim II modeling results and are discussed in Section 9.2.2.2.10 below. In the fall, the DCC may be open somewhat more often under the PA (see Section 6.1.3.3.1.4 of this BiOp). This is because of several operational criteria described in Section 5.A.5.1.4.2 of the CWF BA Appendix 5.A *CALSIM Methods and Results*. The CalSim II modeling showed that in September, in approximately 20% of years, sufficient water was exported by the NDD and the 25,000-cfs threshold for closure of the DCC is not exceeded, whereas it is exceeded under the NAA in the same years and results in closure of the DCC more than under the PA (see Table 5.A.6-31 in CWF BA Appendix 5.A). Additionally, in October-November, reservoir releases later in the year under the NAA triggered the 7,500-cfs Sacramento River at Wilkins Slough threshold assumed to coincide with juvenile salmon migration into the Delta, which resulted in a greater number of days with DCC closed under the NAA. Last, the DCC may also have been open more under the PA to maintain water quality conditions per D-1641 (Rock Slough salinity standard). However, given that most juvenile delta smelt would be expected to be in the LSZ or in the Cache Slough area during this period, any effects are expected to be limited; the extent and location of the LSZ would not differ between projected conditions under existing regulations and the PA during September-December, as shown in the analysis of abiotic habitat for juvenile delta smelt (see CWF BA Section 6.1.3.5.1.1).

There could be times when the DCC closure affects larval/juvenile delta smelt by generating flows that draw them into the south Delta. Any effects of the DCC are captured in the PTM modeling that was undertaken for the south Delta water facilities above to report entrainment effects. There would be little to no difference in the DCC gate openings/closures (*i.e.*, operations) between the projected conditions under existing regulations and the PA, with the DCC only being open for an average of 5 days more under PA in wet years (see CWF BA Table 5.A.6-31 in Appendix 5.A *CALSIM Methods and Results*).

9.2.2.2.7 Suisun Marsh Facilities

The Suisun Marsh Facilities are the Suisun Marsh Salinity Control Gates (SMSCG), Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall. The SMSCG are used to freshen water in Suisun Marsh, using ebb tide flows from the Sacramento River. The distribution systems are used to divert water from major sloughs and distribute that water to duck clubs and other wetland tracts throughout the marsh. Roaring River, which is a screened intake, takes water from the eastern part of Montezuma Slough. Morrow Island, which is an unscreened intake, takes water from Suisun Slough.

Suisun Marsh Salinity Control Gates

No changes in the operational criteria for the SMSCG are proposed. The gates will be closed up to 20 days per year from October through May.

Entrainment, Impingement, and Predation Risk

The SMSCG are generally operated, as needed, from September through May to meet the SWRCB's D-1641 salinity standards in the Suisun Marsh. The number of days the SMSCG are operated in any given year varies depending on hydrology (*i.e.*, more days of SMSCG operation are generally required in drought years, and in wetter years, DWR may not need to use them at all). Historically, the SMSCG were operated for 60-120 days between October and May (during 1988-2004). However, evaluation of the effectiveness of the SMSCG has resulted in it being used less frequently since 2004. The effects of the SMSCG operations on the delta smelt were addressed in the 2008 Service BiOp. The Service's primary concern at the time was that operation of the SMSCG might block part of the spawning migration into the Delta. However, it is now recognized that the delta smelt may use Montezuma Slough as a spawning habitat and frequently use it as a larval and juvenile rearing habitat, which lessens the concerns that were described in 2008.

Under current operations, it is possible for a delta smelt to be entrained into Montezuma Slough when the SMSCG is opened and then closed especially during the late summer and fall when the gates are most likely to be used. It is unknown whether this harms delta smelt. It is possible that striped bass aggregate near the SMSCG, which could elevate predation rates. It is also possible that delta smelt face an increased risk of entrainment into the managed marshes where they would be unlikely to survive (Culberson *et al.* 2004; Service 2008). However one recent study found that the body condition of delta smelt collected from Suisun Marsh was better than at other locations (Hammock *et al.* 2015). The degree to which movement of delta smelt around the LSZ is constrained by opening and closing the SMSCG is unknown.

The operation of the SMSCG can have a small effect on X2, causing it to shift eastward (Service 2008). The modeling for the PA meets D-1641 salinity standards for Suisun Marsh and the fall X2 RPA element in the Service's 2008 BiOp. That said, lower summer outflows were a CalSim II model result in the PA. That could lead to an increase in the use of the SMSCG by ~10-20 days per year. Because of the lower Delta outflows modeled for the PA during the summer months, salinity in Suisun Marsh is anticipated to increase during July-September to levels that would limit use by delta smelt below baseline if the SMSCG are not operated at a higher frequency to offset this modeled effect.

<u>Roaring River Distribution System</u>

The Roaring River Distribution System (RRDS) will continue to operate as identified in the 2008 Service BiOp. There are no operational changes proposed for the RRDS water intake. It is screened and operated to maintain an approach velocity of 0.2 fps to minimize effects to delta smelt from entrainment, impingement, and screen contact. Any effects on larval/young juvenile delta smelt from the RRDS that occur would be expected to be similar between existing conditions and PA, and would represent a continuation of existing regulated operations.

Entrainment, Impingement, and Predation Risk

The RRDS's water intake (eight 60-inch-diameter culverts) is equipped with fish screens (3/32-inch opening, or 2.4 mm) operated to maintain screen approach velocity of 0.2 fps to minimize effects to delta smelt from entrainment and impingement, so that any potential adverse effects to individual migrating adult delta smelt would be minimal.

Based on the RRDS screen specifications and applying the methods used for the NDD (Appendix 6.A, *Quantitative Methods for Biological Assessment of Delta Smelt*, Section 6.A.2.2), individual larval and young juvenile delta smelt smaller than 30 mm (SL) total length could be susceptible to entrainment by the three RRDS intake culverts. Slightly larger juveniles and large adults could be impinged on the screens.

Any effects on larval/young juvenile delta smelt from the RRDS that occur would be expected to be similar between existing conditions and PA, and would represent a continuation of existing operations. As previously noted, flows in Montezuma Slough as a result of SMSCG operations were similar for existing conditions and the PA. Entrainment risk into RRDS appears limited, given that DSM2-PTM modeling for the CDFG (2009b) longfin smelt incidental take permit application did not predict any particles entering RRDS. Therefore, the population-level effect of the RRDS is expected to be minimal.

Morrow Island Distribution System

The Morrow Island Distribution System (MIDS) will continue to operate as identified in the 2008 Service BiOp. No changes in operations are proposed. Any effects on larval/young juvenile delta smelt from the MIDS that occur would be expected to be similar between existing conditions and PA, and would represent a continuation of existing, permitted operations.

Entrainment, Impingement, and Predation Risk

Individual delta smelt could be entrained by the three unscreened 48-inch intakes that form the MIDS intake. However, Enos *et al.* (2007) noted that this would generally only occur in wet years, per Hobbs *et al.* (2005). Enos *et al.* (2007) noted that under normal operations, MIDS is often closed or diversions are small during spring, which may provide some protection of spring-spawning and spring-migrating fish, particularly open-water fish like delta smelt that do not congregate around in-stream structures such as diversions. Enos *et al.* (2007) did not collect any delta smelt during sampling of the MIDS intake in 2004-2006, although they did capture adult delta smelt with purse seines during sampling in the adjacent Goodyear Slough. The population-level effects of the MIDS to adult delta smelt would be minimal, if any, given that entrainment would only be expected to occur in wet years.

As noted by in the 2008 Service BiOp, entrainment into MIDS may be unlikely based on particle tracking studies that have demonstrated low entrainment vulnerability for particles released at random locations throughout Suisun Marsh (3.7%), and almost no vulnerability (<0.1%) to particles released at Rio Vista (Culberson *et al.* 2004). This suggests a minimal population-level adverse effect, which would be similar under NAA and PA (see Tables 5.B.5-31, 5.B.5-32, and 5.B.5-33 in Appendix 5.B, *DSM2 Modeling and Results*).

Goodyear Slough Outfall

Gates will continue to be closed up to 20 days per year from October through May. No changes in gate operations are proposed.

Entrainment, Impingement, and Predation Risk

Opening of the Goodyear Slough outfall culvert flap-gates results in a small southern net flow, with fresher water from Suisun Slough being drawn into Goodyear Slough. In most years, Goodyear Slough is too salty for delta smelt, so they do not often occupy the Slough where they would risk entrainment.

As discussed previously for MIDS, the available sampling data in the area suggest that migrating adult delta smelt would only be susceptible to effects from the Goodyear Slough outfall in wet years (Enos *et al.* 2007), and a minimal population-level effect would therefore be likely to occur, with this effect being common to NAA and PA based on similar flows in Goodyear Slough (see Table 5.B.5-34 in Appendix 5.B, *DSM2 Modeling and Results*).

9.2.2.2.8 North Bay Aqueduct Intake at Barker Slough

No changes in operational criteria are proposed. Operations will continue as identified in the 2008 Service BiOp. The Barker Slough Pumping Plant diverts water from the Cache Slough Complex, which is one of several key delta smelt spawning regions. Adult and larval fish densities in the greater area are among the highest observed. The fish screens protect the adults from entrainment, but it is not known how well they protect larvae. Any effects on larval/young juvenile delta smelt from the diversions to NBA that presently occur would be expected to be similar between existing conditions and PA, and would represent a continuation of existing regulated operations.

Entrainment, Impingement, and Predation Risk

The SWP's Barker Slough Pumping Plant is a screened water diversion that is used to export water to the North Bay Aqueduct serving parts of the northern San Francisco Bay Area (Napa and Solano counties). Maximum pumping capacity is 175 cfs (pipeline capacity). Past daily pumping rates have ranged between 0 and 140 cfs (Service 2008). The NBA Intake is located approximately 10 miles from the mainstem Sacramento River at the end of Barker Slough. Each of the ten NBA pump bays is individually screened with a positive fish screen consisting of a series of flat, stainless steel, wedge-wire panels with a slot width of 3/32 inch. This configuration is designed to exclude delta smelt larger than 25 mm and as such is expected to exclude migrating adult delta smelt from being entrained by the NBA (Service 2008). The bays tied to the two smaller units have an approach velocity of about 0.2 fps, minimizing entrainment of larvae and impingement of larger delta smelt through implementation of the operational criteria (Service 2008).

Historical catch data indicate that delta smelt in Barker Slough has been consistently very low, indicating that a relatively small portion of the delta smelt population in this region is susceptible to NBA diversions. NBA diversions do not appear to have had a substantial effect on delta smelt (Service 2008). Pumping rates at the NBA Barker Slough Intake generally would be similar to what was described in the 2008 Service BiOp, so the potential risk of entrainment, impingement, and predation above what has already been analyzed will be minimal. It is expected that the effects to delta smelt will continue to be relatively low under the PA.

9.2.2.2.9 Other Facilities (*i.e.,* Contra Costa Water District Facilities, Freeport Intake, and Clifton Court Forebay Aquatic Weed Control Program)

The CWF BA describes other facilities as: the Contra Costa Water District Facilities, Freeport Intake, and the CCF Aquatic Weed Control Program.

9.2.2.2.9.1 <u>Contra Costa Canal Rock Slough Intake</u>

Water exports for the Contra Costa Water District Facilities are represented in the hydrologic modeling of the PA and included in the baseline conditions (reflected as the NAA in the CWF BA). No changes in operational criteria are proposed to the facilities in the PA. Operations will continue as identified in the 2008 Service BiOp.

Entrainment, Salvage, and Predation Risk

The 1.75-mm-opening, 0.2 fps-approach-velocity fish screen installed at the Rock Slough intake is intended to prevent entrainment of delta smelt into the Contra Costa Canal. However, the 4 mechanical rakes making up the screen cleaning system are unable to handle the large amount of aquatic vegetation on the fish screen, leading to operation of the fish screen only during ebb tides. At these times, migrating adult delta smelt could be susceptible to entrainment. The operational issues with the fish screen have led Reclamation to test alternative technology (a prototype rake) to improve vegetation removal, an action that NMFS (2015a) concluded would improve fish protection (*i.e.,* screen efficiency) by minimizing the chance a listed fish would be entrained or impinged on the fish screen. In addition, mechanical removal of aquatic weeds within Rock Slough in 2015 to facilitate testing of the new rake design was expected by NMFS (2015b) to improve screen efficiency, reduce predation of listed fish species by vegetation-associated predatory fishes, and reduce fish mortality during screen maintenance.

The 2008 Service BiOp noted that Rock Slough is a dead-end slough with poor habitat for delta smelt, so the numbers of delta smelt using Rock Slough are usually low, as reflected in very few delta smelt having been collected during sampling at the intake. This, combined with relatively small diversions that are similar between the PA and projected conditions, suggests that any population-level effect of the Rock Slough intake on delta smelt would be minimal.

9.2.2.2.9.2 Freeport Intake

The PA proposes no changes in water diversions associated with the Freeport Intake.

Entrainment, Impingement, and Predation Risk

The 1.75-mm-opening, 0.2 fps-approach-velocity fish screen installed at the Freeport Intake is intended to prevent entrainment of delta smelt from water diverted at this facility. Water diversions are not proposed to change from current operations and would be very similar between the baseline and PA for all life stages of delta smelt. The PA does not propose to change operations of the Freeport Intake. As indicated in Sections 9.2.2.1.3 and 9.2.2.3 related to low numbers of delta smelt in the vicinity of the upper Sacramento River reach and furthermore based on the analysis in Section 9.2.2.1.3 in this BiOp, we expect entrainment rates of larval delta smelt at the Freeport Intake to be similar or decreased from what is observed in the baseline.

9.2.2.2.9.3 Clifton Court Forebay Aquatic Weed Control Program

DWR will apply herbicides or will use mechanical harvesters on an as-needed basis to control aquatic weeds and algal blooms in CCF. Herbicides may include Komeen®, a chelated copper herbicide (copper-ethylenediamine complex and copper sulfate pentahydrate) and Nautique®, a copper carbonate compound. These products are used to control algal blooms that can degrade drinking water quality through tastes and odors and production of toxins. Dense growth of submerged aquatic weeds, predominantly *Egeria densa*, can cause severe head loss and pump cavitation at Banks Pumping Plant when the stems of the rooted plants break free and drift into the trashracks. This mass of uprooted and broken vegetation essentially forms a watertight plug at the trashracks and vertical louver array. The resulting blockage necessitates a reduction in the pumping rate of water to prevent potential equipment damage through cavitation at the pumps. Cavitation creates excessive wear and deterioration of the pump impeller blades. Excessive floating weed mats (mostly water hyacinth) also reduce the efficiency of fish salvage at the Skinner Fish Facility. Ultimately, this all results in a reduction in the volume of water diverted by the SWP. Herbicide treatments will occur only in July and August on an as needed basis in the CCF, dependent upon the level of vegetation biomass in the enclosure.

Entrainment, Impingement, and Predation Risk

Because delta smelt within CCF are already entrained and have a nearly 100% mortality rate (Castillo *et al.* 2012), the application of herbicides does not change the impact to the species, though it could have some effect on observed salvage if the fish receive acutely toxic doses of these chemicals.

9.2.2.2.10 Effects to Habitat

Salinity

Conceptually, the freshwater flow regime and its interaction with the system bathymetry and landscape affect the quantity and quality of available habitat (*e.g.*, Peterson 2003). Freshwater flow into and through the Delta is subject to State and Federal regulations. The SWRCB's D-1641 has regulations that apply all year, and include fish protection flows during February-June. The Delta outflow (or X2) regulations in D-1641 vary depending on intra- and interannual changes in watershed hydrology. During very wet periods, X2 may need to be held near 65 km, and under lower flows it must be held near 74 km. During droughts, it can be allowed to move east to about 81 km. During the recent extreme drought, the SWRCB authorized the CVP and SWP to allow movement even further east than the 81-km requirement.

The 2008 Service BiOp's RPA action to increase Delta outflow in the fall following wet and above normal years was based on specific criteria for X2. X2 was used because it is a measurable objective with gaging stations that existed at the time the 2008 Service BiOp was written. This action aimed to restore a greater extent of fall habitat for juvenile delta smelt following wetter years in order to counteract a trend toward lower variability and smaller size of the low-salinity zone during fall of recent years (Feyrer *et al.* 2011; Cloern and Jassby 2012; Bever *et al.* 2016). The fall is a naturally lower flow period than the February-June timeframe covered under D-1641's X2 regulations. Therefore, the fall X2 location is 74 km in wet years and 81 km in above-normal years. Drier years do not have a fall X2 requirement. The PA includes the fall X2 action of the 2008 Service BiOp RPA.

When X2 is near 74 km (~ Chipps Island), the LSZ encompasses most of Suisun Bay enabling delta smelt to broadly occupy the entire Suisun Bay region. When X2 is near 81 km, the LSZ only encompasses Honker Bay in eastern Suisun Bay and the Sacramento-San Joaquin River confluence. This restricts delta smelt distribution somewhat, but still enables them to occupy fairly large open water areas and Montezuma Slough. Based on recent three-dimensional modeling, once X2 moves east of 85 km, the LSZ is entirely east of Suisun Bay and delta smelt distribution is essentially restricted to the legal Delta which has lower bathymetric variability, and warmer and clearer water in most places than Suisun Bay. Contemporary prey densities in the Delta are comparable or higher than in Suisun Bay, though not Suisun Marsh. However, delta smelt may be less able to evade predators in the relatively channelized and more transparent waterways of the Delta.

Research focused on the fall has shown that increases in outflow cause low-salinity water to overlie areas with appropriate tidal current velocity and turbidity, improving habitat conditions for delta smelt (Bever *et al.* 2016). The physical flow mechanisms described for the fall would also apply to the summer months. The quality of habitat for delta smelt is affected by where low-salinity water intersects with the estuary landscape. This is due to the shape of the Delta, which consists mostly of deep canals east of the Sacramento-San Joaquin River confluence. At and west of the confluence, there is much more variable depths particularly where water is just a few meters deep. These semi-shallow areas often have higher turbidity, less submerged vegetation, and more variability in water velocities that delta smelt can exploit. During summer and fall in particular, delta smelt tend to aggregate in the LSZ. Thus, if outflow is high enough to keep the tidal movement of X2 over the semi-shallow Suisun Bay and river confluence region, the intersection of low salinity water with best available bathymetry occurs.

Quality and quantity of summer and fall habitat can affect pre-spawning and spawning adult abundances (IEP 2015), important for subsequent cohort strength. As described in the 2008 Service BiOp, during the fall (September-December) delta smelt are maturing pre-adults that rely heavily on suitable habitat conditions in the low salinity portion of the estuary. The 2008 Service BiOp briefly defined suitable habitat for delta smelt during this time period as "the abiotic and biotic components of habitat that allow delta smelt to survive and grow to adulthood: biotic components of habitat include suitable amounts of food resources and sufficiently low predation pressures; abiotic components of habitat include the physical characteristics of water quality parameters, especially salinity and turbidity."

When X2 moves eastward into the Delta channels, this intersection occurs much less frequently and delta smelt are more likely to be harmed by poor habitat conditions (*e.g.*, elevated vulnerability to predators, greater exposure to *Microcystis* blooms, greater temperature stress, etc.). Therefore, for those instances where the PA results in eastward movement of X2, we would expect to see population-level effects more adverse than in the baseline conditions from effects of reduced habitat availability (*i.e.,* habitat contraction). As noted by Feyrer *et al.* (2007; 2011), analyses conducted over this rearing phase of the delta smelt life cycle provide support for a population-level effect from degraded fall habitat conditions or negative changes in indicators of those conditions, such as eastward movement of X2. In addition, analyses by Miller *et al.* (2012) and Rose *et al.* (2013a, b) suggest that prey density and food supply limitation during this part of the life cycle may also have population-level effects on delta smelt.

On average there are minor changes observed in the location of X2 during the fall as a result of the PA; however, by examining hydrological data across WY types on a monthly average for July, August, September, October, November, and December, greater resolution is possible (see Appendix B).

Under the PA, water exports are increased during the summer months to meet water demand (see Appendix B). September and October during the wet and above normal WY types are operated to meet the fall X2 requirement from the 2008 Service BiOp, resulting in no discernable change in the location of X2 in Septembers and Octobers of wet and above normal WY types between the PA and the future projected baseline conditions (see Figure B-36 and Figure B-40 of Appendix B).

Appendix B provides results of CalSim II modeling for X2 over 82 years for the PA and the projected baseline condition in kilometers for all months. These plots indicate that the PA will further erode juvenile rearing critical habitat by moving X2 further eastward by as much as 5 km compared to current conditions. In July and August, the LSZ is consistently predicted to move eastward from current conditions (see Figure B-27 and Figure B-31 of Appendix B). Under the PA, CalSim II predicts X2 in August will be greater than 84 km 94% of the time (77 of 82 years modeled). In contrast, under the current projected baseline, X2 in August will be higher than 84 km 71% of the time (58 of 82 years modeled). The location of the LSZ is important in determining the quality, both extent and suitability, of juvenile rearing habitat. During juvenile rearing from July through December, eastward movement of the LSZ degrades rearing habitat by reducing the overlap of favorable salinity conditions with food, water depths, and wind-driven turbidity of Suisun Bay. At or above 84 km, the LSZ is upstream of Chipps Island, and entirely out of Suisun Bay and the suitable habitat conditions it provides.

Adults seek fresher water during the migration season (December through March). Under the PA, on average in December through March, there are differences in the location of X2, but no major shifts in the distribution of habitat. The proposed longfin smelt spring outflow criteria will establish target outflow requirements for the months of March, April, and May that maintain outflow levels consistent with existing conditions. The proposed longfin smelt spring outflow criteria will determine protective outflows from March 1 through May 31 every year by using lookup tables derived from a linear relationship between the estimated current month's 8RI at the ELT level and recent historic Delta outflow (1980 – 2016). Reduction in exports down to minimum health and safety requirements established in D-1641 (currently 1,500 cfs) may be necessary.

Implementation of Guiding Principle 1, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to improve habitat conditions for rearing juvenile delta smelt, which may include locating the LSZ in suitable areas of the estuary. This Guiding Principle is intended to minimize adverse effects to delta smelt from operations of a dual conveyance system. Future actions, including operational criteria, will be designed and implemented to minimize the effects of habitat contraction created by the PA's operational scenario. Thus, the adverse effects of habitat contraction are anticipated to be minimized in any future operational scenario.

Water Temperature

Water temperature in the San Francisco Estuary is driven mainly by air temperature, and even in the Delta the relationship between air and water temperature is only slightly affected by fresh water inflow. Kimmerer (2004) noted that at Freeport, high inflow reduces water temperature on warm days, presumably because water reaches the Delta before its temperature equilibrates with air temperature. At Antioch, low inflow increases water temperature on cool days, probably because of the moderating effect of warmer estuarine water moving farther upstream (Kimmerer 2004). The Service (2008) suggested, based on Kimmerer (2004) that water temperatures at Freeport can be cooled up to about 3°C by high Sacramento River flows, but only by very high river flows that cannot be sustained by CVP and SWP operations. In general, flow-related effects on Delta water temperature are expected to be minor (Wagner *et al.* 2011). Specifically, Delta water temperatures are primarily driven by same day air temperatures and water temperatures the previous day (Wagner *et al.* 2011).

Changes in water temperatures under the PA were investigated in the CWF BA using DSM2-QUAL modeling. DSM2-QUAL modeling was performed to predict water temperatures for the projected baseline conditions and PA scenarios at four locations: Sacramento River at Rio Vista, San Joaquin River at Prisoners Point, Stockton Deep Water Ship Channel, and San Joaquin River at Brandt Bridge. Detailed methods are presented in Attachment 5.B.A.4, *DSM2 Temperature Modeling*, of Appendix 5.B *DSM2 Methods and Results*, with results in Section 5.B.5, *DSM2 Results*, of the same appendix. Effects of the PA, as described in CWF BA Appendix 5.B on water temperatures, are likely too small (less than 1 °C) to be resolved with available modeling tools.

The Rio Vista and Prisoners Point stations are of highest relevance to delta smelt. From examination of exceedance plots of Rio Vista mean water temperatures (Figure 5.B.5.40-1 in Appendix 5.B *DSM2 Methods and Results*, Section 5.B.5), the only discernible differences in water temperature were in March, and these were small differences (~0.1°C greater under PA than under projected baseline conditions). At Prisoners Point (Figure 5.B.5.41-1 in Appendix 5.B, Section 5.B.5) differences were evident in January-March, presumably as a result of the HORG retaining a greater proportion of slightly warmer San Joaquin River water in the main stem, combined with less Sacramento River inflow entering the interior Delta. Differences in March were 0.3–0.4°C. Although differences in water temperature between projected baseline conditions and the PA were modeled, these were during a relatively cool part of the year and are not expected to have significant effects on migrating adults in that portion of the Delta.

Delta smelt may begin spawning in the San Joaquin River in February, and spawn during March in most years (see California Department of Fish and Wildlife Spring Kodiak Trawling Data at https://www.wildlife.ca.gov/Conservation/Delta/Spring-Kodiak-Trawl). Previously published modeling studies have indicated that warmer temperatures (caused by climate change) would tend to result in earlier spawning (Wagner *et al.* 2011; Brown *et al.* 2013). Earlier spawning could result in spawning adults being smaller in size, as they would have had less time to grow to maturity (Brown *et al.* 2013). Migrating adult delta smelt may experience slightly warmer temperatures in the lower San Joaquin River, but these temperatures would be expected to be within the tolerance of the species and are not expected to have any population-level impact.

The recent simulation-based life cycle modeling by Rose *et al.* (2013a, b) indicates that egg production has been a major factor affecting delta smelt abundance. Climate change is anticipated to warm Delta water temperatures and could affect the length of time that delta smelt reach adulthood (Brown *et al.* 2013). If this occurs, it would affect egg production. As described above, it is uncertain whether the PA will affect water temperature in the Delta. If it does, that effect would be minor and localized.

The slightly greater Prisoners Point water temperature under the PA that was estimated by DSM2-QUAL could result in shorter embryo incubation time, as well as slightly lower or higher hatching success, depending on the month. The effects would be limited to the portion of the delta smelt population occurring in the San Joaquin River.

Most delta smelt hatch during March-May. In warm years, hatching can begin in February and in cool years it can extend at least into June. Bennett (2005) reviewed delta smelt embryo and larval survival data from laboratory studies and found that optimal hatching occurred at 15–17°C.

River flows tend to have a minor influence on water temperatures in the Delta except at the inflowing river margins (Kimmerer 2004; Wagner *et al.* 2011). The general pattern for Prisoners Point in March suggests that the greater water temperature under the PA would be a slightly more optimal hatching temperature than under the NAA (Figure 5.B.5.41-1 in Appendix 5.B *DSM2 Methods and Results*, Section 5.B.5). In May, temperatures under the PA may be marginally less optimal compared to projected baseline conditions, although these differences were small. Bennett (2005) also noted that incubation time of embryos decreases with increasing water temperature, from around 18 days at 10°C to 9 days at 15°C and 7 days at 20°C. For example, a 0.3°C greater water temperature under PA could result in a 0.5-day shorter incubation time for delta smelt occurring in the lower San Joaquin River.

Bennett's (2005) review of the laboratory studies on water temperature effects on larval delta smelt found that greater water temperature leads to smaller larval length at egg hatching and smaller larval length when first ingesting food. The marginally higher water temperatures estimated under the PA at Prisoners Point could result in delta smelt that are slightly smaller, although the differences between scenarios were small. There could be several effects to delta smelt from smaller size (IEP 2015). First, small size would result in small gape size, which would limit the size of prey items that could be eaten. Second, there may be vulnerability to a wider range of predators. Third, smaller larvae could be more susceptible to hydrodynamic transport toward the south Delta export facilities. Bennett (2005) noted that there is higher mortality of larvae above 20°C. The DSM2-QUAL modeling data for Prisoners Point in June suggested that there could be an increase in the number of days in this range (Figures 5.B.5.41-3 to 5.B.5.41-6 in Appendix 5.B *DSM2 Methods and Results,* Section 5.B.5).

Overall, the DSM2-QUAL analysis suggested that there may be slightly lower larval delta smelt survival in the lower San Joaquin River because of slightly higher water temperature. This would affect the portion of the population occupying this area. Data from the 20-mm surveys indicate that larval delta smelt occur in this area (see Table 7 of Merz *et al.* 2011).

Water temperatures above 20°C become increasingly stressful to juvenile delta smelt up to the lethal range (~25–29°C; Swanson *et al.* 2000; Komoroske *et al.* 2014).The DSM2-QUAL modeling suggested water temperature would be similar or slightly warmer under the PA compared to NAA, at both the Sacramento River at Rio Vista and San Joaquin River at Prisoners Point from July through September. The differences that occurred in the warmer 50% of the years indicated about 0.1–0.2°C greater temperature under the PA (Figure 5.B.5.40-1 and Figure 5.B.5.41-1 in Appendix 5.B *DSM2 Methods and Results,* Section 5.B.7).

As reviewed by the IEP (2015), high summer water temperature has a negative effect on the delta smelt population, as it has been linked to delta smelt subadult abundance in the fall (Mac Nally *et al.* 2010) and long-term population dynamics (Maunder and Deriso 2011; Rose *et al.* 2013a, b). If a water temperature increase occurs in the summer, it could have small to no adverse effect on the whole delta smelt population, through mechanisms including reduced habitat extent, increased metabolic requirements (reduced energy intake for growth), and greater susceptibility to disease or the effects of contaminants (IEP 2015).

Turbidity (Sediment Removal and Water Clarity)

Water clarity (turbidity) is an important habitat characteristic for delta smelt and is a significant predictor of larval feeding success (by providing a visual contrast to enable the larvae to locate and ingest prey; Baskerville-Bridges *et al.* 2004), predation avoidance (Schreier *et al.* 2016), and juvenile distribution (Nobriga *et al.* 2008; Feyrer *et al.* 2011) that has been correlated to long-term changes in abundance or survival either by itself or in combination with other factors (Thomson *et al.* 2010; Maunder and Deriso 2011). Cloern *et al.* (2011) noted the uncertainty in future turbidity trends in the Delta. It is unclear whether a 40-year average decline in turbidity of 1.6% per year will continue, slow or level off. Should such a trend continue, it presumably will further decrease delta smelt habitat quality (Feyrer *et al.* 2011; Brown *et al.* 2013).

Most sediment entering the Delta comes from the Sacramento River (Wright and Schoellhamer 2004). The NDD is expected to divert a portion of the Sacramento River's sediment load, which could result in higher water clarity downstream overtime. The BDCP public draft included estimates of sediment diverted by the NDD at the late long-term time frame (2060) based on historic sediment load estimates for 1991–2002 (see Section 5C.D.3 in the BDCP public draft, Attachment 5C.D to Appendix 5.C *Upstream Water Temperature Methods and Results*). For the effects analysis of the PA in the CWF BA, very similar analytical methods were used based on sediment load estimates for WYs 1991–2003, matched to CalSim II flow and NDD estimates for the same years. The analysis suggested that the NDD could remove a mean of 10% (range: 5–15%) of sediment load entering the Delta. If the Yolo Bypass contribution was ignored, the estimate increased to 11% (range: 7–16%). If this sediment, some of which would be collected in the sedimentation basins (described in CWF BA Section 3.2.2 *North Delta Diversions*), is not returned to the system, it is possible that water transparency in the Delta will increase over time due to project operations. However, the extent of increases in water clarity cannot be accurately predicted without application of a full suspended sediment model incorporating the whole estuary; modeling has been noted to be necessary for assessment of the effects of managing regional transport of sediment in the Delta (Schoellhamer *et al.* 2012). Thus, there is uncertainty associated with proportional diversion methods as presented in the CWF BA.

The CWF BA analysis did not attempt to provide a quantitative estimate of sediment removal by the south Delta export facilities for the PA; based on the estimates by Wright and Schoellhamer (2005), sediment removal by the south Delta export facilities in 1999-2002 averaged around 2% of the sediment entering the Delta at Freeport, *i.e.*, an order of magnitude less than estimated to be removed at the NDD, so the net sediment removal under the PA (NDD exports plus less south Delta exports from existing conditions) would be expected to be appreciably greater than sediment being removed without the project. As described in CWF BA Section 3.2.10.6 *Dispose Spoils*, DWR will collaborate with Service, NMFS, and CDFW to develop and implement a sediment reintroduction plan that minimized effects of sediment removal by the NDD. The proposed sediment reintroduction is expected to require subsequent future approvals from the Corps or Reclamation, in addition to a permit from the CVRWQCB.

Increases in water clarity during the latter parts of spring when suspended sediment concentration decreases may result in adverse effects to individual delta smelt eggs/embryos by making them more visible to predators. Water clarity is related to larval/young juvenile delta smelt feeding success (Baskerville-Bridges *et al.* 2004) and spatial distribution (Sommer and Mejia 2013). As with eggs/embryos and the latter portion of the spawning adult life stage, the occurrence of larval/young juvenile delta smelt bridges the transition between higher flow during winter months and lower flow during summer months, when the suspended sediment concentration in inflowing Sacramento River water decreases and resuspension of sediment delivered in the higher flow months becomes more important.

Occurrence of juvenile delta smelt during the low-flow time of year when suspended sediment concentration in inflow is at a minimum suggests that the NDD's removal of sediment may adversely affect individual juvenile delta smelt by increasing water clarity, given the importance of resuspension of sediment delivered to the estuary by higher flows in winter/early spring. However, implementation of Guiding Principle 3, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to promote turbidity in geographical areas and during temporal windows that may be expected to increase the extent and quality of delta smelt habitat through commitments made in the CWF PA (*i.e.*, sediment management plan) and through actions described in the Delta Smelt Resiliency Strategy. The Guiding Principles, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, are intended to minimize adverse effects to delta smelt from CWF activities by creating a framework for development and implementation of future CWF actions. The Service anticipates that implementation of a sediment management plan consistent with Guiding Principle 3 will supplement sediment within the Delta to minimize the potential effects of sediment removal analyzed in this BiOp.

Entrainment of Food Web Materials

Because delta smelt is principally an open-water fish, it is reliant on a planktonic food web in which phytoplankton is food for copepods that delta smelt prey upon and in some cases, the phytoplankton is also food for other small planktonic protists eaten by the copepods. As described in the *Status of the Species and its Critical Habitat/Environmental Baseline* section, this food web has changed dramatically over time and is less productive than it once was. There is evidence that this has intensified food limitation in the delta smelt population. The primary mechanisms by which entrainment of planktonic organisms affect individual delta smelt is by temporarily reducing density of zooplankton immediately downstream of the NDD or by reducing the load of phytoplankton further into the estuary, causing unknown reductions in food for the zooplankton eaten by delta smelt.

As highlighted by Arthur *et al.* (1996), Jassby and Cloern (2000) and Jassby *et al.* (2002), and the 2008 Service BiOp, CVP and SWP water exports directly entrain phytoplankton and zooplankton which are the base of the food web supporting the production of delta smelt. Thus, water diversions are one cause of the decline in delta smelt food supply. The export of water containing these organisms is one mechanism and the 'dilution' of relatively productive San Joaquin River water by Sacramento River water that is caused by south Delta exports is a second mechanism (Orsi and Mecum 1986; Jassby and Cloern 2000). Clam grazing and ammonium inhibition of per capita diatom growth rates are other well documented causes of zooplankton decline. Entrainment of phytoplankton and zooplankton by the south Delta export facilities generally would be expected to be reduced under the PA, but the NDD would add a new source of loss along the Sacramento River.

The CWF BA examined effects using an assessment of phytoplankton carbon entrained, based on chlorophyll *a* concentration data for Hood (representing the load of entrained phytoplankton), in relation to the biomass of phytoplankton in the Delta (taken from Antioch chlorophyll *a* data, multiplied up to the volume of the Delta). The methods are presented in the CWF BA Appendix 6.A *Quantitative Methods for Biological Assessment of Delta smelt*, Section 6A.4.2. This analysis is an approximation of potential entrainment of phytoplankton carbon load that could be entrained by the NDD. Factors that could minimize any potential effects to delta smelt include the *in situ* productivity of phytoplankton carbon within the Delta, which could be large, and reduced entrainment of phytoplankton carbon by the south Delta export facilities under the PA. Both were analyzed qualitatively in the CWF BA.

Based on information provided in the CWF BA, median (50^{th} percentile) estimates of phytoplankton carbon load entrained by the NDD ranged from around 0.2 metric tons/day in April and May (5^{th} to 95^{th} percentile ranges were 0.00–0.02 to ~ 1.8 metric tons/day) to ~ 1.6 metric tons/day in February (5^{th} to 95^{th} percentile range ~ 0.13 to 5.7 metric tons/day). Estimates of phytoplankton carbon biomass in the Delta for 2004–2015 ranged from less than 23 metric tons (December 2011) to more than 230 metric tons (May 2010). Thus, the percentage of Delta phytoplankton carbon biomass estimated to be entrained by the NDD ranged from 0.0% based on the 5^{th} percentile of entrained load estimates at the NDD during several months up to 12% at the 95^{th} percentile load estimate combined with the minimum biomass estimate in December. The median estimates of total fraction of phytoplankton biomass removed by the NDD ranged from ~ 0.5% to 2% per month when compared to minimum Delta phytoplankton carbon biomass estimates, down to ~ 0.1% to 1% when compared to maximum Delta phytoplankton carbon biomass estimates. On the basis of the 95^{th} percentiles, it appears that the NDD would seldom if ever entrain more than ~5% of the Delta's standing stock of phytoplankton in any given month. The loss of phytoplankton carbon at the NDD must be considered in the context of all CVP and SWP water diversions because inflows to and exports from the Delta strongly affect the flux of bioavailable carbon into the confluence and Suisun Bay (Arthur *et al.* 1996; Jassby and Cloern 2000). If the NDD were used as the only source of Delta exports and without any change in total Delta exports, plankton production would be expected to increase in the western Delta and Suisun Bay because the San Joaquin River is richer in its organic matter load than the Sacramento River (Jassby and Cloern 2000). The PA does not cease exports from the south Delta, but on average annually reduces reliance on the south Delta exports generally by greater than 50 percent. The long-term (1922–2003) average reduction when compared to baseline conditions from the CalSim II modeling ranged from 45% less under the PA in January to ~70% less in October. Only in December (12% less under the PA) were the differences less than 50% (see CWF BA Appendix 5.A *CALSIM Methods and Results*, Figures 5.A.6-27-1 to 5.A.6-27-19 and Table 5.A.6-27). Jassby *et al.* (2002) estimated that on average during spring through fall, the Delta produces 44 metric tons/day of phytoplankton carbon and another 12 metric tons/day flows into the Delta from its tributaries. Of the total 56 tons/day, the south Delta export facilities remove ~8 metric tons/day or about 14% (Jassby *et al.* 2002)[34]. It is anticipated that the overall long-term ~50% reduction in south Delta exports will increase the loading of relatively productive San Joaquin River water to the western Delta and Suisun Bay and therefore will minimize the loss attributable to the NDD, and perhaps could provide a net increase.

CalSim II estimates of total Delta exports also provide context for the difference in potential food web productivity between PA and baseline conditions: total Delta exports on average (1922–2003) would be greater under PA (averaging almost 4.9 million acre feet/year) than under baseline conditions (averaging about 4.7 million acre feet/year). If phytoplankton availability was a linear function of CVP and SWP exports, then the annual average change in biomass would be approximately -4%. However, the timing of differences in exports in relation to different life stages is important, and consideration should also be made of the different average plankton concentrations in Sacramento and San Joaquin River water as well as the *in situ* productivity that would occur in the Delta.

At the population-level, the effects of entrainment of phytoplankton carbon are likely not important in affecting delta smelt prey abundance. As noted by Baxter *et al.* (2010) and the IEP (2015), there has been little study of prey importance for adult delta smelt, and there is no evidence for food limitation in the adult life stage. However, there may be lower loads of phytoplankton carbon into the estuary because NDD entrainment could translate into less food for individual delta smelt larvae and young juveniles. It was estimated that a range from less than 0.1% to over 5% of phytoplankton carbon entering the Delta could be entrained by the NDD in March–June. However, the phytoplankton has to be converted into copepod biomass to be prey for larval delta smelt and that process is not always directly related to phytoplankton density as indexed by chlorophyll *a* concentrations in the water (Kimmerer 2002b). Given lower south Delta exports when north Delta exports are relatively high, there may be a net increase in phytoplankton carbon production in the Delta due to higher loading from the comparatively productive San Joaquin River that could minimize the loss estimated for the NDD, and perhaps could even provide a net gain in production. Implementation of Guiding Principle 5, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to promote food production and transport into areas where habitat conditions are suitable for delta smelt through commitments made in the CWF PA and through actions described in the Delta Smelt Resiliency Strategy. Pursuant to the Delta Smelt Resiliency Strategy, DWR and Reclamation have begun testing actions to focus on the issue of food production and availability of food supply in the estuary. This Guiding Principle is anticipated to minimize effects of the PA operational scenario by guiding development and

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[34] An additional ~5 metric tons per day were estimated to be removed by agricultural diversions. Such losses would present under both the projected baseline conditions and PA.

implementation of actions designed to promote food production and transport into areas with suitable habitat conditions accessible to delta smelt.

Microcystis

The toxin-producing cyanobacteria has been shown to have negative effects on the aquatic foodweb of the Delta (Brooks *et al.* 2012), principally in the south Delta, Antioch, and Franks Tract (Lehman *et al.* 2010). As reviewed by Brooks *et al.* (2012), *Microcystis* can directly affect delta smelt that consume prey containing high concentrations of toxins which can affect growth, survival and reproduction of delta smelt. Microcystis blooms can also indirectly affect delta smelt through alteration of their habitat, toxic effects to copepod prey and alteration of phytoplankton communities (Brooks *et al.* 2012). Blooms occur mostly from June to October, when water temperatures reach at least 19°C (Lehman *et al.* 2013) but can begin as early as May and extend into December if conditions are favorable. Delta smelt juveniles are most likely to experience detrimental effects because this life stage overlaps with the majority of observed blooms. It is important to note that while *Microcystis* blooms have negative effects on the aquatic ecosystem, blooms do not always produce toxins (Bozarth *et al.* 2010).

Microcystis bloom formation is not well understood but several factors have been identified in their growth and formation. Lehman *et al.* (2013) suggested that net flows are a significant factor in maintaining *Microcystis* blooms in the Delta because low flows and their resulting longer water residence times allow the slow-growing colonies to accumulate into blooms.

In addition to water movement, water temperature, turbidity and nutrient concentration are also implicated in the frequency, duration and intensity of *Microcystis* bloom formation (Lehman *et al.* 2013). Each of these factors is expected to change in the near future, independent of the PA, in ways that will affect the likelihood of future bloom formation. Water temperatures are predicted to warm in the future with climate change, increasing the time period in which blooms may occur. Water clarity is also expected to continue to increase in the Estuary in the future as a result of a depleted sediment pool in the Sacramento River watershed (Wright and Schoellhammer 2004) which should increase light penetration for photosynthesis. Nutrient dynamics in the Estuary are also expected to change significantly in 2021 when the Sacramento Wastewater Treatment Plant substantially reduces its nitrogen discharge to the Sacramento River at Freeport (Central Valley Regional Water Quality Control Board 2013). Although nutrient limitation in the Delta is not understood, nitrogen reductions may reduce the frequency or slow the growth of Microcystis blooms.

The potential effects of PA water operations on *Microcystis* bloom formation were assessed using two approaches. For the first analysis, the frequency of water flow conditions (as defined by Lehman *et al.* 2013) conducive to *Microcystis* occurrence was assessed using modeled flow at two locations in the Delta based on DSM2-HYDRO modeling (CWF BA 2016). The two locations were: 1) the San Joaquin River at Jersey Point (QWEST) and, 2) in the Sacramento River at Rio Vista (QRIO). The second analysis used DSM2-PTM for estimates of residence time (CWF BA 2016, Appendix 6.A *Quantitative Methods for Biological Assessment of Delta*

Smelt, Section 6.A.4.3, methods discussion) to inform the potential for *Microcystis* blooms, given the probable importance of residence time in bloom formation. On average, residence time in the Estuary is the inverse of flow (Kimmerer and Nobriga 2008). Both sets of quantitative analyses (*i.e.*, the flow analysis and the residence time analysis) focused on the summer and fall (July-November) because, as previously mentioned, it is during this time of the year that the majority of *Microcystis* blooms occur. Although these analyses consider only one of the known factors influencing *Microcystis* blooms (water flow), more complex models were not available.

The first analysis examined the frequency of years during July-November in which mean monthly flows were within the range at which *Microcystis* has been previously shown to occur per Lehman *et al.* (2013): -240 to 50 m^3/s (cubic meters per second) (approx. -8,500 to 1,800 cfs) for QWEST, and 100-450 m^3/s (approx. 3,500 to 15,900 cfs) for QRIO. Conditions on the San Joaquin River, as represented by QWEST, were similar or improved in the PA as compared to the NAA in all months by varying amounts except during the month of August (Table 9.2.2.2.10-1). For all of the modeled years, the mean monthly flow past Jersey Point within the bloom-associated range decreased except for the month of August where it increased by 1%. This analysis suggests that flow conditions conducive to *Microcystis* bloom occurrence would tend to occur less frequently in the San Joaquin River under the PA than observed in the projected baseline conditions in the San Joaquin River because of the higher QWEST resulting from lower south Delta exports.

Table 9.2.2.2.10-1. Percentage of modeled years (1922-2003) in which means monthly flow in the San Joaquin River past Jersey Point (QWEST) was within or above the range for *Microcystis* occurrence identified by Lehman et al. (2013). Source: CWF BA Table 6.1-24.

	NAA			PA		
	Below range (<240 m^3/s)	Within range (-240 to 50 m^3/s)	Above range (> 50 m^3/s)	Below range (<240 m^3/s)	Within range (-240 to 50 m^3/s)	Above range (> 50 m^3/s)
July	0%	95%	5%	0%	78%	22%
August	0%	98%	2%	0%	99%	1%
September	0%	96%	4%	0%	52%	48%
October	0%	89%	11%	0%	9%	91%
November	0%	91%	9%	0%	53%	47%

Implementation of north Delta export pumping under the PA would result in less Sacramento River flow past Rio Vista, as represented by QRIO, compared to baseline conditions. The mean monthly flow for QRIO for the PA was within the bloom-forming range more frequently in July and November (Table 9.2.2.2.10-2). Therefore, there could be increased potential for *Microcystis* occurrence in the lower Sacramento River under the PA than the projected baseline condition.

Table 9.2.2.2.10-2. Percentage of modeled years (1922-2003) in which means monthly flow in the Sacramento River past Rio Vista (QRIO) was within or above the range for *Microcystis* occurrence identified by Lehman et al. (2013). Source: CWF BA Table 6.1-25.

	NAA			PA		
	Below Range (<-100 m^3/s)	**Within Range (-100 to 450 m^3/s)**	**Above Range (>450 m^3/s)**	**Below Range (< -100 m3/s)**	**Within Range (-100 to 450 m^3/s)**	**Above Range (>450m^3/s)**
July	5%	85%	10%	4%	98%	0%
August	11%	89%	0%	11%	89%	0%
September	12%	59%	29%	52%	48%	0%
October	15%	84%	1%	15%	84%	1%
November	7%	77%	16%	0%	90%	10%

The results of the DSM2-PTM-based residence time analysis include the particle insertion locations upstream (east) of Suisun Bay and Suisun Marsh, because this is where effects of the PA on hydraulic residence time are highest. The effects of the PA on water residence time varied by subregion. There are no published analyses of the relationship between *Microcystis* occurrence and residence time however, on average, residence time in the Estuary is the inverse of flow (Kimmerer and Nobriga 2008) so it is reasonable to assume that the risk of blooms may generally increase with increasing water residence time. The results indicate that under the PA, regions with short residence times sometimes are predicted to have large proportional changes in residence time (*e.g.*, locations near the NDD) and regions with comparatively long present-day residence times typically had moderate to low proportional changes in modeled residence time. Differences between NAA and PA ranged from almost no change in the Sacramento River Deepwater Shipping Channel to sometimes substantial increases in predicted residence times (*e.g.*, Disappointment Slough where median predictions ranged from -3.8 to + 11.9 days, Mildred Island where median predictions ranged from + 5.8 to + 16.5 days, and Victoria Canal where median predictions ranged from + 3.0 to + 11.7 days). These results indicate that *Microcystis* may have considerably more opportunity for growth in parts of the southern Delta particularly when interacting with warm water temperatures during the summer and where present-day blooms are often observed (Lehman *et al.* 2005).

Microcystis bloom timing determines the delta smelt life stage that may be affected. *Microcystis* blooms primarily occur from June through October but can extend into May and December if conditions are favorable. Adult delta smelt (December-March) are the life stage least likely to be affected by blooms. Delta smelt eggs and larvae are present in the Estuary from February through June into the early portion of the bloom "season." However, the temperature threshold for *Microcystis* blooms is 19°C and egg hatching success for delta smelt is low by 20°C (Bennett 2005). Thus the majority of delta smelt eggs or newly hatched larvae will occur outside of the *Microcystis* bloom season. However, there is the potential for exposure of a small proportion of delta smelt eggs and larvae to *Microcystis* blooms in June when the life stage and favorable water temperature conditions coincide.

Juvenile delta smelt rearing at the LSZ could be exposed to blooms in the lower Sacramento and San Joaquin rivers. Based on the analysis of predicted flow range that support *Microcystis* (Lehman *et al.* 2013), greater flows in the lower San Joaquin River (QWEST) under the PA would be expected to result in reduced potential for blooms relative to the projected baseline condition. In the PA, a greater percentage of years were above the range of flows at which *Microcystis* has occurred (*i.e.*, flows are too fast to allow bloom formation). However, the risk of bloom formation and toxic exposure in the Sacramento River at Rio Vista may increase based on the increase in mean monthly flow at that location. The analysis shows an increase in the percentage of time flows in July and November are within the range associated with *Microcystis* blooms, representing an increased risk of exposure to rearing juvenile smelt in the LSZ in the Sacramento River and downstream during those months.

As summarized in the analysis of the PA effects on water residence time in the Estuary already presented, higher residence times were most evident in predictions for the central and south Delta subregions, but also occurred elsewhere (*e.g.*, lower Sacramento River (Chipps Island to Rio Vista) and Cache Slough/Liberty Island). With the possibility of longer duration and more intense *Microcystis* blooms as the result of longer residence time, individual juvenile delta smelt may experience a greater likelihood of lethal or sublethal toxicity, or have reduced prey availability (Ger *et al.* 2009; 2010; Lehman *et al.* 2010; Acuña *et al.* 2012; Brooks *et al.* 2012).

The delta smelt population does not overlap the peak bloom times of the central Delta *Microcystis* bloom in space and time under the PA or modeled future conditions. Most delta smelt are not in the vicinity of the Old and Middle river where residence times were predicted to increase under the PA during the summer and fall because the water quality is not favorable (*i.e.*, low turbidity, high temperature) (Feyrer *et al.* 2007; Nobriga *et al.* 2008). Additionally, blooms occurring in this region (Mildred Island and Victoria Canal) will likely be entrained into exports at the south Delta water facilities and not transported downstream to the LSZ where juvenile delta smelt are rearing.

In summary, predicted flow conditions under the PA are expected to increase *Microcystis* blooms in the Sacramento River and decrease blooms in the San Joaquin River. Residence times indicate the highest potential for bloom formation under the PA will be in the south Delta where net water movement is toward the south Delta water facilities away from rearing delta smelt. Other environmental factors such as water temperature, nutrient concentrations and turbidity will also influence bloom frequency, duration and intensity. There is potential to reduce residence times through preferential south Delta export pumping in order to reduce water residence time during RTO. Due to public safety and drinking water concerns, water operations that are intended to prevent or manage *Microcystis* blooms are both feasible and likely. Additionally, implementation of Guiding Principle 7, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to coordinate the north and south Delta water facilities to limit effects to the delta smelt population from *Microcystis* blooms. Future CWF actions will be developed and implemented consistent with the framework described in the Guiding Principles, as stated in Section 6.1 within the *Description of* *the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation.* Therefore, the Service anticipates that the effects of *Microcystis* blooms described in this analysis will be minimized.

Selenium

The San Joaquin River has elevated levels of selenium from agricultural irrigation runoff (Presser and Luoma 2013). An increase in the volume of San Joaquin River water entering the Delta under the PA, as a result of the reduction in south Delta exports, would be expected to subsequently increase the selenium loading in Delta waters and downstream. Selenium is a naturally-occurring chemical element and essential micronutrient however, in excessive amounts can also have toxic effects (Chapman *et al.* 2010; Stewart *et al.* 2004). The most well-documented and severe toxic symptoms in fish are reproductive deformities in the offspring of maternal fish with high selenium tissue concentrations and larval mortality due to the deformities.

The possibility for the PA to affect delta smelt from feeding on selenium contaminated prey was investigated using the results of 1) DSM2 volumetric fingerprinting estimates, 2) delta water source selenium input concentrations, 3) conversions of water selenium concentration to particulate selenium concentration, and 4) trophic transfer factors, to estimate the concentration of selenium from delta smelt copepod prey to delta smelt tissue (see Section 6.A.4.4 *Selenium* in Appendix 6.A *Quantitative Methods for Biological Assessment of Delta smelt* in the CWF BA). As described in Section 6.A.4.4.4 *Modeling Assumptions* of the CWF BA, this analysis has a number of assumptions leading to uncertainty in the results, including that an observed selenium effects threshold for Sacramento splittail (7.2 μg/g selenium whole-body tissue concentration) is an appropriate surrogate for delta smelt.

Delta smelt selenium tissue concentrations, predicted as monthly means, were highly variable at the five sites investigated (San Joaquin River at Prisoners Point, Cache Slough at Ryer Island, Sacramento River at Emmaton, San Joaquin River at Antioch, and Suisun Bay at Mallard Island). The monthly selenium tissue concentrations were elevated in the PA relative to the projected baseline, sometimes as much as doubling the tissue concentrations compared to the projected baseline. However, in those instances, the concentrations almost always remained well below the comparative effects threshold of 7.2 μg/g. Prisoners Point was the only site at which tissue concentrations exceeded the selected threshold of 7.2 μg/g. Because the predicted tissue concentrations are strongly influenced by the proportion of San Joaquin River water (see Table 6.A-12 in Section 6.A.4.4.1 *Selenium Concentrations in Water* in CWF BA Appendix 6.A *Quantitative Methods for Biological Assessment of Delta smelt*), data from Prisoners Point at a K_d of 6000 (higher bioavailable selenium) represent a conservative high end of selenium exposure to delta smelt from the PA.

Selenium concentration in delta smelt tissue at Prisoners Point had a broad peak from March through June, the months when the fraction of San Joaquin River water was often highest at those sites. Exceedance of the tissue threshold occurred in 7 out of 992 months (0.7%) and only when using the high bioavailable selenium estimate (high K_d). The relatively small number of exceedances for the PA occurred primarily in the months of March, April, and May, where predicted baseline selenium tissue concentrations were observed to be close, or at threshold exceedance.

Exposure to selenium and subsequent effects may vary by life stage. Selenium concentrations in migrating and spawning adult delta smelt would be expected to increase somewhat during the December-June period. Delta smelt have been observed in hatchery conditions to have a higher rate of feeding during egg development but a decline in feeding behavior as eggs mature (Hung *et al.* 2014). Eggs/embryos would not be feeding and therefore would not be exposed to selenium directly. Selenium concentrations in delta smelt eggs would be determined by maternal transfer from the mother's body burden during development; the eggs/embryos would have higher selenium concentrations under the PA than the projected baseline.

For larvae and juveniles, the spring months would result in the greatest concentrations of selenium in delta smelt tissue, as a result of San Joaquin River inflow to the Delta having the greatest contribution to Delta waters in these months. Young juvenile delta smelt that are consuming prey would have a greater risk of accumulating increased selenium under the PA. However, based on the selenium tissue accumulation modeling results the potential to exceed the assumed detrimental threshold of 7.2-µg/g selenium whole-body tissue concentration is very small.

In summary, tissue concentrations of selenium are expected to increase throughout the Estuary under the PA. However, the magnitude of that increase will not be high enough to exceed an established effects threshold for tissue concentrations at four out of five sites investigated. At the fifth site, Prisoners Point, the selenium tissue threshold would be exceeded 0.7% of the time. These modeling results suggest that the risk to delta smelt from increased selenium loading by the PA is very small.

9.2.2.2.11 Summary of Operations-related Effects on Delta Smelt Reproduction, Numbers, and Distribution

The operational scenario analyzed in the PA appears to reduce entrainment of the delta smelt and predation associated with in-water structures in the south Delta. Exports will continue in the south Delta so there will still be an entrainment footprint that extends into the waterways of the interior Delta, though it will generally be a smaller affected area relative to baseline conditions. Implementation of the PA will reduce entrainment risk in the south Delta along the San Joaquin River from Jersey Point to Prisoners Point contributing to the possibility of higher spawning success in this river reach. It is anticipated that entrainment-related effects will be reduced in all but critical WY types. This conclusion is based on the degree of modeled south Delta exports when north Delta bypass flow criteria limit the use of the NDD. Additionally, implementation of Guiding Principle 2, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to facilitate operating the dual conveyance system in a manner that minimizes entrainment-related mortality of migrating and spawning delta smelt and their progeny. This Guiding Principle will ensure that as future operational criteria develop, minimization of entrainment-related mortality will remain a priority.

The approach velocities generated along the NDD fish screens when the diversions are operating will interact with the generally high sweeping velocity of the Sacramento River to block, delay, or impede the migration of adult delta smelt. As a result, the NDD is expected to restrict access to migratory and spawning habitat from the southernmost intake to the northern extent of the species' range. However, available hydrodynamic and incidental catch information indicates that low numbers of delta smelt migrate this far upstream, and therefore NDD construction and operation are only expected to affect a small proportion of the population. Implementation of compensatory mitigation and Guiding Principle 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*, are intended to restore, create, or enhance spawning habitat conditions elsewhere. It is expected that these actions will minimize adverse effects to the delta smelt's ability to access spawning habitat between Clarksburg and Knight's Landing and establish a framework for developing future actions consistent with this BiOp.

Generally speaking, the spring outflow criteria will maintain baseline Delta outflow during March, April, and May, and the February through June D-1641 Delta outflow requirement will also remain in place. However, the CalSim II modeling for the PA resulted in a frequent eastward shift of X2, which will contract rearing habitat in the LSZ into the comparatively narrow and deep shipping channel extending up the Sacramento River. Implementation of Guiding Principle 1, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to improve habitat conditions for rearing juvenile delta smelt, which may include locating the LSZ in suitable areas of the estuary. This Guiding Principle is expected to minimize adverse effects to delta smelt from operations of a dual conveyance system.

There are several other possible but less certain changes in the Action Area that we analyzed for this BiOp. Based on the PA, there is a possibility of increased water clarity, and increased exposure to contaminants and harmful cyanobacteria blooms associated with lower flows at certain times of year. We anticipate somewhere between no change to very small project-related changes in water temperature, and selenium bioaccumulation.

Implementation of Guiding Principles 1 through 8, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is expected to promote ecological conditions suitable for all life stages of delta smelt, and to promote water supply reliability through commitments made in the CWF PA and the Delta Smelt Resiliency Strategy. These Guiding Principles establish a framework in this consultation under which the future CWF actions will be developed to ensure that future consultations related to CWF actions build upon the analysis in this document, and minimize adverse effects to delta smelt.

9.2.2.3 Effects to Recovery

DWR has proposed to minimize the adverse effects of the loss and degradation of habitat by implementing mitigation actions to promote the recovery of the delta smelt in a manner where the mitigation is commensurate with the adverse effect. DWR has proposed to restore or create

1,827.7 acres of habitat to minimize the total loss of available habitat. As we stated previously, habitat loss and degradation are contributing factors to the decline of delta smelt. The proposal to create or restore additional migratory and spawning habitat is a reasonable means of minimizing the adverse effects of the loss of individuals, on the species as a whole, and may benefit the recovery of the delta smelt.

The Service issued a *Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes* (Recovery Plan) in 1996 (Service 1996). The Service is in the process of revising the Recovery Plan for delta smelt. The Service has used the most up-to-date, best available information to outline the recovery needs of delta smelt. Sources used to develop the needs include, but are not limited to:

- the March 5, 1993 delta smelt listing and critical habitat rule;
- the 1996 Recovery Plan;
- the 2008 Service BiOp (Service 2008);
- the September 13, 2010 5-year status review (Service 2010a);
- the April 7, 2010 12- month finding (75 FR 17667; Service 2010b);
- the latest Candidate Notice of Review (Service 2016);
- the draft recovery plan for delta smelt (under development); and
- other resources available to the Service.

Based on available resources, the Service proposes that, in order to recover, delta smelt need a substantially more abundance population, an increase in the quantity and quality of habitat, and other needs as further outlined below:

Abundance - a substantially more abundant population, which is notably linked to the success of recruitment between life stages. Abundance is affected by entrainment, predation, feeding, competition, demographics/genetics, reproductive success, and fish condition and health.

Entrainment and Impingement Risk

- A reduction in entrainment and impingement of adult, juvenile, and larval individuals and their food supply at CVP and SWP pumping facilities, over and above reductions achieved under RTO of the 2008 Service BiOp, to increase the abundance of the spawning adult population and the potential for recruitment of larvae and juveniles into the adult population. This can be done through OMR modified actions to increase protection among life stages.
- A reduction in entrainment and impingement from other water diversion-related structures within delta smelt critical habitat where delta smelt adults, larvae, or juveniles are known or are likely to be impinged or entrained to increase the adult population and the potential for recruitment of juveniles into the adult population.
- A reduction in entrained food supply from other water diversion-related structures and pumping facilities within delta smelt critical habitat.

Predation

- Increased escape cover (*i.e.*, sufficient habitat to reduce/avoid predation from observed increases in water clarity).
- Reduction in predators in the Bay-Delta ecosystem to increase survival of adults, larvae, and juveniles from an overall increase in relative abundance of predator species system-wide.

Feeding

- Increased food quality, production retention, timing and availability.
- Restoration and enhancement of the food web structure in the Bay-Delta to a condition that more closely mimics the natural environment (*i.e.*, pre-water development) to increase survival of delta smelt.

Competition

- Reduction in competition from non-native fish and invertebrates.

Demographic/Genetic

- Maintain or increase genetic diversity within the population and Allee effects (*e.g.*, reduced schooling ability, reduced ability to find mates).

Reproductive Success

- Restoration of migratory and spawning cues from reductions in the spawning season window and modification of natural flow regimes.
- Increase the condition of spawning individuals, such as fish size (*e.g.*, weight, length), fat storage, sufficient calorie intake, and lipid energy.
- Improve delta smelt vital rates, including higher growth rates and higher fecundity levels.
- Improve the sex ratio (males to females) – with recognition that there is uncertainty associated with this need and therefore is identified as needing additional research and monitoring.

Fish Body Condition/Health

- Improve physical health through a reduction in contaminants exposure and other pollutants (*e.g.*, metals, pesticides, CEC's [endocrine disruptors], etc.) within its habitat to increase survival of adults, larvae and juveniles.

Habitat - an increase in the quality and quantity of suitable migratory, spawning, and rearing habitat. Improved habitat quality within the Bay-Delta should enhance delta smelt reproduction and allow for recruitment success necessary to the species to survive. Suitable habitat conditions require habitat diversity, water quality, and flow.

Habitat Diversity

- Increase habitat complexity (*e.g.*, reduction in dead end sloughs) and heterogeneity.

- Increase in the quality and quantity of suitable spawning habitat and substrate (*i.e.*, sandy beaches with sufficient water velocities, available for direct use) due to reductions in sandy beaches system-wide.
- Maintain or increase (*i.e.*, protect, restore, create, or enhance) suitable habitat within designated critical habitat (*i.e.*, with PCEs), further preventing reductions in habitat.

Water Quality
- Improve water quality – suitable water quality constituents within optimal range (*i.e.*, turbidity, DO levels, water temperature, pH, salinity).

Flow
- Improve flow conditions – suitable flow conditions (*i.e.*, velocity, [delta] freshwater outflow, salinity, tidal energy, flow suitable for spawning migration, to trigger movement to spawning areas, and egg incubation)

These can be achieved as a result of active or passive management of water and sediment processes in the San Francisco Bay-Delta ecosystem that mimics more natural (*i.e.*, pre-water development) conditions.

Other needs – Other factors that affect delta smelt include climate change, aquatic invasive macrophytes, harmful cyanobacteria blooms (*Microcystis*), disease, and exposure to in-water work activities.

Climate Change
- Maintain and increase sufficient suitable habitat from threats of ecosystem changes (community and habitat shifts).
- Prevent reductions/shifts in suitable habitat due to sea-level rise and increased droughts and temperatures.
- Maximize delta smelt population resilience in the face of the potential adverse effects of ongoing climate change that are occurring in the Bay-Delta ecosystem.

Aquatic Invasive Macrophytes
- Reduce aquatic invasive macrophytes due to increased predator habitat from changes in water quality as a result of increased water clarity, residence times, and flow reductions.

Harmful Cyanobacteria Blooms (*i.e., Microcystis*)
- Reduce harmful cyanobacteria blooms from increased water residence time/flow reductions and increased anthropogenic nutrient inputs.

Disease
- Reductions in disease to increase survival of adults, larvae, and juveniles.

Risk to Individuals from Exposure to In-water Work Activities (*e.g.*, dredging riprapping, suction dredging, agricultural diversions)

- Reduce sources of harassment, harm, or mortality to delta smelt individuals, habitat loss, and effects to prey density (*i.e.*, modification of food supply).

Effects of the Proposed Action on Recovery

The PA is expected to affect abundance and habitat quality and quantity in several ways. Implementation of Guiding Principles 1 through 8, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to promote ecological conditions suitable for all life stages of delta smelt through commitments made in the CWF PA and through actions described in the Delta Smelt Resiliency Strategy. Table 9.2.2.3.1-1 describes how these Guiding Principles are intended to contribute to recovery of delta smelt.

Table 9.2.2.3.1-1. Guiding Principles' contribution to recovery of delta smelt.

Guiding Principle	Contribution to Recovery
1. Improving habitat conditions for rearing juvenile delta smelt, which may include locating the LSZ in suitable areas of the estuary.	Improvement of rearing habitat is expected to result in higher juvenile survival and recruitment rates. This is especially important for an annual species like delta smelt which relies on successful recruitment of individuals to successfully spawn and contribute to successive generations.
2. Operating CVP and SWP water exports in the south Delta to minimize entrainment of migrating and spawning adult delta smelt and larval/young juvenile delta smelt.	Minimization of entrainment of adult, juvenile, and larvae individuals is expected to increase the abundance of the spawning adult population and the potential for recruitment of larvae and juveniles into the adult population.
3. Promoting increased turbidity in geographical areas and during temporal windows that may be expected to increase the extent and quality of delta smelt habitat through implementation of sediment management plan referenced in the 2017 CWF PA and through actions described in the Delta Smelt Resiliency Strategy.	Increased turbidity would provide better habitat conditions for all life stages of delta smelt. Increased turbidity produced by suspended sediments is expected to increase abundance of juveniles by providing cover for delta smelt to avoid predators and facilitate larval delta smelt feeding.
4. Restoring, creating, or enhancing spawning habitat conditions through use of mitigation commitments made by Reclamation and DWR in the 2017 CWF PA and through actions described in the Delta Smelt Resiliency Strategy.	The mitigation commitments are expected to, at a minimum, replace habitat functions suitable for delta smelt spawning. Reclamation and DWR have committed to provide mitigation in appropriate areas and with conditions to ensure adult and larval delta smelt survive and contribute to the overall

	population.
5. Promoting food production and transport into areas where habitat conditions are suitable for delta smelt.	Enhanced food production and transport is expected to promote the restoration of the food web structure that more closely mimics the natural environment and results in increased survival of larval and juvenile delta smelt.
6. Improving population-level delta smelt habitat conditions through reductions in non-native invasive species.	Reduction of non-native predators is expected to improve survival of individual delta smelt of all life stages, resulting in overall increased abundance of the species. Reduction of non-native invasive aquatic vegetation is expected to improve habitat conditions for delta smelt by improving turbidity and decreasing habitat conducive to non-native predator and competitor fishes.
7. Coordinating operations of the south Delta and NDD water facilities to limit effects to the delta smelt population from cyanobacteria blooms.	Limiting the effects of cyanobacteria blooms can improve survival and body condition of juvenile delta smelt that would eat contaminated prey. This measure will likely benefit juvenile delta smelt the most because this life stage overlaps with the majority of observed blooms.
8. Implementing all actions in a manner that limits, to the maximum extent practicable, impacts to water supply and provides opportunities to recover water supplies consistent with protection of listed species.	Guiding Principles 1 through 7 will likely be protective of all delta smelt life stages and ensure that Guiding Principle 8 would not reduce the contributions to recovery.

Relative to the recovery needs identified above, effects from pre-construction and construction activities resulting from implementing the PA are likely to affect delta smelt and their habitat, as described in *Section 9.2.2*. These effects to the species are likely to be minimized by the proposed conservation measures, including the compensatory mitigation. This mitigation is designed to restore and protect habitat in appropriate areas of the estuary to provide similar functions of the habitat that would be impacted by the PA.

The operational scenario in the PA concurrently provides improvements (decreased entrainment and improved flows in the San Joaquin River) and adverse effects to delta smelt habitat. However, overall habitat conditions are not improved as compared to the current baseline conditions. However, as previously noted under *Operational Uncertainties and the Collaborative Scientific Process*, this operational scenario described in the PA will change between now and when the dual conveyance system goes online. In addition, implementation of the Guiding Principles is expected to minimize many of the effects of the operational scenario in the PA and contribute to recovery by addressing some of the overall factors that are causing the delta smelt population to decline.

9.2.2.4 Effects of the Aggregate Status of the Species/Environmental Baseline, and Proposed Action for Delta Smelt

This section summarizes the aggregate status, baseline, and effects of the PA. As previously noted under *Operational Uncertainties and the Collaborative Scientific Process*, the proposed CWF operational scenario that has been analyzed above will change between now and when the dual conveyance system goes online. Reclamation and DWR have committed to implement future CWF actions consistent with the Guiding Principles, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, and those future actions will be subject to subsequent consultation.

Summary of the Status of the Species

The range-wide status of the delta smelt has been fairly persistently declining since the early 2000s. The 2015 FMWT and 2016 SKT abundance indices were the lowest on record, while the 2016 FMWT index was only slightly higher than 2015. As of February 2017, the adult delta smelt population was estimated to be between 21,709 and 91,864 fish with a point estimate of 47,786 individuals, the second lowest on record. The 2017 SKT index is 3.8, also the second lowest on record. While the absolute abundance estimates likely underestimate actual delta smelt abundance, the trend indicates that the delta smelt population continues to face high risk of extinction (Moyle *et al.* 2016). Like many imperiled species the major threat is, in the broadest sense, loss of habitat, some aspects of which are affected or controlled by CVP and SWP operations and others that are not. Delta smelt habitat conditions and status were recently worsened with several years of drought from 2007-2010 and again with the severe drought conditions of 2013-2016. The increasing rarity of the delta smelt may leave the species more vulnerable to stochastic impacts like contaminant spills or a return of drought and it substantially increases the amount of time that will be needed to improve the species' status. The delta smelt's rarity also decreases the reliability of monitoring programs which carries with it an increased risk of missed opportunities to help the species using real-time management of water operations.

The 2016 year class of delta smelt experienced a positive population growth rate over the 2015 year class. This was the first time positive population growth has been observed since 2011. This rebound may have been caused by any or all of a pulse of high outflow from early March to early April in 2016, the Yolo Bypass plankton experiment in the summer of 2016, or cooler water temperatures during summer in 2016 than the previous significant drought years. The 2017 WY has thus far yielded significant precipitation and snow pack, which has resulted in extended periods of extremely high outflow and positive OMR flow this winter and spring. The Service anticipates that this will contribute to a second consecutive year of suitable conditions for delta smelt and its critical habitat. If conditions remain advantageous through the summer and fall of 2017, delta smelt could experience positive population growth for a second year in a row, which has not been seen in many years.

Summary of the Environmental Baseline and Existing Conditions

Much of the action area has been altered or degraded from its historical state where coverage of freshwater emergent wetlands decreased from 193,224 to 4,253 ha while open-water habitats increased from 13,772 to 26,530 ha (Robinson *et al.* 2014). Much of the delta smelt's habitat is no longer available and remaining habitat is increasingly unable to sustain the population (Moyle *et al.* 2016). Loss of shallow water edge habitat along the Sacramento River and its tributaries has occurred over time from riprapping and will be maintained under existing levee erosion repair consultations. Since the implementation of the 2008 Service and 2009 NMFS BiOps, the RPAs have at times resulted in reduced pumping rates in the south Delta through negative OMR limits and San Joaquin River I/E ratio, in addition to other regulatory processes, to curtail pumping-related effects to delta smelt and other federally listed species. The delta smelt population size has been difficult to monitor due to the low number of individuals remaining. As previously discussed, delta smelt are nearing extinction based on record low numbers observed in monitoring efforts (Moyle *et al.* 2016).

Other sources of injury or mortality to delta smelt occurring in the Delta ecosystem include: dredging; sand-mining; wastewater treatment plant effluent release; aquatic weed control; managed wetland activities; research and monitoring efforts; and other activities that result in small effect to delta smelt (see *Existing Conditions and Previous Consultations in the Action Area*).

Loss and degradation of suitable habitat continues to pose the largest threat to delta smelt. Efforts by Reclamation and DWR are currently being made through the Delta Smelt Resiliency Strategy to improve baseline habitat conditions and therefore abundance of the population (DWR 2016). Another action in progress is habitat restoration through California EcoRestore, in addition to the RPA habitat component 4 (Service 2008) and the SMP.

Summary of the Effects of the PA on the Reproduction, Numbers, and Distribution of Delta Smelt

<u>Reproduction</u>

Pre-construction and construction activities are only expected to result in minor impacts to reproduction of delta smelt. The largest effect to delta smelt from the PA is related to the contraction in available habitat to delta smelt, that supports the migration, spawning, transport, and rearing processes that are necessary for reproduction. The PA will result in permanent habitat loss from the construction of the NDD, HORG, new south Delta water facilities, and barge landings. The NDD is expected to block, delay, or impede adult access to all migratory and spawning habitat from the southernmost intake to the northern extent of their range. The ability for those adults that migrate up the Sacramento River to spawn in the vicinity of the intakes will be reduced and it is expected that they will be subject to increased risks of injury or mortality from impingement and predation. However, low numbers of delta smelt are believed to migrate this far upstream, and therefore NDD construction is only expected to affect a small proportion of the population. In addition, DWR has proposed compensatory mitigation for the loss of this habitat by restoring suitable spawning habitat as stated in Guiding Principle 4 of Section 6.1 within the *Description of the Proposed* Action and 9.2.2.2.1 *Framework for the Programmatic Consultation*. We anticipate this habitat restoration will minimize effects to delta smelt from NDD construction.

The entrainment footprint from continued south Delta pumping that extends into the waterways of the interior Delta toward the west from the south will be reduced from baseline conditions due to the reduced reliance on south Delta exports in most WY types. Habitat conditions will improve along the San Joaquin River, allowing for increased success in delta smelt spawning and larvae escapement to occur in these areas. However, these areas of improvement may be less suitable during critical WYs due to south Delta flow conditions.

The PA ranges on a monthly basis from no change to some adverse effect to X2. The proposed spring outflow criteria would help maintain habitat conditions in the spring months of March, April, and May, which overlap with the spawning period for delta smelt. Increases in exports, from baseline conditions, would be expected in the summer months of July and August based on the operational scenario presented in the PA. Exports would be expected to increase in December when water supply is available. During these times of increased pumping, the PA operations would be expected to result in small eastward changes in the location of X2 (*e.g.*, up to approximately 5 km) (see Appendix B).

During the juvenile rearing season, small changes in X2 would be expected to result in less suitable salinity conditions in the Suisun area contracting the distribution of delta smelt to areas that are more channelized. Loss of rearing juveniles and adult spawners from poor habitat conditions would affect abundance and recruitment contributing to the next generation of delta smelt. Guiding Principle 1 is expected to minimize these potential effects during the development of the final operational criteria by improving habitat conditions for rearing juvenile delta smelt, which may include locating the LSZ in suitable areas of the estuary. Improvement of rearing habitat is expected to result in higher juvenile survival and recruitment rates. This is especially important for an annual species like delta smelt that rely on successful recruitment of individuals to successfully spawn and contribute to successive generations. Guiding Principle 2 is expected to minimize entrainment of adult, juvenile, and larval individuals and is expected to contribute to reproduction of delta smelt by increasing the abundance of the spawning adult population and the potential for recruitment of larvae and juveniles into the adult population.

<u>Numbers</u>

Activities associated with the preconstruction, construction, and operations of the water conveyance facilities will adversely affect individuals by harassment, injury, and mortality of delta smelt and loss/degradation of suitable habitat. Reclamation and DWR, through Guiding Principle 4, and other commitments have proposed to mitigate for the effects to delta smelt individuals and loss of habitat from construction-related activities by protecting and restoring delta smelt spawning, rearing, and migration habitat prior to impacts. Restoration will be performed at a site or sites that will provide the most benefit for delta smelt into the future such as in the vicinity of west Delta, central Delta, north Delta, and Cache Slough Complex. Within these broader regions, examples of site-specific areas include, but are not limited to: Sherman Island, lower San Joaquin River (such as San Andreas Shoal and Prisoners Point area), Sutter and Steamboat sloughs, and waterways within the Cache Slough Complex. The purpose of the mitigation is to protect and improve habitat conducive to replacing or, ideally, increasing the number of delta smelt in the wild. The proposed compensatory mitigation will likely provide habitat conditions in suitable areas of the estuary to improve the functions necessary to support all life stages of delta smelt, which will result in improved survival of individuals.

The Service will be involved in developing the details related to maintenance, monitoring, adaptive management, and implementation of the compensatory mitigation, and will assist in incorporating measures to minimize effects to delta smelt and its critical habitat. These activities will be described and analyzed in the long-term operations consultation and/or subsequent consultations.

By operating the newly proposed and existing water conveyance facilities, there is potential risk to delta smelt individuals (especially larvae, juveniles, and adults) from entrainment or impingement and increased predation rates. Under a dual conveyance, there is expected to be reduced entrainment at the south Delta facilities in all but critical WY types from baseline. Entrainment levels are expected to be maintained, or slightly increased, in critical WY types, similar to what is expected under projected baseline conditions. This is likely due to the heavier reliance on the south Delta facilities when north Delta bypass flow criteria limit the use of the NDD in critical years which results in entrainment levels at the south Delta water facilities similar to what is observed under current regulations. Overall, when analyzing the proposed operational scenario presented in the PA, in most WY types there would be reductions in entrainment levels from the projected baseline conditions. Additionally, Guiding Principle 2 is expected to minimize entrainment of adult, juvenile, and larval individuals and is expected to contribute to improved survival of delta smelt and increase the abundance of the spawning adult population and the potential for recruitment of larvae and juveniles into the adult population.

Under the proposed operational scenario, the delta smelt population will be most affected by the contraction in the quantity and quality of available suitable habitat to rearing juveniles and adult spawners. Habitat availability will be reduced from restricted access in the north due to construction of the NDD. However, the habitat upstream of the NDD is not as frequently used as habitats in the North Delta Arc. As described in the potential operational scenario presented in the PA, negative OMR flows in the south Delta, and eastward movement of the LSZ would also be expected to reduce habitat. The quality of habitat would be affected by small or no changes in salinity, water temperature, water clarity, food supply, *Microcystis*, and selenium under the operational scenario presented in the PA. These changes would reduce numbers of delta smelt by: (1) altering their feeding behavior, (2) altering swimming behavior, (3) reducing the quality and availability of food supply, (4) increasing favorable predator habitats, (5) decreasing cover or shelter, and (6) decreasing reproductive success. The operational scenario in the PA would provide environmental conditions that are likely to allow for predators and competitors that thrive in stable conditions to persist. Although there is no single driver of delta smelt population dynamics (Baxter *et al.* 2008), these effects and current threats hinder the ability of the population to recover and maintain higher levels of abundance in the future (Bennett and Moyle 1996; Bennett 2005; Feyrer *et al.* 2007).

The population has been in a declining trend particularly since 2002 and has been almost undetectable in some surveys since 2012 (Moyle *et al.* 2016). The population is thought to be so small that stochastic factors, such as a multi-year drought, the loss of key spawning or rearing sites, or an increase in local abundance of competitors or predators could cause extinction in the wild in the near future (Moyle *et al.* 2016). For an annual species, factors affecting habitat conditions throughout its short life span are important to its success or failure. It is clear from published research that delta smelt have become increasingly habitat limited over time and that this has contributed to the population declining to its lowest recorded abundance levels in 2015 and again in 2016 (Bennett 2005; Baxter *et al.* 2008; Feyrer *et al.* 2007, 2008; Nobriga *et al.* 2008).

Guiding Principle 1 is expected to minimize the loss and contraction of habitat proposed under the operational scenario in the PA by improving habitat conditions for rearing juvenile delta smelt, resulting in higher juvenile survival and recruitment rates, which will contribute to numbers of delta smelt in the wild. This is especially important for an annual species like delta smelt which relies on successful recruitment of individuals to successfully spawn and contribute to successive generations. Guiding Principle 3 is likely to improve habitat conditions and lead to increased numbers of juveniles by providing cover for delta smelt to avoid predators and facilitate larval delta smelt feeding. Guiding Principles 5, 6, and 7 address ongoing threats to delta smelt and will likely contribute to improved survival of delta smelt.

<u>Distribution</u>

The operational scenario in the PA will result in a contraction of suitable habitat within the range of delta smelt from the permanent removal of, and restricted access to, suitable habitat in the Sacramento River above the NDD, and would be expected to result in reductions in rearing habitat from the west from the eastward movement of X2 during summer months across WY types under the potential operational scenario presented in the PA. The proposed delta smelt habitat mitigation (Guiding Principle 4) is expected to minimize the effect of the contraction above the NDD and, during development of the final operational scenario, the potential effects from operations by improving and protecting habitat elsewhere that provide similar features for migrating, spawning, and rearing delta smelt. The proposed compensatory mitigation will likely provide improved habitat conditions to the population and minimize the effects of the reduced habitat distribution in the northern extent of the delta smelt's range.

Under the operational scenario in the PA, the entrainment footprint in the southern Delta is expected to be smaller than current conditions in all but critically dry WYs. This may result in a shift in distribution of delta smelt migrating and spawning toward the southern Delta and the San Joaquin River. Although not thought to currently be utilized to a great extent by delta smelt, the restriction of the habitat above the NDD will represent a distribution contraction to the species. If there is an increase in the numbers of delta smelt migrating and spawning in the southern Delta and the San Joaquin River, this would represent an increase in habitat utilization by delta smelt in this part of their range. Successful migration and spawning in this area will be realized provided that real-time operational salmonid pulse protections from December through June at the NDD do not result in increased CVP and SWP exports during those months.

Summary of the Effects of the PA on the Recovery of Delta Smelt

With the implementation of the operational scenario described in the PA, overall baseline habitat conditions are not improved (*i.e.,* water temperature, water clarity, food supply, and exposure to contaminants). As described in the PA, Reclamation and DWR propose to further address effects associated with CWF operations through subsequent consultation on actions developed consistent with the framework analyzed in this BiOp. Based on the uncertainty associated with the current PA, we understand that many of the effects discussed in this BiOp will likely not be realized when operations under the CWF PA are implemented. The framework articulated through the Guiding Principles, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, will shape development of future CWF actions in a manner that is consistent with the analysis in this BiOp.

Our analysis outlines threats to delta smelt now and into the future - most of which exist with or without implementation of the PA. Primary threats to delta smelt include habitat loss and degradation, food web alterations (including increased predator and competitor presence and food supply reduction), and persistent exposure to contaminants. Many of these threats are being addressed. The State and Federal agencies have several ongoing actions that are intended to address multiple threats to delta smelt, including the SWRCB's update of the WQCP for the Bay-Delta, the reinitiation of the 2008 Service BiOp and 2009 NMFS BiOp on the long-term operation of the CVP and SWP, California EcoRestore, the Delta Smelt Resiliency Strategy and the update of the *Recovery Plan for Delta and Longfin Smelt.* These and other ongoing efforts will help to reduce existing threats to delta smelt.

9.2.3 Effects to Delta Smelt Critical Habitat from the Proposed Action

9.2.3.1 Background

The following are the delta smelt critical habitat Primary Constituent Elements (PCEs) as defined in the critical habitat rule (Service 1994):

Primary Constituent Element 1: "Physical habitat" is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary's LSZ (Bennett *et al.* 2002; Hobbs *et al.* 2006).

Primary Constituent Element 2: "Water" is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.

Primary Constituent Element 3: "River flow" is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and Old and Middle river flow influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones Pumping Plants. River flow interacts with the fourth primary constituent element, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.

Primary Constituent Element 4: "Salinity" is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5–6.0 ppt (Kimmerer 2004). The 2 ppt isohaline is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 ppt (Jassby *et al.*1995). By local convention, the location of the LSZ is described in terms of the distance from the 2 ppt isohaline to the Golden Gate Bridge (X2); X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby *et al.*1995; Kimmerer 2002b). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from as far downstream as San Pablo Bay (45 km) to as far upstream as Rio Vista on the Sacramento River (95 km). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete its life cycle. In general, delta smelt habitat quality and habitat surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish the more frequently and further the LSZ moves upstream, toward the confluence.

Due to the interrelationship between the PCEs and the intended conservation role they serve for different delta smelt life stages, some effects are similar and overlap across the PCEs. For instance, Delta outflow determines the extent and location of the LSZ and the areas of physical habitat delta smelt are able to utilize at all times of year. Therefore, many of the effects described below for the PCEs are difficult to separate so some effects are repeated for multiple PCEs.

The PA will affect critical habitat to varying degrees in the following ways: 1) the removal of habitat in the construction footprint, 2) the impediment to spawning migration by the NDD intake structures up the Sacramento River beyond Clarksburg, 3) the alteration of water quality, quantity and salinity by water operations of the new and existing CVP and SWP water facilties, 4) localized water quality and hydrodynamic effects from construction, 5) improved larval and juvenile transport out of the San Joaquin River resulting in reduced south Delta entrainment, and

6) potential improved food production. Table 9.2.3.1-1 shows where the effects to critical habitat from the PA are expected to occur for each PCE. Construction will not affect PCEs 3 and 4.

Effects to PCEs were evaluated using various metrics. For PCE 1, we measured acres that would be adversely affected by construction and facility footprints, and weighed them against the compensatory mitigation included as a conservation measure in the PA. For PCE 2, we used DSM2-QUAL modeling, DSM2 hydraulic residence time, DSM2-PTM, and DSM2 fingerprinting outputs. For PCE 3 we used CalSim II modeling outputs. For PCE 4, CalSim II modeling of X2 and DSM2-QUAL salinity outputs were used. The CalSim II model is used by Reclamation and DWR to simulate the operation of the major CVP and SWP water facilities in the Central Valley and generates estimates of river flows, exports, reservoir storage, deliveries, and other parameters. The Delta boundary flows and exports from CalSim II are then used to drive DSM2. DSM2 is a hydrodynamic and water quality model for estimating tidally-based flows, stage, velocity, and salt transport within the estuary. DSM2 also has a particle tracking modeling (PTM) component which uses the velocity fields generated under the hydrodynamics to emulate movement of particles throughout the Delta system. DSM2-QUAL is used to quantify water quality conditions including salinity, water temperatures and source water fingerprinting.

ıe PA on critical habitat by life stage. (Type of effect indicated by cell color: yellow [neutral], and red [negative], ɛy [not applicable]).

ː 1: Physical habitat	PCE 2: Water [quality]	PCE 3: River flow	PCE 4: Salinity [LSZ]
ɪtricted access to the mento River above the NDD	No substantive effect.	Improved San Joaquin River flows during winter migration, improved spawning cues and improved flows reduce entrainment risk. Disruption of migration flows past NDD.	No change in effect.
tion impediment along ɛnto River, small habitat om barge landings and ꞁRG; mitigation will ninimize effects.	No substantive effect.		No change in effect.
	No substantive effect.	Improved San Joaquin River flows during spring/early summer larval transport out of San Joaquin River. Disruption of transport flows past the NDD.	No change in effect.
stantive effect on water depths.	Elevated selenium load from San Joaquin River, small potential increase in *Microcystis* bloom intensity, potential for elevated zooplankton production; small effect on estuary turbidity.	Lower outflow will increase salinity and limit extent/suitability of western parts of critical habitat and the LSZ located upstream.	Lower outflow will increase salinity and limit extent/suitability of western parts of critical habitat and the LSZ located upstream.

9.2.3.2 Effects to Delta Smelt Critical Habitat Related to PCE 2: Water

The PA will cause minor changes in several components of water quality (PCE 2) needed to support delta smelt at all life stages, but which were found to have small to negligible effects as compared to the current projected baseline condition, either alone or in combination with conservation measures proposed as part of the PA. These components include the following:

- **Water temperature:** There is a possibility that the lower Sacramento River inflows to the Delta, as a result from export of colder Sacramento River water at the NDD, may result in water temperature increases in the San Joaquin River. Effects are likely too small (less than 1 °C) to be resolved with available modeling tools. If realized, this small temperature increase is not anticipated to affect the critical habitat's ability to provide adequate water quality for delta smelt at all life stages.

- **Construction sediment and contaminants:** Potential water quality effects in the vicinity of the NDD, HORG, geotechnical explorations, and barge landings include elevated noise from pile driving, increased turbidity/suspended sediments and deposition of sediment onto nearby spawning substrates, and potential mobilization of sediment-associated contaminants during installation, operation, and removal. Impacts lasting more than one year are considered permanent. Water quality is expected to return to baseline levels following cessation of construction activities (approximately 13 years after commencement of construction activities). The potential release of contaminants through spills or sediment disturbance could result in temporary impacts on water quality. With implementation of the proposed pollution prevention, and erosion and sediment control AMMs (see the *Description of the Proposed Action*), potential adverse effects on spawning habitat downstream of the NDD and near barge landings will not alter water quality (PCE 2) required to support all life stages of delta smelt.

- **Sediment load:** Turbidity produced by suspended sediment provides cover for delta smelt to avoid predators and facilitates larval smelt feeding (Ferrari *et al.* 2014; Baskerville-Bridges *et al.* 2004; Sullivan *et al.* 2016). NDD operations will alter critical habitat by entraining and removing Sacramento River suspended sediment which may increase downstream water clarity over time. DWR has committed to reintroduce Sacramento River sediment removed from the water column at the intake sedimentation basins which will minimize the effects to Delta sediment load and turbidity and help to maintain this important aspect of PCE 2. In addition, implementation of Guiding Principle 3, as stated in Section 6.1 within the *Description of the Proposed Action* and Section 9.2.2.2.1 *Framework for Programmatic Consultation*, will ensure that future CWF actions promote turbidity in appropriate locations and times to improve habitat for the species. This Guiding Principle is anticipated to minimize adverse effects of CWF sediment removal to delta smelt designated critical habitat.

- **Food entrainment:** Water exports directly entrain aquatic phytoplankton and zooplankton (Arthur *et al.* 1996; Jassby and Cloern 2000). Annual primary production in the estuary can vary annually due to several factors including consumption by the invasive overbite clam, a long-term decline in total suspended solids, and river flow (Jassby *et al.* 2002). To predict the effects of the PA, phytoplankton carbon was used as an indicator of food web material entrainment. Modeling results suggests that the NDD would seldom if ever entrain more than 5.35% of the Delta's standing stock of phytoplankton in any given month (Table 6.2-20, CWF BA 2016). The export of plankton at the NDD would be offset by the likely increase in organic matter from the more productive San Joaquin River water (Cloern and Jassby 2000). San Joaquin River water contribution at Collinsville (on the Sacramento River north of Sherman Island) is expected to increase across all months and all WY types. It is highly probable that NDD losses will be compensated by San Joaquin River zooplankton production and transport, particularly in summer and fall, during juvenile rearing. Therefore, it is expected that the PA will not cause a net change in the distribution or availability of food in critical habitat. In addition, implementation of Guiding Principle 5, as stated in Section 6.1 within the *Description of the Proposed Action* and Section 9.2.2.2.1 *Framework for Programmatic Consultation*, will ensure that future CWF actions promote food production and transport to critical habitat. This Guiding Principle is anticipated to minimize adverse effects of CWF to delta smelt designated critical habitat by ensuring that future CWF actions are developed in a manner to increase food production and transport into areas accessible to delta smelt.

- ***Microcystis*:** Harmful algae blooms, which can produce toxins, are associated with slow-moving, warm, nutrient rich water. Operations under the PA will increase San Joaquin River outflows during summer by reducing CVP and SWP pumping. Summer outflow under the PA will reduce the likelihood of San Joaquin River at Jersey Point flow falling within the -240 to 50 m^3/s range that is associated with harmful algal blooms in the Delta (Lehman *et al.* 2013). The same CVP and SWP pumping reduction will also cause residence times to increase at Mildred Island and in Middle River. However, should this projected change in residence time increase the frequency of blooms, OMR flows will be negative which will tend to disperse the blooms toward the CVP and SWP and into exports rather than toward the critical habitat supporting rearing of juvenile smelt. Thus, the PA may result in a small increased risk of harmful algal bloom frequency, but the PA water operations will result in little to no alteration to water quality in critical habitat. In addition, implementation of Guiding Principle 7, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*, will ensure that future CWF operations will coordinate south Delta and NDD water facilities to limit the effects to delta smelt from cyanobacteria blooms. This Guiding Principle is intended to protect delta smelt populations and should concomitantly minimize the adverse effects of CWF to water quality in delta smelt designated critical habitat.

- **Selenium:** Selenium is a micronutrient needed by all vertebrates; however, large doses can lead to structural deformities and reproductive failure in fish (Lemly 1993; Lemly 2002). Selenium accumulation at higher trophic levels through dietary exposure can result in deformities and reduced survival. Reductions in south Delta exports will cause small increases of selenium loading into the Delta and Suisun Bay. Operations under the PA will result in an increase in the proportion of San Joaquin River water entering the Delta and

Suisun Bay by reducing the amount of San Joaquin water exported out of the Estuary via the CVP and SWP. By increasing San Joaquin water contribution, the PA results in a small degradation in water quality; however, there is an extremely small likelihood (less than 1% change) that the PA will alter or degrade selenium concentrations such that water quality (PCE2) will not serve its conservation function for the species (CWF BA 2016).

9.2.3.3 Effects to Delta Smelt Critical Habitat for PCEs 1, 3, and 4 by Life Stage

9.2.3.3.1 Spawning Habitat

PCE 1 – Physical Habitat

Delta smelt require physical habitat (meaning specific water depth and in-water substrates) during spawning because the eggs need to attach to substrates that will not smother them during incubation. The construction of the NDD will remove 5.6 acres of critical habitat that include spawning habitat. The three NDD intakes and fish screen structures, each ranging from 1,497 to 1,969 feet in length, will also create an impediment within critical habitat that is likely to isolate another 245 acres of transiently occupied critical habitat with shorelines that include spawning habitat in the Sacramento River from RM 36.8 to the I Street Bridge in Sacramento. This impediment is likely to prevent migrating adult delta smelt from using this spawning habitat. Delta smelt are seasonal residents of the Sacramento River from Isleton to Garcia Bend from February-May. In the Sacramento River above Georgiana Slough, upstream spawning migration is physically more difficult due to the lack of tidal excursion and higher spring river discharge, and thus fewer delta smelt disperse above this location than other areas of the estuary. The Service expects the NDD will limit the seasonal northward expansion of delta smelt range to about the downstream-most diversion near Clarksburg. See 9.2.3.3.4 *Adult Migration Habitat (PCE 1 – Physical Habitat)* for a detailed explanation of how the in-water structures block, delay, or impede migration. Although not currently preferred by the majority of spawners, the exclusion of delta smelt from the northernmost portion of the delta smelt critical habitat would reduce the amount and complexity of available spawning habitat including cooler, freshwater which the species may need during drier years and extreme drought. This area of the Sacramento River also provides critical habitat that could have increasing importance due to sea level rise, reductions in precipitation in the northern Sacramento Valley, and increasing water temperatures associated with climate change.

In the PA, DWR has proposed to compensate for spawning habitat loss through compensatory mitigation prior to construction, including, but not limited to, the purchase of credits at an approved conservation bank (see *Description of the Proposed Action* for details of the proposed mitigation). If compensatory mitigation in the form of spawning habitat improvements were to occur in the Sacramento River from Isleton to Hood, it may ameliorate the loss of critical habitat from the construction footprint. Restoration of 1,827.7 acres of habitat suitable for delta smelt is proposed, of which 74.7 acres is intended to minimize construction effects from the HORG and barge landings, and 1,753 acres is intended to minimize effects from permanent loss of shallow water habitat in the vicinity of and upstream of the NDD. Implementation of Guiding Principle 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*, is intended to restore, create, or enhance spawning habitat conditions through mitigation commitments made by the CWF PA and through actions described in the Delta Smelt Resiliency Strategy. This Guiding Principle is intended to minimize adverse effects to spawning habitat within designated critical habitat.

Construction of the HORG and barge landings will permanently affect 2.9 acres and 22.4 acres of designated critical habitat, respectively. PCEs are present near the HORG, but degraded. Physical habitat for spawning is degraded by steep, leveed, and riprapped banks. Additionally, transport flows are not appropriate to move larvae and juveniles to rearing habitat (entrainment is probable) and water quality is degraded by agricultural drainage.

9.2.3.3.2 Larval and Juvenile Transport Habitat

PCE 3 – River Flow

The PA will directly influence river flows in the Delta and Suisun Bay, which in turn will affect the quality and quantity of delta smelt critical habitat (Service 1994; Bever *et al.* 2016). Exports have the ability to directly alter river transport flows and can interfere with tidal and downstream transport of larvae and juvenile delta smelt to LSZ rearing habitats, resulting in entrainment. However, the shift in exports from the south Delta to the north Delta during the larval and juvenile transport period is expected to maintain or improve transport flow function and decrease entrainment of larval and juvenile delta smelt at the CVP and SWP. In the south Delta, OMR flows more positive than -2000 cfs are expected to provide appropriate transport flows for larval and juvenile smelt from spawning locations in the San Joaquin River and eastern Delta to the LSZ. OMR flows more positive than -5000 cfs are expected to provide appropriate transport flows for larvae and juveniles being transported through Three-Mile Slough and the lower San Joaquin River between Antioch and Jersey Point. Modeled OMR flows are more positive for the PA than modeled projected baseline conditions in March and June and are similar in April and May. OMR will never be more negative than -5000 cfs during the months of March to June (Figure 9.2.3.3.2-1).

River flow may be reduced by the water exports at the NDD as transport flows in shallow water along the eastern stream bank would entrain or impinge eggs and larvae. However, due to the migration impediment presented by the NDD, delta smelt are highly unlikely to be spawned upstream once in-water construction begins.

During the months of December through June, additional protections may be implemented during RTO to protect pulses of out-migrating salmonids in the mainstem of the Sacramento River, which will result in a reduction in water exports at the NDD (refer to the revised May 5, 2017 *BiOp Resolution Log*). CalSim II and the subsequent step-down analyses were not modeled to capture these changes in future decisions because they are based on RTO which is based on fish presence which are unknown at this time. During RTO, there is a potential for a shift in exports between the NDD and south Delta that could increase south Delta water exports in such a way that would reduce the transport flows for larvae and juvenile delta smelt. Subsequent consultations will occur as they relate to those CWF activities subject to future Federal approvals, such as the dual conveyance operations, in which Reclamation and DWR have committed to analyze and further address species effects from CWF operations at that time (refer to the *Consultation Approach* in the *Description of the Proposed Action*). In addition, implementation of Guiding Principle 2, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, will ensure that as future development of CWF operational criteria occurs, in coordination with the CVP and SWP operations in the south Delta, minimization of entrainment of larvae and juvenile delta smelt will be implemented. This Guiding Principle should minimize adverse effects of CWF to larval and juvenile transport flows in delta smelt designated critical habitat.

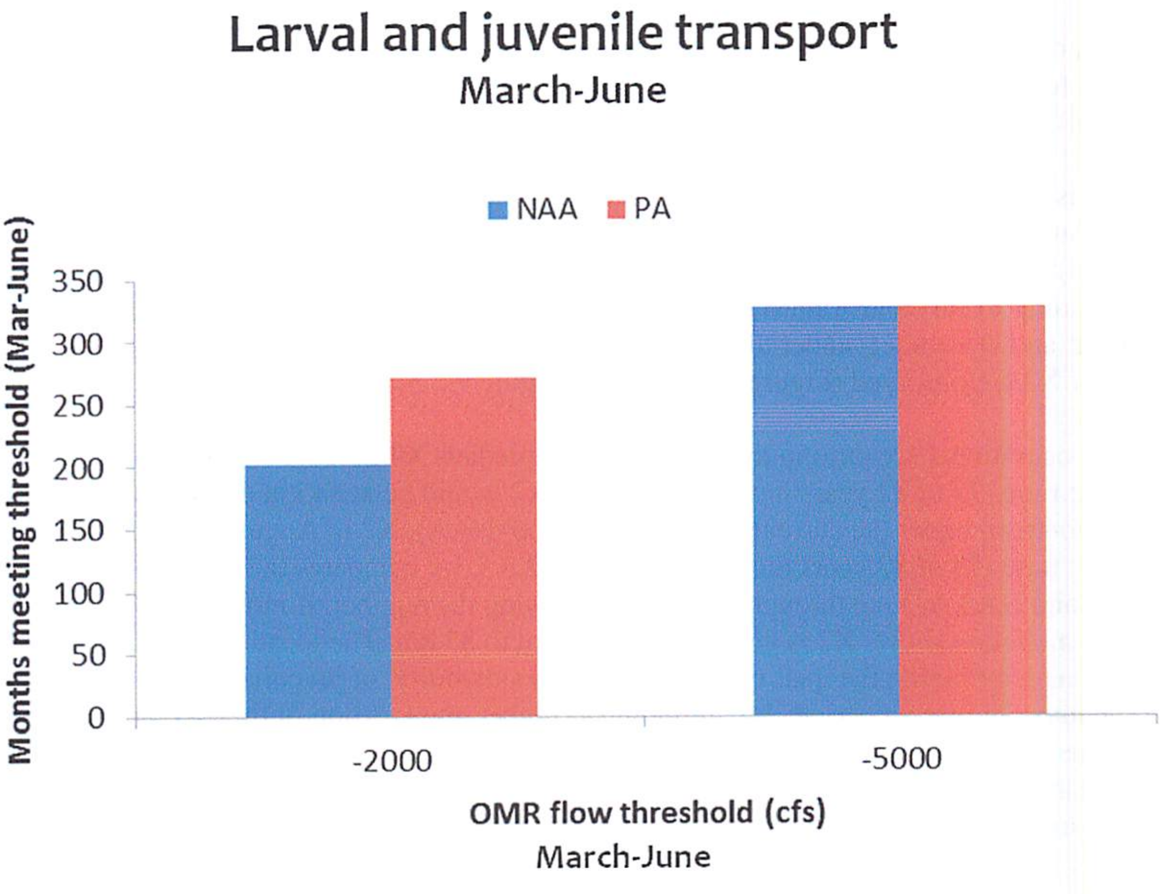


Figure 9.2.3.3.2-1. Comparison of the frequency of months that the NAA and PA were modeled to meet two OMR flow thresholds during the delta smelt larval and juvenile transport period (March-June). Each month was modeled 82 times for a potential maximum frequency of 82 months times a four month period or 328 on the y-axis.

9.2.3.3.3 Rearing Habitat

PCE 4 – Salinity

The LSZ expands and moves downstream when river flows are high. By exporting river flows, the PA can contribute to upstream movement of the LSZ. Ideal rearing conditions for juvenile delta smelt occur when the location of the LSZ maximizes habitat quantity and quality by providing appropriate salinity, turbidity, and food availability. It is important to note that when X2 is at 81 km or above, the upstream extent of the LSZ differs between the Sacramento and San Joaquin rivers. However, the LSZ on the San Joaquin River in late summer and fall is poor quality due to high water clarity and temperature, thus the Service uses X2 on the Sacramento River as the habitat indicator. Appendix B shows the results of CalSim II modeling for X2 over 82 years for the PA and the current projected baseline condition in kilometers for all months. Figures 9.2.3.3.3-2 through 9.2.3.3.3-8 show the difference between scenarios in kilometers over 82 years of modeling during the month of June, and through the juvenile rearing period (July-December). Note that a positive difference indicates an X2 upstream or eastward of the equivalent current projected baseline (NAA) prediction. Based on 82 years of CalSim II modeling, for the months of July, August, and September, the LSZ is consistently predicted to be upstream of current conditions by as much as 5 km when compared to the NAA. Under the operational scenario in the PA in June, the difference in X2 position over the 82 years of modeling is sometimes upstream and sometimes downstream of the NAA (Figure 9.2.3.3.3-2). In July and August, the majority of years X2 is upstream of the NAA (Figures 9.2.3.3.3-3 and 9.2.3.3.3-4). In September (Figure 9.2.3.3.3-5) the majority of years that X2 is upstream of the NAA is similar to July and August, but the magnitude of the difference is smaller. In October, November, and December, under the operational scenario in the PA, small changes in the location of X2 are observed (Figure 9.2.3.3.3-6 to Figure 9.2.3.3.3-8).

Under the operational scenario in the PA, CalSim II predicts X2 in August would be ≥85 km 94% of the time (77 of 82 years modeled) and thus X2 would be at 84 km or eastward in 5 of 82 years. In contrast, under the current projected baseline (NAA), X2 in August will be ≥85 km 71% of the time (58 of 82 years modeled). Figure 9.2.3.3.3-9 compares the operational scenario in the PA and NAA in June through December, showing the number of months (n=82) in which CalSim II modeling shows X2 is greater than or equal to 85 km. The location of the LSZ is important in determining the quality, both extent and suitability, of juvenile rearing habitat. For all of the juvenile rearing period, July through December, the location of the LSZ upstream of the confluence degrades rearing habitat by decoupling favorable salinity conditions from the food availability, water depths, and wind-driven turbidity of Suisun Bay. At or above 85 km, the LSZ is upstream of Chipps Island, and out of Suisun Bay and the suitable habitat conditions it provides (Figure 9.2.3.3.3-10).

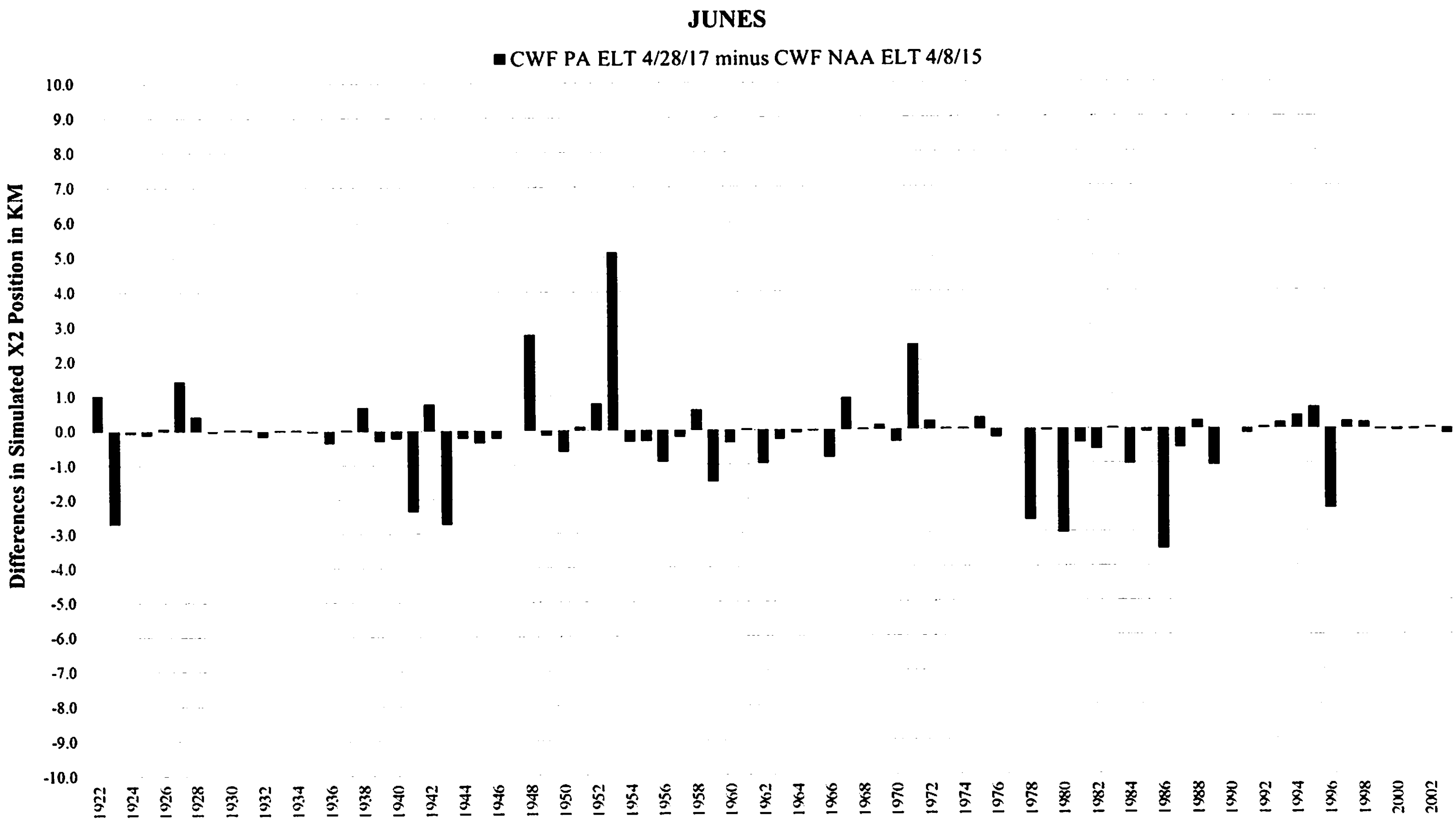


Figure 9.2.3.3.3 Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Junes based on 82 years of CalSim II modeling.

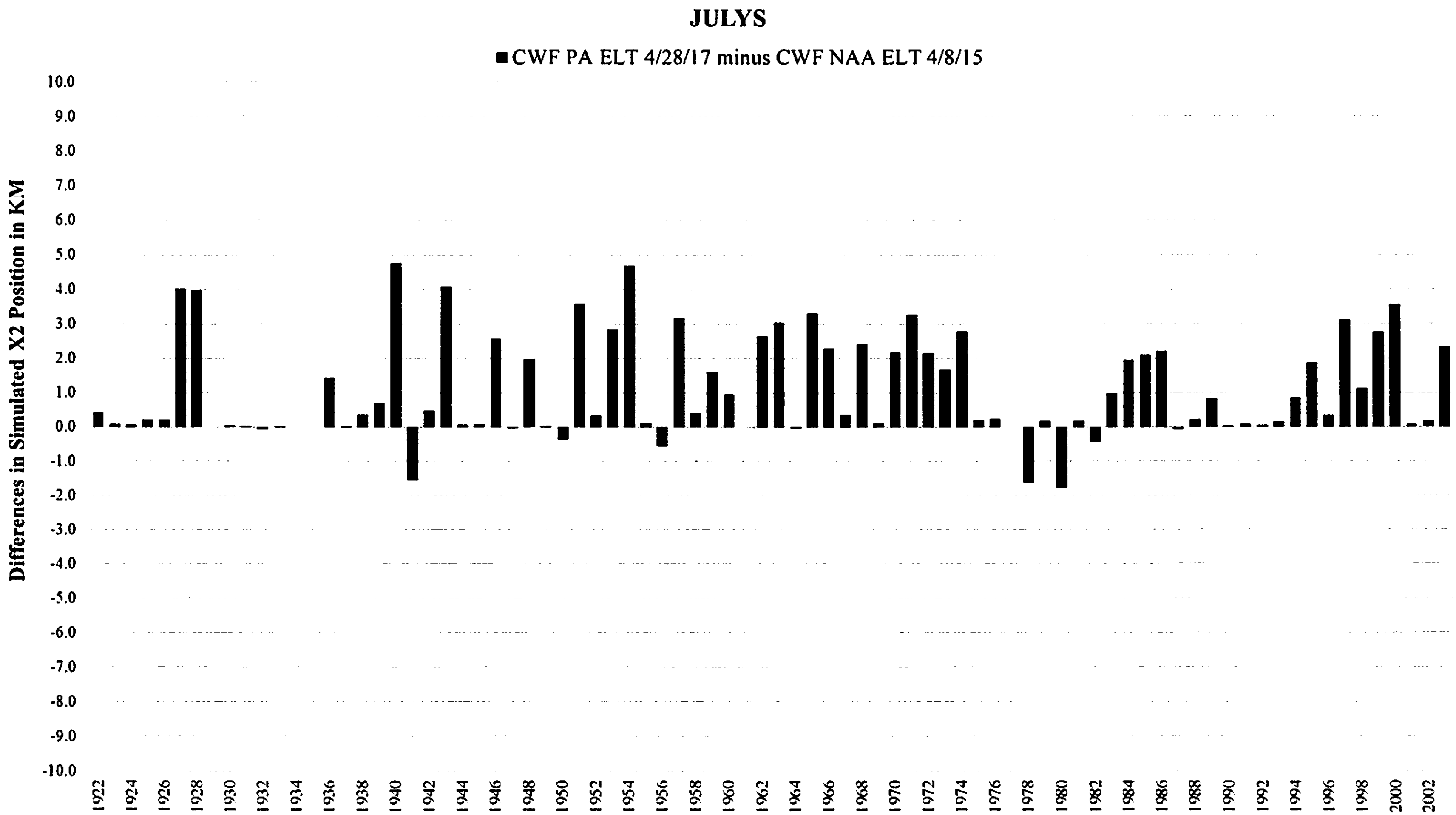


Figure 9.2.3.3.3-3. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Julys based on 82 years of CalSim II modeling.

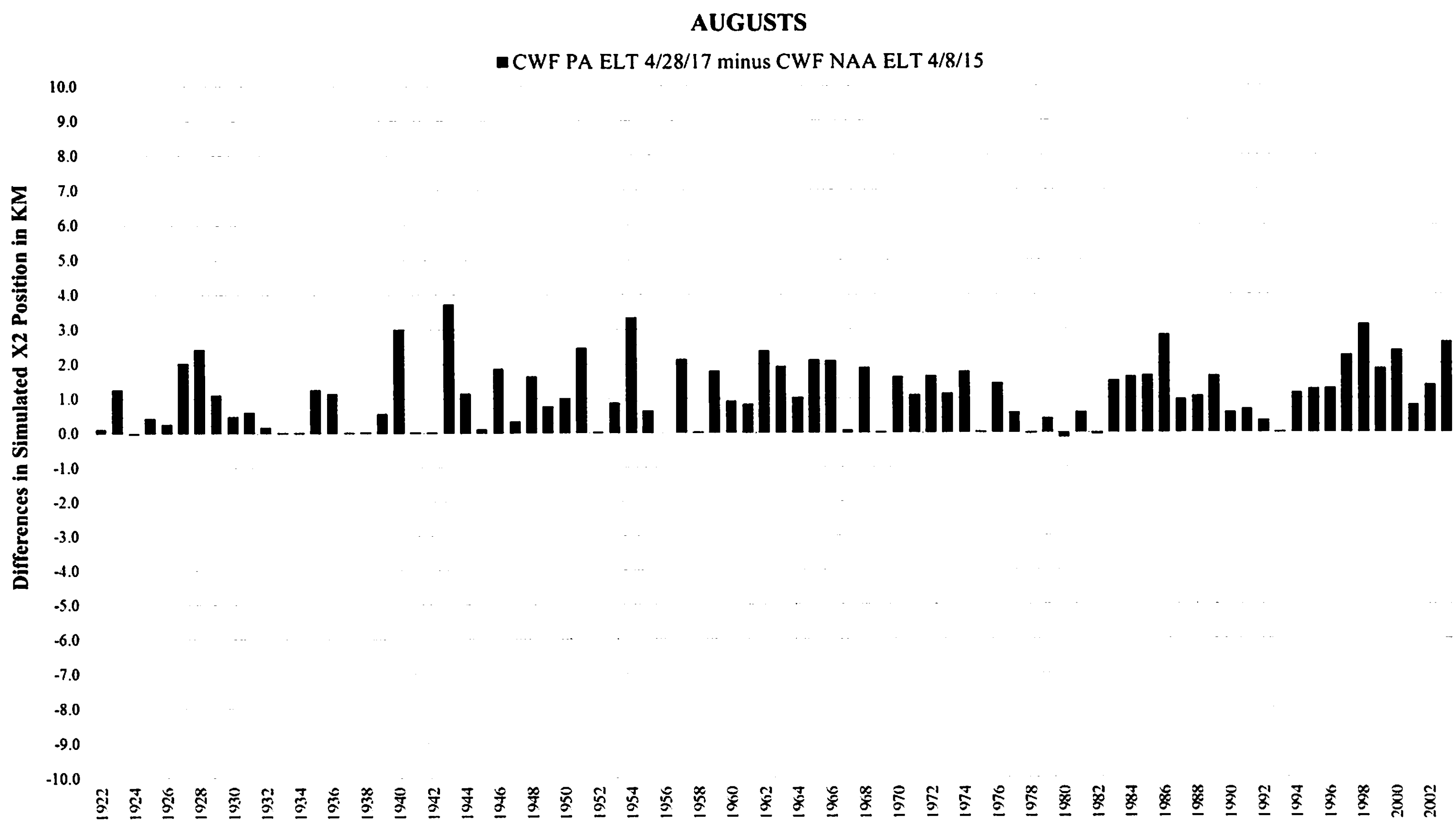


Figure 9.2.3.3.3-4. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Augusts based on 82 years of CalSim II modeling.

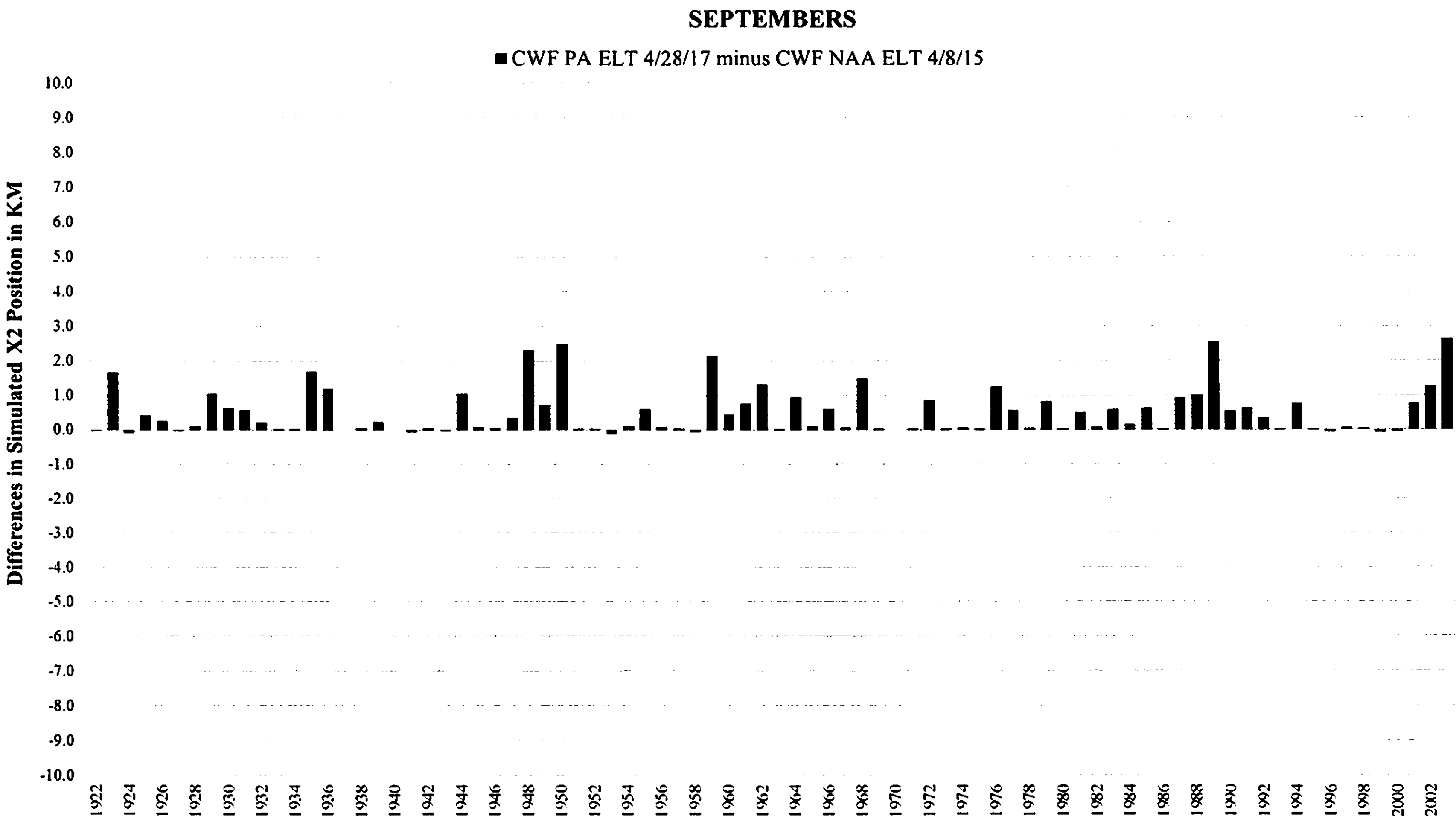


Figure 9.2.3.3.3-5. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Septembers based on 82 years of CalSim II modeling.

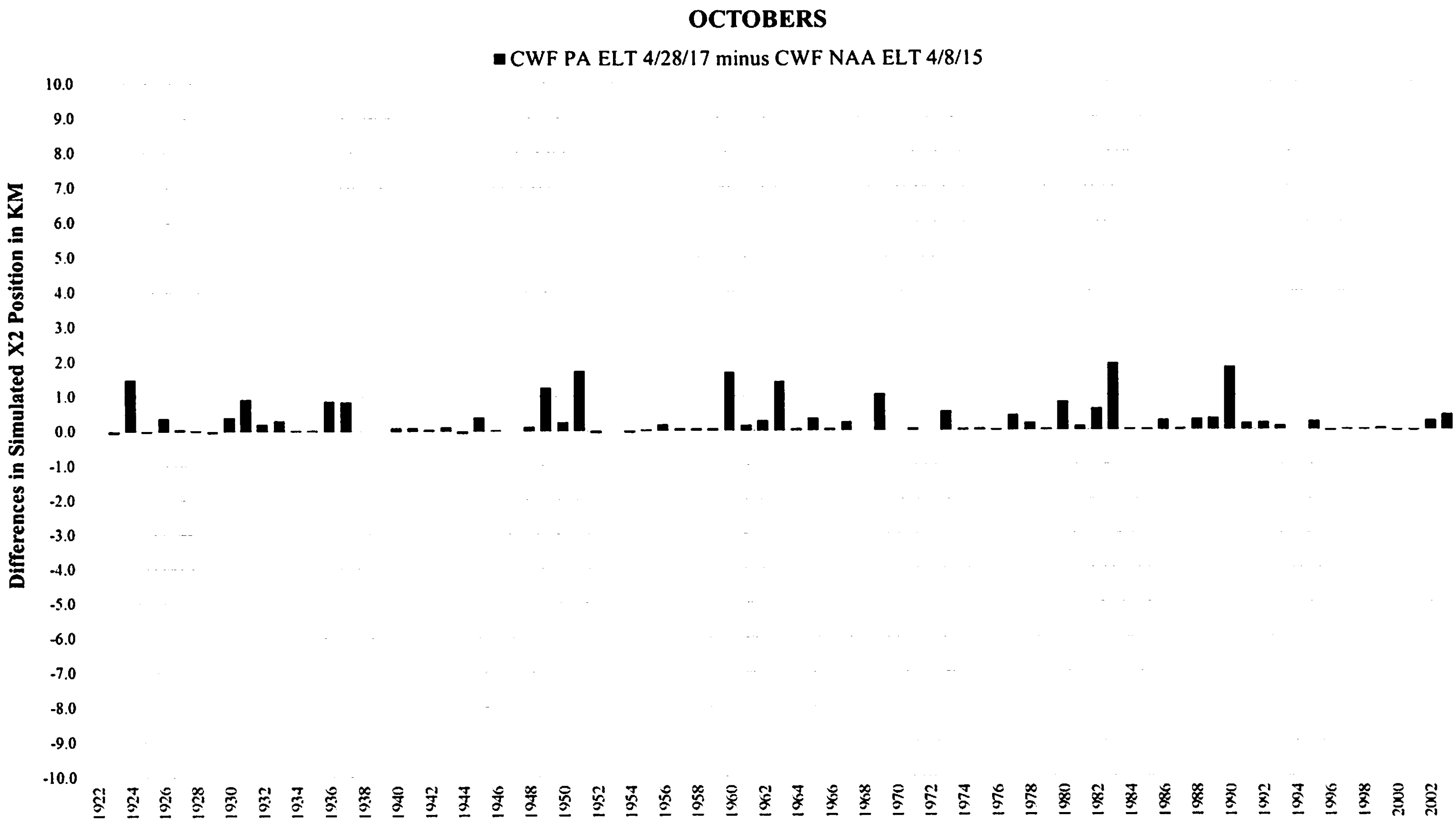


Figure 9.2.3.3.3-6. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Octobers based on 82 years of CalSim II modeling.

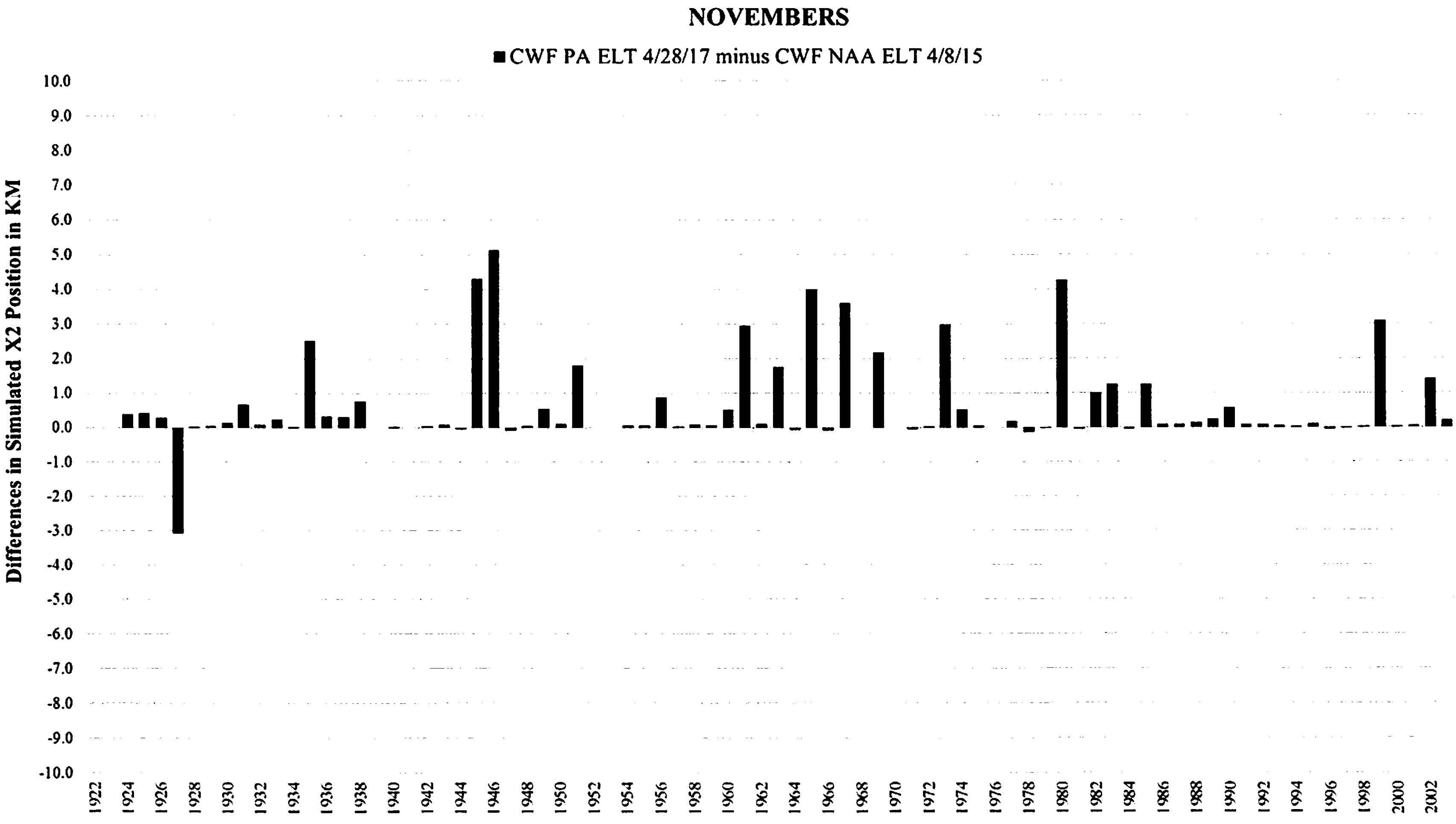


Figure 9.2.3.3.3-7. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Novembers based on 82 years of CalSim II modeling.

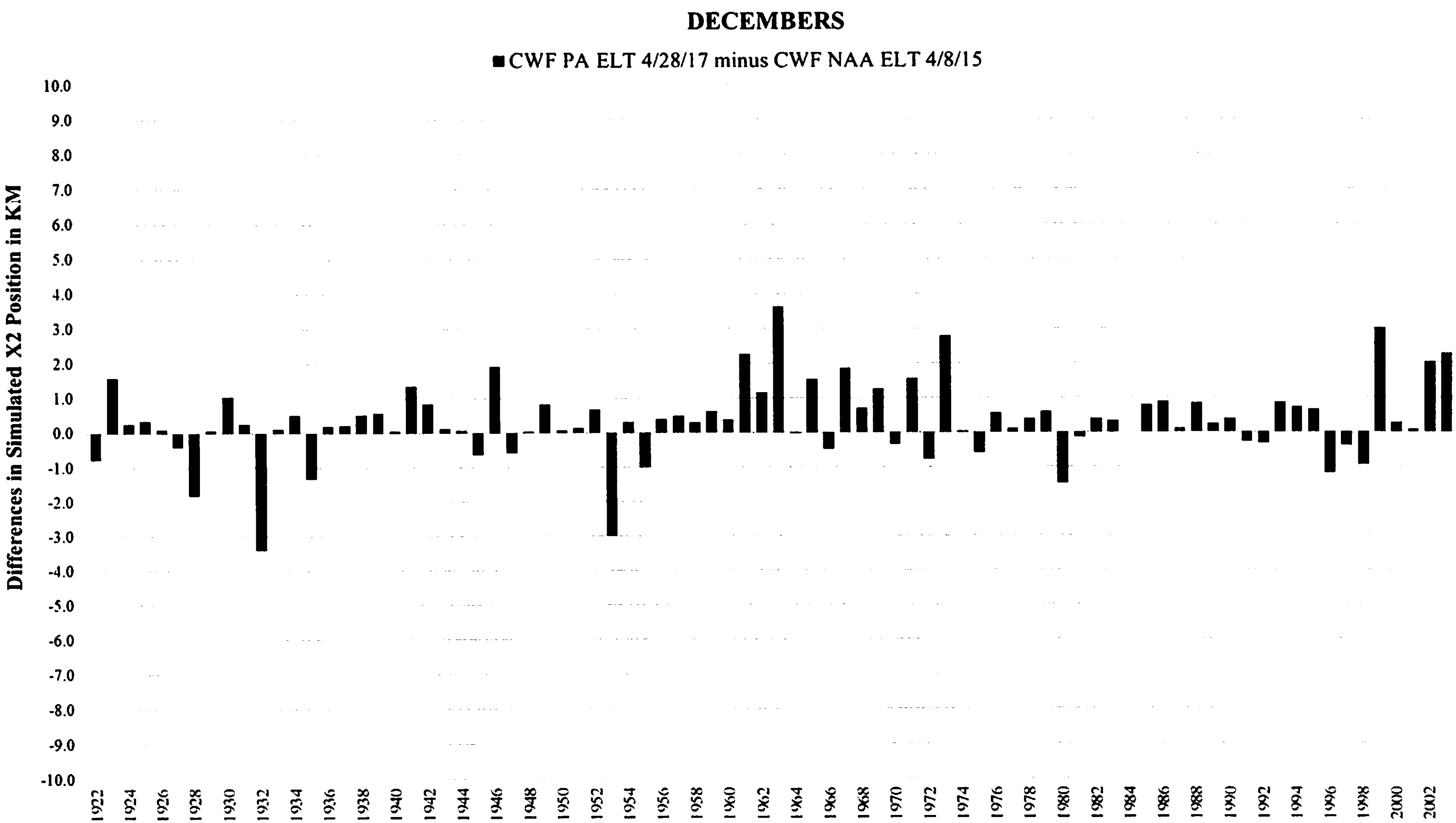
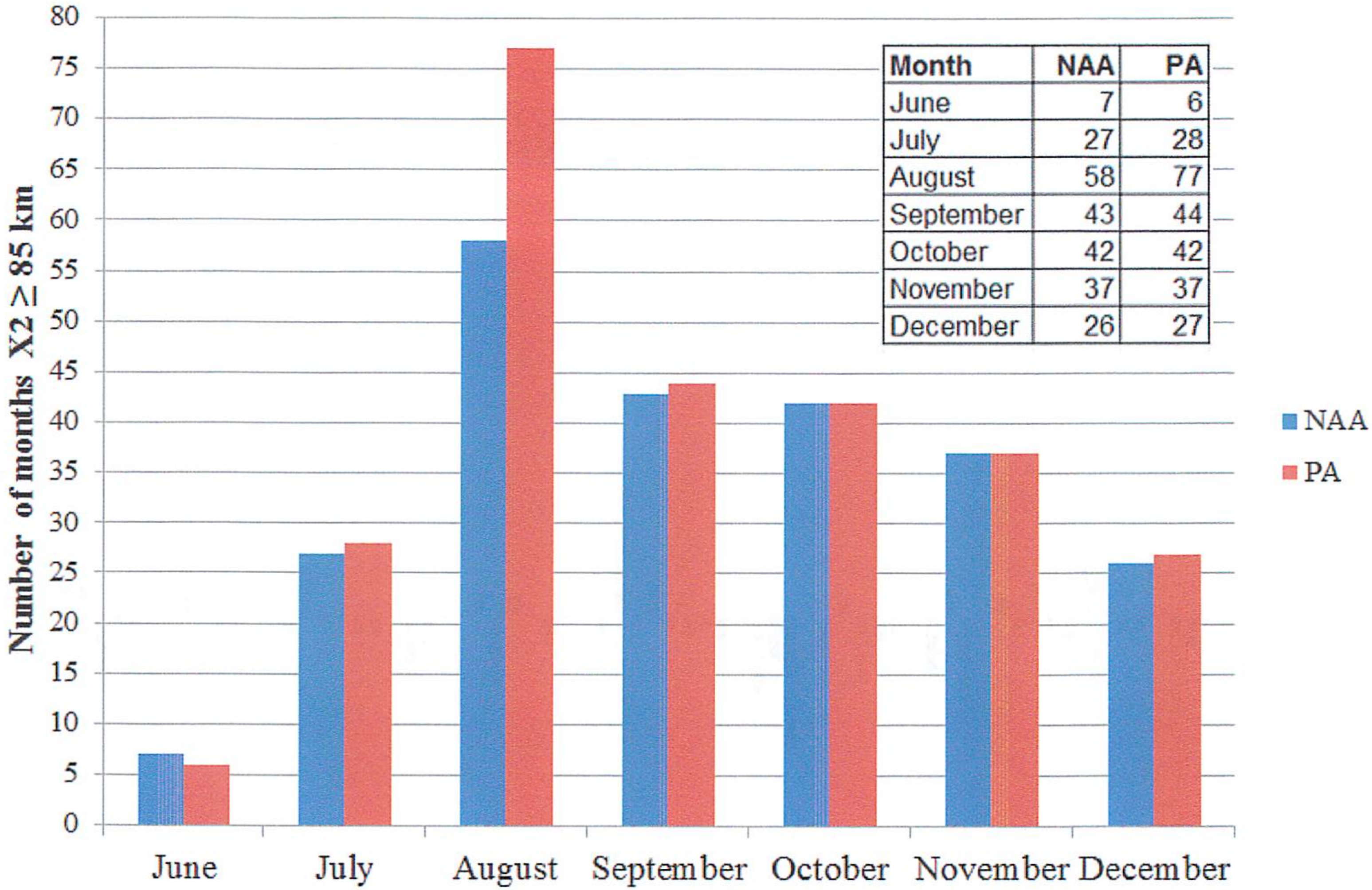


Figure 9.2.3.3.3-8. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Decembers based on 82 years of CalSim II modeling.



Month	NAA	PA
June	7	6
July	27	28
August	58	77
September	43	44
October	42	42
November	37	37
December	26	27

Figure 9.2.3.3.3-9. Comparison of the frequency of months (June-December) for the NAA and PA that CalSim II modeling (n=82) indicates that X2 is at or above 85 km from the Golden Gate Bridge (no overlap of the low-salinity zone with Suisun Bay).

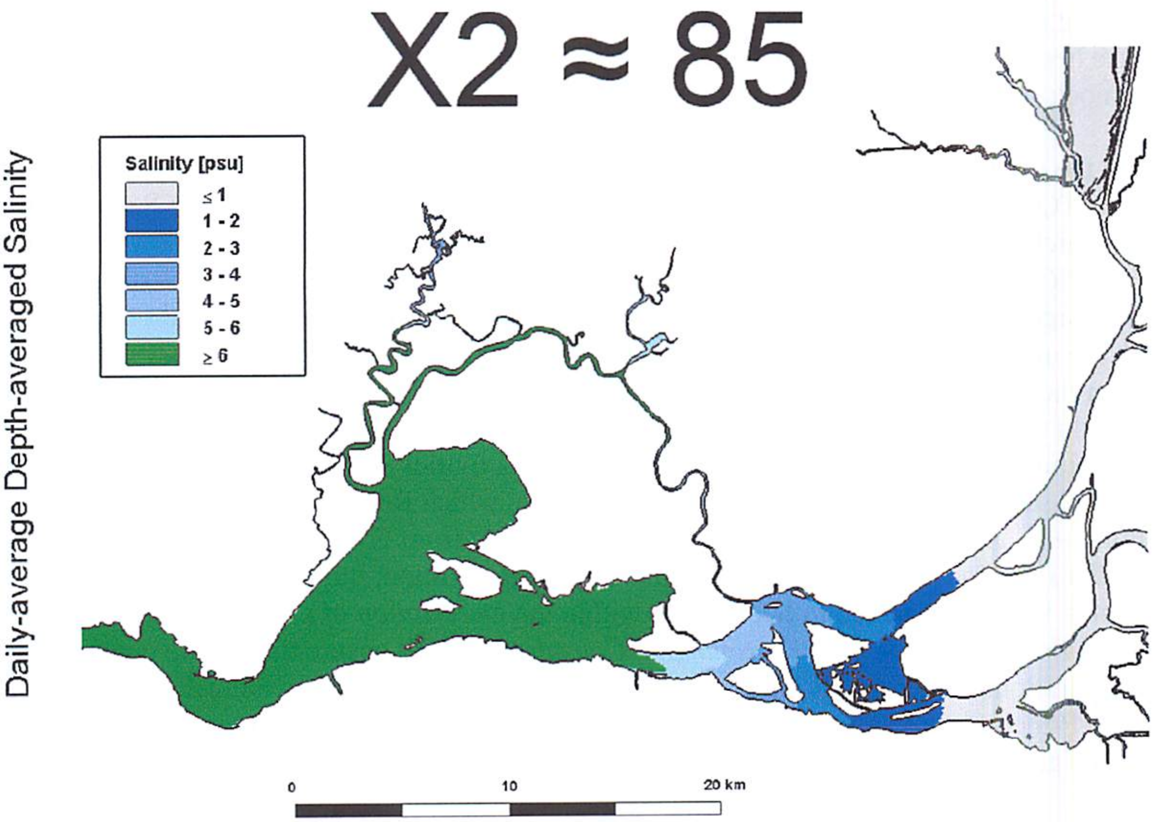


Figure 9.2.3.3.3-10. Daily-averaged depth-average salinity in psu (practical salinity units) between Carquinez Strait and the western Delta for X2 located at 85 km (Delta Modeling Associates 2012).

An additional consequence of the upstream encroachment of X2 by the operational scenario in the PA is increased salinity in the western part of designated critical habitat (approximately 10%), as suggested by the DSM2-QUAL modeling in Montezuma Slough for August and September. This projected salinity increase would further degrade juvenile rearing critical habitat for delta smelt. The preferred salinity range for delta smelt is between about 0.5 and 6 ppt (Kimmerer 2004; Komoroske *et al.* 2016). Delta smelt can tolerate higher salinities, but increased osmoregulation comes at an energetic cost that is highly undesirable to a food-limited fish (Hammock *et al.* 2016; Slater and Baxter 2014). In Montezuma Slough at National Steel in eastern Suisun Marsh, salinity in August is currently above 6 ppt 10% of the time. Under the operational scenario in the PA, salinity would exceed 6 ppt 20% of the time. In September, salinity conditions favorable for smelt would be projected to decrease in frequency from 50% of the time to 40% of the time (CWF BA 2016, Table 5.B.5-28). Thus, the operational scenario in the PA would result in favorable salinity for rearing in Montezuma Slough at National Steel in only wet and above normal years. Further west in Montezuma Slough at Beldon's Landing in north-central Suisun Marsh, favorable salinity conditions in August would occur only 40% of the time and only during wet and above normal years (CWF BA 2016, Table 5.B.5-27). September salinity conditions would be favorable 30% of the time and only in wet years. Salinity in Montezuma Slough would improve in October and November, but this improvement in designated critical habitat quality could only be realized by fish that survive through August and September. Suisun Marsh, including Montezuma Slough, is high quality habitat for delta smelt, because here these fish exhibit better condition and growth, reduced contaminant exposure (Hammock *et al.* 2015), and no risk of entrainment into the CVP and SWP.

During the months of December through June, additional protections may be implemented during RTO to protect pulses of out-migrating salmonids in the mainstem of the Sacramento River, which will result in a reduction in water exports at the NDD (refer to the revised May 5, 2017 *BiOp Resolution Log*). CalSim II and the subsequent step-down analyses did not model these changes in future decisions because they are based on RTO which is based on fish presence which are unknown at this time. During RTO, there is a potential for there to be a shift in exports between the NDD and south Delta that could increase south Delta water exports in such a way that would change the location and suitability of the rearing habitat at the LSZ. Subsequent consultations will occur as they relate to those CWF activities subject to future Federal approvals, such as the dual conveyance operations, in which Reclamation and DWR have committed to analyze and further address species effects from CWF operations at that time (refer to the *Consultation Approach* section of this BiOp). In addition, implementation of Guiding Principles 1 and 2, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, will ensure that future development of CWF operational criteria will improve habitat conditions for rearing juvenile delta smelt. These Guiding Principles are anticipated to minimize adverse effects of CWF to rearing habitat in delta smelt designated critical habitat.

9.2.3.3.4 Adult Migration Habitat

PCE 1 – Physical Habitat

Delta smelt require specific in-water substrates only for spawning, but depth variation is helpful for small fish migrating upstream against net downstream river flows. The in-water structures associated with the NDD construction will block or impede access to critical habitat, preventing migration by adult delta smelt from the downstream-most diversion near Clarksburg to the northern limit of delta smelt critical habitat. Construction cofferdams and the subsequent three NDD intakes and fish screen structures, ranging from 1,497 to 1,969 ft in length, will block, delay, or impede adult fish migration.

Conceptually, delta smelt migrate upstream, using the flood tide and use areas of hydrologic refuge (near the bottom or shoreline) to maintain its position in the estuary during the ebb tide. In the Sacramento River above Georgiana Slough the tide no longer reverses the direction of water flow but slows river velocity. In the Sacramento River above Georgiana Slough, upstream spawning migration is physically more difficult due to the lack of tidal excursion and higher spring river discharge, and thus fewer delta smelt disperse above this location than other areas of the estuary.

Delta smelt ascending the river cannot swim against mid-channel velocities for an extended time and thus critical habitat must provide low velocity paths to facilitate upstream migration along the Sacramento River while also providing cover to avoid predation (CWF BA 2016). In downstream locations vertical and lateral smelt distribution changes have been observed (Bennett *et al.* 2002; Feyrer *et al.* 2013; Bennett and Burau 2015), but these previous studies provide no evidence that delta smelt show affinity to one side of the river or the other when they move on and off shore.

Once constructed, each of the NDD intakes form a vertical wall extending laterally for 1,030-1,404 ft along the east bank of the Sacramento River and extending into the river channel (Figure 9.2.3.3.4-11). If adult delta smelt attempt to ascend the east bank of the river, they will no longer have contiguous shoreline and will need to swim against in-channel velocities if they attempt to pass the screens. By virtue of small body size, delta smelt are relatively "poor" swimmers (Swanson *et al.* 1998). In addition, they are non-continuous swimmers.

For a delta smelt to swim upstream at all, the river velocity has to be less than its sustainable swimming speed. If the river velocity is higher than the sustainable swimming speed and delta smelt cannot escape the current, then they will be pushed back downstream. Based on the observed swimming speed of delta smelt in treadmill studies (Swanson *et al.* 1998; Young *et al.* 2010), the NDD fish screen sweeping velocities, and the length of each NDD screen, the available evidence indicates that a delta smelt would seldom be able to migrate up the east side of the river past a single screen, let alone the length of all three screens, to access the Sacramento River above Clarksburg.

It is also unlikely that delta smelt could exclusively use the west bank to migrate past the NDD. The Sacramento River makes 6 major bends between Isleton and Freeport shunting the highest velocity parts of the river cross section back and forth across the channel, requiring fish to change banks to avoid being swept downstream. In addition to this shifting high velocity water, it seems unlikely that delta smelt could keep swimming up one bank of the river from Isleton to areas upstream because they would eventually need to avoid a predator or be displaced off the shoreline at night when they lose visual reference and become less active. Both of these phenomena would tend to mix migrating smelt across the shorelines from day to day.

Based on observed delta smelt swimming performance, screen length, screen sweeping velocities, and river water velocities during the spring spawning period, it is likely that the NDD in-water structures will delay, impede, or block upstream adult spawning migration, inhibiting the ability of upstream critical habitat to provide for adult migration and spawning. Although not currently preferred by the majority of migrating adults, the elimination of habitat in the northern portion of the delta smelt critical habitat reduces the volume and complexity of available spawning habitat including cooler, freshwater which the species may need during drier years and extreme drought. As addressed in Guiding Principle 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*, compensatory mitigation in the form of spawning habitat improvements in the Sacramento River will be provided at a site or sites that will provide the most benefit for delta smelt critical habitat into the future. Mitigation in the form of spawning habitat creation or restoration in the Sacramento River from Isleton to Hood will minimize the loss of critical habitat from the construction footprint. Habitat mitigation in areas (*e.g.*, west Delta, central Delta, north Delta, Cache Slough) may also compensate for lost spawning habitat but will be less representative of the spawning habitat and its conservation value lost due to the NDD, which includes spawning substrate located in cold, freshwater during drought.

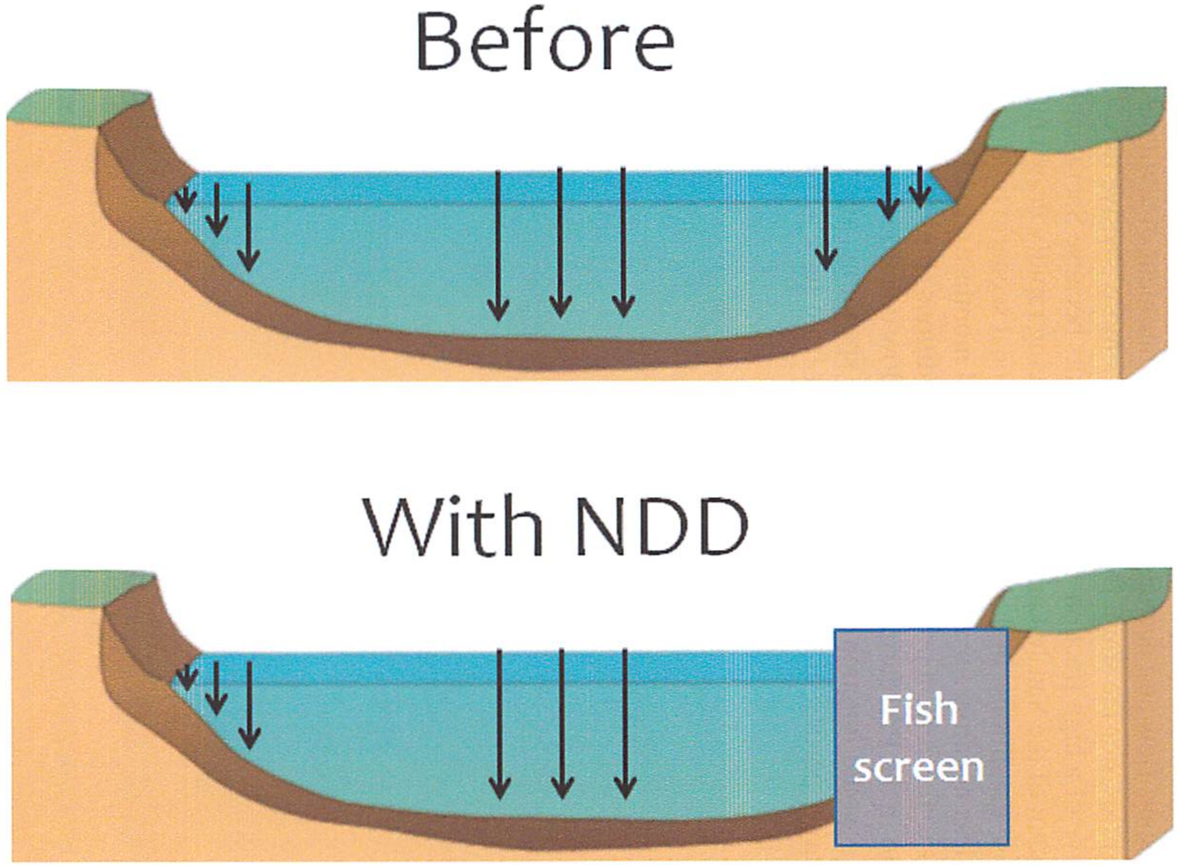


Figure 9.2.3.3.4-11. Demonstration of the low velocity stream margin habitat that will be removed by the NDD construction, intakes, and fish screens. Low velocity habitat is needed by delta smelt to migrate upstream in the Sacramento River above Isleton.

PCE 3 – River Flow

Adult delta smelt need unrestricted access to suitable spawning habitat from December to July. Adequate flow must be maintained to attract migrating adults in the Sacramento and San Joaquin River channels, and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas also should be protected from physical disturbance and flow disruption during spawning migration.

Freshwater flows in combination with increasing turbidity are cues for adult delta smelt to migrate to spawning habitat in December through March (Sommer *et al.* 2011). South Delta water exports alter critical habitat by drawing turbid Sacramento River water into the central and south Delta, encouraging the migration of adult delta smelt further south and east, making them and their offspring vulnerable to entrainment. However, the shift in exports from the CVP and SWP to the NDD during the migration period is expected to maintain or improve critical habitat function related to transport flow and decrease the risk of entrainment of adult delta smelt at the south Delta export facilities. For the south Delta, OMR flows more positive than -2000 cfs are expected to be protective of a high fraction of migrating adults because Sacramento River water flowing into the mainstem of the San Joaquin River is not being rapidly drawn into Old and Middle river under those conditions. In the potential operational scenario presented in the PA, OMR flows would be less negative for adult migration in all months except December, in which flows would be similar to the current projected baseline conditions (Figure 9.2.3.3.4-12). Under the operational scenario in the PA, during adult migration, flow conditions in critical habitat would be increased and would function appropriately to cue spawning, and would reduce entrainment risk in a larger portion of the San Joaquin River from Jersey Point to Prisoners Point.

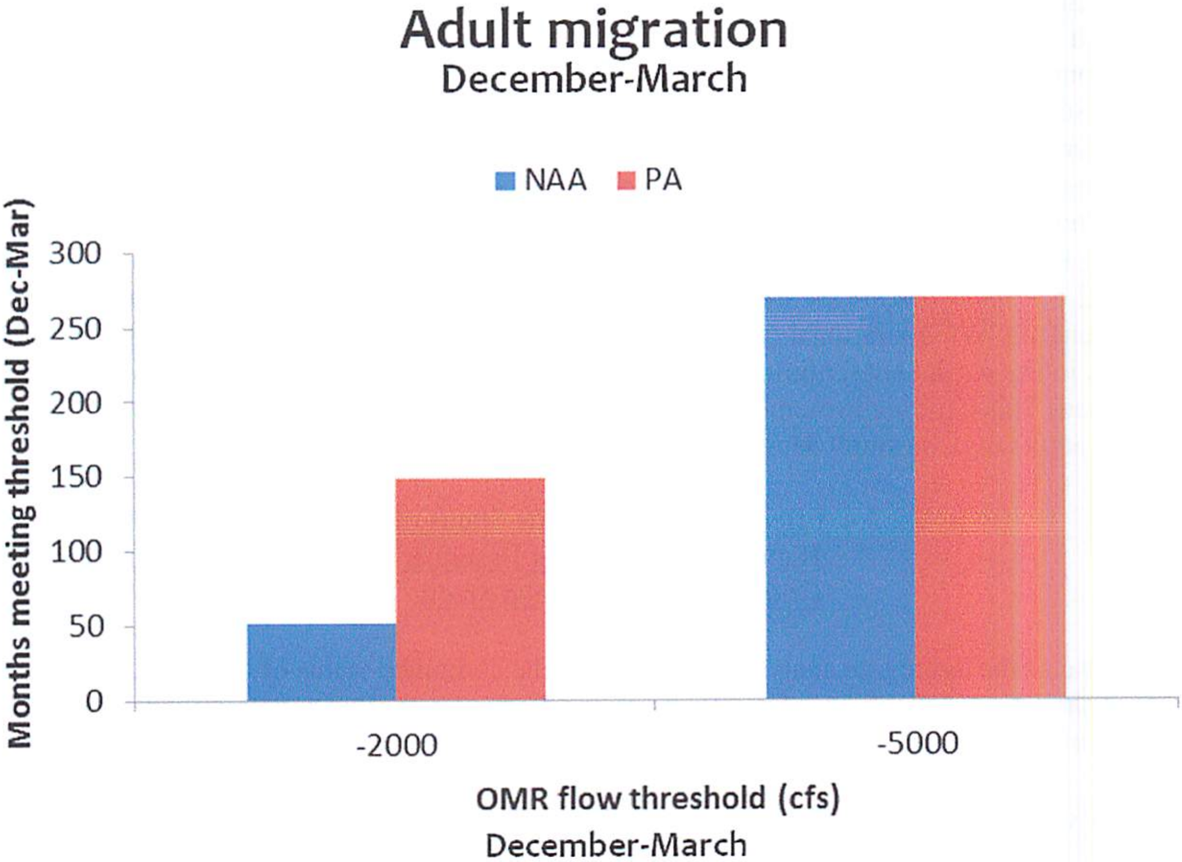


Figure 9.2.3.3.4-12. Comparison of the frequency of months that the NAA and PA were modeled to meet two OMR flow thresholds during the delta smelt adult migration period (December-March). Each month was modeled 82 times for a potential maximum frequency of 82 months times a four month period or 328 on the y-axis.

Small reductions in Delta outflow are predicted during the migration period because total exports would increase. Sacramento River flows would be reduced by small proportions (3-24%) in all months, with the highest flow reductions occurring during the migration period. Flows in the San Joaquin River near Antioch would be reduced in December but increase from January through March. Increased flows in the San Joaquin River during spawning migration would encourage delta smelt to use the San Joaquin River for spawning. Increased outflow in the San Joaquin River would improve the access to spawning habitat and provide appropriate habitat conditions for adult spawning and migration.

During the months of December through June, additional protections may be implemented during RTO to protect pulses of out-migrating salmonids in the mainstem of the Sacramento River, which would result in a reduction in water exports at the NDD (refer to the revised May 5, 2017 *BiOp Resolution Log*). CalSim II and the subsequent step-down analyses were not modeled to capture these changes in future decisions because they are based on RTO which is based on fish presence, which is unknown at this time. During RTO, there is a potential for there to be a shift in exports between the CVP and SWP facilities (NDD and south Delta) that could increase south Delta water exports in such a way that would reduce freshwater flow for adult migrants. Subsequent consultations will occur as they relate to those CWF activities subject to future Federal approvals, such as the dual conveyance operations, in which Reclamation and DWR have committed to analyze and further address species effects from CWF operations at that time (refer to the *Consultation Approach* section of this BiOp). In addition, implementation of Guiding Principle 2, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, will ensure that as future development of CWF operational criteria occurs, in coordination with the CVP and SWP operations in the south Delta, minimization of entrainment of migrating adult delta smelt will be incorporated. This Guiding Principle should minimize adverse effects of CWF flows for migrating adults in delta smelt designated critical habitat.

9.2.3.4 Effects of the Aggregate Status of the Critical Habitat/Environmental Baseline, and Proposed Action on PCEs of Critical Habitat for Delta Smelt

The purpose of the aggregate analysis is to evaluate the combined status of critical habitat, the effects of the PA, and the cumulative effects of non-Federal activities to determine their combined effects to critical habitat, its PCEs, and their conservation function and value.

Summary of the Status and Environmental Baseline for Critical Habitat

As discussed in the Status of Critical Habitat section, the status of delta smelt critical habitat is poor, although the majority of PCEs are present at certain times in most locations (Table 9.2.3.4).

PCE 1 – Physical habitat
Dredging and shipping channel maintenance increase water depths and increase water supply demands needed to maintain the LSZ in Suisun Bay. Levees are covered in large riprap for erosion protection. Over time, both dredging and levee construction and maintenance may have reduced the availability of spawning habitat along channel margins in the Delta. Although altered, spawning habitat with water depth variation is suitable in Suisun Bay and the larger channels of Suisun Marsh, the lower Sacramento River to the I-Street Bridge (including Cache Slough) and the lower San Joaquin River to approximately the City of Stockton.

PCE 2 – Water quality
At the Cache Slough/Liberty Island complex and the upper Sacramento Deepwater Ship Channel, where food availability appears to be adequate, over-summer water temperatures are warm, increasing metabolic rates, and signs of contaminant damage have been observed, with urban or agricultural pesticide runoff being likely sources. Agricultural drainage and urban stormwater runoff result in the continual presence of low levels of herbicides, fungicides, and insecticides throughout critical habitat. Sediment loading from the Sacramento River watershed

continues to decline, reducing sediment load available for resuspension and the maintenance of a turbid environment, which likely reduces cover from predators and provides light scatter that larvae use to find prey. Although water temperatures are a little lower, food availability at the confluence of the Sacramento and San Joaquin rivers and downstream into Suisun Bay is limited in its ability to support rearing juveniles due to the removal of plankton by the invasive overbite clam. Water quality is appropriate in the lower Sacramento River downstream of Rio Vista and in Suisun Bay (Hammock *et al.* 2015).

PCE 3 – River flow

Increasing winter river flows, which serve as queues for adult dispersal prior to spawning (migrants), are appropriate in the Sacramento River and less frequently in the San Joaquin River. In summer, the LSZ has been located in the river channels away from the wind-driven turbidity and food resources found in the shallows of Suisun Bay and Suisun Marsh. The Delta, particularly since 2011, has seen a proliferation of non-native invasive aquatic vegetation as a consequence of reduced outflow associated with drought. Watershed sediment depletion, high summer inflows to the Delta that do not translate into high outflow, and invasive plants work together to increase water clarity and favor non-native predatory and competitor fishes (Moyle and Bennett 2008). Modifications to export operations by the 2008 Service BiOp RPA have resulted in improved larval and juvenile transport flows in the San Joaquin River via Old and Middle river flow, but there is still some entrainment risk to delta smelt adults, larvae, and juveniles.

PCE 4 – Salinity

Salinities are suitable for adult migration, spawning, and larval transport. For juvenile rearing however, water storage, upstream diversions, and in-Delta exports have contributed to a spatially restricted LSZ, which, in turn, has impacted the extent and quality of habitat. Currently, summer-fall salinities in Suisun Bay, Suisun Marsh, and Montezuma Slough are within delta smelt salinity tolerance during the juvenile rearing period (Komoroske *et al.* 2016). However, the delta smelt seldom occurs in the estuary at salinities that begin to cause it physiological stress. Thus, salinity increases linked to changes in Delta outflow tend to be associated with an eastward shift in the spatial distribution of the delta smelt population (Nobriga *et al.* 2008), presumably because salinities can increase beyond what is optimal for osmoregulation given available food resources (Komoroske *et al.* 2014; 2016).

Table 9.2.3.4 The baseline condition and effects of the PA for each delta smelt critical habitat PCE.

Primary Constituent Element	Migrating adults		Spawning adults	
	Baseline	**PA**	**Baseline**	**PA**
PCE 1: Physical habitat	N/A	N/A	Invasive aquatic plant encroachment, dredging altered depths and substrate, channels leveed and riprapped.	Migration impediment along Sacramento River, habitat loss from footprint.
PCE 2: Water [quality]	Degraded water quality including reduced turbidity, agricultural and urban pesticide and nutrient runoff.	No substantive effect.	Degraded water quality including reduced turbidity, agricultural and urban pesticide and nutrient runoff, warmer water shortening spawning season.	No substantive effect.
PCE 3: River flow	OMR flows create entrainment, risk reduced by OCAP RPA.	Improved SJR flows during winter migration, NDD restricts access above Clarksburg.	OMR flows create entrainment, risk reduced by OCAP RPA.	Reduced risk of entrainment in the lower San Joaquin River, OMR risk remains.
PCE 4: Salinity [LSZ]		No change in affect.		No change in effect.
Primary Constituent Element	**Dispersing larvae and juveniles**		**Rearing larvae and juveniles**	
	Baseline	**PA**	**Baseline**	**PA**
PCE 1: Physical habitat	N/A	N/A	Invasive aquatic plant encroachment, dredging altered depths and substrate, channels leveed and riprapped.	No change in effect on water depths.
PCE 2: Water [quality]	Reduced turbidity.	No substantive effect.	Degraded water quality including reduced turbidity, agricultural and urban pesticide and nutrient runoff	Potential small changes: turbidity reduction, increased selenium loading, increased in *Microcystis* bloom frequency.
PCE 3: River flow	OMR flows create entrainment, risk reduced by OCAP RPA.	SJR flows will improve larval/juvenile transport.	Outflow affects salinity and the extent of rearing habitat at the LSZ and Montezuma Slough.	Lower outflow will increase salinity, limit extent and suitability of rearing habitat at the LSZ and Montezuma Slough.
PCE 4: Salinity [LSZ]	NA	NA	LSZ located upstream away from food supply and turbidity.	Lower outflow will increase salinity and limit extent and suitability of western parts of critical habitat, LSZ located in higher in Estuary with degraded habitat extent and suitability.

Summary of the Proposed Action

The operational scenario described in the PA concurrently provides adverse and beneficial effects to delta smelt critical habitat (Table 9.2.3.1). The transfer of exports to the NDD will improve adult migration, and larval and juvenile transport flows in the San Joaquin River from Jersey Point to Prisoners Point, thus improving spawning habitat in this reach of the San Joaquin River by reducing entrainment risk for spawning delta smelt, larvae and juveniles. Improved adult migration and larvae and juvenile transport flows will be realized provided that salmonid pulse protections from December through June at the NDD do not result in increased CVP and SWP exports during those months. Several water quality factors will have small beneficial effects (food web), small negative changes that are negligible (selenium, *Microcystis*) or have no substantive effect when evaluated with the proposed Conservation Measures (sediment entrainment).

The PA will create an impediment on the Sacramento River within critical habitat and alter adult migration flows that will isolate delta smelt from 250.6 acres of spawning habitat. Critical habitat and its PCEs above Intake 2 (RM 41.1) will remain intact but inaccessible to delta smelt. As addressed in Guiding Principle 4, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*, compensatory mitigation in the form of spawning habitat improvements in the Sacramento River will be provided at a site(s) that will provide the most benefit for delta smelt critical habitat into the future. Mitigation in the form of spawning habitat creation or restoration in the Sacramento River from Isleton to Hood will minimize the effect of the loss of and access to critical habitat from the construction footprint.

The potential operational scenario presented in the PA would degrade salinity for juvenile rearing in July, August and September by moving X2 upstream as much as 5 km and restrict use of Montezuma Slough for juvenile rearing in all but wet and above normal years. Implementation of Guiding Principle 1, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for the Programmatic Consultation*, is intended to improve habitat conditions for rearing juvenile delta smelt, which may include locating the LSZ in suitable areas of the estuary, minimizing the adverse effects to delta smelt critical habitat. Future actions, including the development of the final operational criteria, will be designed and implemented to minimize the effects of critical habitat contraction created by the PA's operational scenario. Thus, the adverse effects of habitat contraction are anticipated to be minimized in any future operational scenario.

As discussed in Section 9.2.2.2.2 *Operational Uncertainties and the Collaborative Scientific Process* of this BiOp, the potential CWF operation scenario that has been analyzed in this document will change between now and when the dual conveyance system goes online. Reclamation and DWR have committed to implement future CWF actions consistent with Guiding Principles, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*, and those future actions will be subject to subsequent consultation. Implementation of the Guiding Principles will ensure that effects to delta smelt designated critical habitat from future CWF construction and operations will not appreciably diminish the value of critical habitat for the species.

Summary of Aggregate Effects

The operational scenario in the PA would improve larval and juvenile transport flows (PCE 3) for spawning adults, larvae and juveniles reducing entrainment risk in the San Joaquin River from Jersey Point to Prisoners Point. The operational scenario in the PA would also alter and contract suitable critical habitat, particularly spawning and rearing habitat, reducing the diversity and complexity of critical habitat.

The operational scenario described in the PA would result in (1) additional upstream excursion of X2 from already suboptimal locations of the LSZ in summer, further decoupling the LSZ from PCE 2 (food availability, turbidity, and salinity) for juvenile rearing, (2) further salinity intrusion from the west into Montezuma Slough that will not support rearing delta smelt in three out of five WY types (critically dry, dry, and normal), (3) improve transport flows (*i.e.,* reduced entrainment) for spawning migration, adult spawning and larval and juvenile transport in the lower San Joaquin River from Jersey Point to Prisoners Point, though OMR flows remain insufficient to prevent entrainment into the CVP and SWP, and (4) the NDD which blocks, delays, or impedes access of adult migrants to spawning habitat in the Sacramento River upstream of Clarksburg. The restriction of access to the Sacramento River above Clarksburg of spawning adults excludes delta smelt from the spawning habitat and water quality (cold, freshwater) that could have increasing conservation value due to sea level rise, reductions in precipitation in the northern Sacramento Valley, and increasing water temperatures associated with climate change.

The CWF operational scenario that has been analyzed in this document will change between now and when the dual conveyance system goes online. In the *Description of the Proposed Action*, Reclamation and DWR have committed to implement the Guiding Principles, as stated in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*, and further address effects for CWF operations in the context of subsequent consultations on CWF actions that will include the further development and refinement of the CWF operational criteria. Implementation of the Guiding Principles, and other conservation efforts, will ensure that critical habitat for all life stages will continue to serve its intended conservation role for the species. Based on these commitments, we understand that many of the effects discussed in this BiOp may or may not be realized when CWF is implemented.

Our analysis outlines threats to delta smelt now and in the future - most of which exist with or without implementation of the PA. Primary threats to delta smelt include habitat loss and degradation, food web alterations (including increased predator and competition presence and food supply reduction), and persistent exposure to contaminants. Many of these threats are being addressed on a broader scale in the near term. The State and Federal agencies have several ongoing actions that are intended to address multiple threats to delta smelt, including the State Board's update of the WQCP for the Bay-Delta, the reinitiation of the 2008 Service BiOp and

2009 NMFS BiOp on the long-term operation of the CVP and SWP, California EcoRestore, the Delta Smelt Resiliency Strategy and the update of the recovery plan for delta and longfin smelt. These and other ongoing efforts will help to reduce existing threats to delta smelt.

As discussed in the *Status of Critical Habitat* section, the status of designated delta smelt critical habitat is poor. At least one PCE is always lacking or degraded throughout critical habitat year-round (Table 9.2.1.3-2). The analysis of the effects of the PA on critical habitat found two elements of the PA that will alter delta smelt critical habitat PCEs: 1) block, delay, or impede adult migration on the Sacramento River and 2) a modeled summer outflow regime that reduces LSZ habitat quality. With respect to changes in the location of the LSZ from July through September, implementation of the Guiding Principles as the framework for future CWF consultations, reinitiation of the 2008 Service and 2009 NMFS BiOps on the long-term operation of the CVP and SWP, and other conservation efforts described above, will ensure that juvenile rearing habitat continues to serve its intended conservation role for the species. We expect the CWF AMP to inform the mitigation to minimize effects to critical habitat for adult migrating delta smelt.

9.2.4 Project-level Reinitiation Triggers and Programmatic Approach with Subsequent Consultation

This BiOp uses a programmatic approach to evaluate the elements of the PA that will be subject to future project-specific consultations because of the need for future Federal approvals. The analysis in this BiOp allows for a broad-scale examination of the potential impacts to delta smelt and its designated critical habitat, and examines how the parameters of the CWF align with the survival and recovery needs of listed species occurring in the action area. The remainder of the project elements not addressed programmatically are addressed as a standard, project-level consultation because they are not subject to future Federal approvals. Some project elements and their effects on delta smelt or its critical habitat will change as DWR continues to develop the PA and therefore may require reinitiation for those actions evaluated at a project-level if there are effects to listed species or critical habitat that were not analyzed herein.

Accidental Spills

The extent, location, quantity, and nature of an accidental spill is unknown at this time until the event of the spill occurs. Implementation of CWF BA Appendix 3.F, *General Avoidance and Minimization Measures,* AMM5, *Spill Prevention, Containment, and Countermeasure Plan*, and AMM14, *Hazardous Materials Management*, is expected to reduce the potential for contaminant spills and guide rapid and effective response in the case of inadvertent spills of hazardous materials. With implementation of these and other required construction BMPs (*e.g.*, AMM3, *Stormwater Pollution Prevention Plan*), the risk of contaminant spills or discharges to the river from in-water or upland sources will be minimized. However, reinitiation may be required if habitat is affected or individuals will be exposed to contamination from an accidental spill.

Preconstruction and Construction

Geotechnical Explorations

The location or duration of the geotechnical explorations and their effects on delta smelt or its critical habitat will likely change as the PA is refined. Therefore, reinitiation is required if additional habitat is affected or more individuals will be exposed based on changes in proposed locations of the borings.

Barge Landings

The barge landing locations analyzed in this BiOp represent the general areas for these facilities. Some of the locations and their effects on delta smelt or its critical habitat will likely change as DWR continues to develop the PA and therefore may require reinitiation for those actions. DWR has provided estimates of habitat acreages in the CWF BA that are anticipated to be removed, altered, or degraded from barge landing construction, in the form of shallow water habitat, which encompasses all edgewater substrates including sandy beaches. GIS estimates of the shallow water habitat for the seven barge landing locations were calculated for the CWF BA; however, DWR will ground truth all habitat prior to impact. If the amount of habitat or level of exposure to the effects of the barge landings changes as a result of refinement of the barge landing locations, reinitiation may be required.

This BiOp analyzes a reasonable set of estimates of underwater noise and sediment disturbance effects that are expected to occur from impact pile driving equipment and other methods of cofferdam installation and foundation construction associated with the barge landings based on previous projects that have occurred. However, during implementation, DWR will monitor noise and sediment levels created by heavy construction equipment. If the duration or location of underwater noise or turbidity thresholds extend or peak higher than those analyzed herein, DWR and the action agencies will confer with the Service to determine if project modifications are necessary, and reinitiation may be necessary if additional adverse effects are found to be likely to delta smelt or critical habitat.

NDD

Within this document, NDD construction has been analyzed at a programmatic-level. All in-water work associated with construction of the NDD will require a permit during Phase 2 of the Corps permitting process and additional consultation under section 7 of the Act. DWR will refine estimates of habitat effects and incidental take, and propose compensation consistent with the conservation measures described in the CWF BA Chapter 3, *Description of the Proposed Action*, in association with these future permits.

It is assumed that once the intakes are completed, the area in front of each intake will be dredged to provide appropriate water depths and hydraulic conditions. If dredging is required, DWR has proposed to minimize effects to delta smelt by conducting maintenance activities within the in-water work window of June 1 through October 31, when delta smelt are least likely to occur in vicinity. It is also assumed that periodic maintenance dredging will be needed to maintain appropriate flow conditions and will occur as described in the CWF BA Chapter 3, *Description of the Proposed Action*, and subsequent additional information that has been provided to the Service since submitting the CWF BA. NDD maintenance is also described programmatically herein and associated with Phase 2 of the Corps permitting process; therefore, subsequent consultation with the Service will occur, when additional details on maintenance are available associated with a final NDD design.

CWF BA page 6-22 clarifies that no barge landings are estimated to be constructed along the Sacramento River in the vicinity of the NDD. This was substantiated in subsequent meetings and emails after the CWF BA submittal. Therefore, those calculations are not included in this analysis. If during the course of refining the NDD, there are additional effects not analyzed herein to delta smelt from the need for more than the seven analyzed barge landings, reinitiation will be necessary.

This BiOp analyzes a reasonable set of estimates of underwater noise and sediment disturbance effects that is expected to occur from impact pile driving equipment and other methods of cofferdam installation and foundation construction associated with the NDD based on previous projects that have occurred. However, during implementation, DWR will monitor noise and sediment levels created by their heavy construction equipment. If the duration or location of underwater noise or turbidity thresholds extend or peak higher than those analyzed herein, DWR and the action agencies will confer with the Service to determine if project modifications are necessary, and reinitiation may be necessary if additional adverse effects are found to be likely to delta smelt or critical habitat.

DWR has provided estimates of habitat acreages in the CWF BA that are anticipated to be removed, altered, or restricted from proposed NDD construction activities. Aerial imagery was used to determine these habitat acreages based on the best imagery available at the time of this consultation. DWR will inspect all habitats prior to the impact to confirm the estimates in the PA. Information on the substrate type and vegetation within the footprints are unknown at this time, but is expected to be developed during subsequent consultation on Phase 2 of the Corps permitting process when more information on the final siting and design of the NDD is available. As currently provided, the CWF BA does not quantify the amount of sandy substrate within the shallow water habitat footprint. The area of habitat lost to upstream access is estimated through aerial imagery (an estimate was feasible due to low vegetation in the area covering the substrate) that is expected to be refined when additional information is made available, prior to impact. A future Service-approved monitoring plan is proposed to be developed and could provide details on the monitoring efforts that will be conducted to assess restricted upstream passage from NDD construction and operation.

HORG

Within this document, HORG construction has been analyzed at a programmatic-level. The CWF BA provides estimates of shallow water habitat that is anticipated to be removed, altered, and/or degraded from the proposed construction activities. GIS (geographic information system) spatial data provided by DWR were used to determine these habitat acreages. However, DWR will inspect all potential habitat prior to impact to confirm the estimates provided in the CWF BA, consistent with how the Service has defined shallow water habitat. Information on the substrate type and vegetation within the footprints are unknown at this time, but is expected to be developed during subsequent consultation on Phase 2 of the Corps permitting process when more information is available on the final siting and design of the HORG.

CCF Forebay Construction, CCF Pumping Plant Construction, and Connections to Banks and Jones Pumping Plants

A future Service-approved monitoring plan is proposed to be developed and could provide details on the monitoring efforts that will be conducted to assess potential changes in salvage estimates from existing CVP and SWP operations of the pumping facilities. Monitoring will inform the refinement of effects in the CCF from construction on salvage. Reinitiation may be necessary if salvage estimates are modified from implementation of the PA or if additional adverse effects are found to be likely to delta smelt or critical habitat beyond what has been analyzed in this BiOp and the 2008 Service BiOp.

Operations

Agency decisions related to identifying the final CWF operational criteria will be made in a subsequent consultation, and Reclamation and DWR have committed to analyze and further address species effects from CWF operations at that time. The Guiding Principles in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation* establish a framework in this consultation under which the future CWF actions will be developed to ensure both that future consultations related to CWF actions build upon the analysis in this document and that the CWF is constructed and operated in a manner that promotes the co-equal goals articulated in California's Delta Reform Act. These Guiding Principles are subject to change over time where the best available scientific information indicates that such change is appropriate. In such event, the agencies will evaluate whether the change triggers the requirement to reinitiate consultation.

NDD

Operational criteria have been identified in the *Description of the Proposed Action* for the NDD, such as approach and sweeping velocity; however, there has not been a final design of the NDD facility. The intake design will be developed in coordination with the Service, NMFS, and CDFW during the continued FFTT identified in the CWF BA. The FFTT will further refine the monitoring, research, operational criteria, and other efforts necessary for a 100% design required for the Corps' 408 process and fall under review during the *Adaptive Management Program.* Reinitiation may be required if effects to listed species rise above those analyzed herein for the construction footprint or other project-level components addressed in this consultation. The FFTT will pursue ways to further minimize effects to delta smelt and other federally-listed species that may not necessarily be defined in this BiOp. This BiOp uses a programmatic approach to evaluate the proposed operations in the PA that will be subject to future project-specific consultations because of subsequent Federal approvals. The analysis in this BiOp allows for a broad-scale examination of the potential impacts on delta smelt and its designated critical habitat, and examines how the parameters of the CWF align with the survival and recovery needs of delta smelt occurring in the action area. As discussed above under *Operational Uncertainties and the Collaborative Scientific Process*, the CWF operational scenario that has been analyzed above will change between now and when the dual conveyance system goes online. Reclamation and DWR have committed to analyze and further address species effects from CWF operations at the time of the subsequent consultations within the framework of the Guiding Principles outlined in Section 6.1 within the *Description of the Proposed Action* and 9.2.2.2.1 *Framework for Programmatic Consultation*. Reclamation and DWR have also committed to propose future actions that will avoid jeopardizing the delta smelt and destroying or adversely modifying its critical habitat. Those future actions could include: new or modified operational criteria, minimizing project footprints during the final design phase, conservation efforts to maintain or increase trends in delta smelt abundance, efforts to restore and/or improve habitat conditions that support delta smelt, and other actions to be defined in the future. These future actions will be informed by the State Board process, reinitiation of the 2008 Service BiOp, the *Adaptive Management Program*, and other State and Federal processes.

South Delta Water Facilities

Operational criteria have been identified in the *Description of the Proposed Action* for the existing south Delta water facilities, such as those requirements identified in the RPA of the 2008 Service BiOp governing OMR flows and fall X2 location. However, Reclamation and DWR will likely modify existing (and future dual conveyance) operations. As discussed above, this BiOp uses a programmatic approach to evaluate the proposed operations in the PA that will be subject to future project-specific consultations because of subsequent Federal approvals. The analysis in this BiOp allows for a broad-scale examination of the potential impacts on listed species and their designated critical habitats, and examines how the parameters of the CWF align with the survival and recovery needs of delta smelt occurring in the action area.

HORG

Assumptions have been made on how the HORG will be operated for modeling purposes; however, the HORG operational criteria will be managed in real-time and be considered in future consultations related to subsequent Federal approvals. The gate design will be developed in coordination with the Service, NMFS, and CDFW during the technical team process identified in the CWF BA. The technical team will further refine the monitoring, research, operational criteria, and other efforts necessary for a 100% design required for the Corps' 408 process and fall under review during the *Adaptive Management Program*. The technical team will pursue ways to further minimize effects to delta smelt and other federally-listed species that may not necessarily be defined in this BiOp. This BiOp uses a programmatic approach to evaluate the proposed operations in the PA that will be subject to future project-specific consultations because of subsequent Federal approvals. The analysis in this BiOp allows for a broad-scale examination of the potential impacts on delta smelt and its designated critical habitat, and examines how the parameters of the CWF align with the survival and recovery needs of listed species occurring in the action area.

DCC, Suisun Marsh Facilities, NBA Intake, and Other Facilities

This BiOp uses a programmatic approach to evaluate the proposed operations in the PA that will be the subject to future project-specific consultations because of subsequent Federal approvals. The analysis in this BiOp allows for a broad-scale examination of the potential impacts on delta smelt and its designated critical habitat, and examines how the parameters of the CWF align with the survival and recovery needs of listed species occurring in the action area.

9.2.5 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this BiOp. Future Federal actions that are unrelated to the proposed project are not considered in this section; they require separate consultation pursuant to Section 7 of the Act.

Major human interactions and uses of the landscape within the action area include: agricultural practices; recreational uses; urbanization and industrialism - commercial and private; and greenhouse gas emissions.

Agriculture

Farming occurs throughout the Delta adjacent to many waterways used by delta smelt. Levees are reinforced with continual vegetation removal and riprapping to stabilize the levees and protect the land behind the levees for agricultural purposes. Agricultural practices introduce nitrogen, ammonium, and other nutrients into the watershed, which then flow into receiving waters, adding to other inputs such as wastewater treatment (Lehman *et al.* 2014); however, wastewater treatment provides the bulk of ammonium loading, for example (Jassby 2008). Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect delta smelt reproductive success and survival rates (Dubrovsky *et al.*1998; Kuivila *et al.* 2004; Scholz *et al.* 2012). Discharges occurring outside the action area that flow into the action area also contribute to cumulative effects of contaminant exposure.

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the action area, and many of them remain unscreened. Most diversions of any substantial size and cost have been screened, such as new municipal water diversions, and are routinely screened per existing BiOps. Private irrigation diversions in the Delta are mostly unscreened, but the total amount of water diverted onto Delta farms has remained stable for decades (Culberson *et al.* 2008) so the cumulative impact should remain similar to baseline. Irrigated agriculture is anticipated to continue into the future, especially for permanent crops that rely on Delta water as a controlled water source for growth. Depending on the size, location, and season of operation, these unscreened diversions have the potential to entrain many life stages of aquatic species, including delta smelt. However, the vast majority of private unscreened diversions in the action area are small pipes in large channels that operate intermittently, and mainly during the spring and summer. As a result, even where they do regularly co-occur with these diversions, delta smelt appear to have low vulnerability to entrainment (Nobriga *et al.* 2004). Nobriga *et al.* (2004) reasoned that the littoral location and small size of these diversions reduced their risk of entraining delta smelt.

Urbanization and Industrialism

The Delta Protection Commission's Economic Sustainability Plan for the Delta reported an urban growth rate of about 54% within the statutory Delta between 1990 and 2010, as compared with a 25% growth rate statewide during the same period (Delta Protection Commission 2012). The report also indicated that population growth had occurred in the Secondary Zone of the Delta but not in the Primary Zone and that population in the central and south Delta areas had decreased since 2000. Growth projections through 2050 indicate that all counties overlapping the Delta are projected to grow at a faster rate than the State as a whole. Total population in the Delta counties is projected to grow at an average annual rate of 1.2% through 2030 (California Department of Finance 2012). Table 9.2.5-1 illustrates past, current, and projected population trends for the five counties in the Delta. As of 2010, the combined population of the Delta counties was approximately 3.8 million. Sacramento County contributed 37.7% of the population of the Delta counties, and Contra Costa County contributed 27.8%. Yolo County had the smallest population (200,849 or 5.3%) of all the Delta counties.

Table 9.2.5-1. Delta counties and California population, 2000–2050.

Area	2000 Population (millions)	2010 Population (millions)	2020 Projected Population (millions)	2025 Projected Population (millions)	2050 Projected Population (millions)
Contra Costa County	0.95	1.05	1.16	1.21	1.50
Sacramento County	1.23	1.42	1.56	1.64	2.09
San Joaquin County	0.57	0.69	0.80	0.86	1.29
Solano County	0.40	0.41	0.45	0.47	0.57
Yolo County	0.17	0.20	0.22	0.24	0.30
Delta Counties	3.32	3.77	4.18	4.42	5.75
California	34.00	37.31	40.82	42.72	51.01
Sources: California Department of Finance 2012.					

Table 9.2.5-2 presents more detailed information on populations of individual communities in the Delta. Growth rates from 2000 to 2010 were generally higher in the smaller communities than in larger cities such as Antioch and Sacramento. This is likely a result of these communities

having lower property and housing prices, and their growth being less constrained by geography and adjacent communities.

Table 9.2.5-2. Delta communities population, 2000 and 2010.

Community	2000	2010	Average Annual Growth Rate 2000–2010
Contra Costa County			
Incorporated Cities and Towns			
Antioch	90,532	102,372	1.3%
Brentwood	23,302	51,481	12.1%
Oakley	25,619	35,432	3.8%
Pittsburg	56,769	63,264	1.1%
Small or Unincorporated Communities			
Bay Point	21,415	21,349	-0.0%
Bethel Island	2,252	2,137	-0.5%
Byron	884	1,277	4.5%
Discovery Bay	8,847	13,352	5.1%
Knightsen	861	1,568	8.2%
Sacramento County			
Incorporated Cities and Towns			
Isleton	828	804	-0.3%
Sacramento	407,018	466,488	1.5%
Small or Unincorporated Communities			
Courtland	632	355	-4.4%
Freeport and Hood	467	309[a]	-3.4%
Locke	1,003	Not available	—
Walnut Grove	646	1,542	13.9%
San Joaquin County			
Incorporated Cities and Towns			
Lathrop	10,445	18,023	7.3%
Stockton	243,771	291,707	2.0%
Tracy	56,929	82,922	4.6%
Small or Unincorporated Communities			
Terminous	1,576	381	-7.6%

Solano County			
Incorporated Cities and Towns			
Rio Vista	4,571	7,360	6.1%
Yolo County			
Incorporated Cities and Towns			
West Sacramento	31,615	48,744	5.4%
Small or Unincorporated Communities			
Clarksburg	681	418	-3.9%
Sources: U.S. Census Bureau 2000; U.S. Census Bureau 2011.			
[a] Freeport had a population of 38; Hood had a population of 271.			

Increases in urbanization and housing development can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions will not require consultation with the Service. State or local levee maintenance may also destroy or adversely affect delta smelt spawning or rearing habitat and interfere with natural, long-term spawning habitat-maintaining processes.
Adverse effects on delta smelt and its critical habitat may result from urbanization-induced point and non-point source chemical contaminant discharges within the action area. These contaminants include, but are not limited to, ammonia and free ammonium ion, numerous pesticides and herbicides, pharmaceuticals, and oil and gasoline product discharges. Oil and gasoline product discharges may be introduced into Delta waterways from shipping and boating activities and from urban activities and runoff. Implicated as potential stressors to delta smelt, these contaminants may adversely affect delta smelt reproductive success, survival rates, and food supply.

Contaminants are suspected to be a stressor on delta smelt (Kuivila and Moon 2004; Brooks *et al.* 2012). A study of juvenile delta smelt in five regions encompassing their range examined delta smelt for signs of contaminants and food limitation. The histopathological analysis of the 244 fish sampled in 2012 and 2013 found an 11-fold increase in gill and liver lesion scores in Cache Slough as compared to Suisun Marsh. Higher lesion scores indicate less healthy tissues and are indicative of contaminant-related stress (Hammock *et al.* 2015).

The largest urban discharger to the Delta is the Sacramento Regional Wastewater Treatment Plant (SRWTP). In order to comply with Central Valley Regional Water Quality Control Board Order no. R5-2013-0124, SRWTP has begun implementing compliance measures to reduce its discharge of ammonia and ammonium. Construction of treatment facilities for three of the major projects required for ammonia and nitrate reduction was initiated in March 2015 (Sacramento Regional County Sanitation District 2015). Order No. R5-2013-0124, which was modified on October 4, 2013, by the Central Valley Regional Water Quality Control Board, imposed new interim and final effluent limitations, which must be met by May 11, 2021 (Central Valley Regional Water Quality Control Board 2013). By May 11, 2021, the SRWTP must reach a final effluent limit of 2.0 milligrams per liter (mg/L total ammonia nitrogen) per day from April to October, and 3.3 mg/L per day from November to March (Central Valley Regional Water Quality Control Board 2013). However, the treatment plant is currently releasing several tons of ammonia in the Sacramento River each day. A study by Werner *et al.* (2008) concluded that ammonia concentrations present in the Sacramento River below the SRWTP are not acutely toxic to 55-day-old delta smelt. However, based on information provided by EPA (1999) and other related studies, it is possible that concentrations below the SRWTP may be chronically toxic to delta smelt and other sensitive fish species (Werner *et al.* 2010). In 2010, the same group conducted three exposure experiments to measure the effect concentration of SRWTP effluent. No significant effects of effluent on the survival of larval delta smelt were found. More recent studies (which used concentrations of ammonia higher than typically experienced by delta smelt) have shown that delta smelt that are exposed to ammonia exhibit membrane destabilization. This results in increased membrane permeability and increased susceptibility to synergistic effects of multi-contaminant exposures (Connon *et al.* 2009; Hasenbein *et al.* 2014). Results are unclear at this time as to what the effect of ammonia exposure is on delta smelt, and research is ongoing. EPA published revised national recommended ambient water quality criteria for the protection of aquatic life from the toxic effects of ammonia in 2013. Studies are ongoing to further determine the adverse effects of ammonia on delta smelt.

In addition to concerns about direct toxicity of ammonia to delta smelt, another important concern is that ammonium inputs have suppressed diatom blooms in the Delta and Suisun Bay, thereby reducing the productivity in the delta smelt food web. The IEP (2015) provided the following summary: "Dugdale *et al.* (2007) and Wilkerson *et al.* (2006) found that high ammonium concentrations prevented the formation of diatom blooms but stimulated flagellate blooms in the lower estuary. They propose that this occurs because diatoms preferentially utilize ammonium in their physiological processes even though it is used less efficiently and at high concentrations ammonium can prevent uptake of nitrate (Dugdale *et al.* 2007). Thus, diatom populations must consume available ammonium before nitrate, which supports higher growth rates, can be utilized or concentrations of ammonium need to be diluted. A recent independent review panel (Reed *et al.* 2014) found that there is good evidence for preferential uptake of ammonium and sequential uptake of first ammonium and then nitrate, but that a large amount of uncertainty remains regarding the growth rates on ammonium relative to nitrate and the role of ammonium in suppressing spring blooms." The IEP (2015) further discussed this issue as follows: "Glibert (2011) analyzed long-term data (from 1975 or 1979 to 2006 depending on the variable considered) from the Delta and Suisun Bay and related changing forms and ratios of nutrients, particularly changes in ammonium, to declines in diatoms and increases in flagellates and cyanobacteria. Similar shifts in species composition were noted by Brown (2009), with loss of diatom species, such as *Thalassiosira* sp., an important food for calanoid copepods, including *Eurytemora affinis* and *Sinocalanus doerri* (Orsi 1995). More recently, Parker *et al.* (2012) found that the region where blooms are suppressed extends upstream into the Sacramento River to the SRWTP, the source of the majority of the ammonium in the river (Jassby 2008). Parker *et al.* (2012) found that at high ambient ammonium concentrations, river phytoplankton cannot efficiently take up any form of nitrogen including ammonium, leading to often extremely low biomass in the river. A study using multiple stable isotope tracers (Lehman *et al.* 2014) found that the cyanobacterium *M. aeruginosa* utilized ammonium, not nitrate, as the primary source of nitrogen in the central and western Delta. In 2009, the ammonia concentration in effluent from SRWTP was reduced by approximately 10%, due to changes in operation (K. Ohlinger, Sacramento Regional County Sanitation District, personal communication). In spring 2010, unusually strong spring diatom blooms were observed in Suisun Bay that co-occurred with low ammonia concentrations (Dugdale *et al.* 2013).

Ammonia discharge concerns have also been expressed with respect to the City of Stockton Regional Water Quality Control Plant, but its remoteness from the parts of the estuary frequented by delta smelt and its recent upgrades suggest it is not a significant concern for delta smelt.

Other future, non-Federal actions within the action area that are likely to occur and may adversely affect delta smelt and their critical habitat include: the dumping of domestic and industrial garbage that decreases water quality; oil and gas development and production that may affect aquatic habitat and may introduce pollutants into the water; and State or local levee maintenance that may also destroy or adversely affect habitat and interfere with natural, long-term habitat-maintaining processes.

Recreational Uses

Increased urbanization is also expected to result in increased recreational activities in the action area. Recreational activities, such as the construction and maintenance of golf courses reduce habitat and introduce pesticides and herbicides into the aquatic environment. The Delta, Yolo Bypass, and Suisun Marsh contain numerous parks, extensive public lands, and many interconnected rivers, sloughs, and other waterways that offer diverse recreation opportunities. Privately owned commercial marinas and resorts allow for boating access to the waterways and a variety of other recreational opportunities and services. Private lands also provide several recreational opportunities, particularly hunting.

The Delta is a regional destination for water-based recreationists because of its climatic conditions, variety and abundance of fish, large maze of navigable waterways, and favorable water levels during summer when most regional reservoirs experience substantial drawdown. Activities in the Delta include cruising, waterskiing, wakeboarding, using personal watercraft, sailing, windsurfing, and kiteboarding, as well as fishing and hunting (from land and by boat). Non-powered boating activities in the Delta include sailing, windsurfing, kiteboarding, canoeing, and kayaking.

Hunting has long been a recreational activity in the Delta, with waterfowl hunting being the primary type. Hunting by boat (typically used as a floating blind) is popular at the larger flooded islands, such as Franks Tract and Sherman Island, because hunters seek open, shallow waters and marsh areas where waterfowl congregate (California Department of Boating and Waterways 2003). Licenses and duck stamps to hunt waterfowl are required by the CDFW and the Service. CDFW manages hunting in California, including the public hunting programs at Sherman Island and other smaller wildlife areas. The California Department of Parks and Recreation allow hunting at Franks Tract, designated as Franks Tract State Recreation Area. Boat hunting is also allowed at Big Break, which is managed by the East Bay Regional Park District (Delta

Protection Commission 1997). Late fall through early winter is the designated waterfowl hunting season; starting and ending dates vary each year by species and by hunting method.

Suisun Marsh has historically been a popular duck hunting location; around 1880, the first private duck clubs were established in the marsh, and by 1930, the primary use of Suisun Marsh was waterfowl hunting (DWR 2000). Duck hunting continues to be a use of Suisun Marsh, with 158 private duck clubs located over 52,000 acres in the marsh. These clubs are managed for waterfowl habitat; the wetlands are flooded to coincide with waterfowl season (DWR 2009a, 2011).

Most of the 370 water diversions operating in Suisun Marsh supply water to waterfowl hunting clubs and are unscreened (Herren and Kawasaki 2001). However, the SWP's Roaring River and MIDS diverts most of the water into the marsh. Water is subsequently redistributed further by the many smaller diversions. Roaring River is screened while Morrow Island is not; however, delta smelt entrainment into the MIDS is low due to high salinity in western Suisun Marsh (Enos *et al.* 2007).

Greenhouse Gas Emissions

There is an international scientific consensus that most of the warming observed has been caused by human activities (IPCC 2001; IPCC 2007a; IPCC. 2007b), and that it is "very likely" that it is largely due to man-made emissions of carbon dioxide and other greenhouse gases in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007b; Solomon *et al.* 2009). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities. Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has increased since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions (for these and other examples, see Solomon *et al.* 20092009; IPCC 2014).

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (Meehl *et al.* 2007; Ganguly *et al.* 2009). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increasing global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (Meehl *et al.* 2007; Ganguly *et al.* 2009; IPCC 2014).

Ongoing climate change (Inkley *et al.* 2004; IPCC 2007a, b) will likely adversely affect delta smelt, since climate change will likely result in sea level changes and overall wet and dry cycles, it may result in changes to availability and distribution of habitat and prey, and/or increase numbers of predators, parasites, diseases, and non-native competitors. For the endemic delta smelt, a changing climate may result in range shifts precluded by lack of habitat. For additional information on climate change as it relates to delta smelt, see *Status of the Species*.

Summary of the Cumulative Effects to Delta Smelt

Cumulative effects to delta smelt within the action area include: agricultural practices; recreational uses; urbanization and industrialism - commercial and private; and greenhouse gas emissions. Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the action area, and many of them remain unscreened. Most diversions of any substantial size are routinely screened through consultation with the Service. Private irrigation diversions in the Delta are mostly unscreened; however, the vast majority of private unscreened diversions in the action area are small pipes in large channels that operate intermittently, and mainly during the spring and summer. As a result, even where they do regularly co-occur with these diversions, delta smelt appear to have low vulnerability to entrainment (Nobriga *et al.* 2004).

With the projected growth rate of 1.2% annually through 2030, we can expect to observe future increases in urbanization and housing developments that may ultimately lead to adverse effects to delta smelt spawning or rearing habitat and interfere with natural, long-term spawning habitat-maintaining processes (California Department of Finance 2012).

Delta smelt's exposure to contaminants are inherent in the Delta, ranging in degree of effects. Sources of introduction vary from agricultural use pesticide runoff to urban wastewater treatment discharge, and other potential sources. Implicated as potential stressors to delta smelt, these contaminants may adversely affect delta smelt reproductive success, survival rates, and food supply.

Greenhouse gas emissions leading to climate change and sea-level rise are likely already effecting delta smelt and its habitat. Ongoing climate change as a result of human activities likely imperils delta smelt and the resources necessary for its survival, since climate change threatens to disrupt annual weather patterns, affecting availability and distribution of habitats and/or food base, and/or increase numbers of predators, parasites, diseases, and non-native competitors. In an isolated population such as that of the delta smelt, a changing climate may result in local extinction, with range shifts precluded by lack of habitat.

Summary of the Cumulative Effects to Critical Habitat

Agriculture, urbanization and climate change are most likely to affect critical habitat. PCE 2 (Water Quality) impairment is likely to continue or increase due to agriculture irrigation and municipal waste water discharge which introduces nutrients and pesticides into the watershed.

Water temperatures, influenced by warming air temperatures from climate change, are expected to rise. Delta smelt is currently at the southern limit of the inland distribution of the family Osmeridae along the Pacific Coast of North America and is living in an environment that is energetically stressful. Thus, increased water temperatures associated with climate change may present a significant conservation challenge. PCE 3 (River flow) reductions and the associated PCE 4 (Salinity) intrusion will increase as human population growth places additional demands on water resources and less freshwater will available to maintain the LSZ at a suitable location particularly for juvenile rearing habitat. Climate change will also alter the timing and form of precipitation (rain or snow) in the watershed depending on latitude. Sea level rise will likely influence saltwater intrusion into the Bay-Delta. Elevated salinity could push X2 farther up the estuary with mean values increasing by about 7 km by 2100 (Brown *et al.* 2013). The status of critical habitat (PCEs 2, 3, and 4) will likely be degraded by each of these cumulative effects in the early long-term.

9.2.5 Conclusion

9.2.6.1 Delta Smelt

In conclusion, after reviewing the current status of the delta smelt, environmental baseline, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the preconstruction, construction, and operations of the new and existing CVP and SWP water facilities, as proposed, are not likely to jeopardize the continued existence of the delta smelt. The Service has reached this conclusion based the information presented in the preceding *Status of the Species*, *Environmental Baseline*, *Effects to Delta Smelt from the Proposed Action*, and *Cumulative Effects* sections of this BiOp.

9.2.6.2 Delta Smelt Critical Habitat

In conclusion, after reviewing the current status of delta smelt critical habitat, environmental baseline, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the preconstruction, construction, and operations of the new and existing CVP and SWP water facilities, as proposed, are not likely to destroy or adversely modify delta smelt critical habitat. The Service has reached this conclusion based the information presented in the preceding *Status of the Critical Habitat*, *Environmental Baseline*, *Effects to Delta Smelt Critical Habitat from the Proposed Action*, and *Cumulative Effects* sections of this BiOp.

Section 9.2.7 Delta Smelt Literature Cited

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9.3 California Red-legged Frog

9.3.1 Status of the Species

The Service listed the California red-legged frog (*Rana draytonii*) as threatened on May 23, 1996 (61 FR 25813) and designated critical habitat on May 17, 2010. The action area of the PA is not located within designated critical habitat for this species. A recovery plan for the species was finalized on September 12, 2002 (Service 2002) and a 5-year review of the species was initiated on March 25, 2011 (Service 2011). The following paragraphs provide a summary of the relevant information in the recovery plan and 5-year review.

Recovery Plan

The Recovery Plan for the California red-legged frog identifies eight recovery units (Service 2002). The establishment of these recovery units is based on the determination that various regional areas of the species' range are essential to its survival and recovery. These recovery units are delineated by major watershed boundaries as defined by U.S. Geological Survey hydrologic units and the limits of its range. The goal of the recovery plan is to protect the long-term viability of all extant populations within each recovery unit. Within each recovery unit, core areas have been delineated and represent contiguous areas of moderate to high California red-legged frog densities that are relatively free of exotic species such as bullfrogs. The goal of designating core areas is to protect metapopulations. When combined with suitable dispersal habitat, this will allow for the long-term viability within existing populations. This management strategy identified within the Recovery Plan will allow for the recolonization of habitats within and adjacent to core areas that are naturally subjected to periodic localized extinctions, thus assuring the long-term survival and recovery of California red-legged frogs.

Habitat

California red-legged frogs predominately inhabit permanent water sources such as streams, lakes, marshes, and natural and manmade ponds in valley bottoms and foothills up to 4,921 ft in elevation (Jennings and Hayes 1994, Bulger *et al.* 2003, Stebbins 2003). However, they also inhabit ephemeral creeks, drainages and ponds with minimal riparian and emergent vegetation. Habitat includes nearly any area within 1-2 miles of a breeding site that stays moist and cool through the summer including vegetated areas with coyote brush, California blackberry thickets, and root masses associated with willow and California bay trees (Fellers 2005). Sheltering habitat for California red-legged frogs potentially includes all aquatic, riparian, and upland areas within the range of the species and includes any landscape feature that provides cover, such as animal burrows, boulders or rocks, organic debris such as downed trees or logs, and industrial debris. Agricultural features such as drains, watering troughs, spring boxes, abandoned sheds, or hay stacks may also be used. Incised stream channels with portions narrower and depths greater than 18 inches also may provide important summer sheltering habitat. Accessibility to sheltering habitat is essential for the survival of California red-legged frogs within a watershed, and can be a factor limiting frog population numbers and survival.

Threats

Habitat loss, non-native species introduction, and urban encroachment are the primary factors that have led to the current status of the California red-legged frog throughout its range. Several researchers in central California have noted the decline and eventual local disappearance of California and northern red-legged frogs in systems supporting bullfrogs (Jennings and Hayes 1990; Twedt 1993), red swamp crayfish, signal crayfish, and several species of warm water fish including sunfish, goldfish, common carp, and mosquitofish (Moyle 1976; Barry 1992; Hunt 1993; Fisher and Schaffer 1996). This has been attributed to predation, competition, and reproduction interference. Twedt (1993) documented bullfrog predation of juvenile northern red-legged frogs, and suggested that bullfrogs could prey on subadult California red-legged frogs as well. Bullfrogs may also have a competitive advantage over California red-legged frogs. For instance, bullfrogs are larger and possess more generalized food habits (Bury and Whelan 1984). In addition, bullfrogs have an extended breeding season (Storer 1933) during which an individual female can produce as many as 20,000 eggs (Emlen 1977). Furthermore, bullfrog larvae are unpalatable to predatory fish (Kruse and Francis 1977). Bullfrogs also interfere with California red-legged frog reproduction by eating adult male California red-legged frogs. Both California and northern red-legged frogs have been observed in amplexus (mounted on) with both male and female bullfrogs (Jennings and Hayes 1990; Twedt 1993; Jennings 1993). Thus bullfrogs are able to prey upon and outcompete California red-legged frogs, especially in sub-optimal habitat.

The urbanization of land within and adjacent to California red-legged frog habitat has also affected the threatened amphibian. These declines are attributed to channelization of riparian areas, enclosure of the channels by urban development that blocks dispersal, and the introduction of predatory fishes and bullfrogs.

Diseases may also pose a significant threat, although the specific effects of disease on the California red-legged frog are not known. Pathogens are suspected of causing global amphibian declines (Davidson *et al.* 2003). Chytridiomycosis and ranaviruses are a potential threat because these diseases have been found to adversely affect other amphibians, including the California red-legged frog (Davidson *et al.* 2003; Lips *et al.* 2006). Mao *et al.* (1999 cited in Fellers 2005) reported northern red-legged frogs infected with an iridovirus, which was also presented in sympatric threespine sticklebacks in northwestern California. Non-native species, such as bullfrogs and non-native tiger salamanders that live within the range of the California red-legged frog have been identified as potential carriers of these diseases (Garner *et al.* 2006). Humans can facilitate the spread of disease by encouraging the further introduction of non-native carriers and by acting as carriers themselves (*i.e.*, contaminated boots, waders or fishing equipment). Human activities can also introduce stress by other means, such as habitat fragmentation, that results in the listed species being more susceptible to the effects of disease.

Climate Change

The global average temperature has risen by approximately 0.6 degrees Celsius during the 20th Century (IPCC 2001; IPCC 2007a; IPCC 2007b). There is an international scientific consensus that most of the warming observed has been caused by human activities (IPCC 2001, IPCC 2007a; IPCC 2007b), and that it is "very likely" that it is largely due to manmade emissions of carbon dioxide and other greenhouse gases (IPCC 2007b). Ongoing climate change (IPCC 2007b; Inkley *et al.* 2004; Kerr 2007) likely imperils California red-legged frog and its resources necessary for their survival. Since climate change threatens to disrupt annual weather patterns, it may result in a loss of their habitat and/or prey, and/or increased numbers of their predators, parasites, and diseases. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of California red-legged frog habitat.

Population

California red-legged frogs are often prolific breeders that may live for 8 to 10 years (Jennings *et al.* 1992) and have egg masses containing 2,000 to 5,000 eggs per breeding season (Storer 1925, Jennings and Hayes 1994). Populations can fluctuate from year to year; favorable habitat conditions allow the species to have extremely high rates of reproduction and thus produce large numbers of dispersing young and a concomitant increase in the number of occupied sites. In contrast, the animal may temporarily disappear from an area when conditions are stressful (*e.g.*, during periods of drought, disease, etc.). The species has been extirpated from 70 percent of its former range but populations remain in approximately 256 streams or drainages in 28 counties in California.

9.3.2 Environmental Baseline

DWR modeled 3,616 acres of California red-legged frog habitat in the action area, including 118 acres of aquatic and 3,498 acres of modeled upland cover and dispersal habitat (CWF BA 2016). The action area is not located within the species designated critical habitat, but both the action area and smaller construction footprint are within Recovery Unit 4 of the Recovery Plan and may contain suitable habitat, as described in the *Status of the Species,* and indicated by GIS modeling. The construction footprint and associated effects are located with the range and near the Mount Diablo (CCS-2A) unit of designated critical habitat. There is potential for the species to be present (*i.e.,* inhabit, forage, breed, and disperse) within the action area during the duration of the project as demonstrated by: (1) historic and recent observation of the species within dispersal distance of the construction footprint, (2) presence of constructed drainage features, perennial and seasonal ponds (*e.g.*, levee seepage ponds), that may provide breeding and non-breeding aquatic habitat for the California red-legged frog, (3) presence of suitable upland habitat with rodent burrows and other cover sites within dispersal distance from aquatic habitat, and (4) numerous locations and movement corridors where the species can move within the action area and vicinity.

The Service has completed numerous section 7 consultations concerning California red-legged frog in the action area. Some past substantial consultations near the construction footprint include: (1) *Byron Highway Shoulder Widening Project* (Service File No. 81420-2011-F-072) and (2) *Delta-Mendota Canal/California Aqueduct Intertie Project* (Service File No. 81420-2009-F-1156). Both of these projects have documented presence of the species and permanent habitat loss.

In the action area, California red-legged frog has been detected in aquatic habitats within the grassland landscape west and southwest of CCF and in the vicinity of Brentwood and Marsh Creek along the west-central edge of the action area, and in some upland sites in the vicinity of Suisun Marsh (CWF BA 2016). Protocol level surveys, as described in Service's 2005 *Revised Guidance on Site Assessments and Field Surveys for the California Red-legged Frog,* were not conducted or presented in the CWF BA.

An estimated 69.1 acres of California red-legged frog modeled habitat overlaps with the construction footprint and associated affected area, which includes 1 acre of modeled aquatic habitat and 68.1 acres of modeled upland cover and dispersal habitat.

9.3.3 Effects of the Proposed Action

Certain activities included in the PA will have no effect on this species, since those activities and their resulting effects do not overlap with modeled suitable habitat for the California red-legged frog. Those activities include: safe haven work areas, NDD, tunnel conveyance facilities, and the HORG. Activities included in the PA that will have adverse effects on California red-legged frog and its modeled suitable habitat are: the geotechnical exploration, the CCF modification, power supply and grid connections, CCWD Settlement actions and placement of the reusable tunnel material.

The activities listed above are expected to affect the California red-legged frog through mortality, capture, injury, harassment, and harm of individual eggs, larvae, subadults and adults. Ground disturbance associated with construction activities will result in removal of vegetation and other materials utilized for cover and aestivation, fill or crush burrows or crevices, and reduce the prey base for the California red-legged frog. Since California red-legged frog utilizes small mammal burrows and soil crevices for shelter, individuals may be crushed, buried, or otherwise injured during construction activities. Disturbance caused by construction activities may cause individuals to disperse into areas containing unsuitable habitat, and increase the risk of predation or other sources of mortality. Direct injury or mortality to the animals may result from night-lighting, noise, and vibration, which are further described below.

Increased Vibration

Construction activities could generate vibrations that simulate rain, which could cause accidental emergence from burrows. The effects analysis in the CWF BA describes those vibrations as extending 75 ft outside the project footprint into upland habitat but this description is not supported by the referenced material presented in the CWF BA. The references include: (1) Dimmitt and Ruibal (1980), whom were able to induce emergence by setting an off-balance test tube spinner within 1 meter of the burrow, which vibrated the soil in close proximity to the animals, and observed almost 100% emergence, and (2) California Department of Transportation's (2013) technical monitoring that states that a bulldozer produces perceivable vibration to 135 ft. The CWF BA did not provide an analysis that quantifies how DWR concluded 75 ft. The CWF BA estimated that vibration will affect approximately 4 acres of modeled suitable upland habitat by extending the project footprint in modeled suitable habitat by 75 ft. DWR has proposed compensation at a ratio of 3:1 for the 4 acres as mitigation for all anticipated effects of noise, vibrations, and lighting (ICF Memo 9/23/2016). DWR has not proposed to monitor increased vibrations that could be caused by the proposed construction. Modeled suitable upland habitat will be affected for the duration of construction by increased vibrations.

Increased Lighting

DWR states construction activities could generate light, which could cause California red-legged frog to emerge from burrows or other cover at night and make them vulnerable to predation (CWF BA 2016). The effects of increased ambient lighting on amphibians are well documented. Long and Rich (2006) documented that increased illumination affects mate choice decisions, interindividual spacing, anti-predator behavior, or relative reliance on different modalities (*e.g.*, visual or auditory). Female frogs may also alter their oviposition site choice (Tarano 1998). Chronic illumination, similar to that proposed in the CWF BA, can affect the behavior of individuals, and can affect multiple individuals that are vocalizing simultaneously (Long and Rich 2006). DWR proposes to limit night construction to the greatest extent practicable, but did not quantify the amount of suitable modeled habitat that potentially could be affected by the increase in lighting necessary to complete proposed nighttime construction. DWR has proposed to protect 4 acres of suitable habitat, based on the 75-ft distance from the edge of the construction footprint, as mitigation for all anticipated effects of noise, vibrations, and lighting (ICF Memo 9/23/2016). DWR has also proposed that "*if light spillover into adjacent California red-legged frog habitat occurs, a Service-approved biologist will be present during night work to survey for burrows and emerging California red-legged frogs in areas illuminated by construction lighting. If California red-legged frog is found above-ground the Service-approved biologist has the authority to terminate the project activities until the light is directed away from the burrows, the California red-legged frog moves out of the illuminated area, or the California red-legged frog is relocated out of the illuminated area by the Service-approved biologist*". While Service-approved relocation or stopping construction will minimize lighting effects on individuals that are observed, modeled suitable habitat will be affected for the duration of construction.

Increased Noise

The expected increase in noise levels that California red-legged frog could experience resulting from the construction was not addressed in the CWF BA 2016. DWR did not propose any conservation measures to minimize or avoid this effect. Increased noise levels have been shown to be detrimental to frogs (Kaiser and Hammers 2009; Goosem *et al.* 2007; Nelson 2015). DWR has proposed to protect 4 acres of suitable habitat, based on the 75-ft distance from the edge of the construction footprint, as mitigation for all anticipated effects of noise, vibrations, and lighting (ICF Memo 9/23/2016).

Temporary Habitat Loss

DWR estimates the geotechnical investigations will temporarily affect 6 acres, and the power supply and connections will temporarily affect 12 acres. DWR proposes to restore habitat to pre-project conditions that is affected by the geotechnical investigations and the construction of the power supply and grid connections. Upon completion of the PA, restoration of affected suitable modeled habitat (*e.g.*, construction areas, storage and staging areas, and temporary roads) will be accomplished by recontouring to pre-project elevations and revegetating with native vegetation seed mixture, in order not to be considered a permanent loss of habitat. There is potential for long-term harassment, injury or mortality of individuals in habitat that overlaps with the power supply and grid connections, due to the expected minimal ongoing vegetation management around the poles and under the lines. Any future vegetation management would require reinitiation of this BiOp, since suitable modeled is proposed to be restored, thus effects on suitable modeled habitat are considered temporary.

To minimize effects of the geotechnical investigation, in addition to the proposed conservation measures, work will only occur during the dry season. To minimize the effects of the power supply and connections, in addition to the proposed conservation measures, no construction activities will occur during rain events or within 24-hours following a rain event or during nighttime hours. An open-top trailer will be used to elevate materials for onsite storage above ground such as pipes, conduits and other materials that could provide shelter for California red-legged frogs.

Permanent Habitat Loss

The proposed PA is expected to result in the permanent loss of 52.34 acres of modeled suitable habitat. DWR proposes to compensate for permanent habitat loss and long-term adverse construction effects at a 3:1 ratio by purchasing 157.02 acres habitat within the East San Francisco Bay core recovery area at locations subject to Service-approval. The compensation habitat will be preserved prior to the impact and managed in-perpetuity. Preservation of high value habitat in the East San Francisco Bay core recovery area will allow for the permanent protection, long-term management, and enhancement of the habitat for the California red-legged frog which will contribute to the recovery of this species. Compensation habitat features must include: (1) grasslands containing stock ponds and other aquatic features that provide aquatic breeding habitat, and (2) lands connecting with existing protected grassland.

Preconstruction surveys of the modeled suitable habitat impacted by the project footprint and the relocation of the California red-legged frog may reduce injury or mortality. However, death and injury of individual California red-legged frogs could occur at the time of relocation or later in time subsequent to their release. Although survivorship for translocated members of this species has not been determined, survivorship of translocated wildlife, in general, is lower because of intraspecific competition, lack of familiarity with the location of potential breeding, feeding, and sheltering habitats, increased risk of contracting disease in a foreign environment, and the risk of predation. Improper handling, containment, or transport of individuals will be reduced or prevented by use of a Service-approved biologist, limiting the duration of handling and distance of translocation, and requiring the proper transport and release of the animals. Even with a Service-approved biologist present at the project site, worker awareness, and escape ramps, animals may fall into the trenches, pits, or other excavations, and then risk being directly injured, killed, or be unable to escape and die as a result of desiccation, entombment, or starvation.

9.3.4 Effects to Recovery

The PA would not increase the threats currently impacting the California red-legged frog recovery units or core areas as identified in the recovery plan, as described in the *Status of the Species*, or preclude implementation of recovery actions. The resulting adverse effects of the PA to the species habitat are considered permanent due to the PA's footprint and duration. Suitable habitat affected is outside of any core recovery area; therefore, with implementation of the proposed conservation measures, the PA is expected to result in minimal change in population numbers and distribution.

9.3.5 Reinitiation Triggers

Some project elements and their effects on California red-legged frog will likely change as the PA is refined. Therefore, reinitiation is required if additional habitat is affected or more individuals will be exposed based on these changes, such as proposed locations of vibration, nighttime illumination, noise caused by construction extends past 75 ft of the construction footprint, or any long-term vegetation management associated with the power and supply grid.

9.3.6 Cumulative Effects

The activities described in Section 9.2.5 for delta smelt are also likely to affect California red-legged frog. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 9.2.5. are incorporated by reference into this analysis for the California red-legged frog.

9.3.7 Conclusion

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the California red-legged frog.

Reproduction

The breeding habitat in the action area represents a small proportion of the total breeding habitat within the 28 counties in California where this species is believed to occur. Therefore, the PA will not appreciably affect California red-legged frog reproduction range-wide, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

The aquatic and upland habitat within the action area represents a small proportion of the total amount of habitat range-wide. Also, Reclamation has proposed measures to avoid and minimize the effects of the PA on the species. Despite the proposed conservation measures, we anticipate the PA is likely to adversely affect California red-legged frog; however, the number of individuals affected will be very low relative to the range-wide numbers. Therefore, the PA will not appreciably reduce the number of California red-legged frogs.

Distribution

The habitat within the action area is near the center of their range. We do not anticipate that the range-wide distribution of the California red-legged frog will be reduced because it will not eliminate the species from any recovery core area or county. The effect to the species from habitat loss and fragmentation will be minimized by the proposed compensatory mitigation measures. Therefore, we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

Effects on Recovery

Reclamation and DWR are proposing to minimize the adverse effects of the loss of suitable habitat by implementing actions to promote the recovery of the affected species in a manner where the mitigation is commensurate with the adverse effect. Reclamation and DWR have proposed to restore or protect suitable habitat to offset the total loss of suitable habitat. Habitat loss and degradation are contributing factors to the decline of California red-legged frog; restoration or protection of additional suitable habitat is a reasonable means of offsetting the adverse effects and may benefit the recovery of this species. Consequently, we conclude that the PA would not appreciably reduce the likelihood of recovery of the California red-legged frog.

Conclusion

After reviewing the current status of the California red-legged frog, the environmental baseline for the action area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the California red-legged frog. We have reached this conclusion because:

1. The number of California red-legged frogs likely to be affected by project activities will be low.

2. The low number of individuals likely to be affected by the project will not appreciably reduce the likelihood of survival and recovery of the species range-wide because many more individuals and larger habitat areas outside of the action area will remain.

3. Reclamation and DWR have proposed numerous and comprehensive measures to avoid and minimize potential effects, including compensatory mitigation measures.

4. Reclamation and DWR propose to restore or protect habitat that could support the species.

5. The project is being implemented in a manner that will minimize or avoid effects to California red-legged frogs.

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9.4 California Tiger Salamander

9.4.1 Status of the Species

The Service listed the Central California Distinct Population Segment (DPS) of the California tiger salamander (*Ambystoma californiense*) as threatened on August 8, 2004 (69 FR 48570 48649). Critical habitat was designated in 2005; however, there is no designated critical habitat in the action area for the PA and will not be discussed further. We completed a draft recovery plan for the species on March 10, 2016 (Service 2015) and published a 5-year review on October

21, 2014 (Service 2014). The following paragraphs provide a summary of the relevant information in the draft recovery plan and 5-year review.

Recovery Plan and Five Year Review

The draft recovery plan for the California tiger salamander Central California DPS has been classified in four recovery units. The recovery units represent both the potential extent of Central California tiger salamander habitat within the species' range and the biologically (genetically) distinct areas where recovery actions should take place that will eliminate or ameliorate threats. The recovery units also contain management units. These management units were created to manage recovery units at a finer scale, as well as to ensure that the full genetic, geographic and ecological range of each distinct recovery unit is represented. The strategy to recover the Central California tiger salamander focuses on alleviating the threat of habitat loss and fragmentation in order to increase population resiliency (ensure each population is sufficiently large to withstand stochastic events), redundancy (ensure a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events), and representation (conserve the breadth of the genetic makeup of the species to conserve its adaptive capabilities). By ensuring preservation and management actions within each management unit, the recovery plan ensures the conservation of self-sustaining populations of Central California tiger salamanders throughout the full ecological, geographical, and genetic range of the species. The latest five year review by the Service, determined that the Central California tiger salamander listing status for the species should remain as threatened.

Habitat

The Central California tiger salamander is restricted to disjunct populations that form a ring along the foothills of the Central Valley and Inner Coast Range from San Luis Obispo, Kern, and Tulare counties in the south, to Sacramento and Yolo counties in the north.

The Central California tiger salamander primarily inhabits annual grasslands and open woodlands (Stebbins 1985; Shaffer *et al.* 2013). The Central California tiger salamander requires upland habitat that is occupied by small burrowing mammals such as California ground squirrel (*Otospermophilus beecheyi*) and Botta's pocket gopher (*Thommomys bottae*) that create underground burrow systems utilized by the salamanders throughout the year (Shaffer *et al.* 1993; Seymour and Westphal 1994; Loredo *et al.* 1996; Pittman 2005). Upland habitats surrounding known Central California tiger salamander breeding pools are usually dominated by grassland, oak savanna, or oak woodland (CNDDB 2015). Large tracts of upland habitat, preferably with multiple breeding ponds, are necessary for the Central California tiger salamander to persist. Although Central California tiger salamanders are adapted to breeding in natural vernal pools and ponds, they now frequently use livestock ponds and other modified ephemeral and permanent ponds. Breeding ponds, whether natural or man-made, must have a long enough ponding duration for adult Central California tiger salamanders to breed and also pond water long enough for larvae to mature into juveniles capable of dispersing from the aquatic breeding site to suitable terrestrial habitat. Optimum breeding habitat is ephemeral and dries down before August or September, which prevents bullfrogs (*Rana catesbeiana*) or non-native fish species from establishing breeding populations (Service 2005). California tiger salamanders can be found in permanent ponds; permanent ponds used by California tiger salamanders are usually free of predatory fish or breeding bullfrog populations (Shaffer *et al.* 1993; Fisher and Shaffer 1996). This species is not known to breed in streams or rivers; however breeding populations have been reported in ditches that contain seasonal wetlands (D. Cook 2009; Seymour and Westphal 1994) and in slow-moving swales and creeks situated near other suitable breeding habitat (Alvarez *et al.* 2013).

Threats

The loss, degradation, and fragmentation of habitat as the result of human activities are the primary threats to the Central California tiger salamander (Service 2004, 2014). Aquatic and upland habitat available to Central California tiger salamanders has been degraded and reduced in area through agricultural conversion, urbanization, road construction, and other projects (Service 2014). Central California tiger salamander populations occur in scattered and increasingly isolated breeding sites, reducing opportunities for inter-pond dispersal.

Central California tiger salamander is also threatened by predation from non-native fish (*e.g.*, largemouth bass [*Micropterus salmoides*] and blue gill [*Lepomis macrochirus*]) species or invasive species (*e.g.*, bullfrog). Other threats to the species include road mortality, hybridization with non-native tiger salamanders, contaminants, mosquito control efforts, and livestock grazing.

Climate Change

Central California tiger salamanders may be affected by climate change; however, the Service lacks sufficient certainty about how and how when climate change will affect the species. The distribution of the Central California tiger salamander spans a considerable range in climatic conditions, and it is not clear how the various sub-populations of the Central California tiger salamander might differ in their responses to climate change.

California experiences highly variable annual rainfall events and droughts. California tiger salamanders have adapted to a life history strategy to deal with these inconsistent environmental conditions. For example, given the sensitivity of California tiger salamander breeding success to rainfall amounts and timing, different breeding habitats may serve as sources in different years, buffering the metapopulation against climatic variability (Cook *et al.* 2005). However, despite these life history strategies, climate change could result in even more erratic weather patterns that California tiger salamanders cannot adapt to quickly enough. If a drought occurs, ponds may not persist long enough for larvae to transform and temperature extremes or fluctuations in water levels during the breeding season may kill large numbers of embryos. Presumably, the longevity of adult Central California tiger salamanders is sufficient to ensure local population survival through all but the longest droughts (Barry and Shaffer 1994). However, if long-term droughts become the norm in the future, this will have significant implications for Central California tiger salamanders, because the ponds they depend on for breeding may not hold water long enough to support breeding populations. In addition, drought conditions favor non-native hybrid tiger salamanders in areas where hybrids occur (Johnson *et al.* 2010b).

Population

The Central California tiger salamander has a metapopulation structure of local populations or breeding sites within an area, where dispersal from one local population or breeding site to other areas containing suitable habitat is possible, but is not routine.

The available data suggest that most populations consist of relatively small numbers of breeding adults; breeding populations in the range of a few pairs up to a few dozen pairs are common, and numbers above 100 breeding individuals are rare (CDFG 2010). However, this species exhibits high variation in population numbers and may not breed in an individual pool every year (Loredo and Van Vuren 1996; Trenham *et al.* 2000). The environmental factors that play a role in this fluctuation are not entirely understood, but likely are related to climatic conditions, including the timing of rainfall events, amount of rainfall, or unseasonably high temperatures. Other factors may include predator/prey assemblages, with environmental conditions favoring species that predate on or compete with Central California tiger salamander larvae (Bobzien and DiDonato 2007).

Population numbers of Central California tiger salamanders fluctuate and they may not breed in an individual pool every year. Surveys conducted in a proposed project area that include multiple potential breeding pools may only detect Central California tiger salamander larvae in some of the pools, or even in none of the pools (*e.g.*, in years with low rainfall when the species does not successfully breed). There is a high likelihood that pools that contained no Central California tiger salamander larvae at the time of the surveys could provide suitable breeding habitat in future years when conditions are more favorable.

9.4.2 Environmental Baseline

There are 12,724 acres of modeled suitable Central California tiger salamander habitat in the action area (CWF BA 2016). Both the action area and smaller construction footprint contain habitat for the species, as described in the *Status of the Species* and indicated by GIS modeling.

There is potential for Central California tiger salamanders to be present (*i.e.*, inhabit, forage, breed, aestivate and disperse) within the action area and construction footprint during the duration of the PA as demonstrated by: (1) the area is within the historical and current range of the species, (2) suitable upland and dispersal habitat for juvenile and adult life history stages of the species with rodent burrows and other cover sites, (3) connectivity with known occupied habitat for species, and (4) the presence of numerous seasonal and perennial ponds within the action area, including livestock ponds.

The Service has completed numerous section 7 consultations concerning Central California tiger salamander in the action area. Two of the more substantial consultations near the construction footprint include: (1) Byron Highway Shoulder Widening Project (Service File No. 81420-2011-F-072), and the (2) Delta-Mendota Canal/California Aqueduct Intertie Project (Service File No. 81420-2009-F-1156). Both of these projects have documented presence of the species and permanent habitat loss.

In the action area, there are several occurrences of occupied Central California tiger salamander habitat located immediately southwest of Clifton Court Forebay. There are numerous additional occurrences of California tiger salamander in vernal pool and pond habitats in the nearby grassland foothills. Vernal pool habitats in Yolo and Solano Counties west of Liberty Island and in the vicinity of Stone Lakes in Sacramento County also provide suitable habitat for the species. Protocol level surveys, as described in Service's 2005 *Interim Guidance on Site Assessment and Field Surveys for Determining Presence or a Negative Finding of the California Tiger Salamander*, were not conducted or presented in the CWF BA.

An estimated 58 acres of Central California tiger salamander modeled habitat overlaps with the construction footprint and associated effects.

9.4.3 Effects of the Proposed Action

Certain activities included in the PA will have no effect on this species, since those activities do not overlap with modeled suitable habitat for the Central California tiger salamander. Those activities are the safe haven work areas, north Delta intakes, tunnel conveyance facilities, HORG and placement of the reusable tunnel material. Activities included in the PA that will have adverse effects on Central California tiger salamander and its modeled suitable habitat are the geotechnical explorations, the CCF modification, and power supply and grid connections.

The activities listed above are expected to affect the threatened Central California tiger salamander through capture, harassment, harm, injury and mortality of all life stages. The PA is expected to result in permanent habitat loss. Ground disturbance and construction activities associated with the PA will result in loss of upland habitat used for dispersal, refugia, and foraging. Central California tiger salamanders that are using small mammal burrows or cracks in the soil within the construction footprint of the PA are likely to be killed during grading and ground compaction activities as burrows are crushed and the inhabitants of burrows are entombed. Central California tiger salamanders may be killed or injured from inadvertent trampling by workers from foot traffic and operation of construction equipment during construction activities. Central California tiger salamanders may also become trapped in open excavations or construction trenches, making them vulnerable to desiccation, starvation, and predation. Injury or mortality to the Central California tiger salamanders may result from harassment from night lighting, noise and vibrations due to increased exposure to desiccation and predation, further described below.

Increased Vibrations

Construction activities could generate vibrations that simulate rain, which could cause accidental emergence from burrows. The effects analysis in the CWF BA describes those vibrations as extending 75 ft outside the project footprint into upland habitat but this description is not supported by the referenced material presented in the CWF BA. The references include: (1) Dimmitt and Ruibal 1980, whom were able to induce emergence by setting an off-balance test tube spinner within 1 meter of the burrow, which vibrated the soil in close proximity to the animals, and observed almost 100% emergence, and (2) the California Department of Transportation's (2013) technical monitoring that states that a bulldozer produces perceivable vibration to 135 ft. The CWF BA did not provide an analysis that quantifies how DWR concluded 75 ft. The CWF BA included an estimate that vibration will affect approximately 3 acres of modeled suitable upland habitat because the project footprint extends into modeled suitable habitat by 75 ft. DWR has proposed compensation at a ratio of 3:1 for the 3 acres they identified. DWR has proposed the 3 acres, based on the 75-ft distance from the edge of construction footprint, as mitigation for all anticipated effects of noise, vibrations, and lighting (ICF Memo 9/23/2016). DWR has not proposed to monitor increased vibrations that could be caused by the proposed construction. Modeled suitable upland habitat will be affected for the duration of construction by increased vibrations.

Increased Noise

As stated above, construction associated with CCF modifications are expected to cause increased noise in Central California tiger salamander modeled suitable habitat. DWR did not analyze the expected increase in noise that Central California tiger salamander modeled suitable habitat could experience resulting from the construction of the PA, in the CWF BA. Increased noise levels may also result from construction of the power supply and grid connections, since typical construction heavy equipment is assumed to be used and the utilization of two helicopters to string the connections, which will land and take-off anywhere in the construction footprint. Salamanders sensitive to seismic substrate vibrations and may detect airborne sound despite their atympanic middle ears (Ross and Smith 1978; Christensen *et al.* 2015). Therefore, construction noise, and increased human activity may interfere with normal behaviors such as feeding, sheltering, movement between refugia and foraging grounds, and other essential behaviors of the Central California tiger salamander. DWR has proposed the 9 acres, based on the 3:1 ratio of the 3 acres within 75 feet of the edge of construction footprint, as mitigation for all anticipated effects of noise, vibrations, and lighting (ICF Memo 9/23/2016).

Increased Lighting

Construction activities could generate light, noise and vibrations, which could cause the Central California tiger salamander to emerge from burrows or other cover at night and make them vulnerable to predation (CWF BA 2016). The adverse effects of increased ambient lighting on salamanders are well documented (Rich and Travis 2013). Lighting can affect foraging and movement of salamanders (Placyke and Grave 2001). Construction of the canal work area, associated with CCF modifications is the only activity identified in the CWF BA to increase ambient illumination in Central California tiger salamander model suitable habitat. DWR plans on limiting night construction to the greatest extent practicable, but did not quantify the amount of suitable modeled habitat that potentially could be affected by the increase in lighting necessary to complete proposed nighttime construction. DWR has proposed the 9 acres, based on the 75-ft distance from the edge of construction footprint, as mitigation for all anticipated effects of noise, vibrations, and lighting (ICF Memo 9/23/2016). The duration of construction and increased lighting is expected to be 6 years. While Service-approved relocation or construction stoppage will minimize lighting effects on individuals that are observed, modeled suitable habitat will be affected for the duration of construction.

Temporary Habitat Loss

DWR estimates the geotechnical explorations will temporarily affect 2 acres and the construction of the power supply and connections will temporarily affect 7 acres. DWR proposes to restore habitat to pre-project conditions that is affected by the geotechnical explorations and the construction of the power supply and grid connections. Upon completion of the PA, restoration of affected modeled suitable habitat (*e.g.*, construction areas, storage and staging areas, and temporary roads) will be accomplished by recontouring to pre-project elevations and revegetating with native vegetation seed mixture within one year, in order not to be considered a permanent loss of habitat. Any future vegetation management would require reinitiation of this BiOp, since suitable habitat is proposed to be restored, and thus effects on suitable habitat are considered temporary.

To minimize effects of the geotechnical explorations and the construction of the power supply and grid connections, in addition to the proposed conservation measures, work will only occur during the dry season. To minimize the effects of the power supply and connections, in addition to the proposed conservation measures, no construction activities will occur during rain events or within 24-hours following a rain event or during nighttime hours and an open-top trailer to elevate materials for onsite storage above ground such as pipes, conduits and other materials that could provide shelter for Central California tiger salamanders.

Permanent Habitat Loss

The proposed PA is expected to result in 50 acres of permanent habitat loss (47 acres within the project footprint for the CCF modification and power supply and grid connections and 3 acres that may be affected by activities generating vibrations). DWR proposes to compensate for permanent habitat loss and long-term adverse construction effects by purchasing habitat within the Byron Hills area at a ratio of 3:1, subject to Service-approval. The purchased compensation habitat will be preserved and managed in-perpetuity. Therefore, 150 acres of suitable habitat will be protected. Only terrestrial cover and aestivation habitat loss is proposed to occur; the PA is not expected to result in a loss of any aquatic breeding habitat. To offset the effects of permanent habitat loss, compensation habitat must be adjacent to or near occupied upland habitat. Grasslands targeted for protection will be located near important areas for conservation that were identified in the East Contra Costa County Habitat Conservation Plan/ Natural Community Conservation Plan (HCP/NCCP) and will include appropriate upland and aquatic features, e.g., rodent burrows, stock ponds, intermittent drainages, and other aquatic features, etc.

Preservation of high value habitat identified in the HCP/NCCP within Byron Hills will allow for permanent protection, long-term management and enhancement of habitat for the Central California tiger salamander which will contribute to the recovery of the species. Compensation habitat features must include: (1) large contiguous landscapes that consist of grasslands, vernal pool complex, and alkali seasonal wetland complex and encompass the range of vegetation, hydrologic, and soil conditions that characterize these communities, (2) lands must maintain connectivity with protected grassland, vernal pool complex, and alkali seasonal wetland complex landscapes near proposed construction sites, including connectivity with lands that have been protected or may be protected in the future under the HCP/NCCP, and (3) grasslands containing stock ponds and other aquatic features that provide aquatic breeding habitat for Central California tiger salamander.

Preconstruction surveys of the modeled suitable habitat that is impacted by the project footprint and the relocation of the Central California tiger salamander may reduce injury or mortality. However, death and injury of individual Central California tiger salamanders could occur at the time of relocation or later in time subsequent to their release. Although survivorship for relocated members of this species has not been determined, survivorship of relocated wildlife, in general, is lower because of intraspecific competition, lack of familiarity with the location of potential breeding, feeding, and sheltering habitats, increased risk of contracting disease in a foreign environment, and the risk of predation. Improper handling, containment, lack of disease prevention measures, or improper transport of individuals will be reduced or prevented by use of a Service-approved biologist with experience with this species, limiting the duration of handling and the distance of relocation, and requiring the proper handling, transport, and release of the Central California tiger salamander. Even with a Service-approved biologist present at the project site, worker awareness, and escape ramps, animals may fall into the trenches, pits, or other excavations, and then risk being directly injured, killed, or be unable to escape and die as a result of desiccation, entombment, or starvation.

9.4.4 Effects to Recovery

The PA would not increase the threats currently impacting the Central California tiger salamander in the recovery units or management units identified in the draft recovery plan and described in the status of species, or preclude implementation of recovery actions. The PA is expected to result in permanent loss of 50 acres of Central California tiger salamander habitat. DWR has proposed to offset the adverse effects of the loss of individuals and habitat through conservation of 150 acres of habitat. As stated previously, habitat loss and degradation are contributing factors to the decline of Central California tiger salamander, by protecting and managing an additional 150 acres of habitat in-perpetuity will offset the loss of individuals as a result of the PA and may benefit the recovery of the Central California tiger salamander.

9.4.5 Reinitiation Triggers

Some project elements and their effects on Central California tiger salamander will likely change as the PA is refined. Therefore, reinitiation is required if additional habitat is affected or more individuals will be exposed based on these changes, such as proposed locations of vibration, nighttime illumination, noise caused by construction extends past 75 ft of the construction footprint, or any long-term vegetation management associated with the power and supply grid.

9.4.6 Cumulative Effects

The activities described in Section 9.2.5 for delta smelt are also likely to affect Central California tiger salamander. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 9.2.5. are incorporated by reference into this analysis for the Central California tiger salamander.

9.4.7 Conclusion

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the California tiger salamander.

Reproduction

The breeding habitat in the action area represents a small proportion of the total breeding habitat in California where this species is believed to occur and the PA will not result in loss of breeding habitat. Therefore, the PA will not appreciably affect California tiger salamander reproduction range-wide, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

The aquatic and upland habitat within the action area represents a small proportion of the total amount of habitat range-wide. Also, Reclamation and DWR have proposed measures to avoid and minimize the effects of the PA on the species. Despite the proposed conservation measures, we anticipate the PA is likely to adversely affect California tiger salamander; however, the number of individuals affected will be very low relative to the range-wide numbers. Therefore, the PA will not appreciably reduce the number of California tiger salamanders.

Distribution

The habitat within the action area is near the northern extent of their range. We do not anticipate that the range-wide distribution of the California tiger salamander will be reduced because it will not eliminate or significantly reduce the distribution of the species from any draft recovery unit or county. The effect to the species from habitat loss and fragmentation will be minimized by the proposed compensatory mitigation measures. Therefore, we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

Effects on Recovery

Reclamation and DWR are proposing to minimize the adverse effects of the loss of suitable habitat by implementing actions to promote the recovery of the affected species in a manner where the mitigation is commensurate with the adverse effect. Reclamation and DWR have proposed to restore or protect suitable habitat to offset the total loss of suitable habitat. Habitat loss and degradation are contributing factors to the decline of California tiger salamander; consequently, restoration or protection of additional suitable habitat is a reasonable means of offsetting the adverse effects and may benefit the recovery of this species. Consequently, we conclude that the PA would not appreciably reduce the likelihood of recovery of the California tiger salamander.

Conclusion

After reviewing the current status of the California tiger salamander, the environmental baseline for the action area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the California tiger salamander. We have reached this conclusion because:

1. The number of California tiger salamanders likely to be affected by project activities will be low.

2. The low number of individuals likely to be affected by the project will not appreciably reduce the likelihood of survival and recovery of the species range-wide because many more individuals and larger habitat areas outside of the action area will remain.

3. Reclamation and DWR have proposed numerous and comprehensive measures to avoid and minimize potential effects, including compensatory mitigation measures.

4. Reclamation and DWR propose to restore or protect habitat that could support the species.

5. The project is being implemented in a manner that will minimize or avoid effects to California tiger salamander.

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9.5 Giant Garter Snake

9.5.1 Status of the Species

The Service published a proposal to list the giant garter snake as an endangered species on December 27, 1991 (56 FR 67046). Critical habitat has not been designated for this species. The Service reevaluated the status of the snake before adopting the final rule, and it was listed as a threatened species on October 20, 1993 (58 FR 54053). A Draft Recovery Plan was proposed for the snake on July 2, 1999 (Service 1999) and currently in publication as the *Revised Draft Recovery Plan for the Giant Garter Snake* (Revised Draft Recovery Plan) (Service 2015). A 5-year review was conducted in 2006 where no change of status was recommended (Service 2006). An additional 5-year review was conducted in 2012 where no change of status was recommended (Service 2012). Please refer to the Revised Draft Recovery Plan for the species' description, habitat preference, and life history.

Habitat Loss

Historical records suggest that the giant garter snake inhabited freshwater marshes, streams, and wetlands along with their adjacent associated upland habitats throughout the length of the Sacramento and San Joaquin valleys in Central California. Today only about 5 percent of its historical wetland/upland habitat acreage remains. Nine populations are recognized in the Revised Draft Recovery Plan following an update of the thirteen populations described in the original listing. This change is based on recent surveys, which indicate that two populations were extirpated, and on genetic research, which lead to the grouping together of some of the previously described populations.

The loss and subsequent fragmentation of habitat is the primary threat to the giant garter snake throughout the Central Valley of California. Habitat loss has occurred from urban expansion, agricultural conversion, and flood control. Habitat fragmentation has ultimately resulted in the snake being extirpated from the southern one-third of its range in the San Joaquin Valley.

Other Threats

In addition to large landscape level habitat conversion, the Sacramento/ San Joaquin Delta populations of the giant garter snake are subject to a number of other existing and potential threats which include roads and vehicular traffic, climate change, and predation by non-native species. The recovery strategy is primarily focused on protecting existing, occupied habitat and identifying and protecting areas for habitat restoration, enhancement, or creation including areas that are needed to provide connectivity between populations. This strategy ultimately supports the recovery goal of establishing and protecting self-sustaining populations of the giant garter snake throughout the full ecological, geographical, and genetic range of the species.

Climate change has been linked to increases in the frequency and intensity of weather events, such as heat waves, droughts, and storms (Lenihan *et al.* 2003; California Climate Action Team 2006; IPCC 2007). Extreme events, in turn may cause mass mortality of individuals (by affecting habitat or ecosystem characteristics, for example) and significantly contribute to determining which species will remain or occur in natural habitats (Whitfield *et al.* 2007). As California's average temperature and precipitation change, species ranges tied to climate dependent habitats are moving northward and upward, but in the future, range contractions are more likely than simple northward or upslope shifts (Loarie *et al.* 2008, 2009). Research has already revealed correlations between climate warming and declines in amphibians and reptiles in different parts of the world (Whitfield *et al.* 2007; McMenamin *et al.* 2008; Mitchell *et al.* 2008; Huey *et al.* 2010).

The giant garter snake is considered a semi-aquatic species and due to its habitat preferences, giant garter snake is subject to the detrimental effects of floods and drought. This is likely to be exacerbated with the increase in frequency and intensity of flood and drought events due to climate change. Giant garter snakes may be displaced during a flood, buried by debris, exposed to predators, and subject to drowning when burrows and over-wintering sites become inundated with water. Giant garter snakes are not known to occupy the area within the Sutter Bypass which is flooded regularly (Wylie *et al.* 2005); although snakes are known to occupy the Yolo Bypass during the active season when flooding is unlikely (E. Hansen 2009). Snakes appear to survive at least some inundation of their burrows. Wylie observed snakes emerging from burrows after a period of inundation (G. Wylie, U.S. Geological Survey, personal communication).

Because of the giant garter snake's dependence upon permanent wetlands, water availability will play a significant role in its survival and recovery. In a state where much of the wetland habitat is maintained by managed water regimes, the lack of sufficient water supply may preclude consistent and timely delivery of water to sustain suitable habitat for giant garter snake. Drought conditions place additional strains on the water allocation system. Where populations currently persist on only marginal habitat, emergent drought or higher temperature conditions are likely to result in high rates of mortality in the short term with the effects of low fecundity and survivorship persisting after the drought has ceased (McMenamin *et al.* 2008; Mitchell *et al.* 2008). It is unknown how quickly giant garter snake populations may rebound after severe climatic conditions, particularly since these conditions might further exacerbate the impact from existing threats to giant garter snake, such as habitat loss and fragmentation, and small, isolated populations. Giant garter snake as a species has survived recorded historic droughts, but presumably under conditions where fewer cumulative threats existed.

9.5.2 Environmental Baseline

Nearly all of the research on movement for the giant garter snake has been conducted on individuals in the Sacramento Valley; however, the geography in the Sacramento/San Joaquin Delta is comparably different to the Sacramento Valley due to the island structure of the Delta. These islands are surrounded by numerous large waterbodies, large tributaries and experiences a significant tidal influence from the San Pablo and San Francisco Bays. Giant garter snakes have been found on the various islands in the Delta and utilization and/or the frequency to which they use the large rivers and open tributaries surrounding these islands for dispersal is currently unknown. Giant garter snakes are apparently capable of long-distance movements, although less movement is observed when water is maintained on-site through the summer that supports their habitat (Wylie *et al.* 2002). Movement statistics of giant garter snakes vary greatly and it is likely that giant garter snake movement is different due to the geographical difference of the Delta to the Sacramento Valley. Based on the research conducted in the Sacramento Valley, Hansen (1986) reported that individuals move less than 100 ft (30.5 m) during the spring in favored habitat. At the Colusa Drain, distances between captures of individuals ranged from 0.7 to 3.3 km (Wylie 2003). Using radio telemetry at the same location in 2006, individual mean movement distance was 63 m/day (range of 3–173 m/day), with a corresponding individual movement rate of 104 m/day (range of 12–287 m) during the "active season" (Wylie and Amarello 2006). Mean maximum individual movement distance was 862 m (range of 34–2,791 m), and total movement over the time radio-tracked averaged 4,761 m (range of 107–16,995 m; Wylie and Amarello 2006). Active-season minimum total distance moved at the same site in 2004 ranged from 0.7 to 215 km (Wylie and Martin 2004c).

Population status of giant garter snakes in the Delta is relatively undetermined and likely underestimated because sightings are sporadic in time and distance. As an example, an individual giant garter snake was sighted on Sherman Island near the Antioch Bridge in 1987 with a single reoccurring sighting in 2012 (CNDDB 2012) and a newer sighting in April of 2016 (Service 2016). A documented sighting of a dead individual was recorded around Empire Cut in the south Delta (CNDDB 2010), a live individual was found at Webb Tract in the central Delta (CNDDB 2014), and the most recent occurrences of several live and one dead individual were found in the riprap shoreline on Jersey Island with another possible individual sighted across the waterway by the landowner on Bradford Island during the installation of the 2015 rock drought barrier on False River (DWR 2015). Up to six confirmed sightings of individuals on Sherman Island, Twitchell Island, and Bradford Island have been documented since March of 2016 (Service 2016). Most recently, seven giant garter snakes were observed basking in the riprap shoreline of Jersey Island during a pre-construction survey on May 31, 2017. Seven giant garter snakes were again documented the following day on June 1, 2017. Ten snake skin sheds, presumed to be giant garter snake from the visible faint stripe patterning, were also documented in the same vicinity (Stillwater Sciences 2017).

The recent sightings within the last seven years were mostly by chance and not part of focused surveys which in contrast have had difficulty detecting giant garter snakes in the Delta. Swaim Biological Consulting conducted a series of surveys for giant garter snakes from 2004 to 2005 near the City of Oakley in Contra Costa County, which comprises a large portion of the Hotchkiss Tract immediately south of Bethel Island. No giant garter snakes were found although the trapping effort included both aquatic and terrestrial trap-lines, and was conducted during the active season for the snake (Swaim 2004, 2005a, 2005b, 2005c, 2005d, 2006). DWR also conducted a trapping survey of various sites within the Delta including Sherman Island and Holland Tract that met habitat assessment criteria for giant garter snake during the summer of 2009 (DWR 2010). No giant garter snakes were trapped or observed during those surveys either. Currently, the only known source population for giant garter snake in the Delta region is located in the Eastern Delta at Caldoni Marsh near the City of Stockton. However, it is unlikely that the recent occurrences of snakes found in the Central and Western Delta originated from Caldoni Marsh considering the distances of those occurrences from Caldoni Marsh, the distances between occurrences, and the estimated dispersal range from telemetry studies. The recent number of documented occurrences within close proximity of each other in the western portion of the Delta suggests there is likely a reproducing population of giant garter snake in this region. It should also be noted that giant garter snake in this area are evidently using a habitat feature such as riprap along the edge of a large body of moving water like the San Joaquin River that other giant garter snakes have not been observed using with any frequency elsewhere.

Large (400 - 700 acres) non-tidal wetland restoration efforts were conducted both on Sherman Island through DWR and on Twitchell Island through a partnership of DWR and Ducks Unlimited. These non-tidal inter-island wetlands provide high quality habitat that could support a giant garter snake population. Otherwise, it is largely unknown whether other reproducing source populations of giant garter snake occur within the various wetland habitats of the Central and Western Delta. Focused surveys in these areas are hindered either due to inaccessibility to privately owned lands or lack of resources.

The Corps consulted with the Service on their Sacramento River and Stockton Deepwater Ship Channel Dredging Project (Service File No. 08FBDT00-2016-F-0098). Part of the project involved the placement of dredge spoils onto existing designated Dredging Material Placement Sites (DMPS) and the construction of a new 35-acre DMPS on Twitchell Island. The DMPSs consisted of several acres of land ranging from 26 acres to 590 acres. Five of the eight DMPSs were near suitable wetland habitats for giant garter snake and were considered as potential upland habitat. Placement of dredge spoils on these sites was identified to affect giant garter snake by temporarily disturbing habitat and take of giant garter snake in the form of harassment. The Corps dredging project occurs annually, although the annual use of each DMPS varies. Efforts to create a 140-acre giant garter snake conservation bank (Shin Kee Conservation Bank) adjacent to White Slough Wildlife Area are under way in coordination with the Service and other agencies.

9.5.3 Effects of the Proposed Action

Construction of the HORG is not expected to affect giant garter snake because there is no suitable habitat in the vicinity of those construction activities. Operations of the facilities are not expected to affect giant garter snake; however, if aquatic habitat in the Delta is affected by changing in-Delta land management as a result of water quality changes by the PA, reinitiation may be necessary.

North Delta Diversions

Construction and ground disturbing activities related to the PA are likely to affect giant garter snake. Construction activities at each intake include ground clearing and grading, construction of the intakes and associated facilities, and vehicular use including transport of construction equipment and materials. Giant garter snake may be killed or injured by vehicles and heavy construction equipment used as part of the PA. This effect would be most likely to occur during site clearing (up to several days at each location). Vehicle strikes are a common threat to giant garter snake and several occurrence records of giant garter snake in CNDDB are from dead individuals found along roadsides which were struck by vehicles. Giant garter snakes commonly use roadside ditches for movement corridors or for foraging and are known to use roadsides for basking sites. The recent documented observations of giant garter snakes using riprap along major river levee banks also show that giant garter snakes can use this habitat for basking and sheltering and possibly for foraging or brumation/aestivation. This makes giant garter snakes highly vulnerable to vehicle strikes as giant garter snakes bask on the road or cross back and forth over roads from the various suitable aquatic and upland habitats.

Associated equipment noise, vibration, and increased human activity may interfere with normal behaviors. These behaviors include feeding, sheltering, movement between refugia and foraging habitats, and other essential behaviors of giant garter snake. Project related activities that occur in areas that have suitable habitat but create intolerable levels of disturbance may force individuals from cover and potentially subject them to circumstances that otherwise would not occur and could result in an increased threat to their survival such as predation.

Natural food sources may also be reduced as a result of habitat disturbance and loss. Short-term temporal effects will occur when vegetative cover is removed within upland habitat during project implementation, which may also subject this species to an increased risk of predation. Since snakes use small mammal burrows, soil crevices, and/or rock crevices for shelter for brumation during the winter season and aestivation during extremely hot days during their active period, the PA will likely have some adverse effect by harassing snakes away from suitable habitat or by disrupting brumation/aestivation if snakes are occupying a burrow or rock outcropping. As ground squirrel burrows can be deep and long, maintenance equipment may come into direct contact with an aestivating snake and a snake could be killed from ground disturbing activities. Snakes in terrestrial habitat may also become entombed under soil, crushed or damaged by equipment or personnel, thereby resulting in harm or mortality to individuals. To minimize these effects, DWR proposes a series of conservation measures such as work windows, exclusionary fencing, biological monitoring and worker awareness training.

The NDD is estimated to remove 74 acres of modeled habitat. This includes 12 acres of aquatic habitat and 62 acres of upland habitat. Of the estimated 74 acres of modeled habitat to be removed, 47 acres (3 acres of aquatic and 44 acres of upland) will result from construction of permanent facilities such as intake structures and associated electrical buildings and facilities, and permanent access roads. The remaining 27 acres (9 acres of aquatic and 18 acres of upland) of loss will result from use of the work areas, which will last for approximately 5 years at each intake. The Service considers impacts occurring over multiple years to be a permanent effect to listed species. To compensate for the loss of this habitat and minimize effects from habitat loss to giant garter snake, DWR proposes to either restore or protect high quality habitat areas targeted for giant garter snake recovery at a 2:1 ratio or create suitable habitats at a 3:1 ratio that would still benefit giant garter snake in the Delta. This would require 148 acres at the 2:1 ratio and 222 acres at the 3:1 ratio.

Mitigation/Restoration

DWR proposes to compensate for permanent habitat loss and long-term adverse construction effects by purchasing habitat at a 2:1 ratio if the habitat is within a Service agreed-to high-priority conservation area, such as the eastern protection area between Caldoni Marsh and Stone Lakes. Alternatively, the compensation may be at a ratio of 3:1 for both aquatic and upland habitat if the habitat is not within a high-priority conservation area. Therefore, depending on the habitat quality, the total amount of habitat protected will either be 2,325 acres or 1,550 acres.

Preconstruction Studies (Geotechnical Explorations)

Effects associated with geotechnical exploration are similar to those described for the NDD above. DWR proposes to conduct 1,380 to 1,430 overland borings and will require approximately 24 months using six land-based drill rigs operating concurrently for 6 days per week. Due to the sheer number of geotechnical explorations and the large proposed action area in which they occur, it is anticipated that individual giant garter snake near the localized area of the individual borings may be subject to intolerable levels of disturbance and/or be subject to injury or mortality if they come in contact with the boring machinery or any associated support vehicles or equipment.

DWR proposes that geotechnical explorations will avoid giant garter snake aquatic habitat but may temporarily affect up to 98 acres of upland habitat. The operation of equipment during construction could result in injury or mortality of giant garter snakes associated with the 98 acres of upland habitat. The potential for this effect will be minimized by confining activities within upland habitat to the active season, confining movement of heavy equipment to existing access roads or to locations outside upland habitat, and requiring that all construction personnel receive worker awareness training. The only permanent loss of giant garter snake habitat resulting from geotechnical explorations will be boreholes, which will be grouted upon completion. These holes are very small (approximately 8 inches diameter) and this permanent loss will have negligible effects on the giant garter snake. Except for the minimal habitat loss associated with boreholes, this temporary effect will consist of driving overland to access the boring sites, and storing equipment for short time periods (a few hours to 12 days).

Conveyance Tunnels

The water conveyance facilities that overlap with giant garter snake habitat include a tunnel work area, the intermediate forebay and spillway, a road interchange, vent shafts, barge unloading facilities, temporary or permanent work areas and access roads.

Effects associated with the tunnel conveyance construction are similar to those described for the NDD above. These effects are anticipated to occur throughout the scheduled construction timeframe (2018-2030). Construction activities associated with the conveyance facilities will include short-term segment storage, fan line storage, crane use, dry houses, settling ponds, daily spoils piles, use of power supplies, air, and water treatment. There will also be slurry wall construction at some sites, and associated slurry ponds. Access routes and new permanent access roads will be constructed for each shaft site.

The mapped water conveyance facilities overlap with 220 acres of giant garter snake modeled habitat including 127 acres of upland habitat and 93 acres of aquatic habitat. The 220 acres of giant garter snake habitat to be removed because of conveyance facility construction consists of multiple small areas spread out across the action area. Because the population status of giant garter snake is undetermined, it is unknown the effects to loss of this habitat will have on giant garter snake or whether it will create habitat isolation or fragmentation. To compensate for the loss of this habitat and minimize effects from habitat loss to giant garter snakes, DWR proposes to either restore or protect high quality habitat areas targeted for giant garter snake recovery at 2:1 ratio or create suitable habitats at a 3:1 ratio that would still benefit giant garter snake in the Delta. This would require 440 acres at the 2:1 ratio and 660 acres at the 3:1 ratio.

Clifton Court Forebay Modification

Effects associated with the tunnel conveyance construction are similar to those described for the NDD above. Construction activities at CCF include vegetation clearing, pile driving, excavation, dredging, and cofferdam and embankment construction. Construction at CCF will be phased by location and the duration of construction will be approximately 6 years.

An estimated 238 acres of giant garter snake modeled habitat overlaps with the mapped Clifton Court Forebay modifications where land will be cleared for permanent facilities and temporary work areas. This includes the additional acreages proposed as part of the CCWD supplemental agreement. The 238 acres of modeled habitat includes 17 acres of aquatic habitat and 221 acres of upland habitat. DWR proposes to either restore or protect high quality habitat areas targeted for giant garter snake recovery at 2:1 ratio or create suitable habitats at a 3:1 ratio that would still benefit giant garter snake in the Delta. This would require 479 acres at the 2:1 ratio and 711 acres at the 3:1 ratio.

Power Supply and Grid Connections

Effects associated with the tunnel conveyance construction are similar to those described for the NDD above. Power supply and grid connections include the construction of temporary substations, site preparation for new tower or pole construction, and tower or pole construction with the use of cranes and/or helicopters. Effects are anticipated to only occur for no more than 1 year at each location. Construction of both temporary and permanent transmission line and the associated site preparation is anticipated to temporarily affect 67 acres of giant garter snake upland habitat. Permanent habitat loss will result from pole and tower placement, and will affect less than 1 acre of habitat. DWR proposes to offset the effects of the 67 acres of temporary habitat disturbance by returning these areas to pre-project conditions. The permanent loss of up to 1 acre of upland habitat will be compensated at a 2:1 or 3:1 ratio.

Reusable Tunnel Material Placement Sites

The project proposes to mobilize over 30 million cubic yards of earthen spoils from the tunnels construction and place it over 2,558 acres of land. Each RTM storage area is anticipated to take 5-8 years to construct and fill. This will require the use of heavy earthmoving equipment such as dozers, graders, tillers and other machinery to move and rotate the soils. There is a strong potential to create a continuous level of intolerable disturbance from the movement of vehicle and heavy equipment used to carry spoils to the various sites and deposit the material for storage. Giant garter snakes are not typically found around areas of high disturbance and any giant garter snake occupying or in the vicinity of the proposed RTM placement sites will likely evacuate the area. There would then be a low probability of a giant garter snake returning and reoccupying the site during the continued disturbance essentially making the entire site unusable as habitat for the entirety of the construction timeframe. The RTM placement sites have the potential to become suitable upland habitat after construction and spoil placement has ended if there are suitable emergent aquatic habitats nearby. However, this is speculative and highly dependent on the natural recruitment of vegetative cover and fossorial small mammals.

The project has proposed eight RTM placement sites. Four of the sites occur within the vicinity of the Intermediate Forebay site between the Cosumnes River and the Stone Lakes Preserve. Removal of suitable habitat within these locations may contribute to fragmentation by diminishing the existing string of small habitat blocks between the larger Mokelumne and the Stone Lakes habitat blocks. The Bouldin Island RTM placement site is the largest of the eastern delta sites (excluding the CCF RTM site) and represents a large portion of ground disturbance and block of habitat removal/modification that may serve as a potential barrier to dispersal, genetic intermixing, and contribute to fragmentation by diminishing the existing string of small habitat blocks between the giant garter snake population at the Caldoni Marsh/White Slough Wildlife Area and the recent cluster of giant garter snake occurrences found in and around the western Delta (Sherman Island, Jersey Island, Bradford Island, Twitchell Island, and Webb Tract). This barrier would likely only occur during the construction phase of the RTM placement site until suitable habitat in the area can be created/restored or the formation of suitable emergent vegetation aquatic habitat occurs. This is dependent on future colonization of upland vegetative cover and the fossorial small mammals that would eventually provide the burrows that giant garter snake could use for brumation/aestivation.

RTM placement site construction is estimated to remove 242 acres of giant garter snake modeled habitat. The 242 acres of modeled habitat includes 83 acres of aquatic habitat and 159 acres of upland habitat. DWR proposes to either restore or protect high quality habitat areas targeted for giant garter snake recovery at 2:1 ratio or create suitable habitats at a 3:1 ratio that would still benefit giant garter snake in the Delta. This would require 484 acres at the 2:1 ratio and 726 acres at the 3:1 ratio.

Common Construction-related Activities

These are activities that are associated with the previously described actions. They are general activities and may be used in part or in whole for all sites as necessary. These activities include clearing, site work, ground improvement, borrow/fill, and fill to flood height for necessary levees and embankments.

All of these activities typically require the use of heavy earth moving equipment and vehicles and effects are similar to those described for the NDD above. Any habitat temporarily or permanently affected from construction is analyzed in the specific construction activities described above and any reinitiation triggers will be associated with those specific actions.

9.5.4 Effects to Recovery

For a species like the giant garter snake that has lost much of its former habitat, recovery would necessitate the conservation of much of the remaining habitat that still supports it. Reclamation and DWR are proposing to minimize the adverse effects of the loss of suitable habitat by implementing actions to promote the recovery of the affected species in a manner where the mitigation is commensurate with the adverse effect. Reclamation and DWR have proposed to restore or protect suitable habitat to offset the total loss of suitable habitat. Habitat loss and degradation are contributing factors to the decline of giant garter snake; consequently, restoration or protection of additional suitable habitat is a reasonable means of offsetting the adverse effects and may benefit the recovery of the giant garter snake. Consequently, we conclude that the PA would not interfere with the recovery of the giant garter snake.

9.5.5 Reinitiation Triggers

Some project elements and their effects on giant garter snake may change as DWR continues to develop the PA (*e.g.*, location of the geotechnical explorations, water availability as a result of operation of the facilities) and therefore may require reinitiation if additional effects are likely occur beyond those analyzed herein.

9.5.6 Cumulative Effects

The activities described in Section 9.2.5 for delta smelt are also likely to affect giant garter snake. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 9.2.5 are incorporated by reference into this analysis for the giant garter snake.

9.5.7 Conclusion

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the giant garter snake.

Reproduction

The giant garter snake is found in the action area and several occurrences have been documented from 2013 to 2016 in the western Delta (CDFW 2016, DWR 2015, Service 2016, Stillwater Sciences 2017). Actions from the project may reduce local reproduction as disturbances from construction and the removal of habitat are likely to interfere with normal giant garter snake mating behaviors and fecundity. The reduction in reproductivity in and around the project is anticipated to cause a reduction in the sub-population in the Delta recovery unit for the giant garter snake; however, it is not anticipated to result in the extirpation of giant garter snake and the Service anticipates that giant garter snake will be able to recover the loss of reproduction potential in habitat areas that are proposed to be protected or restored as a conservation measure for the species. Therefore, the PA will not appreciably affect giant garter snake reproduction that would lead to extirpation within the action area and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

The number of giant garter snakes in the action area is relatively low compared to the populations in the Sacramento Valley and populations east of the Delta Recovery Unit based on recent and past records (CDFW 2013, Service 2015). Also, Reclamation and DWR have proposed measures to avoid and minimize the effects of the PA on the species. Despite the proposed protection measures, we anticipate the PA may still result in adverse effects to the giant garter snake; however, the number of giant garter snake affected would be relatively low. This is especially true relative to the range-wide numbers. Therefore, the PA will not appreciably reduce the number of giant garter snake and we conclude the number of giant garter snakes throughout the species' range would not decline.

Distribution

The number of giant garter snakes likely to be affected by projects activities will be relatively low in relation to the species' population numbers range-wide. We also conclude that although giant garter snake will likely experience a reduction in population numbers within the delta recovery unit, they will continue to survive in the action area. Consequently, the water conveyance facility construction will not alter the distribution of the giant garter snake and we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

Conclusion

After reviewing the current status of the giant garter snake, the environmental baseline for the action area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

1. The number of giant garter snakes likely to be affected by projects activities will be low relative to the number of giant garter snake range-wide.

2. The low number of individuals likely to be affected by the project will not appreciably reduce the likelihood of giant garter snake's survival and recovery because many more individuals and larger habitat areas outside of the action area will remain.

3. Reclamation and DWR have proposed numerous and comprehensive measures to avoid and minimize potential effects.

4. Reclamation and DWR propose to restore or protect habitat that could support the giant garter snake.

5. The project is being implemented in a manner that will minimize damage to areas that could support the giant garter snake.

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9.6 Least Bell's Vireo

9.6.1 Status of the Species

The Service listed the least Bell's vireo as endangered in 1986 (51 FR 16474). Large-scale loss of habitat reduced the number of sites where it breeds and curtailed its numbers; nest parasitism by the brown-headed cowbird (*Molothrus ater*) reduced nesting success within much of the remaining breeding habitat. At the time of listing, the Service estimated that 300 territorial males remained in the United States. The project site is not within designated critical habitat for this species and it will not be discussed further.

Recovery Plan

The draft recovery plan for the least Bell's vireo (Service 1998) describes a strategy for securing and managing riparian habitat within its historical breeding range; the Service also recommended annual monitoring, range-wide surveys, and research to monitor and guide recovery. Specifically, the draft recovery plan recommends the criteria for achieving threatened status as stable or increasing populations or metapopulations, each consisting of several hundred or more breeding pairs that are protected and managed at 11 sites along the central and southern California coast and in the vicinity of Anza Borrego in the desert. Recommended delisting criteria include meeting the goal for threatened status, establishing increasing populations or metapopulations along the Salinas River and in the San Joaquin and Sacramento valleys, and a reduction or elimination of threats to the point where least Bell's vireo populations can persist without significant human intervention.

Five-Year Review

The 5-year review for the least Bell's vireo (Service 2006c) is incorporated by reference to provide additional information relevant to the status of the species. The following paragraphs provide a summary of the relevant information in the 5-year review.

In our 5-year review, we recommended revising the status of the species from endangered to threatened because of a ten-fold increase in abundance since listing, expansion of breeding locations throughout southern California, and conservation and management of suitable breeding habitat throughout its range. By 2005, the Service was aware of approximately 2,968 known territories in the United States with the greatest increases in San Diego and Riverside counties. The number of pairs in Orange, Ventura, San Bernardino, and Los Angeles counties also increased substantially; a few isolated individuals and breeding pairs have also been observed in Kern, Monterey, San Benito, and Stanislaus counties. Since publication of our 5-year review, surveys have detected breeding territories along the Amargosa River in the northern Mojave Desert (McCreedy and Warren 2015a) and Whitewater Canyon, Chino Canyon, and Mission Creek in the Coachella Valley (Hargrove *et al.* 2014). The increase in the abundance of least Bell's vireos since the listing is primarily due to efforts to reduce threats such as loss and degradation of riparian habitat and parasitism by brown-headed cowbirds. The control of invasive plants has also increased the amount of suitable habitat available for nesting.

The 5-year review also contained several recommendations for future management of the least Bell's vireo. These recommendations are to finalize a recovery plan for the least Bell's vireo with realistic, objectively based recovery goals; provide funding and technical support for further studies investigating continuing threats from parasitism by brown-headed cowbirds and invasion of riparian habitats by exotic plants, and potentially elevated predation pressures due to habitat fragmentation or presence of exotic predators; develop and implement a systematic program to survey the Salinas, San Joaquin, and Sacramento Valleys and inform future management; and develop systematic survey programs for watersheds in southern California that are not regularly surveyed within a given 5-year period.

West Nile virus may affect some groups of birds disproportionately, either temporarily or persistently (George *et al.* 2015). For example, George *et al.* (2015) found that red-eyed vireos (*Vireo olivaceus*) "experienced significant declines in survival associated with the arrival of [West Nile virus], followed by recoveries to pre-[West Nile virus] levels. Conversely, warbling vireos (*Vireo gilvus*) experienced smaller annual declines in survival than red-eyed vireos after the arrival of West Nile virus but the survival rate continued to decline in subsequent years. We do not know how West Nile virus would affect the least Bell's vireo over time.

Reproduction and Habitat Requirements

Least Bell's vireo is an obligate riparian breeder. The least Bell's vireo typically breeds in willow riparian forest supporting a dense, shrubby understory of mulefat (*Baccharis salicifolius*) and other mesic species (Goldwasser 1981; Gray and Greaves 1984; Franzreb 1989). Oak woodland with a willow riparian understory is also used in some areas (Gray and Greaves 1984), and individuals sometimes enter adjacent chaparral, coastal sage scrub, or desert scrub habitats to forage (Brown 1993). Similar habitats are used during the winter months. Goldwasser (1981) and Salata (1983) believed that structure and composition of vegetation below 3 and 4 m, respectively, were critical. Salata (1983) also reported the importance of a mix of tree size classes, with a mean height of 8 m. Gray and Greaves (1984) recommended protection of ground cover and low shrub layers. Vireos occur in disproportionately high frequencies in the wider sections (greater than 250m) of the riparian relative to site availability (RECON 1989).

Early successional riparian habitat typically supports the dense shrub cover required for nesting and a diverse canopy for foraging. Although least Bell's vireo tend to prefer early successional habitat, breeding site selection does not appear to be limited to riparian stands of a specific age. If willows and other species are not managed, within 5 to 10 years they form dense thickets and become suitable nesting habitat (Goldwasser 1981; Kus 1998). Tall canopy tends to shade out the shrub layer in mature stands, but least Bell's vireo will continue to use such areas if patches of understory exist. In mature habitat, understory vegetation consists of species such as California wild rose (*Rosa californica*), poison oak (*Toxicodendron diversilobum*), California blackberry (*Rubus ursinus*), grape (*Vitis californica*), and perennials that can conceal nests.

Least Bell's vireos use upland habitat, in many cases coastal sage scrub, adjacent to riparian habitat. Vireos along the edges of riparian corridors maintain territories that incorporate both habitat types, and a significant proportion of pairs with territories encompassing upland habitat place at least one nest there (Kus and Miner 1989). The least Bell's vireo arrives on its breeding grounds in mid-March (Brown 1993), with males arriving slightly before females (Nolan 1960; Barlow 1962). This vireo shows a high degree of nest site tenacity (Greaves 1987). Most individuals depart by September (Brown 1993), although some individuals remain on their breeding grounds into late November (Rosenberg *et al.* 1991).

Uplands adjacent to riparian areas provide migratory stopover grounds, foraging habitat, and dispersal corridors for nonbreeding adults and juveniles (Kus and Miner 1989; Riparian Habitat Joint Venture 2004). Foraging occurs most frequently in willows (Salata 1983; Service 1998), but occurs on a wide range of riparian species and even some nonriparian plants that may host relatively large proportions of large prey (Service 1998).

Territory size ranges from 0.5 to 7.5 acres (0.2 to 3 hectares), but on average are between 1.5 and 2.5 acres (0.6 and 1 hectare) in southern California (Service 1998). Spatial differences in riparian habitat structure, patch size, and numerous other factors result in differences in the density of territories within and between drainages.

The main impediments to successful reproduction for least Bell's vireos are nest parasitism by brown-headed cowbirds and availability of suitable breeding habitat. We expect that the continued management of brown-headed cowbirds and restoration of riparian habitat is likely to allow for the continued successful reproduction of the least Bell's vireo.

Numbers

The Service does not conduct regular surveys throughout the range of the least Bell's vireo. The U.S. Geological Survey collects data from biologists conducting surveys for the least Bell's vireo; various workers survey some areas regularly and other results are acquired from surveys that are conducted in support of other activities (*e.g.*, monitoring, preparation of environmental documents for development reviews, etc.). Additionally, not all sites are surveyed every year and the precise locations of surveys may vary from year to year. Consequently, the numbers of territorial males in Table 9.6.1-1 (adapted from Kus *et al.* 2014) do not represent a trend; they do, however, indicate that least Bell's vireos have increased in abundance since the time of listing.

Table 9.6.1-1 Number of least Bell's vireo territorial males.

Year	Number of Territorial Males
2003	1,604
2004	2,098
2005	2,068
2006	1,823
2007	2,088
2008	2,521
2009	3,075
2010	3,280
2011	2,917
2012	2,455
2013	2,597
2014	2,477

Distribution

Least Bell's vireo is one of four subspecies of Bell's vireo and is the only subspecies that breeds entirely in California and northern Baja California. Least Bell's vireo had a historical distribution that extended from coastal southern California through the San Joaquin and Sacramento Valleys as far north as Tehama County near Red Bluff (Kus 2002). The Sacramento and San Joaquin Valleys were the center of the historical breeding range supporting 60 to 80% of the population (51 FR 16474).

The distribution of the least Bell's vireo has increased to some degree since its listing in 1986, although it remains absent from large parts of its former range in the Central Valley. Two recent nesting events, 2005 and 2006 at the San Joaquin River National Wildlife Refuge, and 2010 and 2011 along Putah Creek in Yolo Bypass, indicate the species is attempting to recolonize the Central Valley. We expect that the distribution of least Bell's vireos is likely to continue to increase slowly in the future.

9.6.2 Environmental Baseline

Data on least Bell's vireos from the 1940s through the 1960s are lacking, but extensive surveys of the Central Valley in the late 1970s did not detect a single individual (Goldwasser *et al.* 1980). Least Bell's vireos are rarely observed in the Central Valley; according to eBird, the species has been observed at 7 distinct locations between 2005 and 2013. No individuals have been observed in the Central Valley in the last 3 years. There are no CNDDB records of least Bell's vireos breeding in the action area since at least the 1970s. Two singing males were detected in the Yolo Bypass Wildlife Area (approximately 8 miles from the action area) in mid-April 2010, and again in 2011 (CDFW 2013). No least Bell's vireos were detected in the Yolo Bypass Wildlife Area during surveys in 2012. A singing male was detected in 2013, and surveys were not conducted in 2014 (Whisler personal communication 2015). No least Bell's vireos were detected in the Yolo Bypass in 2015 or 2016, and the site appears to have been abandoned.

The next-nearest known nest site since the 1930s is approximately 4.5 miles south of the action area at the San Joaquin River National Wildlife Refuge in the San Joaquin and Tuolumne River floodplain (Howell *et al.* 2010). This occurrence includes three nests between 2005 and 2007, all in a recently restored portion of San Joaquin River National Wildlife Refuge lands known as "Hagemann's Fields 6 and 9." The 2005 and 2006 nests were successful. The 2007 nest was not successful in that only a female returned to the area, and though it constructed a nest and laid eggs, the nest failed. The 2005 and 2006 nests were in a 3-year-old arroyo willow with understory plants including mugwort, sunflower, gumplant, and creeping wild rye. The 2007 nest was in a dead arroyo willow (Howell *et al.* 2010).

Least Bell's vireos have not been detected within or around the project construction sites; however, surveys have not been conducted. Least Bell's vireos have been detected north of the project area, and those birds likely migrate through the action area. Therefore, least Bell's vireo likely stopover in and use the construction disturbance area for feeding, resting and sheltering during their migration.

9.6.3 Effects of the Proposed Action

It was not possible to do field surveys of the entire action area for the least Bell's vireo because many of the properties are in private ownership. Therefore, suitable modeled habitat was used to identify areas of potential effects. The permanent loss of suitable riparian and scrub habitat is expected as a result of the PA activities. The loss of suitable habitat could diminish available foraging and sheltering habitat for the least Bell's vireo.

Disturbance of least Bell's vireos may cause individuals to move more frequently than they would under natural conditions and result in energy expenditures that could affect the ability of the individual to survive. Workers, equipment, or the placement of ancillary flood control project structures may create enough noise or disturbance to flush least Bell's vireos temporarily from suitable habitat or cause them to avoid small areas of suitable habitat within or adjacent to the action area or abandon it and to seek out new territories. Noise and human/vehicle presence associated with project activities could flush least Bell's vireos from suitable habitat exposing them to higher predation risk and increased energy expenditure.

Water Conveyance Facility Construction

Activities associated with water conveyance facility construction that could adversely affect least Bell's vireos include: the north Delta intakes, tunneled conveyance facilities, reusable tunnel material, power supply and grid connection. These construction activities will destroy or modify habitat that migrating least Bell's vireo use for feeding, resting, and sheltering. Water conveyance facility construction is estimated to last 12 - 15 years, which is long enough to assume that least Bell's vireo will avoid using the estimated 32.25 acres of modeled habitat over the long-term, resulting in permanent impacts from water conveyance facility construction. Construction of the north Delta intakes will result in the loss of an estimated 5 acres of least

Bell's vireo suitable habitat. Construction of the Tunneled Conveyance Facilities will result in the loss of an estimated 11.25 acres of least Bell's vireo habitat. Placement of reusable tunnel material will result in the loss of an estimated 12 acres of least Bell's vireo habitat. Construction of the transmission lines will result in the loss of an estimated 4 acres of least Bell's vireo habitat. The loss will be offset through riparian creation or restoration at a 2:1 ratio for a total of 64.5 acres.

Water Conveyance Facility Construction - Noise, Lighting, Vibration, Bird Strikes on Transmission Lines

In addition to the habitat loss, construction itself has the potential to adversely affect least Bell's vireo. Construction that occurs when the vireo is migrating through the action area (using non-breeding habitat as a stopover to rest or forage) has the potential to harass least Bell's vireos due to noise, vibration, and nighttime lighting effects causing them to move to other locations which could expose individual vireos to increased predation and decreased foraging opportunities. When noises or disturbances are repeated over a long period, they could cause physiological stress to migrating least Bell's vireo.

Intake construction will require the use of loud, heavy equipment within the construction sites as well as along the access reads to the site. Pile driving for the north Delta intakes will create noise and vibration effects. Ongoing maintenance activities at the intakes include intake dewatering, sediment removal, debris removal, and biofouling and corrosion removal and will occur from water-based equipment approximately annually. These activities will have noise and lighting effects.

The tunneled conveyance facilities include tunnel work areas, vent shafts, the pumping plant and shaft location, a new forebay and spillway, tunnel conveyors, barge unloading facilities, fuel stations, and concrete batch plants. Construction noise up to 60 dBA will occur at up to 2,000 ft from the forebay and spillway construction footprint. These activities will have noise and lighting effects.

Power supply and grid connections include construction of temporary power lines to power construction activities and construction of permanent transmission lines to power conveyance facilities. Construction of new transmission lines will require site preparation, tower or pole construction, and line stringing. These activities will have noise and lighting effects. Migrating vireos may be subject to bird strikes at the transmission lines.

RTM activities at each site will include the use of heavy equipment for ground clearing and grading and soil tilling and rotation. Material will be moved to the site using a conveyor belt for long-term on-site storage. These activities will have noise and lighting effects.

Construction activities will create noise up to 60 dBA at no more than 1,200 ft from the edge of the construction footprint unless pile driving is required, in which case noise up to 60 dBA could reach up to 2,000 ft from the edge of the construction footprint. While 60 dBA is the standard noise threshold for birds (Dooling and Popper 2007), this standard is generally applied during the nesting season, when birds are more vulnerable to behavioral modifications that can cause nest failure. There is evidence, however, that migrating birds will avoid noisy areas during migration (McClure *et al.* 2013). To minimize this effect, the noise in the vicinity of least Bell's vireo habitat will be reduced as described in the CWF BA Appendix 3.F, *General Avoidance and Minimization Measures* section. This will include surveying for least Bell's vireo within the 60 dBA noise contour around the construction footprint, and if a least Bell's vireo is found, limiting noise to less than 60 dBA where the bird occurs until it has left the area. Pile driving will be limited to daytime hours within 1,200 ft of least Bell's vireo habitat.

Night lighting may also have the potential to affect migrating least Bell's vireos. While there is no data on effects of night lighting on migration for this species, studies show that migrating birds of other species are attracted to artificial lights and this may disrupt their migratory patterns or cause collision-related fatalities (Gauthreaux and Belser 2006). To minimize this effect, all lights will be screened and directed away from least Bell's vireo habitat as described in the CWF BA Appendix 3.F, *General Avoidance and Minimization Measures* section. There will still be some potential, however, for light-related effects to occur.

It is possible for migrating least Bell's vireo to be injured or killed by colliding with the transmission lines. All project and existing transmission lines will have bird strike diverters installed in a configuration that research indicates will reduce bird strike risk by at least 60% or more, as described in the CWF BA Appendix 3.F, *General Avoidance and Minimization Measures* section. With this implementation of this measure, least Bell's vireo collisions with transmission lines are not likely to occur.

The activities listed above are expected to affect least Bell's vireo in the form of harm and harassment. Construction activities are estimated to result in the permanent habitat loss of 32.25 acres.

9.6.4 Effects to Recovery

Noise, lighting and vibration also have the potential to temporarily cause adverse effects to the least Bell's vireo. These threats will be minimized by Reclamation's proposal to restore or protect suitable habitat for the least Bell's vireo. The restoration and protection of riparian habitat will benefit the least Bell's vireo because of the importance of this habitat type for this species. The relatively small amount of habitat that will be lost (approximately 32 acres as a result of the construction of the water conveyance facilities) will not appreciably alter conditions in the action area. Therefore, we conclude that the PA will not have a permanent effect on the recovery of the least Bell's vireo.

9.6.5 Reinitiation Triggers

Some project elements and their effects on least Bell's vireo may change as DWR continues to develop the PA and therefore may require reinitiation if project elements are located in areas that occur in or near modeled habitat and effects rise above those analyzed herein.

9.6.6 Cumulative Effects

The activities described in Section 9.2.5 for delta smelt are also likely to affect least Bell's vireo. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 9.2.5. are incorporated by reference into this analysis for the least Bell's vireo.

9.6.7 Conclusion

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the least Bell's vireo.

Reproduction

The least Bell's vireo is relatively rare in the action area (Goldwasser *et al.* 1980). Therefore, the PA will not appreciably affect least Bell's vireo reproduction, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

As described in the Reproduction section above, the number of least Bell's vireos in the action area is relatively low, based on recent and past records (Goldwasser *et al.* 1980). Also, Reclamation and DWR have proposed measures to avoid and minimize the effects of the PA on the species. Despite the proposed protection measures, we anticipate the PA may still result in effects to the least Bell's vireo; however, the number of least Bell's vireos affected would be very low. This is especially true relative to the range-wide numbers. Therefore, the PA will not appreciably reduce the number of least Bell's vireos and we conclude the number of least Bell's vireos throughout the species' range would not decline.

Distribution

During migration, least Bell's vireos may stop to rest and forage in variety of vegetation types where construction of water conveyance facilities could be located; the loss of this stop-over habitat will not have a measurable effect on the species.

The number of least Bell's vireos likely to be affected by projects activities will be very low. We do not expect that any least Bell's vireos will be directly killed by construction of the water conveyance facilities, and that very few least Bell's vireos will be affected by the PA activities. We also conclude that least Bell's vireos will continue to survive in the action area regardless of the activities. Consequently, the water conveyance facility construction will not alter the distribution of the least Bell's vireo and we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

Effects on Recovery

For a species like the least Bell's vireo that has lost much of its former known occupied habitat, recovery would necessitate the conservation of much of the remaining habitat that still supports it. Reclamation is proposing to minimize the adverse effects of the loss of suitable habitat by implementing actions to promote the recovery of the affected species in a manner where the mitigation is commensurate with the adverse effect. Reclamation has proposed to restore or protect suitable habitat to offset the total loss of suitable habitat. Habitat loss and degradation are contributing factors to the decline of least Bell's vireo; consequently, restoration or protection of additional suitable habitat is a reasonable means of offsetting the adverse effects and may benefit the recovery of the least Bell's vireo. Consequently, we conclude that the PA would not interfere with the recovery of the least Bell's vireo.

Conclusion

After reviewing the current status of the least Bell's vireo, the environmental baseline for the action area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the construction of the CWF facilities, as proposed, is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

1. The number of least Bell's vireos likely to be affected by projects activities will be very low.

2. The low number of individuals likely to be affected by the project will not appreciably reduce the likelihood of least Bell's vireos survival and recovery because many more individuals and larger habitat areas outside of the action area will remain.

3. Reclamation and DWR have proposed numerous and comprehensive measures to avoid and minimize potential effects.

4. Reclamation and DWR propose to restore or protect habitat that could support the least Bell's vireo.

5. The PA is being implemented in a manner that will minimize damage to areas that could support the least Bell's vireo.

6. The PA will result in the relatively minor loss of resting and foraging habitat and therefore will not adversely affect the least Bell's vireo species' ability to migrate through the action area.

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9.7 San Joaquin Kit Fox

9.7.1 Status of the Species

The Service listed the San Joaquin kit fox (kit fox) as endangered on March 11, 1967 (32 FR 4001). Critical habitat has not been designated for this species. The Service completed a recovery plan for the species on September 30, 1998 (Service 1998) and published a 5-year review of the species on February 16, 2010 (Service 2010). The following paragraphs provide a summary of the relevant information in the recovery plan and 5 year review.

Recovery Plan

The kit fox occurs in nearly all the natural communities of the San Joaquin Valley. Since the species has a broad distribution and requirement for relatively large areas of habitat, it is considered a keystone species and as an umbrella species for the purposes of conservation and recovery of federally-listed species in the valley. The recovery plan identifies of three geographically-distinct core populations, and smaller satellite populations. The recovery plan recognizes that recovery of the species requires a dual track with simultaneous actions, of both: (A) habitat protection and population interchange and (B) population ecology and management. For track A, an important element of the recovery of kit foxes is connecting larger blocks of isolated natural land to core and satellite populations. Connecting large blocks will help reduce the harmful effects of habitat loss and fragmentation. For track B, future studies are needed to help define management actions concerning distribution, habitat utilization and dispersal. The primary goal of the recovery strategy for kit foxes identified in the recovery plan is to establish a complex of interconnected core and satellite populations throughout the species' range.

The latest five review of the species concluded that the kit fox continues to meet the definition of endangered. To delist the species, several additional satellite populations (number dependent on results of track B research) encompassing as much as possible of the environmental and geographic variation of the historic geographic range needs to be established.

The recovery plan identifies the protection of existing kit fox habitat in the northern portion of its range and protection of existing connections between habitat in Contra Costa County and habitat farther south as primary recovery actions.

Habitat

In the San Joaquin Valley before 1930, the range of the kit fox extended from southern Kern County north to Tracy in San Joaquin County, on the west side, and near La Grange in Stanislaus County, on the east side (Grinnell *et al.* 1937; Service 1998). Historically, this species occurred in several San Joaquin Valley native plant communities in the northern portion of their range, kit foxes commonly are associated with annual grassland (Hall 1983) and Valley Oak Woodland (Bell 1994). Kit foxes inhabit grazed grasslands, grasslands with wind turbines, and also live adjacent to and forage in tilled and fallow fields, and irrigated row crops (Bell 1994). Kit foxes use some types of agricultural land where uncultivated land is maintained, allowing for denning sites and a suitable prey base (Jensen 1972, Knapp 1978, Hansen 1988). Kit foxes also den on small parcels of native habitat surrounded by intensively maintained agricultural lands (Knapp 1978), and adjacent to dryland farms (Jensen 1972, Kato 1986, Orloff *et al.* 1986). San Joaquin kit foxes also exhibit a capacity to utilize habitats that have been altered by man. This fox species is present in many oil fields, grazed pasturelands, and "wind farms" (Cypher 2000). Kit foxes can inhabit the margins and fallow lands near irrigated row crops, orchards, and vineyards, and may forage occasionally in these agricultural areas (Service 1998). There are a limited number of observations of kit foxes foraging in trees in urban areas (Murdoch *et al.* 2005). The kit fox seems to prefer more gentle terrain and decreases in abundance as terrain ruggedness increases

(Grinnell *et al.* 1937; Morrell 1972; Warrick and Cypher 1999). Other plant communities in the San Joaquin Valley providing kit fox habitat include Northern Hardpan Vernal Pool, Northern Claypan Vernal Pool, Alkali Meadow, and Alkali Playa.

Overall, kit foxes prefer loose-textured soils (Grinnell *et al.* 1937; Hall 1946; Egoscue 1962, Morrell 1972), but are found on virtually every soil type. Dens appear to be scarce in areas with shallow soils because of the proximity to bedrock (O'Farrell and Gilbertson 1979, O'Farrell *et al.* 1980), high water tables (McCue *et al.* 1981), or impenetrable hardpan layers (Morrell 1972). However, kit foxes will occupy soils with high clay content, such as in the Altamont Pass area in Alameda County, where they modify burrows dug by other animals (Orloff *et al.* 1986).

Threats

The primary threats to the species are: (1) the continued loss of kit fox habitat to agricultural and urban development, (2) the continued threats from pesticide exposure, (3) competitive exclusion by other canids, (4) the highly fluctuating population dynamic of most kit fox populations, (5) the isolation and loss of small subpopulations due to stochastic events and habitat fragmentation, and (6) threats identified since listing, such as off-road vehicle use and loss of prey.

Another threat is vehicle strikes. Little data is available regarding the frequency with which the animals cross roads. The proportion of successful road crossings by these animals likely declines with increasing road size, traffic volume and density, and vehicle speeds. The proportion of kit foxes successfully crossing roads may increase in areas where they obtain more experience crossing roads, such as in and near urban areas. The loss of kit fox to vehicles may constitute a significant population effect within their northern range where they occur in low abundance. Morrell (1970) reported vehicle strikes to be the major cause of death for kit foxes based on study in which 128 of 152 deaths were reportedly caused by automobiles. Within eastern Alameda County, EIP Associates (CNDDB Occ. #585) reported a kit fox along Interstate 205 near the Alameda/San Joaquin County line in 1986; Spencer (CNDDB Occ. #41) reported a single adult running along Kelso Road on June 20, 1992; and Beeman (CNDDB Occ. #39) reported a single adult kit fox crossing Patterson Pass Road on June 23, 1995.

Vehicles constitute a consistent, but variable source of mortality for the animal, based on the frequency with which vehicle strikes occur. Vehicle strikes appear to occur most frequently where roads transverse areas where the animals are abundant. However, the linear quantity of roads in a given area may not be directly related to the number of vehicle strikes in a given area. The type of road (*e.g.*, number of lanes), traffic volume, and average speed of vehicles likely all influence the number of San Joaquin kit fox/vehicle strikes. The number of strikes likely increases with road size, traffic volume, and average speed (Clevenger and Waltho 1999). Also, roads have been documented as barriers to movements by a variety of species, and this effect varies with road size and traffic volume.

Climate Change

Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field *et al.* 1999; Cayan *et al.* 2005; Cayan *et al.* 2006; IPCC 2007). Kit fox subpopulations are threatened by both droughts and high rainfall events (Cypher, California State University-Stanislaus, personal communication; Williams, Kern National Wildlife Refuge Complex, personal communication; Williams *et al.* 1993, Rathbun 1998, Germano and Williams 2005). Kit fox subpopulations, including the relatively large subpopulations at the Naval Petroleum Reserves, California and Carrizo Plains areas, demonstrate large fluctuations in abundance in response to weather-mediated prey levels, which increases the potential for these groups to be extirpated (Cypher *et al.* 2000; Bean and White 2000; Bidlack 2007). Weather conditions usually vary over larger landscape scales, leading to the general expectation that drought-mediated decreases in kit fox abundance, or local extirpation of some groups, should not affect persistence of the species as long as healthy core kit fox populations are not limited to one portion of the range. However, the loss and fragmentation of habitat documented herein has reduced the likelihood that lost sites will be re-colonized (Williams 2007; Cypher 2006; Cypher *et al.* 2007), which is expected to result in a cumulative loss of small groupings over time (Clark *et al.* 2007b).

Because of the expected increased frequency of dry weather and droughts, and substantial precipitation events are expected to negatively affect the native prey species upon which the kit fox depends, the Service expects climate change to pose a substantial threat to the species by further exacerbating interannual fluctuations in kit fox reproductive success and abundance. Changes in the distribution of individual plants species could increase or decrease distributions of key species (Kelly and Goulden 2008; Loarie *et al.* 2008), and are expected to affect kit fox. However, the magnitude of these effects is not known at this time.

Population

Historically, kit foxes may have existed in a metapopulation structure of core and satellite populations, some of which periodically experienced local extinctions and recolonization (Service 1998). Today's populations exist in an environment drastically different from the historic one, however, and extensive habitat fragmentation will result in geographic isolation, smaller population sizes, and reduced genetic exchange among populations; all of which increase the vulnerability of kit fox populations to extirpation. Populations of kit foxes are extremely susceptible to the risks associated with small population size and isolation because they are characterized by marked instability in population density. For example, the relative abundance of kit foxes at the Naval Petroleum Reserves, California, decreased 10-fold during 1981 to 1983, increased 7-fold during 1991 to 1994, and then decreased 2-fold during 1995 (Cypher and Scrivner 1992; Cypher and Spencer 1998).

Many populations of kit fox are at risk of chance extinction owing to small population size and isolation. This risk has been prominently illustrated during recent, drastic declines in the populations of kit foxes at Camp Roberts and Fort Hunter Liggett. Captures of kit foxes during annual live trapping sessions at Camp Roberts decreased from 103 to 20 individuals during 1988 to 1991. This decrease continued through 1997 when only three kit foxes were captured (White *et al.* 2000). A similar decrease in kit fox abundance occurred at nearby Fort Hunter Liggett, and only 2 kit foxes have been observed on this installation since 1995 (L. Clark, Wildlife Biologist, Fort Hunter Liggett, personal communication to P. White, Service, Sacramento, February 15, 2000). It is unlikely that the current low abundances of kit foxes at Camp Roberts and Fort Hunter Liggett will increase substantially in the near future owing to the limited potential for recruitment. The chance of substantial immigration is low because the nearest core population on the Carrizo Plain is distant (greater than 16 miles) and separated from these installations by barriers to kit fox movement such as roads, developments, and irrigated agricultural areas. Also, there is a relatively high abundance of sympatric predators and competitors on these installations that contribute to low survival rates for kit foxes and, as a result, may limit population growth (White *et al.* 2000). Hence, these populations may be on the verge of extinction.

The loss and fragmentation of habitat could also eventually lead to reduced genetic variation in populations of kit foxes that are small and geographically isolated. It is likely that northern populations of kit foxes were once panmictic (*i.e.*, randomly mating in a genetic sense), or nearly so, with southern populations. In other words, there were no major barriers to dispersal among populations. Current levels of gene flow also appear to be adequate, however, extensive habitat loss and fragmentation continues to form more or less geographically distinct populations of foxes, which could potentially reduce genetic exchange among them. An increase in inbreeding and the loss of genetic variation could increase the extinction risk for small, isolated populations of kit foxes by interacting with demography to reduce fecundity, juvenile survival, and lifespan (Lande 1988; Frankham and Ralls 1998; Saccheri *et al.* 1998).

An area of particular concern is Santa Nella in western Merced County where pending development plans threaten to eliminate the little suitable habitat that remains and provides a dispersal corridor for kit foxes between the northern and southern portions of their range. Preliminary estimates of expected heterozygosity from kit foxes in this area indicate that this population may already have reduced genetic variation.

Arid systems are characterized by unpredictable fluctuations in precipitation, which lead to high frequency, high amplitude fluctuations in the abundance of mammalian prey for kit foxes (Goldingay *et al.* 1997, White and Garrott 1999). Because the reproductive and neonatal survival rates of kit foxes are strongly depressed at low prey densities (White and Ralls 1993; White and Garrott 1997, 1999), periods of prey scarcity owing to drought or excessive rain events can contribute to population crashes and marked instability in the abundance and distribution of kit foxes (White and Garrott 1999). In other words, unpredictable, short-term fluctuations in precipitation and, in turn, prey abundance can generate frequent, rapid decreases in kit fox density that increase the extinction risk for small, isolated populations.

The long-term viability of each of these core and satellite populations depends partly upon periodic dispersal and genetic flow between them. Therefore, kit fox movement corridors between these populations must be preserved and maintained. In the northern range, from the Ciervo Panoche in Fresno County northward, kit fox populations are small and isolated, and have exhibited significant decline.

There has never been a comprehensive survey of kit foxes or their habitat except for one core population in western Kern County. What is known comes from incidental sightings, local surveys, research projects, and aerial photos. There are more than several hundred recorded sightings of San Joaquin kit foxes in the San Joaquin Valley (CNDDB 2004).

9.7.2 Environmental Baseline

The southern portion of the PA is located within the northern range of the species' current and historical range, as indicated in the map below.

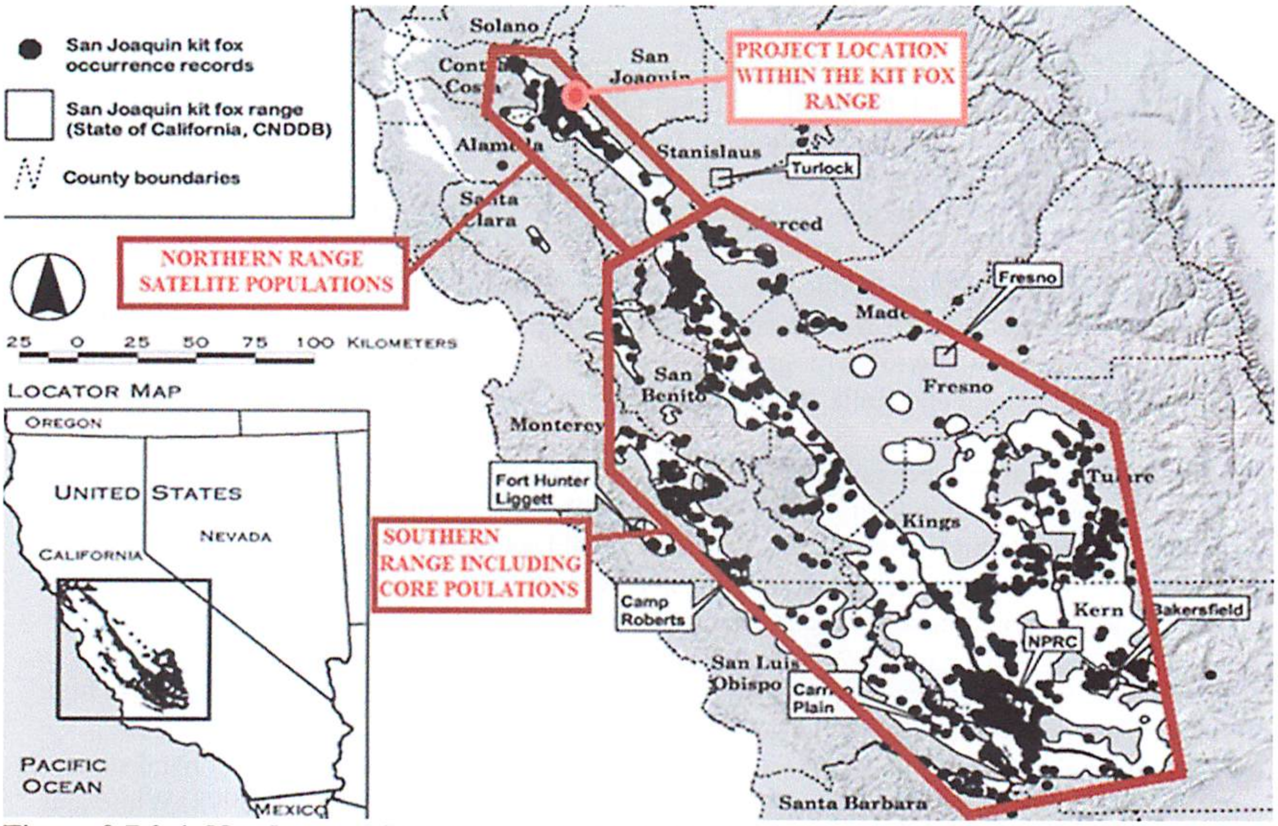

Figure 9.7.2-1. Northern and southern ranges of the San Joaquin kit fox and project location (adapted from the Endangered Species Recovery Program San Joaquin kit fox map, available at http://esrp.csustan.edu/gis/maps/sjkfrange.png).

In January and February 2016, DWR staff completed a habitat analysis for kit fox in the project area and the area immediately adjacent to determine potential utilization by the species. DWR's analysis included onsite and adjacent land vegetation surveys, review of aerials, and review of literature pertaining to habitat requirements. In addition, DWR staff completed an occurrence analysis based on occurrence records, past and present surveys, and best available research.

DWR has identified approximately 60 acres of potential suitable habitat in the action area that overlaps with the construction footprint and associated effects (CWF BA 2016).

The Service has completed numerous section 7 consultations concerning the kit fox in the action area. Some past substantial consultations near the construction footprint include: (1) *Formal Consultation for the Tracy-Livermore Optical Ground Wire Project* (Service File No. 08ESMF00-2012-F-0084-1), and the (2) *Intra-Service Biological Opinion on Issuance of Section 10(a)(B) Incidental Take Permit for the Contra Costa County, the Contra Costa Flood Control and Water Conservation District, the East Bay Regional Park District, and the Cities of Brentwood, Clayton, Oakley, and Pittsburg for Implementation of the East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan* (Service File No. 1-1-07-F-2007). These consultations document potential presence of the species and past permanent habitat loss.

According to the 5-year review (Service 2010b), the northern satellite population has declined with no known breeding. The CNDDB reports 24 occurrences of kit fox within Contra Costa County (CDFW 2014) and in 1973, Swick estimated that Contra Costa County supported a population of 123 kit fox but cautioned that this estimate could be high. The most recent kit fox sightings in Contra Costa County include sightings at Vasco Caves (one in May 2001 and one in June 2002) and a single sighting in 2008 in close proximity to the Los Vaqueros Watershed Administrative Offices. Surveys conducted in 2001 and 2002 in Contra Costa County and Alameda Counties in areas identified as having high potential to support kit fox did not find evidence of recent den occupancy by kit fox (Clark *et al.* 2003). Although these results do not demonstrate that kit fox are absent from these areas, they do suggest that kit fox density is low or their occurrence is periodic. Since the PA occurs within the current distribution of the species and within dispersal distance of known occurrences, the Service assumes presence of the species within the action area.

9.7.3 Effects of the Proposed Action

There is potential for kit fox to be present within the action area and the construction footprint during the duration of the PA, due to accessibility of the construction footprint from suitable habitat in the Bryon Hills area in Contra Costa County, California. A known historical northern satellite population is located there, as discussed in the *Environmental Baseline* section for this species. The activities in the PA expected to have effects on kit fox and its suitable habitat include: the geotechnical explorations, the CCF modification, and the power supply and grid connections. Activities included in the PA that are unlikely to affect the species, since those activities have not been identified by DWR to overlap with suitable habitat for the kit fox include: the safe haven work areas, north Delta intakes, tunnel conveyance facilities, placement of the reusable tunnel material, and the HORG. The activities identified above to have effects on this species will be caused by driving overland, access routes, equipment storage, vegetation clearing, pile driving, excavation, dredging, cofferdam installation, new embankments, utilization of heavy equipment, construction of electric transmission lines, construction of substations, and relocation of electric transmission lines.

Construction Activities

The PA will adversely affect the kit fox through harassing and harming (*i.e.*, permanent habitat loss) individuals inhabiting and/or dispersing through habitat within the action area and construction footprint. Kit foxes could be attracted to construction footprint due to the increased availability of cover (*e.g.*, within pipes, trenches, or materials staging areas) or the increased availability of forage items such as food scraps and trash, increasing their risk of injury. Kit fox near the construction footprint are expected to experience harassment resulting from increased levels of human disturbance and vehicle use and excavation of dens and burrows. These activities could displace kit fox which will make them vulnerable to increased predation, exposure, starvation, or stress through disorientation, loss of shelter, and intraspecific and interspecific aggression. The disturbance caused by the PA resulting from construction noise, nighttime illumination, vibration, odors, and human activity can interfere with sensory perception of kit fox, decreasing their ability to locate prey, pups, or mates, or detect approaching predators. Disturbance can induce stress which can alter normal behaviors. The resulting effects can lead to increased energetic requirements, decreased reproductive success and immunological functions, altered temporal or spatial use patterns, displacement, and in some cases death. Responses to external stresses vary among individuals, causing some animals to be more affected than others; however, it is unknown whether disturbance results in reduced local abundance.

Kit foxes in habitat that overlaps with the transmission line right-of-way, along with helicopter work areas (*i.e.*, take-off and landing areas) may be subject to harassment from the noise and propeller wash of low flying helicopters. While kit fox could also be injured or killed by construction vehicles, the proposed vehicle speed limits are likely to avoid collisions with kit foxes. Effects on the kit fox are expected to be greater during the den selection, gestation, and the early rearing period of the breeding cycle (December through July) than at other times of the year.

Increased Noise

The increase in ambient noise resulting from construction of the PA could reduce the ability of kit fox to hear prey, vocalize to other individuals in the area, or reduce ability to detect predators. Noise disturbance may temporarily impair behavioral patterns of this species' prey. It is expected that effects will be amplified during nighttime construction, since the kit fox is a nocturnal mammal. DWR has stated that ambient baseline noise levels are expected to be near 40 dBA (CWF BA 2016- Appendix 6.B). While kit fox in the action area and near or within the construction footprint currently experience noise disturbance from Bryon Highway, railroad, Bryon Airport and road traffic, construction-related effects are expected to increase noise levels for the duration of the construction (*i.e.*, 6 years). All construction activities will increase ambient noise levels in surrounding areas, approximately 4000-5000 ft from the point source (CWF BA 2016- Appendix 6.B). For example, the construction of the divider wall, embankment, and siphons at CCF will all require pile driving, in combination with the six loudest pieces of construction equipment, noise at these construction areas could reach 60 dBA at up to 2,000 ft from the edge of the footprint and up to 4000 to 5000 ft before noise attenuates to baseline conditions (CWF BA 2016 & Appendix 6.B). DWR has proposed measures to minimize to the greatest extent practicable noise resulting from geotechnical explorations in or adjacent to kit fox habitat.

Increased Night Lighting

Increased nighttime illumination of kit fox habitat will occur from lighting required for nighttime construction. The adverse effects of artificial lighting on nocturnal mammals, such as kit fox, include: foraging patterns changes, predation risk increases, biological clock disruptions, road mortality increases, and disruption of dispersal movements through artificially lit landscapes (Rich and Longcore 2006). DWR did not quantify the amount of acreage that could be affected by the increase in night lighting associated with the PA. DWR has proposed measures to minimize nighttime lighting resulting from PA construction in or adjacent to kit fox habitat.

Potential for Vehicle Strikes

Existing roads that will be utilized are identified in the CWF BA and DWR has stated that effects of driving overland will be confined to the construction footprint. Kit foxes utilize habitat along rural roads and highways near the action area, increasing their susceptibility to mortality or injury caused by vehicle strikes. DWR has proposed to minimize these effects by enforcing a daytime speed limit of 20-mph throughout the worksite, where it is practical and safe to do so, except on county roads and State and Federal highways; also, vehicles will observe a nighttime speed limit of 10-mph throughout kit fox habitat within the action area. Based on these measures, no kit fox are expected to be struck by vehicles as a result of the PA.

Temporary Habitat Loss

Some areas will be temporarily denuded, manipulated, or otherwise modified from their pre-project conditions, thereby removing one or more essential habitat components as a result of project activities including construction, staging, storage, lay down, vehicle access, and parking. Temporary effects must be restored to baseline habitat values or better within one year following initial disturbance. DWR proposes to restore habitat affected by geotechnical explorations and the construction of the power supply and grid connections to pre-project conditions. DWR estimates the geotechnical explorations will temporarily affect 2 acres and the power supply and connections will temporarily affect 9 acres. Upon completion of the PA, restoration of affected suitable habitat that is subject to temporary ground disturbances (*e.g.*, construction areas, storage and staging areas, and temporary roads) will be accomplished by recontouring to pre-project elevations and revegetating with native vegetation seed mixture within one year of disturbance, in order not to be considered a permanent loss of habitat. Any future vegetation management that may affect the restored habitat would require reinitiation of this BiOp.

To minimize effects of the geotechnical investigation, work will only occur during the day, work will be monitored by a Service-approved monitor, all holes deeper than 2 ft will be covered, pipes and culverts bigger than 4 inches will be inspected prior to daily construction activity by a Service-approved biologist. To minimize the effects of the power supply and connections prior to final alignments, there will be a pre-construction survey by a Service-approved biologist and if occupied dens are observed, the Service will be notified and alignment will be designed to avoid the den by at least 200 ft. Once the alignment has been finalized, all proposed conservation measures will be followed.

Compensation and Minimization of Effects

DWR proposes to compensate for permanent habitat loss by purchasing habitat prior to impacts within the Byron Hills area, where there is connectivity to existing protected habitat and to other adjoining kit fox habitat, at a ratio of 3:1 and at locations subject to Service-approval. The compensation habitat will be preserved and managed in-perpetuity with a Service-approved conservation easement and a long-term management plan with appropriate funding mechanism. DWR expects the PA will result in 47 acres of permanent habitat loss; therefore, 141 acres of habitat will be protected. Preservation of high value habitat in the Byron Hills area will allow for the permanent protection, long-term management, and enhancement of the habitat for the kit fox, which will contribute to the recovery of this species. Compensation habitat features must be contiguous patches of unprotected grassland habitat connected to existing habitat that is protected under the East Contra Costa County HCP/NCCP.

Other proposed conservation measures outlined in the CWF BA include requiring a qualified Service-approved biologist to conduct pre-construction surveys; educating workers about the presence of kit fox, their habitat, identification, regulatory laws, and avoidance measures; erecting deterrent fencing to minimize the likelihood of kit foxes entering the construction area; covering all steep-walled holes or trenches more than 2 ft deep at the end of each workday; disposing of all food-related trash items in closed containers and removing from the action area weekly; inspecting all den-like structures such as pipes or culverts prior to being buried, capped or moved; restricting the presence of firearms within the action area to law enforcement personnel; prohibiting bringing domestic animals to the action area; all use of rodenticides and herbicides will be prohibited in San Joaquin kit fox habitat; and finally the Service's 2011 *Standardized Recommendations for Protection of the San Joaquin kit fox prior to or during Ground Disturbance* will be implemented for dens. All of these measures will minimize or avoid kit fox from being injured or killed as a result of exposure to construction activities.

9.7.4 Effects to Recovery

The PA would not increase the threats currently impacting the kit fox core or satellite areas as identified in the recovery plan, as described in the *Status of the Species*, or preclude implementation of recovery actions. The resulting adverse effects of the PA's construction footprint are considered permanent due to duration of construction, proposed structures and ongoing operations and maintenance. The suitable habitat affected is outside of the core recovery areas; therefore, with implementation of the proposed conservation measures, the PA is expected to result in minimal change in population numbers and distribution. DWR has proposed to minimize the adverse effects of the loss of individuals and habitat by implementing conservation measures to promote the recovery of the kit fox in a manner where the mitigation is commensurate with the adverse effect. DWR has proposed to restore or create 141 acres of habitat to offset the total loss of individuals predicted for the life of the PA. As stated previously, habitat loss and degradation are contributing factors to the decline of kit fox; consequently, the proposal to create or restore additional 141 acres of habitat is a reasonable means of minimizing the adverse effects of the loss of individuals on the species as a whole and may benefit the recovery of the kit fox.

9.7.5 Reinitiation Triggers

Some project elements and their effects on the San Joaquin kit fox may change as DWR continues to develop the PA and may require reinitiation if effects rise above those analyzed herein. For the San Joaquin kit fox, these elements may include: any long-term vegetation management associated with the power and supply grid, if the effects of construction vehicle-strikes are not fully avoided, and if the Service-approved biologist during pre-construction surveys of the construction footprint or adjacent area identifies additional suitable kit fox habitat that could be affected but not analyzed in this BiOp.

9.7.6 Cumulative Effects

The activities described in Section 9.2.5 for delta smelt are also likely to affect San Joaquin kit fox. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 9.2.5. are incorporated by reference into this analysis for the San Joaquin kit fox.

9.7.7 Conclusion

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the San Joaquin kit fox.

Reproduction

The action area is located within the portion of the range believed to support a northern satellite population. According to the 5-year review (Service 2010b), this northern satellite population has declined with no known breeding. Therefore, the PA will not appreciably affect San Joaquin kit fox reproduction range-wide, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

The number of individuals affected by the PA will be very low relative to the range-wide numbers. This northern satellite population is thought to be small, evidenced by the lack of dens. Therefore, the PA will not appreciably reduce the number of San Joaquin kit fox.

Distribution

The habitat within the action area is near the northern extent of their range. We do not anticipate that the range-wide distribution of the San Joaquin kit fox will be reduced because it will not eliminate or significantly reduce the distribution of the species. The effect to the species from habitat loss and fragmentation will be minimized by the proposed compensatory mitigation measures. Therefore, we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

Effects on Recovery

Reclamation and DWR propose to minimize the adverse effects of the loss of suitable habitat by implementing actions to promote the recovery of the affected species in a manner where the mitigation is commensurate with the adverse effect. Reclamation and DWR have proposed to restore or protect suitable habitat to offset the total loss of suitable habitat. Habitat loss and degradation are contributing factors to the decline of San Joaquin kit fox; consequently, restoration or protection of additional suitable habitat is a reasonable means of offsetting the adverse effects and may benefit the recovery of this species. Consequently, we conclude that the PA would not appreciably reduce the likelihood of recovery of the San Joaquin kit fox.

Conclusion

After reviewing the current status of the San Joaquin kit fox, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the San Joaquin kit fox. We have reached this conclusion because:

1. The number of San Joaquin kit fox likely to be affected by project activities will be low.

2. The low number of individuals likely to be affected by the project will not appreciably reduce the likelihood of survival and recovery of the species range-wide because the majority of individuals and larger habitat areas outside of the action area will remain.

3. Reclamation and DWR have proposed numerous and comprehensive measures to avoid and minimize potential effects, including compensatory mitigation measures.

4. Reclamation and DWR propose to restore or protect habitat that could support the species.

5. The project is being implemented in a manner that will minimize or avoid effects to the San Joaquin kit fox.

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9.8 Valley Elderberry Longhorn Beetle

9.8.1 Status of the Species

The valley elderberry longhorn beetle was listed as threatened throughout its range and critical habitat was designated on August 8, 1980 (45 FR 52803-52807). Critical habitat for the valley elderberry longhorn beetle does not occur within the action area; therefore, it will not be addressed further in this BiOp.

The status of the valley elderberry longhorn beetle have been assessed in the *Recovery Plan Valley Elderberry Longhorn Beetle* (Service 1984) (Recovery Plan) and the 5-year review (Service 2006). For the most recent comprehensive assessment of the range-wide status of the valley elderberry longhorn beetle, refer to the *Withdrawal of the Proposed Rule To Remove the Valley Elderberry Longhorn Beetle From the Federal List of Endangered and Threatened Wildlife* (Service 2014; 79 FR 55874) (withdrawal notice).

In 2012, the Service recommended the delisting of the valley elderberry longhorn beetle (77 FR 60238). The proposal to delist the valley elderberry longhorn beetle was withdrawn on September 17, 2014 (79 FR 55874), and further analysis has resulted in a range modification for the species (Environmental Conservation Online System (ECOS) 2016), and prompted the Service to develop a new Framework for Assessing Impacts (Service 2017).

Threats, such as the loss of riparian habitat due to development, infrastructure construction and land conversion to agriculture, and the effects of nonnative invasive species were evaluated during the review and discussed in the final withdrawal notice, and continue to act on the valley elderberry longhorn beetle since the withdrawal notice was published. These factors have greatly contributed to the loss and fragmentation of the valley elderberry longhorn beetle metapopulations, including the construction of roads and pipelines. Habitat loss continues to exacerbate the highly fragmented distribution of the valley elderberry longhorn beetle. Direct habitat loss irreversibly damages riparian habitat, specifically to elderberry (*Sambucus* spp.) shrubs. The alteration and loss of habitat surrounding riparian habitat may disrupt the physical processes conducive to functional riparian ecosystems and further fragment the habitat.

Reproduction and Habitat Requirements

Valley elderberry longhorn beetle is endemic to moist valley oak riparian corridors in the lower Sacramento and San Joaquin valleys (Service 1984). The valley elderberry longhorn beetle is closely associated with elderberry, as these plants are an obligate host plant for larvae and are necessary for the completion of the life cycle (Eng 1984; Barr 1991; Collinge *et al.* 2001). The two main species of elderberry used by this species are the blue elderberry (*Sambucus nigra* subsp. *caerulea,* formerly *S. mexicana*) and red elderberry (*S. racemosa*). Blue elderberry is a component of riparian habitats throughout the Central Valley. Although this shrub occasionally occurs outside riparian areas, shrubs supporting the greatest beetle densities are located in areas where the shrubs are abundant and interspersed in significant riparian zones (Talley *et al.* 2006).

Adult valley elderberry longhorn beetles live for a few days to a few weeks between mid-March and mid-May, and are most active from late April to mid-May. The adult beetles feed on the elderberry foliage and possibly its flowers. During this time of activity, the beetles mate, and the female lays eggs on the living elderberry plant host. The eggs are typically placed individually or in small clusters within crevices in the bark or junctions of the stem and trunk or leaf petiole and stem. Eggs hatch within a few days and soft-bodied larvae emerge. The larvae are on the surface of the elderberry from a few minutes to several hours or a day and then bore to the center of the elderberry stems where they create a feeding gallery in the pith at the center of the stem. The larvae develop for 1 to 2 years feeding on pith. The late instar larvae chew through the inner bark, all or most of the way to the surface, then return inside plugging the holes with wood shavings. The larvae move back down the feeding gallery to an enlarged pupal chamber packed with frass. Here the larvae metamorphose into pupae between December and April (Talley *et al.* 2006).

The length of pupation is thought to be about one month with the emergent adult remaining in the chamber for up to several weeks. Adults complete the hole in the outer bark and emerge during the flowering season of elderberry shrubs. The exit holes are circular to oval and range in size from 4 to 10 millimeters in diameter (Talley *et al.* 2006).

Numbers

In the withdrawal notice, we reevaluated the valley elderberry longhorn beetle occurrence records, location, and occupancy data described in our proposed rule, and incorporated new information received since the proposed delisting rule was published (77 FR 60238). The valley elderberry longhorn beetle is a habitat specialist, with limited dispersal ability and a short adult lifespan, and is found in low numbers within a population structure that has become fragmented within its historical range, and continues to be fragmented further by ongoing impacts to its habitat. The valley elderberry longhorn beetle's vulnerable developmental stages (*i.e.*, exposure of eggs and larvae) and its rarity (*i.e.*, low local numbers, low occupancy within its range) are important elements of the metapopulation structure of the species. We concluded that there are extant occurrences of the valley elderberry longhorn beetle at 36 geographical locations in the Central Valley (these locations are based in large part on observations of exit holes, which may not be an accurate depiction of occupancy). However, we acknowledge that there are no current estimates of population size or trends in population numbers for the valley elderberry longhorn beetle.

Distribution

In the withdrawal notice, we reevaluated all available spatial data and provided an updated historical distribution map based on surveys conducted since 1997. We also described the species' distribution in the context of a metapopulation structure and fragmented habitat. The valley elderberry longhorn beetle remains localized in its distribution (low local numbers within a population structure), with limited dispersal ability, and we estimate it occupies less than 25% of the remaining elderberry habitat found within fragmented riparian areas. There has been nearly 90 percent loss of riparian vegetation in the Central Valley, and the fragmentation of this habitat that has resulted in a locally uncommon or rare and patchy distribution (clustered in regional aggregations) of the valley elderberry longhorn beetle within its remaining presumed historical range in the Central Valley (patchy distribution from Tehama County to Fresno County).

9.8.2 Environmental Baseline

The current distribution of valley elderberry longhorn beetle in the action area is largely unknown. There are only three reported occurrences of valley elderberry longhorn beetle in the action area, including one along Middle River north of Tracy and two occurrences along small drainages between the Sacramento River and the Sacramento Deepwater Ship Channel in the vicinity of West Sacramento (CDFW 2013). There are additional historical occurrences from along the Sacramento River corridor and Putah Creek in Yolo County (Jones & Stokes 1987; Service 1984; Barr 1991; Collinge *et al.* 2001). Comprehensive surveys for the species or its host plant, elderberry, have not been conducted and thus the population size and location of the species in the action area is unknown. Distribution is typically based on the occurrence of elderberry shrubs, which are known to occur along riparian corridors throughout the action area, including the Sacramento River, Stanislaus River, San Joaquin River, and along smaller natural and channelized drainages, as well as in upland habitats.

9.8.3 Effects of the Proposed Action

Direct effects are the effects of the PA that directly affect the species; for example, those actions that immediately destroy or adversely affect habitat or displace animals and plants. Individual valley elderberry longhorn beetles and their larvae may be directly injured or killed by actions leading to the loss of habitat (*i.e.*, the killing of or damage to elderberry plants) in which they live. The Service views that any ground disturbance within 20 ft of the dripline of an elderberry plant has the potential to adversely affect that plant and may cause mortality.

Indirect effects are caused by or result from a proposed action, are later in time, and are reasonably certain to occur. Implementation of conservation measures will minimize indirect effects that may occur outside of the 20 ft buffer around an elderberry plant. Elderberry shrubs may be indirectly affected by actions occurring within 100 ft of the of the elderberry plant's dripline. These may include dust accumulating on plants, soil compaction, inappropriate herbicide, and fuel spills.

The life cycle of the valley elderberry longhorn beetle is such that it may be impossible to know whether an elderberry plant is occupied by larvae or not. Without visual verification of adult valley elderberry longhorn beetles being present, the only other indication of occupation is the presence of exit holes in the stems of elderberry shrubs. The presence of exit holes in elderberry shrub stems does translate to a higher likelihood that the shrubs in the general area are occupied, but the lack of exit holes does not indicate a lack of presence of the valley elderberry longhorn beetle. For that reason, the Service assumes that any elderberry plant within the range of the valley elderberry longhorn beetle might be occupied by larvae.

Elderberry shrubs within riparian and grassland habitats within the action area have the potential to provide habitat for valley elderberry longhorn beetles and all suitable habitat is presumed occupied. It was not possible to do field surveys of the entire action area for the valley elderberry longhorn beetle because many of the properties are in private ownership. Therefore, suitable modeled habitat was used to identify areas of potential effect. The model used vegetation types and associations from various data sets to map the distribution of suitable valley elderberry longhorn beetle habitat in the action area (CWF BA 2016). The following assumption was used:

Assumption: Valley elderberry longhorn beetle habitat in the action area is restricted to certain areas and vegetative types.

Rationale: The model identifies habitat for the valley elderberry longhorn beetle as locations where the elderberry shrub is expected to be found in the action area and designates additional habitat as grasslands within 200 ft of streams. Elderberry shrubs are unevenly distributed along riparian corridors and adjacent upland habitats and in some areas may be lacking entirely. Thus, the model conservatively estimates the extent of suitable habitat for valley elderberry longhorn beetle. Elderberry shrubs also occur incidentally along fence rows and in a variety of other disturbed conditions, particularly where birds may congregate and deposit seeds. The model does not include these incidental habitat areas and, thus, in this respect may underestimate the distribution of potential habitat (*i.e.*, elderberry shrubs) for the valley elderberry longhorn beetle in the action area.

Water Conveyance Facility Construction-Habitat Loss

Activities associated with water conveyance facility construction that could adversely affect valley elderberry longhorn beetles in the form of mortality, harm and harassment include: the NDD, tunneled conveyance facilities, RTM, CCF, HORG, safe haven work areas, geotechnical explorations, and power supply and grid connections. These construction activities may affect valley elderberry longhorn beetles. Water conveyance facility construction is estimated to last 12 to 15 years.

According to Reclamation and DWR, implementation of the PA will result in the permanent loss of 277.76 acres of modeled valley elderberry longhorn beetle habitat that is assumed to be occupied. Affected habitats include riparian and elderberry savanna grassland within the action area (Table 9.8.3-1).

Table 9.8.3-1. Permanent loss of modeled valley elderberry longhorn beetle habitat.

Valley Elderberry Longhorn Beetle Modeled Habitat	Permanent Habitat Loss						
	Safe Haven Work Areas	North Delta Intakes	Tunneled Conveyance Facilities	Clifton Court Forebay	Head of Old River Gate	Reusable Tunnel Material	Total
Grassland within 200 ft	1	31	57	73.51	1	65	226.51
Riparian Habitat	1	14	19	1.25	0	14	49.25
Total Acres	**2**	**45**	**76**	**74.76**	**1**	**79**	**277.76**

Implementation of the PA will also result in the temporary loss of 106 acres of modeled valley elderberry longhorn beetle habitat. Affected habitats include riparian and elderberry savanna grassland within the action area (Table 9.8.3-2).

Table 9.8.3-2. Temporary Loss of Modeled Valley Elderberry Longhorn Beetle Habitat

Valley Elderberry Longhorn Beetle Modeled Habitat	Temporary Habitat Loss		
	Geotechnical Exploration	Power Supply and Connection	Total
Grassland within 200 ft	52	35	87
Riparian Habitat	11	8	19
Total Acres	**63**	**43**	**106**

Reclamation and DWR have proposed habitat preservation, creation, and enhancement that will minimize the effects of habitat loss on valley elderberry longhorn beetle (Table 9.8.3-3). This land will be protected and managed for the conservation of the species in perpetuity prior to impacts. The protected lands will provide habitat for breeding, feeding and sheltering commensurate with or better than habitat lost as a result of the PA. These lands will help maintain the geographic distribution of the species and will contribute to the recovery of the species by increasing the amount of habitat that is secure from development threats and the other factors that threaten the species that can be addressed by habitat protection and management.

Table 9.8.3-3. Compensatory mitigation for effects to valley elderberry longhorn beetle*.

Location of Affected Plants	Stems (max diameter at ground level) of affected plants		Exit holes (Yes/No, and number)[1]		Elderberry seedling ratio[2]	Associated natives ratio[3]	Elderberry seedling total[4]	Associated native total[4]
Non-riparian (25 shrubs; 500 stems)	≥1inch, <3 inches	280	No	151	1:1	1:1	151	151
Non-riparian (25 shrubs; 500 stems)	≥1inch, <3 inches	280	Yes	129	2:1	2:1	258	516
Non-riparian (25 shrubs; 500 stems)	≥3 inches <5 inches	115	No	62	2:1	1:1	124	124
Non-riparian (25 shrubs; 500 stems)	≥3 inches <5 inches	115	Yes	53	4:1	2:1	212	424
Non-riparian (25 shrubs; 500 stems)	≥5 inches	105	No	57	3:1	1:1	170	170
Non-riparian (25 shrubs; 500 stems)	≥5 inches	105	Yes	48	6:1	2:1	291	582
Riparian (58 shrubs; 1,058 stems)	≥ 1 inch, <3 inches	709	No	348	2:1	1:1	696	348
Riparian (58 shrubs; 1,058 stems)	≥ 1 inch, <3 inches	709	Yes	361	4:1	2:1	1,444	722
Riparian (58 shrubs; 1,058 stems)	≥3 inch, <5 inches	179	No	86	3:1	1:1	258	86
Riparian (58 shrubs; 1,058 stems)	≥3 inch, <5 inches	179	Yes	93	6:1	2:1	558	186
Riparian (58 shrubs; 1,058 stems)	≥5 inches	170	No	84	4:1	1:1	336	84
Riparian (58 shrubs; 1,058 stems)	≥5 inches	170	Yes	86	8:1	2:1	688	172
Total							**5,186**	**3,565**

* Does not include effects of CCWD; no information on numbers for elderberry stems provided.

1 Presence of exit holes indicating valley elderberry longhorn beetle. All stems measuring one inch or greater in diameter at ground level on a single shrub are considered occupied when exit holes are present anywhere on the shrub.

2 Ratios in this column correspond to the number of cuttings or seedlings to be planted per elderberry stem (one inch or greater in diameter at ground level) as described in the 1999 Valley Elderberry Longhorn Beetle Conservation Guidelines.

3 Ratios in this column correspond to the number of associated native species to be planted per elderberry seedling or cutting planted.

4 Numbers of elderberry seedlings and associated native plants are the required numbers of plantings for compensation if impacts on all 83 shrubs occur. Total seedlings/cuttings and associated natives = **13,823**

83 transplants (plus 830 seedlings/cuttings and natives) x 1,800 sq ft = 149,400 sq ft = 3.43 acres

7,921 remaining seedlings/cuttings and natives at 10 per 1,800 sq ft = 1,425,780sq ft = 32.7 acres

Total area = minimum of **36.1 acres**

The Service currently uses habitat in the form of appropriate sized elderberry shrub stems (>1 inch diameter) as a surrogate to quantify impacts to valley elderberry longhorn beetles. Valley elderberry longhorn beetles are small in size, and their life cycles and patchy habitats make detection difficult and the quantification of impacts to individual beetles impracticable.

According to the CWF BA, there is a total of 31,496.76 acres of modeled valley elderberry longhorn beetle habitat within the action area of the PA. Of that total, Reclamation and DWR have determined that 277.76 acres will be permanently affected and 106 acres will be temporarily affected for a total 383.76 acres of modeled habitat that will be adversely affected. The Service anticipates the mortality of all valley elderberry longhorn beetles within those 383.76 acres. As estimated in the CWF BA, within the 383.76 acres the PA would result in the loss of 83 elderberry shrubs, which will result in the loss of 1,558 elderberry stems of 1 inch diameter or greater.

9.8.4 Effects to Recovery

The loss of suitable habitat will have an adverse effect on the valley elderberry longhorn beetle. Additional actions including but not limited to dust accumulation, soil compaction, inappropriate herbicide, and fuel spills also have the potential to cause indirect adverse effects to the valley elderberry longhorn beetle. These threats will be minimized by Reclamation's and DWR's proposal to protect, create and enhance suitable habitat and implement avoidance and minimization measures for the valley elderberry longhorn beetle. The amount of habitat affected (approximately 383.76 acres of modeled habitat within 31,496.76 acres of modeled habitat) as a result of the construction of the water conveyance facilities will not appreciably alter conditions in the action area. The protection, creation and enhancement of riparian habitat may provide relatively greater benefit to the valley elderberry longhorn beetle because of the importance of this habitat type being conserved into perpetuity.

9.8.5 Reinitiation Triggers

Because elderberry shrubs will continue to grow, reproduce, and die, and continue to be impacted by environmental conditions, it is anticipated that at the time that construction activities begin, these totals (impact and mitigation) will likely be different. If that is the case, reinitiation of this consultation will be necessary to address effects to valley elderberry longhorn beetle that are not addressed in this BiOp.

9.8.6 Cumulative Effects

The activities described in Section 9.2.5 for delta smelt are also likely to affect valley elderberry longhorn beetle. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 9.2.5 are incorporated by reference into this analysis for the valley elderberry longhorn beetle.

9.8.7 Conclusion

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the valley elderberry longhorn beetle.

Reproduction

The valley elderberry longhorn beetle is closely associated with elderberry, as these plants are an obligate host plant for larvae and are necessary for the completion of the life cycle. Approximately 277.76 acres of modeled valley elderberry longhorn beetle habitat that is assumed to be occupied by valley elderberry longhorn beetles are likely to be permanently lost due to construction of the conveyance facilities. Although this habitat is essential for valley elderberry longhorn beetle the area of effect is small compared to the amount of suitable habitat (31,496.76 acres modeled habitat) located within the action area. Therefore, the PA will not appreciably affect valley elderberry longhorn beetle reproduction, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

Comprehensive population surveys for the valley elderberry longhorn beetle, or its host plant, have not been conducted and thus the population size and location of the species in the action area is unknown, therefore estimating the number of valley elderberry longhorn beetles in the action area that may be affected by the construction of the conveyance facilities is difficult. There are only 3 reported occurrences of the valley elderberry longhorn beetle in the action area. The total area of potential effect (383.76 acres) associated with conveyance facility construction is small compared to the amount of suitable habitat (31,496.76 acres modeled habitat) located within the action area. Reclamation and DWR have proposed to preserve, create and enhance suitable habitat that will provide habitat for breeding, feeding and sheltering and would implement AMMs to further reduce potential impacts to the species. Despite the proposed protection measures, we anticipate the PA may still result in effects to the valley elderberry longhorn beetle; however, the number of valley elderberry longhorn beetles affected would be low. This is especially true relative to the range-wide numbers. Therefore, the PA will not appreciably reduce the number of valley elderberry longhorn beetles and we conclude the overall number of valley elderberry longhorn beetles throughout the species' range would not decline.

Distribution

The remaining presumed historical range of the valley elderberry longhorn beetle in the Central Valley consists of patchy distribution from Tehama County to Fresno County. The current distribution of valley elderberry longhorn beetles in the action area is largely unknown. The valley elderberry longhorn beetle population that could be affected by the conveyance facility construction is estimated to affect 383.76 acres of suitable modeled habitat within 31,496.76 acres of modeled habitat within the action area. We conclude that the valley elderberry longhorn beetles will continue to survive in the action area regardless of the activities. Consequently, the water conveyance facility construction will not alter the overall distribution of the valley elderberry longhorn beetle and we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

Effects on Recovery

For a species like the valley elderberry longhorn beetle that has lost much of its former known occupied habitat, recovery would necessitate the conservation of much of the remaining habitat that still supports it. Reclamation and DWR are proposing to minimize the adverse effects of the loss of modeled suitable habitat by implementing actions to promote the recovery of the affected species in a manner where the mitigation is commensurate with the adverse effect. Reclamation and DWR have proposed to preserve, create or enhance habitat to offset the total loss of suitable habitat. This habitat will be protected and managed for the conservation of the species in perpetuity and will provide habitat for breeding, feeding and sheltering and will help maintain the geographic distribution of the species and will contribute to the recovery of the species by increasing the amount of habitat that is secure from development threats and the other factors that threaten the species that can be addressed by habitat protection and management. Since habitat loss and degradation are contributing factors to the decline of the valley elderberry longhorn beetle; preservation, creation and enhancement of additional suitable habitat is a reasonable means of offsetting the adverse effects and may benefit the recovery of the valley elderberry longhorn beetle.

Conclusion

After reviewing the current status of the valley elderberry longhorn beetle, the environmental baseline for the action area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the construction of the PA, as proposed, is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

1. The area of potential effect to the valley elderberry longhorn beetle is small and will not reduce the reproduction, numbers, and distribution of the species.

2. The low number of individuals likely to be affected by the project will not appreciably reduce the likelihood of valley elderberry longhorn beetles survival and recovery because many more individuals and larger habitat areas outside of the action area will remain.

3. Reclamation and DWR have proposed numerous and comprehensive measures to avoid and minimize potential effects.

4. Reclamation and DWR propose to protect, create, and enhance habitat that could support the valley elderberry longhorn beetle.

5. The project is being implemented in a manner that will minimize damage to areas that could support the valley elderberry longhorn beetle.

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9.9 Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp

9.9.1 Status of the Species

The vernal pool tadpole shrimp was listed as endangered and vernal pool fairy shrimp was listed as threatened throughout their respective ranges on September 19, 1994 (59 FR 48136).

The status of the vernal pool fairy shrimp and the vernal pool tadpole shrimp have been assessed in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Service 2005) (Recovery Plan) and 5-year reviews. For the most recent comprehensive assessment of the range-wide status of the vernal pool fairy shrimp, refer to the *Vernal Pool Fairy Shrimp (Branchinecta lynchi) 5-Year Review: Summary and Evaluation* (Service 2007a). For the most recent comprehensive assessment of the range-wide status of the vernal pool tadpole shrimp, refer to the *Vernal Pool Tadpole Shrimp (Lepidurus packardi) 5-Year Review: Summary and Evaluation* (Service 2007b). The Service is currently in the process of finalizing its most recent 5-year reviews for both the vernal pool fairy shrimp and the vernal pool tadpole shrimp.

No change in either species' listing status was recommended in the 5-year reviews. Threats such as the loss of vernal pool habitat primarily due to widespread urbanization were evaluated during the reviews and discussed in the final documents. These threats have continued to act on the vernal pool fairy shrimp and vernal pool tadpole shrimp since the 2007 5-year reviews were finalized. The construction of infrastructure associated with urbanization also has contributed greatly to the loss and fragmentation of the vernal pool species including the construction of roads and pipelines. Habitat loss continues to exacerbate the highly fragmented distribution of the vernal pool fairy shrimp and the vernal pool tadpole shrimp. Direct losses of habitat generally represent an irreversible damage to vernal pools. The alteration and loss of habitat surrounding vernal pool complexes may disrupt the physical processes conducive to functional vernal pool ecosystems. Vernal pool hydrology may be altered by further changes to the patterns of surface and subsurface flows due to the changes in the runoff associated with infrastructure.

9.9.2 Environmental Baseline

Vernal Pool Fairy Shrimp

Vernal pools and seasonal wetlands within the action area are likely to provide habitat for vernal pool fairy shrimp and all suitable habitat is presumed occupied. No surveys have been conducted for the species within the action area, but known occurrences exist.

The PA is within the Altamont Hills core area in the Recovery Plan's Livermore Vernal Pool Region (Service 2005). The Altamont core area is a Zone 1 core area, for which the recovery plan calls for 85 percent of all known occurrences of the vernal pool fairy shrimp to be preserved.

The vernal pool fairy shrimp has been reported from several locations in the action area (Service 2005, 2007a). In the PA, vernal pools that may support the vernal pool fairy shrimp occur in Jepson Prairie, in the CDFW Tule Ranch Unit of the Yolo Bypass, in the Stone Lakes area, near the town of Byron, and along the eastern and northern boundary of Conservation Zone 11. Other potential vernal pool habitat occurs along the eastern boundary of the PA near Stone Lakes. Seven occurrences of the vernal pool fairy shrimp were observed in the south Stone Lakes area and occurrences were found in three locations in the CCF during 2009 surveys conducted by the DWR. A comprehensive survey of vernal pools or habitat for vernal pool fairy shrimp has not been conducted in the action area.

Vernal Pool Tadpole Shrimp

The PA is within the Altamont Hills core area, within the Livermore vernal pool region (Service 2005). The Altamont Hills core area is a Zone 1 core area, the recovery plan calls for 80% of all known occurrences of the vernal pool tadpole shrimp to be preserved range-wide.

Vernal pools and seasonal wetlands within the action area are likely to provide habitat for vernal pool tadpole shrimp and all suitable habitat is presumed occupied. No surveys have been conducted for the species within the action area, but known occurrences exist. Within the PA, vernal pool habitat that may support the vernal pool tadpole shrimp occurs in Jepson Prairie, in the CDFW Tule Ranch Unit of the Yolo Bypass, in the Stone Lakes area, and near the town of Byron. Six occurrences were observed in the Stone Lakes area during 2009 surveys conducted by the DWR. A comprehensive survey of vernal pools or habitat for the vernal pool tadpole shrimp has not been conducted in the action area.

9.9.3 Effects of the Proposed Action

Direct effects are the effects of the PA that directly affect the species. For example, those actions that immediately destroy or adversely affect habitat or displace animals and plants. Individual vernal pool fairy shrimp and vernal pool tadpole shrimp, and their cysts may be injured or killed by actions leading to the loss of habitat (*i.e.*, filling or inundating vernal pools) in which they live. The Service maintains that the partial filling of a vernal pool directly affects the whole vernal pool.

Indirect effects that are caused by or result from a proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action. Vernal pool habitat indirectly affected includes all habitat supported by impacted upland areas and swales, and all habitat otherwise affected by changes to the watershed, human intrusion, introduced species, and disturbance that will be caused by a proposed action.

According to the CWF BA, implementation of the PA will directly affect 6 and indirectly affect 0.2 acres of modeled vernal pool habitat (Table 9.9.3-1) that is assumed to be occupied by vernal pool fairy shrimp and vernal pool tadpole shrimp. Affected habitats include vernal pools and seasonal wetlands within the action area.

6.2 acres of modeled vernal pool habitat will be permanently impacted due to the proposed expansion of the CCF and related construction activities. Changes in hydrology or the degradation of water quality within vernal pools and seasonal wetlands that are not directly affected by the PA may result in indirect effects to vernal pool fairy shrimp and vernal pool tadpole shrimp habitat and may not currently be fully known or described by the CWF BA.

Table 9.9.3-1. Modeled vernal pool habitat affected by the PA.

Total modeled Habitat in Action Area	Type of Effect	Permanent Habitat Affected		
		Clifton Court Forebay Modifications	Restoration	Total Habitat Affected
89 acres	Direct	6 acres	0	6 acres
	Indirect	0	0.2 acre	0.2 acre

Reclamation has proposed habitat preservation, creation, and enhancement that will minimize the effects of habitat loss on vernal pool fairy shrimp and vernal pool tadpole shrimp habitat prior to impact (Table 9.9.3-2). This land will be protected and managed for the conservation of the species in perpetuity. The protected lands will provide habitat for breeding, feeding and sheltering commensurate with or better than habitat lost as a result of the PA. These lands will help maintain the geographic distribution of the species and will contribute to the recovery of the species by increasing the amount of habitat that is secure from development threats and the other factors that threaten the species that can be addressed by habitat protection and management.

Table 9.9.3-2. Affected modeled vernal pool habitat and proposed compensation.

Proposed Compensation	Direct Effect	Indirect Effect	Habitat Compensation Ratio		Total Habitat Compensation	
			Conservation Bank[1]	Non-bank Site[2]	Conservation Bank[1]	Non-bank Site[2]
Preservation (direct and indirect effects)	6 acres	0.2 acre	2:1	3:1	12.4 acres	18.6 acres
Restoration/Creation (direct effects only)	6 acres	N/A	1:1	2:1	6 acres	12 acres

[1] Compensation ratios for credits dedicated in Service-approved conservation banks
[2] Compensation ratios for acres of habitat outside of mitigation banks

9.9.4 Effects to Recovery

The PA would not increase the threats currently impacting the vernal pool fairy shrimp and vernal pool tadpole shrimp as described in the status of species, or preclude implementation of recovery actions. The PA is expected to result in direct and indirect effects to a total of 6.2 acres of vernal pool habitat. DWR has proposed to offset the adverse effects of the loss of individuals and habitat through preservation and creation of up to 30.6 acres of habitat. Habitat loss and degradation are contributing factors to the decline of these species. Protecting and managing habitat in-perpetuity will minimize the effects of the loss of individuals as a result of the PA and may benefit the recovery of vernal pool fairy shrimp and vernal pool tadpole shrimp.

9.9.5 Reinitiation Triggers

Some project elements and their effects on vernal pool fairy shrimp and vernal pool tadpole shrimp may change as DWR continues to develop the PA and therefore may require reinitiation if project elements are located in areas that occur in or near modeled habitat and effects rise above those analyzed herein.

9.9.6 Cumulative Effects

The activities described in Section 9.2.5 for delta smelt are also likely to affect vernal pool fairy shrimp and vernal pool tadpole shrimp. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 9.2.5. are incorporated by reference into this analysis for the vernal pool fairy shrimp and vernal pool tadpole shrimp.

9.9.7 Conclusion

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the vernal pool fairy shrimp and vernal pool tadpole shrimp.

Reproduction

The aquatic habitat used for reproduction in the action area represents a small proportion of the total aquatic habitat range-wide. The compensatory mitigation measures are anticipated to minimize the effects of loss of reproduction resulting from loss and fragmentation of habitat. Therefore, the PA will not appreciably affect vernal pool fairy shrimp and vernal pool tadpole shrimp reproduction range-wide, and we conclude that the effects would not reduce the range-wide reproductive capacity of these species.

Numbers

The aquatic and upland habitat within the action area represents a small proportion of the total amount of habitat range-wide. Also, Reclamation and DWR have proposed measures to avoid and minimize the effects of the PA on these species. Despite the proposed conservation measures, we anticipate the PA is likely to adversely affect these two species; however, the number of individuals affected will be very low relative to the range-wide numbers. Therefore, the PA will not appreciably reduce the number of vernal pool fairy shrimp and vernal pool tadpole shrimp.

Distribution

The vernal pool fairy shrimp have fairly large and dispersed distribution. We do not anticipate that the range-wide distribution of the vernal pool fairy shrimp or vernal pool tadpole shrimp will be reduced because it will not eliminate or significantly reduce the distribution of the species from any recovery core area or county. The effect to the species from habitat loss and fragmentation will be minimized by the proposed compensatory mitigation measures. Therefore, we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

Effects on Recovery

Reclamation and DWR are proposing to minimize the adverse effects of the loss of suitable habitat by implementing actions to promote the recovery of the affected species in a manner where the mitigation is commensurate with the adverse effect. Reclamation and DWR have proposed to restore or protect suitable habitat to offset the total loss of suitable habitat. Habitat loss and degradation are contributing factors to the decline of these two species; consequently, restoration or protection of additional suitable habitat is a reasonable means of offsetting the adverse effects and may benefit the recovery of this species. Therefore, we conclude that the PA would not appreciably reduce the likelihood of recovery of the vernal pool fairy shrimp or vernal pool tadpole shrimp.

Conclusion

After reviewing the current status of the vernal pool fairy shrimp and vernal pool tadpole shrimp, the environmental baseline for the action area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the vernal pool fairy shrimp and vernal pool tadpole shrimp. We have reached this conclusion because:

1. The number of individuals likely to be affected by project activities will be relatively low.

2. The low number of individuals likely to be affected by the project will not appreciably reduce the likelihood of survival and recovery of the species range-wide because many more individuals and larger habitat areas outside of the action area will remain.

3. Reclamation and DWR have proposed numerous and comprehensive measures to avoid and minimize potential effects, including compensatory mitigation measures.

4. Reclamation and DWR propose to restore or protect habitat that could support the species.

5. The project is being implemented in a manner that will minimize or avoid some effects to both species.

9.9.8 Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp Literature Cited

(Service) U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; determination of endangered status for the Conservancy fairy shrimp, longhorn fairy shrimp, and the vernal pool tadpole shrimp; and threatened status for the vernal pool fairy shrimp. Federal Register 59:48136-48153.

(Service) U.S. Fish and Wildlife Service. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Portland, Oregon. xxvi + 606 pp.

(Service) U.S. Fish and Wildlife Service. 2007a. Vernal Pool Fairy Shrimp (*Branchinecta lynchi*) 5-Year Review: Summary and Evaluation. Sacramento, California.

(Service) U.S. Fish and Wildlife Service. 2007b. Vernal Pool Tadpole Shrimp (*Lepidurus packardi*) 5-Year Review: Summary and Evaluation. Sacramento, California.

9.10 <u>Western Yellow-Billed Cuckoo</u>

9.10.1 Status of the Species

The Service listed the western distinct population segment of the yellow-billed cuckoo (western yellow-billed cuckoo) as endangered in 2014 (79 FR 59992). The information in this section is from the final rule, the proposed rule and the CWF BA.

The number of western yellow-billed cuckoos in the western United States has declined substantially over the past 100 years, coincident with the widespread loss and degradation of riverine riparian woodlands. Ongoing threats to the yellow-billed cuckoo include habitat loss from flood control projects and maintenance, alterations to hydrology, development of urban and agricultural areas, climate change, and invasive species.

A recovery plan has not yet been developed for this species. In the absence of a recovery plan, we default to the general conservation needs of the species. For a species like the western yellow-billed cuckoo that has lost much of its former known occupied habitat, recovery would necessitate the conservation of much of the remaining habitat that supports the species. In addition, restoration of suitable habitat that has been disturbed, but otherwise remains undeveloped, would be a priority. Lastly, efforts to establish the species in unoccupied, but otherwise suitable habitat, would contribute to its recovery.

Reproduction and Habitat Requirements

The western yellow-billed cuckoo is a riparian obligate species. Yellow-billed cuckoos use riparian habitat for foraging and nesting. Its primary habitat association is willow-cottonwood riparian forest, but other tree species such as white alder (*Alnus rhombifolia*) and box elder (*Acer negundo*) may be an important habitat element in some areas, including occupied sites along the

Sacramento River (Laymon 1998). Nests are primarily in willow (*Salix* spp.) trees; however, other tree species are occasionally used, including Fremont cottonwood (*Populus fremontii*) and alder. Along the Sacramento River, orchards of English walnut (*Juglans regia*), prune, and almond trees have also been reportedly used for nesting (Laymon 1980). Occupied habitat in Butte County was described by Halterman (1991) as great valley cottonwood riparian forest and great valley mixed riparian forest, including willows, box elder, and white alder. Potential habitat also occurs in valley marshland with willow riparian corridors, such as that found in the Llano Seco area of Butte County.

Western yellow-billed cuckoos may be found in a variety of vegetation types during migration, including coastal scrub, secondary growth woodland, hedgerows, humid lowland forests, and forest edges from sea level to 8,125 ft in elevation (Hughes 1999). Additionally, during migration they may be found in smaller riparian patches than those in which they typically nest. This variety of vegetation types suggests that the habitat needs of the western yellow-billed cuckoo during migration are not as restricted as their habitat needs when nesting and tending young.

On the Santa Ana River, nest site height in willow trees averaged 14 ft, but on the Sacramento River, a nest in a cottonwood tree was reported at 100 ft and canopy cover is typically dense (averaging 96.8% at the nest). Patch size was found to be the most important habitat variable to predict presence of western yellow-billed cuckoos on the Sacramento River (Girvetz and Greco 2009). Large patch sizes (20 to 40 hectares, with a minimum width of 100 meters) are typically required for cuckoo occupancy (Laymon 1998; Riparian Habitat Joint Venture 2004).

Although western yellow-billed cuckoo's nest primarily in willow trees, Fremont cottonwood trees are important foraging habitat, particularly as a source of insect prey. All studies indicate a highly significant association with relatively expansive stands of mature cottonwood-willow forests; however, western yellow-billed cuckoos will occasionally occupy a variety of marginal habitats, particularly at the edges of their range (Laymon 1998). Continuing habitat succession has also been identified as important in sustaining breeding populations (Laymon 1998). Meandering streams that allow for constant erosional and depositional processes create habitat for new rapidly growing young stands of willow, which create preferred nesting habitat conditions for western yellow-billed cuckoo. Lateral channel migration and point bar deposition that create new floodplains and channel bend cut-offs that create floodplain lakes are important processes that create viable western yellow-billed cuckoo habitat (Greco 2013).

A habitat model developed by Gaines (1974) for the yellow-billed cuckoo in the Sacramento Valley includes the following elements: patch size of at least 25 acres, at least 330 ft wide and 990 ft long, within 330 ft of surface water, and dominated by cottonwood/willow gallery forest with a high-humidity microclimate. Laymon and Halterman (1989) further refined the model by classifying habitat patch sizes for suitability. A willow-cottonwood forest patch greater than 1,980 ft wide and greater than 200 acres (81 hectares) is classified as optimum habitat; a patch 660 to 1,980 ft wide and 102.5 to 200 acres (41.5 to 81 hectares) is suitable; a patch 330 to 660 ft wide and 50 to 100 acres (20 to 40 hectares) is marginal, and smaller patches are unsuitable. The

Riparian Habitat Joint Venture recommends restoring habitat in 25 locations to support 625 pairs (25 pairs per location) (Riparian Habitat Joint Venture 2004). Predictions suggest that a minimum of at least 25 pairs in a subpopulation, with interchange with other subpopulations, should be relatively safe from extirpation (Riparian Habitat Joint Venture 2004). To achieve this goal for the Sacramento Valley, it would be necessary to establish or preserve at least 6,070 hectares (15,000 acres) of optimum and suitable habitat. As of 1998, only 2,367 hectares (5,850 acres) of habitat were considered suitable (Laymon 1998).

Limited information is available on home range and territory size. Territory size at the South Fork Kern River ranged from 20 to 100 acres (8 to 40 hectares) (Laymon 1998), and on the Colorado River as small as 10 acres (4 hectares) (Laymon and Halterman 1989). Patch size, type and quality of habitat, and prey abundance largely determine the size of territories (Halterman 1991). Laymon and Halterman (1989) concluded that sites greater than 200 acres in extent and wider than 1,950 ft were optimal and sites 101 to 200 acres in extent and wider than 650 ft were suitable.

Pesticides, whether applied directly onto riparian habitat or sprayed on adjacent agricultural areas, may affect the reproductive success of the western yellow-billed cuckoo. This species preys on katydids, caterpillars, cicadas, and other large insects. A reduction in the availability of suitably sized prey may lead to the abandonment of nesting areas.

Numbers

The proposed listing rule states that population of the western yellow-billed cuckoo "has declined by several orders of magnitude over the past 100 years" and that this decline is continuing. Surveys over the past 15 years (since the Service placed the western yellow-billed cuckoo on the candidate list [66 FR 38611]) have documented losses of breeding pairs in smaller isolated sites and at core breeding areas. The Service estimated the current breeding population at 680 to 1,025 pairs, with 350 to 495 pairs north of the Mexican border and the remainder in Mexico. Because western yellow-billed cuckoos move between nesting areas during the breeding season and may have been counted twice during surveys, these numbers may overestimate the number of breeding pairs.

Distribution

The western yellow-billed cuckoo formerly bred in California, Arizona, New Mexico, Oregon, Washington, western Colorado, western Wyoming, Idaho, Nevada, Utah, and probably southern British Columbia, Canada. The species' current breeding range reaches its northwestern limit in the Sacramento Valley, California (although a small, potentially breeding population exists in coastal northern California on the Eel River). The northeastern portion of the breeding range is in southeastern Idaho. They breed at several sites in California, Nevada, Arizona, and New Mexico. Yellow-billed cuckoos winter in South America from Venezuela to Argentina (Hughes 1999; Sechrist *et al.* 2012) after a southern migration that extends from August to October (Laymon

1998). They migrate north and arrive at California breeding grounds between May and July, but primarily in June (Gaines and Laymon 1984; Hughes 1999; 78 FR 61621).

Studies conducted in 1986 and 1987 indicate that there were approximately 31 to 42 pairs in California (Laymon and Halterman 1987) at that time. Although a few occurrences have been detected elsewhere recently, including near the Eel River, the only locations in California that currently sustain breeding populations include the Colorado River system in southern California, the South Fork Kern River east of Bakersfield, and isolated sites along the Sacramento River in northern California (Laymon and Halterman 1989; Laymon 1998; Halterman 2001; Hammond 2011; Dettling *et al.* 2014; Stanek 2014; Parametrix Inc. and Southern Sierra Research Station 2015). We do not have extensive information on the winter range of the western yellow-billed cuckoo.

9.10.2 Environmental Baseline

Although there are only two historical records in the vicinity of the action area (CDFW 2013), the species is known to have been historically common in riparian habitat throughout the Central Valley, from Kern County north to Redding (Laymon 1998). Yellow-billed cuckoo detections have occurred most frequently in the upper Sacramento River where levees are setback from the river or do not exist. Additionally, the last 20 years has seen a large amount of riparian restoration occur in the upper Sacramento River. Habitat in the action area tends to be more narrow and linear than in the upper Sacramento River. The American River has a wider floodplain due to levees being setback from the channel. There are some patches large enough to support nesting yellow-billed cuckoos, though cuckoos have not been observed nesting along the American River.

In 2013, there were two unconfirmed audible occurrences along the American River Parkway approximately five miles from the action area. These two occurrences were less than five miles apart along the river and heard on the same day (EBird 2015). In 2015, there was a confirmed visual occurrence along the American River located in proximity to both the 2013 occurrences and approximately five miles from the action area (EBird 2015).

There are no recently confirmed western yellow-billed cuckoo breeding locations in the action area. In summer 2009, DWR detected one and possibly two yellow-billed cuckoos in a remnant patch of riparian forest in the vicinity of Delta Meadows (Delta Habitat Conservation and Conveyance Program 2011). Breeding status was not confirmed. The two historic sightings and the two recent sightings of yellow-billed cuckoo in the vicinity of the action area are presumed to be migrating birds.

Most riparian corridors in the action area do not support sufficiently large riparian patches or the natural, geomorphic processes that provide suitable cuckoo breeding habitat (Greco 2013). The species likely continues to migrate along the Sacramento River and other drainages to northern breeding sites in the Sutter Basin and Butte County. There are several remnant riparian patches in the vicinity of Mandeville and Medford Islands that provide riparian vegetation suitable for cuckoos, but do not provide sufficiently large patch size to support breeding cuckoos. There have been few reported occurrences of western yellow-billed cuckoo migrating through the action area. However, it is likely that cuckoos use the action area as stop-over habitat for feeding, resting, and sheltering during their migration.

9.10.3 Effects of the Proposed Action

It was not possible to do field surveys of the entire action area for the western yellow-billed cuckoo because many of the properties are in private ownership. Therefore, suitable modeled habitat was used to identify areas of potential effect. The model identified suitable habitat that the western yellow-billed cuckoo could use during migration as a stopover to rest and forage. The permanent loss of suitable riparian and scrub habitat is expected as a result of the PA activities. The loss of suitable habitat could diminish available foraging and sheltering habitat for the western yellow-billed cuckoo. Western yellow-billed cuckoos are not known to or expected to nest in the action area. In addition, the riparian habitat affected by the construction of the PA does not have habitat patches large enough to support nesting western yellow-billed cuckoos.

Disturbance of western yellow-billed cuckoos may cause individuals to move more frequently than they would under natural conditions and result in energy expenditures that could affect the ability of the individual to survive. Workers, equipment, or the placement of ancillary flood control project structures may create enough noise or disturbance to flush western yellow-billed cuckoos temporarily from suitable habitat or cause them to avoid small areas of suitable habitat within or adjacent to the action area or abandon it and to seek out new territories. Noise and human/vehicle presence associated with project activities could flush western yellow-billed cuckoos from suitable habitat exposing them to higher predation risk and increased energy expenditure.

Water Conveyance Facility Construction-Habitat Loss

Activities associated with water conveyance facility construction that could adversely affect western yellow-billed cuckoos in the form of harm and harassment include: the north Delta intakes, tunneled conveyance facilities, reusable tunnel material, power supply and grid connection. These construction activities will destroy or modify habitat that migrating western yellow-billed cuckoos use for feeding, resting, and sheltering. Water conveyance facility construction is estimated to last 12 - 15 years, which is long enough to assume that western yellow-billed cuckoos will avoid using the estimated 32.25 acres of modeled habitat over the long-term, resulting in permanent impacts as a result of water conveyance facility construction. Construction of the north Delta intakes will result in the loss of an estimated 5 acres of western yellow-billed cuckoo habitat. Construction of the Tunneled Conveyance Facilities will result in the loss of an estimated 11.25 acres of western yellow-billed cuckoo habitat. Placement of reusable tunnel material will result in the loss of an estimated 12 acres of western yellow-billed cuckoo habitat. Construction of the transmission lines will result in the loss of an estimated 4 acres of western yellow-billed cuckoo habitat. This habitat loss will be offset through riparian creation or restoration at a 2:1 ratio for a total of 64.5 acres. This creation or restoration will provide habitat that is not subject to disturbance and will provide migratory cuckoo habitat necessary for feeding, resting, and sheltering.

Water Conveyance Facility Construction - Noise, Lighting, Vibration

In addition to the habitat loss, construction itself has the potential to adversely affect yellow-billed cuckoos. Construction that occurs when the cuckoo is migrating through the action area (using non-breeding habitat as a stopover to rest or forage) has the potential to harass western yellow-billed cuckoos due to noise, vibration, and nighttime lighting effects causing them to move to other locations which could expose individual cuckoos to increased predation and decreased foraging opportunities. When noises or disturbances are repeated over a long period, they could cause physiological stress to migrating western yellow-billed cuckoos.

Intake construction will require the use of loud, heavy equipment within the construction sites as well as along the access roads to the site. Pile driving for the north Delta intakes will create noise and vibration effects. Ongoing maintenance activities at the intakes include intake dewatering, sediment removal, debris removal, and biofouling and corrosion removal and will occur from water-based equipment approximately annually. These activities will have noise and lighting effects.

The tunneled conveyance facilities include tunnel work areas, vent shafts, the pumping plant and shaft location, a new forebay and spillway, tunnel conveyors, barge unloading facilities, fuel stations, and concrete batch plants. Construction noise up to 60 dBA will occur at up to 2,000 ft from the forebay and spillway construction footprint. These activities will have noise and lighting effects.

Power supply and grid connections include construction of temporary power lines to power construction activities and construction of permanent transmission lines to power conveyance facilities. Construction of new transmission lines will require site preparation, tower or pole construction, and line stringing. These activities will have noise and lighting effects. Migrating cuckoos may be subject to bird strikes at the transmission lines.

RTM activities at each site will include the use of heavy equipment for ground clearing and grading and soil tilling and rotation. Material will be moved to the site using a conveyor belt for long-term on-site storage.

Construction activities will create noise up to 60 dBA at no more than 1,200 ft from the edge of the construction footprint unless pile driving is required, in which case noise up to 60 dBA could reach up to 2,000 ft from the edge of the construction footprint. While 60 dBA is the standard noise threshold for birds (Dooling and Popper 2007), this standard is generally applied during the nesting season, when birds are more vulnerable to behavioral modifications that can cause nest failure. There is evidence, however, that migrating birds will avoid noisy areas during migration (McClure *et al.* 2013). To minimize this effect, the noise in the vicinity of western yellow-billed cuckoo habitat will be reduced as described in the CWF BA Appendix 3.F, *General Avoidance* *and Minimization Measures* section. This will include surveying for western yellow-billed cuckoo within the 60 dBA noise contour around the construction footprint, and if a yellow-billed cuckoo is found, limiting noise to less than 60 dBA where the bird occurs until it has left the area. Pile driving will be limited to daytime hours within 1,200 ft of western yellow-billed cuckoo habitat.

Night lighting may also have the potential to affect migrating western yellow-billed cuckoos. While there is no data on effects of night lighting on migration for this species, studies show that migrating birds of other species are attracted to artificial lights and this may disrupt their migratory patterns or cause collision-related fatalities (Gauthreaux and Belser 2006). To minimize this effect, all lights will be screened and directed away from western yellow-billed cuckoo habitat.as described in *Avoidance and Minimization Measures* Section. There will still be some potential, however, for light-related effects to occur.

It is possible for migrating western yellow-billed cuckoos to be injured or killed by colliding with the transmission lines. All project and existing transmission lines will have bird strike diverters installed in a configuration that research indicates will reduce bird strike risk by at least 60% or more, as described in the CWF BA Appendix 3.F, *General Avoidance and Minimization Measures* section. With this implementation of this measure, western yellow-billed cuckoo collisions with transmission lines are not likely to occur.

The activities listed above are expected to affect the western yellow-billed cuckoo in the form of harm and harassment. Construction activities are estimated to result in the permanent habitat loss of 32.25 acres.

9.10.4 Effects to Recovery

The loss of suitable habitat will affect the western yellow-billed cuckoo. Noise, lighting and vibration also have the potential to temporarily cause adverse effects to the western yellow-billed cuckoo. The compensatory mitigation efforts proposed fit within general conservation efforts that we default to for species that lack a recovery plan. These threats will be minimized by Reclamation's and DWR's proposal to restore or protect suitable habitat for the western yellow-billed cuckoo. The restoration and protection of riparian habitat would provide relatively greater benefit to the western yellow-billed cuckoo because of the importance of this habitat type; however, the small amount of habitat involved (approximately 32 acres) will not appreciably alter conditions conducive for migratory western yellow-billed cuckoos in the action area. Therefore, we conclude that the PA will not have a permanent effect on the recovery of the western yellow-billed cuckoo.

9.10.5 Reinitiation Triggers

Some project elements and their effects on western yellow-billed cuckoo may change as DWR continues to develop the PA and therefore may require reinitiation if project elements are located in areas that occur in or near modeled habitat and effects rise above those analyzed herein.

9.10.6 Cumulative Effects

The activities described in Section 9.2.5 for delta smelt are also likely to affect western yellow-billed cuckoo. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 9.2.5. are incorporated by reference into this analysis for the western yellow-billed cuckoo.

9.10.7 Conclusion

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the western yellow-billed cuckoo.

Reproduction

The western yellow-billed cuckoo is a secretive and hard-to detect bird that is relatively rare in the action area (Hughes 1999; Delta Habitat Conservation and Conveyance Program 2011; CDFW 2013; EBird 2015; Halterman *et al.* 2015; 79 FR 59992). Therefore, the PA will not appreciably affect western yellow-billed cuckoo reproduction, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

As described in the Reproduction section above, the number of western yellow-billed cuckoos in the action area is relatively low, based on recent and past records (Hughes 1999, Delta Habitat Conservation and Conveyance Program 2011; CDFW2013; EBird 2015; Halterman *et al.* 2015, 79 FR 59992). Also, Reclamation and DWR have proposed measures to avoid and minimize the effects of the PA on the species. Despite the proposed protection measures, we anticipate the PA may still result in effects to the western yellow-billed cuckoo; however, the number of western yellow-billed cuckoos affected would be very low. This is especially true relative to the range-wide numbers. Therefore, the PA will not appreciably reduce the number of western yellow-billed cuckoos throughout the species' range.

Distribution

During migration, western yellow-billed cuckoos may stop to rest and forage in variety of vegetation types where construction of water conveyance facilities could be located; the loss of this stop-over habitat will not have a measurable effect on the species.

The number of western yellow-billed cuckoos likely to be affected by projects activities will be very low. We do not expect that any western yellow-billed cuckoos will be directly killed by construction of the water conveyance facilities, and that very few western yellow-billed cuckoos will be affected by the PA activities. We also conclude that western yellow-billed cuckoos will continue to survive in the action area regardless of the activities. Consequently, the water conveyance facility construction will not alter the distribution of the western yellow-billed cuckoo and we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

Effects on Recovery

As discussed above, we have not yet developed a recovery plan for the western yellow-billed cuckoo. In the absence of a recovery plan, we default to the general conservation of the species. For a species like the western yellow-billed cuckoo that has lost much of its habitat, recovery would necessitate the conservation of much of the remaining habitat that still supports it.

Reclamation and DWR are proposing to minimize the adverse effects from the loss of suitable habitat by implementing actions to promote the recovery of the affected species in a manner where the mitigation is commensurate with the adverse effect. Reclamation and DWR have proposed to restore or protect suitable habitat to offset the total loss of suitable habitat. Habitat loss and degradation are contributing factors to the decline of western yellow-billed cuckoo; consequently, restoration or protection of additional suitable habitat is a reasonable means of offsetting the adverse effects and may benefit the recovery of the western yellow-billed cuckoo. Therefore, we conclude that the PA would not appreciably reduce the likelihood of the recovery of the western yellow-billed cuckoo.

Conclusion

After reviewing the current status of the western yellow-billed cuckoo, the environmental baseline for the action area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the construction of the California WaterFix facilities, as proposed, is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

1. The number of western yellow-billed cuckoos likely to be affected by projects activities will be very low.

2. The low number of individuals likely to be affected by the project will not appreciably reduce the likelihood of western yellow-billed cuckoos survival and recovery because many more individuals and larger habitat areas outside of the action area will remain.

3. Reclamation and DWR have proposed numerous and comprehensive measures to avoid and minimize potential effects.

4. Reclamation and DWR propose to restore or protect habitat that could support the western yellow-billed cuckoo.

5. The project is being implemented in a manner that will minimize damage to areas that could support the western yellow-billed cuckoo.

The PA will not result in the loss of breeding habitat of the western yellow-billed cuckoo.

9.10.8 Western Yellow-billed Cuckoo Literature Cited

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10.0 INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking incidental to and not the purpose of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by Reclamation and/or the Corps so that they become binding conditions of any grant or permit issued to DWR, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation and/or the Corps have a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation and/or the Corps (1) fails to assume and implement the terms and conditions, or (2) fails to require DWR to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation, the Corps, or DWR must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

The Service has determined that CWF presents a mixed programmatic action, as defined in 50 CFR 402.02. The consultation includes a mix of standard consultation and programmatic consultation. Some of the project elements of the PA are analyzed in this BiOp at a site-specific level for near-term implementation with no future Federal action required. For other project elements, the PA provides a framework for the development of future Federal actions that will be authorized, funded, or carried out at a later time, and this BiOp uses a programmatic approach to evaluate those elements of the PA. Therefore, consistent with our regulations at 50 CFR 402.14(i)(6), this ITS only covers those standard consultation elements of the PA for which incidental take is reasonably certain to occur. The incidental take exemptions provided for in this incidental take statement are effective only upon issuance by Reclamation and the Corps of the proposed federal decisions and approvals for which consultation was requested under section 7.

10.1 Amount or Extent of Take

Due to the implementation of the PA, the Service anticipates the following levels of incidental take. Upon implementation of the Reasonable and Prudent Measures, incidental take associated with the project will become exempt from the prohibitions described under section 9 of the Act.

Delta Smelt

The Service anticipates incidental take of delta smelt adults, juveniles, larvae, and/or eggs will be difficult to detect and quantify because of the species' small size and cryptic nature and therefore it is not possible to provide precise numbers of delta smelt that could be harmed, injured, or killed from all proposed actions. There are numerical limitations with respect to detecting individual delta smelt in the wild, for that reason, it is not practical to express the amount or extent of anticipated take of this species or monitor take-related impacts in terms of individual delta smelt. Of the proposed standard, project-level actions, effects from geotechnical explorations and construction of barge landings will result in incidental take of delta smelt. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the PA, the Service is using shallow water habitat as a surrogate to quantify incidental take of the species. Therefore, to quantify the level of incidental take associated with the geotechnical explorations and construction-related activities, the Service anticipates that all delta smelt within 22.4 acres of shallow water habitat identified in the CWF BA to be permanently or temporarily affected from in-water work activities associated with the barge landings will be subject to incidental take in the form of harm, injury, or mortality and all delta smelt will be subject to incidental take in the form of harm and harass from 100 in-water boring locations that will disturb foraging and sheltering behavior. The amount of shallow water habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat contains features that individual delta smelt use for breeding, feeding, and sheltering (such as spawning substrate) and the anticipated take is caused by such disturbance activities. Injury and mortality are anticipated to be low because of: the current low relative abundance; the magnitude, scope, and timing; and the proposed conservation measures which include minimization measures such as in-water work window restrictions for delta smelt. The Service will consider the amount or extent of incidental take of delta smelt to be exceeded if shallow water habitat is impacted beyond the 22.4 acres identified.

California Red-Legged Frog

The Service anticipates that incidental take of the California red-legged frog will be difficult to detect due to their cryptic nature and wariness of humans. Losses of this species may also be difficult to quantify due to a lack of project-specific species and habitat survey data, the long-term nature of the project, and seasonal/annual fluctuations in their numbers due to environmental or human-caused disturbances. For these reasons, it is not practical to express the amount or extent of anticipated take of this species or monitor take-related impacts in terms of individual California red-legged frogs. Due to the difficulty in quantifying the number of California red-legged frogs that will be taken as a result of the PA, the Service is using modeled suitable habitat as a surrogate to quantify incidental take of the species. Therefore, to quantify the level of incidental take associated with the PA, the Service anticipates that all California red-legged frogs within the 69.1 acres of modeled suitable habitat identified in the CWF BA to be permanently or temporarily affected by pre-construction and construction activities will be subject to incidental take in the form of harm, injury, or mortality. The amount of habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat is likely to contain features that California red-legged frogs use for breeding, feeding, and sheltering (such as aquatic features and burrows) and the anticipated take is caused by such disturbance activities. Injury and mortality are anticipated to be low because of the proposed conservation measures which include confining activities to the dry season, limiting light disturbance, and providing escape ramps. The Service will consider the amount or extent of incidental take of California red-legged frog to be exceeded if modeled suitable habitat is impacted beyond the 69.1 acres identified.

California Tiger Salamander

The Service anticipates that incidental take of the Central California tiger salamander will be difficult to detect due of its cryptic and fossorial nature, and predominantly nocturnal behavior. Losses of this species may also be difficult to quantify due to a lack of project-specific species and habitat survey data, the long-term nature of the project, and seasonal/annual fluctuations in their numbers due to environmental or human-caused disturbances. For these reasons, it is not practical to express the amount or extent of anticipated take of this species or monitor take-related impacts in terms of individual Central California tiger salamanders. Due to the difficulty in quantifying the number of Central California tiger salamanders that will be taken as a result of the PA, the Service is using modeled suitable habitat as a surrogate to quantify incidental take of the species. Therefore, to quantify the level of incidental take associated with the PA, the Service anticipates that all Central California tiger salamanders within the 58 acres of modeled suitable habitat identified in the CWF BA to be permanently or temporarily affected by the standard consultation elements will be subject to incidental take in the form of harm, injury, or mortality. The amount of habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat is likely to contain features that California tiger salamanders use for breeding, feeding, and sheltering (such as aquatic features and burrows) and the anticipated take is caused by such disturbance activities. Injury and mortality are anticipated to be low because of the proposed conservation measures which include confining activities to the dry season, limiting light disturbance, and providing escape ramps. The Service will consider the amount or extent of incidental take of Central California tiger salamander to be exceeded if modeled suitable habitat is impacted beyond the 58 acres identified.

Giant Garter Snake

The Service anticipates that incidental take of the giant garter snake will be difficult to detect due to their cryptic nature and difficulty in finding individuals with the exception of roadways. For these reasons, it is not practical to express the amount or extent of anticipated take of this species or monitor take-related impacts in terms of individual giant garter snakes in areas besides roadways. We expect the incidental take to be in the form of: (1) harm, through the loss of suitable habitat (*i.e.*, cover, food prey), (2) harass, through disturbance during construction or project activities, and (3) injury or mortality though the contact of construction equipment and/or vehicles or increased susceptibility to predation. We expect the loss of suitable habitat is likely to interfere with normal foraging, sheltering, and reproduction behaviors of all giant garter snake that use the project area. Due to the difficulty in quantifying the number of giant garter snakes that will be taken in the form of harm and harass, or injury and mortality, the Service is using modeled suitable habitat as a surrogate to quantify incidental take of the species. Therefore, to quantify the level of incidental take associated with the PA, the Service anticipates that all giant garter snakes inhabiting or utilizing the 865 acres of modeled suitable habitat identified in the CWF BA to be permanently or temporarily affected by the standard consultation elements will be subject to incidental take in the form of harm, harass injury, or mortality. The amount of habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat is likely to contain features that giant garter snakes use for breeding, feeding, and sheltering (such as small fossorial mammal burrows or natural crevices around man-made features such as concrete culverts) and the anticipated take is caused by such disturbance activities. The Service will consider the amount or extent of giant garter snake to be exceeded if modeled suitable habitat is impacted beyond the 865 acres identified.

Injury or mortality of giant garter snake as a result of contact with construction equipment and/or vehicles on the roadways within the modeled suitable habitat can be quantified and monitored. The Service expects that no more than two (2) giant garter snakes will be killed or injured in a single construction year by contact with construction equipment and/or vehicles. The Service will consider the amount or extent of incidental take of giant garter snake to be exceeded if a total of three (3) or more giant garter snakes are killed or injured in a single construction year.

Least Bell's Vireo

The Service anticipates that incidental take of the least Bell's vireo will be difficult to detect because they are very rarely noted in migration. For this reasons, it is not practical to express the amount or extent of anticipated take of this species or monitor take-related impacts in terms of individual least Bell's vireo. We expect the loss of modeled suitable habitat is likely to result in incidental take in the form of harm of least Bell's vireos that use the project area. Due to the difficulty in quantifying the number of least Bell's vireos that will be taken as a result of the PA, the Service is using modeled suitable habitat as a surrogate to quantify incidental take of the species. Therefore, to quantify the level of incidental take associated with the PA, the Service anticipates that all least Bell's vireo within the 27 acres of modeled suitable habitat identified in the CWF BA to be permanently or temporarily affected by the standard consultation elements will be subject to incidental take in the form of harm. The amount of habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat is likely to contain features that least Bell's vireo use for breeding, feeding, and sheltering (such as riparian habitat) and the anticipated take is caused by such disturbance activities. Injury and mortality are anticipated to be low because of the proposed conservation measures which include pre-construction surveys during the breeding season, and limiting noise and lighting impacts if birds are detected. The Service will consider the amount or extent of incidental take to be exceeded if modeled suitable habitat is impacted beyond the 27 acres identified.

San Joaquin Kit Fox

The Service anticipates that incidental take of the San Joaquin kit fox will be difficult to detect due to their rare sightings in the northern part of their range, nocturnal behavior and propensity to seek refuge within dens if injured, harassed or startled. For these reasons, it is not practical to express the amount or extent of anticipated take of this species or monitor take-related impacts in terms of individual San Joaquin kit foxes. Due to the difficulty in quantifying the number of San Joaquin kit foxes that will be subject to incidental take as a result of the PA, the Service is using modeled suitable habitat as a surrogate to quantify incidental take of the species. Therefore, to quantify the level of incidental take associated with the PA, the Service anticipates that all San Joaquin kit foxes within the 58 acres of modeled suitable habitat identified in the CWF BA to be permanently or temporarily affected by the standard consultation elements will be subject to incidental take in the form of harm. The amount of habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat is likely to contain features that San Joaquin kit fox use for feeding and sheltering (such as burrows and foraging habitat containing prey) and the anticipated take is caused by such disturbance activities. Injury and mortality are anticipated to be low because of the proposed conservation measures which include limiting noise and lighting impacts and avoidance of occupied dens. The Service will consider the amount or extent of incidental take to be exceeded if modeled suitable habitat is impacted beyond the 58 acres identified.

Valley Elderberry Longhorn Beetle

Valley elderberry longhorn beetles are small in size, and their life cycles and patchy habitats make detection difficult and the quantification of impacts to individual valley elderberry longhorn beetles impractical in addition to a lack of project-specific species and habitat survey data. Due to the difficulty in quantifying the number of valley elderberry longhorn beetles that will be subject to incidental take as a result of the PA, the Service is using modeled suitable habitat as a surrogate to quantify incidental take of the species. Therefore, to quantify the level of incidental take associated with the PA, the Service anticipates that all valley elderberry longhorn beetles within the 383.76 acres of modeled suitable habitat identified in the CWF BA to be permanently or temporarily affected by pre-construction and construction activities will be subject to incidental take in the form of harm, harassment, and mortality. The amount of habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat is likely to contain elderberry shrubs that valley elderberry longhorn beetle use for breeding, feeding, and sheltering and the anticipated take is caused by such disturbance activities. Injury and mortality are anticipated to be low because of the proposed conservation measures which include avoiding disturbance to (if possible) or transplanting elderberry shrubs, and avoiding construction activities during the active season (if possible). The Service will consider the amount of extent of incidental take to be exceeded if modeled suitable habitat is impacted beyond the 383.76 acres identified.

Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp

The Service uses habitat as a surrogate to quantify the amount of take when assessing the impacts of actions to both vernal pool fairy shrimp and vernal pool tadpole shrimp. The amount of habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat is likely to contain the features that vernal pool fairy shrimp and vernal pool tadpole shrimp use for breeding, feeding, and sheltering and the anticipated take is caused by such disturbance activities. Both species of vernal pool crustaceans are small in size, and their complex life cycles and ephemeral habitats make detection difficult and the quantification of impacts to individual vernal pool fairy shrimp and vernal pool tadpole shrimp impractical. Due to the difficulty in quantifying the number of vernal pool fairy shrimp and vernal pool tadpole shrimp that will be taken as a result of the PA, the Service is quantifying incidental take of the fairy shrimp and tadpole shrimp in the form of harm as all fairy and tadpole shrimp within the 6.2 acres of modeled suitable habitat identified in the CWF BA to be permanently or temporarily affected by pre-construction and construction activities. The Service will consider the amount or extent of incidental take to be exceeded if modeled suitable habitat is impacted beyond the 6.2 acres identified.

Western Yellow-billed Cuckoo

The Service anticipates that incidental take of the western yellow-billed cuckoo will be difficult to detect because they are very rarely noted in migration. For these reasons, it is not practical to express the amount or extent of anticipated take of this species or monitor take-related impacts in terms of individual least Bell's vireo. We expect the loss of modeled suitable habitat is likely to result in incidental take in the form of harm of western yellow-billed cuckoos that use the project area. Due to the difficulty in quantifying the number of western yellow-billed cuckoos and that will be taken as a result of the PA, the Service is using modeled suitable habitat as a surrogate to quantify incidental take of the species. Therefore, to quantify the level of incidental take associated with the PA, the Service anticipates that all western yellow-billed cuckoos within the 27 acres of modeled suitable habitat identified in the CWF BA to be permanently or temporarily affected by the standard consultation elements will be subject to incidental take in the form of harm. The amount of habitat disturbance is an appropriate way to measure the anticipated extent of incidental take because this habitat is likely to contain the riparian habitat that western yellow-billed cuckoos use for breeding, feeding, and sheltering and the anticipated take is caused by such disturbance activities. Injury and mortality are anticipated to be low because of the proposed conservation measures which include pre-construction surveys during the breeding season, and limiting noise and lighting impacts if birds are detected. The Service will consider the amount or extent of incidental take to be exceeded if modeled suitable habitat is impacted beyond the 27 acres identified.

10.2 Effect of the Take

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to the delta smelt, California red-legged frog, California tiger salamander, giant garter snake, least Bell's vireo, San Joaquin kit fox, valley elderberry longhorn beetle, vernal pool fairy shrimp, vernal pool tadpole shrimp, and western yellow-billed cuckoo.

10.3 Reasonable and Prudent Measures

The Service has determined that the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the California red-legged frog, California tiger salamander, delta smelt, giant garter snake, least Bell's vireo, San Joaquin kit fox, valley elderberry longhorn beetle, vernal pool fairy shrimp, vernal pool tadpole shrimp, and western yellow-billed cuckoo:

1. Minimize the effects of construction activities to California red-legged frog, California tiger salamander, delta smelt, giant garter snake, least Bell's vireo, San Joaquin kit fox, valley elderberry longhorn beetle, vernal pool fairy shrimp, vernal pool tadpole shrimp, and western yellow-billed cuckoo and their habitat in the action area.

2. Minimize effects to delta smelt through ongoing collaborative efforts focused on the final design and construction procedures for the new and existing infrastructures (*e.g.*, CCF). As appropriate, representatives from DWR, Reclamation, CDFW, NMFS and the Service will participate. These technical teams will convene before construction begins at the facility and will meet periodically until DWR completes final design modifications.

10.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation and/or the Corps shall ensure DWR as the applicant shall ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

The following Terms and Conditions implement Reasonable and Prudent Measure Number 1:

1. Reclamation and/or the Corps shall ensure DWR as the applicant shall ensure that the contractors and operators of the equipment comply with this BiOp, where the contractors and operators involved in the PA will be educated and informed as to the *AMMs* in the CWF BA and *Terms and Conditions* in this BiOp.

2. Reclamation and/or the Corps shall ensure DWR as the applicant develops a Service-approved monitoring plan as identified in the *Description of the Proposed Action* in this BiOp.

3. At least 30 days prior to the onset of any construction-related activities, Reclamation and/or the Corps shall ensure DWR as the applicant submits to the Service, for approval,

the name(s) and credentials of biological monitors it requests to conduct activities specified for this project. Information included in a request for authorization must include, at a minimum: (1) relevant education, (2) relevant training on species identification, survey techniques, handling individuals of different age classes, and handling of different life stages by a permitted biologist or recognized species expert authorized for such activities by the Service, (3) a summary of field experience conducting requested activities (to include project/research information and actual experience with the species), (4) a summary of BiOps and/or informal consultations under which they were authorized to work with the listed species and at what level (such as construction monitoring versus handling), this should also include the names and qualifications of persons under which the work was supervised as well as the amount of work experience on the actual project including detail on whether the species was encountered or not, and (5) a list of Federal Recovery Permits [10(a)1(A)] if any, held or under which individuals are authorized to work with the species (to include permit number, authorized activities, and name of permit holder).

No project activities shall begin until the action agencies have received written Service approval for biologists to conduct specified activities.

4. Reclamation and/or the Corps shall ensure DWR as the applicant complies with all monitoring and reporting requirements as identified in the *Reporting Requirements* in this BiOp.

The following Terms and Conditions implement Reasonable and Prudent Measure Number 2:

1. Reclamation and/or the Corps shall ensure DWR as the applicant minimizes effects to delta smelt through ongoing collaborative efforts related to final design and construction procedures for the new and existing infrastructures.

2. Reclamation and/or the Corps shall ensure DWR as the applicant prepares and provides to the Service draft and final reports summarizing the technical team's efforts.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the PA. If, during the course of the action, this level of incidental take is exceeded, reinitiation of consultation and review of the reasonable and prudent measures provided is required. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

10.5 Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, Reclamation and/or the Corps shall ensure DWR as the applicant shall adhere to the following reporting requirements. Should this anticipated amount or extent of incidental take be exceeded, Reclamation and/or the Corps must reinitiate formal consultation as per 50 CFR 402.16.

1. The Service must be notified within one working day of the finding of any injured or dead listed species or any unanticipated/unauthorized damage to its habitat or modeled suitable habitat associated with the PA. Notification will be made to the Endangered Species Division Assistant Field Supervisor at the San Francisco Bay-Delta Fish and Wildlife Office at (916) 930-5603, and must include the date, time, and precise location of the individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual of the listed species is found, Reclamation and/or the Corps shall ensure DWR as the applicant shall follow the steps outlined in the Disposition of Individuals Taken section below.

2. Reclamation and/or the Corps shall ensure DWR as the applicant works with the Service, as proposed, to develop monitoring plans to address monitoring of baseline habitat conditions and effects of the facilities after operations commence. Reclamation and/or the Corps shall ensure DWR as the applicant must provide reports to the Service which describes the outcomes of these monitoring efforts.

3. Reclamation and/or the Corps shall ensure DWR as the applicant shall submit monthly construction compliance reports prepared by the action agencies, DWR, or the Service-approved biologist to the San Francisco Bay Fish and Wildlife Office. These reports shall detail: (i) dates that construction occurred; (ii) pertinent information concerning the success of the project in meeting Conservation Measures; (iii) an explanation of failure to meet such measures, if any; (iv) quantified actual ground disturbance with photographs; (v) known project effects on listed species, if any; (vi) occurrences of incidental take of listed species or modeled suitable habitat, if any; (vii) documentation of employee environmental education; and (viii) other pertinent information.

Disposition of Individuals Taken

Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as the Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, and the name of the person who found it, and the bag containing the specimen frozen in a freezer located in a secure site, until instructions are received from the Service regarding the disposition of the dead specimen. The Service contact persons are the Assistant Field Supervisor of the Endangered Species Division at the San Francisco Bay-Delta Fish and Wildlife Office at (916) 930-5603; and the Resident Agent-in-Charge of the Service's Office of Law Enforcement, 5622 Price Way, McClellen, California 95562, at (916) 569-8444.

11.0 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1. The Service recommends that Reclamation, the Corps, and DWR participate in recovery planning and implementation of conservation actions consistent with recovery planning documents.

2. The Service recommends that Reclamation, the Corps, and DWR develop procedures that minimize the effects of all other in-water activities that it conducts within the action area on delta smelt.

3. The Service recommends Reclamation and the Corps work with willing partners to establish and maintain a diverse population of delta smelt for refuge and research purposes, managed to ensure adequate genetic diversity.

4. We recommend that the Reclamation conduct protocol-level surveys for federally-listed species when suitable habitat is present within or may be affected by any proposed actions in the future.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

12.0 REINITIATION—CLOSING STATEMENT

This concludes formal consultation on the CWF. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any additional take will not be exempt from the prohibitions of section 9 of the Act, pending reinitiation.

If you have questions concerning this BiOp, please contact Kaylee Allen, Field Supervisor of the San Francisco Bay-Delta Fish and Wildlife Office, at the letterhead address or at (916) 930-5603.

13.0 LITERATURE CITED FOR ALL SECTIONS EXCLUDING SECTION 9.0

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Appendix A. Species and critical habitat not likely to be adversely affected.

Reclamation has determined that the following species and critical habitat may be affected, but are not likely to be adversely affected by the PA. We concur with their determinations, and provide our rationale below.

Suisun Species (Suisun Thistle and its Critical Habitat, Soft Bird's-beak and its Critical Habitat, Salt Marsh Harvest Mouse, California Clapper Rail)

The Service concurs that the PA is not likely to adversely affect the salt marsh harvest mouse and California clapper rail because changes in the operation of the salinity control gates in Suisun Marsh would have negligible effects. Therefore, no substantial changes in the extent or quality of habitat or in the risk of toxicological effects from exposure to contaminants are expected.

The Service concurs that the PA is not likely to adversely affect the soft bird's-beak and its critical habitat or Suisun thistle and its critical habitat, because changes in the operation of the salinity control gates in Suisun Marsh would have negligible effects. Therefore, no substantial changes in the extent or quality of habitat and critical habitat for these two species are expected.

California Least Tern

The Service concurs with Reclamation's determination that the PA may affect, but is not likely to adversely affect the California least tern. The PA will result in permanent loss of 269 acres of open water in and around the CCF that constitutes modeled California least tern foraging habitat. However, the modeled foraging habitat in and around the CCF is considered fringe habitat and rarely used by the California least tern as it is rarely seen in the Delta. The primary foraging and nesting habitat near the PA occurs in the regions of the San Francisco Bay, San Pablo Bay, Suisun Bay, Honker Bay and the Confluence of the Sacramento and San Joaquin rivers. The proposed construction activities are located at least 20 miles from the nearest known or recently active California least tern nesting locations and typically, foraging habitat for California least tern is located within 2 miles of their colonies (Atwood and Minsky 1983). On the rare occasion that California least tern attempt to utilize the CCF or other aquatic areas near construction it would likely be able to avoid these areas and utilize foraging habitat elsewhere without detrimental disturbance of their normal foraging, sheltering or reproductive behaviors.

Riparian Brush Rabbit

The Service concurs with Reclamation's determination that the PA may affect, but is not likely to adversely affect the riparian brush rabbit. The riparian brush rabbit is currently only found at the southern end of the Delta. The closest portion of the PA that may affect riparian brush rabbit is the construction of the HORG. The nearest known occupied habitat is located at the oxbow preserve which is approximately 1.1 miles southeast from the HORG. The Oxbow Preserve is almost completely isolated and surrounded by a residential unit to the east and the San Joaquin River to the west. The proposed construction site for the HORG is on the other side of the San Joaquin River from the Oxbow Preserve and is composed of a set of highly modified and frequently used levees surrounded by active agriculture. There is also currently active construction of multiple residential housing units as part of a large planned community project on the eastern end of Stewart Tract which would further prevent riparian brush rabbit from migrating into the project area. Although riparian brush rabbit can use levee riparian areas for foraging and shelter, the Service conducted site visits of the proposed construction site and determined there was no suitable riparian habitat on the levees nearby that would provide sufficient cover or other basic habitat requirements for the survival of riparian brush rabbit. There is no suitable riparian brush rabbit habitat within or near other portions of the construction footprint for the water conveyance facilities; therefore, other activities associated with the water conveyance facilities are not likely to adversely affect this species.

California Tiger Salamander Critical Habitat

The Service concurs with Reclamation's determination that PA may affect but is not likely to adversely affect California tiger salamander's designated critical habitat. The Service's concurrence is based on the species' designated critical habitat not occurring within the action area for the PA.

Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp Critical Habitat

Critical habitat for the vernal pool tadpole shrimp occurs in the PA at the northern edge of Suisun Marsh. Critical habitat for vernal pool fairy shrimp occurs just west of CCF, and also at the northern edge of Suisun Marsh.

A portion of the PA is within vernal pool fairy shrimp critical habitat unit 19B. Unit 19 A-C encompasses a total of 7,892 acres. Although there is designated critical habitat for the vernal pool fairy shrimp within the action area of the PA, the activities associated with the PA will not affect the primary constituent elements (PCEs) of the critical habitat unit. The described impacts by the PA to designated vernal pool fairy shrimp critical habitat will occur outside of areas that include PCEs and include areas that don't appear to have a direct supporting role in vernal pool fairy shrimp populations within unit 19B.

Critical habitat for the vernal pool tadpole shrimp occurs in the PA at the northern edge of Suisun Marsh, but the PA, as described, is not likely to adversely affect vernal pool tadpole shrimp critical habitat.

Appendix B. Location of X2 position.

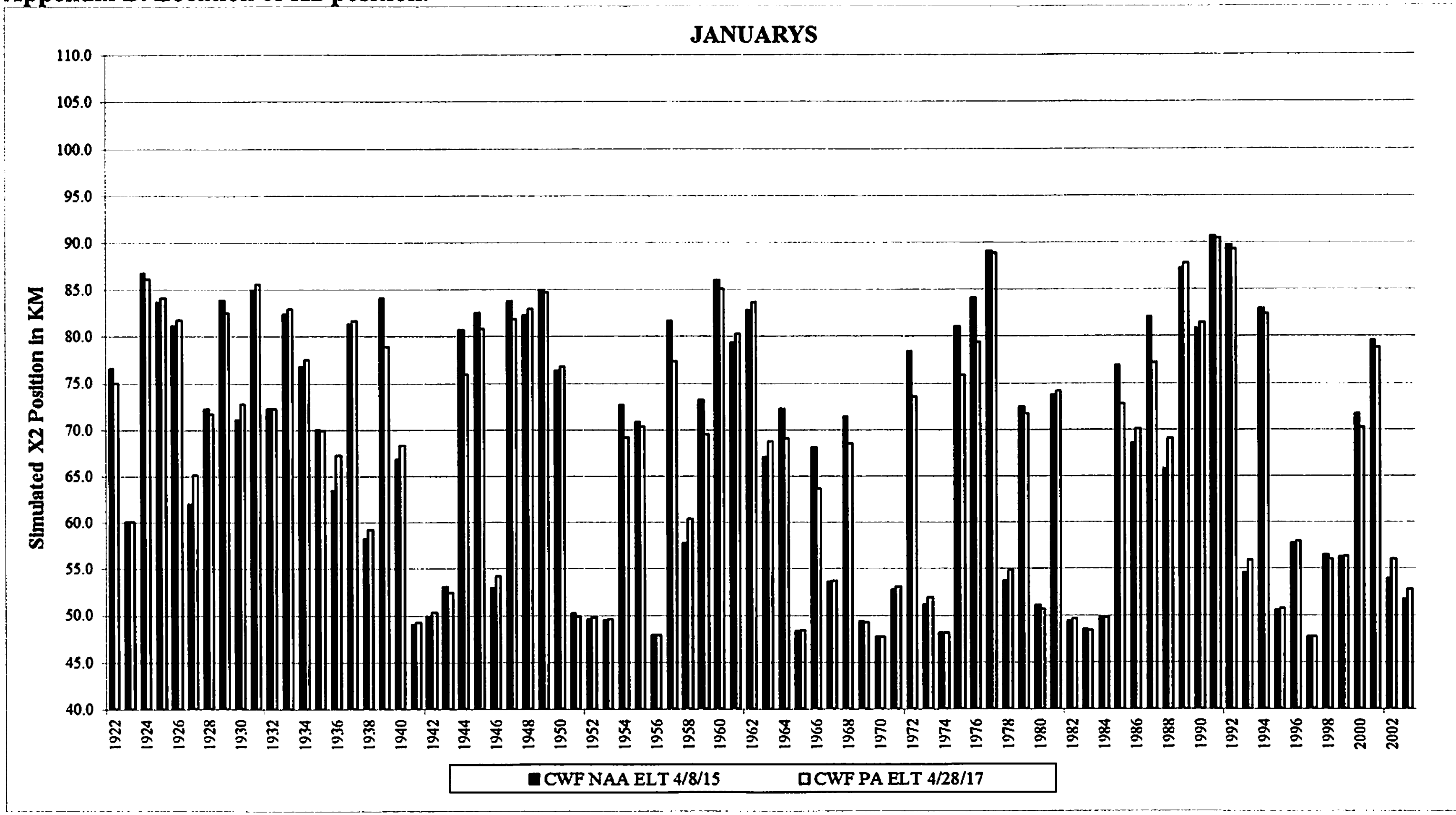


Figure B-1. 82 years of simulated X2 position in kilometers for all Januarys based on 82 years of CalSim II modeling.

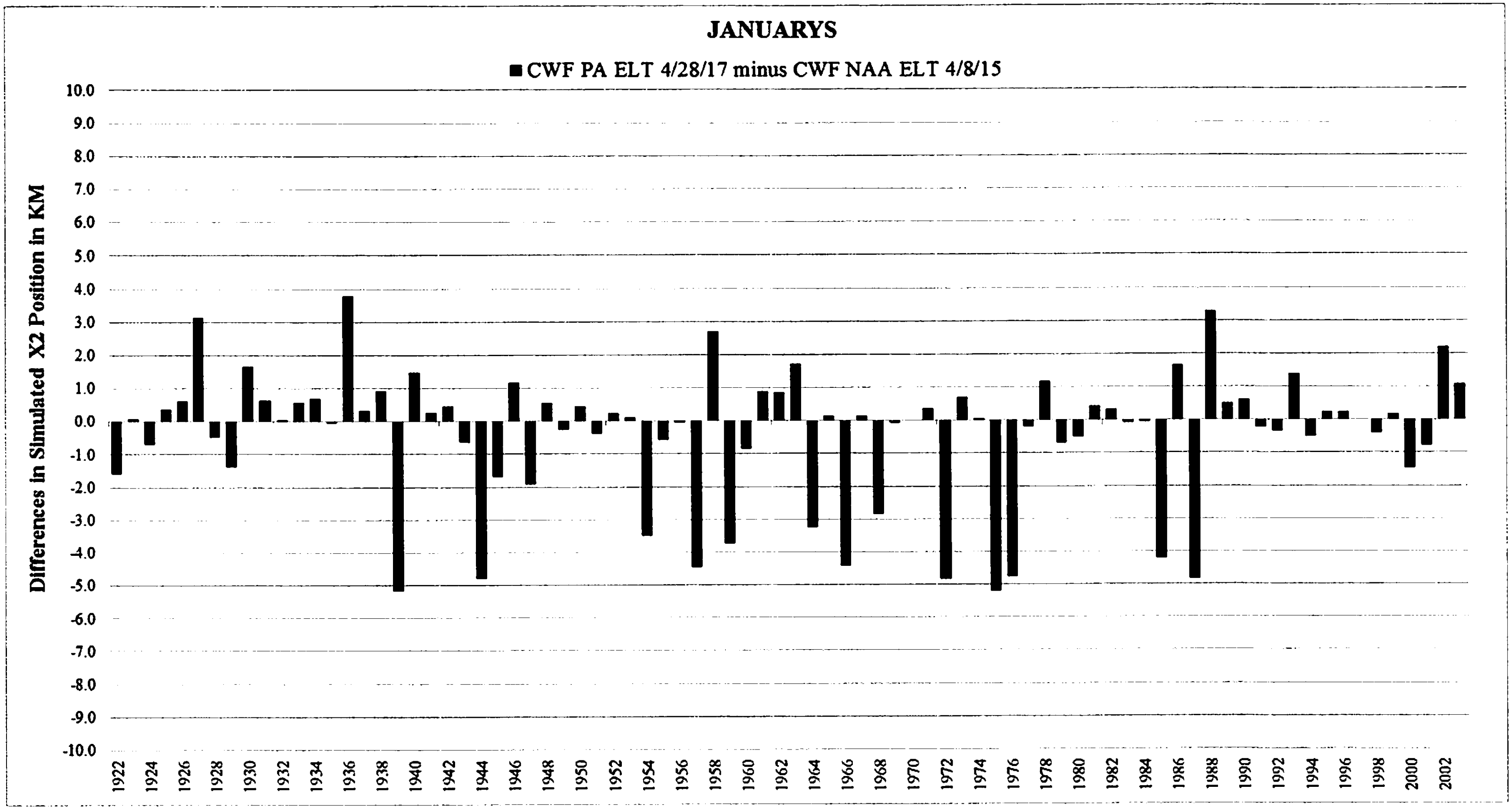


Figure B-2. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Januarys based on 82 years of CalSim II modeling.

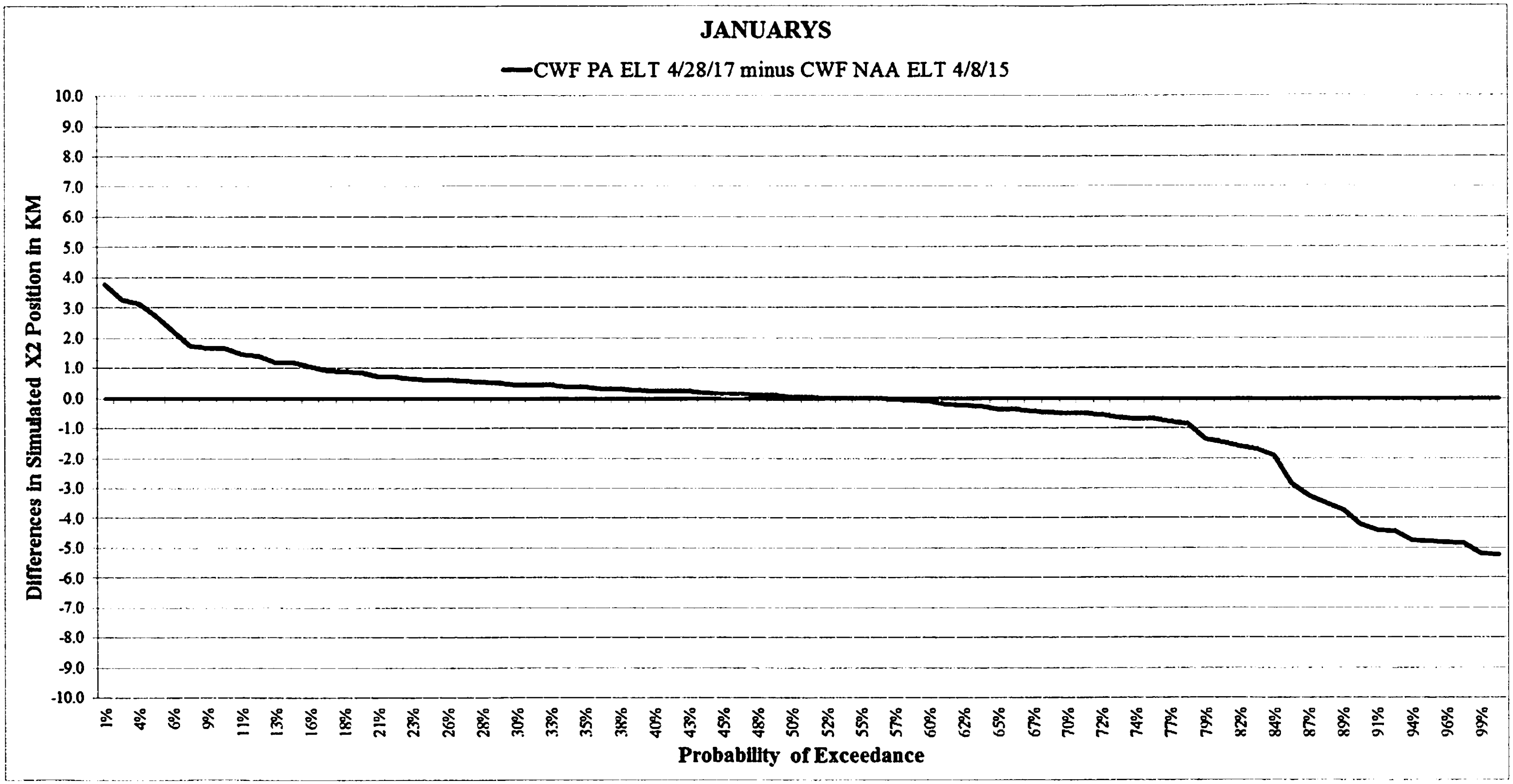
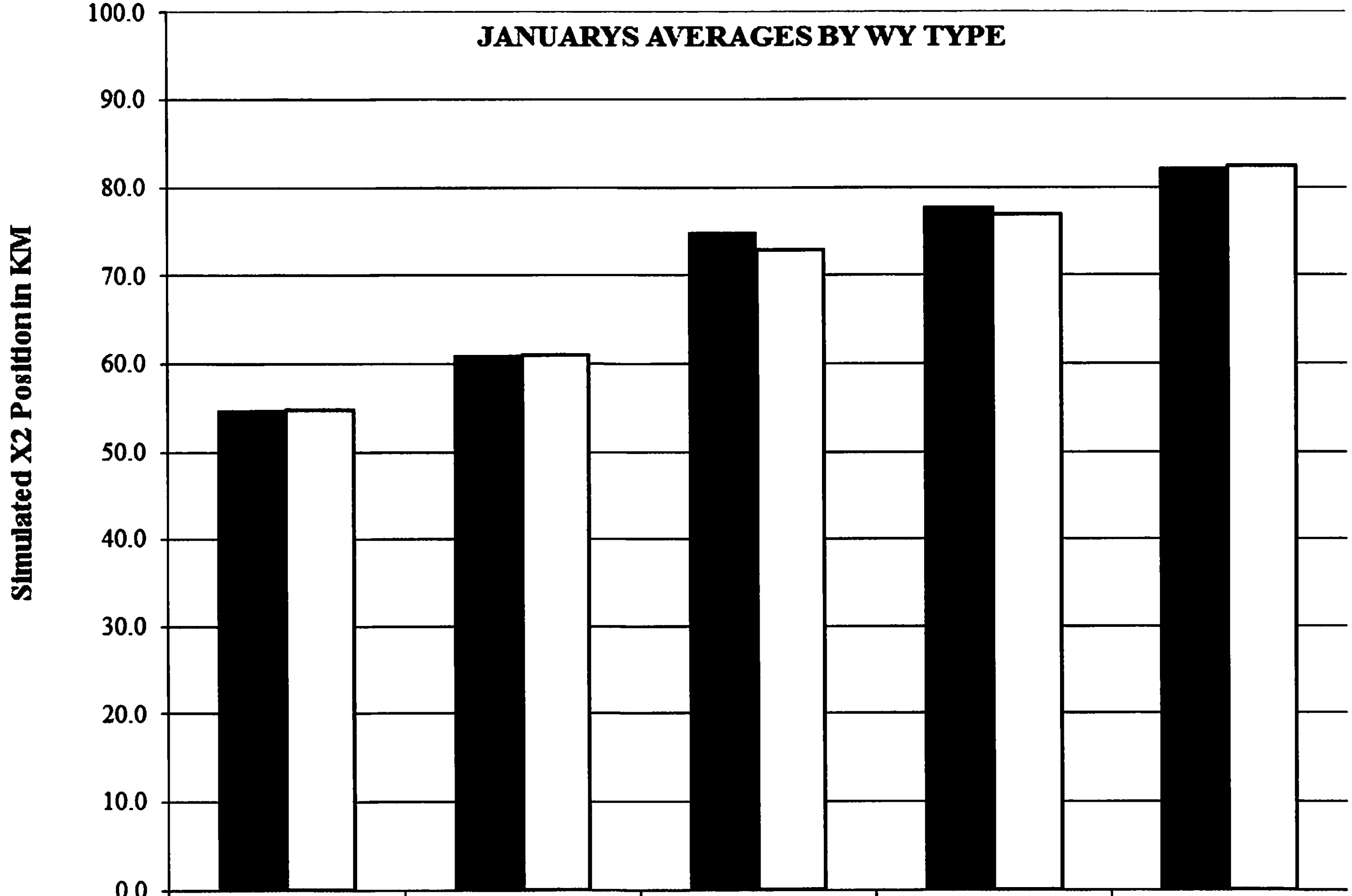


Figure B-4. Probability of exceedances of differences in simulated X2 position for all Januarys based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	54.8	61.0	74.9	77.8	82.2
□ CWF PA ELT CH20170428	54.8	60.9	72.9	77.0	82.4

Figure B-3. Simulated X2 position averaged by WY type for all Januarys based on 82 years of CalSim II modeling.

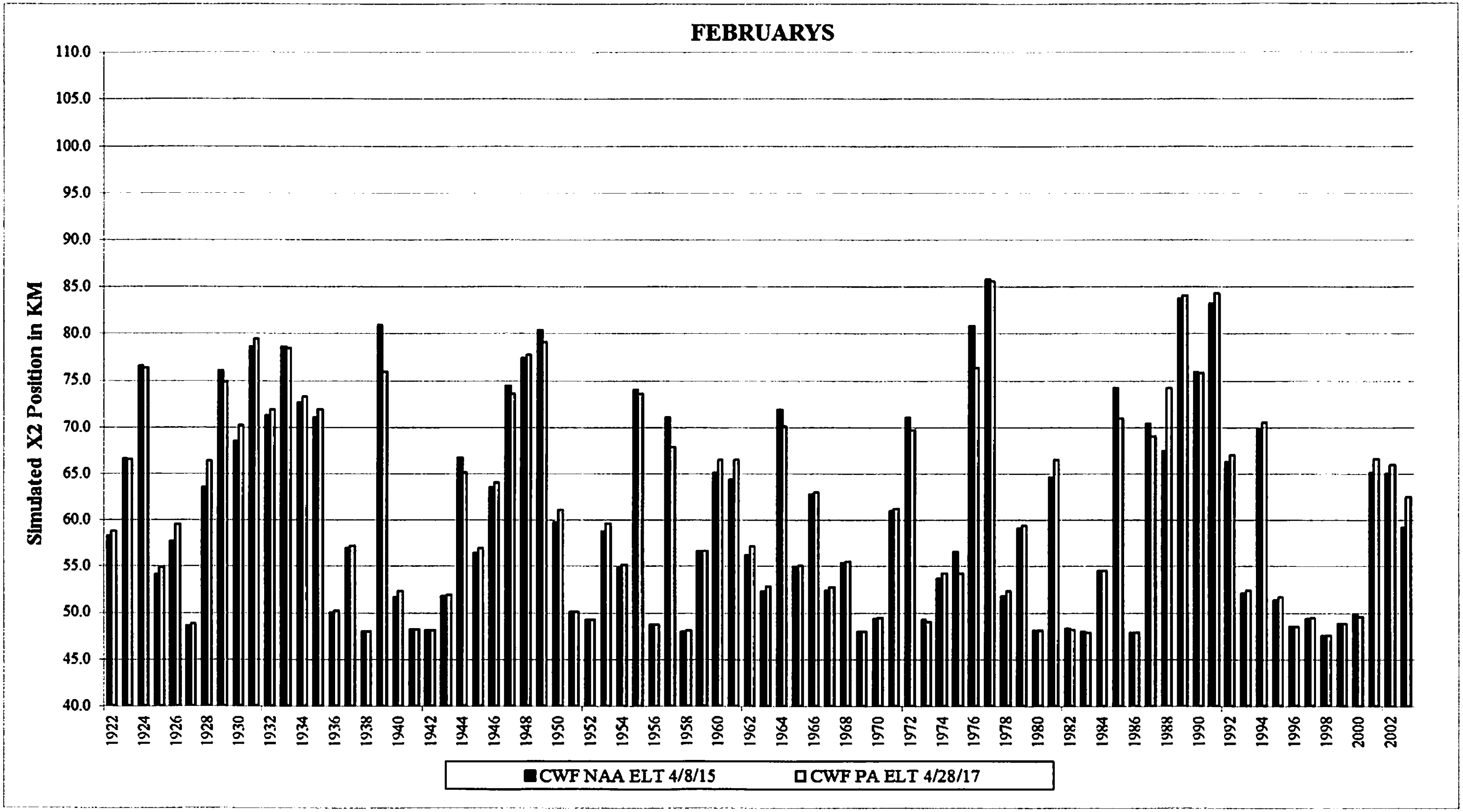


Figure B-5. 82 years of simulated X2 position in kilometers for all Februarys based on 82 years of CalSim II modeling.

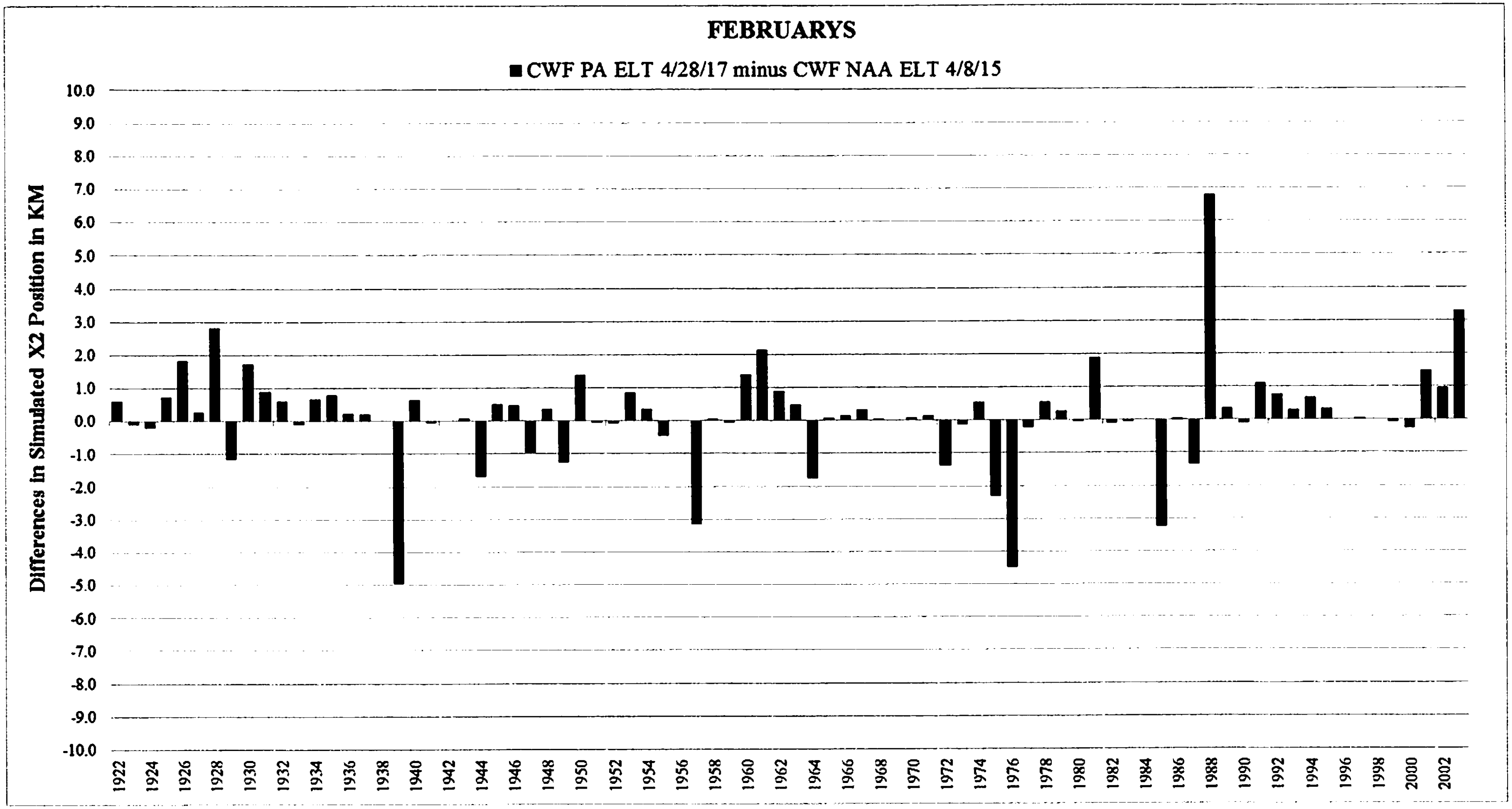


Figure B-6. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Februarys based on 82 years of CalSim II modeling.

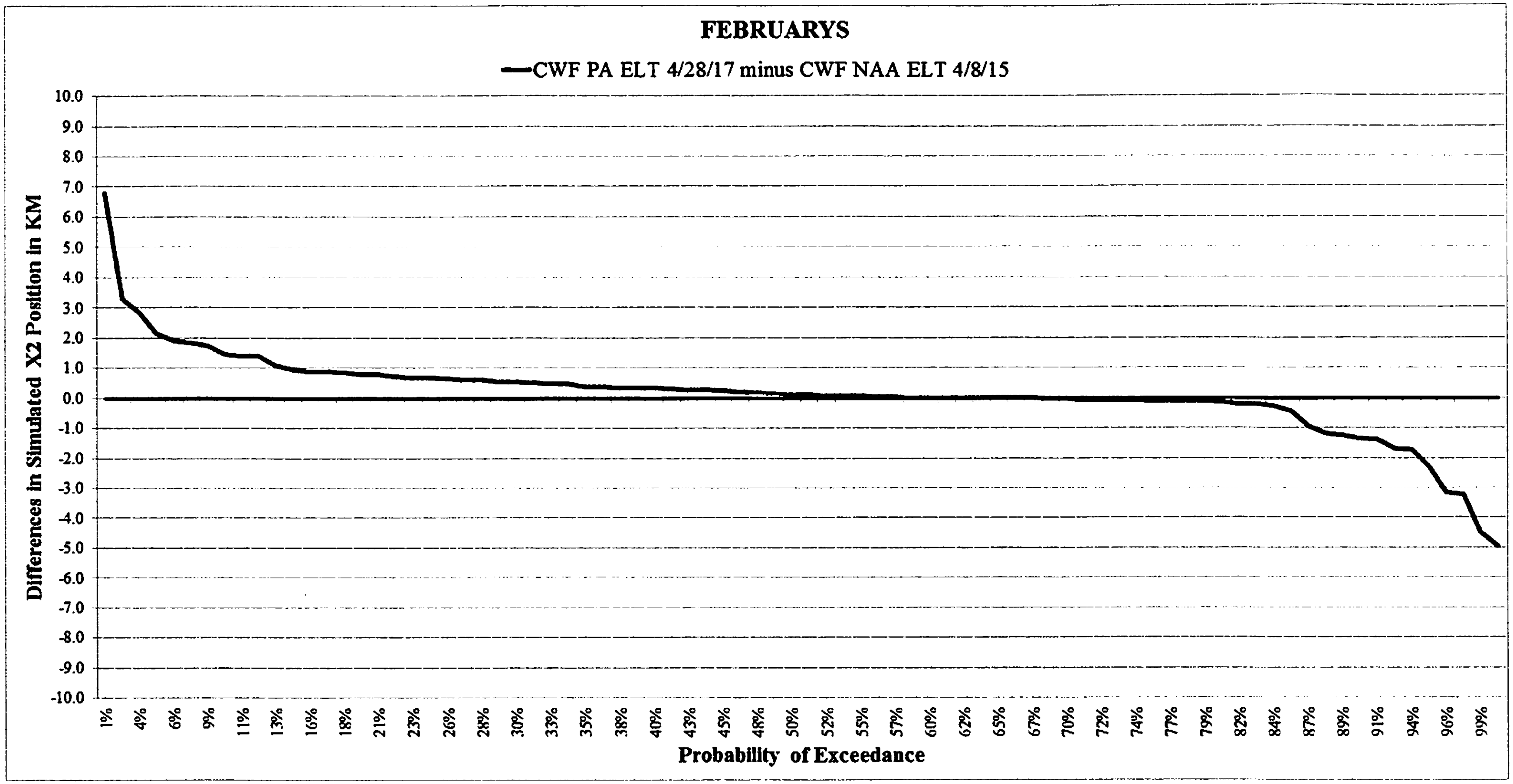
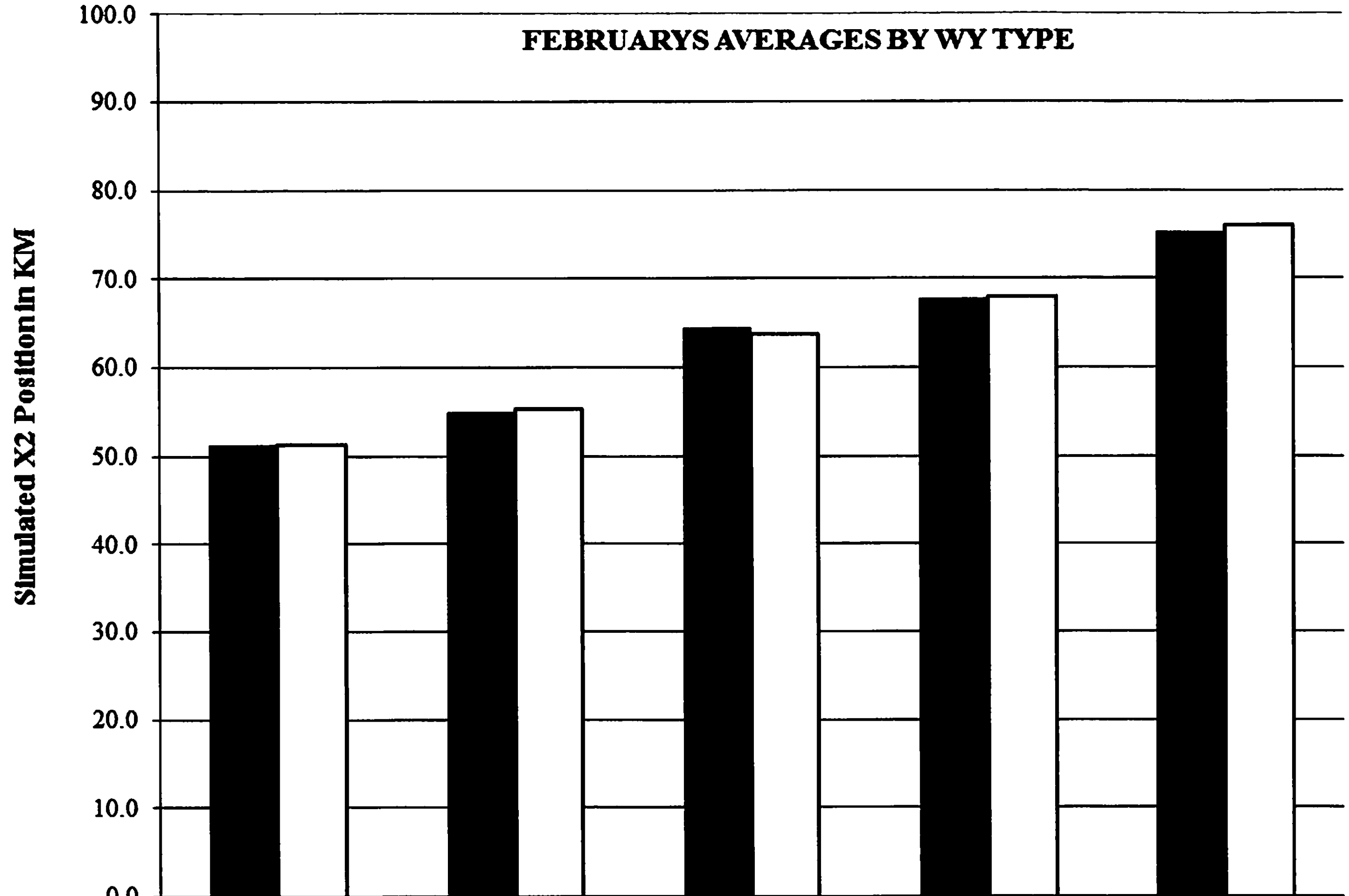


Figure B-7. Probability of exceedances of differences in simulated X2 position for all Februarys based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	51.2	54.9	64.4	67.7	75.2
□ CWF NAA ELT CH20150408	51.3	55.3	63.7	67.9	76.0

Figure B-8. Simulated X2 position averaged by WY type for all Februarys based on 82 years of CalSim II modeling.

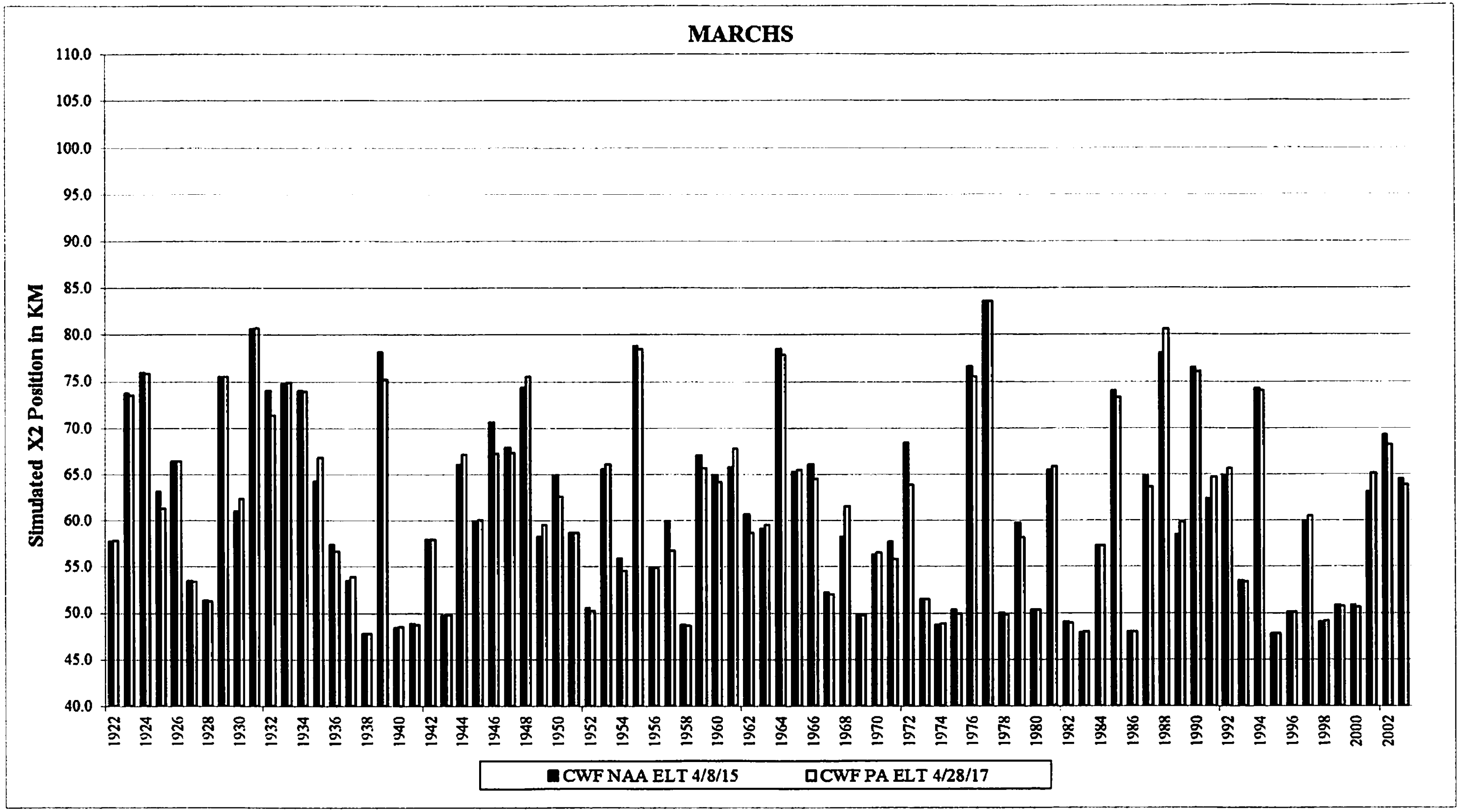


Figure B-9. 82 years of simulated X2 position in kilometers for all Marchs based on 82 years of CalSim II modeling.

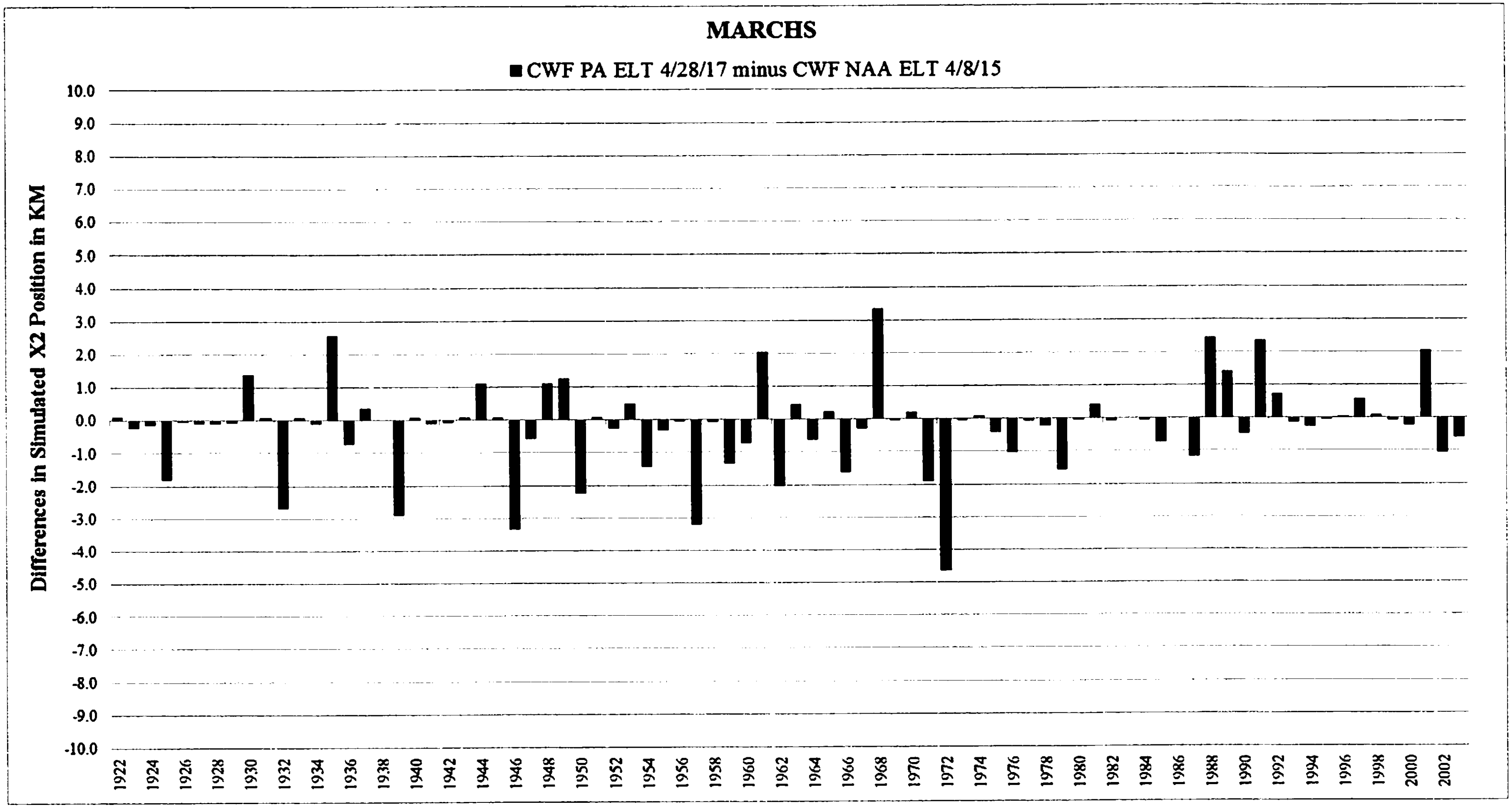


Figure B-10. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Marchs based on 82 years of CalSim II modeling.

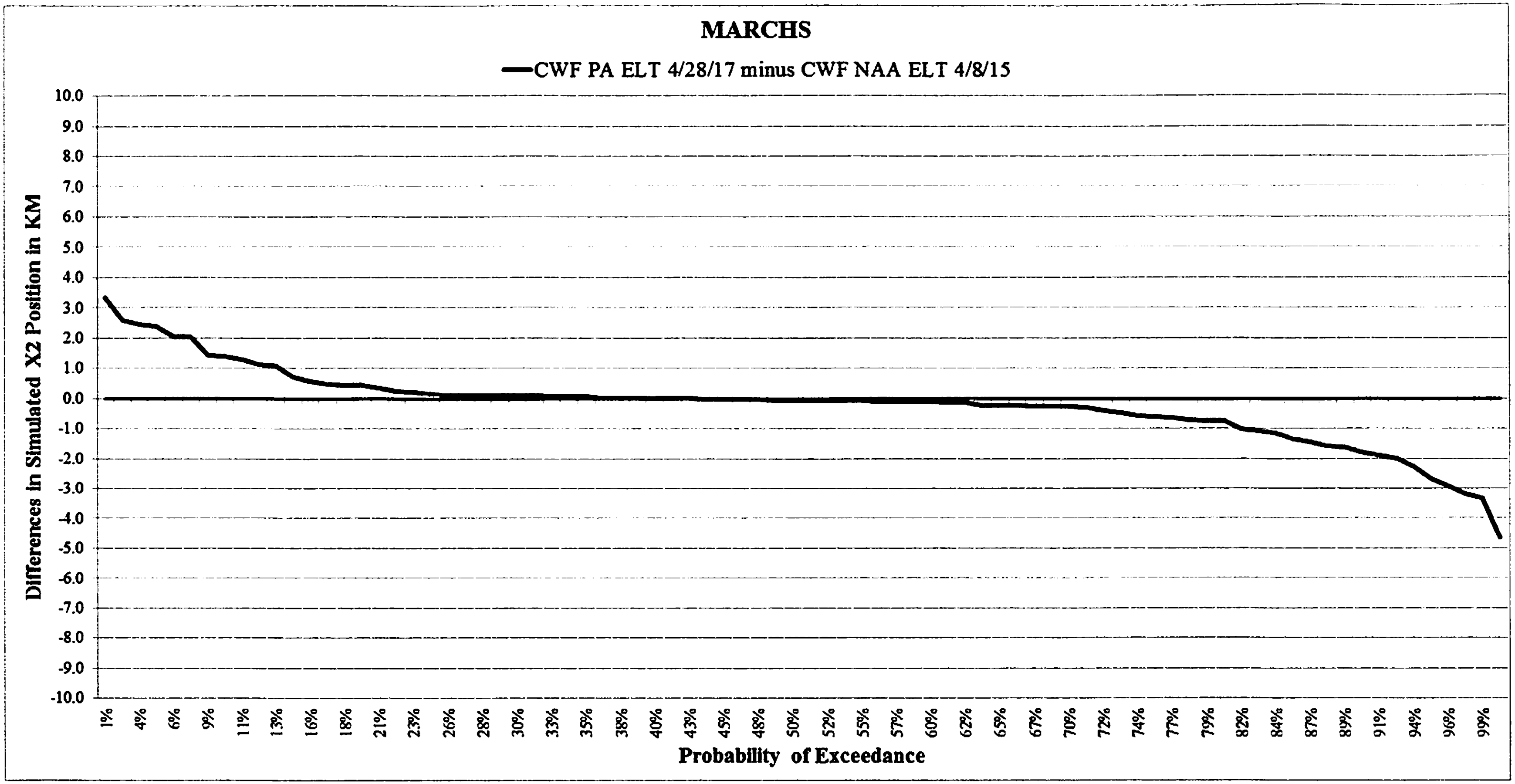
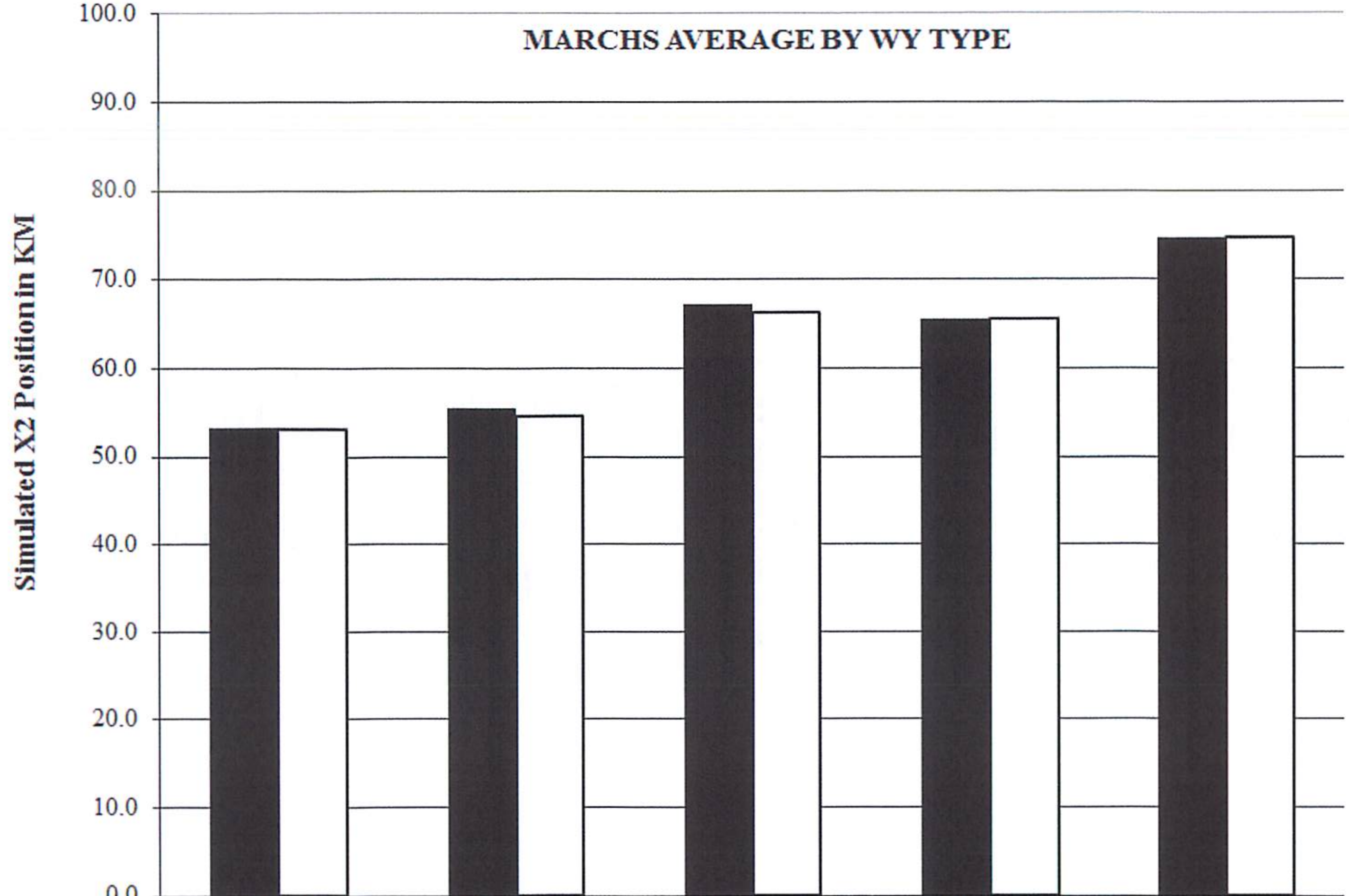


Figure B-11. Probability of exceedances of differences in simulated X2 position for all Marchs based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	53.1	55.3	67.1	65.6	74.6
□ CWF PA ELT CH20170428	53.1	54.6	66.2	65.6	74.8

Figure B-12. Simulated X2 position averaged by WY type for all Marchs based on 82 years of CalSim II modeling.

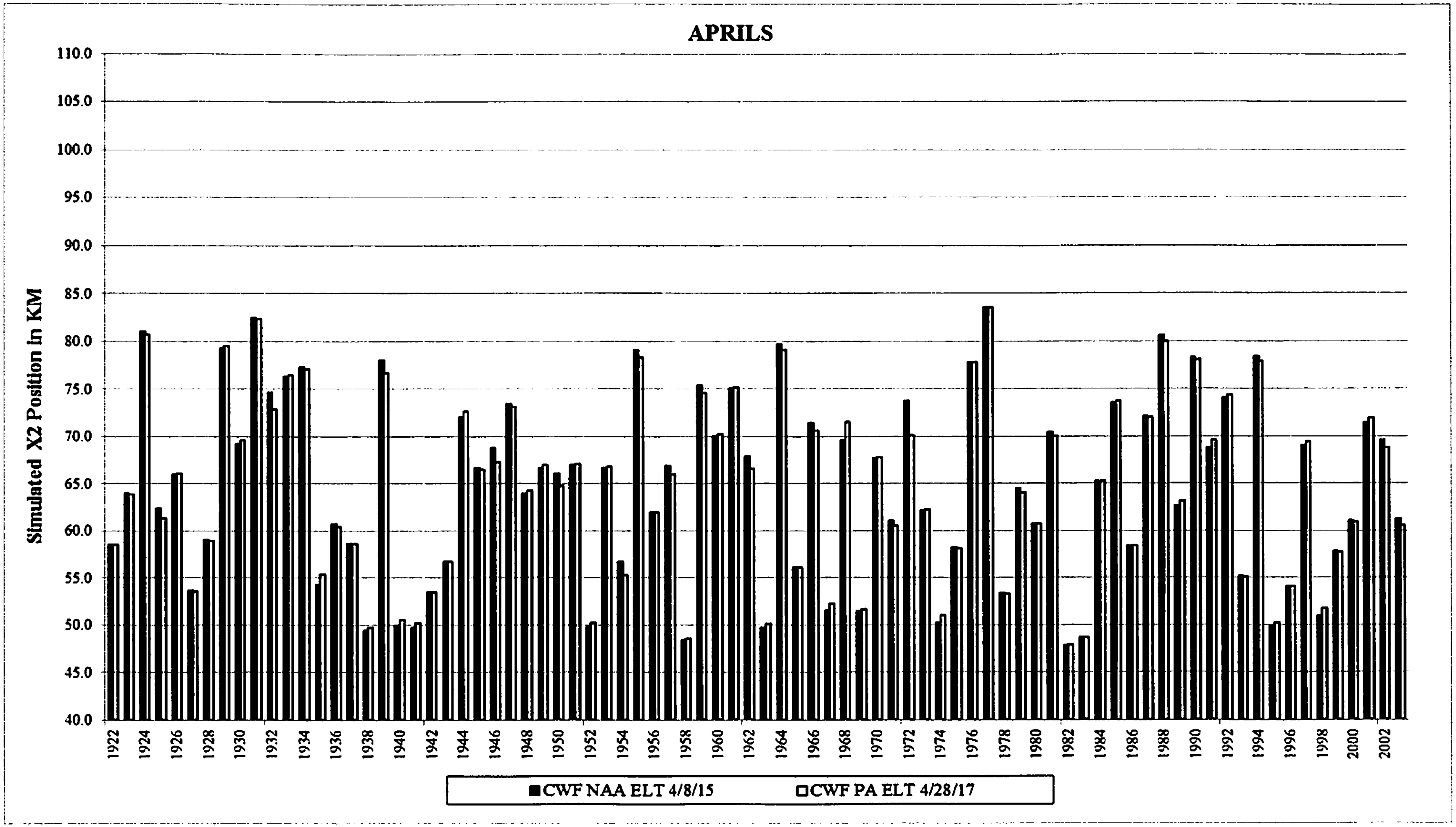


Figure B-13. 82 years of simulated X2 position in kilometers for all Aprils based on 82 years of CalSim II modeling.

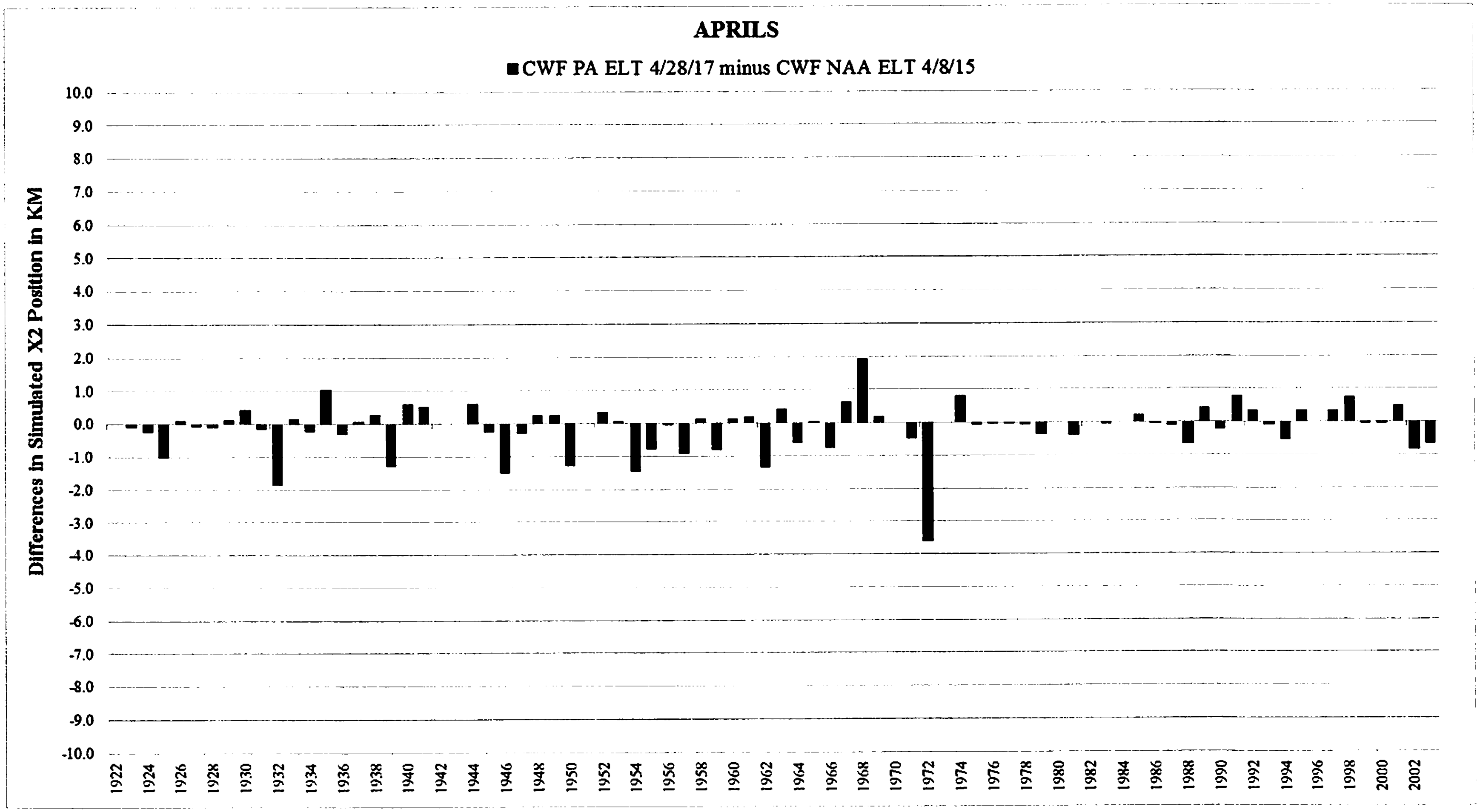


Figure B-14. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Aprils based on 82 years of CalSim II modeling.

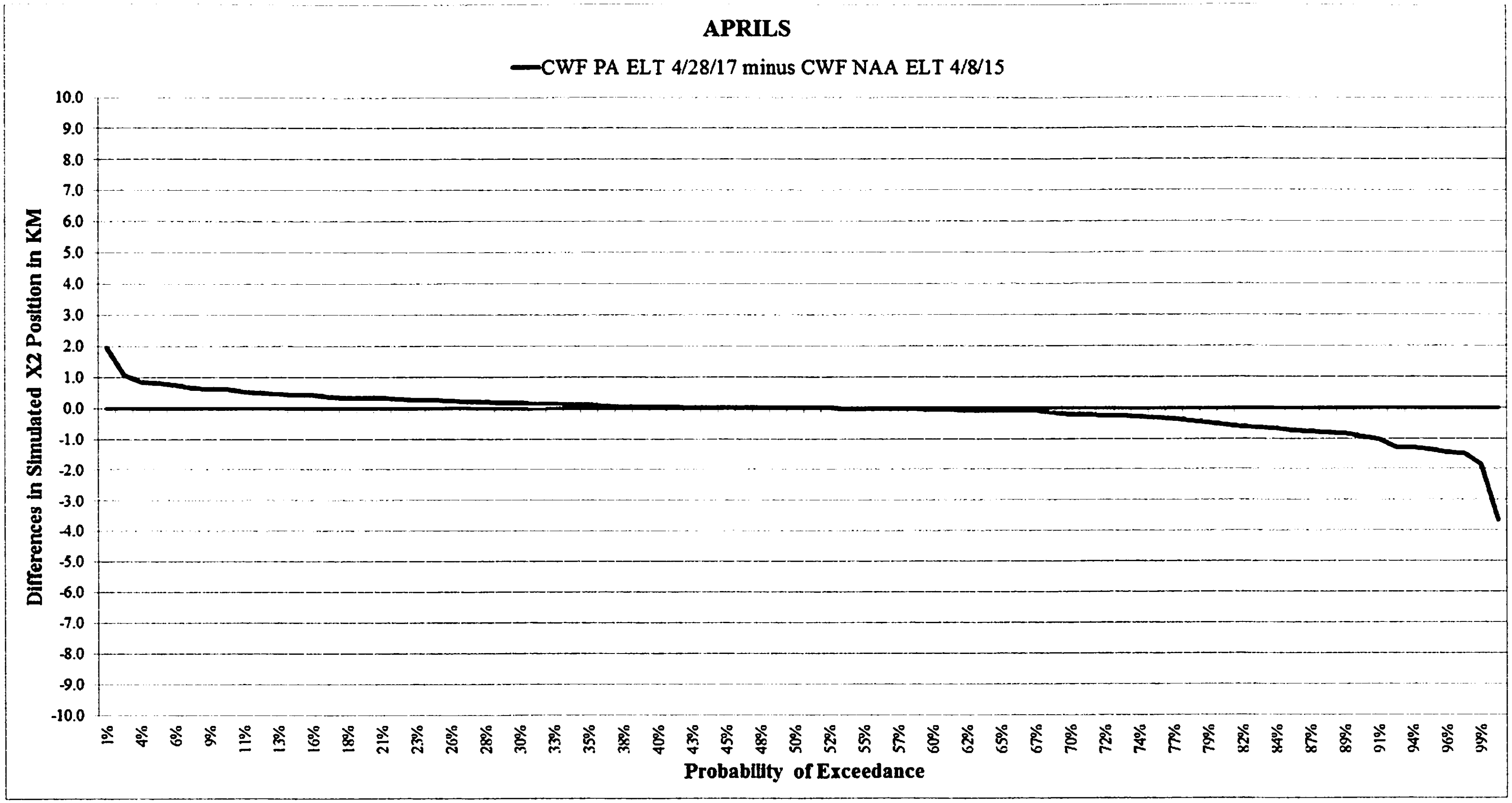
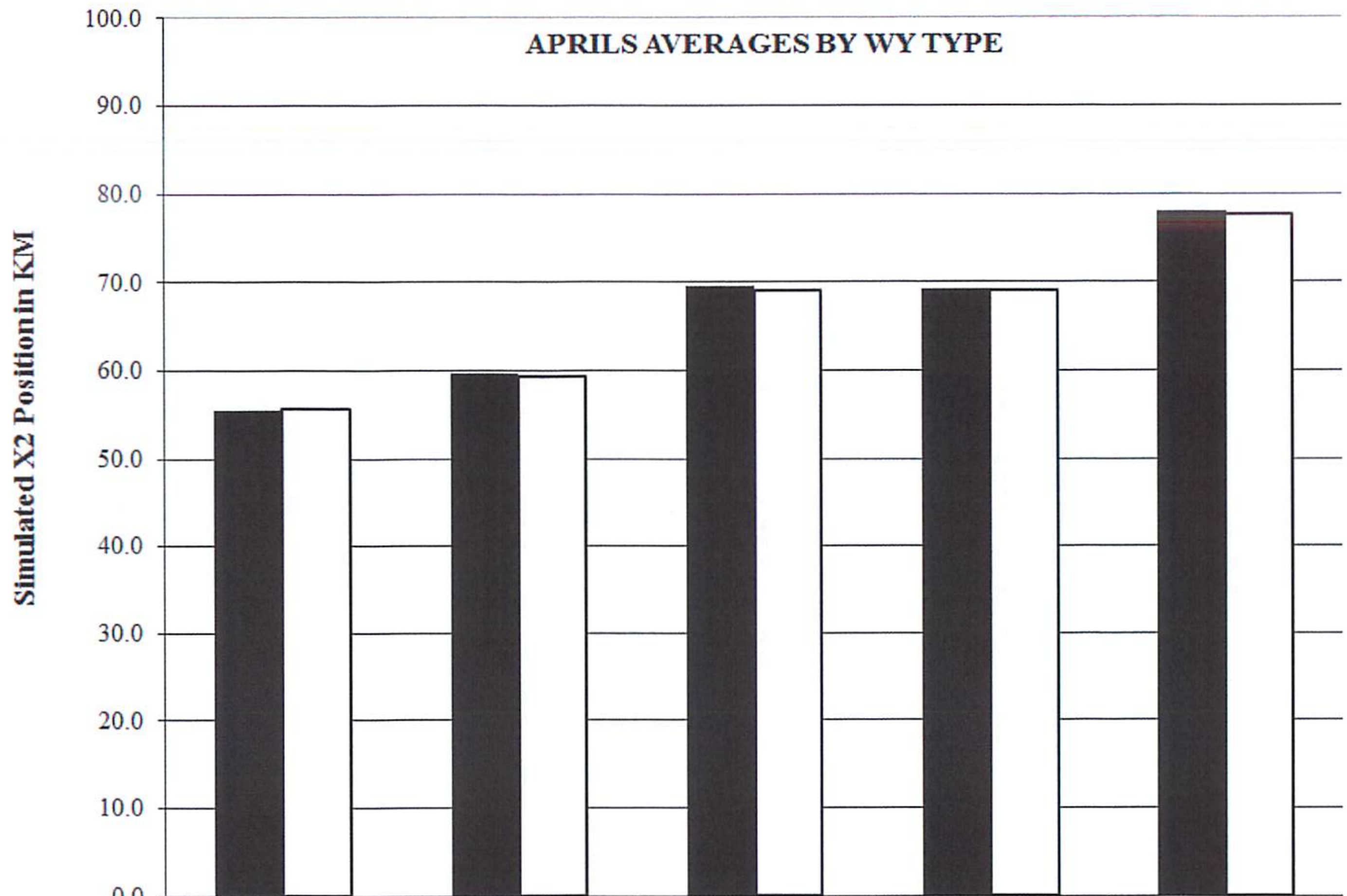


Figure B-15. Probability of exceedances of differences in simulated X2 position for all Aprils based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	55.5	59.7	69.5	69.1	77.9
□ CWF PA ELT CH20170428	55.7	59.4	69.0	69.0	77.7

Figure B-16. Simulated X2 position averaged by WY type for all Aprils based on 82 years of CalSim II modeling.

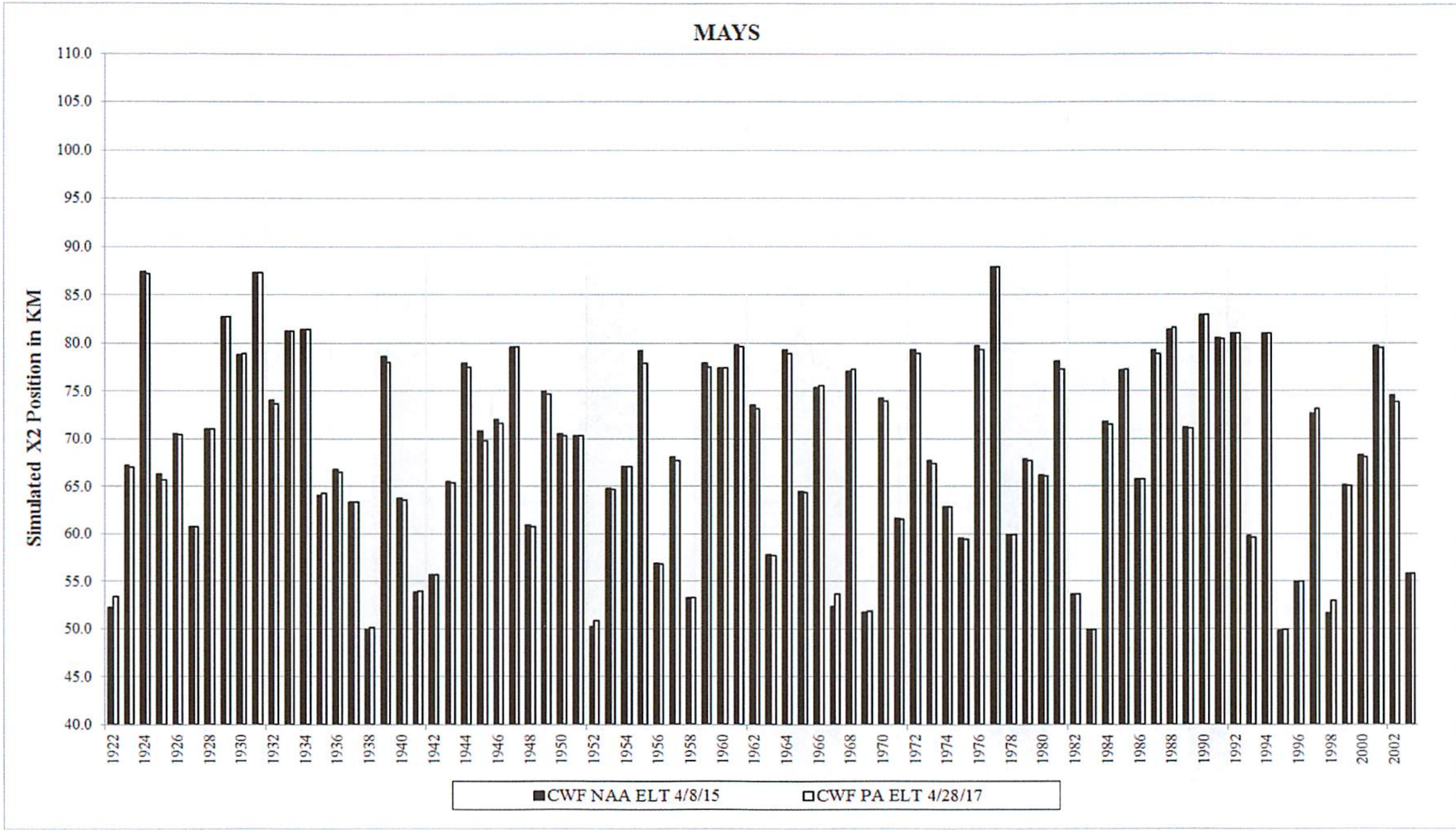


Figure B-17. 82 years of simulated X2 position in kilometers for all Mays based on 82 years of CalSim II modeling.

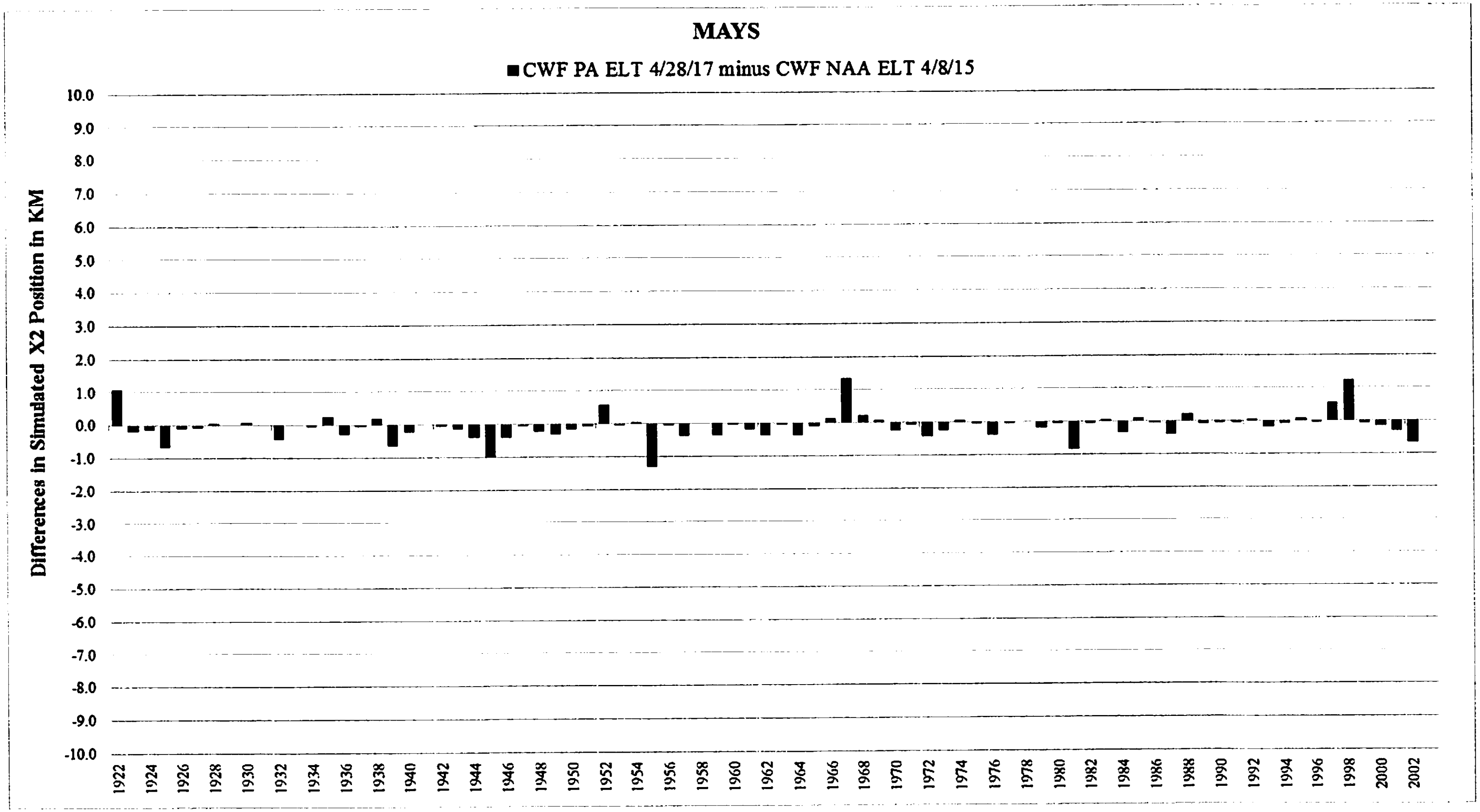


Figure B-18. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Mays based on 82 years of CalSim II modeling.

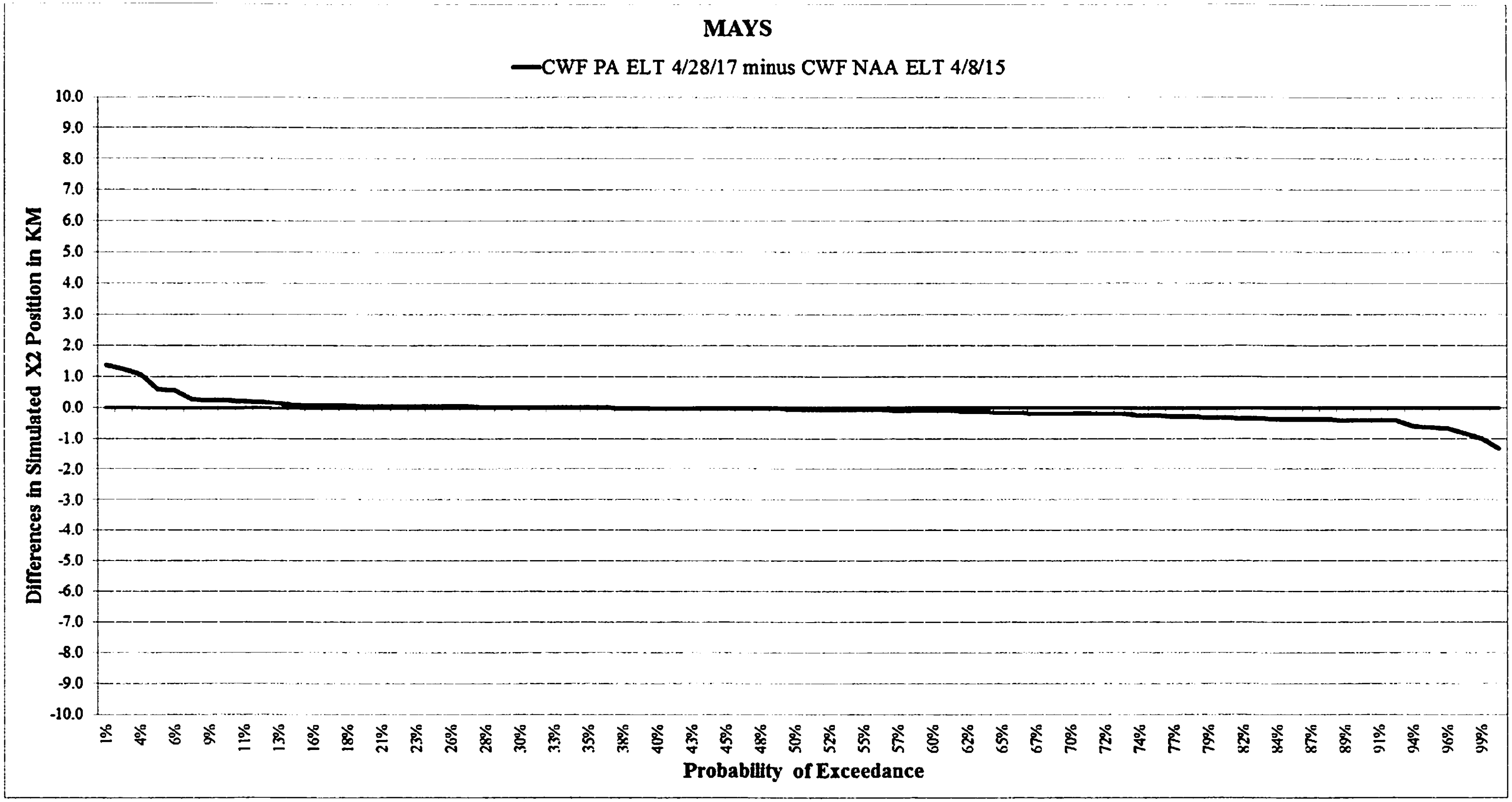
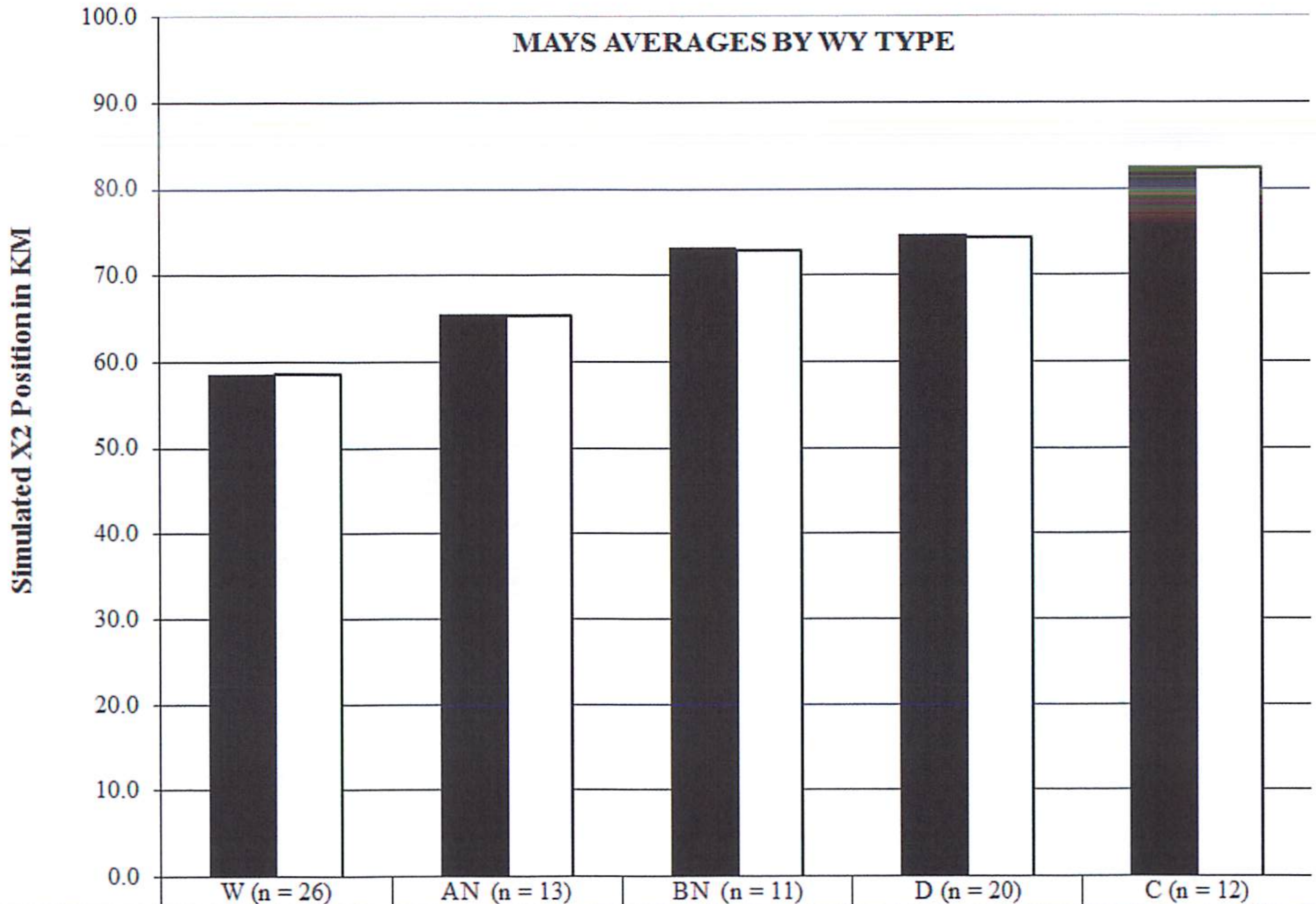


Figure B-19. Probability of exceedances of differences in simulated X2 position for all Mays based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	58.6	65.4	73.2	74.6	82.4
□ CWF PA ELT CH20170428	58.7	65.3	72.9	74.3	82.4

Figure B-20. Simulated X2 position averaged by WY type for all Mays based on 82 years of CalSim II modeling.

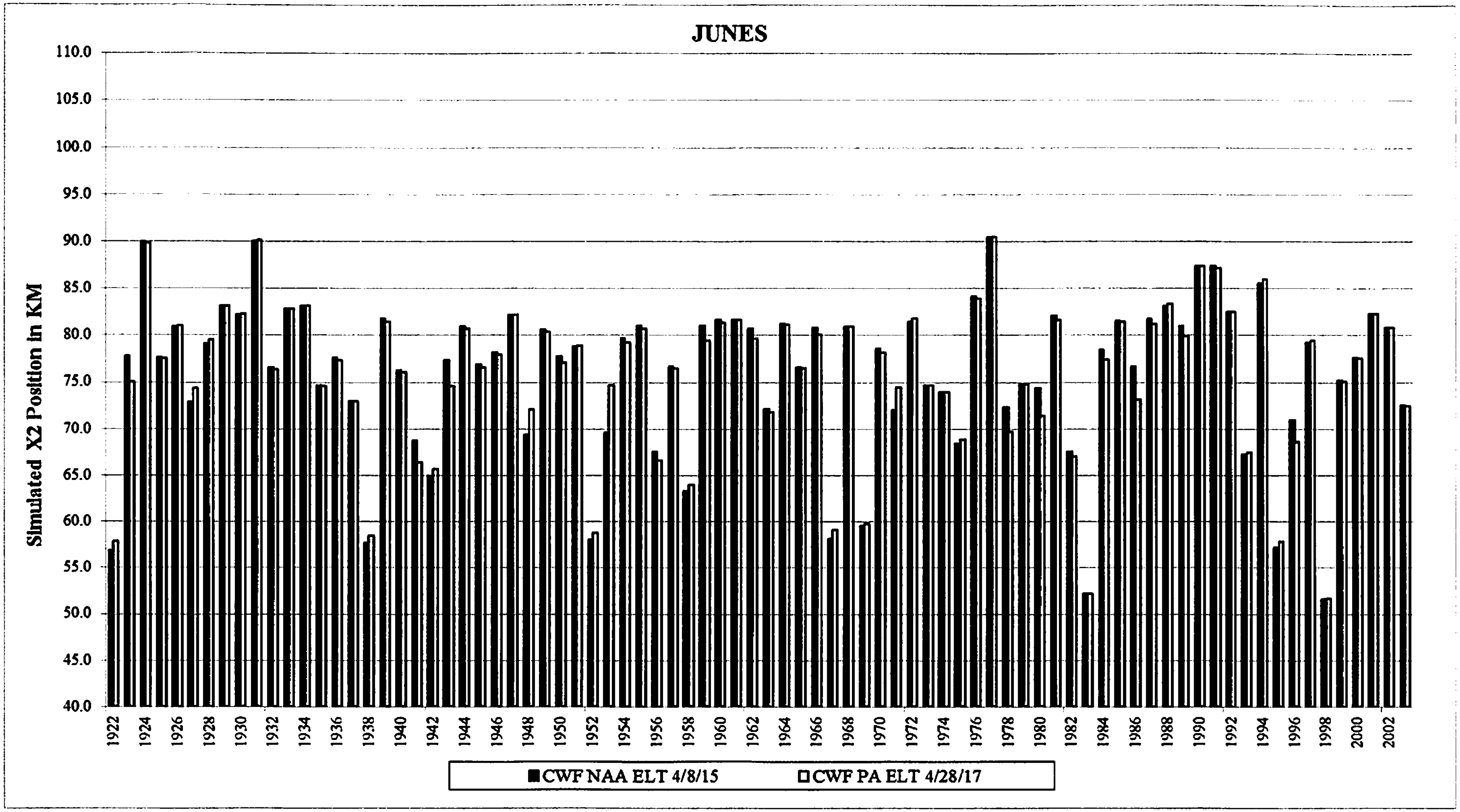


Figure B-21. 82 years of simulated X2 position in kilometers for all Junes based on 82 years of CalSim II modeling.

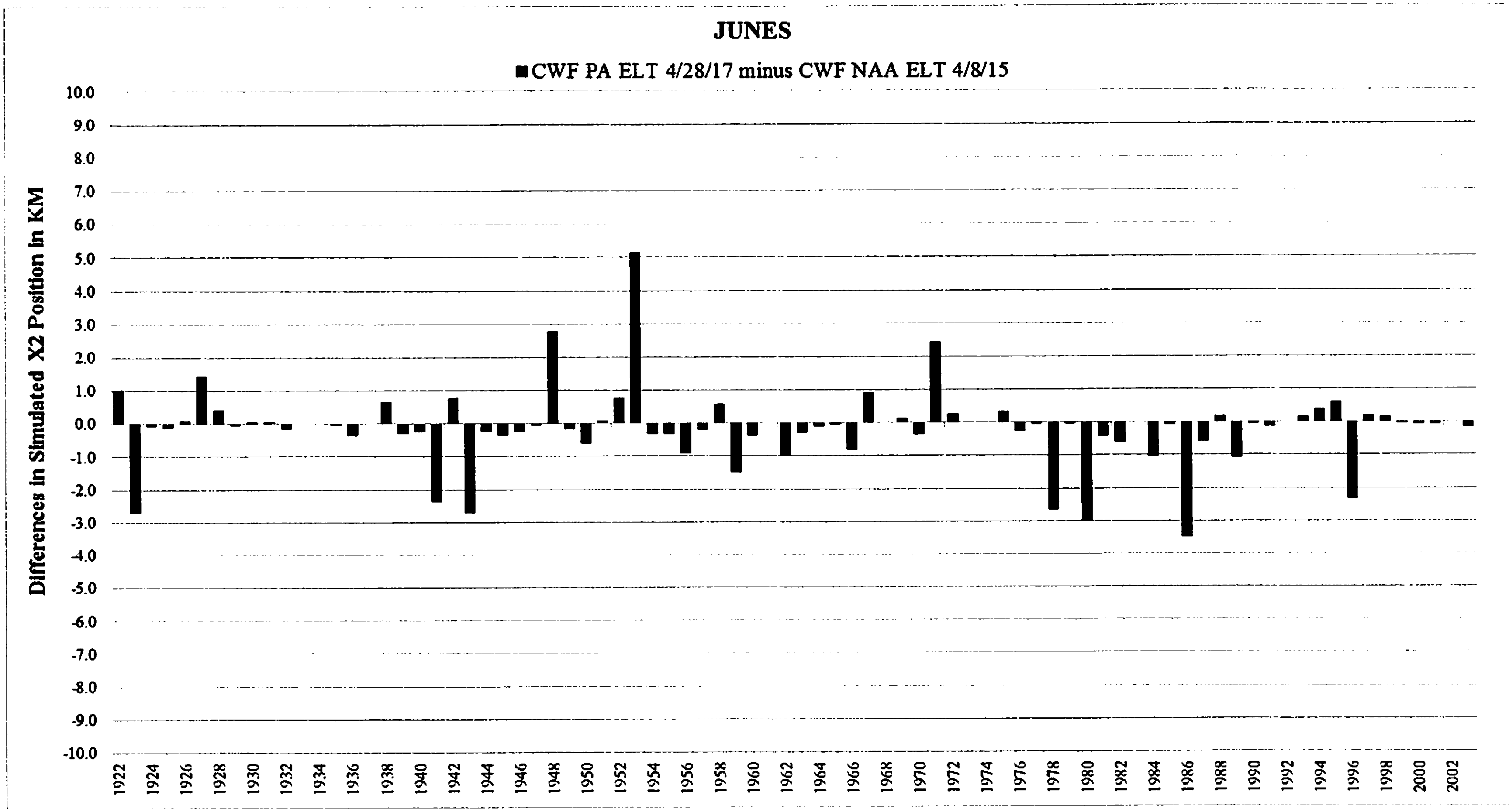


Figure B-22. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Junes based on 82 years of CalSim II modeling.

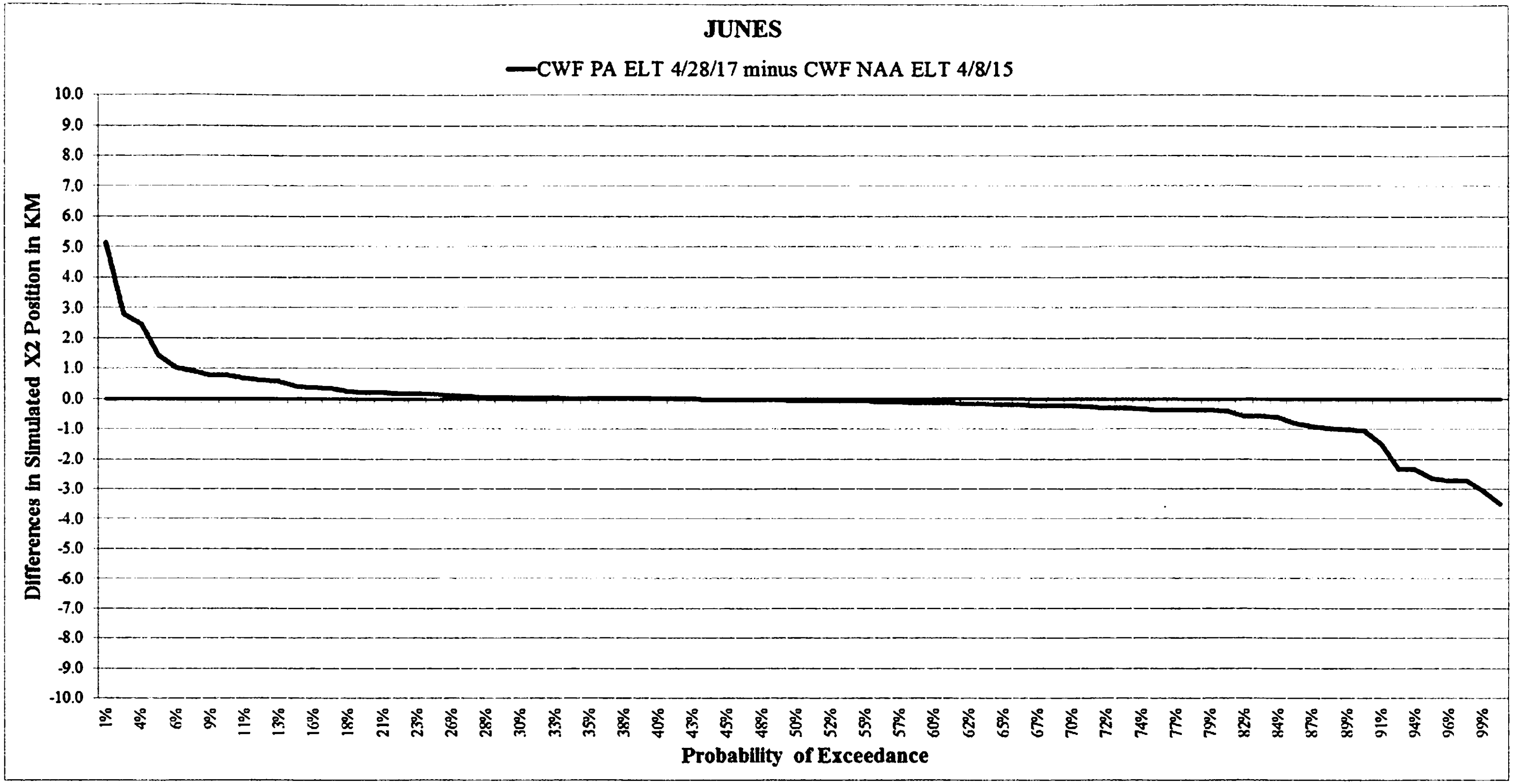
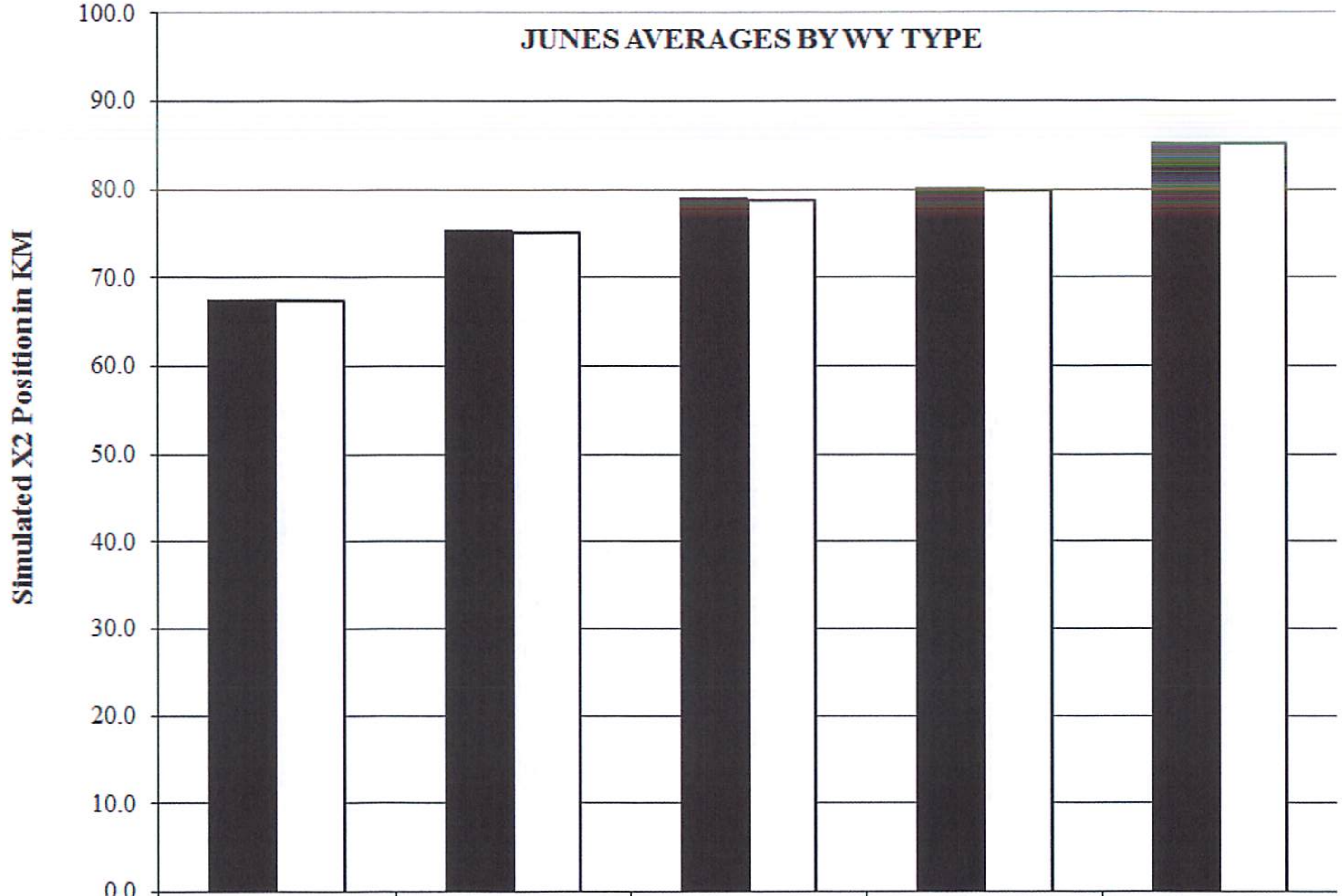


Figure B-23. Probability of exceedances of differences in simulated X2 position for all Junes based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	67.4	75.4	79.1	80.1	85.2
□ CWF PA ELT CH20170428	67.4	75.1	78.7	79.9	85.2

Figure B-24. Simulated X2 position averaged by WY type for all Junes based on 82 years of CalSim II modeling.

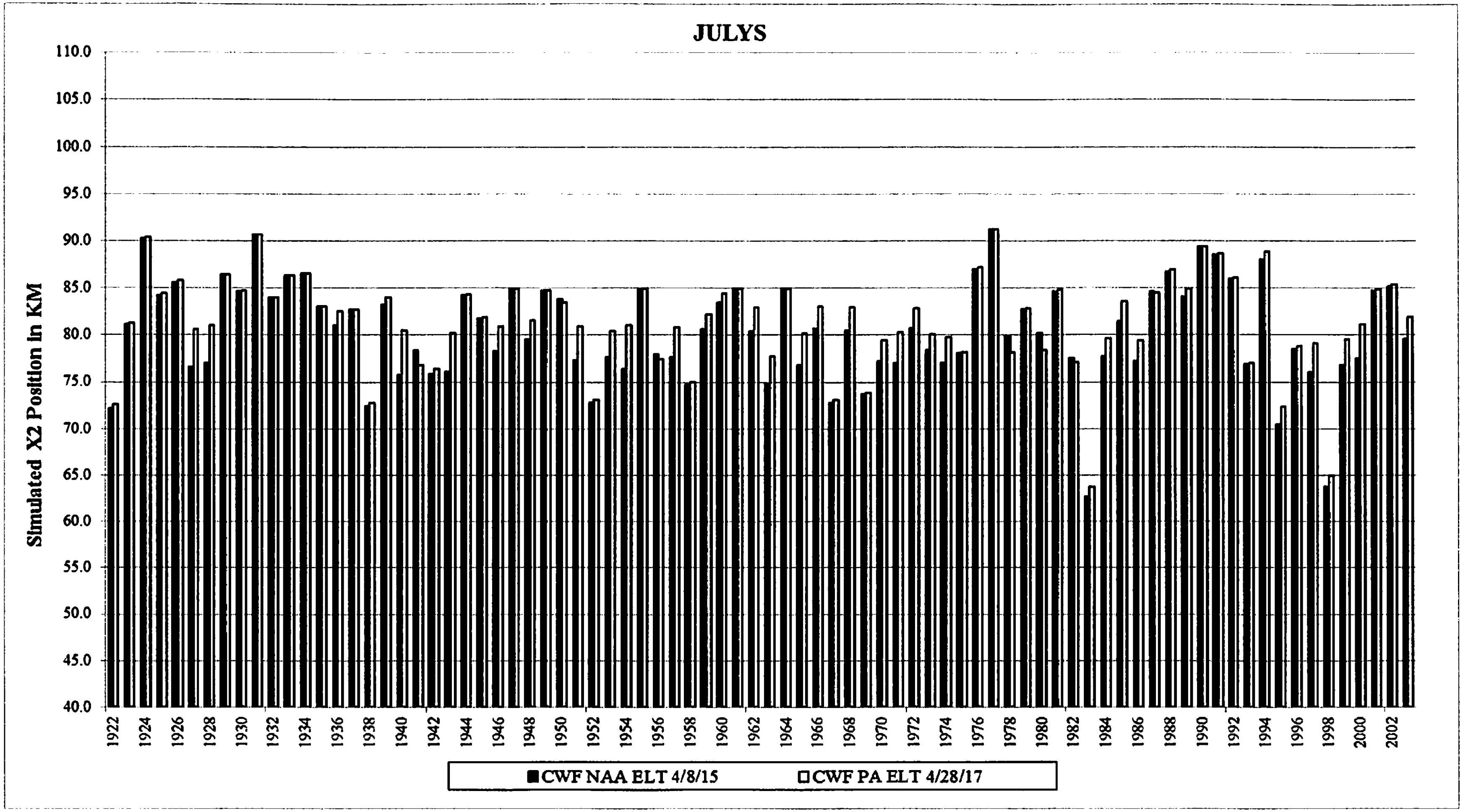


Figure B-25. 82 years of simulated X2 position in kilometers for all Julys based on 82 years of CalSim II modeling.

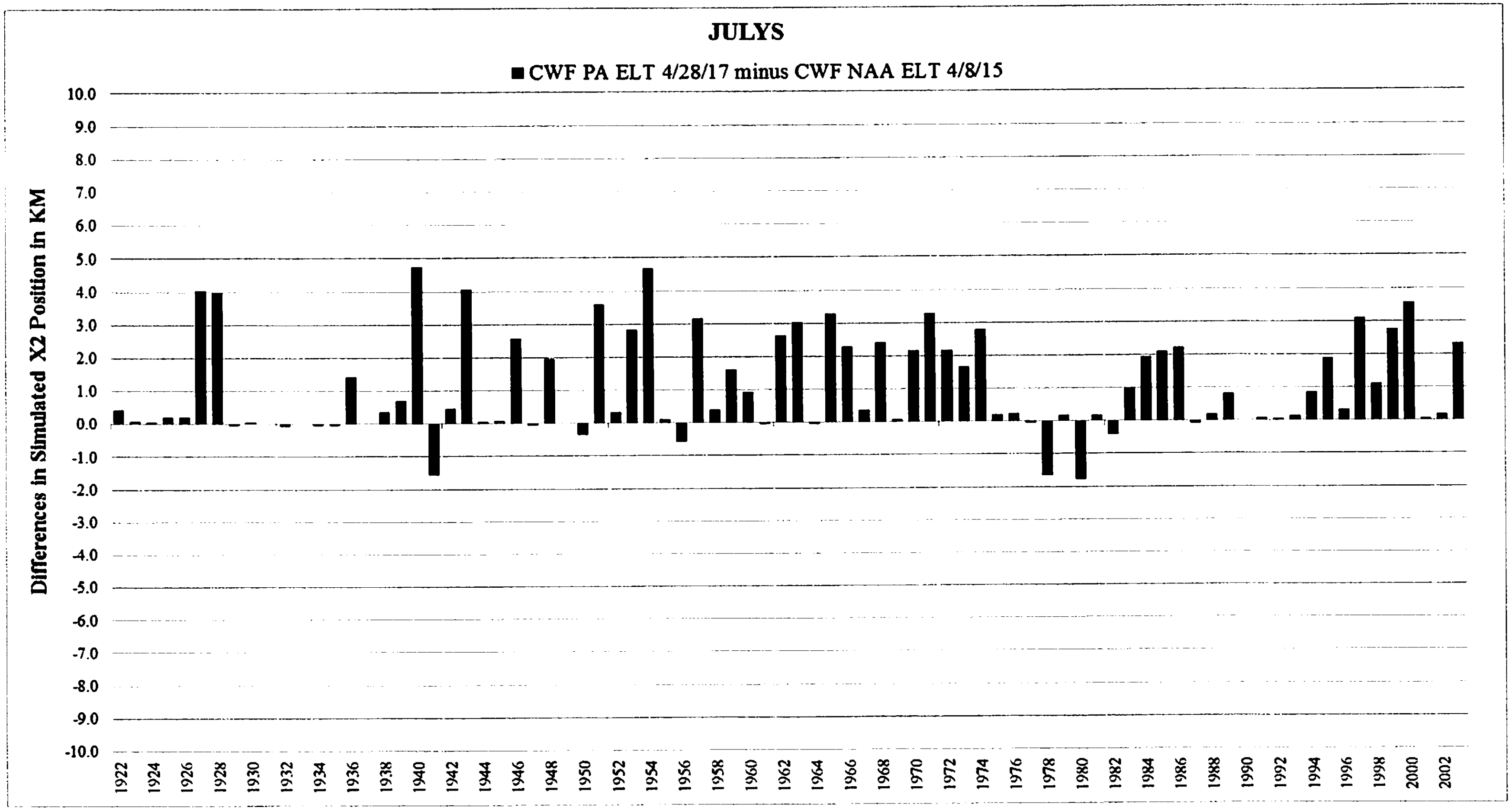


Figure B-26. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Julys based on 82 years of CalSim II modeling.

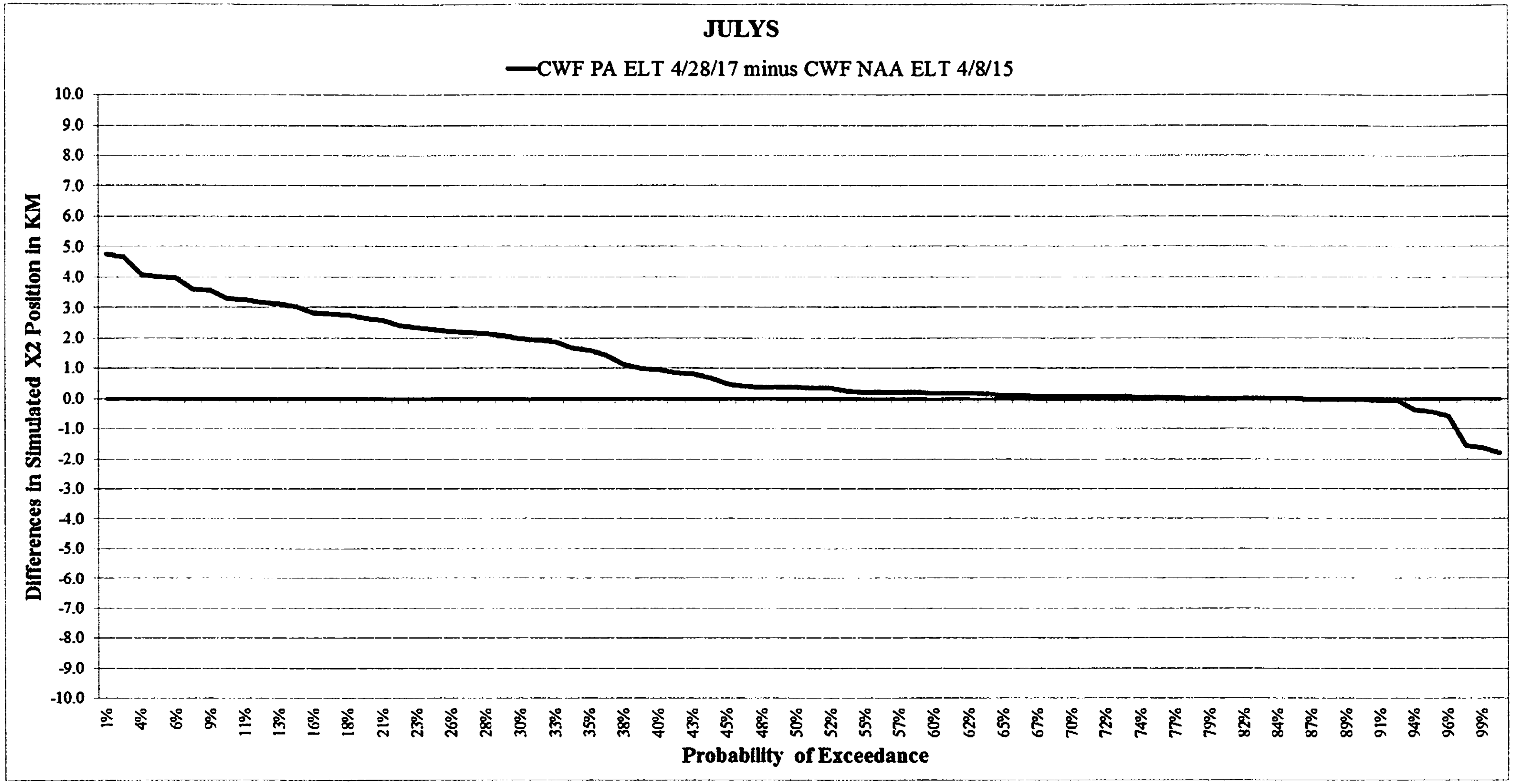
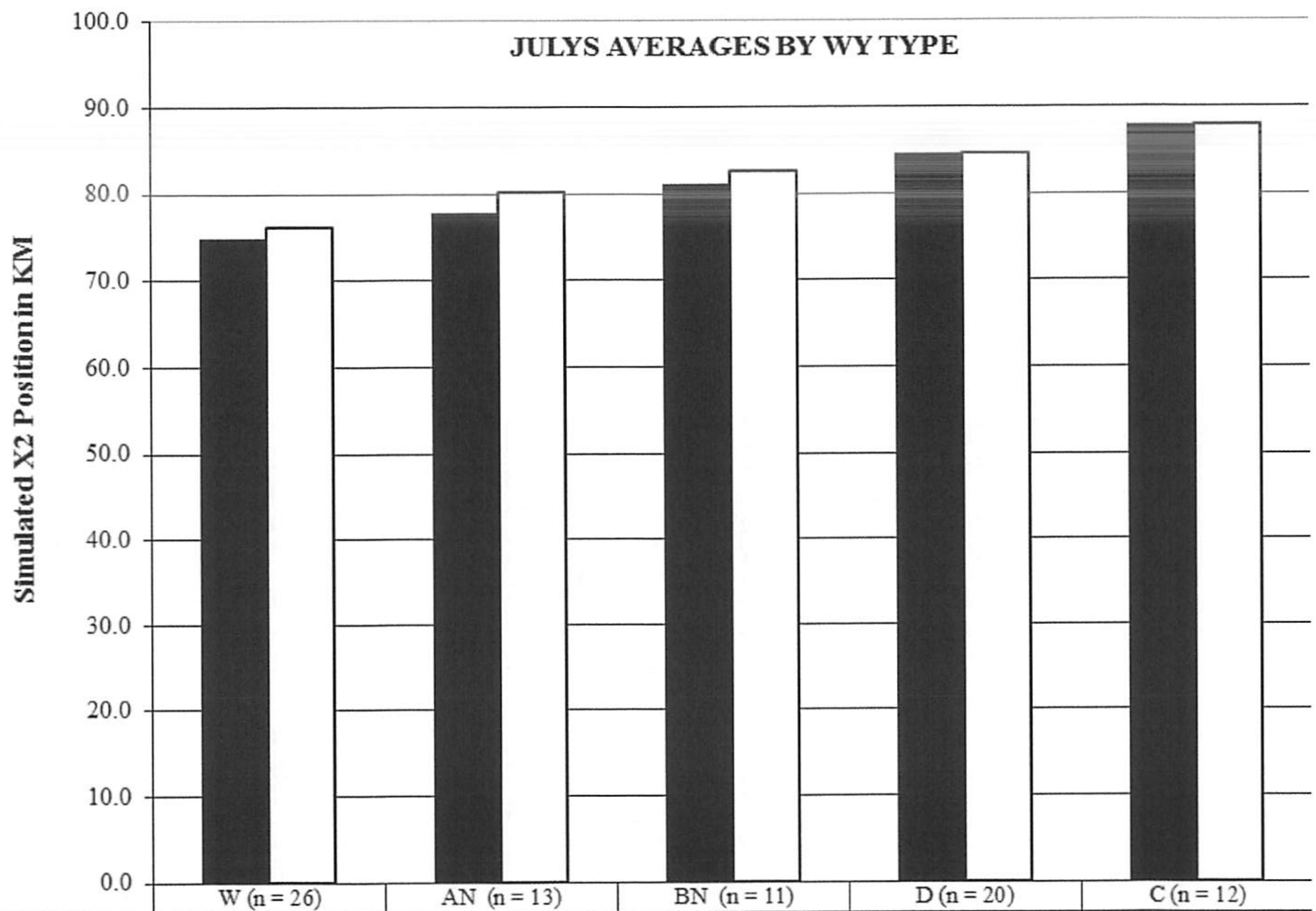


Figure B-27. Probability of exceedances of differences in simulated X2 position for all Julys based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	74.9	77.8	81.0	84.5	87.9
□ CWF PA ELT CH20170428	76.2	80.2	82.6	84.6	88.0

Figure B-28. Simulated X2 position averaged by WY type for all Julys based on 82 years of CalSim II modeling.

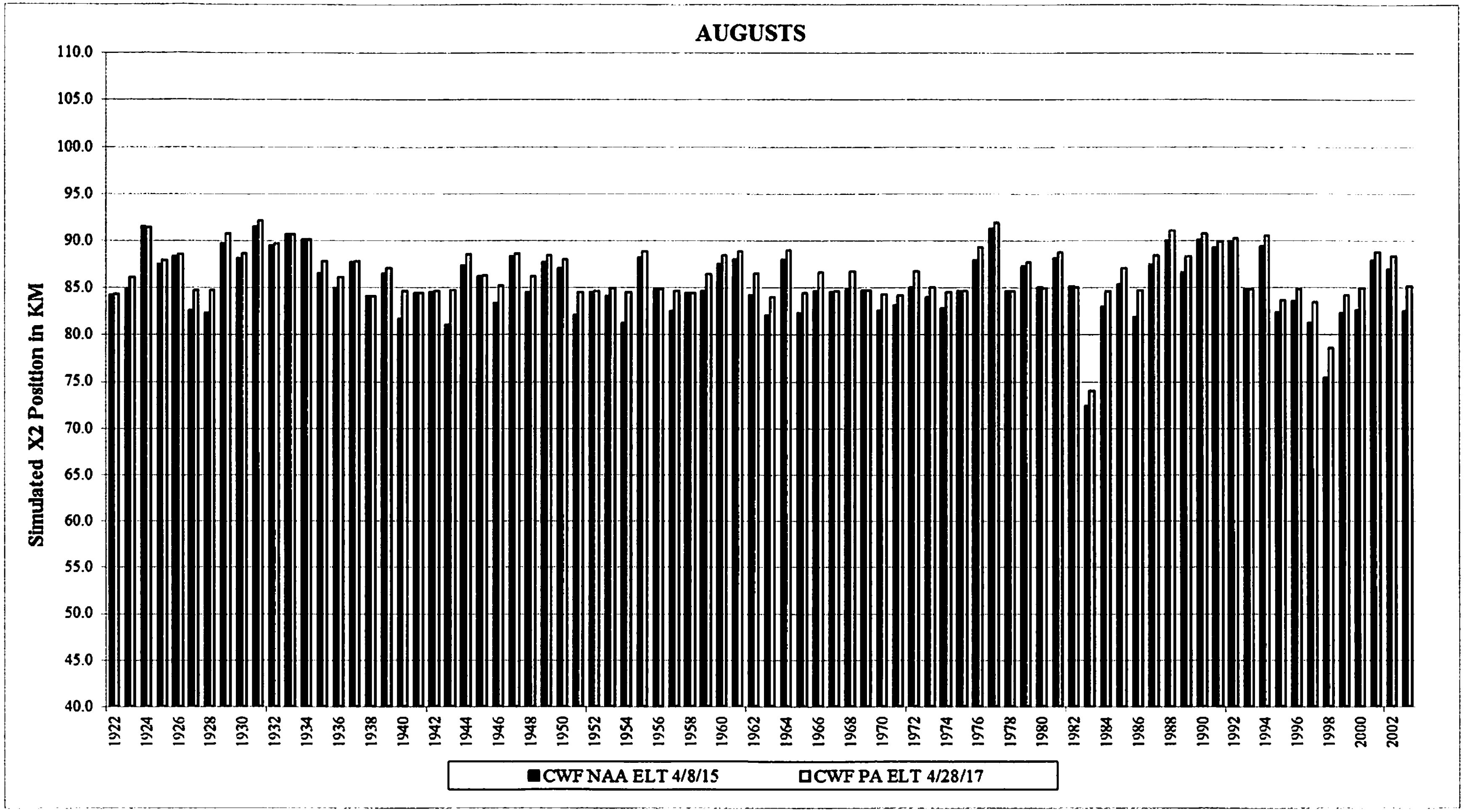


Figure B-29. 82 years of simulated X2 position in kilometers for all Augusts based on 82 years of CalSim II modeling.

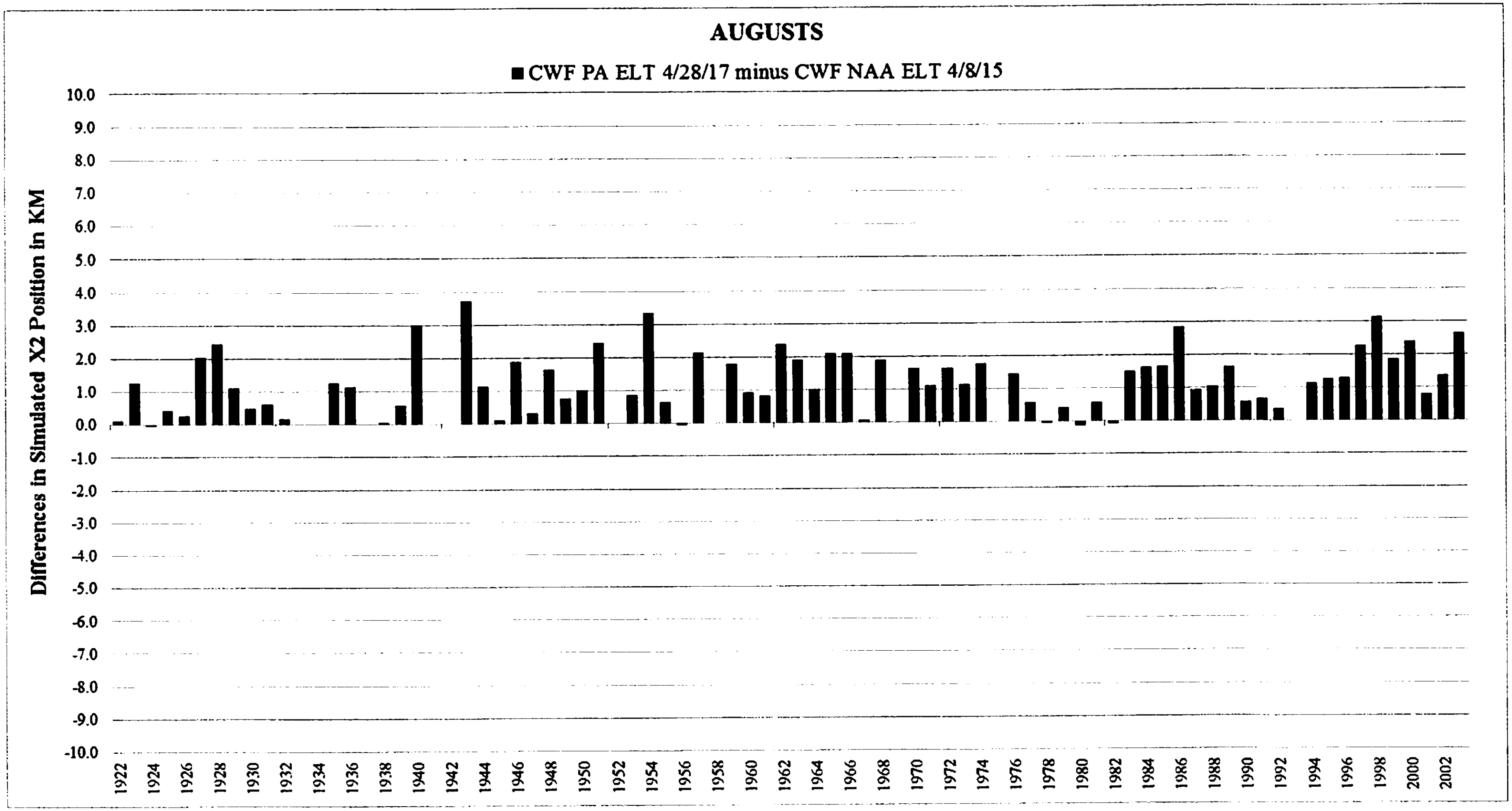


Figure B-30. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Augusts based on 82 years of CalSim II modeling.

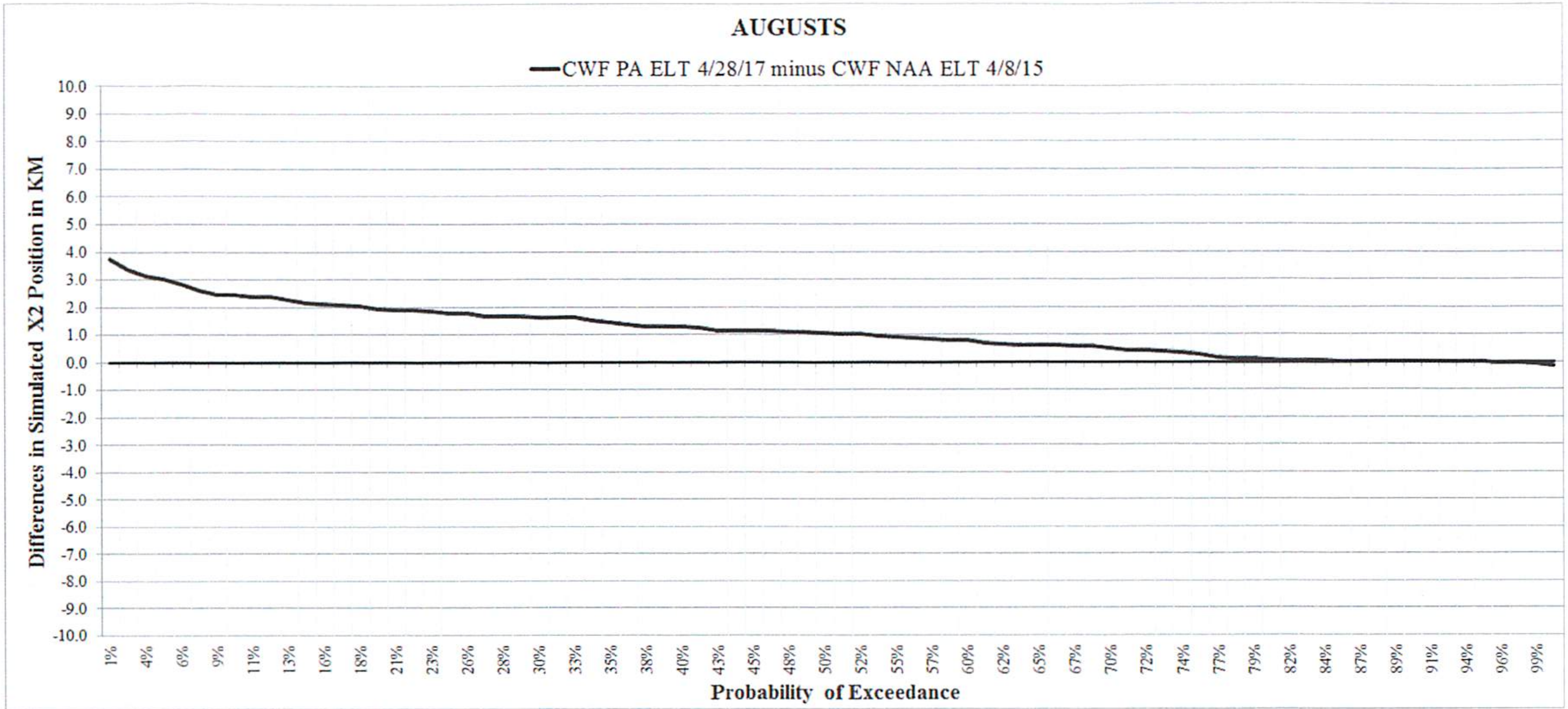
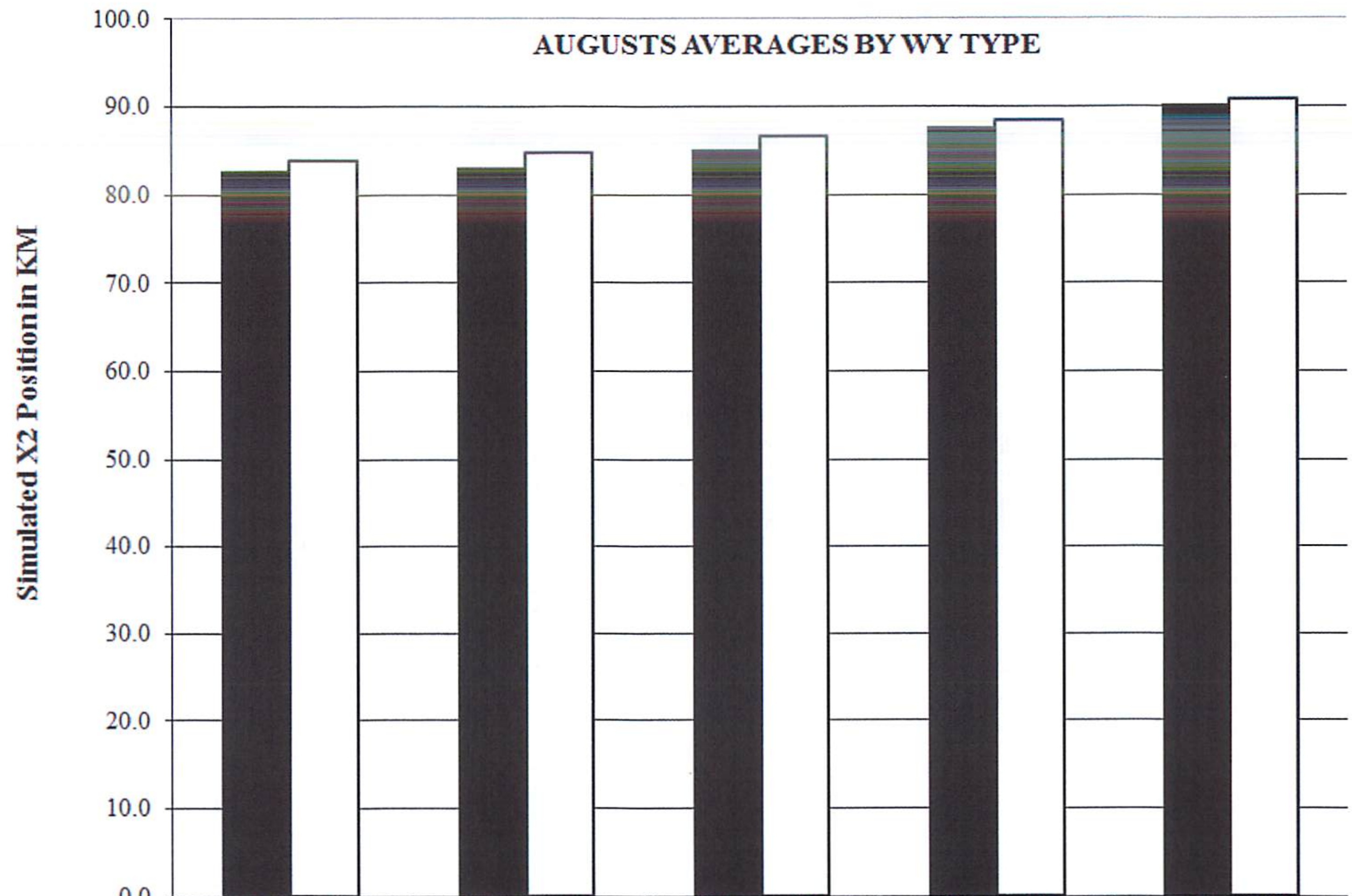


Figure B-31. Probability of exceedances of differences in simulated X2 position for all Augusts based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	82.7	83.0	85.1	87.7	90.3
□ CWF PA ELT CH20170428	83.9	84.8	86.6	88.5	90.8

Figure B-32. Simulated X2 position averaged by WY type for all Augusts based on 82 years of CalSim II modeling.

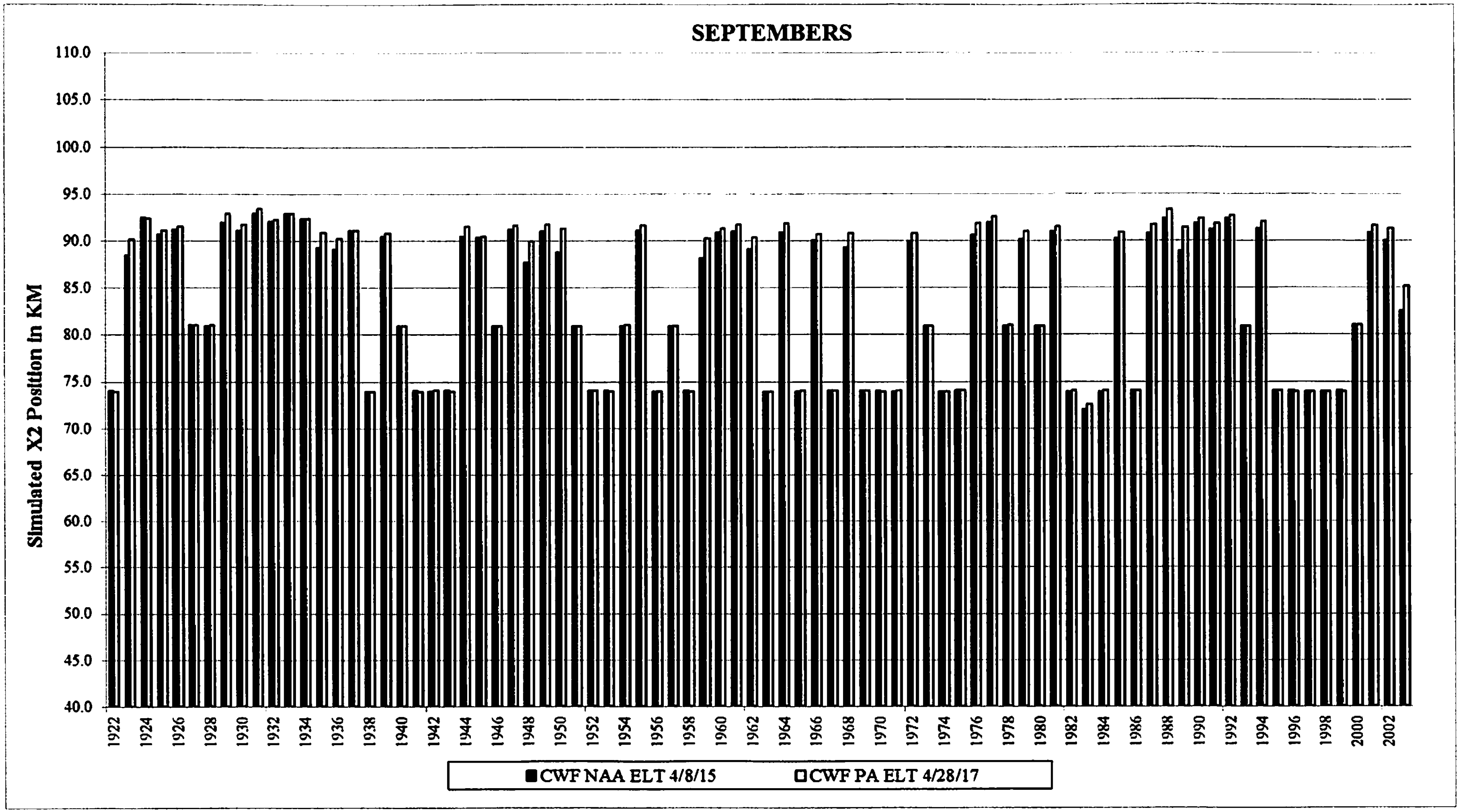


Figure B-33. 82 years of simulated X2 position in kilometers for all Septembers based on 82 years of CalSim II modeling.

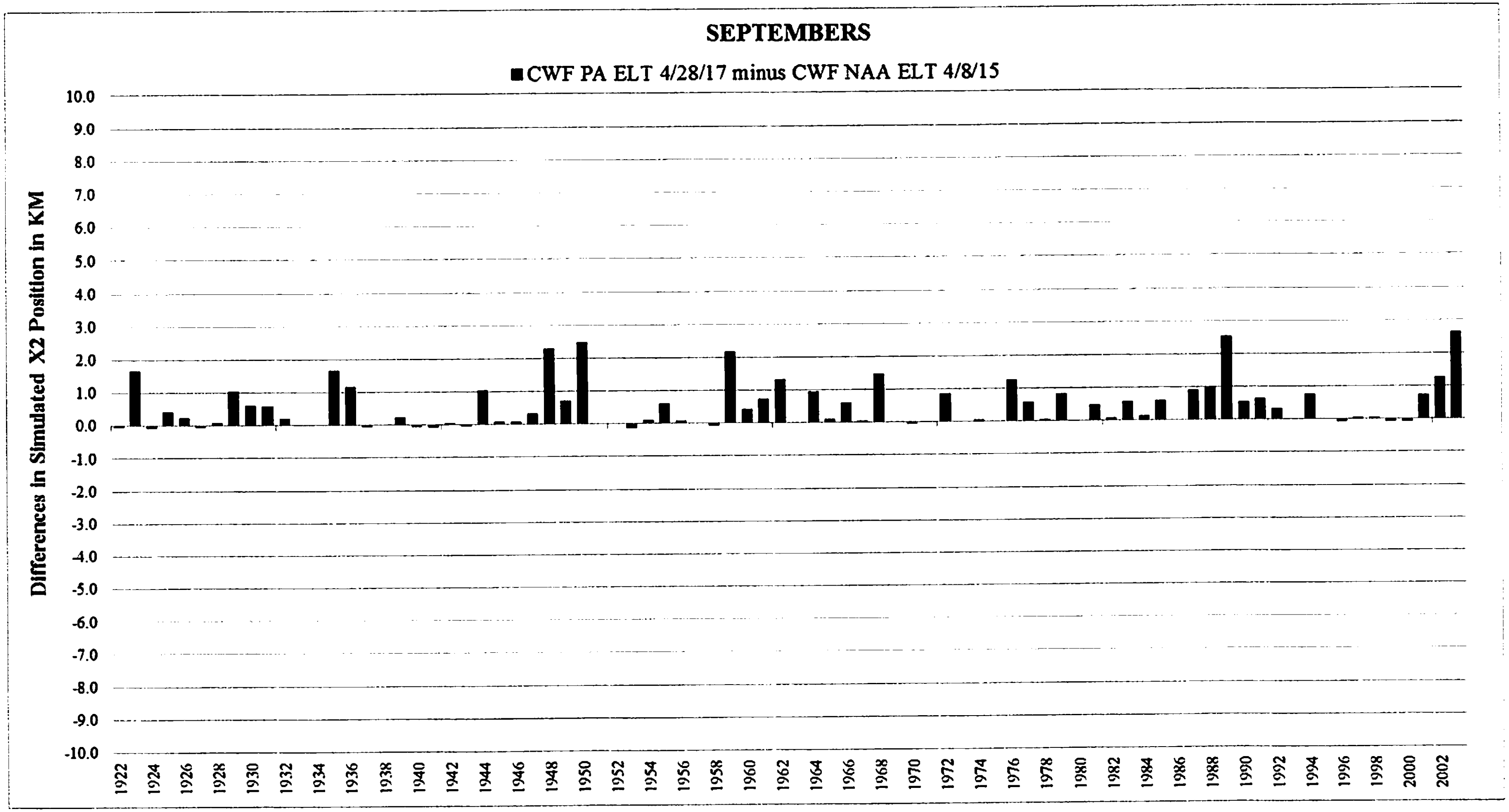


Figure B-34. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Septembers based on 82 years of CalSim II modeling.

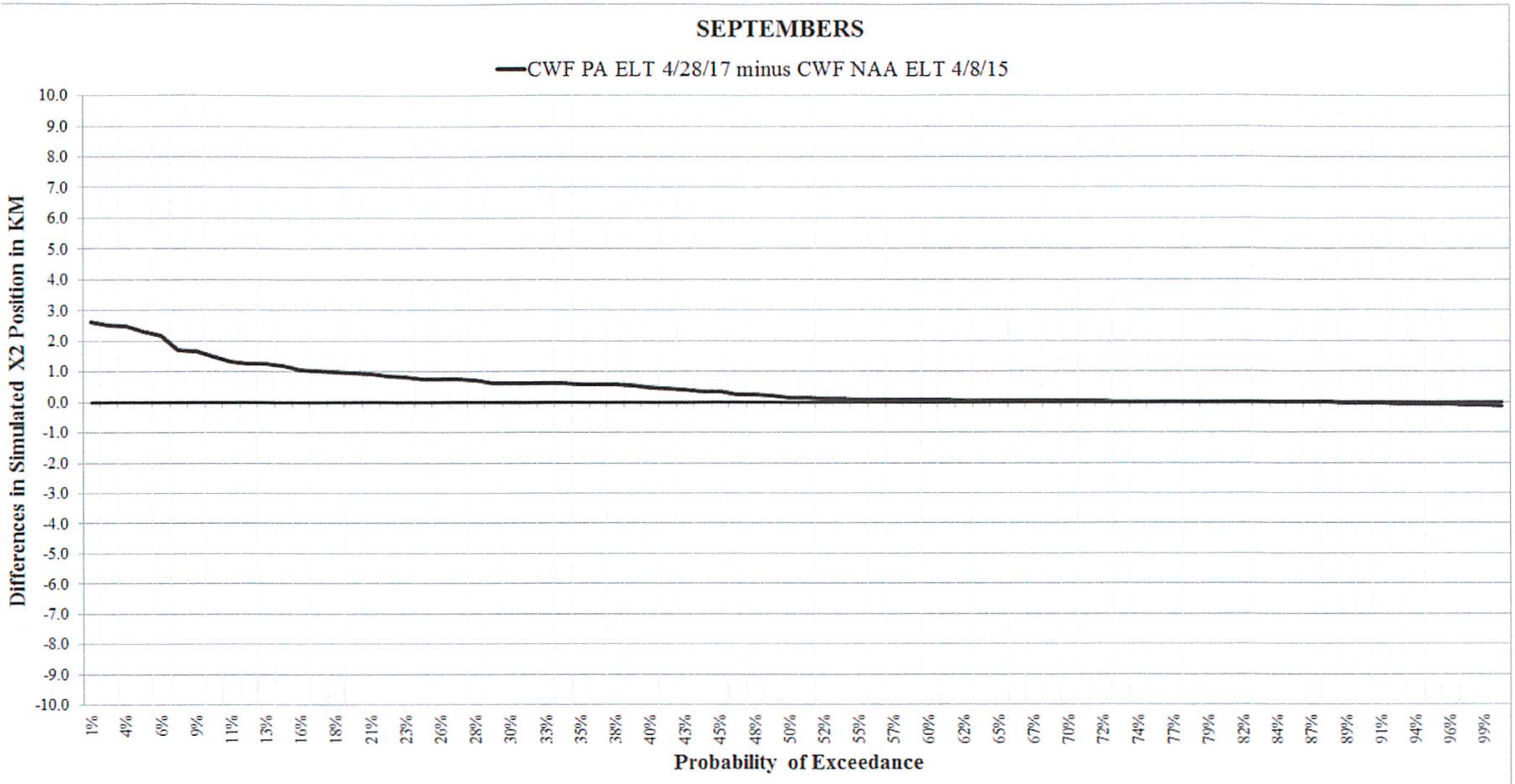
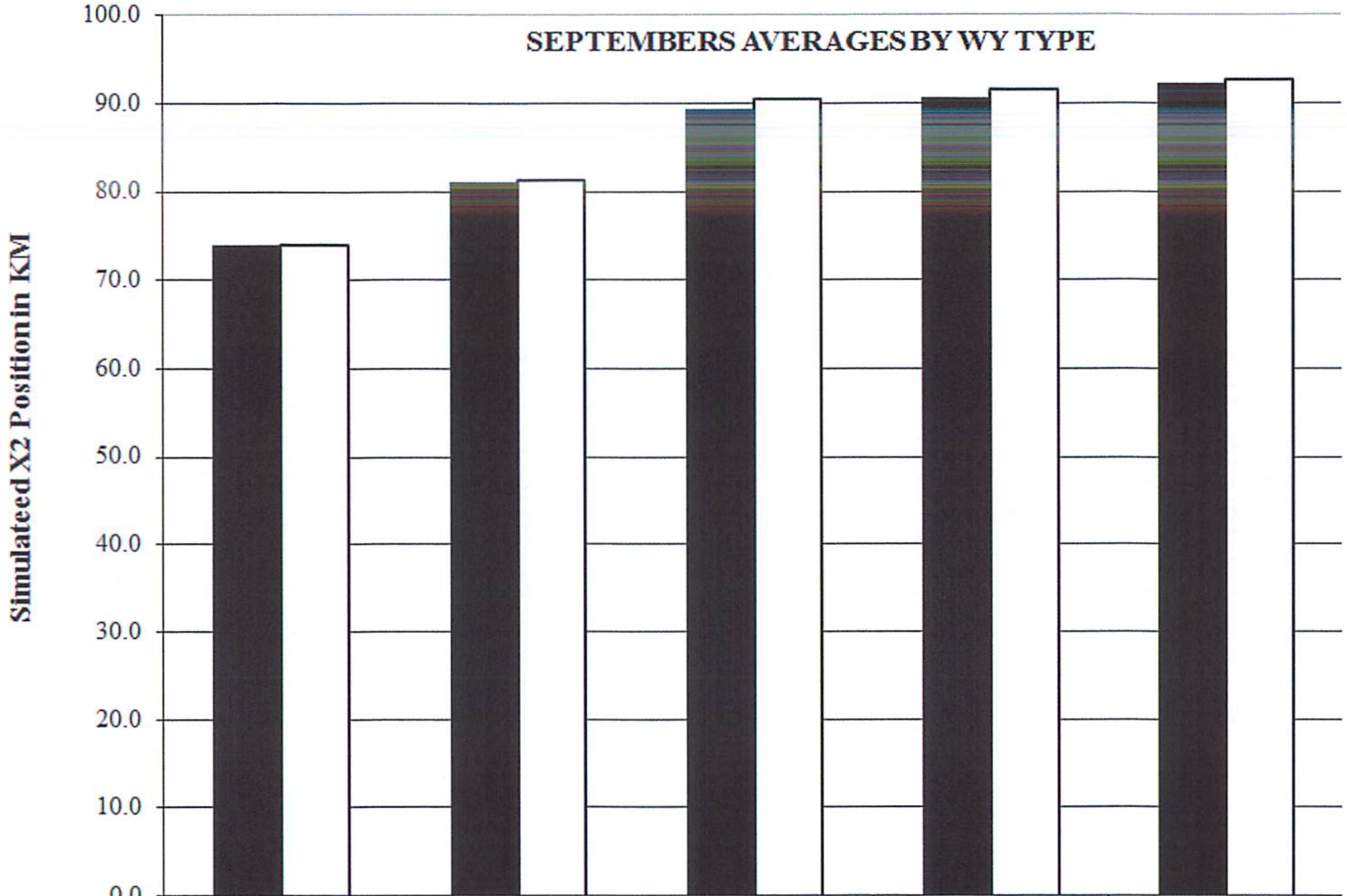


Figure B-35. Probability of exceedances of differences in simulated X2 position for all Septembers based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	73.9	81.1	89.4	90.6	92.1
□ CWF PA ELT CH20170428	74.0	81.3	90.5	91.5	92.6

Figure B-36. Simulated X2 position averaged by WY type for all Septembers based on 82 years of CalSim II modeling.

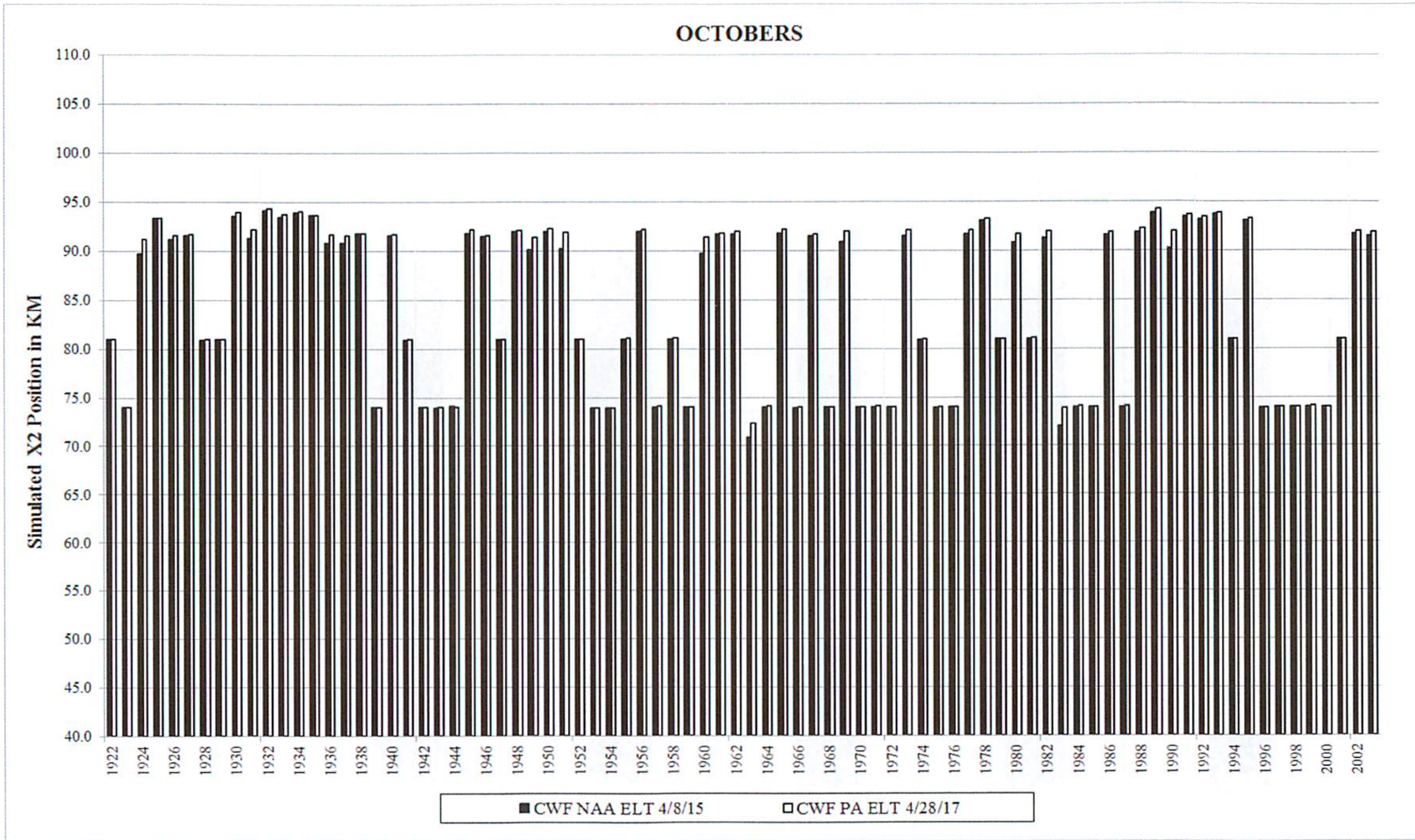


Figure B-37. 82 years of simulated X2 position in kilometers for all Octobers based on 82 years of CalSim II modeling.

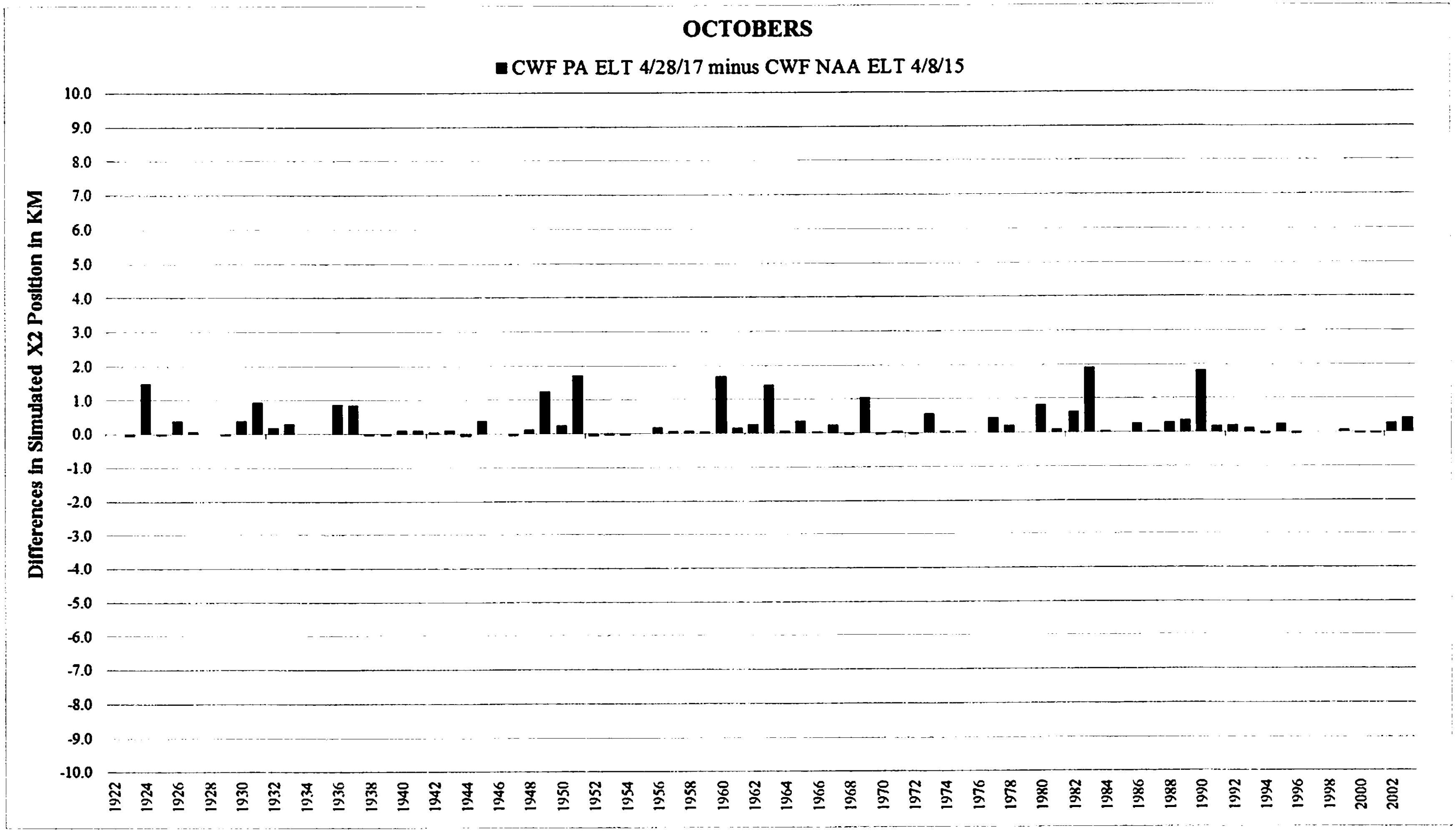


Figure B-38. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Octobers based on 82 years of CalSim II modeling.

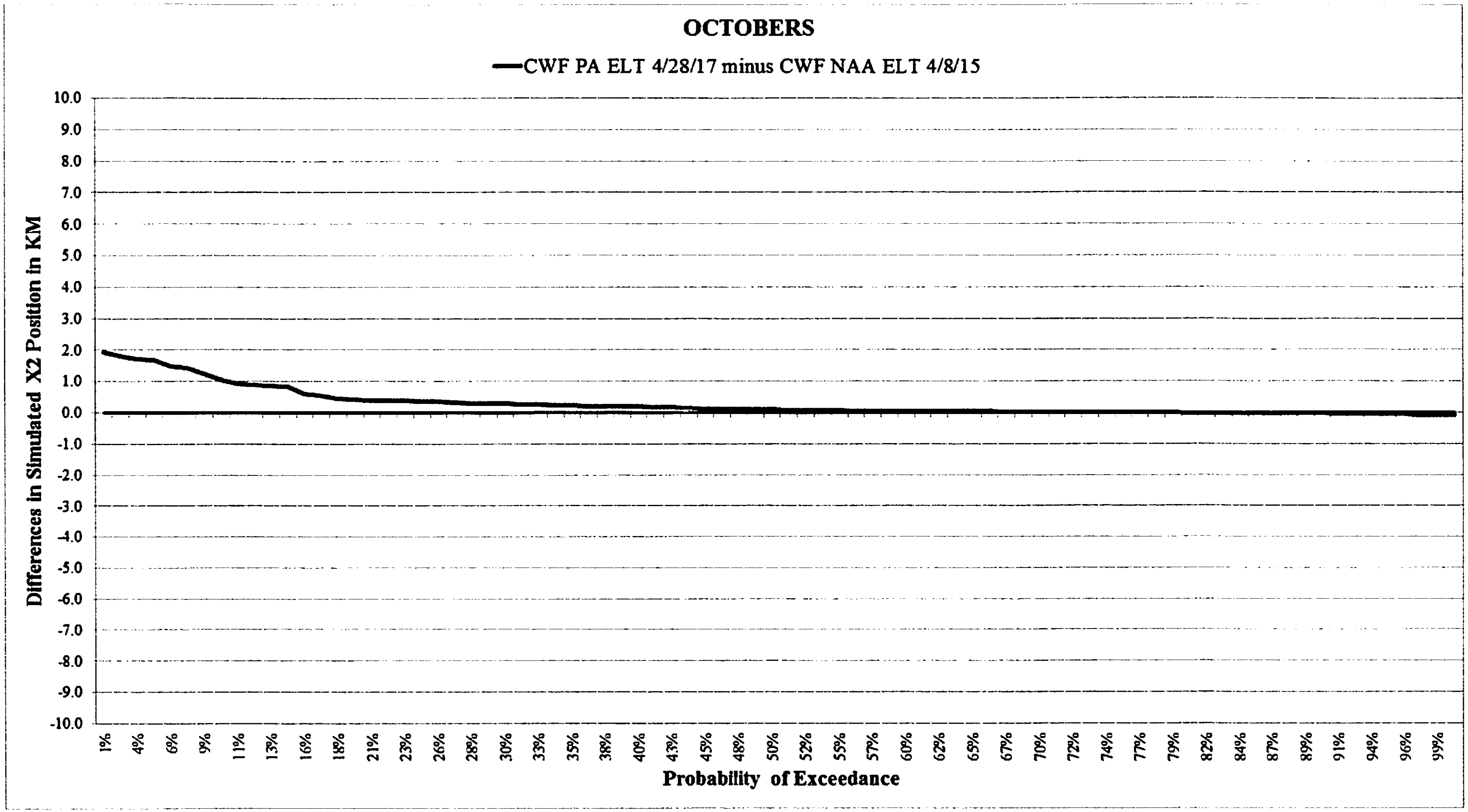
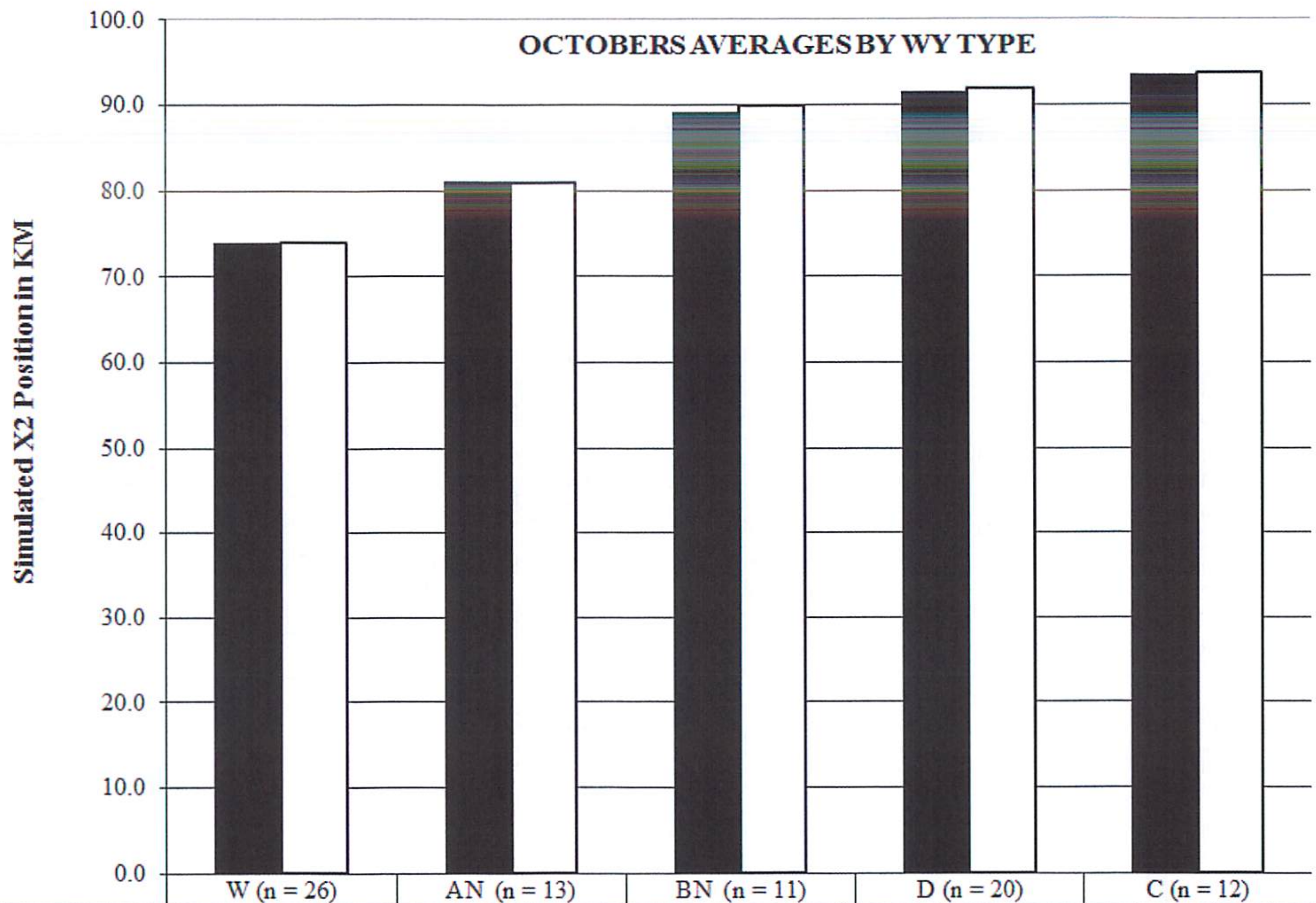


Figure B-39. Probability of exceedances of differences in simulated X2 position for all Octobers based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	73.9	81.0	89.1	91.5	93.6
□ CWF PA ELT CH20170428	74.0	81.0	89.9	92.0	93.7

Figure B-40. Simulated X2 position averaged by WY type for all Octobers based on 82 years of CalSim II modeling.

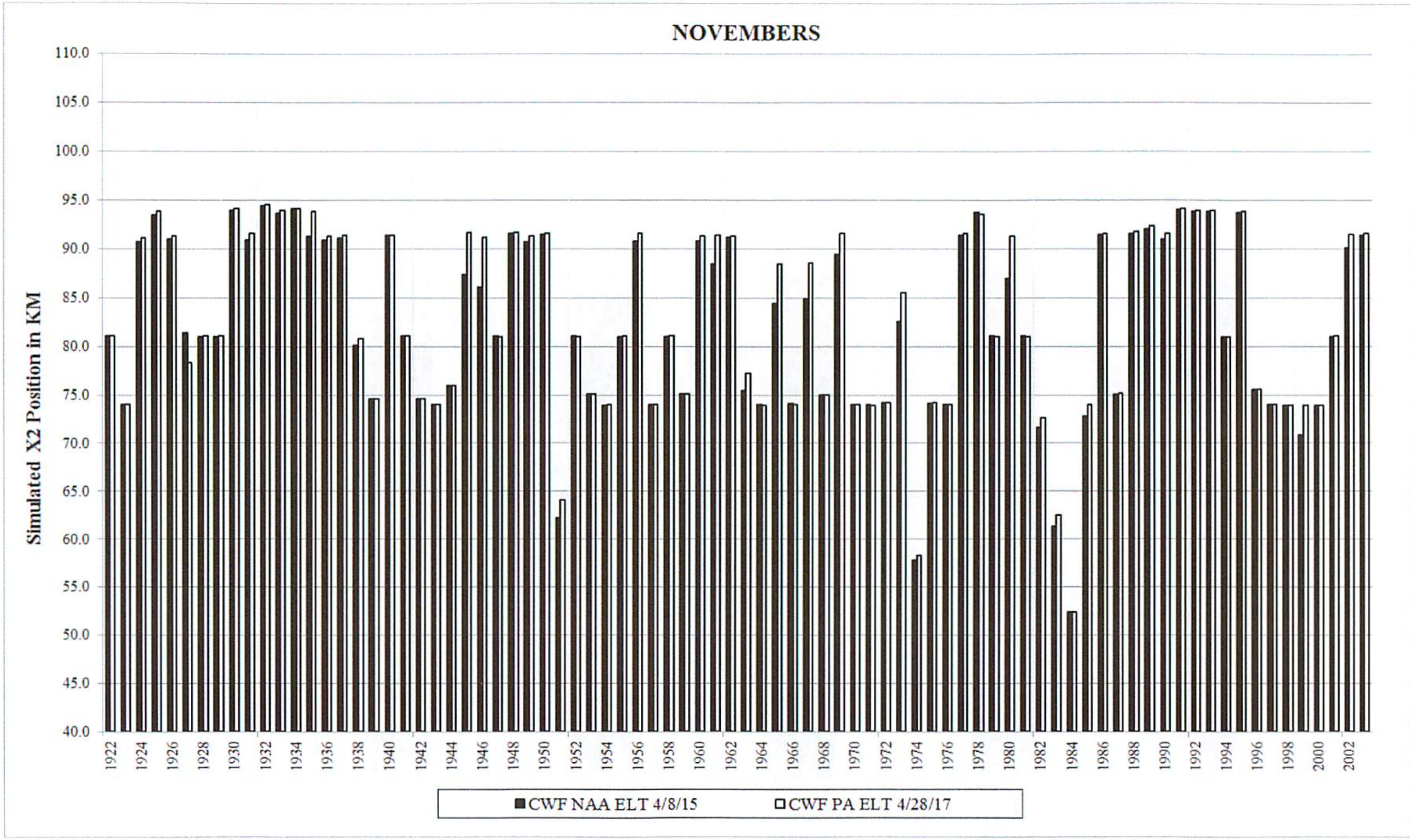


Figure B-41. 82 years of simulated X2 position in kilometers for all Novembers based on 82 years of CalSim II modeling.

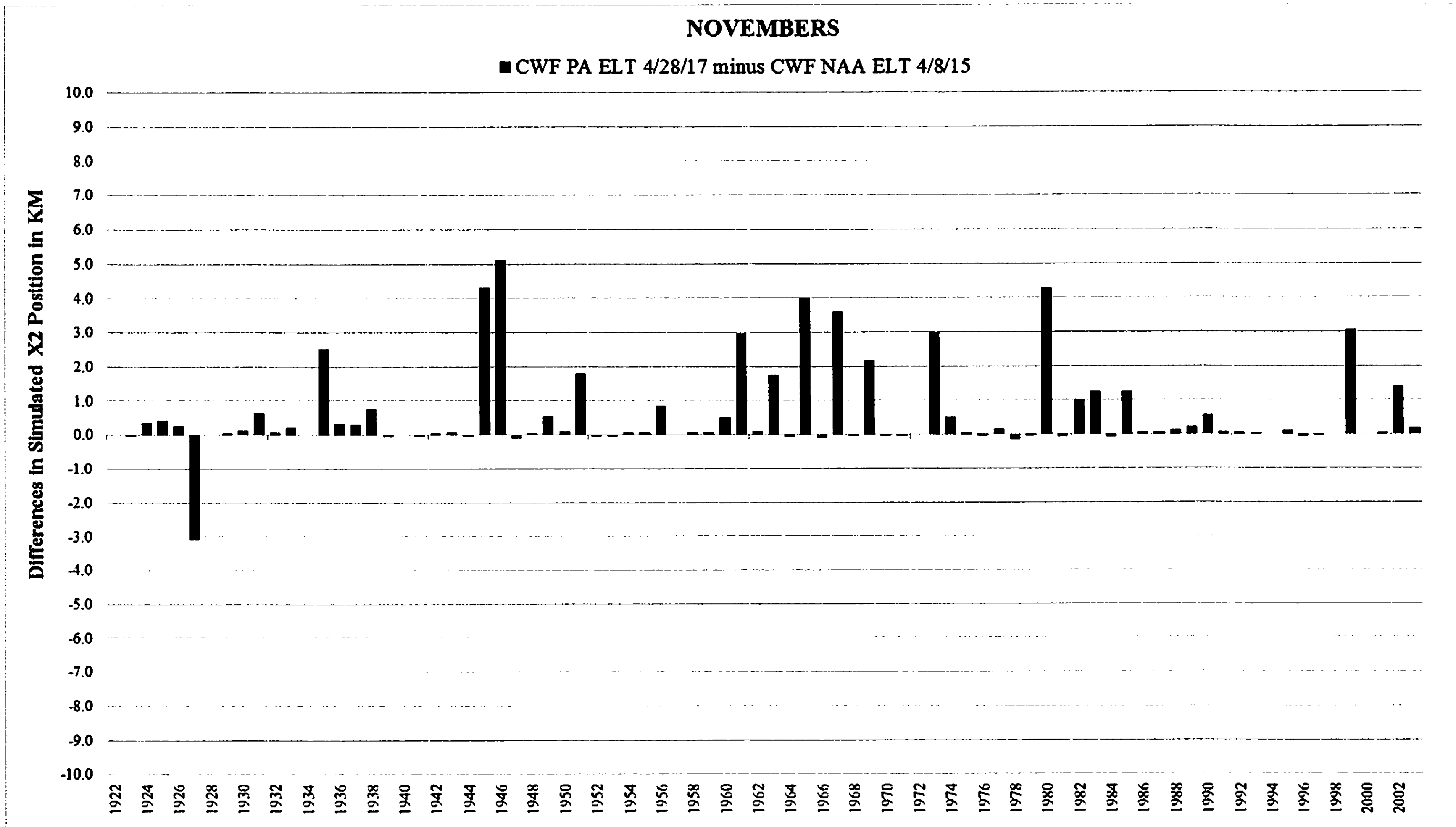


Figure B-42. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Novembers based on 82 years of CalSim II modeling.

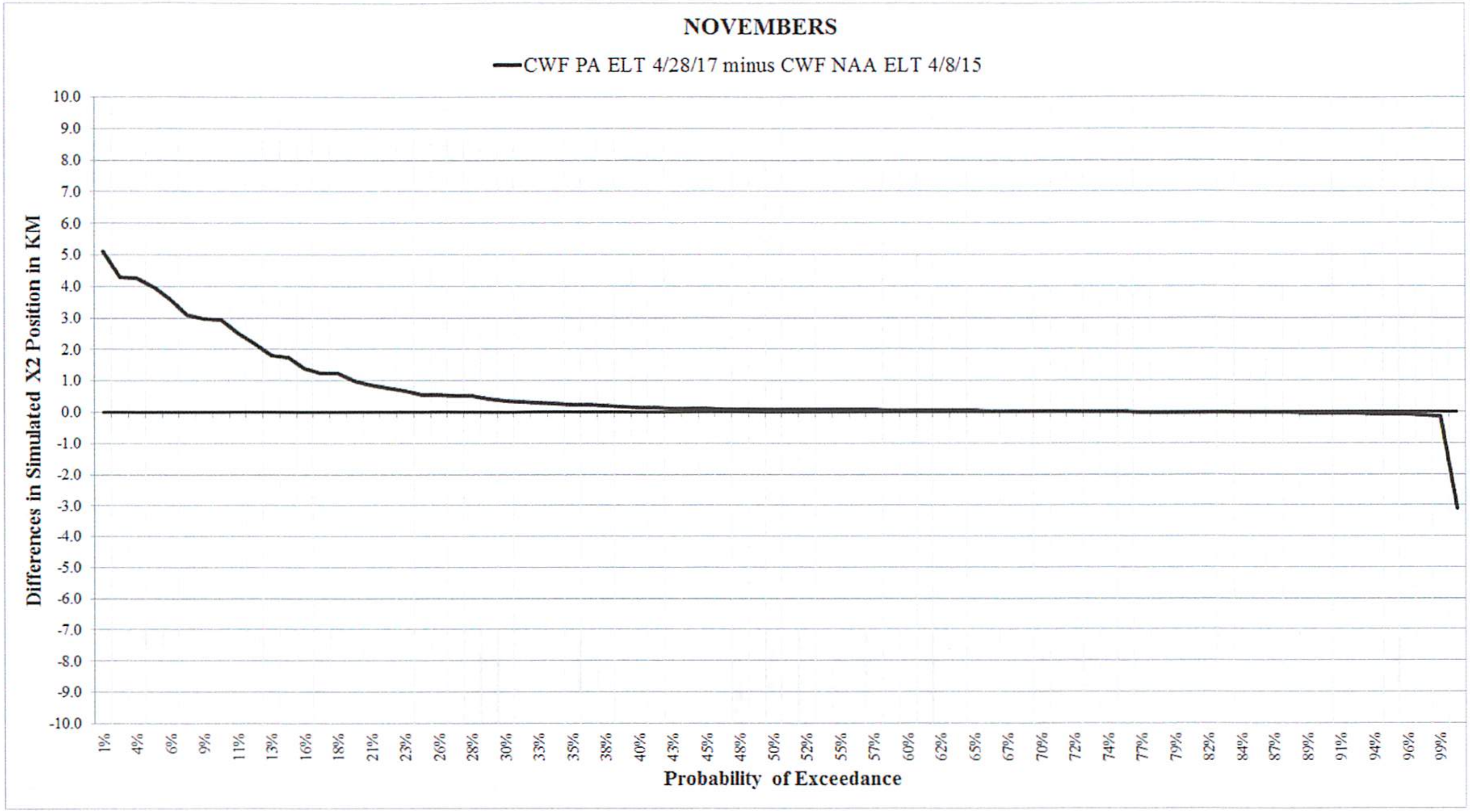
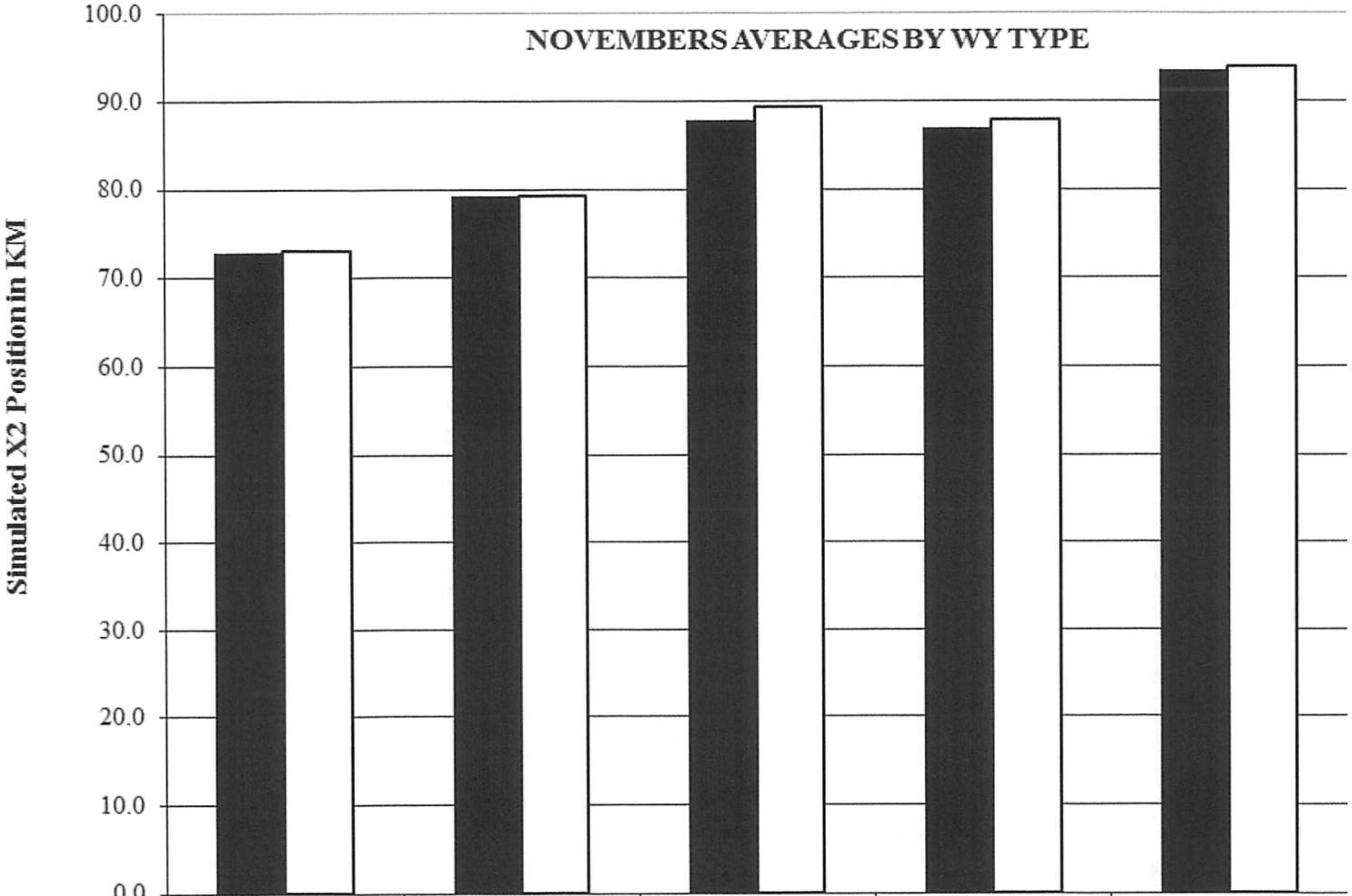


Figure B-43. Probability of exceedances of differences in simulated X2 position for all Novembers based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	72.9	79.3	87.7	86.8	93.5
□ CWF PA ELT CH20170428	73.1	79.3	89.3	87.9	93.9

Figure B-44. Simulated X2 position averaged by WY type for all Novembers based on 82 years of CalSim II modeling.

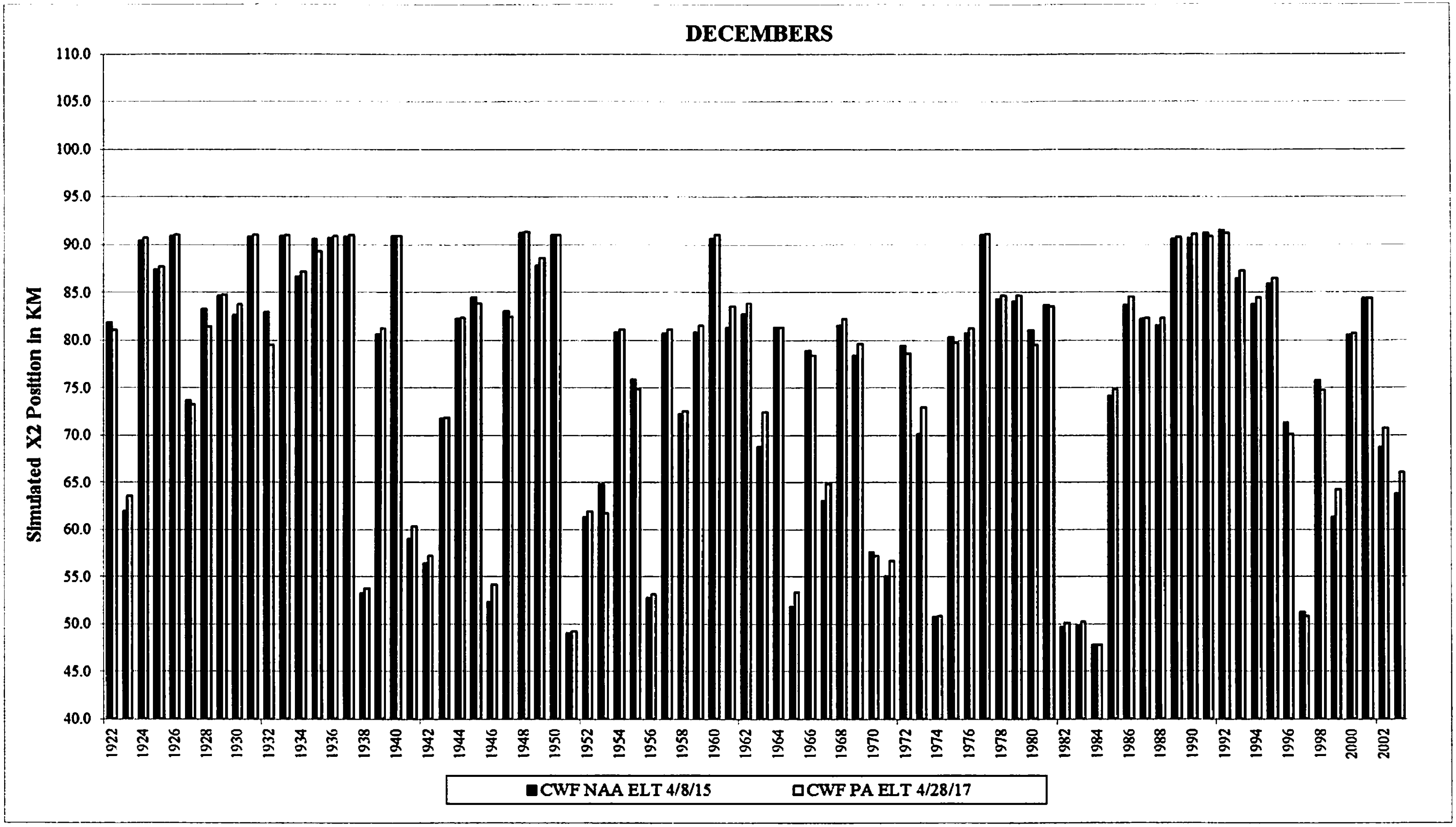


Figure B-45. 82 years of simulated X2 position in kilometers for all Decembers based on 82 years of CalSim II modeling.

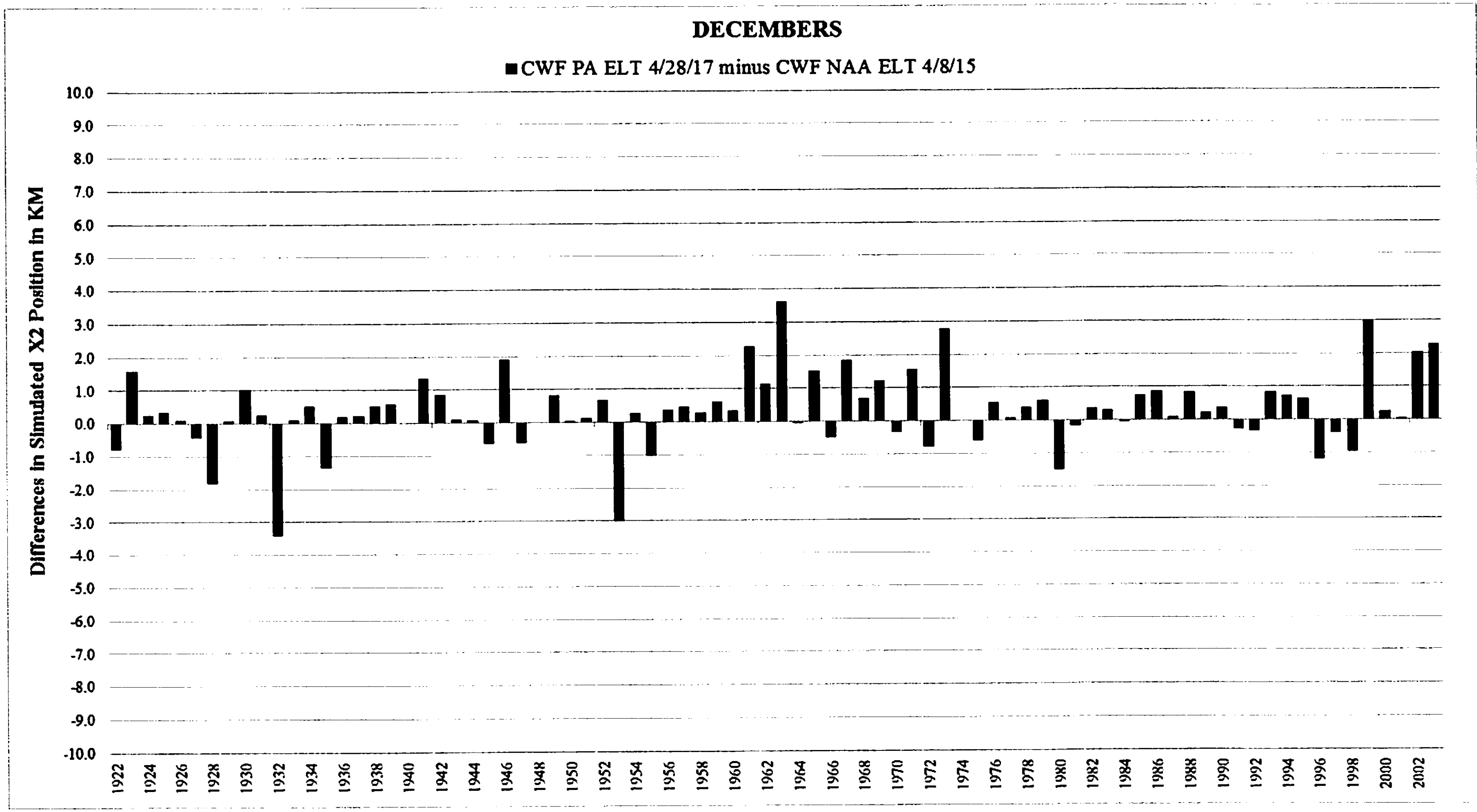


Figure B-46. Difference in the position of X2 in kilometer between the PA and the current projected baseline conditions (NAA) for all Decembers based on 82 years of CalSim II modeling.

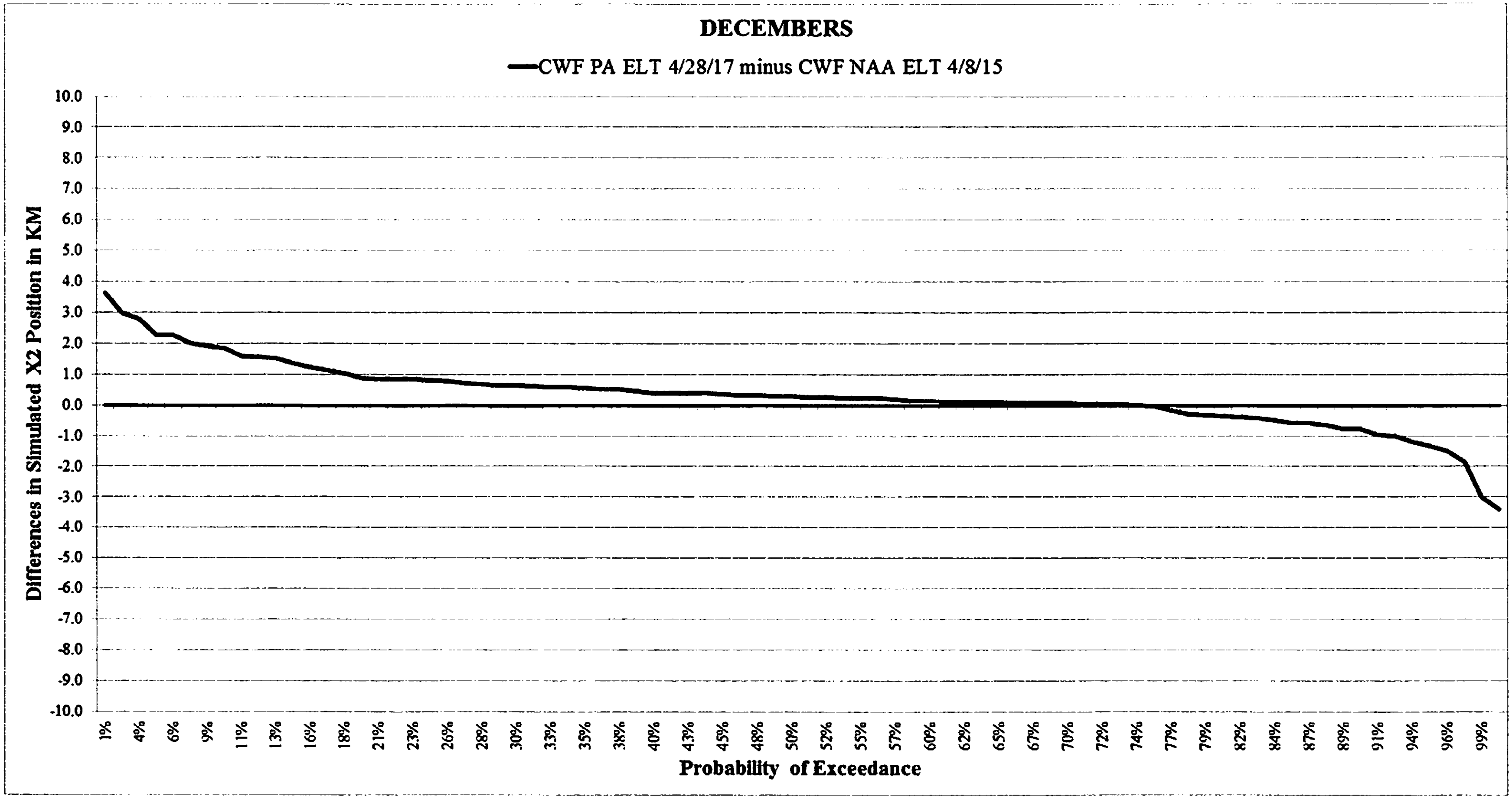
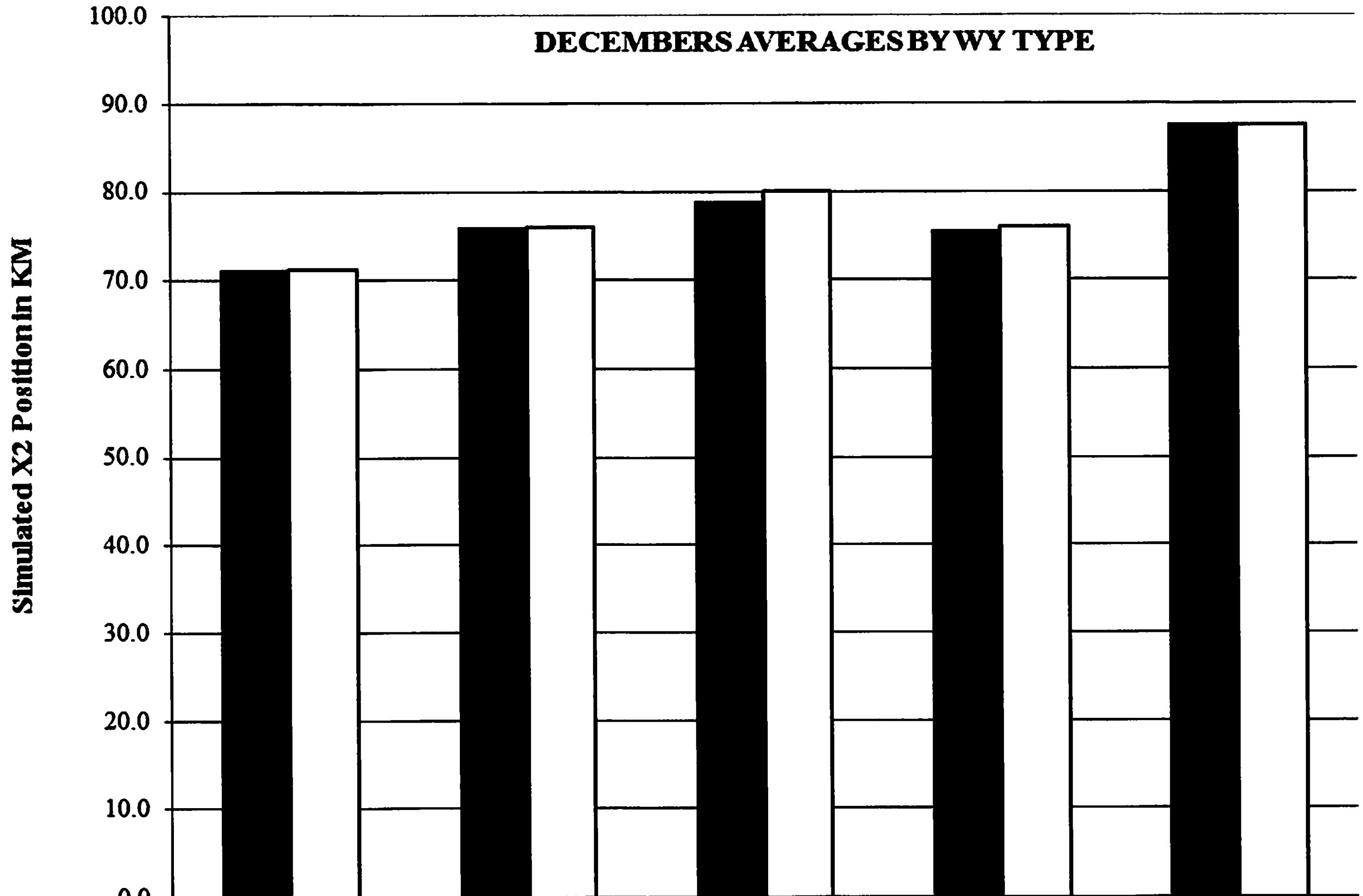


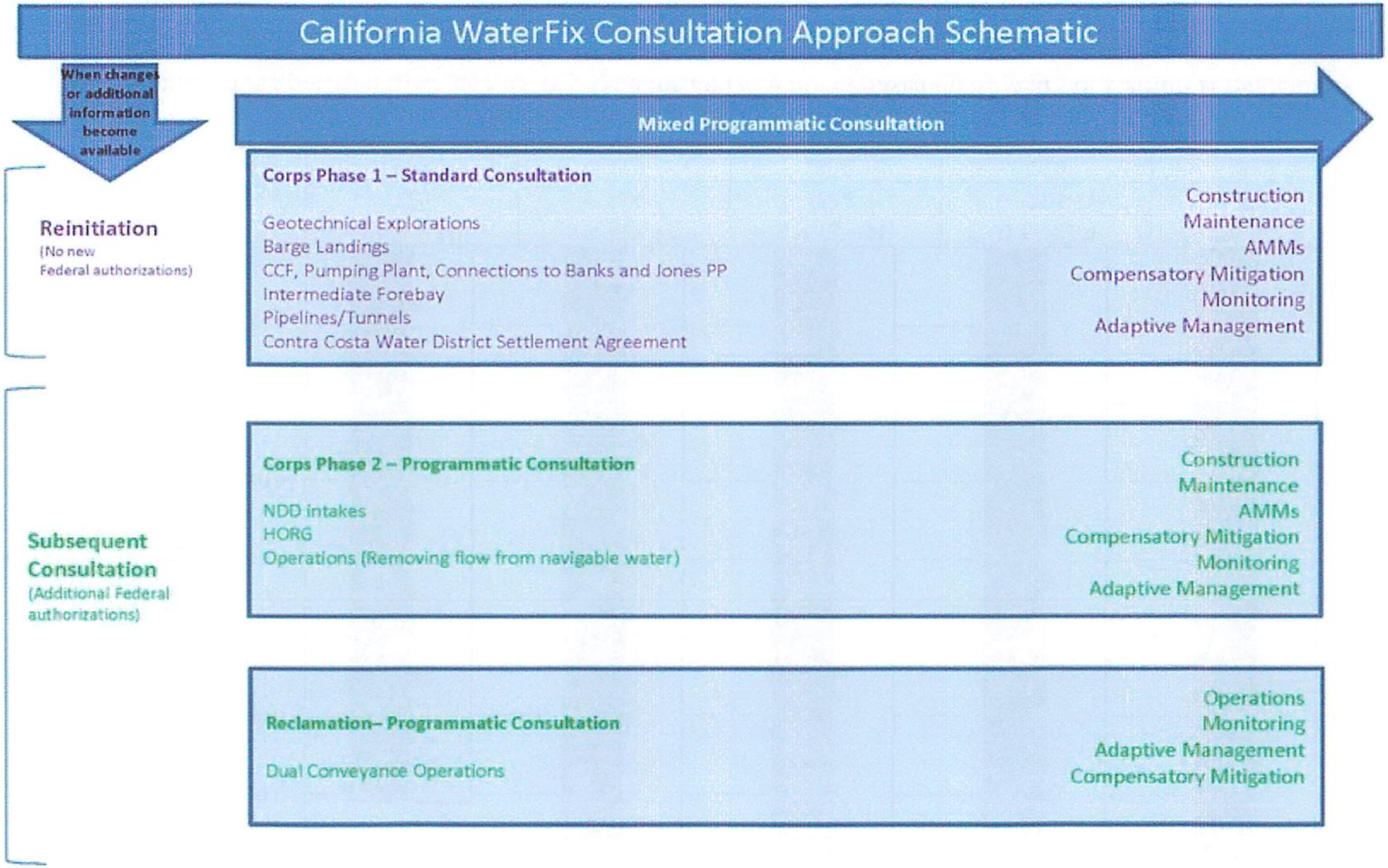
Figure B-47. Probability of exceedances of differences in simulated X2 position for all Decembers based on 82 years of CalSim II modeling.



	W (n = 26)	AN (n = 13)	BN (n = 11)	D (n = 20)	C (n = 12)
■ CWF NAA ELT CH20150408	71.1	76.0	78.8	75.5	87.6
□ CWF PA ELT CH20170428	71.3	75.9	80.1	76.0	87.5

Figure B-48. Simulated X2 position averaged by WY type for all Decembers based on 82 years of CalSim II modeling.

Appendix C. Consultation Approach Schematic and Phase 2 Maps.



Consultation Approach Schematic

When changes or additional information become available

Reinitiation
(No new Federal authorizations)

Phase 1 Standard Consultation

U.S. Bureau of Reclamation (Reclamation): Federal Action Agency
U.S. Army Corps of Engineers (Corps): Federal Action Agency
Department of Water Resources (DWR): Applicant

Federal Action(s):	Corps CWA 404 and R&HA Section 10*	Corps CWA 404 and R&HA Section 10*	Corps CWA 404 and R&HA Section 10*	Corps CWA 404 and R&HA Section 10*
Lead Action Agency:	Reclamation	Reclamation	Reclamation	Reclamation
Action Agency:	Corps	Corps	Corps	Corps
Proposed Action:	Geotechnical Explorations (overwater and land-side)	Barge Landings	Intermediate Forebay	Conveyance Tunnels

	Including:
	• Construction
	• Implementation of AMMs
	  • Monitoring
		Including:
		• Construction
		• Maintenance
		• Implementation of AMMs
		• Compensatory Mitigation
		  • Monitoring
		  • Adaptive Management
			Including:
			• Construction
			• Maintenance
			• Implementation of AMMs
			• Compensatory Mitigation
			  • Monitoring
			  • Adaptive Management
				Including:
				• Construction
				• Maintenance
				• Implementation of AMMs
				• Compensatory Mitigation
				  • Monitoring
				  • Adaptive Management

Consultation Approach Schematic

When changes or additional information become available

Reinitiation
(No new Federal authorizations)

Phase 1 Standard Consultation (continued)

U.S. Bureau of Reclamation (Reclamation): Federal Action Agency
U.S. Army Corps of Engineers (Corps): Federal Action Agency
Department of Water Resources (DWR): Applicant

Federal Action(s):	Corps CWA 404 and R&HA Section 10*	Corps CWA 404 and R&HA Section 10*	Corps CWA 404 and R&HA Section 10*
Lead Action Agency:	Reclamation	Reclamation	Reclamation
Action Agency:	Corps	Corps	Corps
Proposed Action:	Clifton Court Forebay, Pumping Plant, Connections to Banks and Jones Pumping Plants	Power Supply and Grid Connections	Contra Costa Water District Settlement Agreement

	Including:
	• Construction
	• Maintenance
	• Implementation of AMMs
	• Compensatory Mitigation
	  • Monitoring
	  • Adaptive Management
		Including:
		• Construction
		• Maintenance
		• Implementation of AMMs
		• Compensatory Mitigation
		  • Monitoring
		  • Adaptive Management
			Including:
			• Construction
			• Maintenance
			• Implementation of AMMs
			• Compensatory Mitigation
			  • Monitoring
			  • Adaptive Management

Consultation Approach Schematic

Subsequent Consultation
(Additional Federal authorizations)

Phase 2 Programmatic Consultation

U.S. Bureau of Reclamation (Reclamation): Federal Action Agency
U.S. Army Corps of Engineers (Corps): Federal Action Agency
Department of Water Resources (DWR): Applicant

Federal Action(s):	Corps CWA 404 and R&HA Section 10*	Corps CWA 404 and R&HA Section 10*
Action Agencies:	Corps	Corps
	Reclamation	Reclamation
Proposed Action:	North Delta Diversion Intakes	Head of Old River Gate

Including:
- Construction
- Operations
- Maintenance
- Implementation of AMMs
- Compensatory Mitigation
  - Monitoring
  - Adaptive Management

Including:
- Construction
- Operations
- Maintenance
- Implementation of AMMs
- Compensatory Mitigation
  - Monitoring
  - Adaptive Management

2008 and 2009 BiOps Reinitiation Consultation

U.S. Bureau of Reclamation (Reclamation): Federal Action Agency
Department of Water Resources (DWR): Applicant

Federal Action(s):	Long term Operation of the CVP in Coordination with Long Term Operation of the SWP
Action Agencies:	Reclamation
	Corps
Proposed Action:	Operation of existing CVP and SWP facilities and CWF

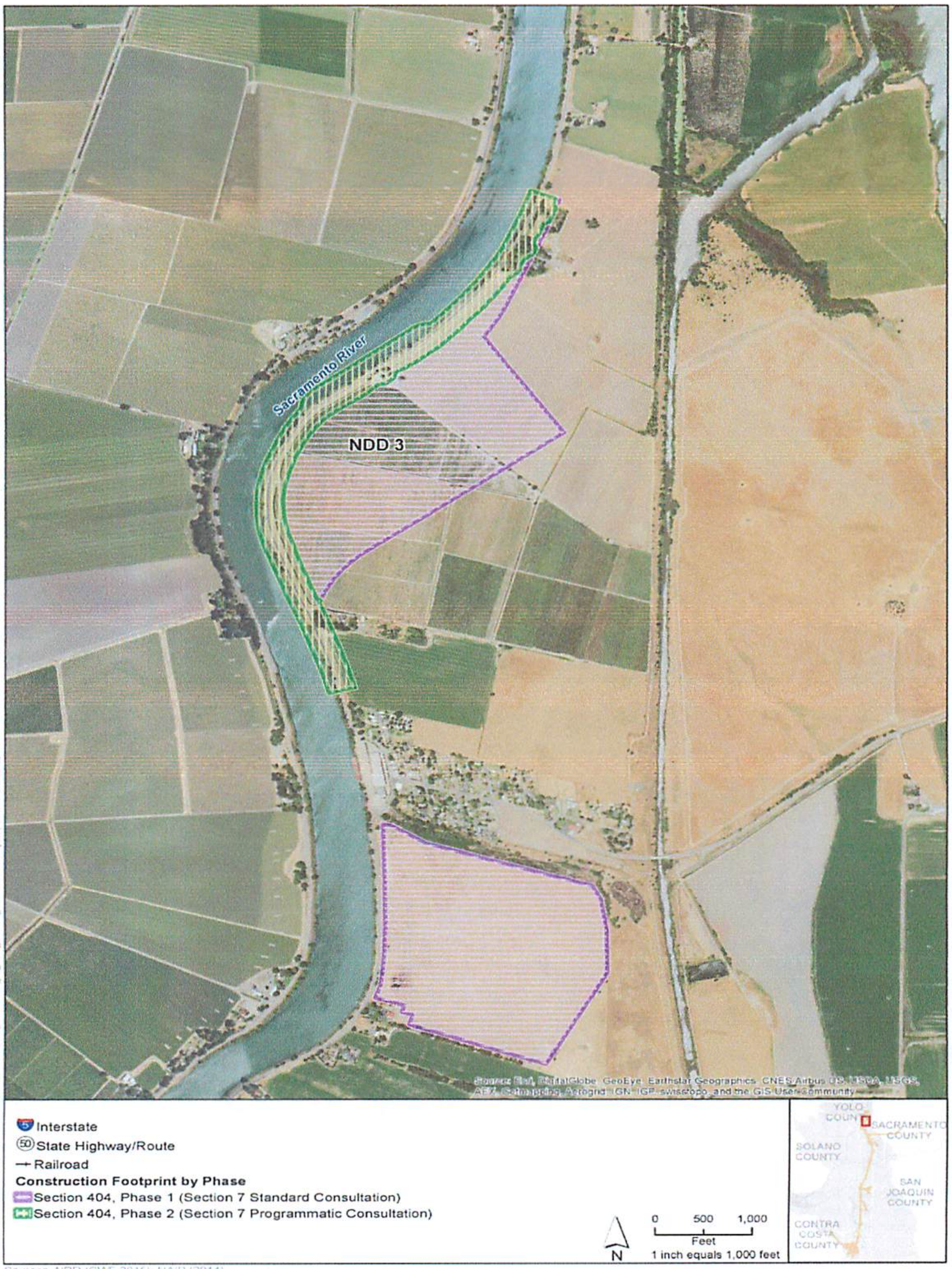
Including:
- Monitoring
- Adaptive Management
- Compensatory Mitigation
  - Monitoring
  - Adaptive Management

Construction Sites Covered Under the Section 404 Phase 2 Permits (Programmatic Consultation)
California Water Fix Program
Head of Old River Gate (HORG)

Sources: NDD (CWF 2015); NAIP (2014)

Construction Sites Covered Under the Section 404 Phase 2 Permits (Programmatic Consultation)
California Water Fix Program
North Delta Diversion (NDD) #2

CALIFORNIA WATER FIX



Sources: NDD (CWF 2015); NAIP (2014)

Construction Sites Covered Under the Section 404 Phase 2 Permits (Programmatic Consultation)
California Water Fix Program
North Delta Diversion (NDD) #3

CALIFORNIA WATER FIX

Sources: NDD (CWF 2015); NAIP (2014)

Construction Sites Covered Under the Section 404 Phase 2 Permits (Programmatic Consultation)
California Water Fix Program
North Delta Diversion (NDD) #5

CALIFORNIA WATER FIX