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9.1 INTRODUCTION

Figure 9-1 shows the flash card for Building Block 1.7: Isolated Conveyance Facility Alternatives.

9.1.1 Background

The purpose of an Isolated Conveyance Facility (ICF) would be to protect the state's water supply by providing a conduit for freshwater around the Sacramento–San Joaquin River Delta (Delta), including capabilities to resist failure during a major earthquake or flood. The key features of the ICF are summarized on Figure 9-1.

A historical summary of events pertinent to the ICF follows (DWR 1995):

- 1960: California voters approved the Burn-Port Act to assist in the financing of the State Water Project. This act authorized Delta facilities for "water conservation, water supply in the Delta, transfer of water across the Delta, flood and salinity control, and related functions." In the same year, the Department of Water Resources (DWR) proposed the Delta Water Project to serve as the Delta water facility of the State Water Project (SWP). Subsequently, DWR and the California Department of Fish and Game established the Delta Fish and Wildlife Protection Study and the Interagency Delta Commission (with the U.S. Bureau of Reclamation [USBR] and the U.S. Army Corps of Engineers) to develop a mutually acceptable plan for the Delta.
- 1965: The Interagency Delta Commission recommended the Peripheral Canal as the water transfer plan. The Peripheral Canal would convey water from the Sacramento River at Hood to the state and federal pumping plants in the south Delta. The Peripheral Canal would eliminate interference with Delta waterways, release freshwater to the Delta waterways and release freshwater to Delta channels to maintain water quality and mitigate impacts to fish.
- 1966: DWR designated the Peripheral Canal as the Delta facility of the SWP.
- 1969: the Department of the Interior adopted USBR's Peripheral Canal Feasibility Report, which recommended that the project be a joint-use facility of the SWP and the Central Valley Project (CVP) with costs shared equally. Although the Peripheral Canal was supported by two subsequent administrations, the facility was never constructed due to lack of funding, cost, and concern over possible improper operation. Also some interests feared that in times of water shortage, institutional, statutory, and contractual guarantees for Delta protection could be changed or ignored and water needed to protect the Delta would be exported.
- 1973: the Delta Environmental Advisory Committee concluded that a federal-state Peripheral Canal, properly designed and operated, was necessary to protect the Delta.
- 1975: DWR began to reassess the Peripheral Canal, resulting in Bulletin 76, July (1978), which identified and considered numerous alternative water transfer facilities.
- 1980: The State Legislature passed and the Governor signed Senate Bill 200. This bill authorized the Peripheral Canal and provided specific guarantees to protect the Delta and to meet the water needs of the SWP through the year 2000.

- 1982: California voters defeated Proposition 9, which included the Peripheral Canal, the Senate Bill 200 package of statewide facilities, and Delta protection, by a 3-2 margin. In the same year DWR and the Department of Fish and Game signed the Delta Pumping Plant fishery mitigation agreement for direct fish loss.
- 1983: DWR published *Alternatives for Delta Water Transfer*, which examined four alternatives for improving the water transfer system (DWR 1983). The alternatives examined included a dual transfer facility that included an isolated conveyance facility (similar to the Peripheral Canal) and improvements to channel conveyance capacities in the north and south Delta. This dual conveyance configuration did not pass the selection process used in that investigation.
- 1993: The Delta smelt was listed as a threatened species and actions were defined (such as pulse flows on the Sacramento River and limitations on certain flows within the Delta) to improve conditions for the smelt and the winter-run salmon.
- 1997: CALFED issued *Facility Descriptions and Updated Cost Estimates for an Isolated Delta Conveyance Facility.* This report recommended an ICF similar in configuration to the Peripheral Canal to restore the ecological health and improve the general water management of the Delta.
- 2000: The CALFED Record of Decision outlined a preferred Stage 1 alternative that included a screened through-delta facility concept and improved fish facilities in the south Delta. The Record of Decision left open the possibility of an ICF if a through-delta concept was not feasible.

9.1.2 Purpose and Scope of Building Block

The purpose of this building block is to evaluate risk reductions of an ICF on Delta habitat, water supply reliability, water quality, and flood protection. The ICF would provide a north-to-south freshwater corridor through the construction of an isolated canal around the eastern periphery of the Delta.

The scope of this building block includes reviewing geotechnical and hydraulic information, construction methodologies, cost evaluations, and risk reductions. A summary of the collected data is presented in this report.

9.1.3 Objective and Approach

The objectives of this analysis are to confirm the engineering feasibility of the building block, evaluate the risks, and estimate the order of magnitude costs. The approach is to review existing documentation, research new information (e.g., current land uses, equipment) and present findings and conclusions.

9.2 CONCEPTUAL DEVELOPMENT OF IMPROVEMENT

9.2.1 Analysis Criteria and Basis of Design

For this building block, ICF capacities of 5,000, 10,000, and 15,000 cubic feet per second (cfs) were evaluated. The canal embankment was set at an elevation of 3 feet above mean higher high water (MHHW). The 3-foot freeboard would account for fluctuations in MHHW and wave run-up from wind. The canal embankments are expected to suffer damage as a result of large seismic events and floods; such damage to the canal would require repair. However, embankments would be designed so that seismic and flood damage would not lead to breaches. Repair and resumption of operations would be expected to occur within 3to 6 months.

9.2.2 Design

The design of the ICF is based on four reference reports:

- State of California DWR Division of Design and Construction, Delta Water Facilities Peripheral Canal: Preliminary Design Report, July 1973 (DWR 1973).
- CALFED Storage and Conveyance Refinement Team, Facility Descriptions and Updated Cost Estimates for an Isolated Delta Conveyance Facility, October 1997 (CALFED 1997).
- CALFED Bay-Delta Program, Water Management Planning Branch, Isolated Facility, Conceptual Analysis of Incised Canal Configuration, September 1999 (CALFED 1999).
- Washington Group International (WGI), Isolated Facility, Incised Canal Bay-Delta System Estimate of Construction Costs, prepared for The State Water Contractors, August 2006 (WGI 2006).

The 1999 CALFED report (1999) is used as the primary basis of design for this building block. The ICF would transport from 5,000 to 15,000 cfs of freshwater in an unlined canal. The 1999 CALFED report based the design on a flow velocity of 1.6 feet per second (fps) at a depth of 23.5 feet for a 10,000 cfs system. The ICF would consist of about 44 miles of unlined earth canal extending from the Sacramento River at Hood to the SWP and the CVP pumping stations at Clifton Court in the south Delta. The WGI report (2006) calculated the dimensions of the 15,000 cfs canal at a bottom width of 340 feet and a top width that varied from 500 to 700 feet, depending on the height of the embankment.

Related facilities would include an intake structure with fish screens on the Sacramento River at Hood, eleven inverted siphons, four flow control structures, and a pumping plant near Disappointment Slough.

The WGI report (2006) describes two main routes for the ICF, as shown on Figure 9-2. The Route 1 alignment follows the original alignment, as shown in the 1999 CALFED report. The Route 2 alignment incorporates a shift of portions of the canal to the west to avoid residential encroachment and take advantage of lower land prices in the Primary Zone. This report considers Route 2, with the pumping plant located midstream, near Disappointment Slough.

The water surface profile for the ICF shown on Figure 9-3 was assumed to be essentially the same as that presented in the 1999 CALFED report, as the design velocity and canal characteristics are similar. Head losses that occur at the siphons and other canal features need to be further analyzed in subsequent studies and design work.

A pumping station would be required to lift the water in the canal about 15 feet to provide sufficient head to obtain the desired velocity and flow. In the WGI report (2006), two alternative pumping station locations were suggested. An “incised” canal places the pumping station at the downstream end of the canal. This section evaluates a “raised” canal that places the pumping station midstream, near Disappointment Slough.

9.2.3 Operations

Three different ICF canal capacities were evaluated. It is understood that the same total volume of water would be diverted, but three different flow rates are evaluated: 5,000 cfs, 10,000 cfs, and 15,000 cfs. The difference in operation is that diversion activity would occur for a longer period with a facility capacity of 5,000 cfs as compared to a facility capacity of 15,000 cfs.

It is assumed for the purposes of this analysis that total minimum outflows from the Delta would not change. Export would be shifted from the south Delta to the north Delta, from which releases from the State Water Project and the Central Valley Project can be directed more efficiently to the pumps at Clifton Court Forebay.

The ICF could be operated to maintain a minimum flow in the Sacramento River. This minimum flow would likely be seasonal and depend on fish habitat, urban freshwater intake, and downstream agricultural requirements. Flow releases from upstream reservoirs, such as Lake Shasta and Lake Oroville, would be used during summer months to supplement natural flows in the Sacramento River and maintain habitat and salinity at acceptable levels. Seasonal demands and downstream storage capacity would also come into play.

The water available to send into the ICF would depend on the seasonal flows available in the Sacramento River watershed and releases upstream from SWP and CVP reservoirs. Figure 9-4 shows Sacramento River flow variations between 2001 and 2006.

Current flows in the San Joaquin alone are inadequate to supply sufficient water to the pumps at Clifton Court. Water is drawn toward Clifton Court Forebay from other parts of the Delta such that water flows backward through the Old River and Middle River branches of the San Joaquin River.

9.3 COST ESTIMATE

The costs for the 5,000 cfs, 10,000 cfs, and 15,000 cfs canals are listed in Tables 9-1 and 9-2. A breakdown in costs for the 15,000 cfs canal is listed in Table 9-1. The cost estimate is based on previous conceptual-level designs, and the costs are in 2007 dollars. This estimate accounts for contingency, surveys, design, construction management, and contract administration costs, but does not include financing costs or environmental mitigation costs. Note that the cost estimate excludes fish screens; these costs are accounted for in Building Block 3.3.

9.3.1 Quantities

The quantities for the cost estimate were taken primarily from the WGI report (2006) for Route 2, with a pumping station at Disappointment Slough. The following items differ from the WGI report.

As stated above, embankment quantities were calculated with a higher embankment. This cost estimate assumes an embankment elevation at 3 feet above MHHW.

A cost item was added for flow shutoff gates at some of the siphons to prevent a large flood event from extending flooding from one island to the next through the open siphons. These gates are only expected to be necessary in islands where the 100-year flood event is above the top of the ICF embankment.

It is expected that the embankments will be constructed of suitable materials (see Section 4, Building Block 1.2: Upgraded Delta Levees; see also URS 2007c). The potential locations of these materials in relation to Route 2 for the ICF are shown on Figure 9-5 for the north Delta and Figure 9-6 for the south Delta.

9.3.2 Unit Costs

Unit costs for the construction cost estimate were based in part on the following sources:

- Unit costs from previous reports that were escalated using the USBR Construction Cost Index Trends
- Build-ups from equipment manufacturer performance data and R.S. Means cost data
- Unit prices found in other building blocks (e.g., Building Block 3.3: Install Fish Screens)
- Caltrans
- Recent contractor bid prices on public projects

Real estate costs are based on the sale prices of Primary Zone land in the Delta between 2002 and 2005.

9.3.3 Intake Facilities

Intake facilities would likely be built near Hood, though other locations have been proposed. The purpose of the intake is to divert water into the canal while preventing debris and fish from entering. A description of the fish screen facilities and costs are included in Section 15.

9.3.4 Excavation

Organic, highly plastic, or permeable soils (e.g., clean gravels) will need to be removed from the canal embankment foundations and spoiled within the canal right-of-way. Figure 9-7 shows the locations and depths of organic materials. The thickness of the organic soils averages about 10 feet north of Disappointment Slough and about 15 feet south of this location. Excavated soils from the canal would be stockpiled in the canal right-of-way, moisture conditioned, and used to construct canal embankment fills. In areas, where suitable soils are unavailable for embankment construction, soils would either be transported from other areas of the canal alignment or be imported.

9.3.5 Canal Embankments

The top of the embankment would be placed 3 feet above the MHHW elevation, as shown on Figure 9-8. MHHW was chosen as the design basis for the top of the embankment. Three feet of freeboard was added to the MHHW to account for wind waves, run-up, and fluctuations in the MHHW elevation. Where the normal operating level of the canal (the water surface elevation [WSE]) is greater than the MHHW, the top of the embankment would be 3 feet above the maximum WSE.

Raising the top of the embankment to the elevations of the 100-year flood (based on the Federal Emergency Management Agency Federal Insurance Rate Maps) was considered, but not included in this conceptual design. Flooding from a storm event would likely result in an inflow of freshwater into the canal, which should not pose a water quality problem. Control structures would need to be placed at each siphon to prevent flooding of adjacent islands. The control structures and approaches would need to be designed to the Federal Insurance Rate Map elevation for operational purposes.

9.3.6 Bridges

The cost estimate includes the construction of 14 new roadway bridges and three new railroad bridges. Costs for the roadway bridges are based on the current Caltrans square-foot cost data. The roads that will likely require new bridges include State Routes 4, 12 and 34, Tracy, Lambert, Walnut Grove, Peltier, Woodbridge, Atherton, McDonald, Calpack, and Bonatti, and Middle River roads as well as Laurel Lane.

Three railroad bridges will also need to be installed. It is not known whether their grades will need to be raised.

9.3.7 Siphons and Flow Control Structures

Concrete siphons would be constructed to pass the canal water beneath existing sloughs and rivers. Reinforced concrete siphons would include transition structures to funnel the water in the facility into and out of the siphons. Cofferdams would be needed to close off the sloughs where the siphons are to be constructed. Special considerations would be needed to construct a siphon across the San Joaquin Ship Channel to avoid disruption of shipping through the channel. Figure 9-9 shows a typical configuration for a six-barrel siphon; each barrel would be about 30 feet square with walls that are 3 to 4 feet thick.

Flow-control structures would be needed along the alignment to control the water surface elevation along the canal at certain locations. For this building block, four flow-control structures are assumed based on the 1999 CALFED report. Further hydraulic analyses would be needed to confirm the number and location of the control structures. Control structures would also be needed at the outlets of the canal into the SWP and CVP facilities.

Flood-control gates would need to be incorporated into the siphons to prevent water from overtopping the canal embankments and flooding adjacent islands.

9.3.8 Pumping Station

A low-head pumping station is needed to provide sufficient gradient to maintain the design flows. The pumping station would raise the water surface elevation about 15 feet. Eleven pumps, two with variable-speed drives were assumed. This cost estimate also assumes the location at Disappointment Slough, near the center of the alignment.

The costs for the pumping station are derived from the USBR Mechanical Engineer's Pumping Plant Cost Curves. From the cost curves, the estimated cost of a pump station with a flow of 15,000 cfs at a total head of 20 feet is $156,500,000 in October 1995 dollars. This value was adjusted for the number of pumps, two of which would be variable speed, and the USBR cost index to escalate costs to mid-2007.

9.3.9 Right-of-Way

Land required for Route 2 is in the Primary Zone. Land in the Primary Zone is agricultural and generally lower in price than land in the Secondary Zone and subject to possible development.[1] Route 2 was developed specifically to move the canal away from land that was already developed or soon to be developed and therefore more expensive. The width of the right-of-way was taken as 1,300 feet for the entire 44-mile length. This works out to about 6,900 acres for a 15,000 cfs canal. A cost of $10,000 per acre was estimated from sale prices of undeveloped land in the Delta between 2002 and 2005 and escalated to 2007 costs using the USBR land price index for each year.

9.3.10 Other Cost Considerations

9.3.10.1 Suitable Materials

One of the major cost factors of the ICF is its proximity to suitable foundation conditions and embankment materials. The original Peripheral Canal alignment was placed along the eastern periphery of the Delta to take advantage of better soil conditions than further west within the Delta where deep organic (peat) soils are more prevalent. Though Route 2 is outside of the higher Secondary Zone property values closer to Stockton, it is also more likely to encounter unsuitable materials and thus larger costs for organic layer replacement.

9.3.10.2 Soil Permeability

Measures that might include blanketing the canal with impervious soils (possibly combined with appropriate underdrain measures) or removal and replacement of permeable sand and gravel layers may be required if the underlying soil permeability threatens adjacent areas.

[1] The 1992 Delta Protection Act defined a Primary Zone and a Secondary Zone within the legal Delta. The act provided stringent protection against further urban development within the Primary Zone. Areas within the Secondary Zone, which include the rest of the legal Delta, have less stringent protection (URS/JBA 2008h, Section 2).

9.3.10.3 Productivity

Productivity will likely be negatively impacted by wet weather. As the Delta was essentially at one time a marsh, dewatering and downtime while soil, haul roads and stockpiles dry, may be a significant factor during winter construction.

9.3.10.4 Groundwater Treatment

During construction of an ICF, significant groundwater would be encountered. The groundwater would need to be removed from the construction zones and discharged into adjacent sloughs or rivers. Construction water discharges are regulated by the state, which may require testing and treatment of the groundwater before discharge. The CALFED Bay-Delta Program has identified poor groundwater quality on other canal projects in the area (CALFED Bay-Delta Program 2007). The Sacramento Regional County Sanitation District recently constructed a new interceptor that required an extensive treatment plant for groundwater encountered during construction. Costs for groundwater treatment can be significant. Sampling along the alignment would provide guidance as to what constituents are present in the groundwater and the probable treatment requirements.

9.3.10.5 Agricultural Economic Losses

A significant amount of agricultural land would be taken out of production. Also, some land might be left isolated by the ICF and also taken out production. Some of this lost land could also be converted to habitat.

9.4 RISK REDUCTION ESTIMATE

9.4.1 Water Quality

Over the past 60 years, 70 percent of the water entering the Delta has entered from the Sacramento River. Only an average of 13 percent enters from the San Joaquin River into the south Delta. If the net flow out of the Delta remains the same, the salinity levels of water exiting the Delta would likely not change significantly.

The water pumped at Clifton Court Forebay comes from both the Sacramento River and the San Joaquin River. However, flows in the San Joaquin River are relatively small compared to pump station capacities. The San Joaquin, Middle, and Old rivers occasionally flow backwards toward the pumps at Clifton Court Forebay. The pumps pull water from the Sacramento River in the north Delta to the south end of the Delta. This flushing action raises the total organic content and levels of bromides in the water as it passes through the Delta.

Construction of the ICF may allow flows to return to a more natural pattern in the San Joaquin River. These flows may not necessarily improve water quality in the south Delta. South Delta salinity levels and other measures of water quality may be higher when flushing is primarily dependent on flows from the San Joaquin River rather than being assisted by export flows through the state and federal project pumps. Thus, increased flows in the San Joaquin River may be needed to improve south Delta water quality. Separately, if the existing south Delta export intakes remain functional in a dual conveyance arrangement, pumping could fluctuate between south Delta and north Delta sources, depending on which source provides the greater benefits.

Due to tidal influences and returns from agricultural drainages, the quality of Sacramento River water deteriorates as the river moves toward the ocean. When considering export water quality, intake facilities located upstream on the Sacramento River (Hood) are preferred to downstream intake facilities (e.g., Clifton Court Forebay, Isleton, or Walnut Grove).

One benefit of the ICF would be an improvement in the quality of water exported from the south Delta. The water would likely be cheaper to treat due to the lower levels of total organic content and other substances that are picked up as the water moves through the Delta. Other areas may see a reduction in water quality due to the lower flows in the Sacramento River downstream of Hood. Due to the substantial flows in the Sacramento River, these reductions in water quality may be minimal.

Additional water quality modeling is needed to better define the impacts and costs discussed above. The net value of improvements in the quality of water exported in the south Delta is likely greater than the sum costs of decreased water quality at other locations around the Delta. These costs could be further reduced by direct connections to the ICF by other water systems.

9.4.2 Water Delivery Reliability

Currently, the primary threat to water delivery reliability is the incompatibility of the state and federal project pumps and Delta smelt populations. Water deliveries have been curtailed due to the high mortality rates for Delta smelt at these pumps. These impacts are reviewed below and in Section 15, which discusses fish screens. The ICF would be designed to eliminate this threat, the current actual source of unreliability to the state’s water supplies.

A second major threat to water supply reliability is the fact that a large failure of the levee system within the Delta (e.g., due to an earthquake) could pull saline water into the Delta (a “gulp”), disrupt CVP and SWP pumping, and thereby reduce CVP and SWP deliveries. With the ICF, water is diverted around the Delta, away from those islands most likely to be inundated by brackish water during a levee break. The ICF would be protected by its embankments from MHHW levels; hence, the impact of Delta levee breaches would be eliminated. Although some damage to ICF embankments may occur, they will be designed to minimize the possibility of breaching and to facilitate repairs. The ICF should be repaired and operational within 3 to 6 months after a major damaging event. This time frame would be a dramatic improvement over the possibility of 2, 3, or more years without Delta exports using the present through-Delta conveyance.

The economic benefit due to a reduced disruption of water exports can be calculated as the risk of a disruption to water supplies without the ICF minus the risk of a disruption to water supplies with the ICF. The costs associated with a disruption to urban and rural water supplies without the ICF were estimated in Phase 1 of the Delta Risk Management Strategy (DRMS) Economic Consequences Technical Memorandum (URS/JBA 2008f). The information contained within this section is largely sourced from this work.

Although the risk of failure in water delivery based on seismic or flood events is still present, construction of the ICF would result in a significant reduction in risk; indeed, this reduction in risk is a primary motivation for considering the facility. The ICF may also facilitate recovery efforts by providing additional freshwater to the south Delta that could be used to flush out brackish floodwater.

9.4.3 Water Delivery Efficiency

Water currently released from state and federal storage facilities north of Sacramento River flows out of the Delta toward Suisun Bay and to the pumps in the south Delta. An ICF may decrease the percentage of the released water that would be required as carriage water to maintain Delta water quality standards. Thus, even if exactly the same amount of water is exported, it can be diverted more efficiently. This increased efficiency would mean more flexibility for the timing of Delta outflows when they are advantageous. Diversion windows would also be less impacted by environmental issues, such as impacts to the Delta smelt and other fish.

Peak flows in the Sacramento River might also be more efficiently funneled to water exports rather than as outflow through Suisun Bay. A review of existing water models and new studies would be needed to determine the diverse benefits from increases in water diversion efficiency.

9.4.4 Operational Flexibility

With a dual conveyance system, pumping could be shifted back and forth from the north Delta to the south Delta, depending on flow conditions, the relative impacts on the ecosystem, and the varying timing of fish migration patterns. Improved fish screens would likely need to be installed in the south Delta to continue diverting there, even on a limited schedule.

9.4.5 Ecosystem Impacts of the Isolated Conveyance Facility

The ICF would impact ecosystems as outlined below:

- Terrestrial habitats and occurrences of special-status species may be affected.
- Fish habitat and fish passage may be disrupted during construction across waterways.
- The intake of fish in the northern portion of the Delta at the ICF intake may increase, depending on the effectiveness of the screening.
- Fish intake may be reduced at SWP and CVP water export facilities.
- Water may be increased in the following tributaries used for anadromous fish spawning: Cosumnes River, Mokelumne River, Calaveras River, and San Joaquin River.
- The amount of protected and restored wildlife habitat may increase in sections of purchased land parcels.

The impacts of this building block on the ecosystem are discussed further in Appendix 9A.

9.4.6 Potential Indirect Risk Reductions in the Context of the Scenarios

Depending on the size of the embankments, the ICF would reduce the area flooded in individual islands due to a levee failure. The ICF embankments would also function in the same manner as levees, effectively dividing existing islands into two parts.

9.5 FINDINGS AND CONCLUSIONS

The ICF would provide a north-to-south freshwater corridor through the construction of an isolated canal around the eastern periphery of the Delta. A west-side routing might also be considered, probably at higher cost but possibly with other advantages. The ICF considered here would include the following components:

- Intake structure near Hood
- Canal excavation and embankment construction to the elevation of MHHW level plus 3 feet
- Road and railroad bridge crossings
- Siphons under rivers and sloughs
- Flow-control structures
- Pumping station at Disappointment Slough

The ICF would reduce vulnerability to water export disruption due to Delta levee failure and flooding and would thus represent significant risk reduction over the present water conveyance through Delta channels. The ICF could be operated to improve water supply reliability and the water quality of exported water. The ICF could also serve to reduce flooding and subsequent flood damage. It would also reduce the potential for catastrophic economic damage.

Although the canal embankments would be constructed to have 3 feet of freeboard above MHHW, the canal would be overtopped by large flood events (e.g., 100-year flood). However, such flooding would result in freshwater entering the canal and thus should not pose water quality issues. After such large flood events, repairs of the canal embankments would be needed. Also, damage is expected to the canal embankments as a result of large seismic events. Such damage to the canal would require repair. In both cases, the embankments would be designed to avoid severe damage (e.g., breaches) and to facilitate repair and resumption of operations within 3 to 6 months.

The following additional investigation and research are recommended if the ICF were to move forward:

- Determine the base flow levels to be maintained in the Sacramento River. The base flow level may fluctuate depending on the variable and sometimes opposing needs of habitat, fish migration, agriculture, water quality, and exports.
- Research and summarize the impact of the ICF on Delta water quality for agricultural and urban uses for intakes other than at the south Delta project pumps.
- Set parameters for operation of the facility within the state water rights and water quality control system.
- Model the ICF in CALSIM (a California water resources simulation model) to assess the likely operating regime under normal (non-breach) conditions.
- Model the ICF using the DRMS risk analysis models to assess the actual residual risks from earthquakes and floods, under both current and future conditions in 2050 and 2100.
- Model the ICF in CALVIN (California Value Integrated Network Model) to assess the economic benefits.

- Study subsurface conditions along the ICF route to refine the ICF location and provide geotechnical design information.
- Model the changes in water quality in the Delta due to the operation of the ICF.

Tables

Table 9-1. Summary Cost of a 15,000 cfs Isolated Conveyance Facility (Cost excludes fish screens)

No.	Description	Estimated Cost ($ million)
1	Intake Facilities	400.0
2	Bridges and Culverts	88.5
3	Pumping Plant	230.0
4	Excavation	272.1
5	Embankment	382.6
6	Right of Way	141.1
7	Other (seeding, roads, fencing, etc)	62.4
8	Siphons and Controls	1,103.6
9	Control Structures for SWP and CVP	106.7
10	Maintenance Facility and SCADA	10.0
--	Subtotal Estimated Cost	2,797.0
--	Mobilization/Demobilization – 5% of Subtotal	139.9
--	Subtotal	2,936.9
--	Contingency – 30% of Subtotal	881.1
--	Subtotal	3,818.0
--	Survey, Design, CM and Administration – 30% of Subtotal	1,145.4
--	**Total Estimated Cost**	**4,963.3**

See Appendix 9B for cost details.

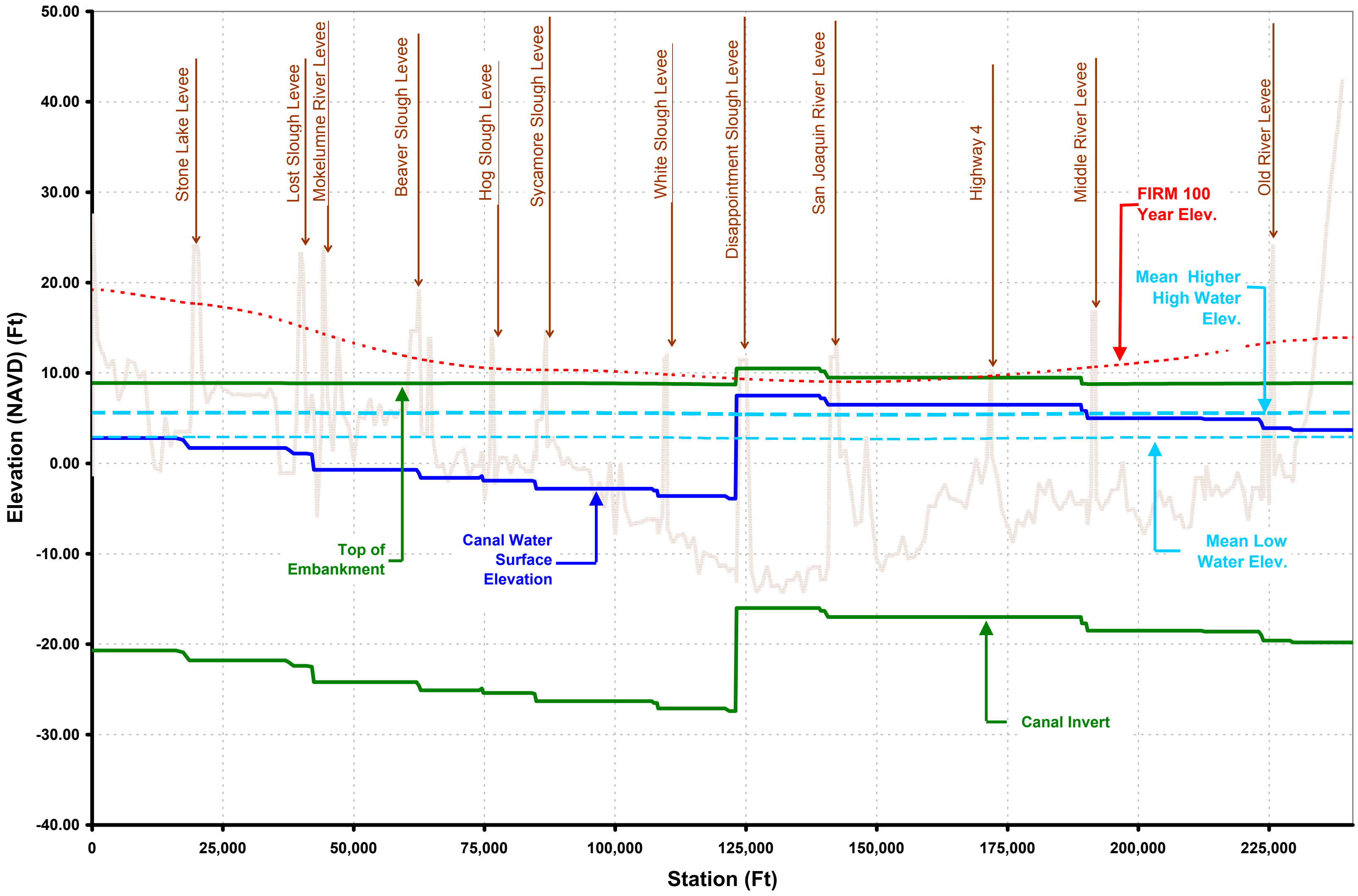
Table 9-2. Summary of Costs of the Isolated Conveyance Facility Alternatives (Costs exclude fish screens)

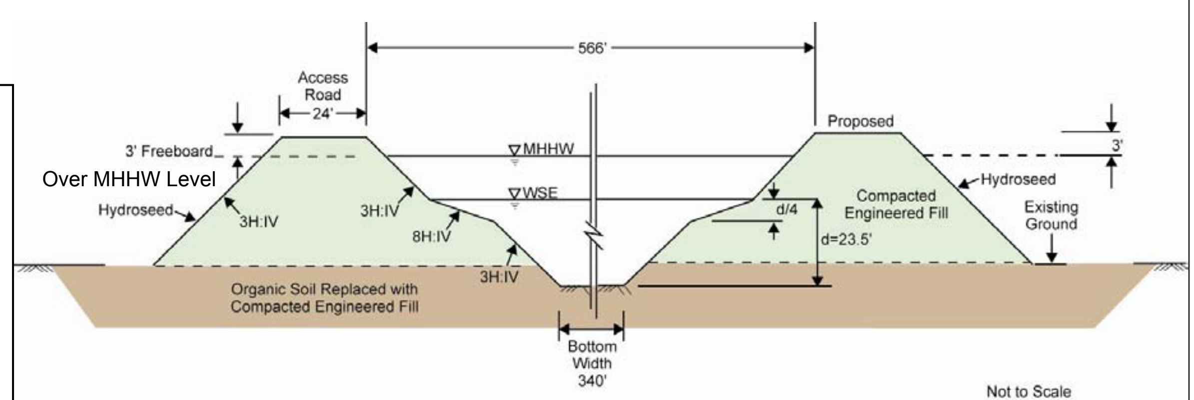
Capacity	Estimated Cost
5,000 cfs	$3.2 billion
10,000 cfs	$4.1 billion
15,000 cfs	$4.9 billion

cfs = cubic feet per second

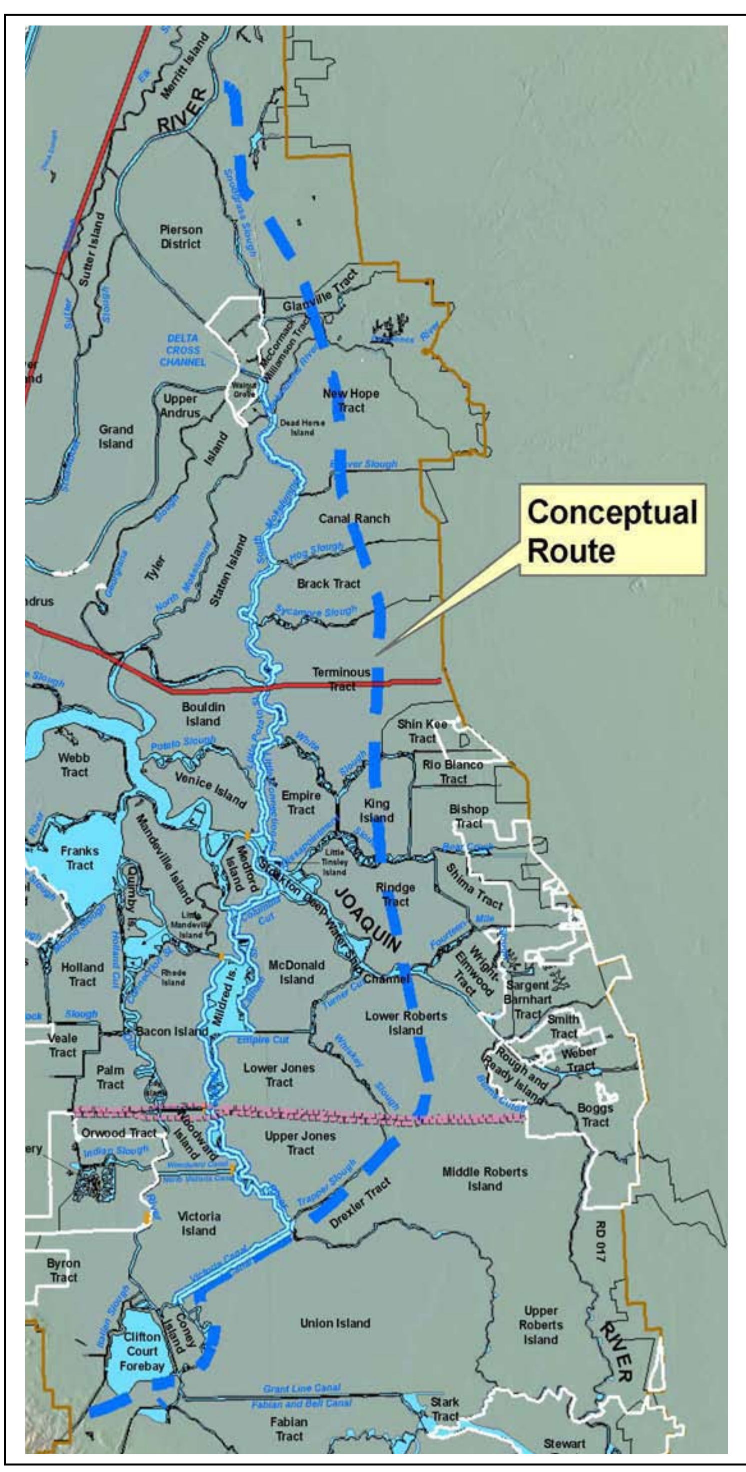
Figures

Isolated Conveyance Facility - Route 2 - Midstream Pump Station Profile





Cross Section
(15,000 cfs)



SITE PLAN
(Canal Length ≈ 44 Miles)

BENEFITS/RISK REDUCTION

- Improves Export Water Quality
- Decreases Fish Entrainment at Pumps
- Reduces Water Treatment Costs
- Reduces Salt Accumulation in Agricultural Soils
- Increases Water Supply Reliability — Less Disruption from Earthquakes
- Increases State Water System Efficiency
- Increases Water Delivery Options
- Reduces Flooding from Seismic Event
- Low Fish Screen Costs

PROJECT LIMITATIONS

- Decreased Flows in the Sacramento River
- Operational Plan to be Defined
- Land Acquisition
- Construction Impacts
- High O&M Cost to keep up with Sea-Level Rise

PROJECT COSTS

- 15,000 cfs Facility = $4.9 billion
- 10,000 cfs Facility = $4.1 billion
- 5,000 cfs Facility = $3.2 billion

Note: Estimated Costs do not include environmental mitigation or power infrastructure to the pumping plant.

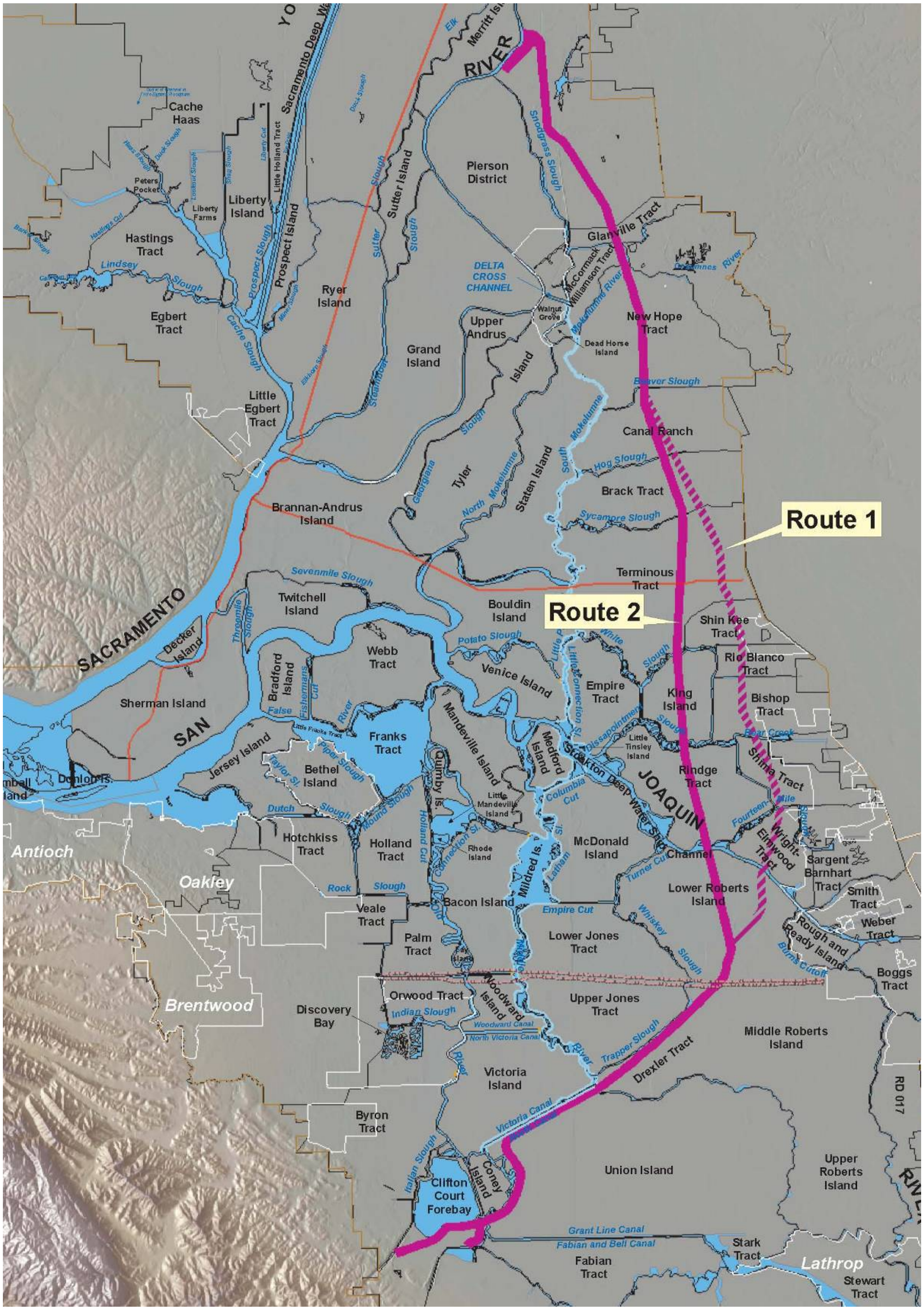


Figure 9-2 Isolated Conveyance Facility Routes 1 and 2

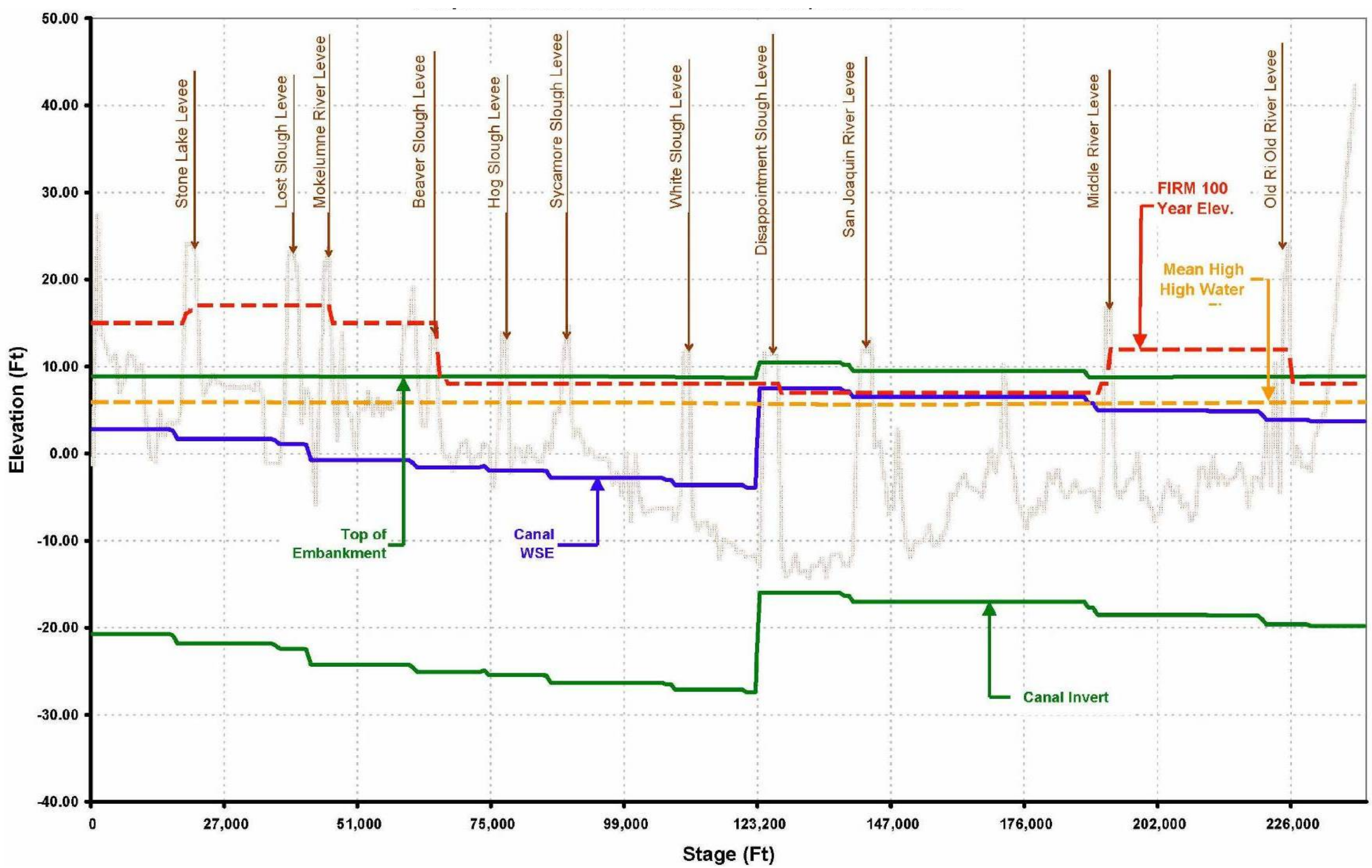


Figure 9-3 Isolated Conveyance Facility Route 2 Profile – Midstream

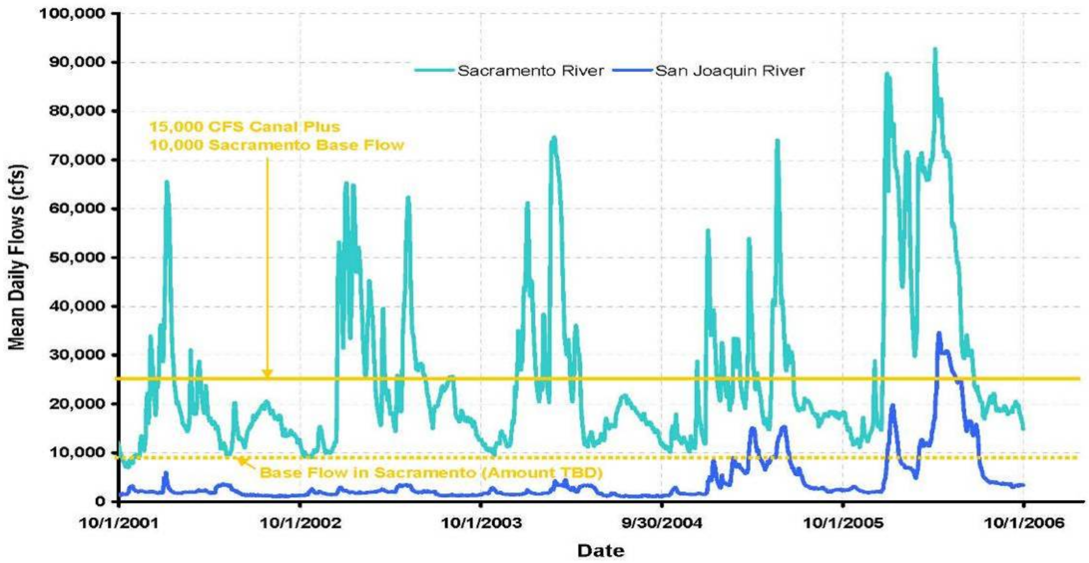


Figure 9-4 Historical Flows in the Sacramento and San Joaquin Rivers

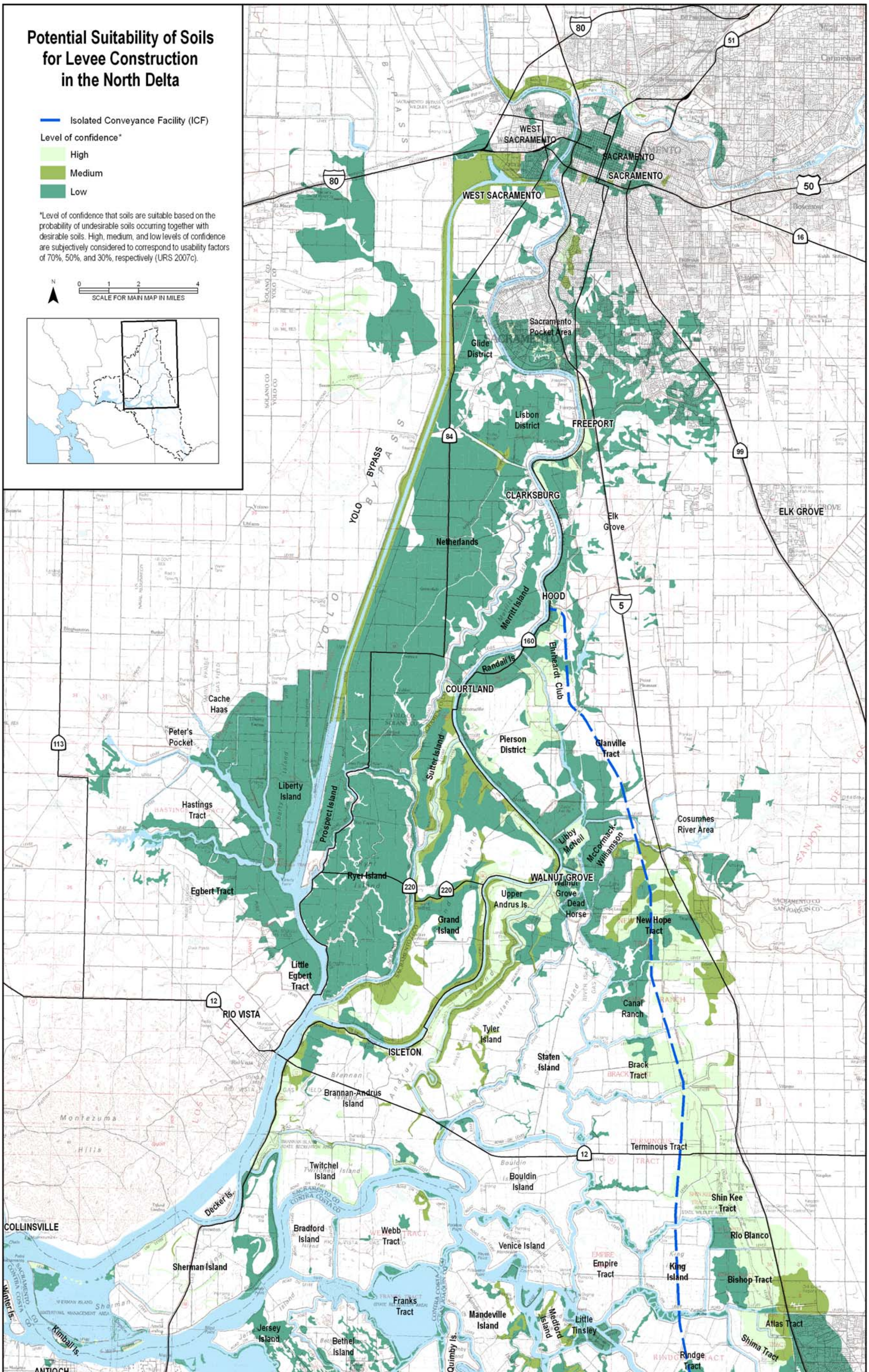


Figure 9-5 Potential Suitability of Soils for Levee Construction in the North Delta

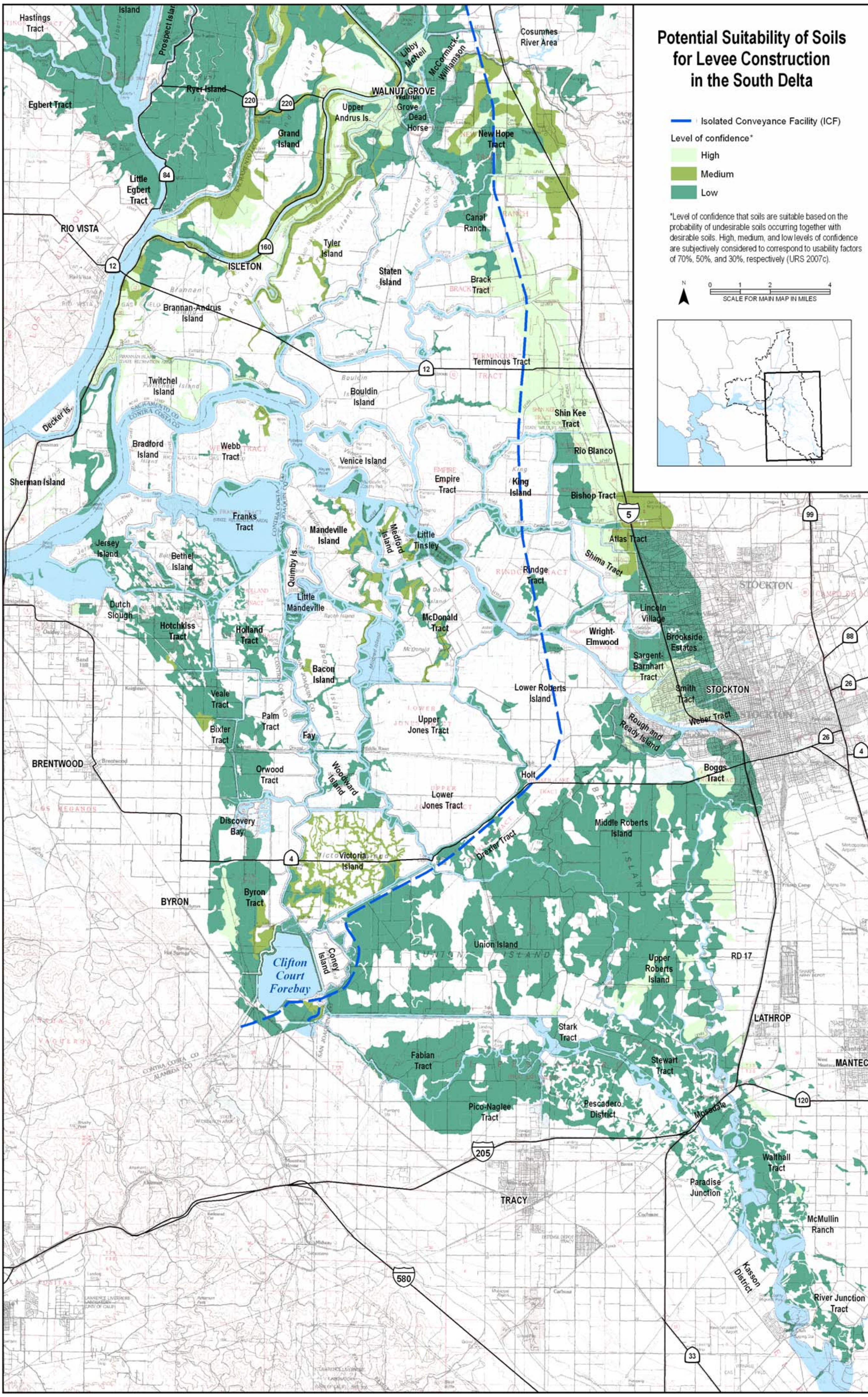


Figure 9-6 Potential Suitability of Soils for Levee Construction in the South Delta

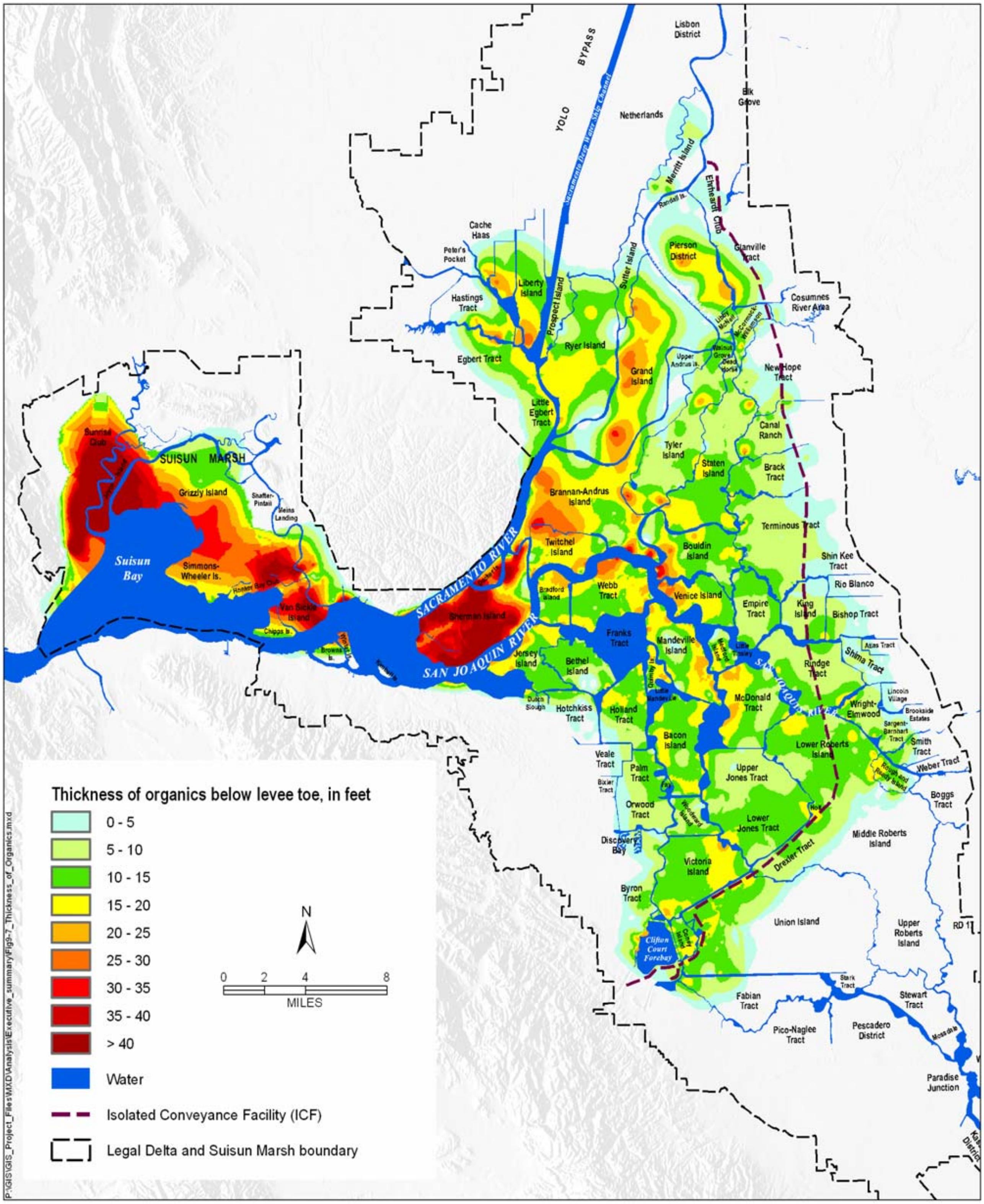


Figure 9-7 Thickness of Organics in the Delta

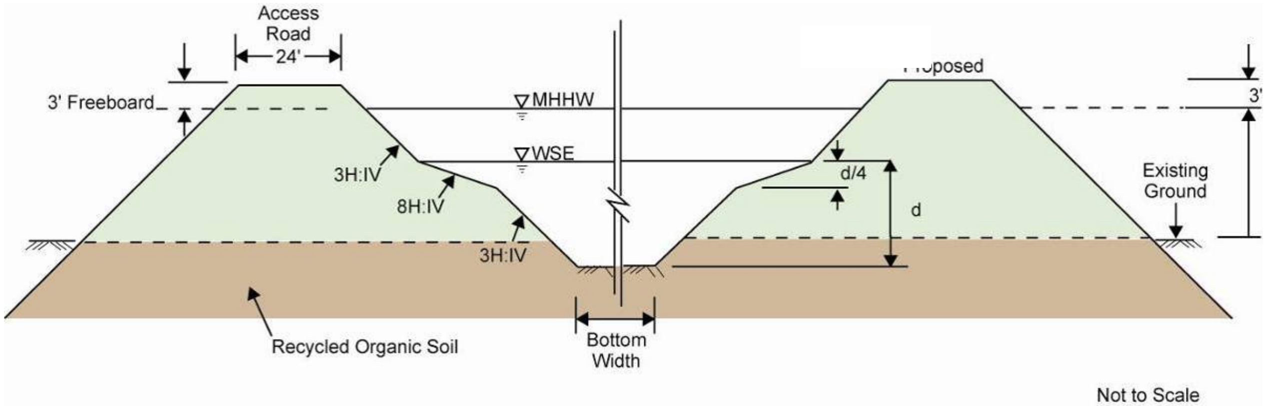


Figure 9-8 Canal Cross Section

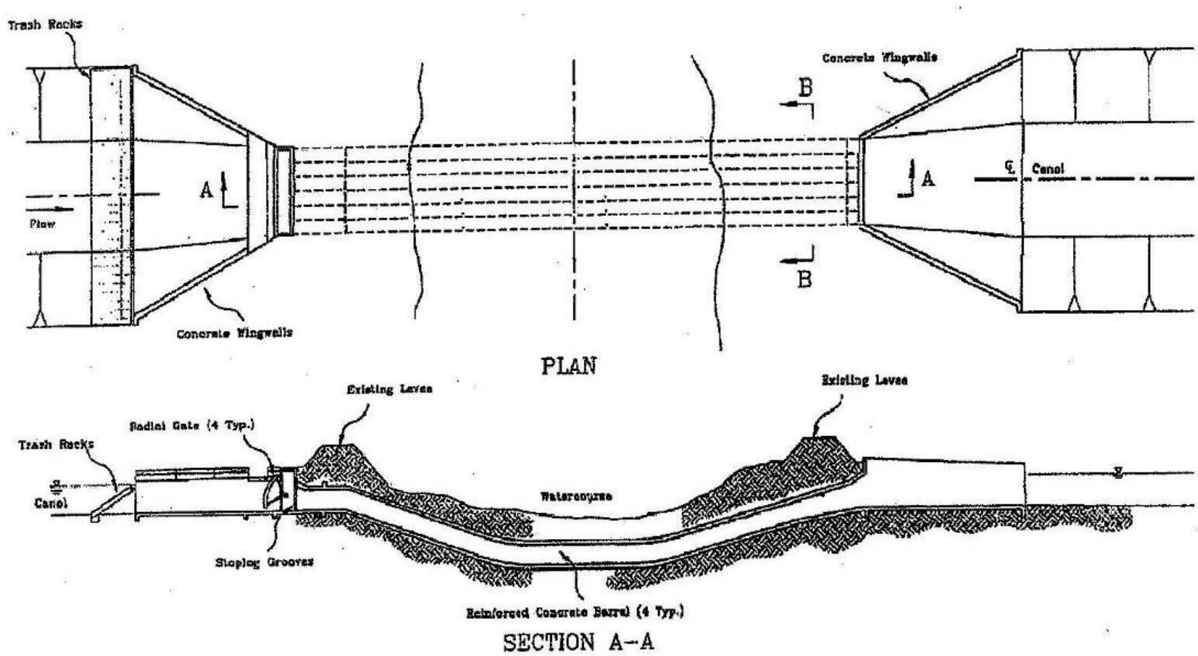


Figure 9-9 Typical Siphon Plan and Profile

Appendix 9A
Ecosystem Impacts of Building Block 1.7: Isolated Conveyance Facility Alternatives

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Acronyms

cfs	cubic feet per second
CVP	Central Valley Project
EFH	Essential Fish Habitat
ESU	evolutionarily significant unit
ICF	Isolated Conveyance Facility
mm	millimeter
SWP	State Water Project

9A.1 ECOSYSTEM IMPACTS OF THE ISOLATED CONVEYANCE FACILITY

The Isolated Conveyance Facility (ICF) would be located near the eastern side of the Sacramento–San Joaquin River Delta (Delta).

The ICF would impact ecosystems in the following manner:

- Loss of terrestrial habitats and occurrences of special-status species due to construction of the ICF
- Increase in protected and restored wildlife habitat in sections of purchased land parcels unsuitable for re-sale
- Disruption of fish habitat and fish passage during construction over or under waterways
- Increase in intake of fish in the northern portion of the Delta from the ICF intake, depending on the effectiveness of fish screening
- Overall reduction in fish entrained into water exports
- Reduction in fish intake at State Water Project (SWP) and the federal Central Valley Project (CVP) water export facilities
- Increase in water in the following tributaries used for anadromous fish spawning: Cosumnes River, Mokelumne River, Calaveras River, and San Joaquin River

9A.2 TERRESTRIAL HABITAT

The areas of terrestrial habitats and observed occurrences of special-status species that are directly lost due to construction of the ICF are depicted in Figure 9A-1. Special-status species include four plant species (Suisun Marsh aster *[Aster lentus]*, rose mallow *[Hibiscus lasiocarpus]*, mudflat quillplant *[Lilaeopsis masonii]*, and delta mudwort *[Limosella subulata]*) and two wildlife species (Swainson's hawk *[Buteo swainsonii]* and the western pond turtle *[Emys (= Clemmys) marmorata])* (see Table 9A-1 for species statuses). The majority of land impacted is agricultural vegetation type that has little habitat value (Figure 9A-1; see Impact to Ecosystem Technical Memorandum (URS/JBA 2008e] for description of vegetation types and benefits of agriculture to bird species). The total loss of agricultural area is small relative to agricultural land in the entire Delta. Small portions of herbaceous ruderal upland and riparian trees would also be impacted. In addition to these observed occurrences, many special-status species may also be observed in the area (Table 9A-1).

9A.3 NEW WILDLIFE AREAS

Segmentation of land parcels for the construction of the ICF would create parcel segments whose size and shape or location make them unsuitable for resale. These areas may be designated for wildlife areas.

9A.4 WATERWAY OBSTRUCTION

Siphons would be used to conduct water under the waterways during ICF construction. Cofferdams would be erected during construction to place siphons under waterways. The cofferdams would temporarily block water on the following waterways: Cosumnes River, Mokelumne River, Beaver Slough, Hog Slough, Sycamore Slough, White Slough, Disappointment Slough, Calaveras River, San Joaquin River, and Middle River. These areas are within the essential fish habitat (EFH) of listed runs of chinook salmon (*Oncorhynchus tshawytscha*), and within the critical habitat of steelhead salmon (*Oncorhynchus mykiss*). The blockage may obstruct migration and juvenile rearing of listed species and evolutionarily significant units (ESUs), including chinook salmon (Central Valley fall ESU, federal candidate, and California species of concern; Central Valley late fall run ESU, federal candidate, and California species of concern; Central Valley winter run ESU, federal and California endangered; Sommarstrom et al. [2007]) and impact habitat used for juvenile rearing, spawning, and holding by steelhead salmon (federal and California threatened). Central Valley spring-run chinook salmon (federal and California threatened) do not use any waters affected by the ICF. Impacts to listed fish species may be avoided by timing siphon construction to avoid migration of salmon.

- Central Valley fall-run chinook salmon use the Cosumnes River, Mokelumne River, Calaveras River, and San Joaquin River for migration and juvenile rearing. Spawning occurs upstream of the ICF location on the Mokelumne River, Calaveras River, and tributaries of the San Joaquin River. The Cosumnes River is used as an opportunistic/intermittent spawning river. Adult migration of fall-run chinook salmon is from late July to December, spawning takes place from October to December, and juvenile emigration occurs from January to June.
- Central Valley late fall-run chinook salmon use White Slough, Disappointment Slough, Calaveras River, San Joaquin River, and Middle River for opportunistic/intermittent spawning, holding, and rearing. Adult migration for late fall-run chinook salmon occurs from October to mid-April, spawning occurs from January to April, and juvenile emigration occurs from October to March.
- Central Valley winter-run chinook salmon use the Calaveras River and San Joaquin River for opportunistic/intermittent spawning, holding, and rearing. Adult migration for winter-run chinook salmon occurs from November to June, spawning occurs late April to mid-August, and juvenile emigration occurs from January to June.
- The threatened Central Valley winter steelhead salmon enters freshwater from August through October. They hold in the main stem of the major rivers until tributary flows are high enough for spawning (Moyle 2002). Spawning begins in December and can extend into April. This ESU represents the longest freshwater migration of any winter-run steelhead salmon (NOAA 1998). No EFH has been designated for the Central Valley steelhead salmon. The location of the ICF falls within the critical habitat of the Central Valley steelhead salmon, and they may use all locations for migration, spawning, holding, and rearing.

9A.5 ENTRAINMENT IN INTAKE

The impacts of the water intake structure on the Sacramento River are related to size of fish in the vicinity and the rate of flow into the intake. A detailed description of fish screens on the ICF is provided in Section 15, Building Block 3.3: Install Fish Screens. Several features of the intake design that lead to fish entrainment at CVP and SWP facilities are avoided in the ICF intake, including diverting water from a flowing river rather than a dead-end canal and use of appropriate fish screens to prevent entrainment of small pelagic fish, such as Delta smelt (*Hypomesus transpacificus*).

Many fish species may occur within the vicinity of the ICF intake (Table 9A-2). The listed fish species, Delta smelt and several listed chinook salmon runs, are likely to be affected by the intake structure on the Sacramento River. The intake is not likely to impact green sturgeon (*Acipenser medirostris*), another listed species that occurs in the area, because of the large size of this species. Green sturgeon normally spawn upstream of Hamilton City, and their larvae are not likely to be entrained in the intake structure.

- Green sturgeon: Spawning occurs upstream of intake (upstream of Hamilton City). Intake structure is not likely to impact green sturgeon.
- Delta smelt: Intake structure is within critical habitat, but upstream of normal distribution. Diversion of water through the intake may affect amount of freshwater flow downstream in Delta smelt habitat. Any Delta smelt using the Sacramento River at intake site may be entrapped or entrained. Any spawning of Delta smelt upstream of intake structure may result in the entrapment of larvae, and juveniles may be carried downstream.
- Salmonids: Juveniles may be trapped in intake structure while emigrating downstream to the ocean.
    - Juvenile fall-run chinook salmon emigrate downstream within a few months of emergence and may be susceptible to entrapment from the intake structure.
    - Juvenile late fall-run chinook salmon rear in the upper Sacramento River for 7 to 12 months, measure between 150 and 170 millimeters (mm) in length during emigration downstream to the ocean and are likely large enough not to be impacted by the intake structure during emigration.
    - Juvenile winter-run chinook salmon rear in natal streams for 5 to 10 month before emigration and are likely large enough not to be impacted by the intake structure during emigration.
    - Juvenile spring-run chinook salmon rear in streams for 3 to 15 months, depending on flow conditions. Typical residence time is around 10 to 15 months, after which juveniles emigrate at a larger size. The short residence time (e.g., 3 months) is due to high flows washing juveniles downstream. In this event, fish are small but unlikely to be entrained because of the large volume of water flowing past the intake during high flows.
    - Juvenile winter-run steelhead salmon (Central Valley) emigrate to the ocean at 1 to 3 years of age and measure between 100 and 250 mm in length. Because of their size, they are not likely to be impacted by the intake structure during migration.

Table 9A-3 presents the chinook salmon’s uses of waters affected by the ICF by ESU, and Table 9A-4 shows the seasonal uses by ESU.

9A.6 REDUCTION IN INTAKE

The alternative operational capacities for the ICF are 5,000, 10,000, and 15,000 cubic feet per second (cfs). The two smaller operational flow alternatives may require supplemental withdrawals from the south Delta (i.e., operation as a dual conveyance system). In the case of supplemental south Delta withdrawals, loss of fish due to entrainment and stress from salvage operations would result. The fish species that are found in salvage at SWP and that may be entrained are presented in Table 9A-5. However, the difference in impact on fish between a 5,000 cfs pumping rate and a 10,000 cfs pumping rate is not well understood. Intuitively, decreased pumping at the south Delta facilities is expected to result in decreased fish entrainment at those facilities; however, available information is not adequate to evaluate the differential impacts of supplemental pumping resulting from the 5,000 cfs and 10,000 cfs ICF alternatives. Fish screening efficiencies at the south Delta pumping facility change in undocumented ways across a range of pumping rates (Bob Fujimura, pers. comm., July 2007). Also, fish entrainment rates vary seasonally within years and across years depending on total population sizes and relative geographic and temporal distribution of spawning; the way in which alternative pumping scenarios will interact with these annual and seasonal variations in fish susceptibility has not been studied. Also, increased direct diversions of freshwater from the Sacramento River at the ICF diversion facility would have unknown effects on water circulation in the lower Sacramento River, central Delta, and south Delta; these altered hydrodynamics might change fish entrainment rates at a given pumping rate from those that occur today at similar rates.

Several features of the design of the intakes at CVP and SWP facilities contribute to entrainment of fish. The design of the intake structure of the CVP and SWP facilities essentially creates a dead-end intake into which fish flow with water. In the intake canal, fish are removed from water going into the export pumps by concentrating fish out of the intake water with behavioral louvers and a set of screens. The efficiency of the behavioral louvers depends on the species-specific response of fish to the turbulent eddies and change in direction of flow created by the louvers. The gates are typically more efficient for large-bodied migratory strong swimmers and less efficient for small pelagic fish (bottom dwellers that are not typically exposed to turbulent eddies found in the upper water column) and have extremely little efficiency for removing planktonic eggs and larvae. Fish directed to the bypass with behavioral louvers are then further concentrated through fish screens. Due to the design, fish impingement on screens is low. The screens become less efficient at high flows. The fish monitoring process at SWP involves counting individuals and identifying species in a sub-sample of fish captured for salvage. Extrapolation of these data to counts of fish lost to entrainment requires a measurement of the efficiency of the screens to remove specific fish; the efficiency of the screens for Delta smelt has not been evaluated.

9A.7 BENEFITS, VALUES, AND CONSTRAINTS

9A.7.1 Benefits and Values

The ICF would result in an overall reduction in fish entrained into water exports. The reduction in entrainment of fish in water exports would be due to (1) increased efficiency of newer fish screen designs, (2) the “T” intake design, in which fish can escape entrainment by continuing along with the flowing river rather than by being mechanistically removed from the dead-end channel to the export pumps, as with the current design at SWP and CVP facilities.

The ICF would allow increased flow of water from the Sacramento River to the south Delta, thereby decreasing flows from the San Joaquin River. The ICF would be beneficial because flow in the San Joaquin River is currently low compared to historical flows due to upstream dams. Low flows may be responsible for the low dissolved oxygen levels in the San Joaquin River. Increased flows may flush high levels of phytoplankton production near Stockton out of the Delta toward the Sacramento River, the lower San Joaquin River, and Suisun Bay, which have phytoplankton levels greatly depreciated from historical levels (e.g., Jassby 2005). The lack of phytoplankton in this area is thought to influence the overall health of the Delta and specifically the population size of the federally threatened Delta smelt. Implementation of the ICF would also increase flows in tributaries other than Sacramento River, including the Cosumnes and Mokelumne rivers in the north Delta.

9A.7.2 Constraints

Special-status species of terrestrial wildlife might be impacted during the construction of the ICF, and small amounts of sensitive habitat might be lost. Waterway obstruction during the construction of the ICF might impact migration and emigration of several listed species of anadromous fish. The ICF intake might expose a different suite of species of fish to entrainment, though entrainment of fish is expected to be lower due to intake design and fish screens. This analysis did not consider the impacts of canal dredging, but this action might be expected to have temporary impacts on fish and riparian habitat on the sides of the dredged sloughs.

Tables

Table 9A-1 Terrestrial Listed Species Located Within the Vicinity of the Isolated Conveyance Facility

Species name	Common name	Status[1]			
		Federal	California	CDFG	CNPS
Actinemys marmorata	Western pond turtle	None	None	SC	
Actinemys marmorata marmorata	Northwestern pond turtle	None	None	SC	
Agelaius tricolor	Tricolored blackbird	None	None	SC	
Ambystoma californiense	California tiger salamander	Threatened	None	SC	
Ardea herodias	Great blue heron	None	None		
Athene cunicularia	Western burrowing owl	None	None	SC	
Atriplex joaquiniana	San Joaquin spearscale	None	None		1B.2
Branchinecta lynchi	Vernal pool fairy shrimp	Threatened	None		
Branchinecta mesovallensis	Midvalley fairy shrimp	None	None		
Buteo regalis	Ferruginous hawk	None	None	SC	
Buteo swainsoni	Swainson's hawk	None	Threatened		
California macrophyllum	Round-leaved filaree	None	None		1B.1
Carex comosa	Bristly sedge	None	None		2.1
Carex vulpinoidea	Fox sedge	None	None		2.2
Circus cyaneus	Northern harrier	None	None	SC	
Delphinium recurvatum	Recurved larkspur	None	None		1B.2
Desmocerus californicus dimorphus	Valley elderberry longhorn beetle	Threatened	None		
Elanus leucurus	White-tailed kite	None	None		
Eremophila alpestris actia	California horned lark	None	None	SC	
Eryngium racemosum	Delta button-celery	None	Endangered		1B.1
Hibiscus lasiocarpus	Rose-mallow	None	None		2.2
Hydrochara rickseckeri	Ricksecker's water scavenger beetle	None	None		
Hygrotus curvipes	Curved-foot hygrotus diving beetle	None	None		
Lanius ludovicianus	Loggerhead shrike	None	None	SC	

Table 9A-1 Terrestrial Listed Species Located Within the Vicinity of the Isolated Conveyance Facility

Species name	Common name	Status[1]			
		Federal	California	CDFG	CNPS
Laterallus jamaicensis coturniculus	California black rail	None	Threatened		
Lathyrus jepsonii var. jepsonii	Delta tule pea	None	None		1B.2
Lepidurus packardi	Vernal pool tadpole shrimp	Endangered	None		
Lilaeopsis masonii	Mason's lilaeopsis	None	Rare		1B.1
Limosella subulata	Delta mudwort	None	None		2.1
Perognathus inornatus inornatus	San Joaquin pocket mouse	None	None		
Rana aurora draytonii	California red-legged frog	Threatened	None	SC	
Scutellaria galericulata	Marsh skullcap	None	None		2.2
Scutellaria lateriflora	Blue skullcap	None	None		2.2
Symphyotrichum lentum	Suisun Marsh aster	None	None		1B.2
Taxidea taxus	American badger	None	None	SC	
Thamnophis gigas	Giant garter snake	Threatened	Threatened		
Tropidocarpum capparideum	Caper-fruited tropidocarpum	None	None		1B.1
Valley Sink Scrub	Valley Sink Scrub	None	None		
Vulpes macrotis mutica	San Joaquin kit fox	Endangered	Threatened		

[1] A CNDDB (July 2007) quad search was conducted on the seven USGS quads that intersect the alignment of the ICF (Courtland, Bruceville, Thornton, Terminus, Holt, Woodward Island, and Clifton Court Forebay).

CDFG = California Department of Fish and Game
CNPS = California Native Plant Society

Table 9A-2 Fish Species in the Vicinity of the Isolated Conveyance Facility Intake

Species Name	Native/Non-native	ESA Status	Age Group	Juvenile Size*
California Roach	Native	No special legal status	Juveniles, Adults	smaller
Central Valley Steelhead/Rainbow Trout	Native	Threatened (Fed/CA)	Smolt, Adults	bigger
Chinook salmon, spring run	Native	Threatened (Fed/CA)	Fry, Smolt, Adults	bigger
Chinook salmon, late fall run	Native	Candidate/Special Concern (Fed/CA)	Fry, Smolt, Adults	bigger
Chinook salmon, Winter Run	Native	Endangered (Fed/CA)	Fry, Smolt, Adults	bigger
Delta Smelt	Native	Threatened (Fed/CA)	Larvae, juveniles, adults	smaller
Green Sturgeon	Native	Threatened (Fed)	Larvae, juveniles, adults	bigger
Hardhead HH	Native	No special legal status	Larvae, juveniles, adults	bigger
Hitch	Native	No special legal status	eggs, juveniles, adults	bigger
Lampreys (all spp.)	Native	No special legal status	Larvae, juveniles, adults	smaller
Pacific Brook Lamprey	Native	No special legal status	Larvae, juveniles, adults	smaller
Prickly Sculpin	Native	No special legal status	Juveniles, Adults	bigger
Riffle Sculpin	Native	No special legal status	Juveniles, Adults	bigger
Sacramento Blackfish	Native	No special legal status	Larvae, juveniles, adults	bigger
Sacramento Pikeminnow	Native	No special legal status	Larvae, juveniles, adults	bigger
Sacramento Splittail	Native	Special Concern (CA)	Larvae, juveniles, adults	bigger
Sacramento Sucker	Native	No special legal status	Larvae, juveniles, adults	bigger
Speckled Dace	Native	No special legal status	Juveniles, Adults	smaller
Threespine Stickleback	Native	No special legal status	Juveniles, Adults	smaller
Tule Perch	Native	No special legal status	Juveniles, Adults	bigger
White Sturgeon	Native	No special legal status	Larvae, juveniles, adults	bigger
American Shad	Non-native	No special legal status	Egg, larvae, juveniles, adults	smaller
Bigscale Logperch	Non-native	No special legal status	Juveniles, Adults	bigger
Black Bullhead (BLBH)	Non-native	No special legal status	Juveniles, Adults	smaller
Black Crappie	Non-native	No special legal status	Juveniles, Adults	bigger
Bluegill	Non-native	No special legal status	Juveniles, Adults	bigger
Brown bullhead	Non-native	No special legal status	Juveniles, Adults	smaller
Channel catfish	Non-native	No special legal status	Juveniles, Adults	bigger
Common Carp	Non-native	No special legal status	Juveniles, Adults	bigger
Fathead Minnow (FHM)	Non-native	No special legal status	Juveniles, Adults	smaller
Golden Shiner	Non-native	No special legal status	Juveniles, Adults	smaller

Table 9A-2 Fish Species in the Vicinity of the Isolated Conveyance Facility Intake

Species Name	Native/Non-native	ESA Status	Age Group	Juvenile Size*
Goldfish	Non-native	No special legal status	Juveniles, Adults	smaller
Inland Silverside	Non-native	No special legal status	Eggs, larvae, juveniles, adults	smaller
Largemouth Bass	Non-native	No special legal status	Juveniles, Adults	bigger
Mosquitofish	Non-native	No special legal status	Juveniles, Adults	smaller
Red Shiner	Non-native	No special legal status	Juveniles, Adults	smaller
Redear Sunfish	Non-native	No special legal status	Juveniles, Adults	bigger
Striped Bass	Non-native	No special legal status	Egg, larvae, adults	bigger
Threadfin shad	Non-native	No special legal status	Eggs, larvae, juveniles, adults	smaller
Wakasagi	Non-native	No special legal status	Larvae, juveniles, adults	smaller
Warmouth	Non-native	No special legal status	Juveniles, Adults	bigger
White Catfish	Non-native	No special legal status	Juveniles, Adults	bigger
White Crappie	Non-native	No special legal status	Juveniles, Adults	bigger

* Juveniles identified as "smaller" are more susceptible to being pulled through the screen.
ESU = evolutionarily significant unit

Table 9A-3 Chinook Salmon Uses of Waters Affected by Isolated Conveyance Facility by ESU

Water Body	ESU	Use at Location	Comment
Cosumnes River	Fall-run	Adult migration, holding, rearing	Opportunistic/intermittent spawning occurs upstream
Mokelumne River	Fall-run	Adult migration, holding, rearing	Spawning occurs upstream
Beaver Slough	None	None	No chinook salmon use this body of water
Hog Slough	None	None	No chinook salmon use this body of water
Sycamore Slough	None	None	No chinook salmon use this body of water
White Slough	Late fall-run	Opportunistic/intermittent migration, spawning, holding, rearing	
Disappointment Slough	Late fall-run	Opportunistic/intermittent migration, spawning, holding rearing	
Calaveras River	Fall-run	Adult migration, holding, rearing	Spawning occurs upstream
	Late fall-run	Opportunistic/intermittent migration, spawning, holding, rearing	
	Winter-run	Opportunistic/intermittent migration, spawning, holding, rearing	
San Joaquin River	Fall-run	Adult migration, holding, rearing	Spawning occurs upstream
	Late fall-run	Opportunistic/intermittent migration, spawning, holding, rearing	
	Winter-run	Opportunistic/intermittent migration, spawning, holding, rearing	
Middle River	Late fall-run	Opportunistic/intermittent migration, spawning, holding, rearing	

ESU = evolutionarily significant unit

Table 9A-4 Chinook Salmon Seasonal Uses by ESU

ESU	Use at Location	Dates
Fall-run	Adult Migration	July-December
	Spawning	October-December
	Incubation	October-March
	Rearing and Emigration	January-June
Late Fall-run	Adult Migration	October-mid April
	Spawning	January-April
	Incubation	January-June
	Rearing and Emigration	October-March
Winter-run	Adult Migration	November-June
	Spawning	Late April-mid August
	Fry Emergence	Mid June-mid October
	Emigration	January-June

Notes:
ESU = Evolutionarily Significant Unit

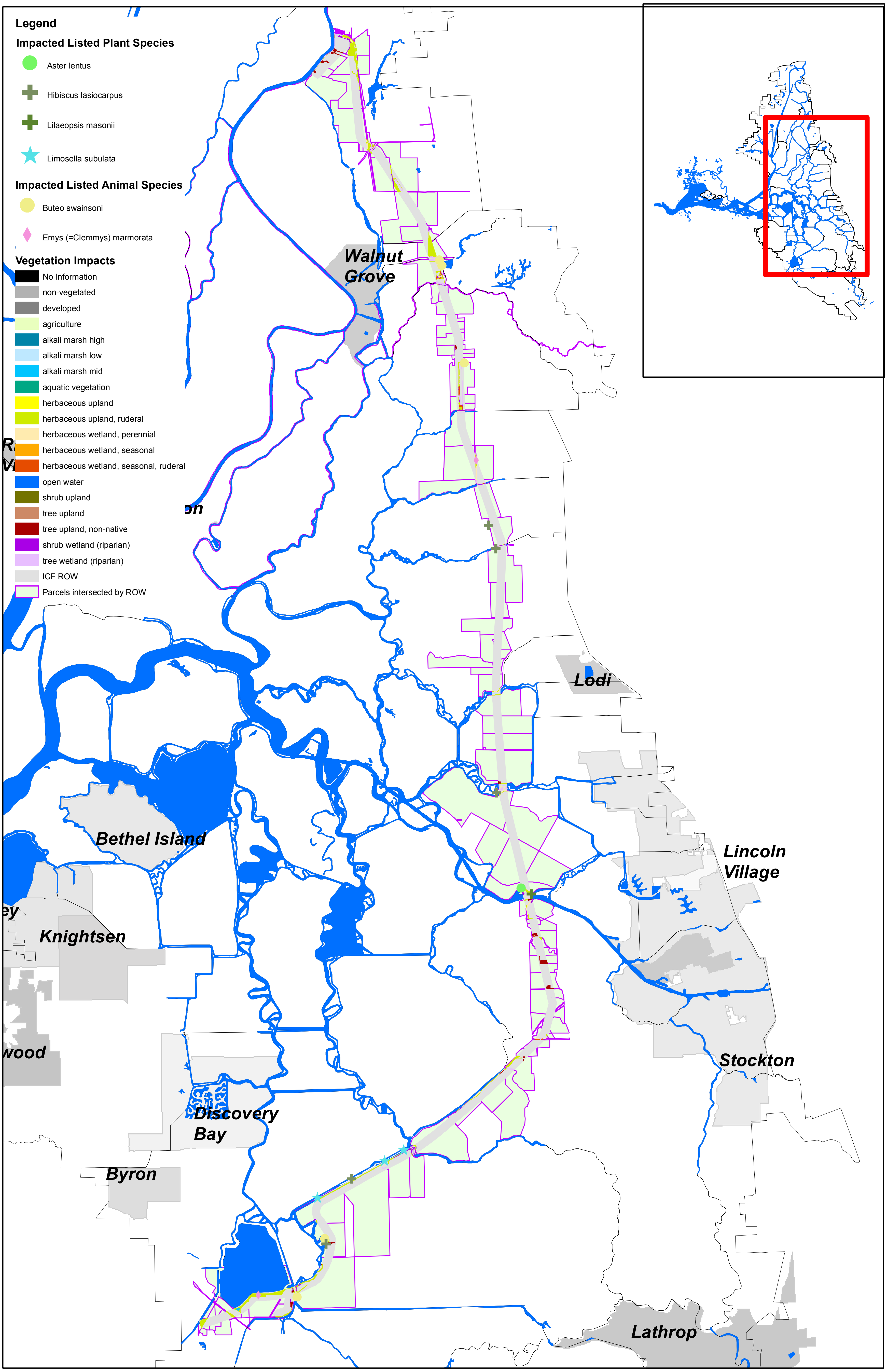
Table 9A-5 Fish Species Found in State Water Project Salvage

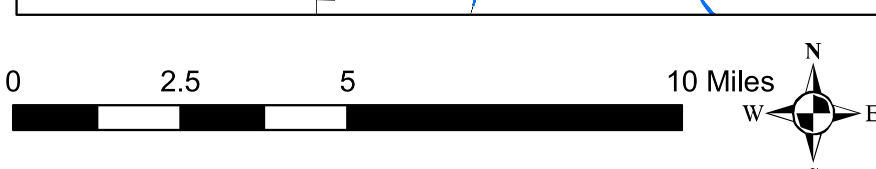
Species Name	ESA Status
American Shad	No special legal status
Bigscale Logperch	No special legal status
Black Bullhead	No special legal status
Black Crappie	No special legal status
Blue Catfish	No special legal status
Bluegill	No special legal status
Brown Bullhead	No special legal status
California Roach	No special legal status
Chinook Salmon, spring run	Threatened (Fed/CA)
Chinook Salmon, late fall run	Candidate/Spcl Concern (Fed/CA)
Chinook Salmon, winter run	Endangered (Fed/CA)
Common Carp	No special legal status
Chameleon Goby	No special legal status
Channel Catfish	No special legal status
Delta Smelt	Threatened (Fed/CA)
Fathead Minnow	No special legal status
Freshwater Eel	No special legal status
Golden Shiner	No special legal status
Goldfish	No special legal status
Green Sturgeon	Threatened (Fed)
Green Sunfish	No special legal status
Hardhead	No special legal status
Hitch	No special legal status
Inland Silverside	No special legal status
Lampreys (all spp.)	No special legal status
Largemouth Bass	No special legal status
Longfin Smelt	No special legal status
Mosquitofish	No special legal status
Northern Pike	No special legal status
Pacific Brook Lamprey	No special legal status
Pacific Herring	No special legal status
Pink Salmon	No special legal status
Prickly Sculpin	No special legal status
Pumpkinseed	No special legal status
Rainwater Killifish	No special legal status
Red Shiner	No special legal status
Redear Sunfish	No special legal status
Riffle Sculpin	No special legal status
Sacramento Blackfish	No special legal status
Sacramento Perch	No special legal status
Sacramento Squawfish	No special legal status
Sacramento Sucker	No special legal status
Shimofuri Goby	No special legal status
Silver Salmon	No special legal status
Smallmouth Bass	No special legal status

Table 9A-5 Fish Species Found in State Water Project Salvage

Species Name	ESA Status
Speckled Dace	No special legal status
Sacramento Splittail	Special Concern (CA)
Staghorn Sculpin	No special legal status
Starry Flounder	No special legal status
Central Valley Steelhead/Rainbow Trout	Threatened (Fed/CA)
Striped Bass	No special legal status
Striped Mullet	No special legal status
Sunfish (generic)	No special legal status
Surf Smelt	No special legal status
Threadfin Shad	No special legal status
Threespine Stickleback	No special legal status
Tui Chub	No special legal status
Tule Perch	No special legal status
Wakasagi	No special legal status
Warmouth	No special legal status
White Bass	No special legal status
White Catfish	No special legal status
White Crappie	No special legal status
White Sturgeon	No special legal status
Yellow Bullhead	No special legal status
Yellow Perch	No special legal status
Yellowfin Goby	No special legal status

Figures





Agriculture vegetation type is not displayed for clarity.
Impacts to listed plant and animal species include those occurring within 500 ft of the ICF ROW.

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URS	26815935 Delta Risk Management Strategy (DRMS) Phase 2	ISOLATED CONVEYANCE FACILITY IMPACTS TO ECOSYSTEM	Figure 9A-1

Appendix 9B

Preliminary Cost Estimate for 15,000 cfs Isolated Conveyance Facility

Summary Cost Estimate (with detail)
Isolated Conveyance Faility (15,000 cfs)

Item	Item	Unit Measure	Unit Cost	Quantity	Total Cost	Notes/ Assumptions
1	**Intake Facilities**	**LS**	$ 400,000,000	1	**$ 400,000,000**	
2	**Bridges and Culverts**	**LS**	$ 88,519,073	1	**$ 88,519,073**	Caltrans cost basis
3	**Pumping Plant**	**LS**	$ 230,000,000	1	**$ 230,000,000**	
4	**Excavation**					
	Scraper Excavation (1 mile haul)	CY	$ 6.05	10,469,604	$ 63,341,104	Note 1
	Dragline Excavation (0 mile haul)	CY	$ 2.97	46,657,170	$ 138,571,795	Note 1
	Backhoe Excavation (.5 mile haul)	CY	$ 4.40	14,922,492	$ 65,658,965	Note 1
	Dewatering	LS	$4,500,000.00	1	$ 4,500,000	
					$ 272,071,864	
5	**Embankment**					Notes 3,4
	Replace Organic Soils (Imported Material Stockpile 10 mile haul)	CY	$ 12.18	22,715,733	$ 276,677,632	Notes 2, 3, 6 and 8
	Replace Organic Soils and Build Embankment	CY	$ -		$ -	Not Used
	Embankment South of Dissappointment Slough		$ 12.18	8,697,659	$ 105,937,488	
6	Right of Way	AC	$ 10,000	6,600	$ 66,000,000	
	Relocation of Existing Property	LS	$ 75,108,000	1	$ 75,108,000	
7	Other (Seeding, Roads, Fencing, etc.)	LS	$ 62,357,470	1	$ 62,357,470	
					$ 586,080,590	
8	**Siphons and Controls**					
	Concrete Box (6-30'x30')	CY	$ 780	863,070	$ 673,307,370	
	Inlet and Outlet Transitions Concrete	CY	$ 368	243,000	$ 89,424,000	Notes 1, 7,9
	Dewatering	LS	$ 11,087,595	1	$ 11,087,595	
	Turnout Structure w/200 cfs Capacity	LS	$ 1,000,000	0	$ -	
	Temporary River Realignment	LS	$ 61,060,770	1	$ 61,060,770	
	Flow Control Structures	LS	$ 1,400,000	24	$ 33,600,000	
	Flood Control Gates	LS	$ 5,000,000	6	$ 30,000,000	
	Riprap	TON	$ 60	376,820	$ 22,609,200	
	Access Roads	MILE	$ 1,000,000	2.89	$ 2,890,000	
	Unique Items River Siphons (Sand, Gravel, Sheet Piling, etc.)	LS	$ 53,636,967	1	$ 53,636,967	
	Other Siphon and Control Costs @ 20%	LS	$ 126,033,071	1	$ 126,033,071	Note 5
					$ 1,103,648,972	
9	**Control Structures for SWP and CVP**	**LS**	$ 106,715,120	1	**$ 106,715,120**	
10	**Maintencance Facility and SCADA**	**LS**	$ 10,000,000	1	**$ 10,000,000**	
	SUBTOTAL ESTIMATED COST				**$ 2,797,035,619**	
	Mobilization/Demobilization - 5% of Subtotal (WGI)				$ 139,851,781	
	SUBTOTAL				**$ 2,936,887,400**	
	Contingency - 30% of Subtotal	Subtotal			$ 881,066,220	
	SUBTOTAL				**$ 3,817,953,620**	
	Survey, Design, CM and Administration - 30% of Subtotal (URS)				$ 1,145,386,086	
	TOTAL COST				**$ 4,963,339,706**	

Not Included in Cost Estimate

Permits
Power to Pumping Plant
Enviromental Mitigation
Financing

Notes/Assumptions

General notes:
Used Quantities from WGI report except for Embankment
NAVD 88 Datum
Weather impacts not included
60 hr work week

1. Includes 10% loss in productivity due to extended work week (6
2. Ten foot Organic Depth
3. Embankment constructed from excavated materials
4. Embankment base constructed from imported materials
5. per CALFED 1997 Isolated Delta Conveyance Facility Report.
6. 10-mile haul; place imported soils to replace organics for embankment foundation.
7. Rebar, formwork and earth work included.
8. Organics disposed of on site in ROW.
9. Flood gates assumed for siphons where embankment elevation is below FIRM Flood el.