STATE OF CALIFORNIA -- THE RESOURCES AGENCY
ARNOLD SCHWARZENEGGER, *Governor*

DEPARTMENT OF WATER RESOURCES
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June 17, 2008

Mr. Phil Isenberg, Chair
and Members of the
Delta Vision Blue Ribbon Task Force
650 Capitol Mall, 5th Floor
Sacramento, California 95818

Dear Chair Isenberg and Members of the Task Force:

Attached, please find the Department of Water Resources' report on the operational assessment of a Dual Conveyance System as requested by the Blue Ribbon Task Force. The report is focused on the factors of the combined operation of through-Delta and isolated facility improvements for the purposes of water supply reliability and ecosystem sustainability.

The Department evaluated the elements of a Dual Conveyance System and the interrelationship of the operational effects on fishery flows, storage, water quality and water supply. A small array of operational scenarios was tested to illustrate operational effects on these areas of interest. However, it is recognized that a broader range of operational scenarios must be evaluated to ensure achievement of the co-equal objectives of water supply reliability and ecosystem health.

Due to its preliminary nature, this assessment does not include the integration of a number of conservation measures that would be part of a comprehensive Delta solution. Further integration of Dual Conveyance facilities and operations are being developed in the Bay Delta Conservation Plan process.

If you have additional questions, please contact me at (916) 653-1099.

Sincerely,

Original Signed By

Katherine F. Kelly, Chief
Bay-Delta Office

Attachment

copies w/attachment: Mr. John Kirlin, Executive Director
Delta Vision Blue Ribbon Task Force

Mr. Leo Winternitz, Chief Deputy Director
CALFED

An Initial Assessment of Dual Delta Water Conveyance

As requested by the Delta Vision Blue Ribbon Task Force

Prepared by California Department of Water Resources

May 2008

Prepared under the supervision of
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An Initial Assessment of Dual Delta Water Conveyance

As requested by the Delta Vision Blue Ribbon Task Force

Prepared by California Department of Water Resources

An assessment of a Dual Conveyance System was requested in the Delta Vision Blue Ribbon Task Force November 30, 2007 report, *Our Vision of the California Delta*. A Dual Conveyance System would consist of two components, one would route water through the Delta and the second would route water through an isolated conveyance facility around the Delta. Through-Delta Component options could range from operating the export facilities as they currently exist to constructing additional facilities within the Delta to be operated in coordination with the existing facilities. Isolated Conveyance Component options could range in size and alignment. A Dual Conveyance System is expected to provide better Delta fishery protection and water supply reliability.

1. Background

Currently, the State Water Project (SWP) and federal Central Valley Project (CVP) divert water primarily from the Sacramento and San Joaquin Rivers for use by cities and farms in the Central Valley, San Francisco Bay Area, and southern California. Delta water diversions are made in the southern Delta. The increasing number of operation regulations and restrictions placed upon Delta exports reflects the conflict between Delta water supply, water quality and environmental needs.

Both the Delta Vision Task Force and the Bay Delta Conservation Plan (BDCP) Steering Committee have completed over a year of work on their respective tasks. The outcome of both processes is that changes are needed in the way water is moved across or around the Delta in order to better protect the environment and water supplies for California's Economy. In its November 30, 2007 Delta Vision Report, the Task Force "recommends an assessment of Dual Conveyance as a preferred direction." In the November 2007 Points of Agreement for the BDCP process, the BDCP Steering Committee identified as the "most promising approach" for achieving its joint goals of protecting at-risk fish species and water supply "a new conveyance system including diversion at a new diversion point on the Sacramento River and an isolated system to convey water around the Delta."

Studies have been done throughout the years to examine better ways to route water through the Delta. Studies have also been done on routing water around the Delta in an isolated conveyance system. As noted above, both the Delta Vision and BDCP processes have identified at this time that modified Delta water conveyance in some sort of Dual Conveyance System as either the "preferred direction" or the "most promising" for further evaluation. More detailed analysis of such a Dual Conveyance System is needed to evaluate whether it can provide possible solutions to the environmental and water supply conflicts we face in the Delta.

As noted in the BDCP November 2007 Points of Agreement, the operation of any new Dual Conveyance System is critical and will take some time to develop. The large array of possible operational scenarios of a Dual Conveyance System is not explored in this report.

This task is underway in the BDCP process and will take several months before recommendations can be made to the BDCP Steering Committee for their evaluation. Until that process is complete, the benefits and impacts of a Dual Conveyance System cannot begin to be fully assessed. As will be explained later, this report uses a sensitivity analysis approach to begin to understand how a Dual Conveyance System might be operated to benefit both the environment and water supply reliability. It is designed to inform the BDCP effort and the Task Force on issues and opportunities that can be addressed with the operational flexibility provided by a Dual Conveyance System.

2. Summary

The Blue Ribbon Task Force, in its November 30, 2007 report entitled *Our Vision of the California Delta*, recommended that an assessment be made of a Dual Conveyance water supply system. Specifically the Task Force requested:

> "An assessment of a Dual Conveyance System as the preferred direction, focused on understanding the optimal combination of through-Delta and isolated facility improvements. The criteria to be considered should include at least the following performance standards:
>
> – *Water supply reliability;*
> – *Seismic and flood durability;*
> – *Ecosystem health and resilience;*
> – *Water quality;*
> – *Projected schedule, cost and funding;*
> – *Additional performance standards that may be identified by the Task Force."*

The Department of Water Resources (Department) has evaluated elements of a Dual Conveyance System and the interrelationship of the operational effects on fishery flows, storage, water quality, and water supply. Several operational scenarios have been evaluated to illustrate the effects on these areas of interest.

While the Department has not arrived at an optimal combination of Dual Conveyance components, the operational considerations that must be weighed in determining an optimal combination have been identified. These considerations involve operating criteria for the State Water Project (SWP) and the Central Valley Project (CVP) and habitat and in-Delta water use benefits.

Findings on Water Supply Reliability

The studies of a Dual Conveyance System evaluate maximum allowable diversions into an Isolated Conveyance Component of 5,000 cubic feet per second (cfs), 10,000 cfs, and 15,000 cfs. Three studies analyze operating the Isolated Conveyance Component as the first priority. Two additional studies, one constraining the Isolated Conveyance Component to 5,000 cfs and the other to 10,000 cfs, assume 5,000 cfs is pumped by the Through-Delta Component first.

For each of the five Dual Conveyance scenarios, the reliability of exporting a given quantity of water significantly increases over the current operation of the SWP and the CVP, which includes the restrictions on flows in the south Delta (in Old and Middle Rivers) ordered by federal Judge Wanger. The potential increases in exported water reliability and quantity are very dependent upon the water quality and fish protection measures required in the Delta. The Dual Conveyance scenarios assume the south Delta flow restrictions are no longer needed for fish protection and, therefore, may result in more water being pumped from the south Delta than currently allowed.

The increases in the reliability and quantity of exports shown in the Dual Conveyance studies are primarily due to the higher allowable export levels for the SWP/CVP, reduction in salinity intrusion due to less through-Delta pumping, and no Court-ordered flow restrictions on Old and Middle Rivers in the south Delta. In the scenarios where the maximum diversion into the Isolated Conveyance Component is constrained to 5,000 cfs or 10,000 cfs, more negative impacts to ecosystem health occurs over the scenarios where less water is routed through the Delta during times when it is sensitive for fish.

The Dual Conveyance studies do not show a significant reduction in reservoir storage north of the Delta. This is because the rules for operating the reservoirs are the same in each of the studies. This report also includes an example of how operation rules for a Dual Conveyance can cause severe reductions in upstream storage; illustrating that these rules must be carefully developed to assure these reductions do not occur.

Findings on Seismic and Flood Durability:

The plan for recovery after a catastrophic earthquake is an important design consideration for a Dual Conveyance System. The Isolated Conveyance Component would be designed to withstand a catastrophic seismic event and extreme flood conditions. The Through-Delta Component may or may not be designed to withstand catastrophic conditions. Significant cost increases are associated with constructing a Through-Delta Component to withstand a catastrophic earthquake.

Findings on Ecosystem Health and Resilience:

A Dual Conveyance System provides opportunities to increase food and food quality for Delta fish species and to decrease predation and entrainment associated with the SWP and CVP Delta facilities. Under the operation scenarios where the Isolated Conveyance Component is constrained, the flow of water through the Delta is increased to a point where it creates significant reverse flows in Old and Middle Rivers. These reverse flows have been considered a surrogate for fish entrainment risk. Under each of the Dual Conveyance operation scenarios, the average monthly position of X2 shifted upstream about 2 km more than the current operations. This is due to the increased amounts of water being exported from the Delta under the Dual Conveyance operation scenarios.

Findings on Water Quality:

Salinity in the western Delta is much less sensitive to flow changes resulting from the Dual Conveyance scenarios than the central or south Delta. The operation of the Through-Delta component of a Dual Conveyance System affects water quality in the southern and central Delta when south Delta exports are low and San Joaquin River water quality dominates. Under current conditions, salinity in the south Delta is reduced when the state and federal projects bring Sacramento River water south where it dilutes the higher salinity San Joaquin River water. However, when Sacramento River water is diverted through the Delta at times when it is sensitive for native fish, it may be considered significantly detrimental for those species. The Through-Delta component of Dual Conveyance facilities may be used at times not considered sensitive for fish to benefit water quality in the south Delta.

Projected Cost and Funding:

Two general alignments for an Isolated Conveyance Component were estimated for capital cost, a western alignment and an eastern alignment. The western alignment cost is estimated at $7.4 billion. An eastern alignment is estimated to cost about $4.2 billion. Much of the difference in costs is associated with the tunneling required in the western alignment. Another cost difference is the amount of pumping needed for each alignment. The eastern alignment is estimated to require a lift of about 20 feet from the river elevation to convey it through the Isolated Conveyance Component. The western alignment requires a lift range of 45 to 95 feet, depending on the alignment of the tunnel. This also has a direct effect on energy use and operational costs. The costs for a Through-Delta Component range significantly. If no improvements are made, there is no cost for the component. If improvements are included, the cost ranges from $1.2 to $9.6 billion depending upon the level of seismic protection included in the component.

3. Purpose and Scope of Report

The purpose of this report is to respond to a request of the Delta Vision Task Force in their November 30, 2007 Delta Vision Report. The California Bay Delta Authority requested the Department prepare this assessment as part of the ongoing efforts related to the Bay Delta Conservation Plan (BDCP) development. The assessment of Dual Conveyance contained in this report is very preliminary. The engineering work contained in this report is just beginning and will be refined as the configuration and operation of a Dual Conveyance System is refined. This will be done through the BDCP process and in the development of the associated environmental documents.

Scope of this Report

A Dual Conveyance System consists of two components: an Isolated Conveyance Component and a Through-Delta Component. Two approaches to each component are evaluated. For the Isolated Conveyance Component, eastern and western general alignments are evaluated. For the Through-Delta Component, use of only existing facilities is evaluated as well as through-Delta improvements similar to those evaluated in the BDCP Conservation Strategy Evaluations Report (SAIC, September 17, 2007). These components form four general configurations for a Dual Conveyance System. They are (1) an Eastern Alignment of the Isolated Component with the existing through-Delta facilities, (2) and Eastern Alignment of the Isolated Component with an improved Through-Delta Component, (3) a Western Alignment of the Isolated Component with existing through-Delta facilities, and (4) a Western alignment of the Isolated Component with an improved Through-Delta Component. The report will first discuss the engineering aspects of these configurations and their estimated costs. It then provides an assessment of Dual Conveyance per the criteria the Task Force outlined in its recommendations of November 30, 2007:

- Water supply reliability;
- Seismic and flood durability;
- Ecosystem health and resilience;
- Water quality;
- Projected schedule, and funding.

Last, this report presents the next steps taking place as part of the BDCP process to develop possible operating criteria for a Dual Conveyance System.

4. Potential Dual Conveyance Facilities

Components of a Dual System

A Dual Conveyance System would consist of two components, one would route water through the Delta and the second would route water through an isolated conveyance facility around the Delta. Through-Delta Component options could range from operating the export facilities as they currently exist to constructing additional facilities within the Delta to be operated in coordination with the existing facilities. Isolated Conveyance Component options could range in size and alignment. Figures 2 through 5 illustrate four potential configurations of a Dual Conveyance System.

Through-Delta Component

The current method for conveying water of the SWP and the CVP is solely based upon through-Delta conveyance. Facilities of the SWP and CVP include reservoirs on the Sacramento and the San Joaquin rivers. The rivers themselves are used as conveyance channels. The Delta Cross Channel, near Walnut Grove, controls the flow of Sacramento River water into the eastern Delta. Internal Delta channels are used to convey the water from the Delta Cross Channel through the central Delta to the pumping and fish salvage facilities of the SWP and CVP in the south Delta, near the town of Tracy. The installed maximum pumping capacity of the SWP and CVP facilities is 10,300 cfs and 4,600 cfs, respectively, for a combined pumping capacity into both the SWP and CVP aqueducts of about 15,000 cfs. A system of three temporary barriers (assumed to be replaced with permanent operable gates) in the south Delta protects water stage for local agricultural diversions. This existing through-Delta conveyance configuration combined with an Isolated Conveyance Component forms Dual Conveyance Configurations A and C, evaluated in this report.

In the Delta Risk Management Study (DRMS) and the BDCP efforts and other venues, ideas have been explored to modify through-Delta conveyance by constructing additional facilities. One proposal is designed to provide greater separation between Delta channels that could serve as fish habitat from channels that convey water for export. Channel separation would require barriers or gates to be constructed in four south and central Delta channels that separate Old River from Middle River. In addition, a screened diversion facility would be constructed in the vicinity of Middle River and Victoria Canal. In BDCP Option 2, the Through-Delta Option, the screened diversion is connected by a siphon to Clifton Court Forebay. Conveyance limitations associated with the siphon may warrant additional facilities to be constructed. These elements form the basis for the improved Through-Delta Component for this report.

Isolated Conveyance Component

The Isolated Conveyance Component is proposed as a diversion facility from the Sacramento River. One or more positive fish screens would be constructed on the Sacramento River somewhere between the City of Sacramento and town of Hood. A supply channel would be constructed from the point of diversion on the Sacramento River to the state and federal export facilities in the south Delta. Two different alignments are evaluated in this report: one on the east side of the Delta and one on the west side of the Delta. The Isolated Conveyance Component following an eastern alignment would include pumping stations and siphons to traverse several Delta sloughs and rivers. A facility following a western alignment would include a pipeline under Cache Slough and tunnels under the Sacramento and San Joaquin rivers. Since a majority of the precipitation and water storage is in the north, the operation of this component of a Dual Conveyance System must be integrated with the operation of reservoirs on the Sacramento River and its tributaries.

5. Physical Features of Dual Conveyance

Dual Conveyance Components

For the purposes of this report, the description of a Dual Conveyance System includes four possible configurations. They are:

A. Eastern Alignment Isolated Facility with no through-Delta Improvements
B. Eastern Alignment Isolated Facility with through-Delta Improvements
C. Western Alignment Isolated Facility with no through-Delta Improvements
D. Western Alignment Isolated Facility with through-Delta Improvements

These configurations are shown in figures 2 through 5.

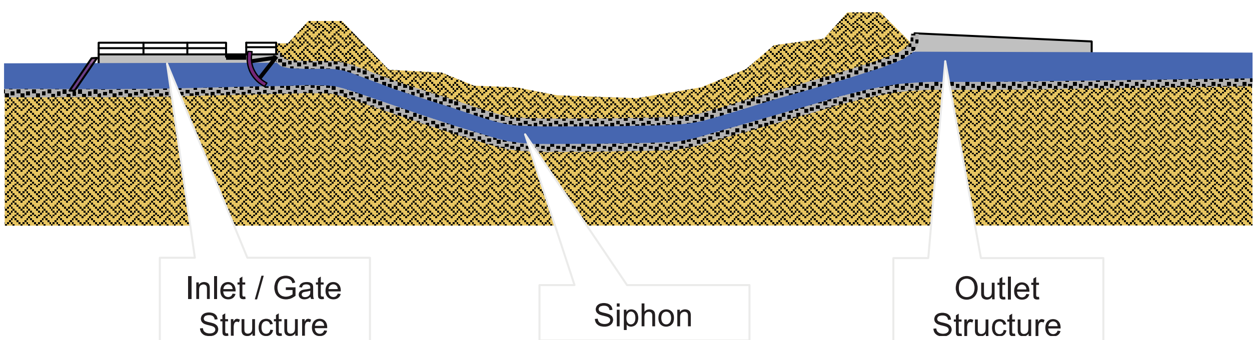
Eastern Alignment Isolated Conveyance Component

The Eastern Alignment of an isolated facility includes a 41-mile canal that skirts the eastern edge of the Delta (Figures 2 and 3). The facility includes an intake placed at the Sacramento River near Hood, assumed to divert up to 15,000 cfs of water from the river.

The new canal would be isolated through Delta sloughs and rivers using siphons and culverts. A new forebay would be constructed on the island south of the existing Clifton Court Forebay and north of the Delta Mendota Canal. A gated outlet structure would be provided at the new forebay to deliver 4,600 cfs of water to the Jones Pumping Plant of the CVP. The new forebay would connect to the California Aqueduct by a new 10,300 cfs capacity unlined canal.

The intake facilities at Hood include a trash rack, flood control gates, sedimentation basin, fish screen, fish bypass channel, low head pumping plant, and control structure. The pumping plant would require the water by 20 feet for it to flow to the export facilities. Siphons would be constructed at the Mokelumne, San Joaquin, Old, and Middle Rivers; and Beaver, Lost, Snodgrass, and Disappointment Sloughs (see Figure 1 for a typical siphon section). Culverts would be located at White, Sycamore, and Hog Sloughs. Bridges would need to be constructed or altered at State Route Highways 160 at Hood, 12, and 4; and at Lambert, Dierssen, Twin Cities, Barber, Walnut Grove, Blossom, Peltier, Woodbridge, Eight Mile, McDonald, Tracy, Calpack, Clifton Court, Byron, and Burns Roads. Affected railways are the Burlington Northern Santa Fe and Southern Pacific.

Figure 1
Typical Siphon for Crossing Sloughs and Rivers



The location of the isolated facility is near the alignment of the Peripheral Canal proposed in the 1970s. Construction of the isolated facility would consist of a cut and fill method so that acceptable excavated materials could be used for embankment levees. Based on information obtained during the planning phase of the Peripheral Canal, it is expected that most of the foundation materials that will be encountered during excavation consists of cohesive soils. Some peat and silty and sandy materials will also be encountered. Geotechnical exploration and testing will confirm the type and extent of foundation materials. Laboratory testing and analyses will determine the strength and suitability.

Excavation will most likely be performed in segments. Dewatering wells will most likely be installed to provide a dry work area while the canal is being excavated and embankments are being constructed.

The top of the embankment would be at least four feet above the maximum water surface to provide freeboard for wind-driven waves, embankment consolidation, subsidence, and erosion. The embankment height would be increased in some areas to allow for significant subsidence, flood protection, and climate change impacts. Although design has not begun, the design engineers are assuming a 40 inch rise in sea level by the year 2100. Recent guidance for the Delta Vision effort may raise this design criterion to 55 inches.

Western Alignment Isolated Conveyance Component

Department staff have also examined the construction of an Isolated Conveyance Component located on the west side of the Sacramento River (Figures 4 and 5). A proposed western alignment extends approximately 52 miles from the "Pocket Area" in southern Sacramento County to a new forebay located adjacent to Clifton Court Forebay. The conveyance system begins as an open channel that extends approximately 19 miles from the Sacramento River, parallels the Yolo Bypass, and terminates where the Deep Water Channel meets Cache Slough. A pumping plant would be constructed at the end of the channel. The pumping plant would need to add 45 to 95 feet of hydrostatic head to provide enough energy to convey the water to the export facilities. By comparison, this is twice to over four times the pumping energy required in the eastern alignment. Water would be pumped through a 10.6-mile pipeline that extends below Cache Slough and continues on the west side of the Sacramento River.

Long and short, deep-tunnel alternatives were examined to convey the water across the Sacramento and San Joaquin Rivers near Rio Vista. Both tunnel alternatives terminate into a canal. The canal terminates at a new, 40-acre forebay. Water is conveyed through a short channel that extends from the new forebay to Italian Slough leading to Banks Pumping Plant. The short channel bifurcates and joins the canal leading to Jones Pumping Plant.

Facilities along the alignment include fish screens and trash racks at the intake, a pumping plant, cut and fill canals, pipelines, siphons, box culverts, tunnels, forebay, surge tank, and energy dissipater with plunge pool.

DWR has not performed geotechnical exploration along the western alignment so foundation materials for the canals and pipelines are unknown. Although it is anticipated that suitable material will be available at depth for tunneling, exploration will be needed to confirm this assumption.

6. Through-Delta Components

Existing Delta Facilities and the South Delta Improvements Program

The major features for a Through-Delta Component already exist and are in use. The system includes existing Delta rivers and channels, the Delta Cross Channel, intake systems at Clifton Court Forebay and the Jones Pumping Plant, and fish screens and salvage facilities at both the SWP and CVP export facilities.

Figure 2
Configuration A – Eastern Alignment Isolated Facility with no through-Delta Improvements
Several potential eastern alignments are shown

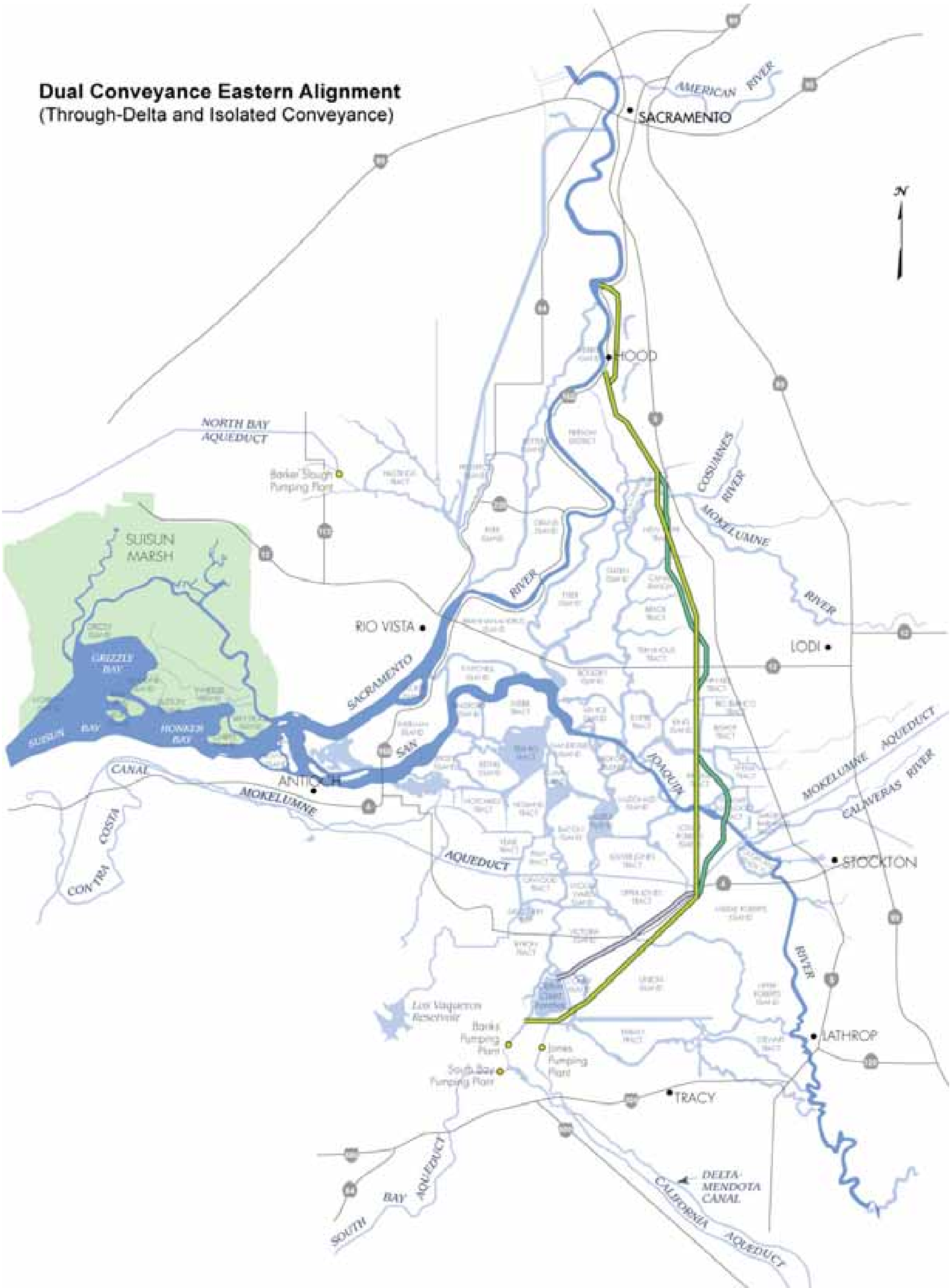


Figure 3

Configuration B – Eastern Alignment Isolated Facility with through-Delta Improvements
Several potential eastern alignments are shown.

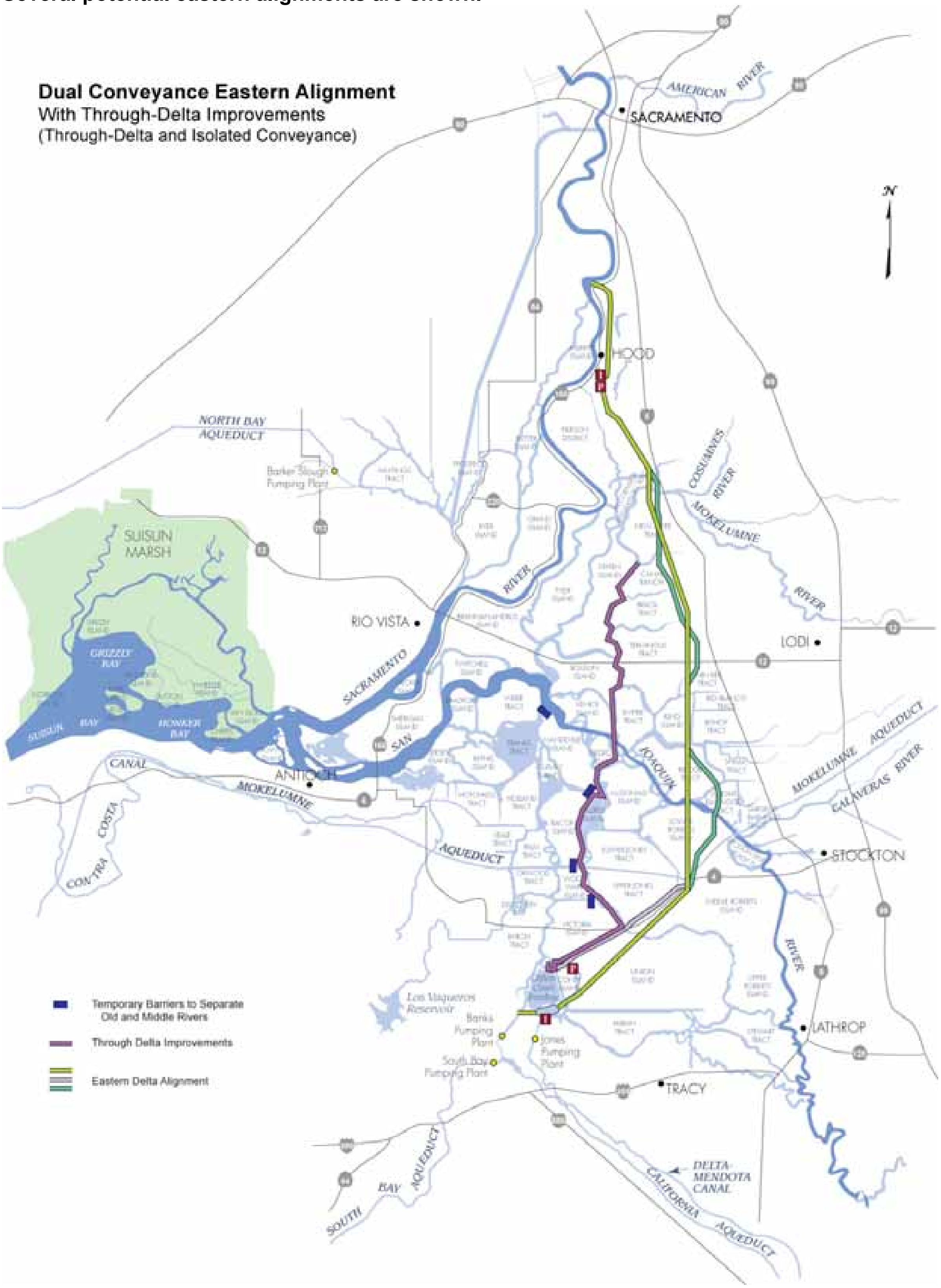


Figure 4
Configuration C – Western Alignment Isolated Facility with no through-Delta Improvements Two potential western alignments are shown.

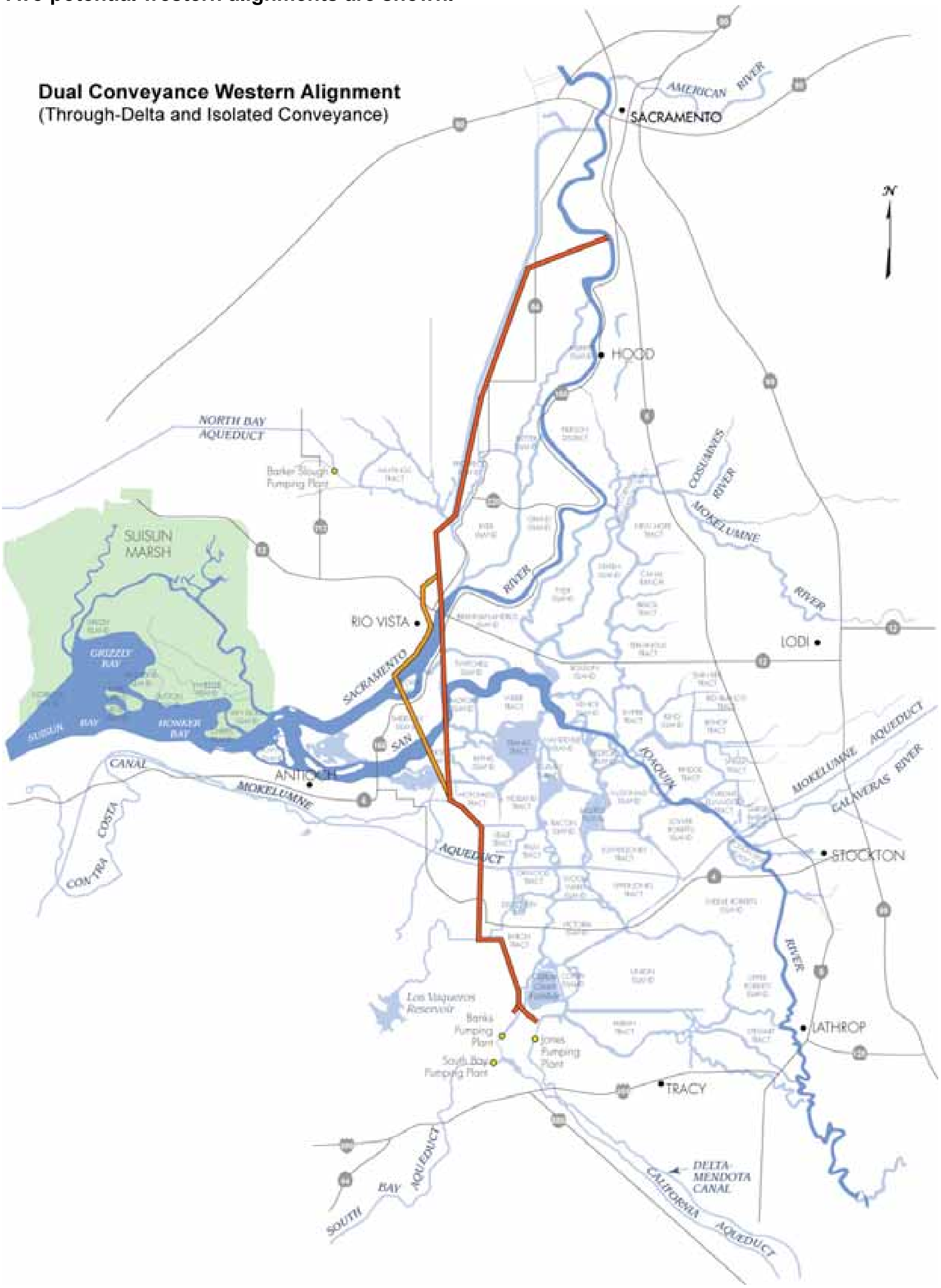
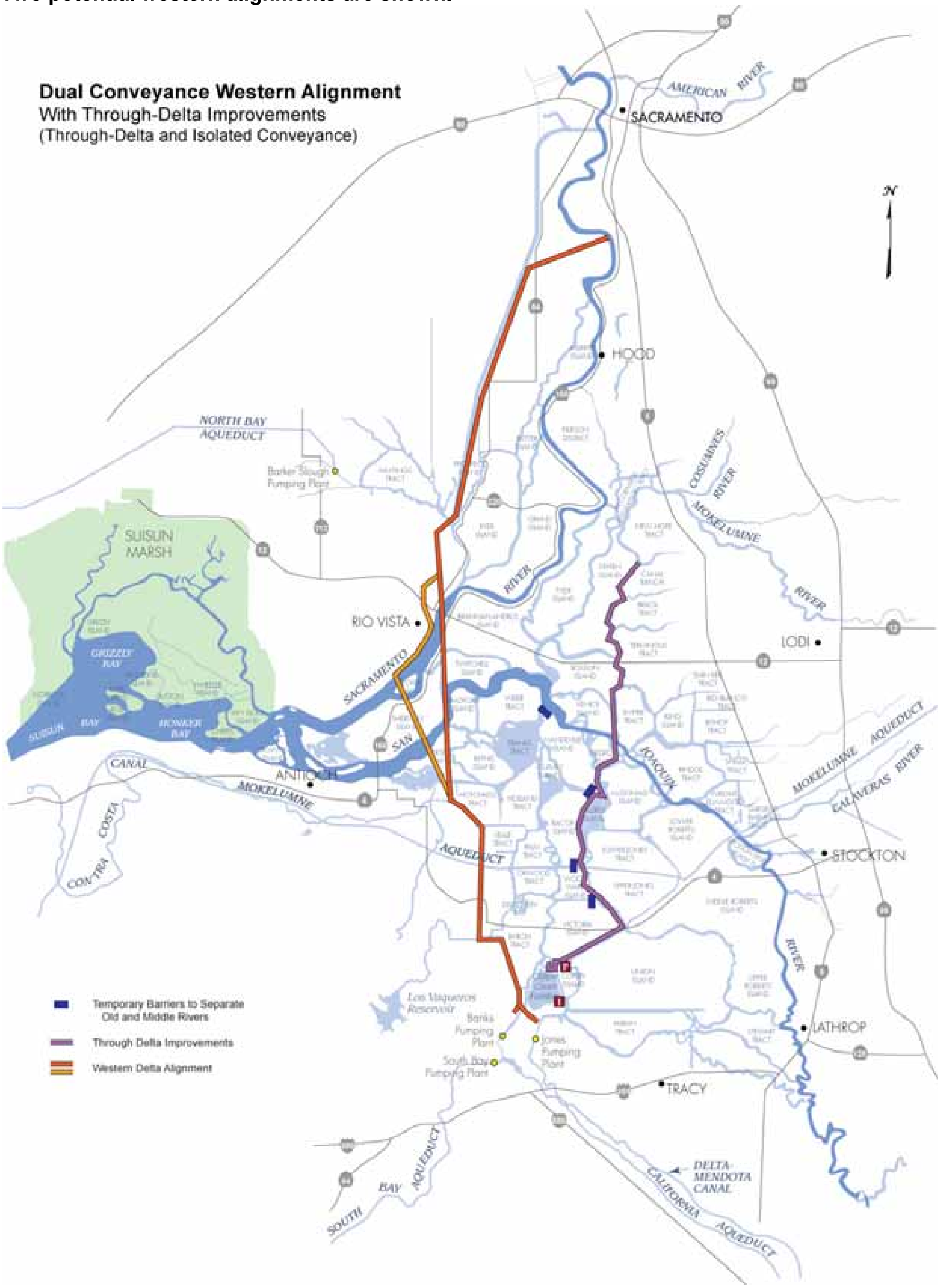


Figure 5
Configuration D – Western Alignment Isolated Facility with through-Delta Improvements
Two potential western alignments are shown.



The SWP facilities are physically capable of diverting 8,500 cfs, but have a design pumping capacity of 10,300 cfs. The design pumping capacity is equivalent to DWR's water right and is matched to the California Aqueduct capacity. The intake on Old River allows water into Clifton Court Forebay up to a sustained capacity of 8,500 cfs. The Forebay is used to minimize the impacts the SWP diversions might have on low tide stage in south Delta channels. By taking water in during a portion of the high tide, Clifton Court gates can be closed during the low tide, thus not lowering water levels at the critically low times. The Department's diversion into Clifton Court Forebay is currently limited 6,680 cfs for much of the year. Increases are allowed mid-December through mid-March if the San Joaquin River flow is above 1000 cfs and in July through September to make up for pumping reductions to protect fish. The 10,300 cfs pumping capacity is used to maximize pumping during off-peak energy consumption periods. The CVP facilities are capable of diverting 4,600 cfs.

For nearly two decades, the Department has been seasonally installing and removing four temporary barriers in the south Delta channels. One barrier, at the Head of Old River, protects San Joaquin River Salmon and is installed and removed twice per year. The remaining three barriers are intended to maintain water stage in south Delta channels. The temporary barriers are ineffective at promoting circulation in the south Delta, which is used to dilute the locally prevalent San Joaquin River water with the Sacramento River water transported through the Delta by the export facilities. The Department and the U.S. Bureau of Reclamation (Reclamation) have completed a Final EIR/EIS for the South Delta Improvements Program (SDIP), which proposes to replace the temporary barriers with permanent operable gates. In prior modeling, it was determined that the SDIP permanent gates would dilute the water in the south Delta channels much more effectively than the temporary barriers. It is anticipated that the Through-Delta Conveyance Component without any other through-Delta improvements may benefit from the installation of the SDIP gates. The Department is continuing the permitting process with the intent to construct these gates if they are shown to be warranted with near-term or long term Delta facilities.

Through-Delta Improvements

The major features for the Through-Delta Component include retrofitting selected existing levees, constructing setback levees, dredging channels, and installing barriers and a siphon. Through-Delta improvements are included in Figures 3 and 5. The existing levees that were constructed over peat soil and loose sand would be retrofitted by placing riprap for erosion protection, placing fill material for freeboard, flattening slopes for stability and habitat restoration, and removing trees and overgrown vegetation for better inspection. Since the reliability of the existing levees is uncertain because of foundation conditions, setback levees would be constructed where needed using engineered fill on competent foundation materials. For the purpose of determining cost estimates for this report, it is assumed the tops of the setback levees would extend approximately seven feet above the 100-year flood elevation to provide freeboard for flooding and climate change. It is also assumed approximately 75 miles of levees would be retrofitted and setback levees would be constructed at Staten, Bouldin, Venice, Medford, McDonald, Mandeville, Bacon, Woodward, Victoria, Union, and Coney Islands; and New Hope, Canal Ranch, Brack, Terminus, and Empire Tracts. In addition, there would be dredging of approximately 60 miles of channels at the South Fork Mokelumne and Middle Rivers; Little Potato, Little Connection, Columbia Cut, and Whiskey Sloughs; and Victoria Canal. Barriers would be installed at Old River, Connection Slough, Bacon Island, and Woodward Canal. A siphon would be constructed at Old River to transport water into Clifton Court Forebay. The costs for these improvements are included in Table 1.

These are not the only possibilities for through-Delta improvements. DWR is continuing a detailed evaluation of improvements in the Franks Tract area as part of its ongoing CALFED efforts to improve water quality, conditions for fish, and water supply. Studies include the evaluation of an operable gate on Three Mile Slough. That operation could be changed at times to either help keep turbid Sacramento River water in the winter from entering the San Joaquin River system and thereby lessen the attraction of adult delta smelt into the lower San Joaquin River and southern Delta or reversed in order to tidally pump Sacramento River water into the Lower Joaquin River system to help improve water quality in the western and southwestern Delta. In addition, through the BDCP process, evaluations are continuing about the possible near-term through-Delta improvements. These potential improvements include two operable gates in the southwestern Delta to help isolate the flows in Middle River from those in Old River to improve protection of delta smelt in the winter and spring. These evaluations are not complete and cost estimates have not yet been prepared but they will be substantially less than the costs for the improvements mentioned above.

7. Capital Costs

Cost Estimates

Costs have been estimated for the eastern and western alignments and for through-Delta improvements. For the purposes of this report, the cost estimates are added to provide a total cost for each of the four configurations. They are summarized in Table 1.

All estimates include a contingency cost for engineering, construction management, legal, and project administration costs of approximately 30%. The cost estimates do not include possible near-term through-Delta improvements being considered in the BDCP process.

For configuration A, the cost for construction of the canal is the highest at 26% of the total cost, followed by the radial gates for the siphons at 17%.

For configuration C, the cost of the tunneling is more than 50% of the total cost.

Retrofitting existing levees and constructing setback levees for the through-Delta improvements are the most expensive features. These actions are needed if the Through-Delta Component is to be designed to endure a catastrophic earthquake. Due to the high cost associated with this approach, relying on the Isolated Conveyance Component as the means to recover from a catastrophic earthquake should be strongly considered. If the Isolated Conveyance Component is relied upon for earthquake recovery, the costs for levee setbacks and retrofitting are optional. Costs for through-Delta improvements appear as a range based on the improvements included.

The cost estimate for the short and long tunnel options is $7.3 billion and $7.5 billion, respectively. These estimates do not include environmental permitting or mitigation or power facilities costs. Combining the cost of facilities for the Through-Delta Component with the costs for West Canal Alignment to create a Dual Conveyance System produces a range of total cost of approximately $8.6 to $17.2 billion.

Table 1 – Estimated Costs for Dual Conveyance Configurations A through D ($ Billion)

FEATURES	CONFIGURATIONS			
	A	B	C	D
Eastern Alignment[1] **–** Canal, intake, fish screen, pumping plant, control structure, siphons, bridges, culverts, utility relocation, railway impacts, forebay, land, some mitigation	$4.2 B	$4.2 B	--	--
Western Alignment[2] **–** Canal, pipeline, pumping plant, pipeline, tunnel, forebay, no mitigation	--	--	$7.4 B	$7.4 B
Through-Delta Improvements 1[3] **–** Levee earthwork, setback levees	--	$8.6 B		$8.6 B
Through-Delta Improvements 2 – Channel dredging, intake, siphon, operable gates		$1.2 B		$1.2 B
TOTAL	$4.2 B	$5.4 B - $14 B	$7.4 B	$8.6 B - $17.2 B

1 Cost estimates for the eastern alignment include real estate, environmental documentation, and mitigation.

2 Cost estimates for the western alignment include real estate.

3 Cost estimates for the through-Delta improvements include environmental documentation and mitigation.

8. Seismic and Flood Durability

The Isolated Conveyance Component would be designed to resist damage from a sizable seismic event, which has yet to be determined. In larger earthquake events, the facility could sustain some damage but could be repaired. Constructing an improved Through-Delta Component to withstand a catastrophic earthquake would require the setback levees identified in the cost section above.

Seismic and flooding issues have been identified as risks to the overall health of the Delta in a draft "Delta Risk Management Strategy (DRMS), Phase I: Risk Analysis" report, dated June 26, 2007, prepared by URS Corporation for DWR. This report has undergone review, and based on suggestions by an independent science panel, the probabilities discussed below may be updated when the report is re-released in June, 2008. The review to date indicates that the numbers will not change substantially. The DRMS Phase 2 report on risk reduction, due later this summer, will develop building blocks that can be used to reduce risks, and evaluate how a Dual or Isolated Conveyance System can reduce these risks.

The risks to the structural integrity and sustainability of the Delta identified in the DRMS Phase 1 report include seismic events, flooding, unexpected failures, subsidence, and climate change. The report concludes that there is a high probability of multiple simultaneous seismic-related levee failures. Using 2005 conditions, in the next 25 years the risk of a seismic event that would result in 20 or more simultaneous levee failures and severely disrupt water conveyance for a substantial period of time is 37%. This risk increases to about 41% in 2050 and 47% in 2100. The U.S. Geological Survey created a graphic depiction of the increasing risk of catastrophic earthquake (Figure 6). In 2003, USGS estimated the risk of having a 6.7 magnitude earthquake before 2032 at 62%.

Phase 2 of DRMS goes beyond evaluating risks and develops building blocks that can be used to reduce risk. These building blocks directly apply to a Dual Conveyance System. The DRMS building blocks are combined into the levee improvement, armored pathway, and isolated conveyance facility scenarios. These scenarios are being evaluated to determine their effectiveness in reducing risk. For example, scenarios that include levee improvement or enhanced emergency response building blocks will demonstrate their ability to reduce the risk of catastrophic levee failures in the Delta. Currently, prior to implementation of any new Delta levee improvement projects that may result from DRMS, Through-Delta conveyance has the highest initial risk of failure. Without a major earthquake event or completion of Delta improvements, the risk continues to increase. These risks can be reduced but not eliminated with the implementation of Delta levee improvement projects.

The components of Through-Delta Improvements 1, described in Table 1, include setback levees. These levees would be designed to withstand strong shaking as well as extreme flood events. For example, unsuitable foundation materials would be removed and replaced with suitable materials. Similarly, in isolated conveyance alternatives, levee embankments for the isolated facility would be constructed on suitable foundation materials and be high enough to prevent flood water and rising waters (as a result of climate change) from entering into the canal. Along the western alignment, either route of the deep tunnel would be constructed in firm foundation.

Levees and canal embankments would use earthen construction methods. The advantage of earthen construction in seismic events is its ability to pass seismic energy. In a Dual Conveyance System it is assumed that an isolated canal, designed to be resistant to most seismic events, would serve as the conveyance method should Delta exports be compromised by numerous Delta levee failures. While the of a Dual Conveyance System cannot be constructed to be invincible to seismic induced stresses, it can be constructed to be seismically durable or repairable. Even under the maximum creditable seismic event used to design Isolated Conveyance, the cost and time frame for these repairs would be much quicker than those for the Through-Delta Conveyance component.

Any Isolated Conveyance Component would maximize the use of a cut-and-fill method to minimize the amount of material imported or exported from the site. Design criteria would also assume a 40 inch rise in sea level over the next 100 years or higher based on the best available science. As stated earlier, recent guidance for the Delta Vision effort may raise this design criterion to 55 inches. One advantage of using earthen construction methods when there is uncertainty associated with the magnitude of future sea level rise is the simplicity of modifying the height of the containing canal embankments. Earthen embankments can often be raised in a manner that utilizes the existing structure.

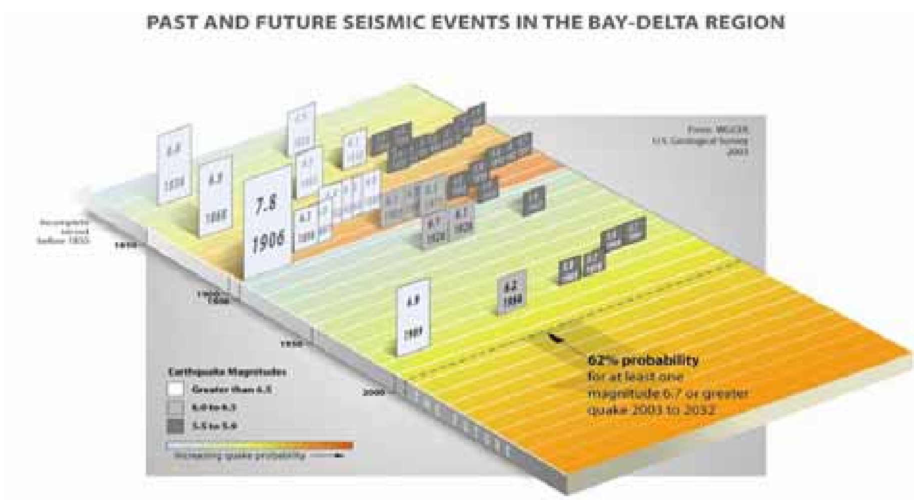


Figure 6

Seismic Event Risk

9. Operations Criteria

Sensitivity analysis of operating criteria

A Dual Conveyance System provides significant flexibility for operations. The degree of flexibility depends on the volume and timing of water moved through the individual conveyance components (isolated vs. through-Delta), their location and design, and the regulatory framework in which they operate. The information presented in this report is from computer simulations conducted very early in the analysis of potential operations. The analysis is a sensitivity-level evaluation using simplifying assumptions which will be refined in subsequent studies in the BDCP process. For example, the studies primarily examine the use of both conveyance components at the same time throughout the year and only constrain the diversion capacity and priority of the operation of the components. This sensitivity analysis is to simulate possible operating criteria that may be developed that constrain the operation of one of the Dual Conveyance System components based on the requirements to protect beneficial uses in the Delta.

Results from computer models help to determine the effectiveness of the water operation scenarios at meeting the current set of operating requirements of the SWP and CVP contained in their water right permits. We know that new criteria will be developed specifically for a Dual Conveyance System operation based on best available science. At this stage, it is premature for DWR to forecast what these criteria might be. This sensitivity analysis should be helpful to understanding the kind of flexibility and opportunities that a Dual Conveyance System has for meeting the potential operating criteria.

Three different pumping constraints of the Isolated Conveyance Component are studied; 5,000 cfs, 10,000 cfs, and 15,000 cfs. The remainder of the exported water is taken via the Through-Delta Component. These are by no means an exhaustive set of operational scenarios, nor is it assumed that an optimal operation of a Dual Conveyance System is bounded by them. However, each of these operation model runs illustrates important impacts of decisions made within these test runs. So each of these model runs will help to inform thinking for future operational criteria of a Dual Conveyance System.

Operations for Dual Conveyance

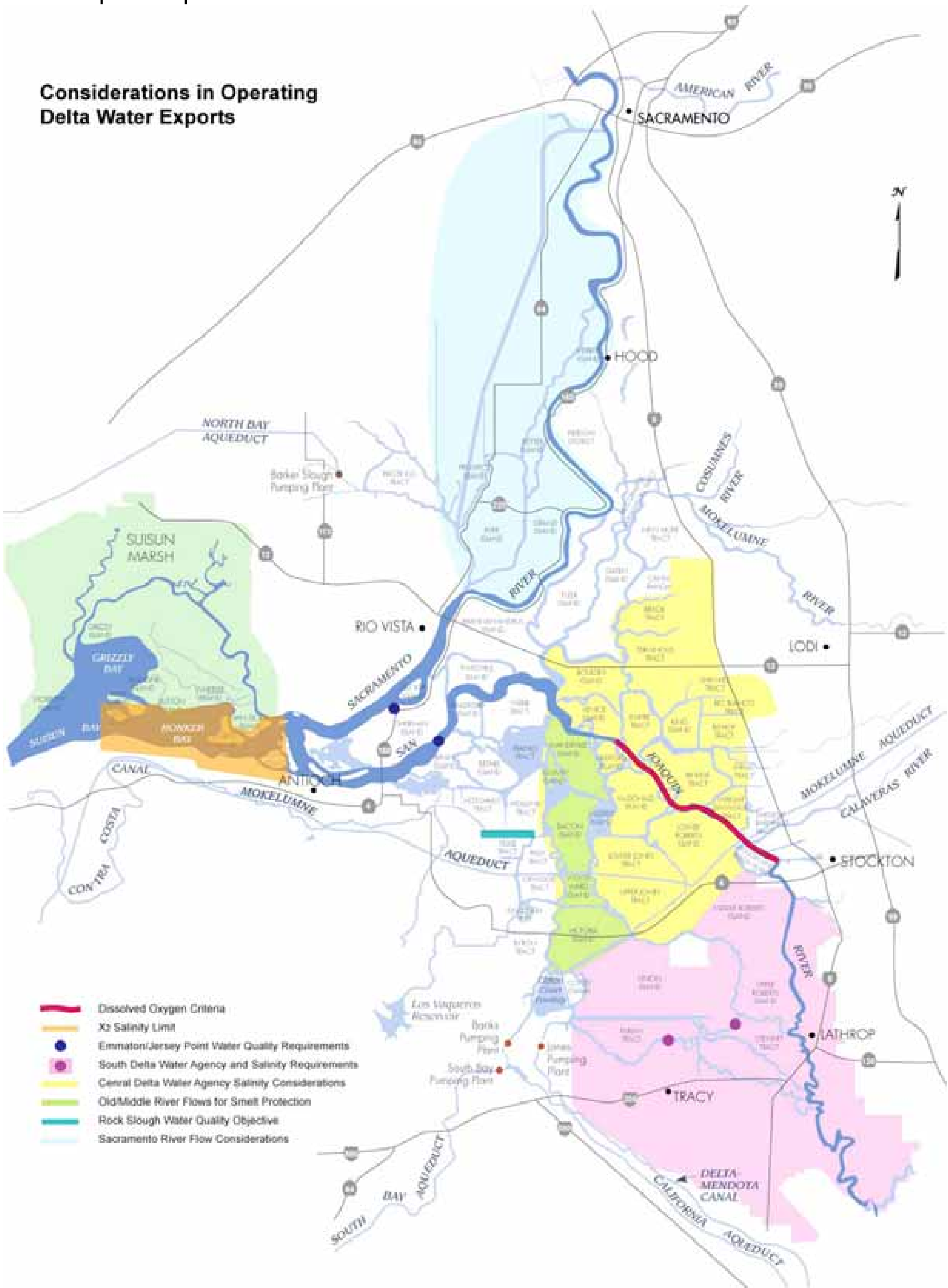
The Bay Delta system is probably the most, if not one of the most, heavily regulated areas in California. Regulations exist for the protection of native Delta species, municipal water users, agricultural water users, and terrestrial species in Suisun Marsh. Each of these water users can be affected when the Delta is modified or when flows of water are modified. Figure 7 shows the many different considerations that must be weighed when making changes. Water quality and flow requirements are contained in the water right permits of the SWP and CVP in water right Decision 1641. The D-1641 standards are used in each of the model runs conducted in this report.

Salinity has long been used as a surrogate for water quality. It is often the measure of the acceptability of water for specific uses. Lower salinity water is desirable for agricultural and municipal uses. The State Water Resources Control Board (Board) regulates salinity for agricultural uses by establishing an electrical conductivity objective throughout the Delta. The Board included this objective in the water right permits of the SWP and CVP. The Contra Costa Water District is protected from high salinity water in these permits by regulating chloride concentrations in Rock Slough.

Salinity is impacted by the water that flows into the Delta. The three major sources of water that flow into the system are the Sacramento River, the San Joaquin River, and the San Francisco Bay. On an average summer day, the Sacramento River flows at about 10,000 cfs, while the San Joaquin River would flow much lower, around 2,000 cfs. The tidal flows entering and exiting the Delta from the San Francisco Bay are on the order of 300,000 cfs.

Factors such as wind, tide stage, and the amount of water flowing out of the Delta are significant factors affecting how much Bay salinity intrudes into the Delta. The amount of water flowing out of the Delta is referred to as net Delta outflow. With respect to potential operations of Delta water conveyance, the net Delta outflow must remain the same to keep the tidal salinity influence the same.

Figure 7
Delta Exports Operational Considerations



The salinity in the south Delta is controlled by San Joaquin River salinity and influence in south Delta channels. Because the flows in the river are fairly low, the salinity of the San Joaquin River is largely controlled by upstream discharges. Per water right permits for the operation of New Melones Reservoir, Reclamation often releases water on the Stanislaus River to help control salinity in the San Joaquin River where it enters the Delta. Discharges within the Delta further degrade the water quality as water flows through the southern Delta. During the summer and fall months, the state and federal water projects pull the fresher Sacramento River water south towards the export facilities. In doing so, Sacramento River water is commingled with San Joaquin River water resulting in lower salinity than what is typically in the San Joaquin River and southern Delta. If the state and federal water projects ceased diverting from the south Delta and, instead, diverted water around the Delta at that time, the commingling process would be eliminated and the resulting water in the southern and central Delta would be higher in salinity than it is under the current operations. Dual Conveyance System operations can be used in flexible ways to maintain different salinity regimes for the ecosystem while allowing water diversions to continue.

Still, bringing Sacramento River water south to the export facilities is insufficient to meet the South Delta water quality criteria. The Department has proposed the implementation of the South Delta Improvements Program which would install up to four operable gates in south Delta channels to induce mixing of the Sacramento and San Joaquin River water while providing acceptable water levels for south Delta agricultural water users.

Without the influence of Sacramento River water in the south Delta, the agricultural water quality objectives in the south Delta could not be met as reliably during parts of the year. Under a Dual Conveyance System, Sacramento River water could be brought south to the export facilities, and the farmers, during those parts of the year when it was safe for listed fish species.

But the commingling process of taking Sacramento River water south to the export facilities also reverses the net flow of Old and Middle Rivers. When the flows are reversed in Old and Middle Rivers during the winter and spring months, drifting fish and fish larvae can be entrained at the export facilities. In the December 2007 decision by Federal Judge Wanger, limits were placed on the magnitude of the reversed flow in Old and Middle Rivers. Taking water around the Delta through a screened diversion on the Sacramento River could reduce these negative Old and Middle River flows during the sensitive times of the year.

A positive flow out of the Delta is the consideration behind the X2 regulations. Although X2 is a measurement of the average location of the 2 parts per thousand isohaline, its use as an operation criteria for SWP and CVP operations is primarily to assure there is ample water exiting the Delta (also known as Net Delta Outflow) for the protection of fish and fish habitat. When there is sufficient flow out of the Delta, there is less risk of listed fish in the western portion of the Delta being influenced by the southerly flow of Sacramento River water destined for the export pumps in the south Delta. The location of X2 has also been thought to be an indicator of the suitability of habitat for longfin smelt and several other species of fish and invertebrates. If water exports were being done from the Sacramento River instead of the south Delta, the need for X2 to move fish away from the influence of the southern Delta SWP and CVP diversions may be diminished.

If X2 were no longer a regulatory limit, the amount of water exiting the Delta would be driven by the need to meet other existing standards such as the Rock Slough salinity standard or the Export/Inflow ratio. In the BDCP process, potential changes to regulatory limits will be examined as potential supplements to conservation measures.

Water for new habitat conservation measures

As a matter of developing habitat conservation measures, it has been suggested that some Sacramento River water be allowed to flow down the Yolo Bypass to create fish habitat and improve food supplies in the western Delta area near Cache Slough. Any water used for this purpose would be water that is not available to meet a potential Sacramento River flow requirement at the diversion location for an Isolated Conveyance Component. However, much of the water flowing down the Yolo Bypass habitat area would be available to meet in-Delta salinity requirements downstream of where Cache Slough meets the Sacramento River.

10. Water Supply Reliability

The computer simulations conducted thus far were done in the absence of more detailed information on how different operations could be beneficial to the environment and without significant changes to the computer simulation software. In these simulations, the water quality operations constraints of D-1641 have been incorporated, with the exception of south Delta agricultural salinity standards, which require the presence of permanent operable gates. A short description of the simulation and the name of the simulation is given in Table 2. The Dual Conveyance System can provide for salinity regimes that are different from the one produced by operating to the D-1641 requirements. Additional studies would be needed to investigate this aspect of Dual Conveyance operation.

Computer Simulation - Isolated Conveyance Priority

The first set of computer runs, referred to as “Isolated Conveyance First”, were conducted by Department staff to examine concurrent operations of an Isolated Conveyance Component with a Through-Delta Component, giving priority to moving water through the Isolated Conveyance Component up to the capacity of the constraint placed on it. In these studies, the Through-Delta Component is used mostly when moving water through the isolated system is insufficient to meet the water needs contained in the operation study. The studies are set up however to take advantage of opportunistic pumping, regardless of the Isolated Conveyance priority, using the Through-Delta Component when there is sufficient supply in the Delta from the San Joaquin River or Eastside Streams. The affect of this amount of pumping is minor.

In these runs, the inflow to Clifton Court Forebay via the Through-Delta Component is restricted by the current operating constraint of 6,680 cfs with rates above that depending on elevated San Joaquin River inflows mid-December to mid-March. However, the Banks pumping plant is allowed to pump at its full 10,300 cfs if the additional water is available from the isolated component.

Table 2

Computer Simulation Descriptions

	Reference Cases		Isolated Conveyance First			Through-Delta First	
Operation Constraint	Reference Case	Reference Case w/Old and Middle River	5,000 cfs Isolated Conveyance Constraint	10,000 cfs Isolated Conveyance Constraint	15,000 cfs Isolated Conveyance Constraint	5,000 cfs Isolated Conveyance Constraint	10,000 cfs Isolated Conveyance Constraint
Description	Permitted export operations with and without Old and Middle River Flow restrictions		5,000 cfs in Isolated System remainder through-Delta	10,000 cfs in Isolated System remainder through-Delta	15,000 cfs in Isolated System minimal through-Delta	First 5,000 cfs through-Delta; up to 5,000 in Isolated System; remainder through-Delta	First 5,000 cfs through-Delta; up to 10,000 in Isolated System
Name	Reference Case	Reference Case w/OMR	"5K ICC First"	"10K ICC First"	"15K ICC First"	"5K ICC Next"	"10K ICC Next"

The three runs comprise a rudimentary evaluation of the sensitivity of the operating criteria to constrained use of the Isolated Conveyance Component. Diversion capacities of 5,000 cfs, 10,000 cfs, and 15,000 cfs are evaluated. As noted earlier, the maximum rate of diversion of 15,000 cfs closely matches the combined capacities of the SWP Banks pumping plant (10,300 cfs) plus the pumping capacity of the CVP Jones pumping plant (4,600 cfs). In each case, there is no assumed Sacramento River by-pass flow required to divert water into the Isolated Conveyance Component beyond the flow requirements at Rio Vista contained in D-1641. The studies include the assumption that the Delta water quality and flow requirements contained in the existing water right permits of D-1641 for operating the SWP and CVP are in effect. Examples of these requirements are the Rock Slough salinity objective and the required location of X2. In the "15K ICC First" study where first priority for export is given to an Isolated Conveyance Component with a maximum capacity of 15,000 cfs, minimal exports are made from the south Delta. This scenario, in essence, is analogous to a pure isolated conveyance scenario.

To evaluate the water supply reliability capabilities of an "Isolated Conveyance First" operation under the existing D-1641 standards, the amount of Delta exports for each study is compared to the amount of Delta export in the Reference Case and the Reference Case with restrictions on Old and Middle River flows. The results are summarized in the following table (Table 3). In each of the "Isolated Conveyance First" runs, there is a significant increase in annual Delta exports which ranges from 420 thousand acre-feet (TAF) to 1230 TAF for the long-term average and 230 TAF to 770 TAF during the dry periods. As a first-pass analysis, these results support the intuitive conclusion that an isolated conveyance facility has a large potential for improving water supply reliability and providing operational flexibility for environmental considerations. However, these results are not directly comparable to the reference cases because of changes in water quality and to the Old and Middle River flows. These changes are discussed below and in subsequent sections.

In this cursory evaluation, the studies do not include reductions in exports during December through June associated with the interim operation requirements for flows in Old and Middle rivers put in place by federal Judge Wanger to protect delta smelt. The results of the “5K ICC First” and the “10K ICC First“ studies show export levels during the winter and spring where Old and Middle River flows would be more negative than allowed by the court-imposed rules. The “5K ICC First” scenario has longer periods with higher magnitudes of negative flow. The “10K ICC First” scenario has fewer periods of less magnitude because less water would be exported from the south Delta. The ”15K ICC First” scenario, because of the assumed first priority of diversion, has no operation-induced negative flows in Old and Middle rivers. A comparison of Old and Middle River flows is discussed in Section 9, Ecosystem Health and Resilience.

Whereas less pumping from the south Delta increases Old and Middle River flows, it could result in less dilution of the San Joaquin River water with Sacramento River water thus leading to an increase in salinity in the southern and central Delta. A subsequent analysis would investigate the water quality and flow effects within Delta channels of any assumed operation and facility configuration.

Table 3

Total Exports for Dual Conveyance Operation Scenarios

Total Exports for Isolated Conveyance Priority and Through-Delta Conveyance Priority

(TAF/Year)

Banks Pumping: 10,300 cfs in Dual Conveyance; 6,680 cfs in Reference Cases

			Isolated Conveyance First						Through-Delta First			
			5,000 cfs Isolated Conveyance Constraint		10,000 cfs Isolated Conveyance Constraint		15,000 cfs Isolated Conveyance Constraint		5,000 cfs Isolated Conveyance Constraint		10,000 cfs Isolated Conveyance Constraint	
Total Exports (Annual Average)	Reference Case	Reference Case w/OMR	Study Results	Differences from Ref Cases	Study Results	Differences from Ref Cases	Study Results	Differences from Ref Cases	Study Results	Differences from Ref Cases	Study Results	Differences from Ref Cases
Long Term Average Oct 1922-Sep 2003	6,020	5,300	6,440	420-1140	6,500	480-1200	6,530	510-1230	6,470	450-1170	6,500	480-1200
Drought Period Average (1928-34, 1976-77, and 1986-92)	3,620	3,120	3,850	230-730	3,890	270-770	3,840	220-720	3,740	120-620	3,770	150-650

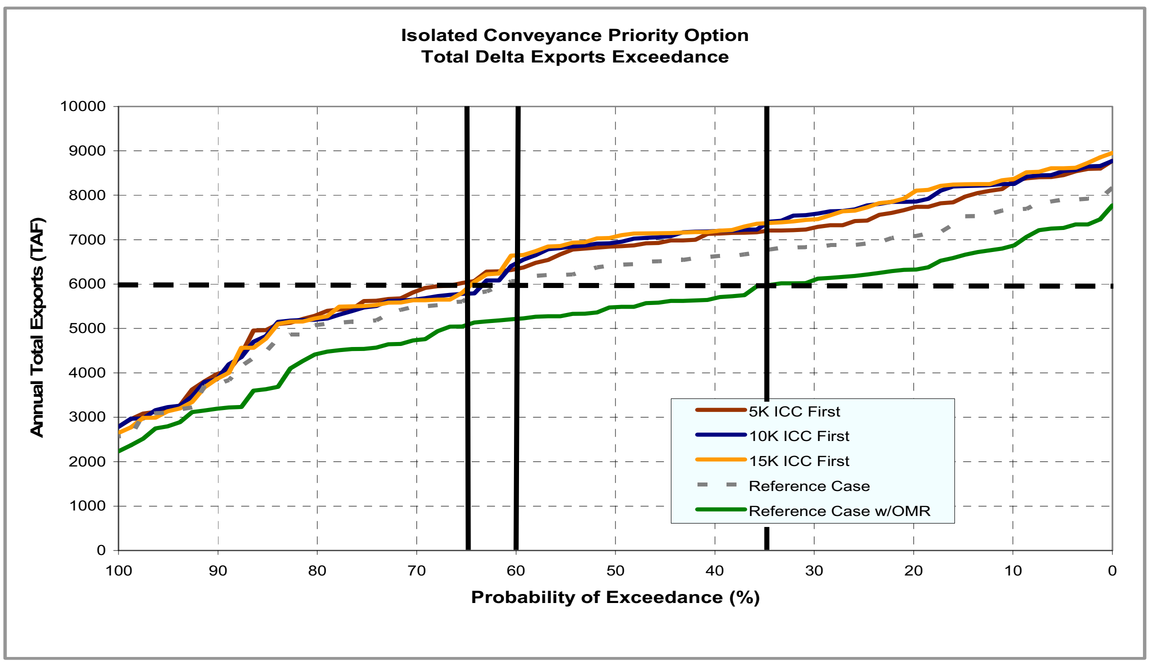
Figure 8, the Total Exports Exceedence chart for the Dual Conveyance System under the “Isolated Conveyance First” operation shows the export amounts for all 82 years of simulated operation ranked from lowest to highest. The curves show that for the lower values, those with a 90% exceedence probability or greater, the export amounts for the

Dual Conveyance operations are very similar. This is due to the lack of water available for export. Generally for this curve, the lower exports on the left are due to dry hydrologic conditions and the high exports on the right are due to wetter conditions. Export amounts in the middle portion of the graph may be determined by other factors such as interior Delta water quality requirements, in-stream requirements, water project operations criteria or the monthly pattern of flows entering the Delta.

The Dual Conveyance operation scenarios equal or improve the reliability of providing a given amount of export. For example under the Reference Case, there is about a 60% chance that exports would be at least 6 million acre-feet. Under the Reference Case with OMR flows, the probability of exceedence drops to 35%. For the Dual Conveyance operation scenarios, the probability increases to about 65%

Figure 8 Isolated Conveyance Priority Option

Total Delta Exports Exceedence Curve



Computer Simulation - Through-Delta Component First Priority

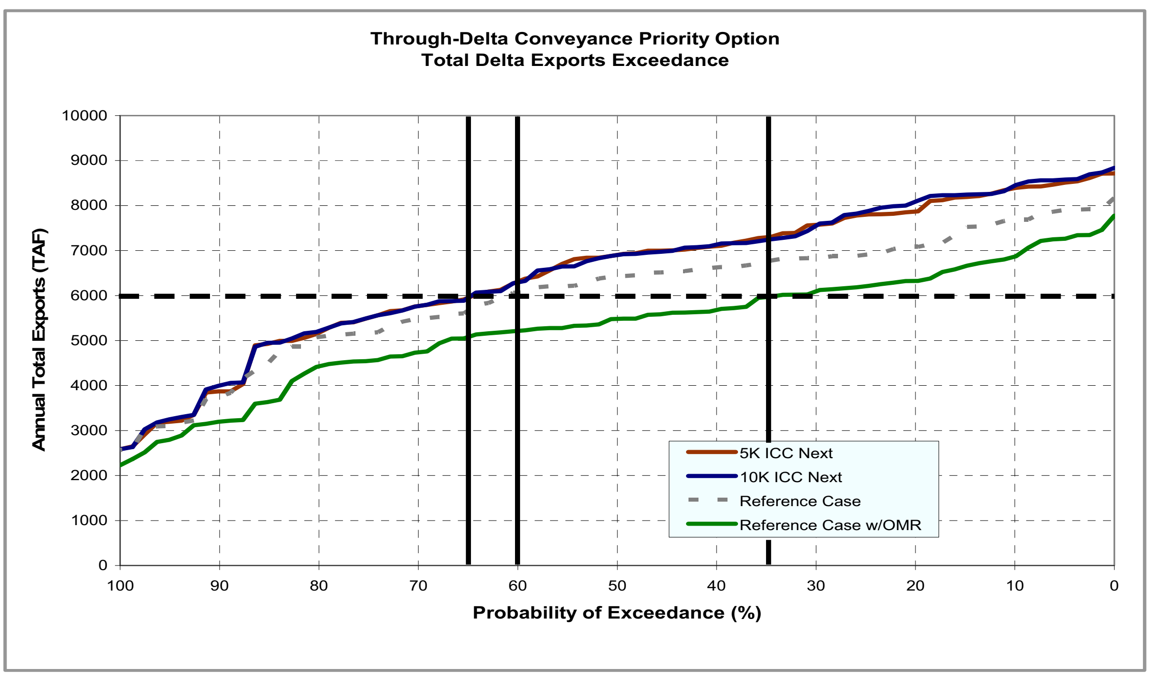
In the second set of runs, the operational priority is to use the Through-Delta Component before the Isolated Conveyance Component of the Dual Conveyance System. The operation assumes up to 5,000 cfs of Delta exports is required to come through the Delta. The Isolated Conveyance Component is not operated until this limit is surpassed. The two studies simulate situations where it is necessary to maintain a certain level of circulation and quality in the Delta. Both the SWP and the CVP are assumed to use the Isolated Conveyance Component for exports in excess of the 5,000 cfs. The studies examine isolated conveyance constraints of 5,000 and 10,000 cfs. An isolated component capability of 15,000 cfs is not necessary because, given the Through-Delta Component requirement of a minimum of 5,000 cfs, the maximum amount to be conveyed through the isolated component would not exceed 10,000 cfs. During periods when the Isolated Conveyance Component with the assumed maximum capability of 5,000 cfs is insufficient, the remaining available export is taken by the through-Delta facilities.

As shown in Table 3, the long-term average increase in annual exports for the two “Through-Delta Conveyance First” studies is similar to the Isolated Conveyance priority studies and ranges from 450 TAF to 1200 TAF. The average annual value for the drought periods ranges from 120 to 650 TAF for the “Through-Delta Component First” studies. These drought-period values are less than the comparable values for the “Isolated Conveyance First” scenarios because more water is needed to be released from reservoirs to maintain salinity levels at Rock Slough or in the western Delta while exporting through the Delta. Relying on through-Delta conveyance during the winter and spring months could significantly reduce the benefit to Delta fish species. In these studies, just as in the “Isolated Conveyance First” studies, Old and Middle River flow restrictions are not in place. Under these conditions, there are times in the winter and spring when there are significant reverse flows, well in excess of the interim rules of operation imposed in the federal court decision.

Figure 9, the Total Exports Exceedence chart for the “Through-Delta Component First” studies shows all 82 years of simulated operation. In general, the Through-Delta Conveyance options meet or improve the reliability of providing a given amount of export. The exceedence curves are similar to the ones for “Isolated Conveyance First”. For example, the probability that 6 MAF of total exports will be met or exceeded increases to about 65% for the Through-Delta scenarios, the same probability shown in Figure 8.

Figure 9 Through-Delta Priority Option

Total Delta Exports Exceedence Curve



Operations Impact on Reservoir Storage North of the Delta

An overview of the reservoir storages resulting from the assumed Dual Conveyance scenarios indicates relatively minor changes when compared with the reference cases. Figures 10 and 11 are exceedance curves for total reservoir storage at the end of September, the end of the water year. This storage is an important component for the following year's water supply for the SWP and CVP. The reservoirs included in the total are Lake Shasta, Trinity Reservoir, Oroville Reservoir and Lake Folsom. The curves are relatively similar. This is because several of the key operational parameters are the same for the studies. The water quality requirements for the Delta are contained in D-1641 and are the same for each of the studies. The rule curve prescribing annual project exports and the targeted amount of carryover storage are also the same for these studies.

Operational rules for an isolated conveyance facility can, however, have a significant affect on upstream storage. This point is illustrated by analyses conducted for Option 4 for the BDCP. Option 4 is analyzed in the BDCP Conservation Strategy Evaluations Report (SAIC, September 17, 2007) and includes an isolated conveyance facility along the eastern alignment. The option is for a "pure isolated" conveyance but could also apply to the operation of the Isolated Conveyance Component of a Dual Conveyance System.

In the early stages of developing this scenario, minimum flow targets for the Sacramento River at Rio Vista were used as surrogates for a diversion bypass flow requirement. A diversion bypass flow requirement is the amount of flow required to be in the Sacramento River to divert water into an Isolated Conveyance Component at Hood. A bypass flow requirement does not apply when no diversion is being made. Upstream reservoir releases must be made to support minimum flow targets at Rio Vista regardless of whether diversions are being made into an Isolated Conveyance Component.

In the initial analysis, the values of the minimum Rio Vista flow targets were assumed to be in the range of 9,000 cfs January through June, and 4,000 to 5,000 cfs July through December. The results showed excessive reductions of upstream storage during the 1928-34 and 1987-92 critical drought periods as storage withdrawals are needed to augment the natural runoff to achieve the targets.

Subsequently, the assumed flow parameters and operation of the Delta Cross Channel (DCC) gates were changed to limit the upstream impact while achieving the objectives of the initial flow parameters. The DCC was assumed to be closed year-round. The Rio Vista flow requirements were reduced in Dry and Critical years to reflect the dry conditions. The requirements were relaxed in these years to a range of 3,500 to 5,000 cfs as described in the BDCP Options Evaluation Report, Appendix B (Sept., 2007). The revised assumptions did not resolve the problem of excessive withdrawals from upstream storage.

The evaluation is now focusing on a "diversion bypass flow" requirement, rather than a downstream minimum flow requirement to control the timing and amount of diversion into an Isolated Conveyance Component. The use of a bypass flow requirement should alleviate some of the upstream storage effects of the Rio Vista flow requirements because upstream storage releases would not be required to meet a flow target.

Figure 10 Isolated Conveyance Priority Option

End of September Total Storage Exceedence Curve

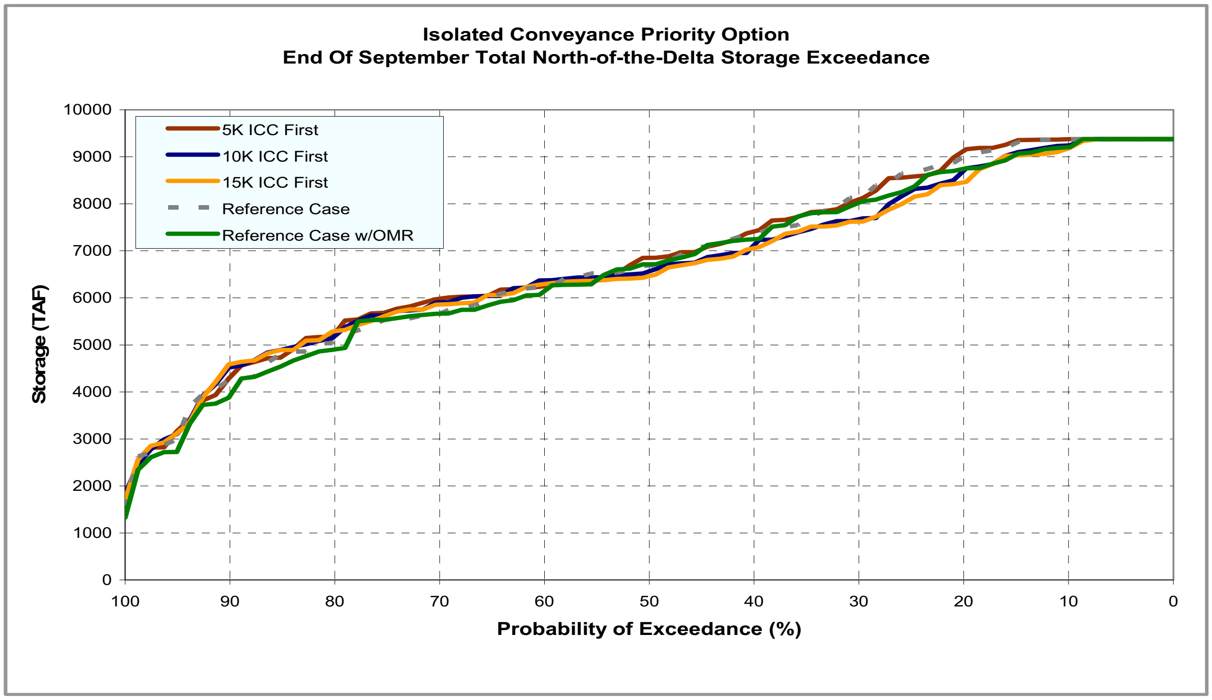
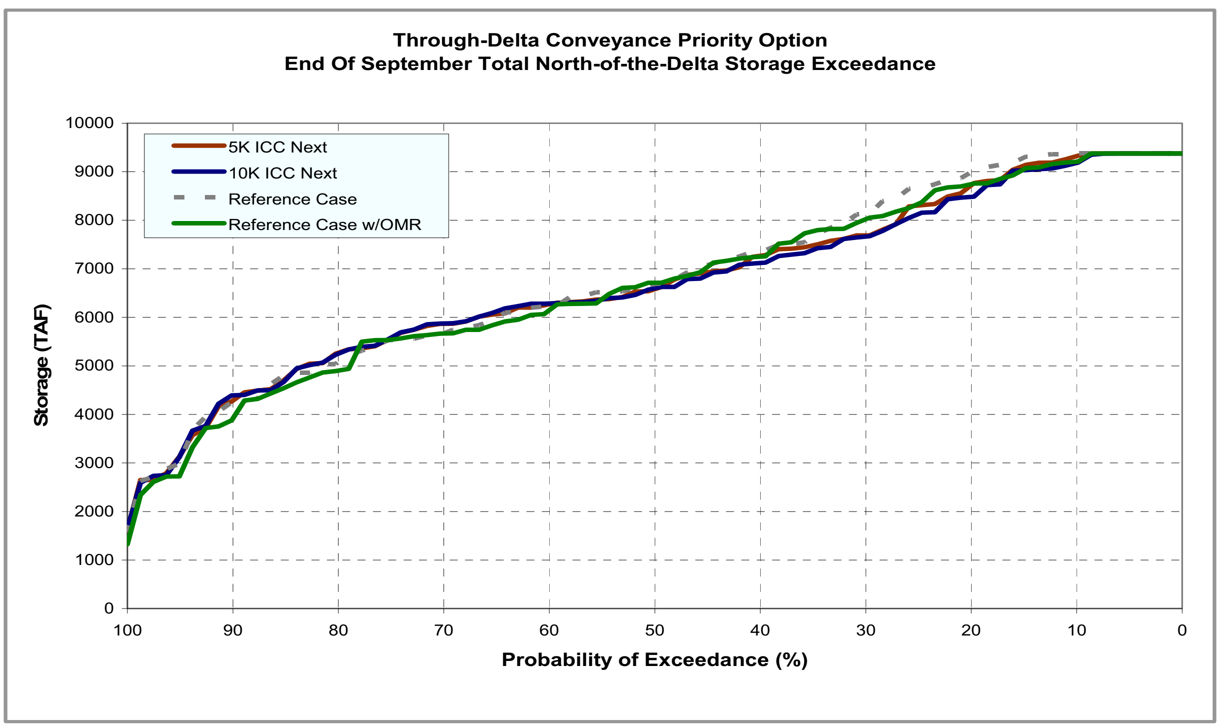


Figure 11 Through-Delta Priority Option
End of September Total Storage Exceedence Curve



11. Ecosystem Health and Resilience

Meeting the goal of ecosystem health solely through changes in Delta conveyance is not realistic given that ecosystem health is dependent on and interdependent with many other characteristics of the habitat and stressors of the various listed species. Because Delta conveyance has been identified as a stressor for various fish species, changing the conveyance method to reduce the strain conveyance places on those species is warranted.

It is generally agreed by fish biologists focusing on delta smelt abundance, that eliminating or significantly reducing south Delta water diversions at the SWP and CVP export facilities during the sensitive life stages will improve the conditions for sustaining the delta smelt population. The related time periods are the winter and spring of each year, extending into late spring for some years. With longfin smelt being considered for listing by the Department of Fish and Game and U.S. Fish and Wildlife Service, the sensitive period would generally be from mid-December through May. This period also coincides with the period of greatest precipitation and the opportunities to convey water not captured by reservoirs.

According to the BDCP Conservation Strategy Options Evaluations Report (SAIC, September 17, 2007), Dual conveyance facilities would have a moderate to high benefit to fish species by reducing stressors. The stressors considered to be highly important in the BDCP study are reductions in food availability, rearing habitat, flow turbidity, spawning habitat, and food quality. In each of these areas, the report concludes a Dual Conveyance System has the potential to produce a moderate benefit.

The stressors considered to be moderately important in the BDCP report are predation, fish entrainment at the SWP and CVP export facilities, and exposure to toxics. Dual Conveyance is considered to provide a moderate benefit in terms of predation (in Clifton Court Forebay), and a high benefit in reducing SWP and CVP fish entrainment.

The highly-important stressors of food availability and quality, and rearing habitat are improved by the increase in water residence time and the increased influence of the San Joaquin River in the western Delta.

Under the Dual Conveyance option in BDCP, Option 3, two projects would be built: one that can isolate conveyance of state and federal project water during periods when Delta exports are most harmful and that expands opportunities for restoring fish habitats throughout a larger portion of the Delta; and a second project that takes water through a highly modified Delta into a separate siphon intake on Victoria Canal. This second half of that Dual Conveyance System effectively helps to separate the water conveyance use of the Delta from the habitat use. Much of the expected benefit to habitat quality and food availability associated with this option is a result of this separation of conveyance and habitat.

San Joaquin River water is considered higher in primary productivity upstream of the Stockton Deep Water ship channel (Lehman, January 2007). In BDCP Option 3, this water is directed toward the western Delta rather than toward the Deep Water Ship Channel where there is considerable die off of algae and plankton during some parts of the year. Highly productive water in the western Delta and long residence times due to slower flow velocities may improve food availability and quality for fish. However, the slower water velocities expected in Woodward Canal, Railroad Cut, and Connection Slough may promote growth of one or more invasive species already present in the area. Any invasive species that competes for food, reduces the turbidity of the water, or provides predators an advantage would reduce the benefits of any of the BDCP Options.

Still, under BDCP Option 3, reductions in entrainment and predation are a result of implementing an isolated conveyance facility. Moving the state and federal project intakes to the Sacramento River near or north of the town of Hood for a portion of the year would reduce the negative frequency and magnitude Old and Middle River flows which are believed to benefit the delta smelt. A minimum required flow past the proposed intake on the Sacramento River would have to be established based on the presence of fish and the amount of water being diverted. Sacramento River water in excess of what is being diverted will flow past the intake structure and into the Delta waterways to support water quality and downstream flow requirements.

Use of an Isolated Conveyance Component will also improve conditions for fish if it is designed with a positive-barrier fish screen. The current fish facility at the SWP export facilities includes a louver fish screen which reduces the number of fish entrained by keeping fish in a bypass channel leading to a fish salvage facility. A positive fish screen keeps fish in the river and allows only water into the diversion facility. The slots in the screen are too narrow for the fish to pass through. Flow towards the positive fish screen, regulated by an “approach velocity” design criteria, is essential to prevent impingement of a fish on the screen. Flow in the river past the screens prevents entrainment by actively providing a flow away from the diversion facility. This is in contrast to the south Delta export facility which functions as an end point for much of the flow in the local channels. Since the diversion facilities on the Sacramento River are outside of the bulk of the current population of delta smelt, it is unlikely the diversion would entrain many smelt.

With the flexibility of a Dual Conveyance System, water can be diverted by the intake that would be most beneficial for or have the least impact upon fish at the time of the diversion. This flexibility is important because several fish species occupy different areas of the Delta during certain periods of their life cycle.

One fish protection measure currently in the operations criteria for the SWP/CVP exports is the position of X2. The location of X2 is controlled by the Net Delta Outflow. The criteria require a maximum X2 position each winter and spring months, depending on the water-year type. Water years are classified into five categories; Wet, Above-normal, Below-normal, Dry and Critical. X2 is the location of the 2 parts per thousand salinity contour (isohaline), one meter off the bottom of the estuary, as measured in kilometers from the Golden Gate Bridge. The abundance of several estuarine species has been correlated with X2. However, in recent years Net Delta Outflow is exhibiting much less benefit to fish abundance. In the 1995 State Water Resources Control Board Bay-Delta Plan, an electrical conductivity value of 2.64 mS/cm is used to represent the X2 location.

The location of X2 is modeled in all five of the computer simulations representing Dual Conveyance. Because X2 is a water quality parameter with which the model must comply, the X2 location does not vary noticeably between these model runs. Figure 12 shows the average monthly location of X2 based upon the 82-year simulations. The X2 position for Dual Conveyance is up to 2 kilometers east of the X2 position for the Reference Case with

OMR restrictions. The X2 position values resulting from the other reference case are not significantly different from the Reference Case w/OMR values. Figure 12 shows the approximate location of X2 relative to the portion of the West Delta where it is located. The Martinez Bridge is about 86 river kilometers from the Golden Gate Bridge, and the west end of Chipps Island is about 74 kilometers upstream. Tables 4 and 5 show the average X2 positions by month for each Water Year Type classification as well as the average for all year types for the Dual Conveyance Case and the Reference Case w/ OMR. Except for two entries having a difference of 3 kilometers (January, Wet year and September, Below-Normal year), the difference in monthly X2 positions for the water-year types range from 1 to 2 kilometers.

Table 4

Average X2 Position (in kilometers) for the Dual Conveyance Case

Water Year Type	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Wet	85	82	79	73	67	67	69	72	75	78	82	84
Abobe Normal	87	73	68	65	58	57	61	65	69	71	76	76
Below Normal	87	82	73	64	62	62	65	69	74	78	84	87
Dry	88	81	76	69	64	64	66	69	71	75	80	83
Critical	88	83	78	69	61	61	63	68	73	77	82	86
All	87	84	79	72	66	66	68	72	76	79	84	87

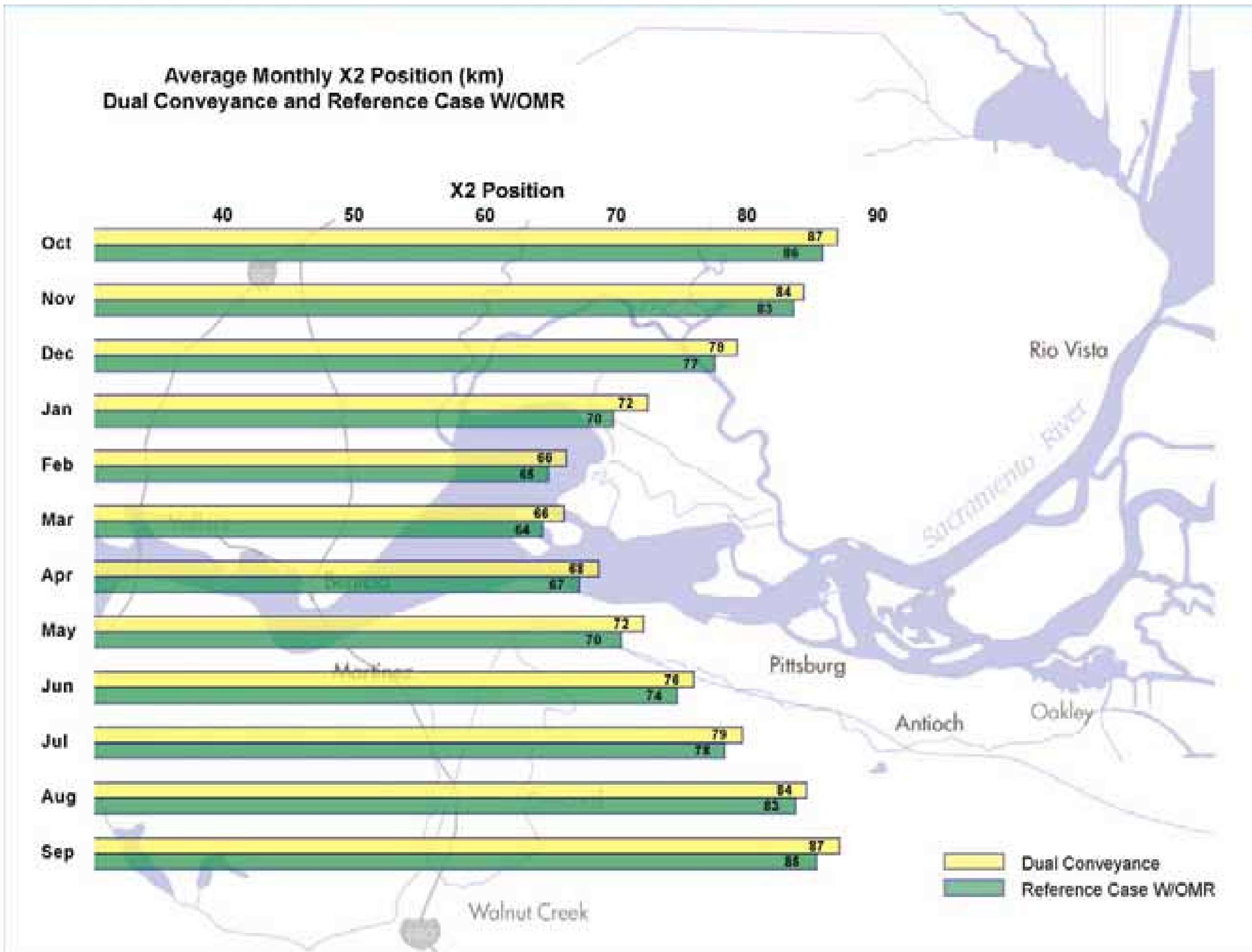
Table 5

Average X2 Position (in kilometers) for the Reference Case w/ OMR

Water Year Type	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Wet	84	81	77	70	66	65	67	70	74	77	81	83
Abobe Normal	86	72	67	63	57	56	60	64	68	70	76	74
Below Normal	86	82	72	63	60	61	64	67	73	77	83	84
Dry	87	80	75	67	63	62	65	68	70	74	79	82
Critical	87	83	76	67	61	60	62	66	72	75	81	84
All	86	83	77	70	65	64	67	70	74	78	83	85

Figure 12

Average X2 Position for Dual Conveyance and Reference Case w/ OMR

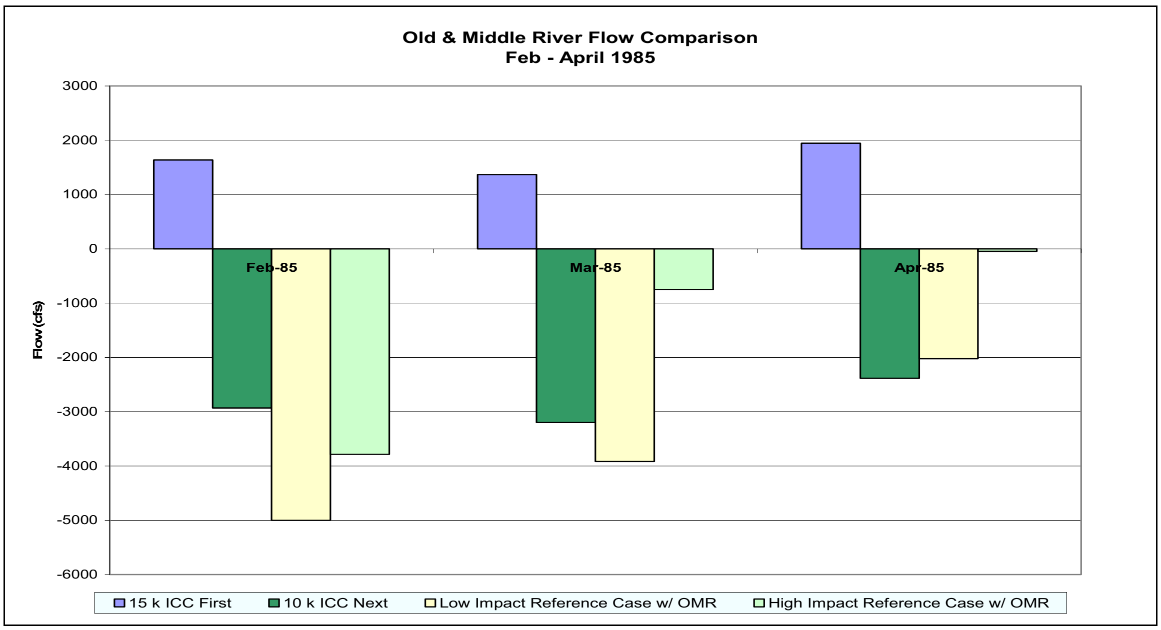


Daily flows in Old River and Middle River naturally flow northward toward the central Delta. These flows are reversed when south Delta exports or water being used locally are more than the flow the San Joaquin River supplies at the head of Old River. One of the temporary delta smelt protections instituted for 2008 is regulating these Old and Middle River (OMR) flows to prevent or reduce the transport of delta smelt from the central Delta to the export facilities. For late February through most of June, the restrictions are presented as a range of OMR flows. To capture the potential impact on the exported water supply of the range of these restrictions, two different model runs were completed; a low-impact run and a high-impact run. The low-impact study allows greater exports and larger reverse OMR flows than the high-impact study. The results of these runs are averaged to produce the results for the Reference Case w/OMR in this report. Figure 13 illustrates the OMR values for February through April 1985, a fairly average year, for the high and low impact runs; the "10K ICC Next" study, in which 5,000 cfs is conveyed through the Delta first; and the "15K ICC First" study, which has a minimal amount of export in the south Delta.

Neither of the Dual Conveyance studies includes the OMR restrictions. The “10K ICC Next” study produces reverse flows near or within the range of the high- and low-impact studies. The ”15K ICC First” study has positive OMR flow for all three months, indicating greater protection for delta smelt. This comparison signals the need to examine another mode of operation of a Dual Conveyance System where exports from the south Delta are nearly eliminated during the winter and spring months and maintained at low levels during the remainder of the year when water quality in the south Delta would benefit.

Figure 13

Model Simulation results for February - April 1985 of Old and Middle River Flow Variations.



12. Water Quality

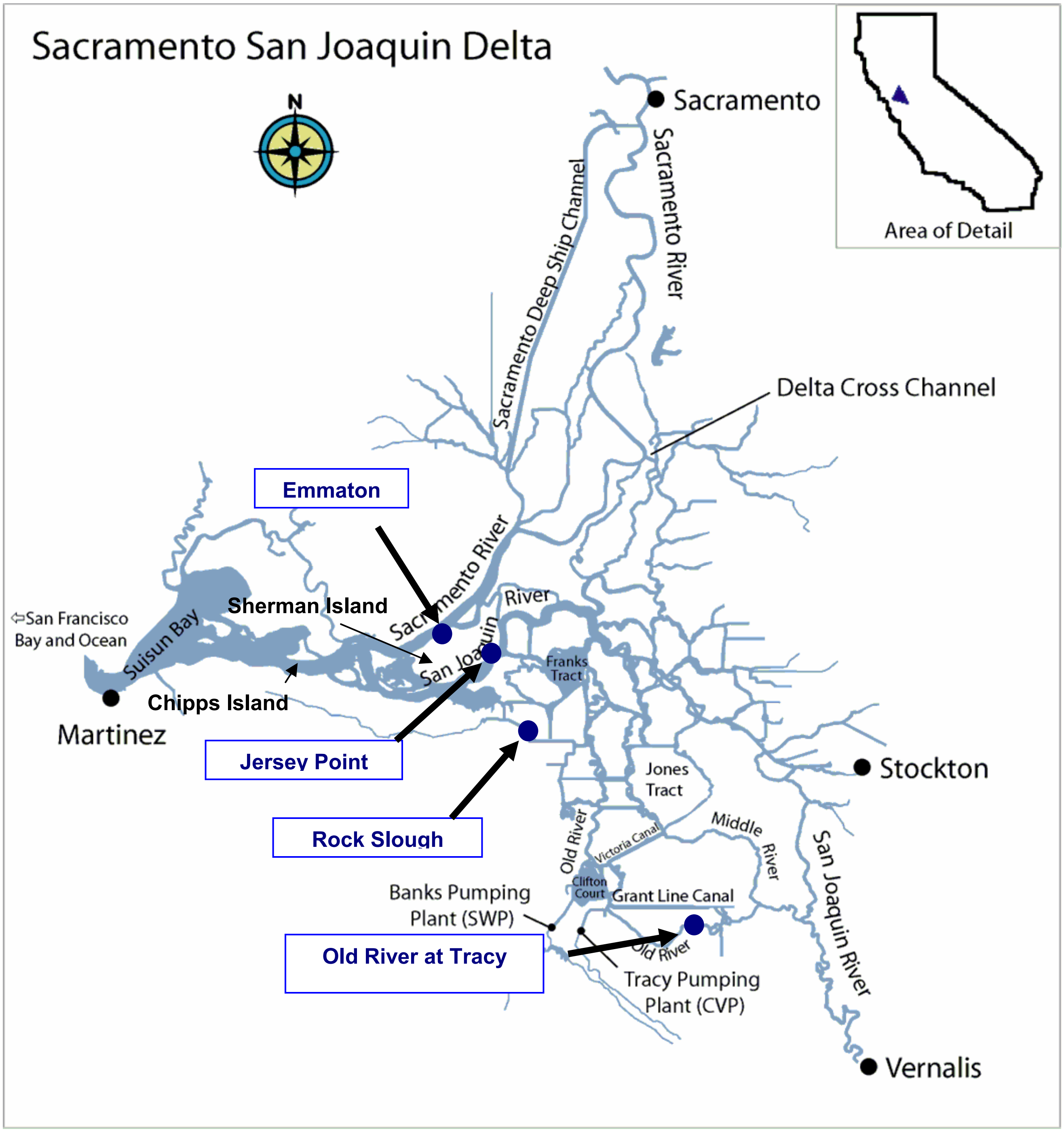
Salt Water Intrusion Concerns

How far the tidal salinity intrudes into the Delta is dependent upon the amount of flow from the Sacramento and San Joaquin rivers and eastside streams that flows out of the Delta to push against the tides. Water that is consumed within and pumped from the Delta reduces the amount of flow leaving the Delta, referred to as the Net Delta Outflow. In general, if a proposed operation of a Dual Conveyance System does not change the Net Delta Outflow from the base operation, the salinity in the far western Delta, near Chipps Island, will not change. This is because the force against the tides remains the same and because the low salinity of the river flows have a negligible effect on the large volume of higher-salinity tidal flows. For a given set of conditions, therefore, if the location for pumping an amount of water by the SWP and CVP were moved from the south Delta to one on the Sacramento

River, the amount of Net Delta Outflow and the resulting salinity in the far west Delta would not change. Figure 14 shows the location of key water quality monitoring stations, as well as the location of Chipps Island.

Figure 14

Select Water Quality Compliance Locations in the Sacramento San Joaquin Delta



Salinity in the lower reaches of the Sacramento and San Joaquin rivers near Sherman Island (Figure 14) may be affected by proposed operations of a Dual Conveyance System. Figure 15 shows the monthly average salinity, measured in electroconductivity (EC), at Jersey Point on the San Joaquin River. The curves are for the “Reference Case” and “Reference Case w/OMR” and two possible Dual Conveyance operations; one with the first 5,000 cfs going through the central and south Delta channels to the export locations and up to 10,000 cfs being transported by the Isolated Conveyance Component (“10K ICC Next”), and one with a minimal amount passing through the central and south Delta channels and up to 15,000 cfs being pumped by the Isolated Conveyance Component (”15K ICC First”).

The curves are relatively close to each other and follow the same pattern. This similarity is expected since Jersey Point is a location for compliance with the D-1641 water quality standards and the simulations are done to meet these standards. Higher salinity, for all operations, occurs in the late summer and fall. This is the time when higher salinity intrusion occurs due primarily to proportionately less Delta outflow being required by the D-1641 standards. (In the late winter, spring and early summer, proportionately more Delta outflow is required.) When compared to both reference-case operations scenarios, the results for both Dual Conveyance operation scenarios show lower salinity levels in the late summer and fall. This is due to more of the San Joaquin River flowing towards the ocean in the Dual Conveyance operations and, therefore, reducing the amount of ocean salinity intrusion. In the Reference Case and Reference Case w/OMR studies, a larger portion of the San Joaquin River is taken by exports. During the period when salinity intrusion is low (winter to early summer), the results show a slightly higher salinity for both Dual Conveyance simulations compared to the Reference Case with OMR restrictions and lower or equivalent salinity compared to the Reference Case.

The results for Emmaton (See Figure 16) show the highest salinity for the ”15K ICC First” operation. This is mainly due to the flow through the Isolated Conveyance Component reducing the fresh water flow in Sacramento River, which in turn increases the salinity intrusion at places on the Sacramento River like Emmaton.

The general rule for the far western edge of the Delta does not apply to salinity, and other water quality constituents, in the central and south Delta. The flow conditions in the central and south Delta are very different than the western Delta and water quality is very dependent upon how a Dual Conveyance System is operated.

Central Delta

Water quality in the central Delta is influenced by the quality of the Sacramento River water being moved across the Delta by the operation of the state and federal export facilities and by the quality of water from the San Joaquin River.

Figure 17 shows the monthly average salinity, measured in EC, for the Rock Slough area of the central Delta for the four simulations discussed earlier. Because only a small amount of water is being exported from the south Delta under the ”15K ICC First” simulation, salinity

Figure 15 -- Monthly Electrical Conductivity for Jersey Point in the West Delta

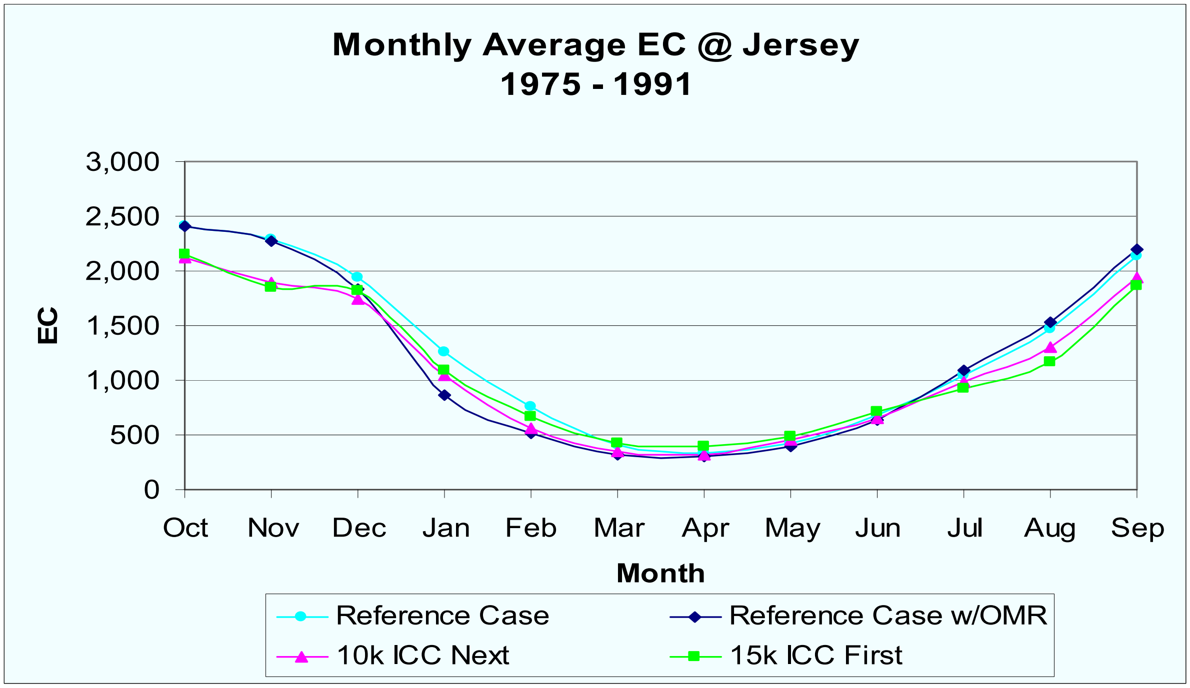
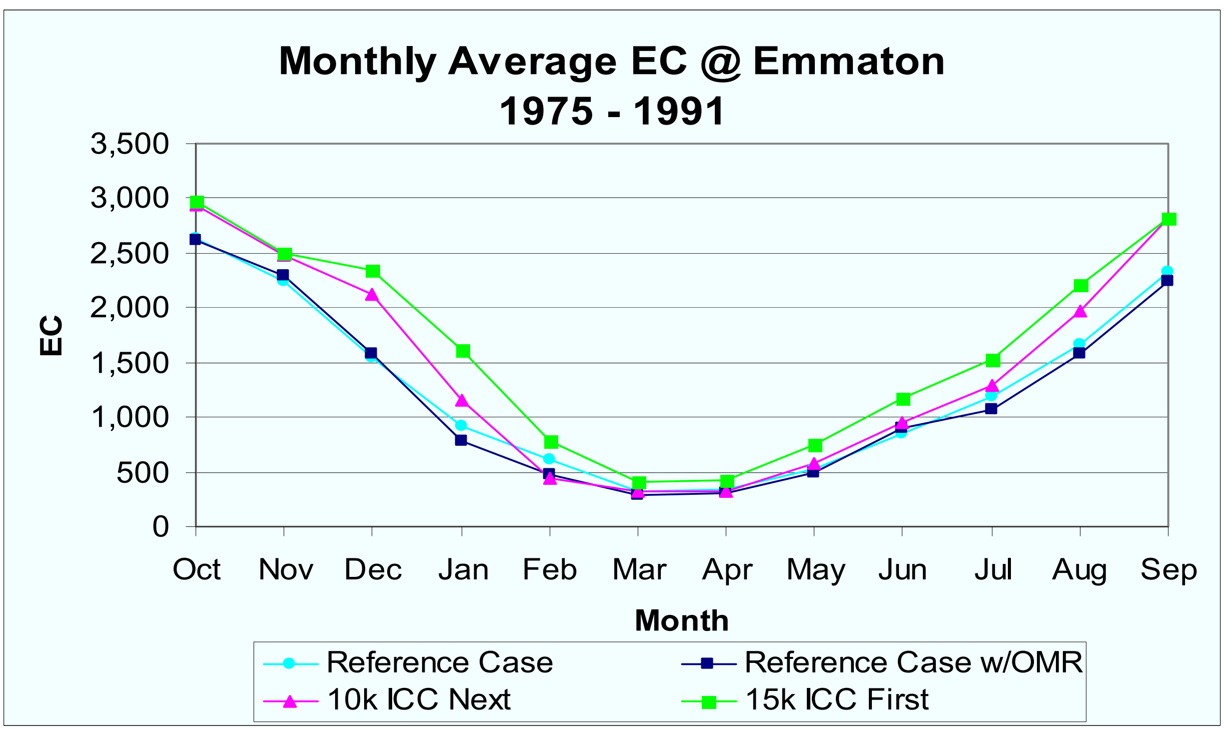


Figure 16 -- Monthly Electrical Conductivity at Emmaton.

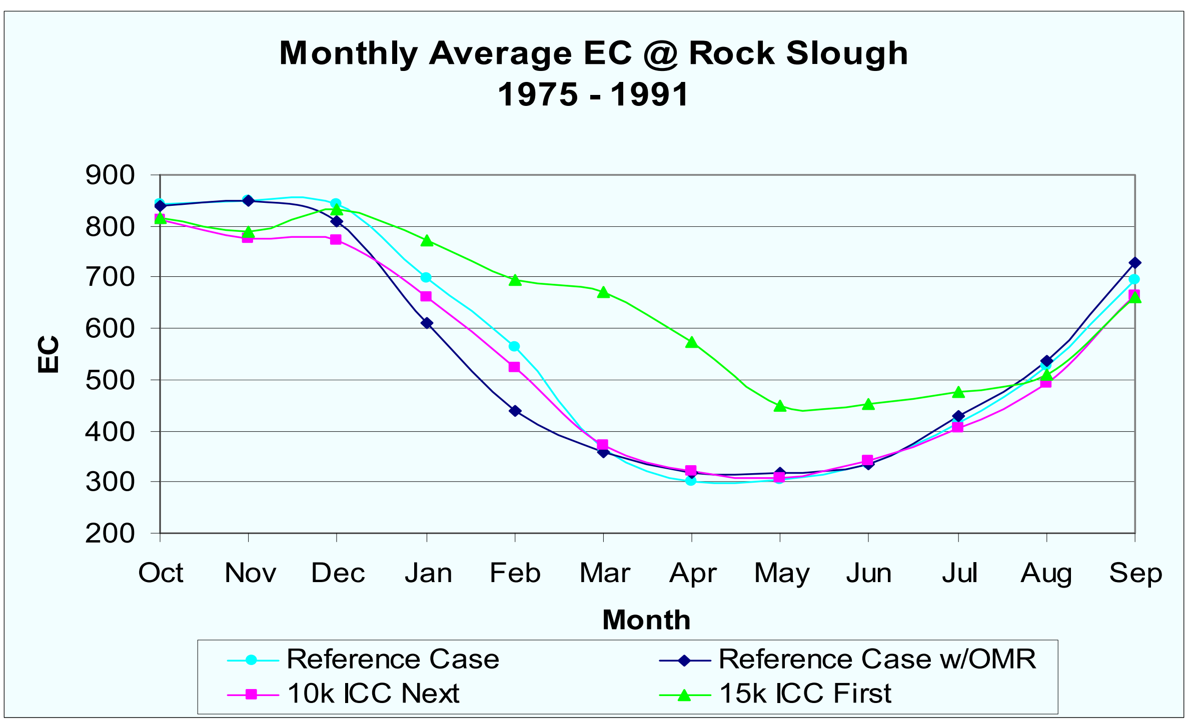


significantly increases in the Rock Slough area during the winter, spring, and summer months than in the other modeling scenarios. This is because the Sacramento River water is no longer available to improve water quality in the area. In the "Reference Case w/OMR", the salinity is lower than the "Reference Case" during the winter months and is slightly higher during the spring months when Old and Middle River Flow constraints are more restrictive. In the "10K ICC Next" model run, the state and federal exports are being conveyed through the central Delta which reduces the salinity in the spring and summer months when much of the exports occur.

Water project operations in the Delta are often controlled by the need to meet drinking water quality salinity compliance levels in Rock Slough, the intake for the Contra Costa Water District. These operations are required under the Department's water right permit and contained in the State Water Resources Control Board's Decision 1641. The BDCP Steering Committee may propose changing one or more salinity standards if warranted and agreed upon in the BDCP. Municipalities that divert water from the Delta may, through the BDCP process, wish to participate in a Dual Conveyance System which could allow the existing municipal water quality standards to be changed.

In all four operations scenarios, the modeling assumes the presence of the permanent operable gates proposed in the South Delta Improvements Program. These gates circulate water through the south Delta, but would have little or no effect on the central Delta.

Figure 17 -- Monthly Electrical Conductivity for Rock Slough in Central Delta



South Delta

Water quality in the south Delta is influenced by San Joaquin River water quality and local discharges. During periods of no pumping at the state and federal export facilities, the flow from the San Joaquin River is split at the head of Old River; about half of the river flows into south Delta channels via Old River and half continues down the San Joaquin River towards Stockton. Under Dual Conveyance, during periods when the projects may not be allowed to pump from the Delta, water quality in the south Delta will be comprised of San Joaquin water quality plus any degradation local water use may cause.

Currently, temporary barriers are used in the south Delta to reduce the impacts of the south Delta exports on water levels. These temporary barriers are made of rock and gated culverts. The barriers essentially act as weirs and simply trap high tides. In 2002, the Department and Reclamation embarked on the South Delta Improvements Program (SDIP), which would install permanent operable gates to protect water levels and improve water quality by increasing water circulation in south Delta channels. The program's EIR was certified in December 2006. Permitting for the SDIP operable gates is being pursued and expected to be completed in early 2009. Following receipt of the required permits, the Department will re-evaluate the project in light of the BDCP process to ensure that construction of the operable gates is still appropriate given new long-term conveyance options.

Figure 18 shows a comparison of the salinity at Old River near Tracy Road. This location happens to be one of the four South Delta locations where the salinity standards are defined. The differences in the curves are primarily due to the impacts of South Delta permanent gate operations tidally moving the water that is pulled upstream by the exports upstream further into the South Delta. The water that is tidally moved upstream with the aid of the permanent gates consists primarily of the Sacramento River, ocean water, in-Delta returns, and San Joaquin water. When salinity intrusion is low and Sacramento flows within the south Delta are high, the water tends to be lower in salinity. When that water is tidally moved upstream into the South Delta, it mixes with the San Joaquin water and other in-Delta sources. Results from both the "15K ICC First" and the "10K ICC Next" show an overall degradation (December through August) compared to both reference cases. As stated previously, the computer simulations contained in this report can be described as forming a preliminary sensitivity analysis. As such, the operation criteria for the SDIP gates for all operation scenarios are the same. The gate operation criteria were developed for a reference case scenario and should be modified for more detailed studies on Dual Conveyance.

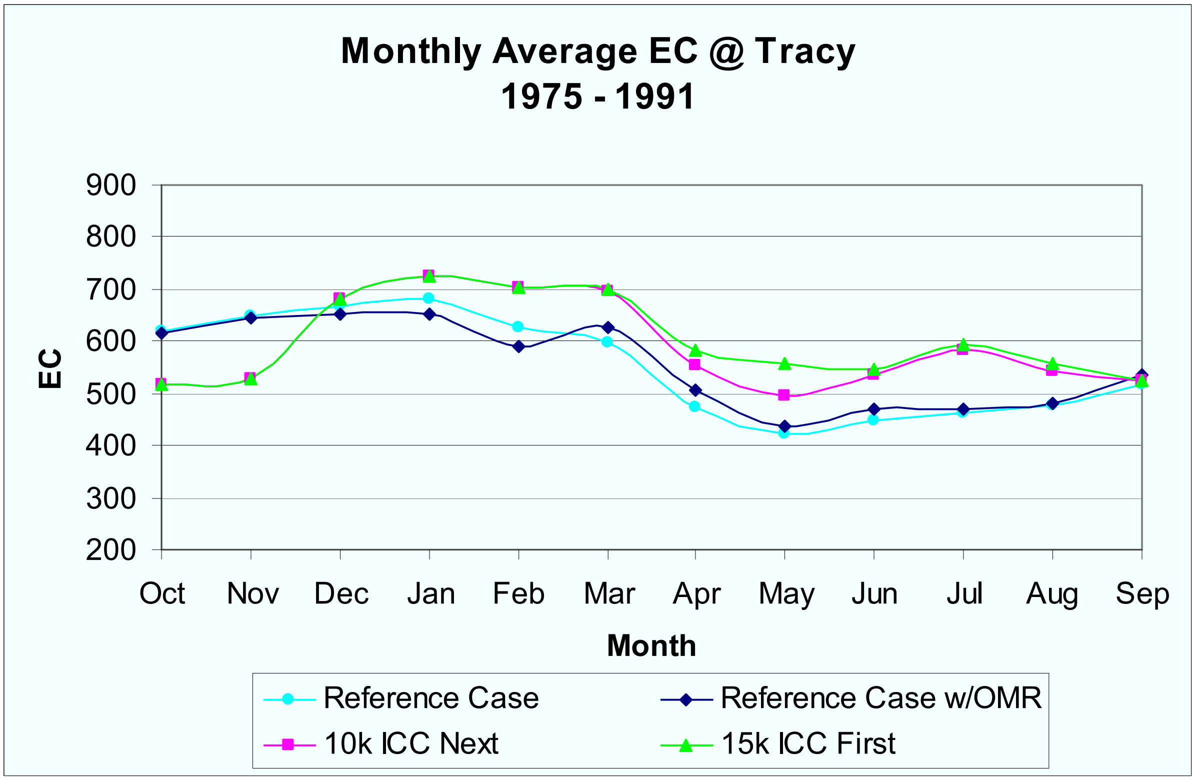
13. Projected Schedule and Funding

Schedule

Before facilities can be constructed for a project, the project must undergo environmental review and permitting. Dual Conveyance facilities are being evaluated as part of the Bay Delta Conservation Plan.

Work has begun to develop the environmental documentation, an Environmental Impact Report/Environmental Impact Statement (EIR/EIS), for the BDCP program. At a minimum,

Figure 18 -- Monthly Electrical Conductivity in Old River Near Tracy, the South Delta



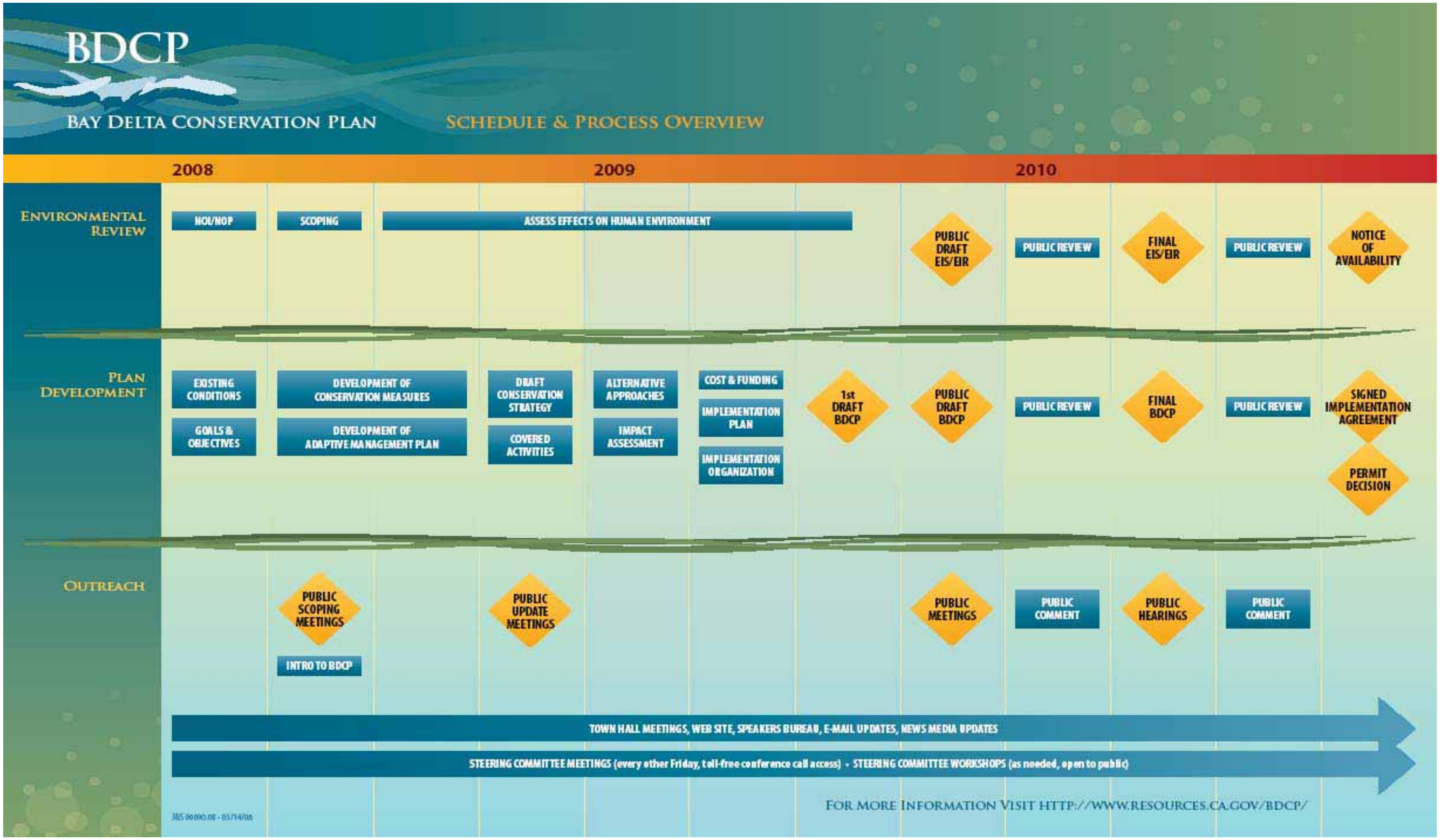
the EIR/EIS process will consider the Governor's four alternatives for Delta Conveyance. Some of these may be eliminated in the screening process. The EIR/EIS document will provide environmental review of the BDCP and the project-specific level review of conservation measures that are sufficiently developed. Dual Conveyance facilities and some habitat restoration actions are among the measures to have a sufficient level of detail for project specific coverage. The BDCP would elicit coverage under the federal and state Endangered Species Acts. This coverage would include operations of facilities.

BDCP is scheduled have a draft EIR/EIS available for public review by the end of 2009. The Final EIR/EIS would be delivered by the Middle of 2010. Permitting and final design would take approximately one year. Construction would take approximately 4 years. Land acquisition will continue throughout the planning, design, and construction process. Table 6 summarizes this information. Figure 19 provides more detail on the program schedule.

Table 6
Time Line for Completing Dual Conveyance

2009	2010	2011	2012 – 2016
Draft EIR/EIS	Final EIR/EIS	Permitting and Final Design	Construction of Dual Conveyance

Figure 19
Bay Delta Conservation Plan Schedule



14. Next Steps

A Dual Conveyance configuration or perhaps a few Dual Conveyance configurations will be considered in the eventual Bay Delta Conservation Plan EIR/EIS. Along with Dual Conveyance, the options for no changes to conveyance, use of only through-Delta conveyance, and use of only isolated conveyance will also be considered along with several habitat conservation measures.

The BDCP Conveyance Work Group is proposing an approach for arriving at an operations plan for Dual Conveyance facilities. Its description follows.

Process for Developing Possible Operating Parameters and Values

The Conveyance Work Group will develop draft flow parameters and values for use in evaluating the performance of various dual conveyance operations. Flow parameters and values will be sequentially developed for a dual conveyance facility for four main topic areas in the Delta based on biological needs for these areas in the following order:

1. Sacramento River Inflow which includes Rio Vista flows, Delta Cross Channel flows, and the Isolated Conveyance Facility diversion bypass criteria
2. Low salinity zone which includes Delta Outflow criteria
3. West and South Delta flow criteria for Through-Delta diversions from the export facilities in the South Delta
4. San Joaquin River Inflow assumptions

First, flow parameters and values for the Sacramento River Inflow and Low Salinity Zone will be prepared. Flow parameters for the Sacramento River and low salinity zone are anticipated to include:

- Flows into the Yolo Bypass
- Isolated Conveyance Facility diversion bypass flows
- Operation of the Delta Cross Channel gates
- Flows in the Sacramento River at Rio Vista
- Delta outflow or location of low salinity zone during various times of the year

Flow parameters and values will subsequently be developed and proposed for the criteria for Through-Delta operations and San Joaquin River inflow assumptions using a similar approach used for the first two topic areas.

The BDCP Consultant Team will identify parameters and the expected benefits and uncertainties of criteria developed. This step is likely to produce a range of operational scenarios for a Dual Conveyance System. Coarse-level evaluations will continue to assess how these scenarios operate with existing criteria for non-biological beneficial uses like agricultural, municipal, and industrial uses. As conflicts are identified, potential solutions will be identified and presented. The Conveyance Work Group would receive a presentation of the operational scenarios and evaluation results. The most promising scenarios would be retained for refinement and further evaluation. A report of the most promising scenarios is expected to be finished by the end of June 2008.