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Tables

Figures

Project Description

2.1 INTRODUCTION

Note: Figure, table, and appendix numbers are being revised.

2.1.1 Project Overview

The 2-Gates Project is intended to provide temporary, cost-effective, immediate protection to delta smelt from entrainment in State Water Project (SWP) and Central Valley Project (CVP) export facilities by controlling the combined OMR flows. This would be accomplished by the installation of temporary "butterfly gates" in Old River and Connection Slough and operation of those gates when turbidity and salinity conditions are expected to support upstream movement of delta smelt.

Changes to the movement of water and the timing of water movement were evaluated using a set of hydrodynamic models that function in a manner similar to the "Delta Simulation Model II" (DSM2),[1] its associated modules, and post-processing applications. Overall, the results from the DSM2-related models indicate that under certain hydrologic conditions (including all normally expected OMR flows) when sensitive fish are located north and west of the 2-Gates Project facilities, the gates would be effective at reducing entrainment of delta smelt, other weak swimming fish, and plankton from the western and central Delta by the SWP and CVP export facilities in the southern Delta (model results are included in Appendices A, B, C, and D. Preliminary results from other newly developed adult delta smelt behavioral model applications further indicate that distribution and density of adult delta smelt can be modified to reduce their potential entrainment at the CVP and SWP export facilities while they are operating within the pumping restrictions identified in the OCAP BOs (USFWS 2008, NMFS 2009).

Entrainment reduction may be accomplished by controlling the distribution and continuity of turbidity and salinity conditions that appear to be a component of pre-spawning, adult delta smelt habitat. Preliminary results from the newly developed adult delta smelt behavioral model applications (Appendix B) suggest that the distribution and density of adults could be modified to reduce the potential for entrainment at the CVP and SWP export facilities, in concert with pumping restrictions (USFWS 2008) and the Project operations of the gates (Figure 2-1). The distribution of larval and juvenile delta smelt depends on spawning locality (distribution of spawning adults) and Delta hydrodynamics (USFWS 1994). Keeping pre-spawning adult delta smelt substantially out of the south Delta may reduce potential entrainment of their progeny (larval and juvenile life stages). Tidal operation of the 2-Gates Project also may increase dispersive mixing of water in the central or southern Delta seaward toward the western Delta. This has the potential to (1) disperse larval/juvenile smelt spawned in the central and southern Delta away from the export pumps, thereby reducing entrainment risk, (2) enhance juvenile transport westward toward rearing habitat near Suisun Bay, and (3) enhance export of nutrients and phytoplankton to the west Delta. These actions would reduce

[1] DSM2 models calculate stages, flows, velocities in channel segments in the Delta and is the basis for many post processed models that calculate water quality parameters and the movement of individual particles. Detailed descriptions of this model are available at http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/models/dsm2/dsm2.cfm.

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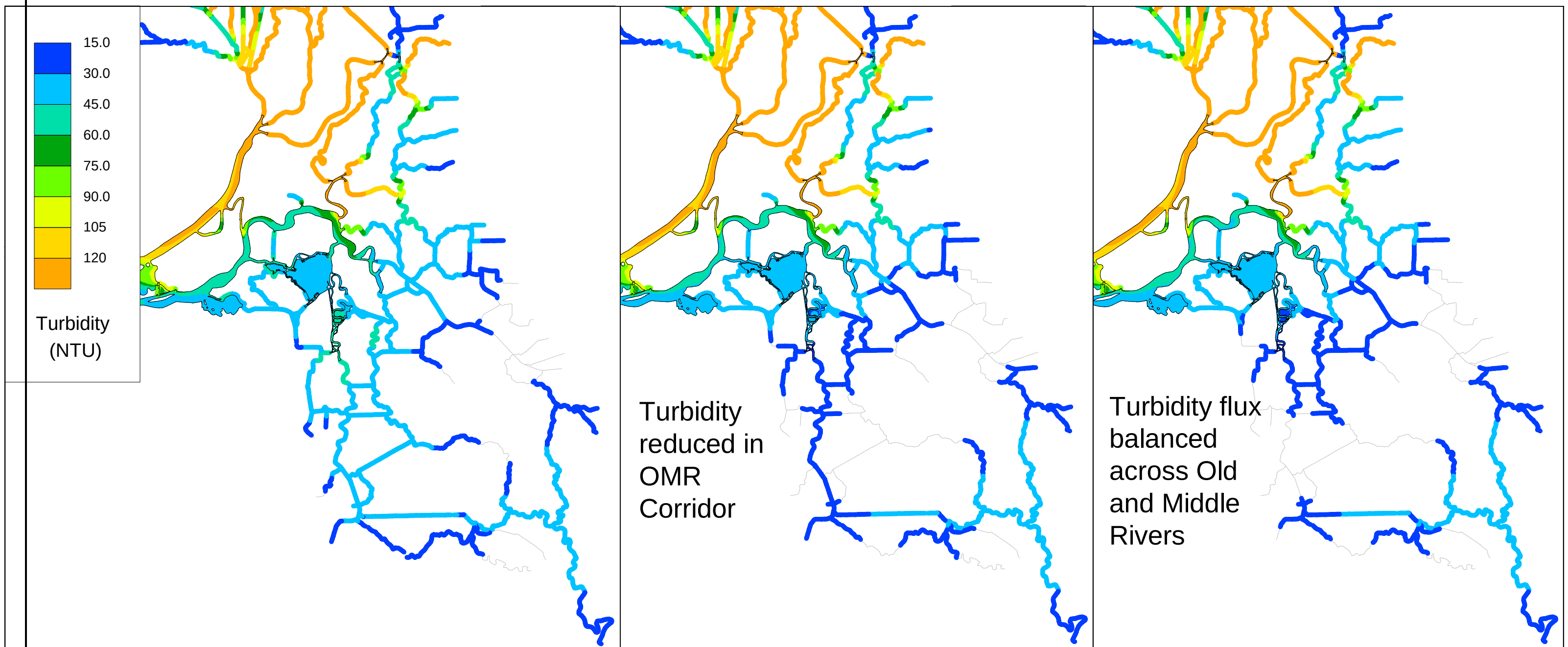
entrainment of pre-spawning adults while allowing the SWP and CVP export facilities to operate above the minimum values specified in the OCAP BOs (USFWS 2008, NMFS 2009).



Historic Condition Reduction of OMR Flow With Gate Operation

Figure 2-1. Operation of 2-Gates Project to Reduce Adult Delta Smelt Entrainment by Balancing Turbidity Flux along Old and Middle Rivers.

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The Project is designed to have the operational flexibility to test alternative water management and fish protection strategies. It includes a monitoring component that is intended to verify that operable gates can control water quality factors, such as turbidity, salinity, temperature. Monitoring data would be used to guide real-time operation of the gates, verify the model information, evaluate Project effects on delta smelt and other sensitive species, and modify operational procedures as needed (the complete Monitoring Plan is included in Appendix E). Real-time adjustments to operations would be made as needed to reduce delta smelt entrainment while minimizing or avoiding impacts on other listed species. Monitoring also would be used to adjust operations based on changing conditions in the Delta, including changes associated with CVP and SWP operations.

2.1.2 Purpose of the Project

The 2-Gates Project proposes to reduce entrainment of delta smelt by the SWP and CVP export facilities, either achieving or exceeding the protection goals established by the OCAP BO for delta smelt (USFWS 2008) while allowing water exports to exceed the minimum levels allowed by the RPAs described in the USFWS and NMFS OCAP BOs and complying with other water management requirements (State Water Resources Control Board [SWRCB] Water Right Decisions 1485 and 1641 [D-1485 and D-1641]). In particular, the Project is intended to demonstrate that operable gates, strategically placed in the central Delta and managed in conjunction with some restrictions on reverse (negative) flows in Old and Middle Rivers (OMR flows), can provide equal or greater protection for delta smelt than restrictions on reverse OMR flows alone. The proposed 2-Gates Project is designed as a demonstration project to test this premise.

The 2-Gates Project could be used to support future decision-making regarding the installation of more permanent operable gates for the protection of aquatic resources in the Delta. Should such a permanent project be implemented in the future, it would be subject to separate environmental review and permitting processes, which would evaluate pertinent information collected from operation of the 2-Gates Project. The 2-Gates Project has independent utility, however, and is not dependent upon the implementation of any longer-term plan, including the Bay-Delta Conservation Plan (BDCP). It would not result in a long-term commitment to permitting or constructing permanent gate structures in Old River and Connection Slough. The 2-Gates Project is removable, if required, once the demonstration phase ends.

2.1.3 Need for the Project

The CVP and SWP are operated under the OCAP and other water rights and water quality requirements and must comply with the RPAs contained in the recent BOs for the OCAP issued by the USFWS (2008) and NMFS (2009). The RPAs include actions to limit negative OMR flows to reduce entrainment of fish at the CVP and SWP export facilities. In addition, the CVP and SWP must operate within the water resource management controls described in D-1485 and D-1641. Depending on the level of pumping allowed, water supply impacts can be severe. Therefore, the water agencies that rely on the CVP and SWP are proposing ways to reduce entrainment losses of delta smelt at the export facilities while reliably meeting water supply needs.

2.1.4 Project Objectives

The 2-Gates Project objectives are:

- Provide cost-effective and immediate protection to delta smelt equaling or exceeding that provided by implementation of the USFWS OCAP BO alone.

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- Avoid adverse effects on listed species and other aquatic resources in the Delta, including Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), Central Valley steelhead (*O. mykiss*), North American green sturgeon (*Acipenser medirostris*), and longfin smelt (*Spirinchus thaleichthys*).
- Allow OMR flows/SWP and CVP water exports to exceed the minimum established by the USFWS and NMFS OCAP BOs while operating within all water management requirements.
- Improve understanding of the processes that influence movement and entrainment of delta smelt in the SWP and CVP export facilities in order to minimize entrainment in the future.

2.1.5 Project Location

The Old River and Connection Slough sites are located in the central Delta, approximately 13 and 16 miles northwest of Stockton, and 4.8 and 6.8 miles north and northwest of Discovery Bay, respectively. The nearest developed areas are located in the City of Oakley, about 2.4 miles west of the Old River site. The regional location is shown in Figure 2-2, and a more detailed view of the area surrounding the Project sites is shown in Figure 2-3. The Contra Costa County-San Joaquin County boundary is formed by the Old River; therefore, Project construction at this site would occur in both counties. The Connection Slough site is located entirely in San Joaquin County. As shown on Figure 2-3, the Old River site is located on Old River between Holland Tract and Bacon Island, about 3 miles south of Franks Tract and about 1 mile north of the confluence of Old River and Rock Slough. The Connection Slough site is located about 3.5 miles southeast of Franks Tract between Mandeville Island and Bacon Island and between Middle River and Little Mandeville Island.

2.1.6 Conceptual Foundation

Project design and operations are based on a conceptual understanding of patterns and relationships of Delta hydrodynamics, changes in water quality parameters, delta smelt life cycle, delta smelt behavioral responses to flow and water quality cues at different life stages, and salvage at the export facilities, as reviewed below.

The distribution of adult delta smelt is affected by a variety of factors including hydrodynamics, season, and water quality attributes. Recent evidence suggests low water transparency is a key characteristic of delta smelt habitat (Bennett 2005, Feyrer et al. 2007, Nobriga et al. 2008). Water transparency is an important predictor of occurrence for delta smelt. This relationship has been observed for adults (Spring Kodiak Trawl data, Bennett 2009) and juveniles (20 mm survey, Bennett 2009; Fall Midwater Trawl, Feyrer et al. 2007). The recently released OCAP BO (USFWS 2008) points to the relationship between turbidity and delta smelt occurrence, particularly water quality conditions of electrical conductivity less than 400 µmhos/cm and turbidity greater than 12 nephelometric turbidity units (NTU). Upstream migration appears to be triggered by abrupt changes in flow and turbidity associated with the first flush of winter precipitation (Grimaldo et al. in press). Delta smelt seeking these conditions are thought to move into the central Delta by surfing the tides and can remain in these areas of suitable water quality as they are moved about by the tides.

Entrainment risk depends on geographic distribution, with the greatest risk occurring near the south Delta and water export facilities (Kimmerer 2008). It appears that turbidity in excess of 12-15 NTU is correlated with and may be a functional cue for the annual spawning migration by delta smelt from Suisun Bay to the Delta. Under certain hydrologic and operating conditions, these water quality conditions can be substantially moved into the central and south Delta due to reversal of flows on the lower San Joaquin River. Review of salvage trends found a correlation in several years between elevated turbidity, high exports, and increased salvage

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(USFWS 2009) (Figure 3). When exports are high, OMR flows can become reversed and flow south toward the facilities (i.e., reverse OMR flows). Daily salvage of delta smelt at the export facilities is correlated with reverse OMR flows (Kimmerer 2008).

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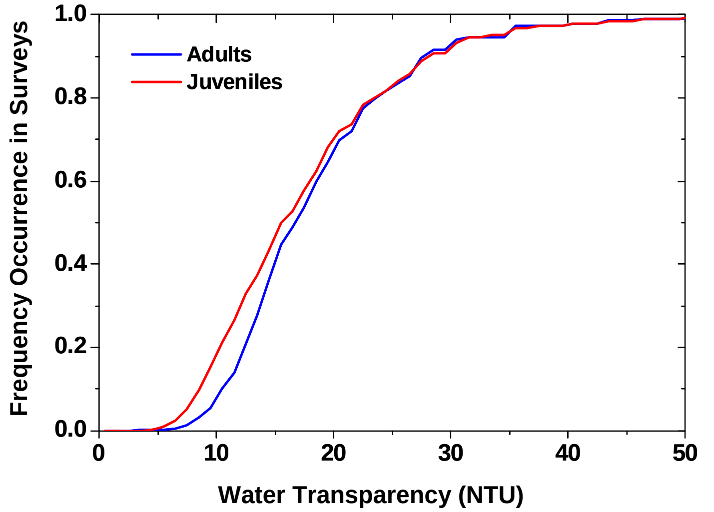

NOTE: The water transparency values (i.e. turbidity) were derived from Secchi depth readings from DWR EMP data collected at Chipps Island (1986-1999) and converted to turbidity by a nonlinear regression equation.

Figure 3. Relationship between Occurrence of Delta Smelt and Turbidity and Cumulative Frequency of Capture.

The adult distribution of delta smelt presumably affects the location of spawning and the spatial distribution of their progeny. This would affect the entrainment risk of juveniles in the Delta until they move downstream to rearing habitat near Suisun Bay.

The location and structure of the turbidity field is affected by freshwater inflow, tidal flows, and other Delta hydrodynamics, as revealed by recent hydrodynamic modeling of turbidity and flow conditions with and without 2-Gate operations (Appendix D of the SCIENCE REPORT). During high river flow periods, turbidity enters the Delta from the Sacramento River and Georgiana Slough and enters the south Delta through Old River and Middle River. When these two water bodies meet, they form a turbidity "bridge" from central and west to south (Figures 2.1-1 and 2.1-2). This continous high turbidity zone allows smelt to move south toward the pumps. Water management actions (operation of the SWP and CVP export pumps) consistent with the OCAP RPA actions prevent or delay the turbidity bridge from forming by reducing negative OMR flows, thus keeping smelt away from the export pumps. The proposed gates, when operated in conjunction with OMR

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flow requirements, may provide greater control and more flexibility in keeping turbidity away from the pumps.

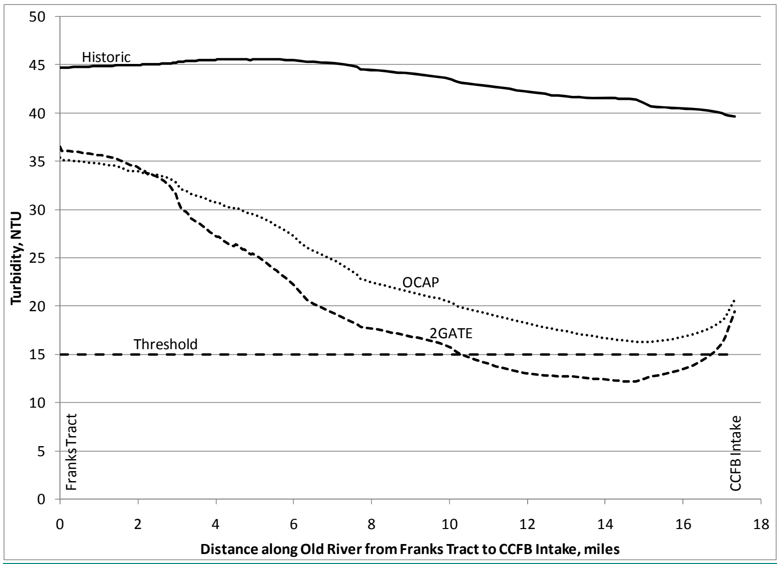

Figure 6. Longitudinal Profile of Modeled Turbidity along Old River from Franks Tract to Clifton Court Forebay.

Entrainment reduction may be accomplished by controlling the distribution and continuity of turbidity and salinity conditions that appear to be a component of pre-spawning, adult delta smelt habitat. Increased salvage of adult delta smelt is correlated with high turbidity and negative OMR flows (Grimaldo et al. in press). Preliminary results from the newly developed adult delta smelt behavioral model applications (Appendix D of the SCIENCE REPORT) suggest that the distribution and density of adult delta smelt could be modified to reduce their potential entrainment at the CVP and SWP facilities, in concert with the pumping restrictions from the USFWS OCAP BO (2008) and the 2-Gates Project operations. Keeping pre-spawning adult delta smelt substantially out of the south Delta could also reduce potential entrainment of their progeny (larval and juvenile life stages).

The gates may also be operated to enhance transport of delta smelt away from the export facilities. Hydrodynamic modeling suggests that opening the gates on ebb tides can enhance mixing of water in the central Delta and can disperse flows seaward toward the western Delta (Figure 7, Appendix D of the SCIENCE REPORT). This has the potential to benefit delta smelt by (1) dispersing larvae and juveniles away from the export pumps, thereby reducing entrainment risk, and (2) enhancing juvenile transport westward toward rearing habitat near Suisun Bay. Particle tracking modeling of different water management scenarios suggest that entrainment of juveniles could be potentially reduced (Figure 2.1-3). Finally, this dispersive mixing process could also be used to improve habitat in the Sacramento-San Joaquin confluence area by facilitating westward transport of nutrients and plankton originating in the upper San Joaquin River and southern Delta. The Pelagic Organism Decline (POD) studies have hypothesized that “bottom up” factors, such as the quality and availability of food, may have important consequences for pelagic fishes including delta smelt. Low and declining primary productivity in the estuary is likely a principal cause for the long-term

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pattern of relatively low and declining biomass of pelagic fishes (Baxter et al. 2008). Dispersive mixing would cycle nutrients into the western Delta that otherwise would have been exported.

2.1.7 Questions Addressed by the Project

The key questions that would be addressed by the Project are:

- Can the Project reduce pre-spawning adult delta smelt entrainment in the CVP and SWP export facilities by maintaining a zone of low turbidity between the export facilities and the central and western Delta?
- Can the Project reduce juvenile delta smelt entrainment in the facilities by enhancing dispersive mixing to transport them from the south and central Delta into the western Delta?

Balanced flow and turbidity hypotheses have been developed with regard to the principle mechanisms influencing adult delta smelt movement. The ability to influence delta smelt distribution is expected to

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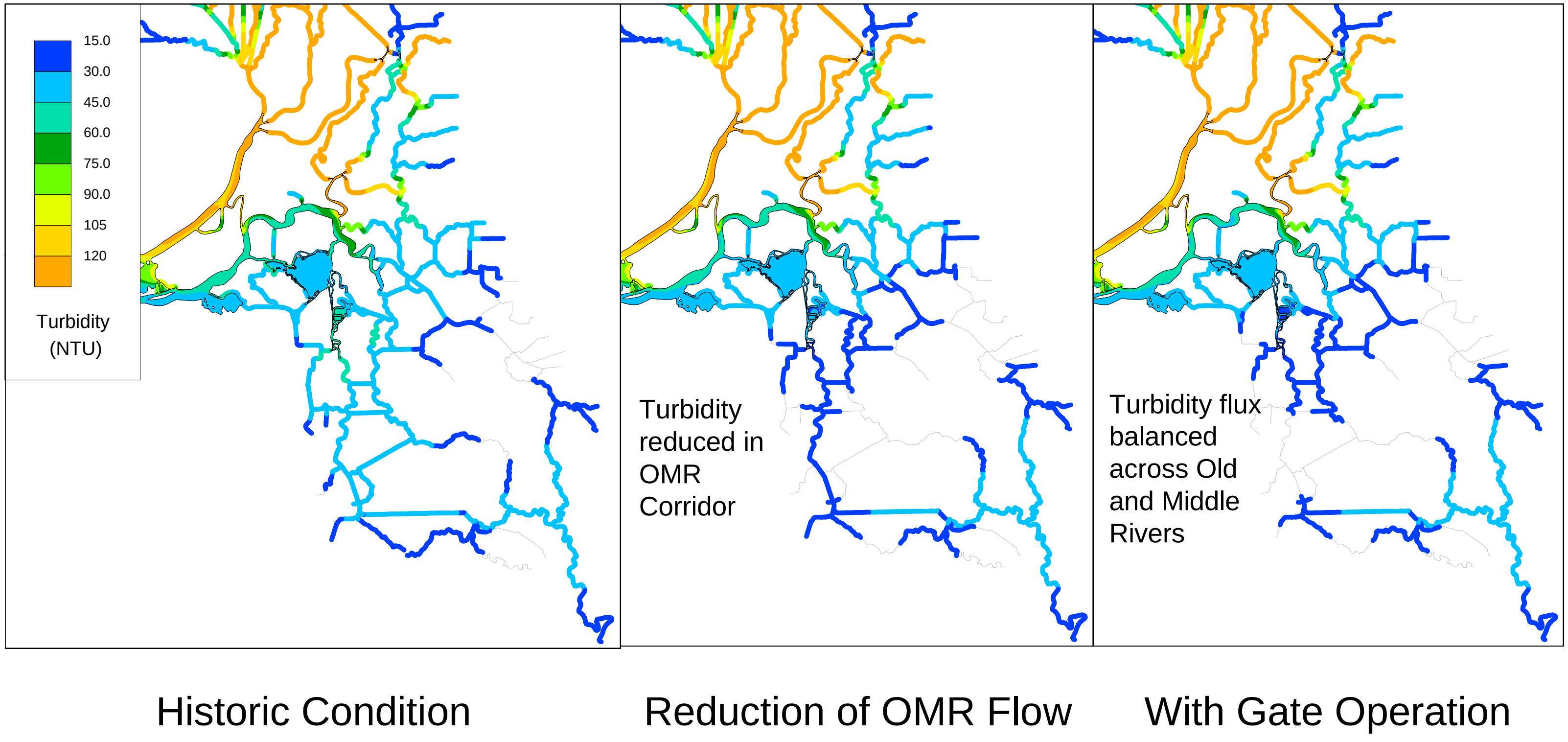

Figure 5. Operation of 2-Gates Project to Reduce Adult Delta Smelt Entrainment by Balancing Turbidity Flux along Old and Middle Rivers.

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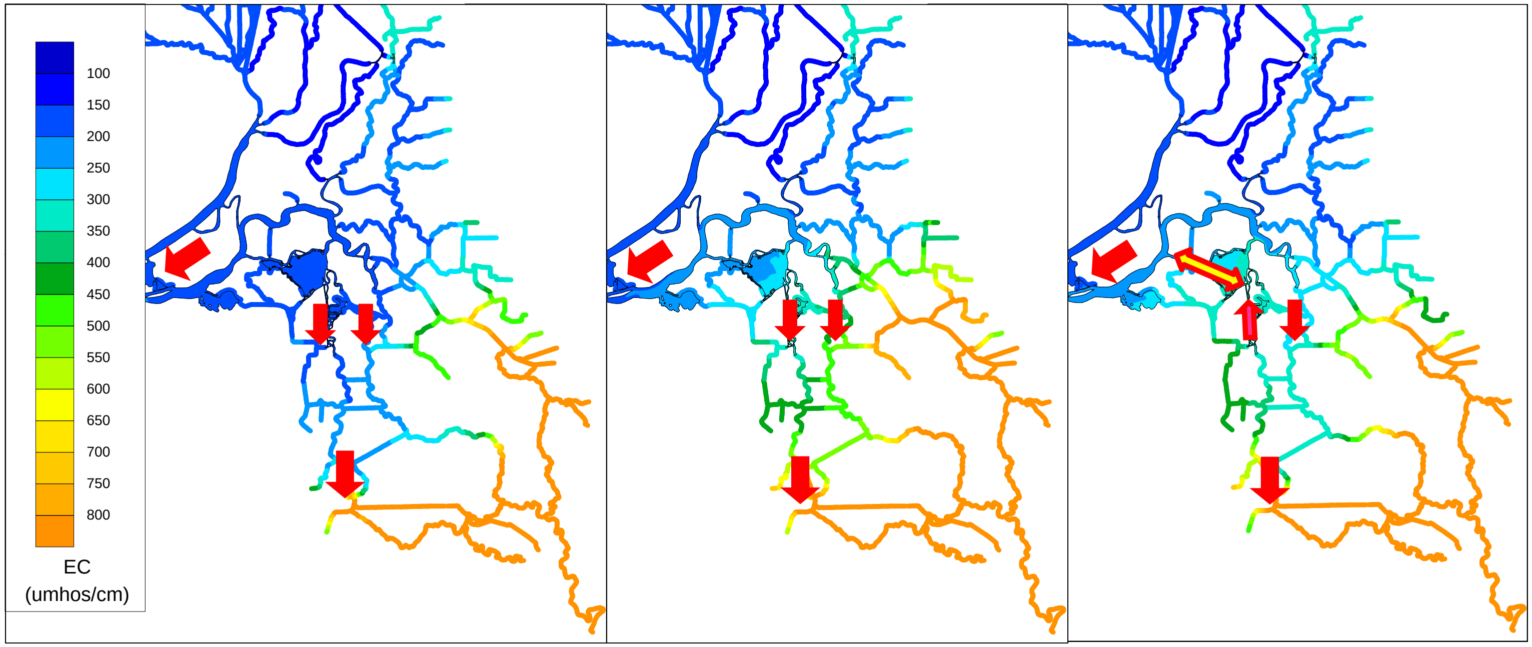

Historic Condition

Reduction of OMR Flow

With “Open on Ebb” Gate Operation

Figure 7. Operation of 2-Gates Project to Reduce Larval/Juvenile Delta Smelt Entrainment.

influence the regions of spawning and distribution of larva and juvenile delta smelt. Two hypotheses have been developed regarding flow and turbidity effects of gate operations:

1. 2-Gates Project operations, coordinated with allowable changes in export levels, can control net flows in Old River to achieve a predictable balance of flows in both Old and Middle Rivers.

2. 2-Gates Project operations, coordinated with allowable changes in export levels, can balance net flows between Old and Middle Rivers to maintain a low turbidity region in Old and Middle Rivers.

Hypotheses also have been developed regarding the physical migration cues for pre-spawning adult delta smelt and the effectiveness of the project in reducing adult delta smelt entrainment:

3. Migration of pre-spawning adult delta smelt from the Suisun Bay into the Delta and freshwater habitats occurs when initial winter storm events increase Sacramento River turbidity in the Delta to above a threshold of 12-15 NTU.

4. Maintaining a low turbidity region in Old and Middle Rivers reduces adult delta smelt salvage at the export facilities.

The following hypothesis also was developed to examine Project effects on a hydrodynamic process for juvenile delta smelt transport:

5. Opening the Old River gate on ebb-tide and closing it on flood creates net circulation downstream on Old River and upstream on Middle River that increases mixing between Franks Tract and western San Joaquin River.

Table 2-1 presents these hypotheses, the metrics that would be used to evaluate the hypotheses, and data sources used to describe the results of the evaluations.

Table 2-1. Hypotheses/Questions

No.	Hypotheses and Questions	Metrics[1]	Data sources
Balanced Flows and Turbidity			
1	2-Gates Project operations can control net flows in Old River to achieve a predictable balance of flows in both Old and Middle Rivers.	▪ Flows in Old and Middle Rivers.	▪ Existing and new flow monitoring stations. ▪ RMA modeled flows[2].
2	2-Gates Project operations, can balance net flows between Old and Middle rivers, as indicated in 1, to maintain a low turbidity region in Old and Middle Rivers.	▪ Flows in Old and Middle Rivers ▪ Turbidity (observed) down Old and Middle Rivers and into Franks Tract and lower San Joaquin River. ▪ Model results for flows and turbidity from forecasting and from concurrent conditions.	▪ Existing and new flow monitoring stations. ▪ Existing and new water quality stations (turbidity, EC, temperature and chlorophyll a). ▪ RMA modeled flows and turbidities[2].
Delta Smelt Migration and Salvage			
3	Migration of pre-spawning adult delta smelt from the Suisun Bay into the Delta and freshwater habitats occurs when initial winter storm events increase Sacramento River turbidity in the Delta to above a threshold of 12-15 NTU.	▪ Storm event (1st of season) ▪ Delta inflow ▪ Sacramento River flows ▪ Turbidity ▪ Delta smelt catch at fixed stations, one each in the Sacramento and San Joaquin rivers.	▪ Existing and new flow monitoring sites. ▪ New turbidity, EC and water temperature stations. ▪ Daytime fish catches in a stationary Kodiak or Midwater trawl over a ~12-hr tide cycle (Appendix D).

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No.	Hypotheses and Questions	Metrics [1]	Data sources
No.	Hypotheses and Questions	Metrics [1]	Data sources
Balanced Flows and Turbidity			
4	Maintaining a low turbidity region in Old and Middle Rivers reduces adult delta smelt salvage.[3]	▪ Turbidity ▪ Observed Salvage ▪ Model results for salvage	▪ Existing and new flow stations ▪ Existing and new water quality stations. ▪ Vessel-based turbidity monitoring down the Old and Middle Rivers ▪ Salvage
Dispersive Mixing			
5	Open-on-ebb operations increase dispersive mixing between the south-central Delta and lower San Joaquin River through Franks Tract-False River.	▪ Net flows in Old and Middle Rivers ▪ Calculate salt flux decomposition in False River west of Franks Tract or possibly measure bromide time series (Appendix E) ▪ Salinity and salts gradients from OR –FT-FR-SJR. ▪ Fingerprinting estimates based on bromide time series.	▪ Existing and new flow monitoring stations. ▪ Additional field data to fingerprint water source (e.g. bromide sensor)

1. Additional discussions are planned at the science panel.
2. RMA hydrodynamic model would run trials run over 1-2 weeks with controllable and stable net flows and exports. Test on same tide phase for both. Neap and spring >=twice each, learning as we go. First measure with gates open, then a few days with the gates operating (closed for all or some portion of 24 hours). This is not a pulse flow test.
3. Test is for no difference in mean flow for model runs with gates open and a difference when Project is operating, with multiple model runs. Do mean observed flows fall in range of predicted net flows, i.e., predictions are correct? Assume that the distribution of random variation under historic conditions applies to the test conditions. Use appropriate tests taking into account autocorrelation if necessary.

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2.2 STRUCTURAL COMPONENTS

The Project involves the installation and operation of two gate structures mounted on commercially available cargo barges, one in Old River and one in Connection Slough. A plan view of the design at both the Old River and Connection Slough sites is shown on Figures 2-4 and 2-5, respectively. A conceptual view of the Old River operational gate system showing gates opened and closed is shown in Figure 2-6. Detailed design plan views, cross-sections, and layouts for the Old River and Connection Slough sites are included in Appendices F and G, respectively.

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2.2.1 Gate Structures

Approximately 85-foot long butterfly gates would be mounted on steel barges and ballasted into place on prepared beds in both the Old River and Connection Slough channels. The barges would be further held by large rocks (lock rock) placed along each side to provide additional resistance to lateral forces from tidal flows, and they would be keyed into sheet pile dikes.

The butterfly gate design consists of double gates that are supported on a center pivot to allow vessels to pass through the gates when they are open. The gates are designed to accommodate commercial and large private vessel traffic typical for the Old River and Connection Slough locations. When open, the Old River gates would provide a 75-foot wide navigation opening, which is consistent with the navigation opening provided at the BNSF Railway Bridge, located just south of the Old River site, and the Connection Slough gates would provide a 60-foot opening. Both sites would include boat ramps to provide passage for smaller recreational boats (a maximum of 24 feet and 10,000 pounds) when the gates are closed.

The gate top elevation would be +8 feet, and the pipe frame supporting the gates would be at +12 feet. The top of the sheet pile dikes would be +6.6 feet, and the top of the levees are set at 10.5 feet. The gate sill (barge deck) elevation would be at -13 feet. An operator house would be constructed on the gate barges.

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The barge supporting the gates are expected to be approximately 200 feet long and 50 feet wide at the Old River Site and 180 feet by 50 feet at the Connection Slough Site, but their size may be changed as design/value engineering of the structure progresses, and actual available barges are identified and procured. The gate barge would be approximately 12 feet high and designed with abutments to join the sheet pile dike at both ends. Barges would be sunk onto a prepared foundation at each gate location. The foundation would be prepared by dredging approximately 20 feet of peat beneath the foot print of the barge and refilling it with crushed rock.

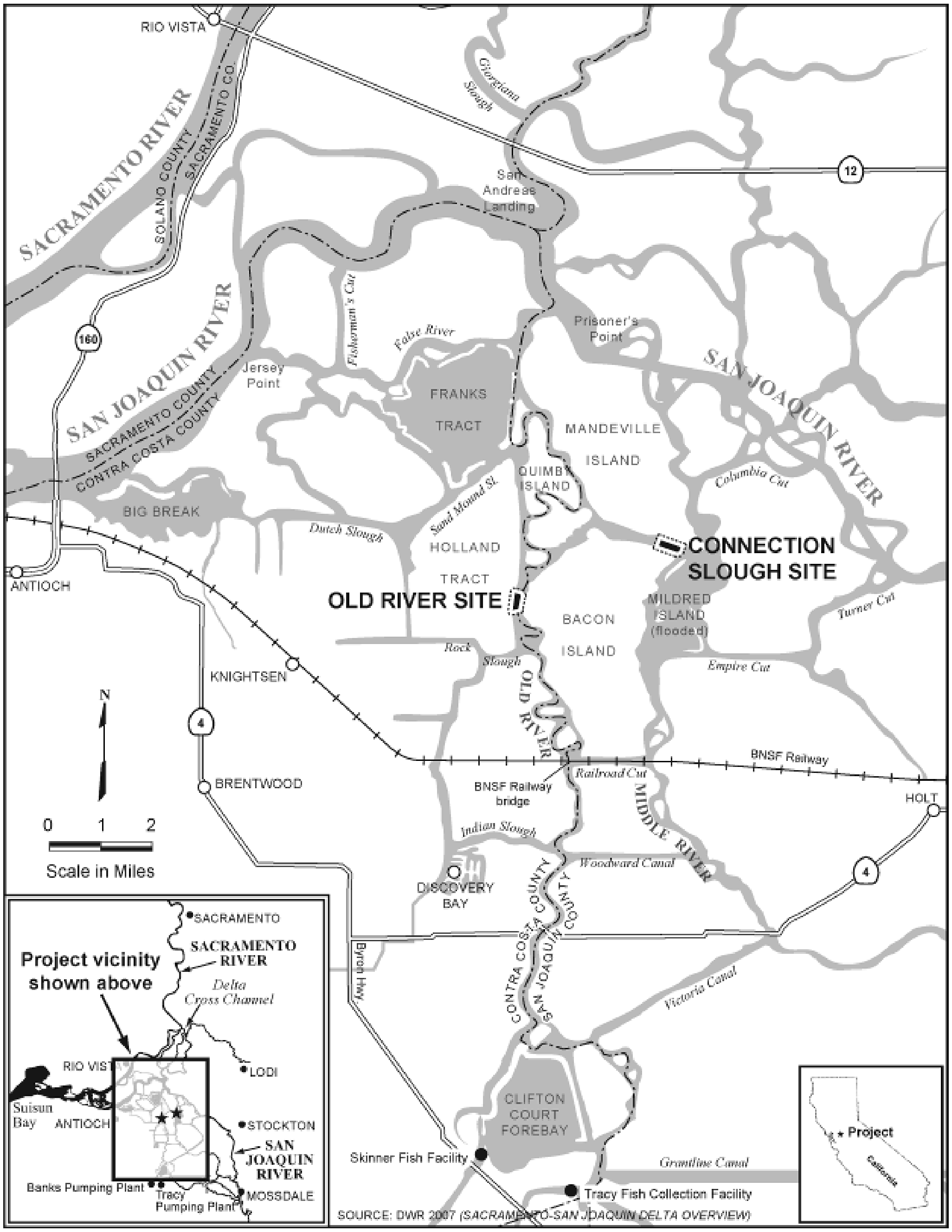

Figure 2-1 2-Gates Project, Regional Location

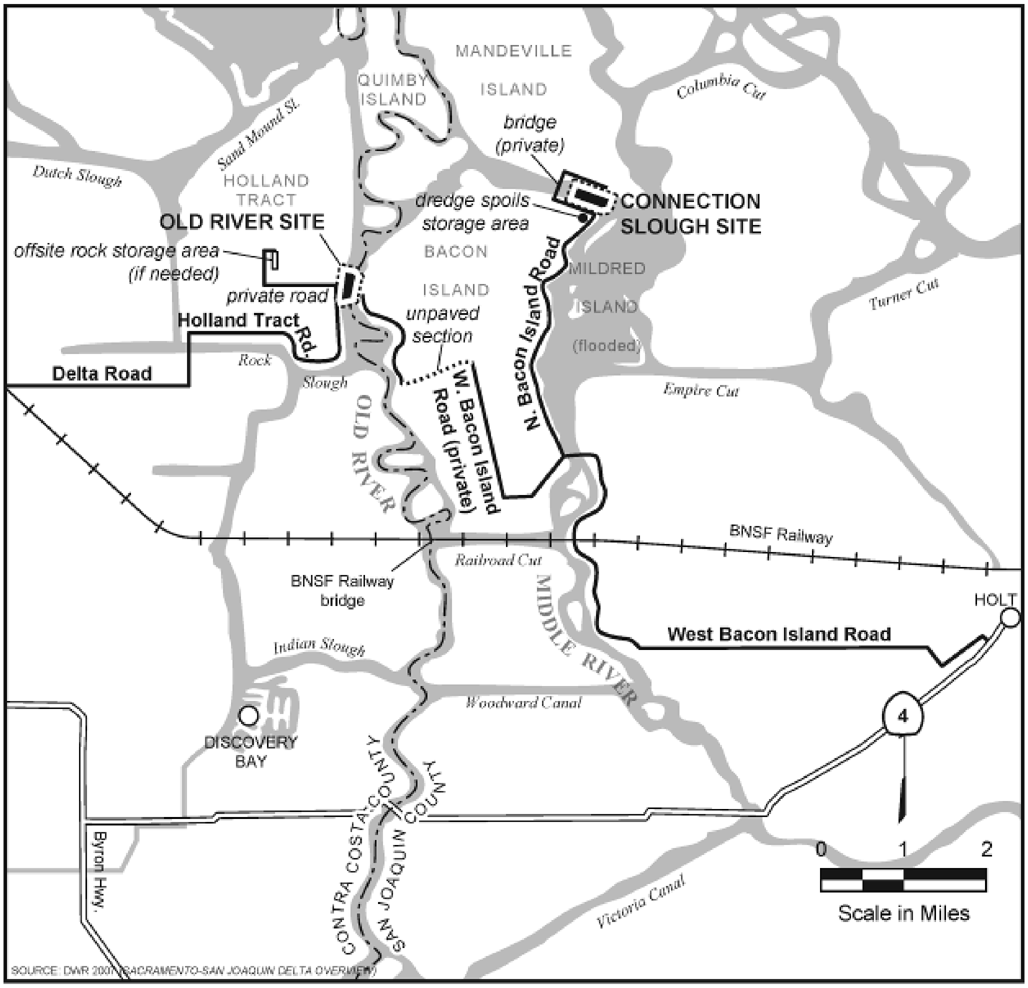

Figure 2-2 2-Gates Project, Project Vicinity with Construction Access

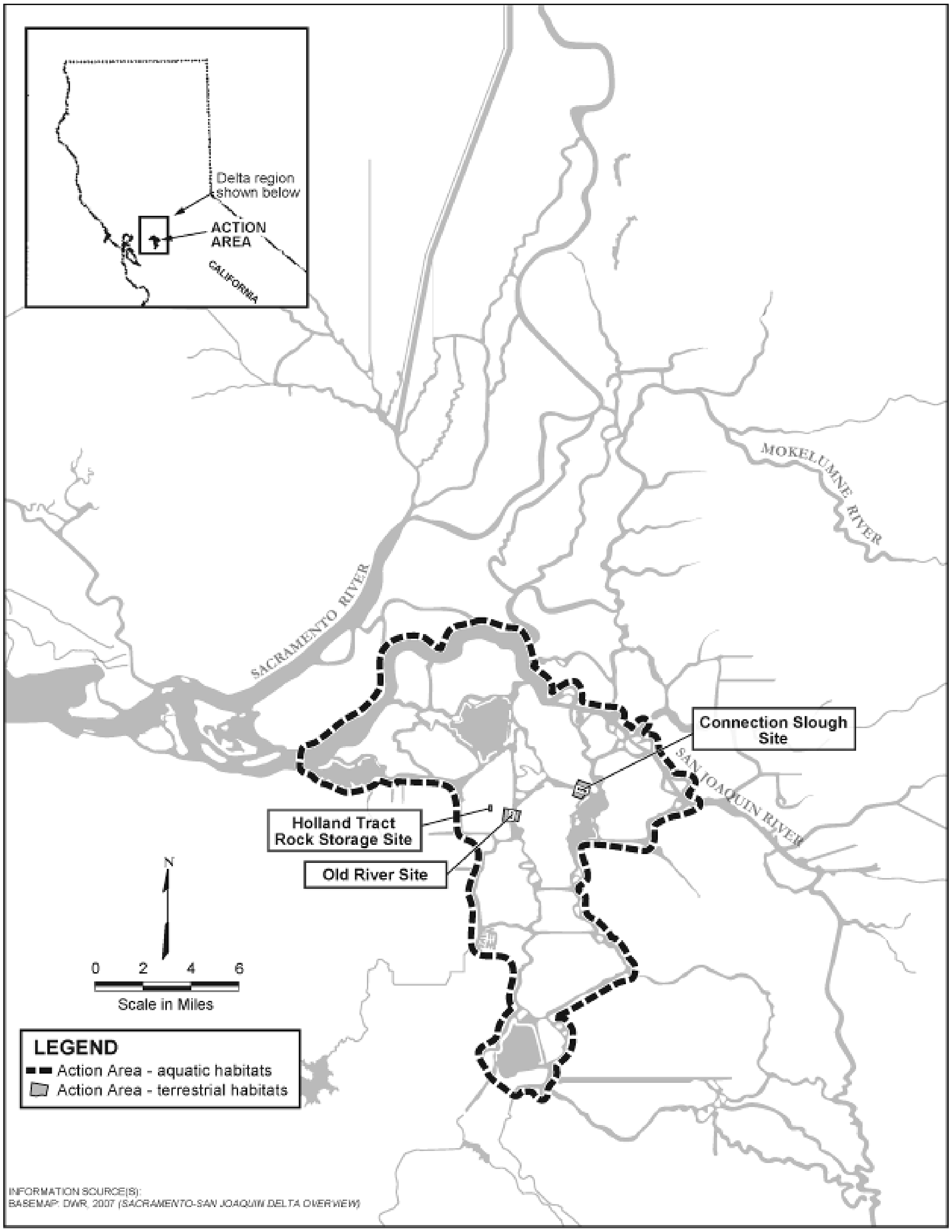

Figure 2-3 Aquatic and Terrestrial Action Areas for Biological Assessment

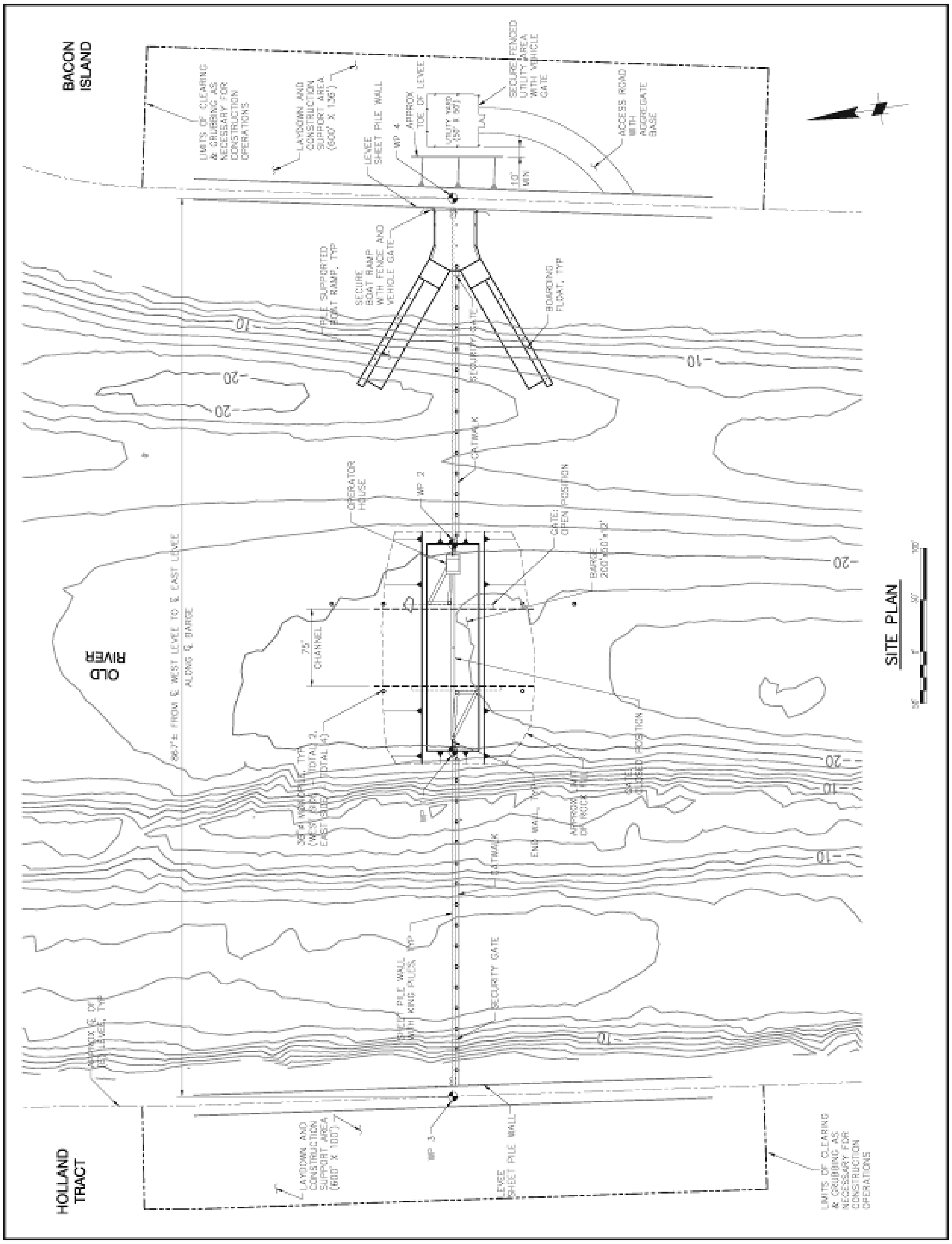

Figure 2-4 Old River Site Plan View

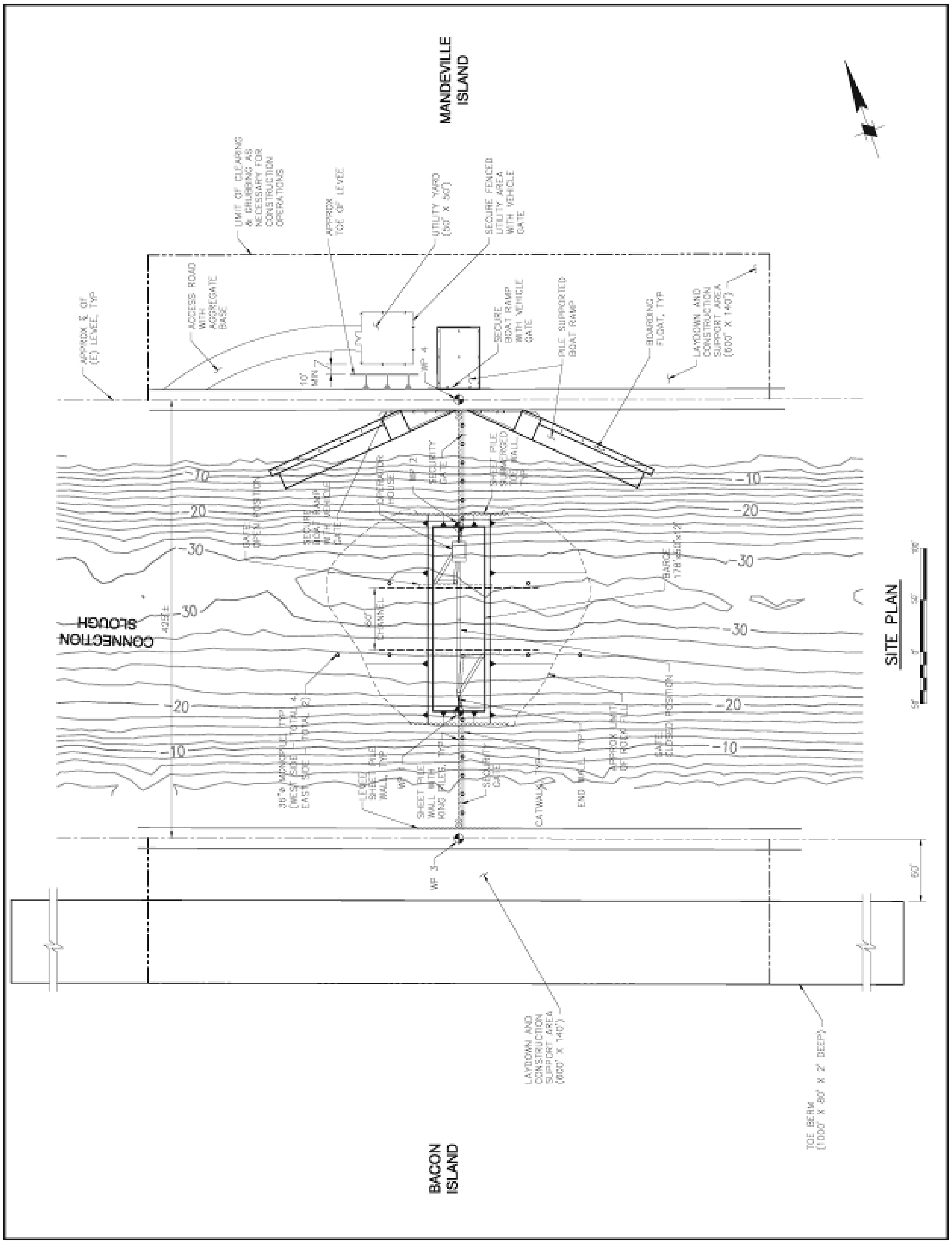

Figure 2-5 Connection Slough Site Plan View

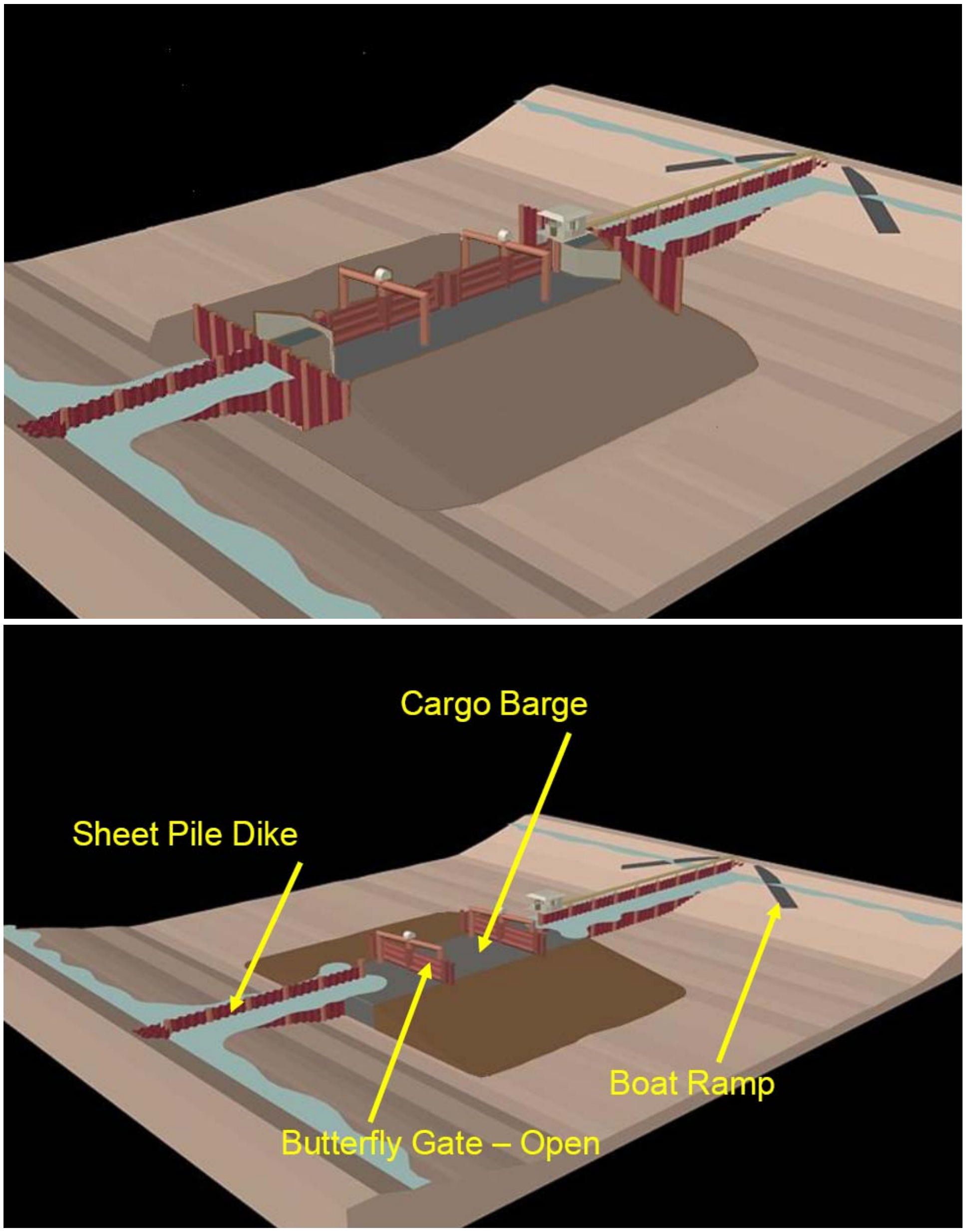

Figure 2-6 Old River Slough Site Conceptual View Showing Gates Closed and Open

2.2.2 Sheet Pile Wall

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A sheet pile wall would be placed between the gate structures and the levees that line the Old River and Connection Slough channels. At the Old River site, which is approximately 800 feet wide, about 300 feet of sheet pile dike would be placed at both ends of the approximately 200-foot-long grounded barge, extending to the adjacent levees. At the Connection Slough site, which is approximately 400 feet wide, about 100 feet of sheet piles would be placed at both ends of the approximately 180-foot-long grounded barge to anchor it to the river banks. The sheet pile wall would extend into the levees on both sides of the channel. A 50-foot perpendicular sheet pile dike would be installed into levees at each end of the sheet pile walls for approximately 25 feet on either side of the wall. Tying the sheet pile wall into the levee would require removal of a strip of existing levee slope protection material. At the gate barge end, a special end piece fabrication would be required to facilitate barge placement tolerances. The sheet pile wall would be constructed without excavating existing river bed peat material, thus minimizing the risk of seepage through the existing levees and the need for constructing cut-off walls within the existing levees.

Preliminary analysis has been performed to check the required depth of embedment and estimate the strength criteria for the sheet piles acting as the dam between the gate structure and the levee. Based on this analysis, sheet piles in lengths of 60 to 70 feet would be required to be driven approximately 30 feet deep, into the underlying sand layer. To complete the sheet pile wall, the sheet piles would be supported by 36-inch diameter king piles, set on approximately 20-foot centers at both locations.

2.2.3 Boat Ramps

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Boat ramps (and associated small boat trailers and trucks) would be provided to facilitate portage of small boats around the closed gates when the gates are closed. Two pile-supported boat ramps would straddle the sheet pile walls at each of the two sites. Boarding floats would be provided alongside the ramps to facilitate staging of the boat launch and retrieval operation. The boat ramps would be tied into the existing levee roads and would require widening of the levee area to provide sufficient maneuvering space to accommodate launching and retrieving boats.

2.2.4 Levees

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The levees would be bolstered on either side of the gates for a distance of approximately 50 feet using sheet piles and rock consistent with the agreement with Reclamation District 2025 associated with Holland Tract, Reclamation District 2028 associated with Bacon Island, and Reclamation District 2027 associated with Mandeville Island.

2.2.5 Mechanical and Electrical Components

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The barge would incorporate the piping and valves necessary for ballasting and de-ballasting operations, thus allowing the barge to be removed if necessary. The pumps, compressors, and generators for this operation would be provided on a separate construction support barge. Once the barge was submerged, the construction support barge would be removed until needed to lift the barge out of the water.

The electrical system would be powered by electric power from Pacific Gas & Electric (PG&E), using the nearby power line at each site; or pending the PG&E interconnection, a skid-mounted diesel generator located on an upland area next to the existing levee would be used. The generator skid would be a self-contained system with generator, diesel engine, starter batteries, fuel tank, etc. Should the system need to run continuously for an extended period of time, an additional fuel tank skid with fuel pump could be required.

Cabling would transmit the electrical power from the PG&E pole or the generator to the operator house. The operator would use levers on the control console to open and close the gates. The operator house would include outlets, fluorescent lights, and a wall-mounted heating, ventilating, and air-conditioning unit. The operator would control three sets of flood lights, allowing the eastern and western gates and boat ramp to be illuminated. These lights would be shielded and directed toward the facilities. No bare bulbs would be used. Channel marker lights would be U.S. Coast Guard (USCG) approved.

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2.2.6 Navigation Markers

Signage would comply with navigation requirements established by the U.S. Aids to Navigation System and the California Waterway Marker system as appropriate. A boat safety exclusion zone would be established to keep small boats clear of the closed gates in case gates begin to open, both to avoid gate swing and potential rapid changes in water velocity. The safety exclusion zone also is intended to keep small boats clear of the upstream side of the barrier during floods when the barrier is spilling and boats could be swept over the barrier. Channel markers also would be installed to indicate that the center opening (between the gate pivot posts) is the only navigable opening in the structure, and the side openings are not to be used.

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2.2.7 Fender System

A fender system would protect the gate structures from potential vessel impact. The fenders would consist of six steel mono-pile dolphins constructed at each site. Three fenders would be placed at the sides of the navigation channel on the upstream and on the downstream approaches to the gates approximately 40 feet from the face of the barge. Commercial vessels and recreational boats intending to pass through the gates would enter the channel aligned with the gate opening and would not change direction until they passed through the gate structure.

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2.3 PROJECT CONSTRUCTION

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Construction of the gate structures would involve dredging the barge foundations and refilling them with crushed rock. Sheet pile dikes would be installed, and the barges then would be sunk to the foundations and keyed into the sheet pile walls. Rock would be added to the sides of the barges and at each end to the lock the barges in place. Boat ramps would be constructed at each site and the existing levees would be widened to accommodate activities at the boat ramps. The Project would be built primarily from the water, using barges and other vessels within the river channels. Materials would be brought to the site by barges. Some construction also would take place from the levees; for example, boat ramps would be constructed on one adjacent levee at each gate site. The following describes the major construction practices that would be followed in greater detail.

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2.3.1 Dredging and Rock Placement

Prior to the installation of the barge-mounted gate system, the channel bottom would be dredged to remove unstable peat material, and a gravel sub-base foundation would be installed. Based on the geotechnical investigation, the weak peat material would be removed for the gate barge foundation by a barge-mounted clamshell dredge. Foundation preparation for the gate barge consists of dredging peat material estimated at 5,500 cubic yards for Connection Slough and 7,000 cubic yards for Old River from the bed of Old River and Connection Slough to the top of the underlying compact sand layer (believed to be at about elevation -30 feet ± at both sites).

Dredged material would be disposed of locally on Bacon Island near the junction of Middle River and Connection Slough (Figure 2-2). Dredged material from the Connection Slough site can be sidecast over the levee. Material from Old River would need to be placed on a barge, moved to the disposal area then off loaded over the levee at the Bacon Island site. The disposal area would be surrounded by a low berm in order to contain any runoff. Disposal of the 12,500 cubic yards of material would require about 2.5 to 3 acres. A roughly 240-foot long by 65-foot wide support mat would be needed for the gate barge. The support mat or foundation would be roughly 5 feet thick. The foundation would consist of a layer of crushed rock to an elevation of -25 feet, which would be graded flat for bedding the gate barge.

While not anticipated to be required, removal of the peat material from the barge foundation area may require additional sheet pile installation near the outside ends of the excavated areas closest to and parallel with the levees. It is currently anticipated that the additional sheet piles would be installed as a precaution to mitigate any potential seepage. These can be eliminated during construction should peat excavation not result in seepage.

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2.3.2 Sheet Pile Walls

Sheet piles and king piles would be installed using vibration driving techniques. The sheet pile dike would tie into the levee and would require removal of vegetation and riprap along a 75-foot length of levee on each side of each site.

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2.3.3 Gate Barge Construction and Installation

Assembly and fabrication of the gate structures and electrical and mechanical installation would be carried out in Rio Vista by the contractor. The converted barges would then be floated to the Old River and Connection Slough sites. Sheet pile installation, dredging work and bedding rock placement would have been completed prior to gate barge arrival at the sites. The barges would be cleaned prior to their placement in the channels, and residual oils, lubricants, and other contaminants would be removed. The barges would then be ballasted to the prepared sites on the river bottom, fendering dolphins would be installed, and rock fill work would begin. Guide piles may be installed to help position the barge during the ballasting / grounding procedure, but these piles would be removed once the barge is in place.

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2.3.4 Construction Power Supply

Power for facilities installation would be provided by stand-alone generators at each Project site. The need for temporary power for construction is anticipated only for land-based welding or small winches or hoists to position barrier sheet elements. Most, if not all, welding and sheet pile placement is anticipated to be from a waterside barge.

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2.3.5 Laydown and Construction Support Areas

Areas on Bacon Island and Holland Tract adjacent to the Old River gate site (measuring approximately 600 feet by 100 feet) have been identified for laydown and construction. Both locations would require clearing, grubbing, and grading per the contactor's recommendations. Similarly, on Connection Slough, an area on Bacon Island and Mandeville Island adjacent to the Project location (measuring approximately 600 feet by 140 feet) has been identified for laydown and construction.

These areas would include the pile-supported boat ramp estimated to be 80 feet by 40 feet and a 50-foot by 50-foot utility yard. The adjacent construction sites also may be used for storage of materials removed when the gate is deconstructed, pending reuse of the material for gate re-installation.

An area of approximately 12 acres on Holland Tract is available for storage of materials such as rock if significant rock needs to be removed and stored beyond the adjacent construction area prior to reinstallation. It is quite possible the Project would not require a rock storage laydown area since much of the gate is being constructed of sheet piles, and the barge foundations would remain in place.

Land areas would be needed for construction of the gate structures, tie-in of the sheet pile walls to sheet piles in the levees, boat ramps, creation of abutments to bolster the levees at the gate locations, and for any other land-side facilities such as parking for construction personnel and operations staff, and generators. Laydown areas would need to include initial staging of rock or sheet pile, as well as vehicles or equipment. Finally, approximately 3 acres of land would be needed for disposal of dredged material. The general geographic areas in which rights are expected to be needed for construction and laydown are shown in Figure 2-2. The offsite rock storage area on Holland Tract and spoil disposal area on the Bacon Island side of Connection Slough as required by Reclamation District 2028 are illustrated in Figures 2-2 and 2-3 and in Appendix F, Sheet C-21 and Appendix G Sheet C-81.

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2.3.6 Access

Most of the construction (e.g., dredging, placement of rock, and driving sheet pile) would be done from barges. However, it may be necessary to deploy earthmoving equipment on the islands to install levee buttresses. Figure 2-2 shows the access routes that would be needed from public roads to the Project locations. Movement of earthmoving equipment during construction is expected to be limited to the construction/laydown areas shown above. Truck access to the dredged material disposal site would be within the Connection Slough and Old River work areas.

Connection Slough and Old River Project Sites are navigable from the San Joaquin River. The Old River Site is accessible by land from Holland Tract and Bacon Island. The west Old River levee is on Holland Tract and is accessible by road by proceeding through the town of Knightsen and crossing Delta Road Bridge on Delta Road. The Old River project site is then accessed via a private road. The east side of the Old River Site is accessible via a private road crossing Bacon Island from east to west about 2 miles north of the Middle River Bridge and approximately 10 miles from State Route (SR) 4. Part of this access road on Bacon Island is unpaved. The Connection Slough Site can be accessed by Bacon Island Road. The Mandeville Island side of the Connection Slough Site is accessed via a bridge crossing Connection Slough (Figure 2-2).

Any degradation of levee roads, private or maintenance roads and other access roads that result from land based construction equipment use would be restored to pre-construction conditions. For example, it may be necessary to grade and apply gravel to the Holland Tract access road. It may be necessary to grade and gravel the unpaved part of the private road on Bacon Island. It also may be necessary to pave small sections on the Bacon Island Road between SR 4 and Connection Slough to ensure safe passage of land-based construction equipment.

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2.3.7 Vessel Passage during Construction

During construction, the contractor would maintain vessel access as needed. Notices of construction would be posted at local marinas and in the Local Notice to Mariners. Navigational markers would be used to prevent boaters from entering the construction area, and speed limits would be posted. Safe vessel passage procedures would be coordinated with the USCG and California Department of Boating and Waterways.

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2.3.8 Construction Schedule

The 2-Gates Project facilities would be installed in the fall of 2009 during the window for in-channel activities that was established by regulatory agencies to protect sensitive aquatic species. This window extends from September 1 until November 30. Construction work at the Old River and Connection Slough sites would be completed in about seven weeks. It would take place in the fall of 2009 in order to minimize impacts to sensitive aquatic and terrestrial resources as well as to avoid peak recreational use periods (Table 2-2). Site preparation prior to the placement of the barges would require about one month. This includes dredging the foundation areas of the barges, placing rock in the dredged area, and the installation of sheet pile walls. Placement of the barges would occur at the end of the site preparation period and would require approximately about two weeks to install each barge. Sheet pile installation would most likely be conducted during daylight hours only; dredging would be conducted 24 hours per day, as would rock placement and gate barge installation. Additional construction site details are presented in Appendices F and G.

Table 2-2 2-Gates Project Construction Timing and Duration

Construction Activity	Construction Timing	Construction Duration
Construction of sheet pile wall, dredging, installation of barge foundation rock	October – November 2009	Five weeks
Installation of barge with gates and anchor rock	November 2009	Two weeks

2.4 PROJECT OPERATIONS

The Project facilities would be operational immediately upon the completion of construction, and gates would be operated between December and June from 2009 to 2014. Gate structures including sheet pile walls would remain in place with gates in an open position from July through November of each year. A gate operator would be present at each site 24 hours a day during the operational period and would open and close the gates in response to fish protection criteria as well as to accommodate passage of commercial vessels and large recreational boats. The operator also would coordinate the operations necessary for passage of small recreational boats using the levee boat ramps when the gates are not otherwise open or open for approved large vessel traffic.

The Project would be operated by Reclamation or its designee in consultation with the Smelt Working Group (SWG), the Delta Operations for Salmon and Sturgeon Technical Working Group (DOSS), and the Water Operations Management Team (WOMT) in a manner that considers overall Delta ecosystem health and the needs of commercial and recreational boaters.

Detailed operational parameters and actions are described in more detail below. Gate operations would occur when smelt distributions are located north and west of the "region of control" of the Project facilities as determined by flow, water quality, and biological data collected by Project monitoring.

2.4.1 Factors Considered in Project Operations

2.4.1.1 Hydrodynamics and Water Quality Factors Affecting Smelt Entrainment

Historical entrainment of delta smelt at the export facilities has primarily occurred during the period of December through June. The recently released OCAP BO (USFWS 2008) identifies the linkages between turbidity and delta smelt occurrence. Adult delta smelt pre-spawning distribution is believed to be strongly related to specific ranges of salinity and turbidity. Water quality conditions characterized by electrical conductivity less than 400 µmhos/cm and turbidity greater than 12 NTU are associated with the occurrence of delta smelt. Delta smelt seeking these conditions are thought to move into the central Delta by surfing the tides to remain in areas of suitable water quality. Under the current configuration of the south Delta, high exports during early winter can cause net flow reversals of Old and Middle rivers, drawing water with the

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water quality conditions identified above into the south Delta. These conditions can lead to entrainment of pre-spawning adult delta smelt in SWP and CVP export facilities. In addition, adult delta smelt spawning dispersal into the south Delta would likely result in a high risk of entrainment for their progeny due to the proximity of the export facilities.

2.4.2 Hydrodynamic and Behavioral Models

A variety of models were developed by Resource Management Associates (RMA) to establish the Project concept and operational protocols (Appendix D):

- Hydrodynamics and Turbidity – These models (RMA2 and RMA 11) were used to simulate flow and turbidity patterns to identify opportunities for balancing flows in Old and Middle Rivers and controlling distribution of turbidity into the south Delta channels.
- Delta Smelt Behavioral Model – This model is based on a particle tracking model, incorporating known delta smelt behavior in response to water quality and flow gradients. This modeled theoretical pre-spawning adult response to flows and turbidity under existing and Project conditions. This allowed refinement of different gate operational scenarios to optimize desired turbidity conditions.

Each of the models is described below, and further details are provided in Appendix D.

2.4.2.1 Hydrodynamic and Turbidity Modeling

RMA has developed and refined models of the Sacramento-San Joaquin Delta system (Delta model) utilizing the RMA finite element models for surface waters (see Appendix D). The RMA models are a generalized hydrodynamic model used to compute two-dimensional depth-averaged velocity and water surface elevation (RMA2), and another model (RMA11) is a generalized two-dimensional depth-averaged water quality model that computes a temporal and spatial description of water quality parameters. RMA11 uses stage and velocity results from RMA2. The Delta model extends from Martinez to the confluence of the American and Sacramento Rivers and to Vernalis on the San Joaquin River. Daily average flows in the model are applied for the Sacramento River, Yolo Bypass, San Joaquin River, Cosumnes River, Mokelumne River, and miscellaneous eastside flows which include Calaveras River and other minor flows. The model interpolates between the daily average flows at noon each day. Delta Islands Consumptive Use (DICU) values address channel depletions, infiltration, evaporation, and precipitation, as well as Delta island agricultural use. DICU values are applied on a monthly average basis and were derived from monthly DSM2 input values. Delta exports applied in the model include SWP, CVP, Contra Costa exports at Rock Slough and Old River intakes, and North Bay Aqueduct intake at Barker Slough. Dayflow and IEP database data are used to set daily average export flows for the CVP, North Bay Aqueduct and Contra Costa's exports.

RMA ran a set of hydrodynamic, EC, and Turbidity simulations to form the basis of the initial gate operations schedule. The modeling study evaluated how conditions change in the Delta under (1) historical conditions, (2) historical conditions operated under the OCAP RPAs, and (3) operated under OCAP RPAs with the Project. Historical simulations were run for the period between December and July for 1999-2000, 2002-2003, 2003-2004 and 2007-2008. These years were selected because they were the only ones with adequate data (i.e. turbidity) to support the analysis.

2.4.2.2 Delta Smelt Behavioral Modeling

Delta smelt distribution and entrainment was modeled with two distinct particle tracking techniques representing the adult life stage and the larval/juvenile life stages (detailed in Appendix A). Adult delta smelt are not well represented using passive particle tracking techniques because they are sufficiently strong

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swimmers to resist tidal flows by moving out of the current and into shoals or near the bed where velocities are low. Entrainment of adult delta smelt occurs during the period when the fish choose to move upstream for spawning. Periods of peak entrainment are correlated with high turbidity in the neighborhood of the exports resulting from storm flows. RMA developed a particle behavior model to simulate the movement of adult delta smelt during this period based on simulated distributions of salinity (represented as electrical conductivity, EC) and turbidity. Because turbidity is a key driver for the distribution of adult smelt, the optimum gate operation to minimize adult entrainment is based on controlling progress of the turbidity plumes from the Sacramento and San Joaquin Rivers and reducing the turbidity along Old and Middle Rivers downstream of the export facilities.

Larval and juvenile delta smelt are considered to be small enough to represent as passively transported particles. Initial evaluation of gate operations for minimizing larval and juvenile entrainment was performed by CH2M Hill. In that study the DSM2-PTM was use to evaluate potential entrainment for smelt monitoring locations around the Delta. In this analysis a passive particle tracking methodology (developed by Dr. Edward Gross with Dr. Lenny Grimaldo [USBR] and Dr. Ted Sommer [DWR]) is used to represent the spatial and temporal distribution of larval and juvenile delta smelt, considering hatching rates, growth, and mortality. Hatching rates are derived through an automated tuning algorithm that develops a best fit estimate of regional hatching rates from the historic 20mm Trawl Surveys. Optimizing gate operations to minimize larval and juvenile entrainment involves minimizing advective and dispersive transport from regions of the Delta where fish densities are highest.

Both the adult and larval/juvenile particle tracking analyses utilize the RMA Bay-Delta Model for hydrodynamics and water quality simulation and the RMATRK particle tracking model.

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2.4.2.3 Real-Time Forecast Modeling

The following summary outlines the essential functions of a forecasting model to guide pre-emptive gate operations, using as a starting point the initial gate operations described here. This model is currently under development and would be operational when initial gate operations take place.

Effective real-time forecasting requires knowing initial water quality and flow conditions, acquiring and interpreting delta smelt survey and salvage data, operations forecasts, and timely agency interaction. Forecasts would utilize the most recent field observations of delta smelt distribution and density; and forecasted estimates of inflow, inflow water quality, and operations. For each forecast period, several simulations may be performed using alternative estimates of future conditions. An initial set of forecast simulations would be performed using best estimates of future operations provided by Reclamation and DWR system operators. Upon review of delta smelt distribution and entrainment estimates by the SWG, a second set of forecast simulations may be performed with revised future operations with the objective of identifying operations that reduce expected delta smelt entrainment.

In real-time, an initial set of forecast simulations would be performed using best estimates of future operations provided by Reclamation and DWR system operators. Upon review of delta smelt distribution and entrainment estimates by the SWG, a second set of forecast simulations may be performed with revised future operations with the objective of identifying operations that reduce expected delta smelt entrainment.

2-Gates Operations in Conjunction with OCAP BO Flow Management 2-Gates operations would be conducted in conjunction and coordination with the OCAP BO Old and Middle River RPAs. Flow, salinity, turbidity, and particle forecasting simulations would be performed to forecast timing of the Old River and Connection Slough gate operations consistent with the RPAs. OMR flows restrictions would be achieved primarily through export curtailments.

2.4.3 Gate Operation Protocols

Since the 2-Gates Project is being proposed as a temporary solution aimed at reducing delta smelt entrainment, it is useful to describe an operating plan that is sufficiently flexible to adapt to real-time monitoring and predictive hydrodynamic, water quality, and delta smelt behavior modeling. DSM2 modeling results have shown that the operational effects of various measures of entrainment are strongly influenced by the initial distribution of delta smelt and relatively short duration adverse hydrodynamic conditions in winter and spring. The following operating measures are described as examples of different operations under changing field conditions (Table 2-3).

Table 2-3 – Proposed Operational Scenario

Scenario	Season	Operational Schedule	Notes
Pre-spawning Adult protection	December-March	Gates closed from approximately 0.5 hour to 2.5 hours daily	▪ Gates would be operated to balance flows and maintain a turbidity gap in Old and Middle Rivers ▪ Operations triggered when turbidity. ≥ 12 NTU at San Joaquin River at Jersey Point. ▪ This period ends once water temperatures ≥ 12 degrees C
Larvae and Juvenile Protection	March to March 31	Old River gate closed on flood tide (twice daily, up to 10 hours total daily) and open on ebb and slack tides (~14 hours daily). Connection Slough gate closed except during slack tide (~4 hours daily).	▪ Gates would be operated to maximize dispersive mixing ▪ Commence operational scenario once water temperatures ≥ 12 degrees C
	April 1- May 31	Gates open all time	▪ Gates would not be operated during these months
	June 1-June 30	Old River gate closed on flood tide (twice daily, up to 10 hours total daily) and open on ebb and slack tides (~14 hours daily). Connection Slough gate open ~4 hours per day on slack-tides.	▪ Cease gate opertions June 30 or when Delta water temperatures ≥ 25 degrees C.
No Project Operations	July – November	Gates open all time	▪ Gates would be open continuously

2.4.3.1 Pre-spawning Adults — December through March

The 2-Gates Project operations are designed to be operated in conjunction with and in coordination with OMR flows prescribed through the USFWS and NMFS OCAP BOs (USFWS 2008, NMFS 2009). Project operations would take place in consultation with the SWG, DOSS, and the WOMT. The 2-Gate Project operations, in conjunction with OMR restrictions, would be guided by the following two actions:

The Old River and Connection Slough gates would be operated when triggering turbidity concentrations ≥ 12 NTU begin to appear at the region of influence of the 2-Gates, defined here as San Joaquin River at Jersey Point. Hydrodynamic modeling results indicate that the gates would be operated to balance flow to manage turbidity and adult delta smelt distributions, generally within the region of influence of 2-Gates. Behavioral modeling has shown that the 2-Gates Project, in conjunction with OMR flow restrictions, is effective in maintaining the turbid conditions linked to pre-spawning movement of delta smelt within the region of influence of the gates, thereby reducing the entrainment of delta smelt at the CVP and SWP pumps. These actions may also control the initial distribution of larval and juvenile delta smelt in locations that reduce the probability of entrainment at the CVP and SWP export facilities.

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Preemptive management of turbidity and associated adult delta smelt distributions would be accomplished using 2-Gates operations in conjunction with OMR flow restrictions established by the USFWS OCAP BO. Under this BO, the restriction of OMR negative flow rates would be triggered when turbidity is ≥ 12 NTU at three interior Delta sites (San Joaquin River at Prisoners Point, Jersey Point, and Victoria Canal). 2-Gates operations, however, would be triggered when when turbidity is ≥ 12 NTU at Jersey Point. These operations would actively manage turbidity distribution farther downstream and several days earlier than would occur under the USFWS OCAP BO RPAs alone. Hydrodynamic modeling indicates that this action would be effective in restricting smelt passage and reducing entrainment in conjunction with the 2-Gates. These operations would be taken until the three-station daily mean water temperatures at Mossdale, Antioch and Rio Vista ≥ 12ºC, signaling a transition from adult to larvae/juvenile delta smelt management actions. This typically would occur between mid-February and mid-March.

Daily operations of the gate during this period would involve closing both gates between 0.5 and 2.5 hours per day to balance daily flows. This is expected to manage the movement of the turbidity distribution and thus manage the distribution of adult delta smelt.

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2.4.3.2 Larvae and Juveniles — March through June

The 2-Gates operations for larvae/juvenile smelt would take place from March through June except during April and May, which are the months when San Joaquin River inflow-export ratios established in the NMFS OCAP BO are in effect. In March and June, the gates would be open on ebb tides and closed on flood tides for the protection of larvae and juveniles. During the San Joaquin River inflow-export period, the gates would remain open. 2-Gates operations and OMR restrictions would be governed by the following two actions:

- Based on the real-time monitoring of hydrodynamic conditions, 2-Gates operations and OMR restrictions for larvae/juvenile delta smelt would be imposed, in consultation with the SWG, DOSS, and the WOMT, when the three-station daily mean water temperatures at Mossdale, Antioch and Rio Vista are ≥ 12ºC, signaling a transition from adult to larvae/juvenile delta smelt management actions.
- 2-Gate operations and OMR restrictions would take place, consistent with boundary conditions of OMR discretionary operations, until June 30 or until the daily average temperature reaches 25ºC for three consecutive days at Clifton Court Forebay.

Daily gate operations under this scenario would involve (1) the Old River gate closed about 10 hours per day on flood-tide and open on ebb-tide (including slack-tides) about 14 hours per day, and (2) the Connection Slough gate open about 4 hours per day on slack-tides. The gates would remain open during April and May. During June, the gates would be open on weekends to facilitate vessel passage.

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2.4.3.3 July through November

The gates would not be operated from July through November, and would remain in a fully open position, because delta smelt are not found in the Delta once temperatures reach 25°C or until their up estuary migration begins in December.

2.4.3.4 Boat Navigation

The lead agencies would keep the Sector Waterways Management Division (USCG Station Yerba Buena Island) informed about the Project, so that relevant information regarding the gates, methods of vessel passage, expected closure schedule, and duration of barrier installation activities is included in the Local Notice to Mariners as appropriate. The USCG also would update navigation charts as appropriate. An educational program would be implemented to inform boaters of the purpose of the Project, expected duration of installation activities and gate closures, and operational characteristics of the gates. The program would include notices in local newspapers and boater publications as appropriate; notices also would be posted at local marinas and boat launches and on the Project website (http://www.baydeltalive.com/?page=Projects&subpage=Project%20Page&view=Project%20Page&id=563). Details regarding the anticipated schedule for gate openings and closures are included in Table 2-3.

Gate operators would be at the gates 24 hours a day and would open the gates for emergency situations when contacted by the USCG or Sheriff's Department and to allow access by large commercial and recreational vessels. Small recreational vessels up to 24 feet in length and less than 10,000 pounds would be allowed to portage around the 2-Gates facilities via the use of the boat ramps and small boat trailer facilities provided. As described above, two pile-supported boat ramps would straddle the sheet pile walls at each of the two sites.

2.4.4 Hydraulic Considerations

Under normal water conditions, the gates would not be submerged completely because the gate frames rise above the gates and would be visible under most water stages. During large flood events, the sheet pile wall would be over-topped, but all in-channel structures would be designed to withstand over-topping during such events. The gates would be open during flood events and would accommodate 100-year flood flows with an approximately 0.1-foot change in flood stage elevation compared to existing conditions.

The gates are designed to operate up to a 3-foot maximum surface water differential elevation on either side of the gates; however, because of high velocities at this differential, they would only be operated up to a differential of 1.5 feet.

2.5 MONITORING FRAMEWORK

The 2-Gates Project is a limited-term demonstration project proposed for up to a five-year trial period. Integral to the Project is a comprehensive monitoring and special studies program that serves multiple roles, including to provide:

- Information for efficient Project gate operation decisions.
- Data to test hypotheses and which should reduce uncertainties regarding delta smelt responses to Project gate operations behavior, preferred habitat and life histories.
- Data to allow verification and testing of the models for future evaluation of operational changes.
- Data on the changes in flow, turbidity and other variables to evaluate the effects of the Project operations.
- Data to evaluate potential Project effects on other species of interest (e.g., predation risk at gate structures, movement of salmonids and sturgeon).
- Guidance for adaptive modifications of project operations and structures.

This monitoring plan is attached as Appendix X. The approach also incorporates several special studies (and associated monitoring) required to test the physical process and delta smelt response concepts underlying project design (Appendices X and X).

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In order to understand the effects of 2-Gates Project operations on hydrodynamic processes, a network of fixed-site sampling stations would be placed at key locations throughout the Delta (Appendix X). These stations either coincide with or would augment the network of existing Delta monitoring stations (Figure 2-7, Table 2-4). These stations would monitor time-histories of various constituents such as temperature, salt, turbidity, and chlorophyll (Chl-a) at these locations, but would also measure the change in amount of these constituents. Co-locating constituent and discharge measurements make these calculations possible. The information would show how constituents vary in time at key locations in response to 2-Gate operations, and a record would be established of how 2-Gates operations alter exchanges between regions in the Delta through these key channels.

These above special studies would be part of a larger monitoring and special studies program intended to provide a comprehensive picture of Project effects and effectiveness, particularly in regard to possible impacts on other listed species (Appendix X). This larger program is currently being developed in collaboration with regulatory agency representatives (e.g., NMFS and USFWS) and system monitoring entities, such as the Interagency Ecological Program (IEP). Because of concerns regarding expanding biological sampling in the Delta, which can result in additional "take" of listed species, Reclamation and ______ have been collaborating on the development of a "trawl-cam," a trawl-mounted camera to harmlessly identify, measure,and count fish as they pass out the cod end of a trawl. Successful development of such a non-destructive sampling technique would provide the ability to expand sampling while not increasing take of listed species. The system is ready for field testing this spring and would be incorporated into the monitoring program for the 2-Gates project as appropriate. It is expected that this comprehensive monitoring program would include:

- Identification of key potential Project impacts on other species that would be addressed by the Monitoring Program.
- Expansion of acoustic tag based investigations of the survival and pathways of juvenile salmon emigrating through the Delta to address occurrence and survival in areas influenced by the Project.
- Expansion of the principal existing adult delta smelt abundance and distribution monitoring effort, IEP's Spring Kodiak Trawl Survey, to cover the full season of Project adult operations and to intensify sampling in the area of the Delta affected by the Project.
- Temporal and geographical intensification of the principal juvenile delta smelt abundance and distribution monitoring effort, IEP's 20mm Survey, to better assess juvenile smelt responses to Project operations.
- New large-fish acoustic camera monitoring at gate locations to assess gate effects on adult sturgeon and salmon migration, and to assess the abundance and behavior of fish predators in the vicinity of the gates.
- Compilation of data from all relevant existing, expanded, and new monitoring programs, such that it is easily available for use by Project staff and collaborators.
- Establishment of data synthesis and information dissemination infrastructures to feed adaptive management decision making regarding Project operations. It is expected that existing decision making bodies, such as the Smelt Working Group and Water Operations Management Team would be the principle recipients of monitoring information related to the Project.

Because the Delta is complex and always changing, controlled experiments are generally not possible. It is the intent to use the full body of information gathered through hydrodynamic modeling, and Project monitoring,

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special studies and field testing programs to draw inferences and conclusions about Project effects and effectiveness and expand our knowledge about how the Delta.

Monitoring Stations for Flow and Water Qualtiy

HYDRODYNAMICS

Flow conditions in the Sacramento and San Joaquin Delta are monitored at 19 existing sites from the Sacramento River at Freeport and the San Joaquin River at Mossdale to Collinsville (see Table 2-4 and Figure 2-7). The stations are maintained by DWR, USGS, and Reclamation. Five new sites would be added including one on the San Joaquin River at Oulton Point, and sites at either side of each gate (see Figure 2-7).

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ELECTRICAL CONDUCTIVITY

EC in the Sacramento and San Joaquin Delta is monitored at 15 existing sites from the Sacramento River at Freeport and the San Joaquin River at Mossdale to Collinsville (see Table 2-4and Figure 2-7). The stations are maintained by DWR, USGS, and Reclamation. EC would be added to the existing Victoria Canal site and to five new sites as noted in the Hydrodynamics paragraph above.

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TURBIDITY

Turbidity in the Sacramento and San Joaquin Delta is monitored at four existing sites from the Sacramento River at Freeport and Hood and at Jersey Point and Prisoner's Point on the San Joaquin River (see Table 2-4 and Figure 2-7). The stations are maintained by DWR, USGS, and Reclamation. Turbidity would be added to eleven existing stations and to the five new sites as noted in the Hydrodynamics paragraph above (see Table 2-4).

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WATER TEMPERATURE

Water temperature in the Sacramento and San Joaquin Delta is monitored at five existing sites in the Central Delta (see Table 2-4 and Figure 2-7). The stations are maintained by USGS and Reclamation. Water temperature would be added to eight existing stations and to the five new sites as noted in the Hydrodynamics paragraph above (see Table 2-4).

DISSOLVED OXYGEN

Dissolved Oxygen in the Sacramento and San Joaquin Delta is monitored at one existing site in the Victoria Canal (see Table 2-4 and Figure 2-7). This station is maintained by USGS. Dissolved Oxygen would be added to twelve existing stations and to the five new sites as noted in the Hydrodynamics paragraph above (see Table 2-4).

CHLOROPHYLL-A

Chlorophyll-a in the Sacramento and San Joaquin Delta is monitored at one existing site at the San Joaquin River at Mossdale (see Table 2-4 and Figure 2-7). This station is maintained by DWR. Chlorophyll-a would be added to twelve existing stations and to the five new sites as noted in the Hydrodynamics paragraph above (see Table 2-4).

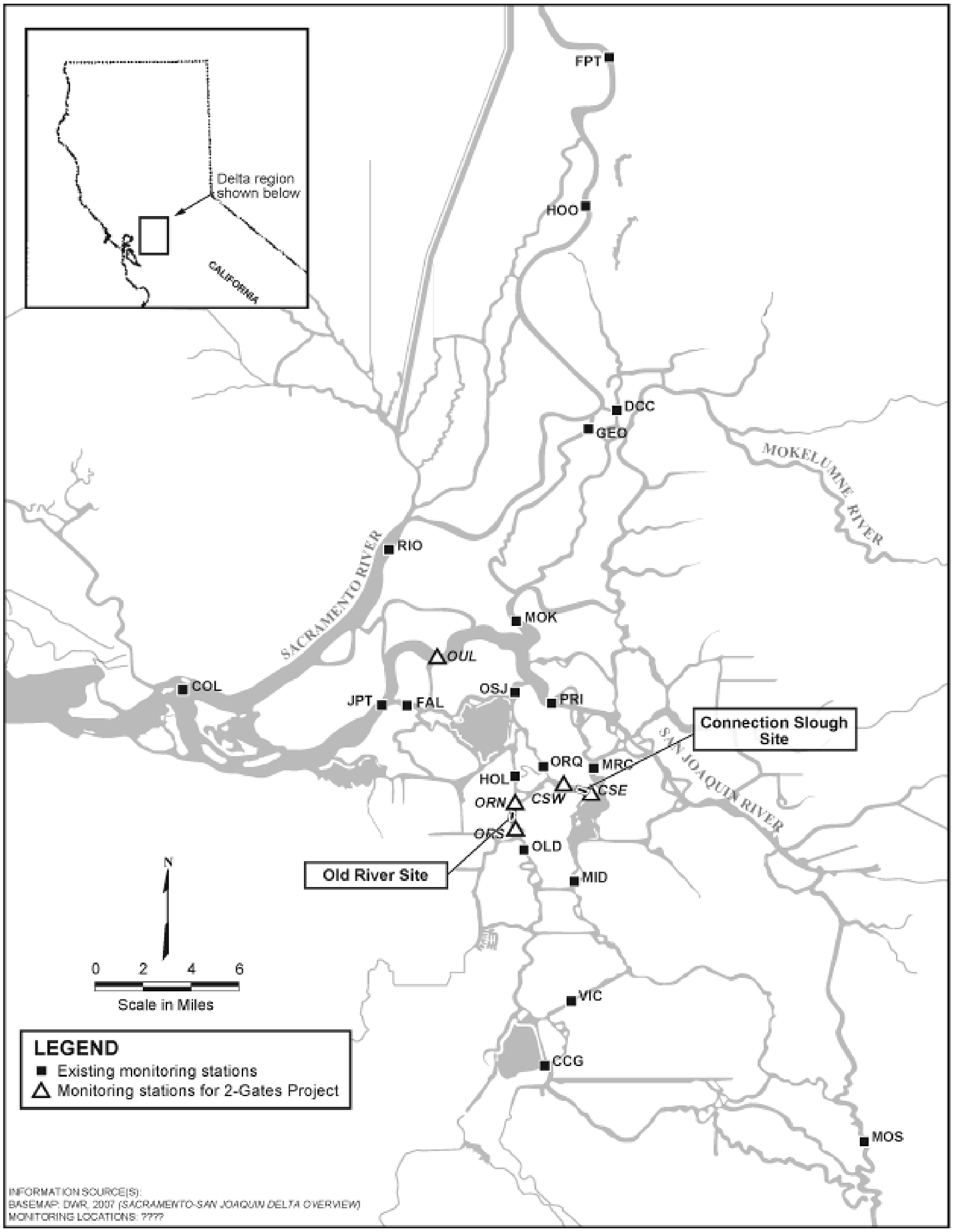

Figure 2-7 Locations of Existing DWR, Reclamation, and USGS Monitoring Stations in the Delta and Stations Added for the Project

Table 2-4 Existing and New Monitoring Stations and Parameters Supporting Operations of the 2-Gates Project

	Owner			Parameter Measured					
	USBR	DWR	USGS	Flow	Electrical Conductivity	Turbidity	Water Temp	Dissolved Oxygen	Chlorophyll -a
Locations of Existing Monitoring Stations									
Sacramento River at Freeport (FPT)		●		E		E			
Sacramento River at Hood (HOO)		●	●	E	E	E			
Delta Cross Channel (DCC)			●	E	E				
Georgiana Slough (GEO)			●	E					
Sacramento River at Rio Vista (RIO)			●	E	E				
Sacramento River at Collinsville (COL)	●		●	E	E	N	N	N	N
San Joaquin River at Mossdale (MOS)		●		E	E	N	N	N	E
San Joaquin River at Prisoners Point (PRI)	●		●	E	E	E	E	N	N
San Joaquin River at Jersey Point (JPT)		●	●	E	E	E	N	N	N
Mokelumne River at Andrus Island (MOK)			●	E					
Middle River at Columbia Cut (MRC)			●	E	E	N	N	N	N
Middle River at Bacon Island (MID)		●	●	E	E	N	N	N	N
Old River at Franks Tract (OSJ)			●	E	E	N	E	N	N
Old River at Quimby Island (ORQ)			●	E	E	N	E	N	N
Old River at Bacon Island (OLD)		●	●	E	E	N	N	N	N
False River (FAL)			●	E	E	N	E	N	N
Holland Cut (HOL)			●	E	E	N	E	N	N
Victoria Canal (VIC)			●	E	N	N	N	E	N
Clifton Court Gates (CCG)			●	E	E	N	N	N	N
Locations of New Monitoring Stations									
San Joaquin River at Oulton Point (OUL)					N	N	N	N	N
N of Old River Gate (ORN)					N	N	N	N	N
S of Old River Gate (ORS)					N	N	N	N	N
W of Connection Slough Gate (CSW)					N	N	N	N	N
E of Connection Slough Gate (CSE)					N	N	N	N	N

Note: “E” refers to existing monitoring activity; “N” refers to new monitoring activity added for 2-Gates Project.

DELTA SMELT AND LONGFIN SMELT

DFG monitors the distribution and abundance of adult delta smelt using the Spring Kodiak Trawl (SKT). Stations 809, 812, 815, 901, and 902 are in close proximity to the gates (see Figure 2-8). Presence of adult delta smelt at these stations would indicate higher risk of potential entrainment. DFG's existing program monitors smelt monthly, beginning in February or March depending on conditions. The 2-Gates Project would require sampling twice a week beginning in December.

The distribution of larval and juvenile smelt is monitored by the DFG's 20 mm survey using the same stations as the SKT on a monthly basis. The 2-Gates Project would require sampling twice a month beginning in March.

Existing salvage monitoring would be employed to evaluate periods of entrainment within the CVP and SWP project facilities to assess performance of the 2-Gates operations.

SALMON AND STEELHEAD

Coordinated studies of acoustically tagged salmon and steelhead occurred on the Sacramento, Mokelumne and San Joaquin rivers in 2008-2009. These studies collectively released thousands of acoustically tagged fish that were individually tracked by remote receiving stations installed throughout the Delta (see Figure 2-9). Some of these fish traveled to the vicinity of the gates and on to the fish salvage facilities. If similar studies are anticipated during 2-Gates Project operations, the plan would support additional acoustic tagging and remote recording sites on either side of each gate to better evaluate how salmon and steelhead move passed the gate structures and into and through the central and south Delta.

GREEN STURGEON

Very little information is available on how green sturgeon use the Delta, including what life stages are present and what areas of the Delta are used for feeding or rearing. Sturgeon are not taken in the ongoing netting operations but are collected at the CVP and SWP export facilities. This project may provide an opportunity to use fish collected at the facility, acoustically tag the fish and release them in the project vicinity. This would provide basic information on distribution of green sturgeon, at least during the time that the acoustic receivers are deployed during winter and spring for salmon and steelhead.

Fish Passage and Predation

SONIC CAMERAS (DIDSON CAMERAS)

Sonic cameras (DIDSON cameras) would be used to detect large fish or fish populations in the vicinity of the gates and in other similar habitats in Old River and Connection Slough. Cameras would be fixed or boat mounted and pre-set to detect target species in designated depth ranges and sizes. The boat mounted DIDSON camera would be operated at established monitoring points used to repetitively monitor conditions on both sides of each gate (see Figures 2-10 and 2-11). Monitoring sites would include near-gate sites and sites in other locations in the channel without a gate structure. The boat mounted DIDSON camera would also be used to investigate changes in fish distribution during times when the gate is opened or closed,. DIDSON cameras would be used to monitor:

- Predator fish in the vicinity of the gate structures compared to predators in other similar habitats.

- Whether sturgeon or other migratory fish are detected passing the gate when open or closed, or if they persist in the gate area when the gates are closed.

- Possible behavior of fish near the gate structures.

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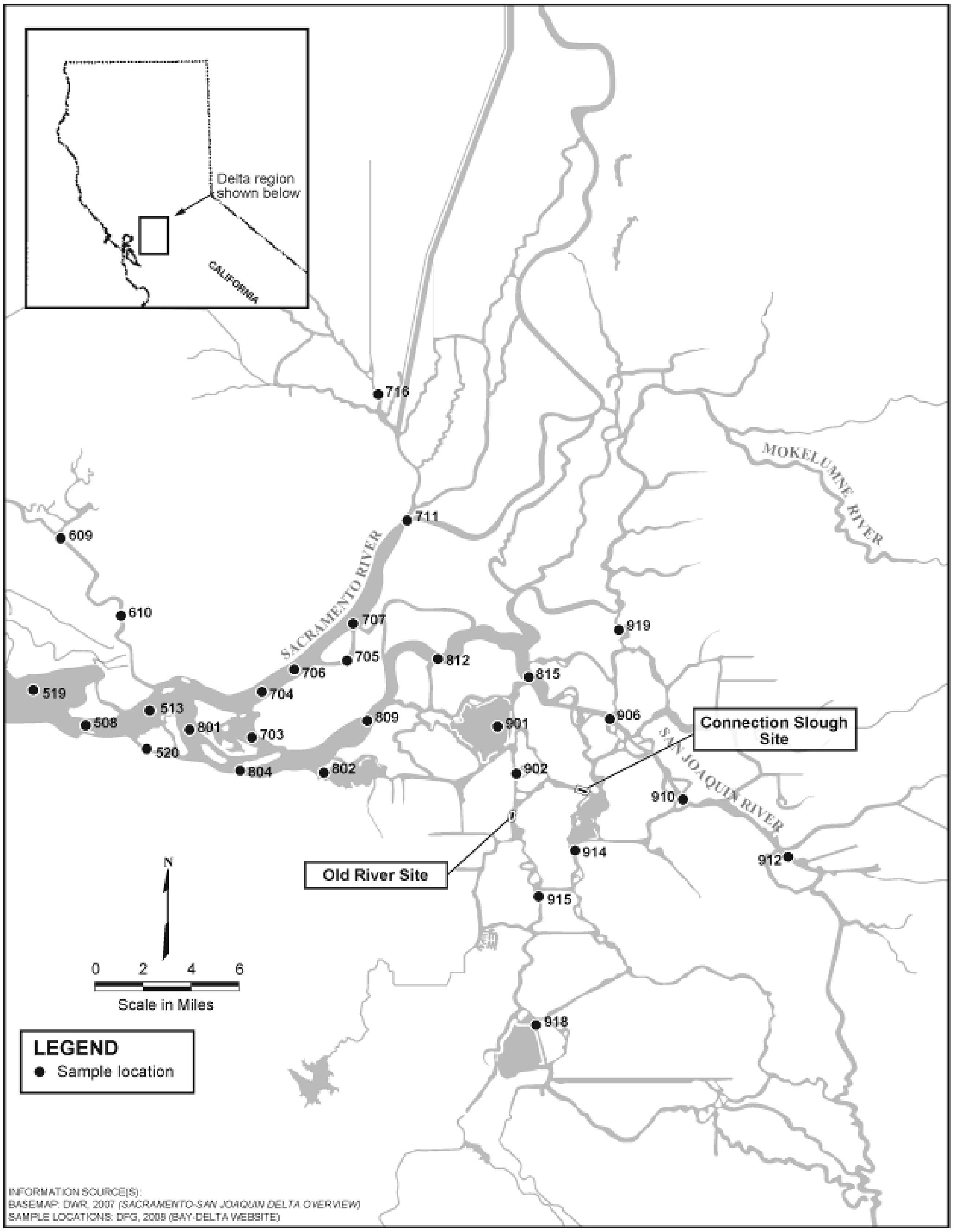

Figure 2-8 IEP Interior Delta Monitoring Stations for Fisheries Surveys

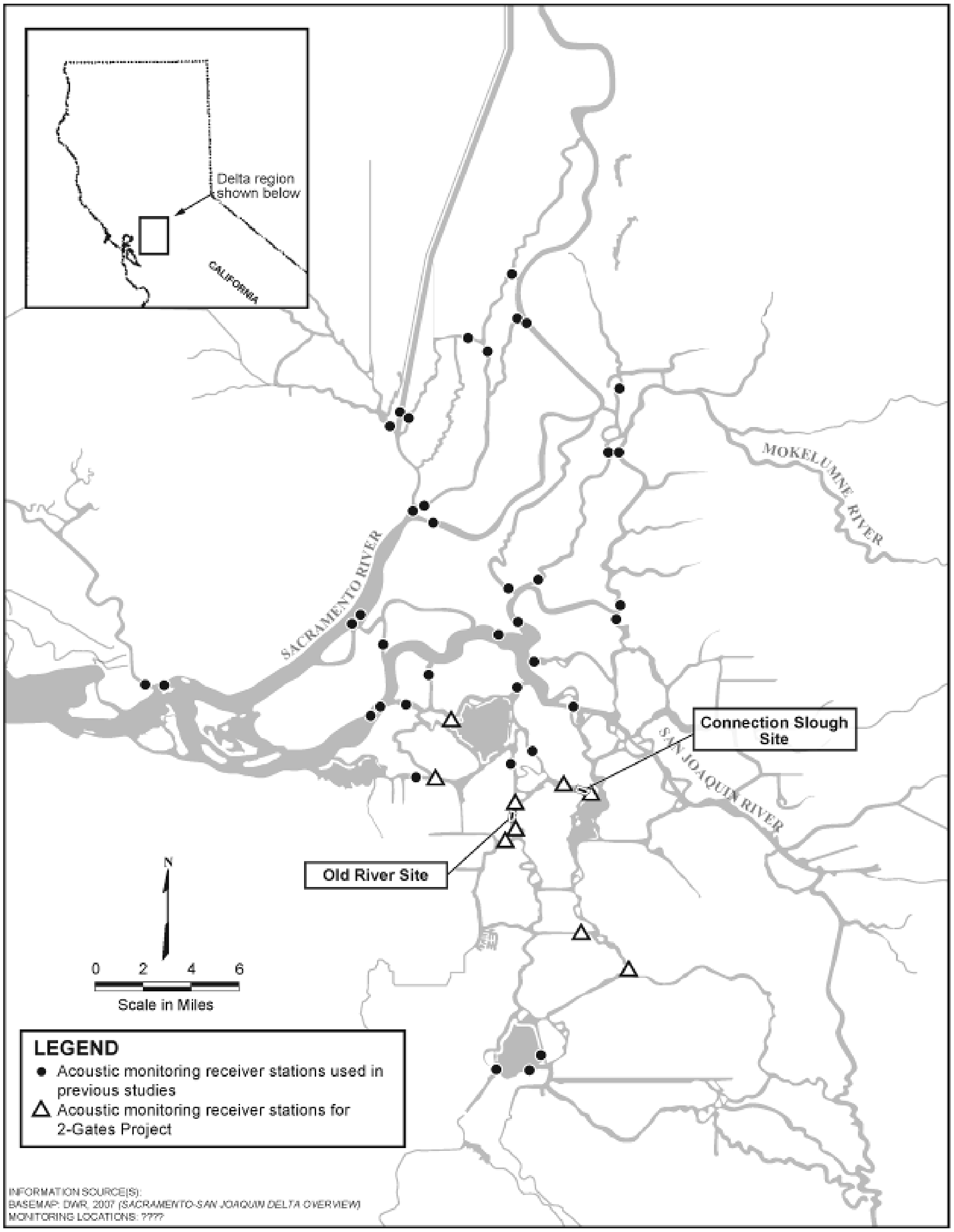

Figure 2-9 Acoustic Monitoring Stations Used in Previous Studies and Monitoring Stations Added for the Project

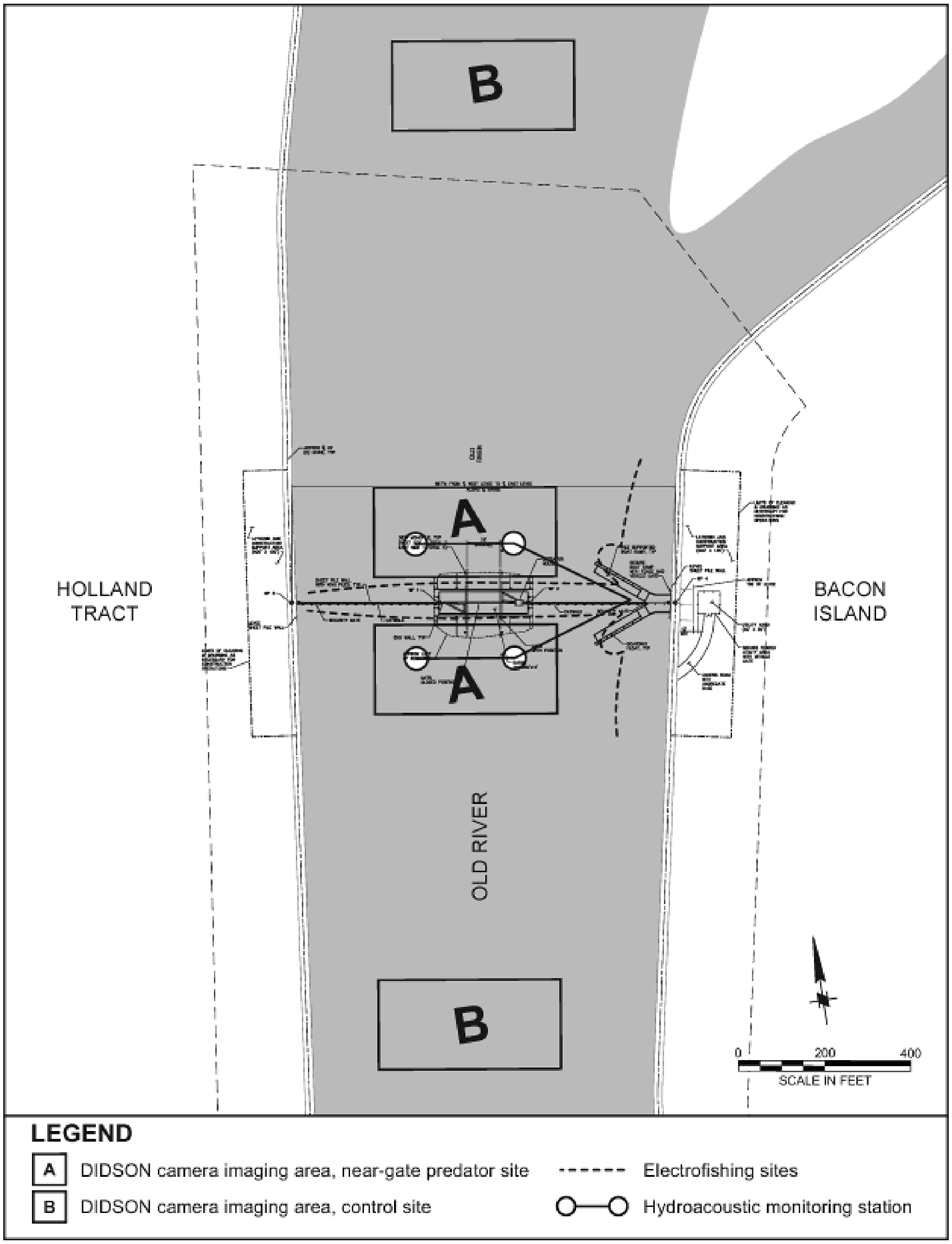

Figure 2-10 Old River Gate Area showing location of continuously recording hydrophone array, monitoring areas for boat-based DIDSON imaging and electrofishing sites.

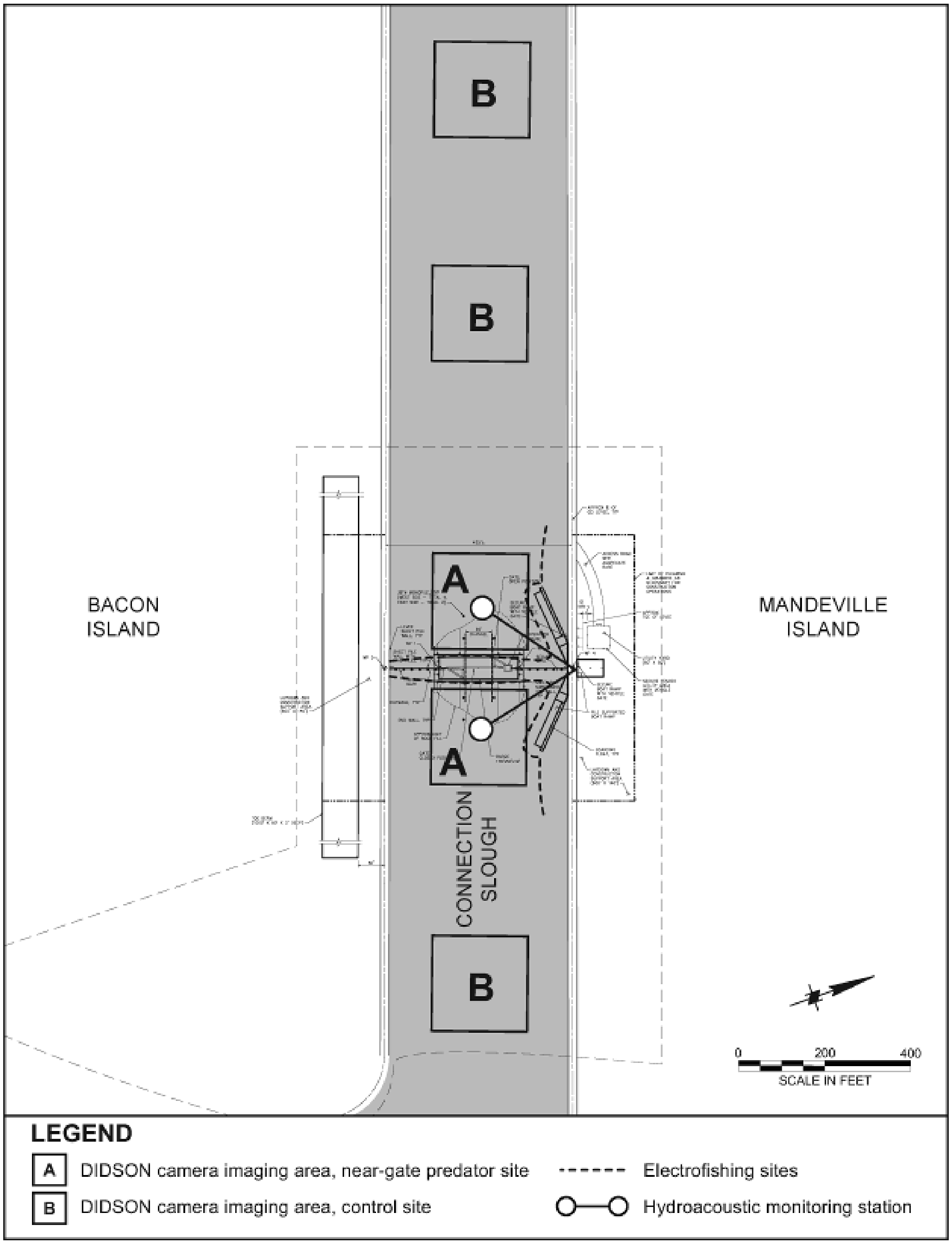

Figure 2-11 Connection Slough Gate Area showing location of continuously recording hydrophone stations, areas for boat-based DIDSON imaging and electrofishing sites.

BOAT ELECTROFISHING, SEINES, GILLNETS AND ANGLING

Boat mounted electrofishers may be used to assess fish populations in the vicinity of the gates. Electrofishing may be used to sample fish in close proximity to the gates and at other locations without gates. Electofishing may be used to reduce predator populations in the vicinity of the gate if assessments indicate a high abuandacne of large predatory fish. Seines, angling or large mesh gill nets may be used to remove predator fish such as striped bass or largemouth bass from the area near the gates.

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2.5.1 Data Collection and Distribution

All data would be collected in accordance with established, standardized sampling protocols. Existing sampling programs would utilize existing written sampling protocols when conducting sampling at new locations or times. New written protocols would be developed for new monitoring programs, such as DIDSON camera monitoring. All written protocols would be refined for project needs and provided to Reclamation and , for review and comment. All data would be collected to the highest standard of accuracy.

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All data would be carefully entered and stored in specifically designed Access databases. These databases would include both existing agency databases and a new 2-Gates monitoring team database. Data would be pulled from agency databases and the 2-Gates monitoring team database by the 2-Gates analysis and synthesis team (Figure C-6).

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2.5.1.1 Quality Assurance/Quality Control

All data pulled from agency and project team databases would be subject to 2-Gates monitoring team QA/QC procedures. These procedures would include written protocols, staff training, data checks, fish identification verification, and peer-review procedures. Written protocols would be developed for all sampling and monitoring, and provided during staff trainings to ensure all data are collected according to established standards. Field data would be checked at collection. All monitoring data would be tagged as preliminary, provisional, or final prior to use in updates and reports by the analysis and synthesis team.

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2.5.1.2 Analyses Framework

Monitoring results would be utilized to drive an adaptive management feedback loop in which the Project team and agency representatives would analyze the data that is collected, communicate the results, and make decisions to adapt operations and monitoring. Key elements that would be considered include:

- Determining the effectiveness of OCAP and 2-Gates triggers for gate operations including the 12 NTU turbidity threshold and Old River/Middle River reverse flow ratios.
- Defining desired water quality conditions and fish abundance indices in order to gauge project effectiveness over short and long time scales.
- Defining thresholds for considering and implementing operational changes.
- Defining the types of operational changes that could feasibly be implemented.
- Obtaining baseline data from existing or additional monitoring programs.
- Refining existing water quality and fish behavior models to better define the relationship between hydrodynamics, turbidity, and fish response based on new data.

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Statistical analyses may be performed with several programs (i.e., S+, R, Origin, PRIMER, JMP and Excel). Daily and weekly memorandums, as well as monthly reports, would be written by the analysis and synthesis team and provided to the SWG and the DOSS. The SWG and DOSS may make additional data requests to the analysis and synthesis team. After analyzing the memorandums and reports the SWG amd DOSS would provide operational recommendations to the WOMT. The WOMT would make major decisions on operational changes related to the Project. The WOMT may request additional information and analysis from the SWG or the Project analysis and synthesis team (Figure X –to be added).

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2.5.1.3 Products and Disposition of Results

Deliverables would include monthly progress reports with invoices, brief daily and weekly memorandums, e-mail status updates, alerts and meetings on potential problems or surprises affecting operations or deliveries, presentations at science conferences, and annual drafts and final reports. All deliverables and results from the 2-Gates monitoring effort would be provided to the WOMT and the SWG for incorporation into the decision making process for operation of the SWP and CVP facilities and to the entity responsible for operating the gates. Under a follow-on assignment, report sections may be developed and submitted for peer-reviewed publications to broadly disseminate the findings of the 2-Gates monitoring team, so other Central Valley projects may benefit from lessons learned here.

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2.5.1.4 Feedback to Project team

The SWG and the WOMT would provide the Project analysis and synthesis team with feedback in a variety of forms. The SWG and WOMT may need additional data and analysis, an answer to a specific question, or clarification on a statement made in an analysis document. Furthermore, the SWG and WOMT would make annual assessments of whether Project monitoring protocols were meeting the needs of Project decision makers. An open line of communication between the SWG, DOSS, and the WOMT, and the Project analysis and synthesis team would be essential to the success of the monitoring program.

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2.6 PROJECT MAINTENANCE

Project facilities would require limited maintenance, which would include:

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- Infrequent fueling and lubrication of emergency generators,
- Repair of coatings (e.g., painting) necessary to maintain equipment function, and
- Equipment repair essential to maintain Project function.

On-site maintenance would occur on a regular basis through qualified contracting services retained as part of the operational protocols of the Project. Annual maintenance activities would be scheduled to occur during the summer-fall non-operations period.

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2.7 FACILITIES REMOVAL

In 2014, at the completion of the five-year demonstration period, the barges and all associated facilities would be deballasted and removed from the Project sites. Rock fill would be removed down to the initial channel bed elevation and transported from the area on barges or by trucks to the off-site rock storage area shown in Figure 2-2. All other structures and materials including the boat launching structures would be removed. The removal process would take approximately four weeks.

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2.8 SITE RESTORATION

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Disturbed areas would be restored after initial construction and after Project structures were removed, including construction laydown areas, land-based utility yards, and pile-supported boat ramps. Restoration activities would be facilitated by siting access routes, laydown areas, and structures to avoid sensitive areas (e.g., wetlands) and by limiting the duration of the use of land-based areas. The construction laydown areas would be used only during the associated land-based construction/removal periods. The affected areas would be restored to meet local land use and resource agency requirements as soon as they were no longer needed. The pile-supported boat ramps would be removed as soon as they are no longer necessary, and the area below these decks also would be restored to meet local land use and resource agency permit conditions.

A restoration plan would be developed, as required by applicable regulatory agencies, and would be completed prior to the onset of construction. The restoration plan would identify areas that would be restored and restoration methods. Seed mixes, schedules, success criteria, and success monitoring for restoration of wetlands, streams, and drainages would be identified. The restoration plan would be included in the contract specifications.

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2.9 PROTECTIVE MEASURES FOR LISTED SPECIES

This section describes the features of the Project that have been incorporated into the design and construction approaches to avoid and protect listed species and habitats.

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2.9.1 Avoidance of Sensitive Resources

Qualified biologists and archaeologists have been working closely with the Project engineers to design the Project in the least environmentally damaging manner. Sensitive biological resources have been identified and avoided to the extent feasible. Avoidance measures also would be used in the field during construction as a result of preconstruction surveys or at the direction of permitting documents or additional consultations. If required, the construction would be coordinated through a specialist familiar with the species involved. The locations of all sensitive biological (and cultural) resources and the methods to avoid them would be included in the construction drawings.

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2.9.2 Minimization of Impacts on Sensitive Aquatic Species

Project construction and operations have been designed to reduce or eliminate potential adverse effects on sensitive aquatic species. Further, the Project contains augmentations to existing monitoring programs to inform day-to-day operations of project facilities and further reduce adverse effects to resident and anadromous species. Adverse effects on listed aquatic species have been identified in this MND/EA and measures to minimize or avoid those effects are included in this MND/EA. The Project is subject to the permitting requirements of the USFWS, NMFS, and DFG, and these agencies may impose additional measures for any issues not addressed in this MND/EA. The lead agencies would comply with the RPAs or other actions required by these regulatory agencies.

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2.9.3 Erosion, Sediment Control, and Spill Prevention Measures

Installation of the gates may result in sediment being disrupted to create increased turbidity within the areas where dredging would occur. Areas along the levees that are cleared prior to construction or where materials would be stored may disturb soil and vegetation and expose sites to possible erosion. Best Management Practices (BMPs) would be undertaken in accordance with the California Code of Regulations. Spill prevention measures detailed in the Storm Water Pollution Prevention Plan (SWPPP), as required under the

National Pollutant Discharge Elimination System permit mandated by the Central Valley Regional Water Quality Control Board, would be developed to prevent or minimize soil erosion and protect against storm water runoff. In addition, the contractor would be required to make special provisions to prevent contamination, related to fuel or oil spills from construction vehicles, and to designate specific areas for vehicle fueling, oil changing, and washout of concrete trucks with controls to eliminate runoff.

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The following standard erosion and sediment control measures and practices would be used during and after construction to ensure that impacts from soil erosion and sedimentation are less than significant:

- Minimize site disturbance
- Perform initial cleanup
- Compact subsurface backfill material
- Leave topsoil in roughened condition
- Construct water bars
- Perform seeding and mulching
- Install erosion control blankets
- Install silt fencing and straw bale dikes
- Conduct daily inspections and periodic maintenance of erosion and sediment control measures

These measures are routinely implemented in the construction industry and have been proven successful for similar projects.

The following measures have been incorporated into the Project design and operations plan in order to minimize impacts on water quality and aquatic species from in-channel construction:

- The dikes on either side of the barge that supports the operable gates would be constructed of sheet piles instead of rock. This would minimize impacts by:
  - Minimizing the footprint of the Project
  - Minimizing the amount of dredging that is necessary along the bottom of Connection Slough and Old River, thus reducing the amount of soft bottom habitat loss, turbidity caused by dredging, dredged material, and the dredge disposal area required.
  - Minimizing the amount of turbidity resulting from in-water construction activities by reducing the footprint area of dikes connecting the gate structure to adjoining levees and reducing in-channel excavation only to that directly under the gate structure.
  - Reducing predation because sheet piles provide less habitat structure for predator fish in the vicinity of the gates.

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2.9.4 Turbidity Criteria

For the construction phase (late summer to early winter 2009) and the removal in 2014, the following turbidity control performance measures would be implemented, subject to the approval of the applicable resource agencies (USFWS, NMFS, and DFG). The primary turbidity control method would be the cessation of activities (e.g., dredging) contributing to the increase in local turbidity.

- The Project contractor would minimize turbidity increases in surface waters to the extent practicable by conducting all in-water activities in a manner that minimizes turbidity through the implementation of approved BMPs and complying with the requirements of the RWQCB Water Quality Certification. The water quality criteria for turbidity in the Delta are as follows:

– Where natural turbidity is between 0 and 5 NTUs, increases would not exceed 1 NTU.

– Where natural turbidity is between 5 and 50 NTUs, increases would not exceed 20 percent. Where natural turbidity is between 50 and 100 NTUs, increase would not exceed 10 NTU.

– Where natural turbidity is greater than 100 NTUs, increases would not exceed 10 percent. These limits would be eased during in-water working periods to allow a turbidity increase of 15 NTU over background turbidity as measured in surface waters 300 feet downstream from the working area.

In determining compliance with above criteria, appropriate averaging periods may be applied, provided that beneficial uses would be protected. Turbidity would be monitored by taking grab samples for analysis of NTU levels twice per day during the work period.

2.10 ENVIRONMENTAL COMMITMENTS/MINIMIZATION AND AVOIDANCE MEASURES INCORPORATED AS PART OF THE PROJECT

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The following mitigation measures have been identified as part of the environmental impact analysis conducted in the associated MND/EA Mitigated Negative Declaration/ Environmental Assessment (MND/EA) and would be implemented as part of the Project. All of the mitigation measures noted in the MND/EA have been identified below to fully disclose all details of the Project but many are not relevant to aquatic resources. At both sites land adjacent to the levees is lower then the water surface in the channels therefore, disturbance to these areas are not likely to affect fishery resource through the process of erosion. Seasonal wetland affects are evaluated in the Terrestrial portion of this BA. The mitigation measures that are relevant to aquatic species are Mitigation Measure BIO-8 and Mitigation Measures REC-1 and REC-2.

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Mitigation Measure BIO-1: Avoidance, minimization, and mitigation measures for GGS would include the conduct of preconstruction surveys, biological monitoring during construction, and the implementation of the following protection measures by the Project Proponent:

Mitigation Measures (a) and (b) would be applied if land-based construction occurs during the active season for GGS:

(a) All land-based site disturbance, including gate construction and removal shall be conducted during the active season for GGS, between May 1 and September 30, when the snakes are active and the risk of direct mortality is lessened. Before any ground-disturbing construction activities begin, a Service-approved biologist would conduct focused surveys for this species on the Project site. At a minimum a visual preconstruction survey would be conducted not more than 24 hours before the start of construction in any portion of the Project site slated for ground-disturbing activities. Focused surveys must be conducted every year in which Project construction activities or land-based disturbance occurs.

Construction related activities may require daily monitoring during the active season for GGS. If this is deemed necessary, all land-based disturbance and channel/water work shall be monitored by a Service-approved biologist and a visual survey would be conducted every morning prior to equipment moving to avoid crushing animals. When possible, habitat features useful to GGS would be avoided or removal would be closely monitored by the Service-approved biologist. Habitat features include rip-rap, rodent burrows, debris piles, and dense vegetation.

There is a potential that trapping surveys would be effective in some areas of the Project site and may be implemented upon approval of this method by DFG and USFWS.

(b) Not less than 48 hours prior to the start of any construction activities, including the removal of the structures, the Service-approved biologist would monitor the installation of exclusionary fencing around the terrestrial portion of the area subject to disturbance. The fencing would contain one-way exits so snakes within the fenced area would be able to escape but not reenter. The fence would be installed during the active season, May 1 to September 30, to avoid potential impacts to snakes using underground upland retreats. Habitat features suitable for GGS within the perimeter of the fence would be removed under the direct supervision of the biologist, and any snake detected would be allowed to leave on its own accord. The USFWS and DFG would be notified within 24 hours of any GGS (living or dead) observed during Project construction.

Mitigation measure (c) would be applied if land-based construction occurs during the dormant season for GGS:

(c) Implemention of the following mitigation measure would reduce the potential for impacts on GGS to a less-than-significant level because preconstruction surveys would identify whether the species is present, and monitoring would ensure that appropriate measures were implemented to avoid impacts. Construction also would be scheduled during periods when GGS are active and risk of direct mortality are lessened. Exclusionary fencing also would be used to ensure that snakes can leave, but not reenter the construction area, and workers would be trained in appropriate practices. A qualified biologist in possession of a recovery permit for GGS would conduct a preconstruction survey of the site and would monitor all initial site disturbance, including vegetation clearing, the removal of piles of debris, construction materials, agricultural equipment, riprap along the levees, and other materials that may provide suitable upland refugia for giant garter snakes. The biologist would monitor all initial site disturbance in areas where small mammal burrows or subsurface features that provide hibernation habitat are present. The biologist would have the authority to direct the excavation of suitable hibernation habitat in a manner that would maximize the potential for live salvage and minimize the risk that snakes would be crushed or wounded. A USFWS and DFG-approved captive salvage facility would be identified prior to the start of ground disturbance. If live GGS are detected during construction, the permitted biologist would salvage and protect the snake in the approved facility until it can be released during the active season (May 1 to September 30) to suitable habitat outside the area of disturbance. The USFWS and DFG would be notified within 24 hours of any GGS observed during Project construction.

Mitigation measures (d) through (g) would be applied regardless of the timing of construction activities.

(d) Before construction and prior to removal, a worker environmental training awareness program would be conducted by a Service-approved biologist. The training would include a description of the GGS including natural history and habitat, a review of the State and Federal listing of the species, the general protection measures to be implemented to protect the species, and a delineation of the limits of the work areas. Employees also would be required to sign documents stating that they understand that the taking of listed species and destruction or damage of their habitat could be a violation of State and Federal law.

(e) If the species is observed at the construction site at any time during construction or operations, work would cease immediately within 200 feet of the area until the snake leaves the work area under its own volition and is out of harm's way. USFWS and DFG would be contacted immediately.

(f) A monitoring report of all activities associated with surveys and mitigation for this species would be submitted to DFG and USFWS no later than one month after land-based construction is completed.

(g) At the end of the 2-Gates Project, terrestrial and wetland habitat disturbed during construction and removal of the gates shall be restored to pre-Project conditions. Restoration work may include replacing riprap removed during construction and replanting with plant species that were removed during construction and removal activities.

Mitigation Measure BIO-2: The Project Proponent would implement the following measures to minimize potential impacts on western pond turtles:

(a) Not more than 48 hours prior to the start of site disturbance, a qualified biologist familiar with western pond turtle behavior would conduct focused visual surveys for western pond turtles and any nesting activity (i.e. nests, egg shell fragments) on the Project site. Preconstruction surveys should include available nesting habitats within 1319 feet of suitable aquatic habitats that would be impacted during construction or removal of the Project. After the preconstruction surveys, silt fencing, buried not less than 6 inches at the base, would be installed around the perimeter of the laydown area, and the removal of vegetation within the laydown areas that is required for Project construction would be conducted under the direct supervision of the qualified biologist.

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(b) If juvenile or adult turtles are found aestivating or hibernating on the Project site, construction work would cease within 50 feet of the area and the biologist would move the individuals out of the construction area to suitable habitat prior to resuming construction work. If a nest is found in the construction area, DFG would be notified immediately to determine appropriate measures to protect or relocate the nest. Surveys must be conducted every year in which land-based construction activities occur.

(c) A letter report documenting survey methods and findings would be submitted to DFG following the completion of the preconstruction survey.

(d) Before land-based construction, a worker environmental training awareness program would be conducted by a qualified biologist. The training would include instruction regarding species identification, natural history, aquatic and upland nesting habitat, the general conservation measures to be implemented to protect the species, and a delineation of the limits of work.

Mitigation Measure BIO-3: Conduct surveys for western burrowing owl and, avoidance or mitigation for owls, if present. The Project proponent would implement the following measures to minimize potential impacts on burrowing owls:

The California Burrowing Owl Consortium's Burrowing Owl Survey Protocol and Mitigation Guidelines (1997) and the DFG Staff Report on Burrowing Owl Mitigation (1995) state that mitigation actions should be carried out from September 1 to January 31. These documents explain that reproductive timing may vary with latitude and climatic conditions, therefore the Staff Report states that the time frame to carry out mitigation activities should be adjusted accordingly.

(a) Surveys consistent with the California Burrowing Owl Survey Protocol (California Burrowing Owl Consortium 1997) would be conducted in all areas where construction-related site disturbance may occur and within a 500-foot buffer of land-based disturbance. A survey to determine if suitable burrows (larger than 3.5 inches diameter) are present in all areas of ground disturbance would be conducted. If no burrows suitable for burrowing owls are present in areas of ground disturbance then no other activities are necessary to avoid effects to individuals.

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(b) If suitable burrows are present in the Project area then all areas of ground disturbance (including access roads) should be surveyed for occupancy by burrowing owls within 30 days of initial ground disturbance. The California Burrowing Owl Survey Protocol (CBOC 1997) calls for up to four surveys on four separate days to determine burrowing owl presence or absence.

(c) No disturbance would occur within 250 feet of occupied burrows during the breeding season (February 1 through August 31). If burrowing owls are present within 160 feet of construction during the non-breeding season (September 1 through January 31), a site-specific impact avoidance plan would be prepared by a burrowing owl biologist[5] and submitted to DFG for approval. The Plan would describe passive relocation procedures and maintenance of one-way doors during site disturbance, if applicable, and habitat restoration after the Project is completed. Passive relocation procedures would include the installation of one-way doors in burrow entrances by a qualified biologist. One-way doors would be left in place not less than 48 hours to ensure that owls have left the burrow prior to excavation of the burrow by the qualified biologist.

(d) If construction activities result in the loss of occupied habitat, mitigation consistent with the DFG Staff Report on Burrowing Owl Mitigation Guidelines (1995) would be provided by permanently protecting not less than 6.5 acres of suitable habitat per pair or unpaired resident owl at a location acceptable to DFG. Long-term management and monitoring of protected habitat acceptable to DFG would be provided.

(e) Before land-based site disturbance, a worker environmental training awareness program would be conducted by a qualified biologist. The training would include instruction regarding species identification, natural history, habitat, and protection needs. If the species is observed at the construction site at any time during construction, construction work would cease within 160 feet of the area until the animal can be moved to a safe location consistent with DFG regulations.

(f) A monitoring report of all activities associated with surveys and mitigation for this species would be submitted to DFG within one month after construction is completed. If owls are observed in the study area, monitoring reports would be submitted to DFG before any action is taken. CNDDB reports would be submitted within one month of each observation with a copy to the local DFG biologist.

Mitigation Measure BIO-4: Conduct preconstruction surveys for Swainson's hawk prior to construction activities and implement avoidance or mitigation activities for Swainson's hawk, if present:

(a) Surveys consistent with the Swainson's Hawk Technical Advisory Committee's Recommended Survey Methodology (May 31, 2000) shall be conducted by a wildlife biologist with first-hand knowledge of Swainson's hawk reproductive behavior within 0.25 mile of site disturbance activities such as gate construction or removal if such activities are scheduled to occur between March 15 and September 15.

(b) If occupied Swainson's hawk nests are detected within 0.25 mile of site disturbance activities, site disturbance shall be postponed until a qualified nest monitor determines that the young birds have fledged and are no longer reliant on the nest site.

If site disturbance is proposed within 0.25 mile of an active nest before the young birds have fledged, the Project Proponent shall consult with DFG to determine the appropriate course of action, which may include nest monitoring by a biologist with stop-work authority in the event of disturbances to nesting behavior, a reduced no-disturbance buffer if site conditions suggest that a reduced buffer area would not disturb nesting behavior (amount and type of ongoing disturbance, such as farm activities, boating, traffic, etc.), and acquisition of a 2081 Permit from DFG and adherence to any other conditions imposed under the permit.

[5] A burrowing owl biologist is a wildlife biologist who can demonstrate first-hand knowledge of burrowing owl reproductive behavior and has demonstrable field experience monitoring burrowing owl reproductive behavior during all stages of the nesting cycle (i.e., courtship, egg-laying, incubation, nestling, emergent juvenile and dispersal stages).

Mitigation Measure BIO-5: Conduct preconstruction surveys for black rail prior to gate removal activities and avoidance or mitigation activities, if present:

> Surveys consistent with the Point Reyes Bird Observatory Black Rail Survey Protocol (PRBO undated, Spautz et al 2005) shall be conducted between March 15 and May 31 in the year when gate removal is scheduled. If black rail are detected within 0.25 mile of the gates, measures to avoid impacts to nesting behavior shall be developed in consultation with DFG and implemented. Such measures may include a delay in gate removal until young birds are foraging independently, nest monitoring by a qualified biologist with stop-work authority in the event that gate removal operations posed a risk to nest habitat, and acquisition of a 2081 Permit from DFG and adherence to any other conditions imposed under the Permit.

Mitigation Measure BIO-6: Conduct preconstruction surveys for nesting birds prior to construction activities and implement avoidance or mitigation activities for nesting birds, if present:

> If site disturbance commences between February 15 and August 15, a pre-construction survey for nesting birds would be conducted by a qualified wildlife biologist. If nests of either migratory birds or birds of prey are detected on or adjacent to the site, a no-disturbance buffer in which no new site disturbance is permitted would be fenced with orange construction fencing or equivalent, and the buffer would be observed until August 15, or the qualified biologist determines that the young are foraging independently or the nest has failed. The size of the no-disturbance buffer would be determined by a qualified wildlife biologist in consultation with DFG and the USFWS, and would take in to account local site features and pre-existing sources of potential disturbance. If more than 15 days elapses between the survey and site disturbance, the survey would be repeated.

Mitigation Measure CR-1: CA SJO 214H would be shown on contractor specifications with the direction that Project activities are to be kept as far away from the site as possible. Additionally, protective fencing would be installed as follows: (1) at the south end of the lay down area; (2) along the east shoulder of the levee road; (3) approximately 100 feet south of the site; and (4) along the western edge of the corn field east of the site. The site also would be monitored periodically (e.g., every week) during construction by the general contractor and its supervisory staff to ensure that the protective measures are effective and that no damage has been sustained to the camp structures.

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Mitigation Measure CR-2: The Mandeville Island Portion of the Connection Slough site would be surveyed by a qualified archaeologist prior to the onset of construction. The purpose of this study would be to (1) determine if cultural resources are present in or near the Project area and (2) better define the relationship between the Project boundaries and the Mandeville School complex.

Mitigation Measure CR-3: The Mandeville Island School site would be shown on contractor specifications with the direction that Project activities are to be kept as far away from the site as possible. Additionally, protective fencing would be installed at locations identified by the archaeologist. The site also would be monitored periodically (e.g., every week) during construction by the general contractor and its supervisory staff to ensure that the protective measures are effective and that no damage has been sustained to the camp structures.

Mitigation Measure CR-4: Due to the presence of archaeologically sensitive Piper series soils immediately adjacent to the Holland Tract storage site, all ground-moving activities and the operation of heavy equipment would be restricted to the 12-acre site to prevent incidental damage to possible archaeological resources.

Mitigation Measure CR-5: Before initiating construction or ground-disturbing activities associated with the Project, all construction personnel would be alerted to the possibility of uncovering buried cultural resources. The general contractor and its supervisory staff would be responsible for monitoring the construction for disturbance of cultural resources. If any cultural resources, such as structural features, unusual amounts of bone or shell, artifacts, human remains, or architectural remains, are encountered during any development activities, work would be suspended and DWR and Reclamation would be immediately notified. DWR and Reclamation would retain a qualified archaeologist who would conduct a field investigation of the specific site and recommend reasonable mitigation deemed necessary to protect or recover any cultural resource concluded by the archaeologist to represent historical resources or unique archaeological resources. DWR and Reclamation would be responsible for approval of the recommended mitigation if it is determined to be feasible. DWR and Reclamation would implement the approved mitigation before the resumption of construction activities at the construction site. After DWR and Reclamation are notified, work may proceed on other portions of the Project sites while mitigation of impacts on archaeological resources is implemented.

Mitigation Measure CR-6: In the event that the archaeological survey of the Mandeville Island site identifies archaeological resources, the area shall be fenced and the site would be avoided.

Mitigation Measure CR-7: In accordance with the California Health and Safety Code, if human remains are uncovered during construction at the Project site, the construction contractors would immediately suspend work within 50 feet of the remains, and the Contra Costa County Coroner would be immediately notified. If the remains are determined by the County Coroner to be Native American, the Native American Heritage Commission (NAHC) would be notified within 24 hours of making that determination (Health and Safety Code Section 7050[c]), and the guidelines of the NAHC shall be adhered to in the treatment and disposition of the remains. The NAHC would then assign a Most Likely Descendent (MLD) to serve as the main point of Native American contact and consultation. Following the coroner's findings, the MLD and the archaeologist would determine the ultimate treatment and disposition of the remains and take appropriate steps to ensure that additional human interments are not disturbed. DWR and Reclamation would be required to implement any feasible, timely formulated mitigation deemed necessary for the protection of the burial remains. Construction work in the vicinity of the burials would not resume until the mitigation is completed.

Mitigation Measure TRANS-1: The lead agencies will coordinate with the Contra Costa and San Joaquin County Sheriff's and Fire Departments to notify them of the construction schedule and identify alternative access methods if needed.

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