DRAFT

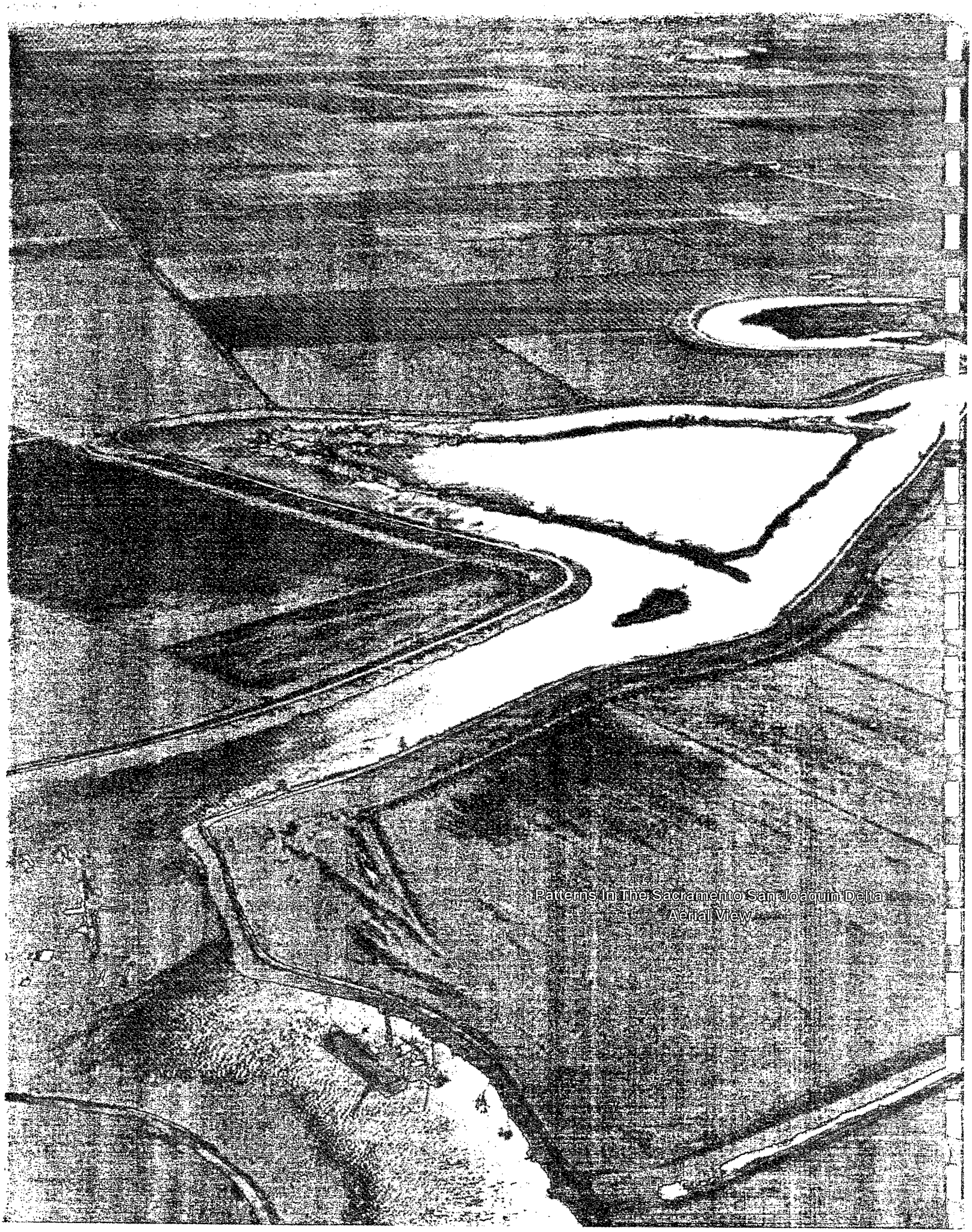
ENVIRONMENTAL IMPACT REPORT
ENVIRONMENTAL IMPACT STATEMENT

SOUTH DELTA WATER MANAGEMENT PROGRAM

Phase I of Water Banking Program

June 1990

California Department of Water Resources
United States Bureau of Reclamation


Patterns In The Sacramento San Joaquin Delta
Aerial View

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California Department of Water Resources
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Draft Environmental Impact Report
Draft Environmental Impact Statement
South Delta Water Management Program

Prepared by

California Department of Water Resources

U.S. Bureau of Reclamation

This Environmental Impact Report/Environmental Impact Statement (EIR/EIS) is prepared in compliance with the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA).

The California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (Reclamation) propose to implement the South Delta Water Management Program (SDWMP). This program is one of three water management programs being conducted to address issues surrounding the Sacramento-San Joaquin Delta and is a vital step in a future water banking program.

This EIR/EIS evaluates the South Delta Water Management alternative facilities, and other methods of water supply augmentation and demand-reduction. Under the SDWMP, nine alternatives, including no-action, are analyzed. The preferred alternative is to: enlarge Clifton Court Forebay to about 5,000 surface acres with two new intakes; enlarge some existing south Delta channels; acquire a U.S. Army Corps of Engineers permit to increase diversion capability to allow for DWR's Banks Pumping Plant to operate at a maximum of 10,300 cubic feet per second; and construct up to four mitigation and enhancement barrier-type facilities in south Delta channels.

The cumulative impacts of this and related projects are also evaluated.

For further information regarding this EIR/EIS, contact Fred Bachmann, California Department of Water Resources, 1416 Ninth Street, P. O. Box 942836, Sacramento, California 94236-0001, telephone (916) 324-4751; or Douglas Kleinsmith, U.S. Bureau of Reclamation (MP-750), 2800 Cottage Way, Sacramento, California 95825-1898, telephone (916) 978-5121.

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FOREWORD

Three related Environmental Impact Reports/Environmental Impact Statements (EIR/EIS's) are scheduled to be released to the public in 1990: The South Delta Water Management Program (SDWMP), the North Delta Water Management Program (NDWMP) and Los Banos Grandes (LBG) Offstream Storage Reservoir. The SDWMP is the first phase of the California Department of Water Resources (DWR) water banking program and is designed to resolve local south Delta water supply problems. Before a final decision is made on this program, draft EIR/EIS's on the other two programs will be available for public review. Concurrent with these programs, DWR, the Department of Fish and Game (DFG), and the U. S. Bureau of Reclamation (Reclamation) will continue to conduct public negotiations with input from environmental interests and water users to determine a future agreement to protect Delta estuary fish. The planning programs are designed to be compatible with, and offer, specific mitigation measures to advance this agreement.

This draft EIR/EIS covers actions to be taken over the next several years under the SDWMP. The program consists of several individual actions, most of them to be undertaken by DWR as a part of the State Water Project. The program features involve the same Delta waterways used by Reclamation's Central Valley Project, and, thus, potentially could influence Reclamation operations and/or facilities. Furthermore, there are specific project objectives—namely, improvement of water levels, quality, and circulation in the south Delta channels and fishery conditions—that correspond with Reclamation's objectives for the south Delta. Therefore, Reclamation has joined in the preparation of this general program document and is currently involved in several of the negotiations described. A report on site specifics of the federal portion of the program will be prepared to obtain Congressional authorization for construction of appropriate project features. As necessary, that authorization report and final EIR/EIS will include additional environmental analysis for any site specific National Environmental Policy Act compliance requirements.

The South and North Delta Water Management programs are responding to the growing consensus that "no action" in the Delta is unacceptable and that improvements are needed to correct existing problems. Current operation adversely affects the water quality of drinking water, impacts fisheries, lowers project reliability, and creates concerns with local water diverters, which led to a lawsuit in 1982. Improvements proposed by these Delta Water Management Programs are designed to reduce or eliminate these problems and assist other ongoing efforts to provide flood control improvements for the Delta. Also, the current system is not able to provide the operational flexibility to meet the "water banking" concept approved by the Legislature in 1984. Many factors support this banking concept as an environmentally workable method to meet California's growing water needs.

Water banking is the concept of moving water into storage facilities south of the Delta during winter high-flow conditions, when fishery impacts are less pronounced, and using this stored water during drier periods to reduce diversions from the Delta. The improved hydraulics, with a federal permit to increase diversions in the Delta, proposed by the SDWMP, would permit diversions of these flows when they are

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available. Storage facilities such as the Kern Water Bank (ground water storage) or the proposed LBG would provide the storage capacity for this banking operation.

The EIR/EIS's have been carefully organized into individual reports guided by comprehensive statewide planning to improve the decision-making processes. The use of coordinated individual reports was selected to provide added attention to program evaluations as well as flexibility in scheduling and program implementation. At the same time, the interrelationships between each program and their combined effects are addressed in detail by statewide planning documents, cumulative impact evaluations, comprehensive system operation studies, and Delta estuary mitigation activities. Positive results have been achieved with other Delta programs during the last 10 years using coordinated individual reports and a step-by-step approach.

The interrelationship of these reports has been considered in DWR's latest update of the California Water Plan—Bulletin 160-87, *California Water: Looking to the Future* (November 1987). Also, as part of the engineering and environmental assessment for each program, the cumulative impacts and project operations of combining projects were evaluated. This information will be available to negotiators that are developing an agreement to provide for Delta fishery protection, which, in turn, will become an integral part of the complete Delta program.

David N. Kennedy, Director
Department of Water Resources
State of California

Lawrence F. Hancock, Regional Director
Mid-Pacific Region
U.S. Bureau of Reclamation

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STATE OF CALIFORNIA
George Deukmejian, Governor

THE RESOURCES AGENCY
Gordon K. Van Vleck, Secretary for Resources

DEPARTMENT OF WATER RESOURCES
David N. Kennedy, Director

Lawrence A. Mullnix
Deputy Director

Robert G. Potter
Deputy Director

James U. McDaniel
Deputy Director

L. Lucinda Chipponeri
Assistant Director for Legislation

Susan N. Weber
Chief Counsel

Division Of Planning

Edward F. Huntley ..... Chief

Delta Planning Branch

Karl P. Winkler ..... Chief

This report was prepared under the supervision of

Fred Bachmann ..... Supervising Engineer, Water Resources
Naser Bateni ..... Senior Engineer, Water Resoources

The principal authors were

David Brown ..... Environmental Specialist IV
Robert Suits ..... Associate Engineer, Water Resources
Waiman Yip ..... Associate Engineer, Water Resources
Edward Lawler ..... Assistant Engineer, Water Resources
Mohammad "Mike" Mirmazaheri ..... Assistant Engineer, Water Resources
Phillip B. Rutan ..... Assistant Engineer, Water Resources
Judy Fong ..... Junior Engineering Technician
Richard Hoagland ..... Student Assaistant

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Editorial and Production Services were provided by

Earl G. Bingham ..... Research Writer
Sylvia Blake ..... Branch Secretary
Mary Holton ..... Office Assistant II
Frances Niederberger ..... Office Assistant I

Drafting Services were provided by

Gayle Dowd ..... Engineering Technician II
Charles Lano ..... Senior Delineator

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See Appendix O for a complete list of preparers.

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EXECUTIVE SUMMARY

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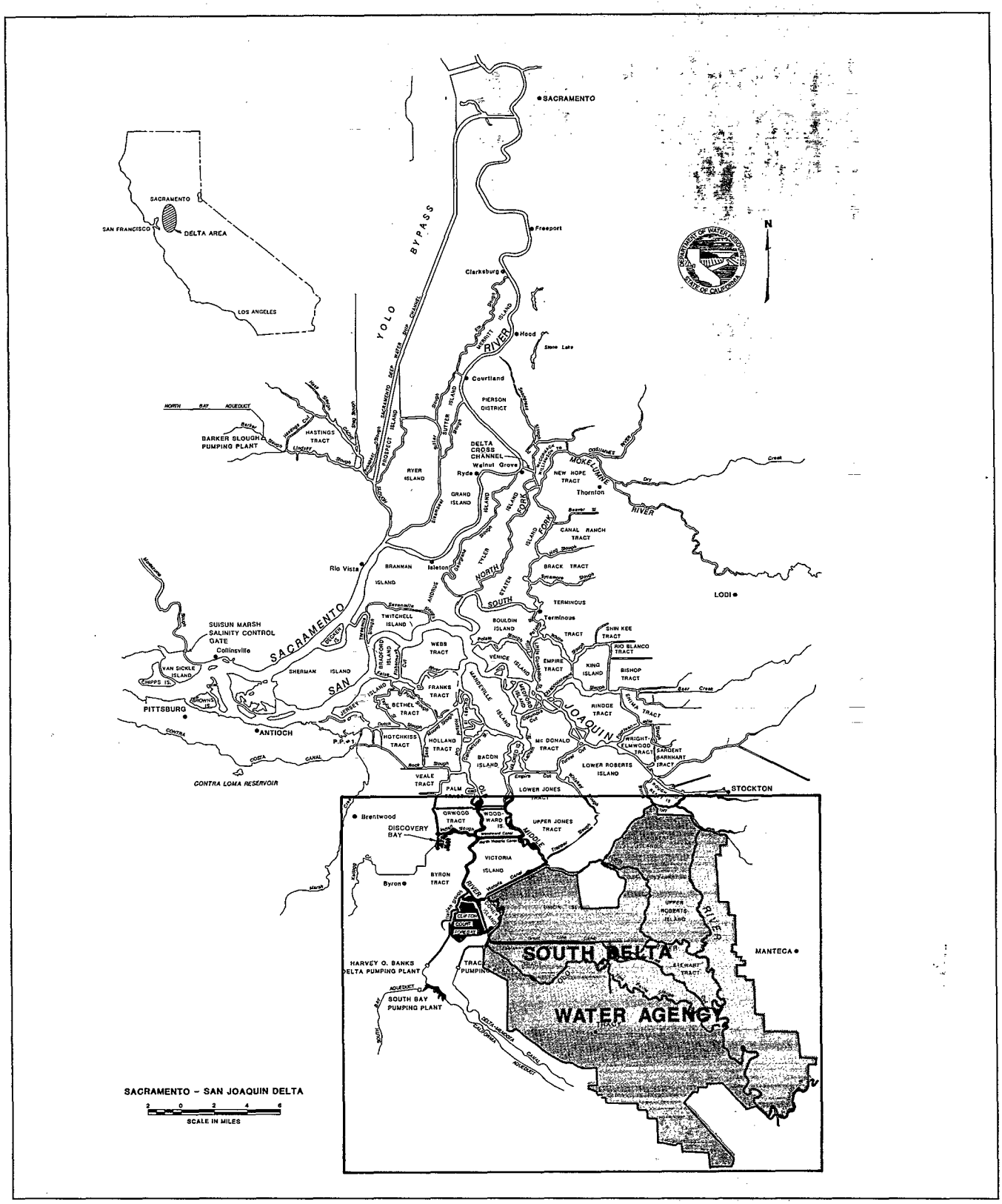

Figure 1. South Delta Water Management Study Area

EXECUTIVE SUMMARY

The California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation) propose to implement the South Delta Water Management Program (SDWMP). This program is one of three water management programs being conducted to address issues surrounding the Sacramento–San Joaquin Delta and is the first step in a future water banking program. The South Delta Water Management Study Area is shown in Figure 1. This draft report incorporates comments from earlier public scoping meeting. Additional comments from the review of this draft will be included in the final environmental document.

The environmental documentation process provides information for the public, government agencies, and decision makers about the potential significant environmental effects of implementing the SDWMP. In addition, this environmental documentation will identify alternatives and possible ways to reduce or prevent environmental impacts. The information will be used to obtain federal regulatory permits that govern projects in the Delta estuary.

An integral part of this process is continuous communication and cooperation with the public, governmental agencies, and environmental groups to improve the decision-making process for both the preferred alternative and adopted mitigation measures. Included in this process are 1) public comments, 2) public scoping meetings, 3) wide distribution of planning reports, 4) organization of special meetings with environmental groups and interested entities, and 5) development of and commitment to implementation and monitoring of a mitigation plan.

This draft EIR/EIS covers actions to be taken over the next several years under the SDWMP. The program consists of several individual actions, most of them to be undertaken by DWR as a part of the State Water Project. The program features involve the same Delta waterways used by Reclamation's Central Valley Project, and, thus, potentially could influence Reclamation operations and/or facilities. Furthermore, there are specific project objectives—namely, improvement of water levels, quality, and circulation in the south Delta channels and fishery conditions—that correspond with Reclamation's objectives for the south Delta. Therefore, Reclamation has joined in the preparation of this general program document and is currently involved in several of the negotiations described below. A report on site specifics of the federal portion of the program will be prepared to obtain Congressional authorization for construction of appropriate project features. As necessary, that authorization report and final EIR/EIS will include additional environmental analysis for any site specific National Environmental Policy Act compliance requirements.

The Delta is an important resource with a complex and sensitive environment. DWR, Reclamation, and the Department of Fish and Game (DFG) have formed a negotiating group with a broad range of expertise to provide protective measures for the Bay–Delta estuary. DWR and Reclamation are committed to provide staff resources and participation to develop a mutually acceptable agreement. The SDWMP will utilize and contribute to these negotiations to develop mitigation measures. Other important contributions will come from the North Delta Water Management Program (NDWMP), including elimination or reduction of reverse Delta flow patterns caused by the project.

This protection, together with other commitments discussed under "Mitigation Measures," was designed to reduce adverse impacts. To provide further protection for the Delta, DWR and Reclamation will take other steps:

- Negotiate with South Delta Water Agency (SDWA) to protect local agricultural water diversions and provide for interim New Melones releases.
- Integrate mitigation measures that consider improved flow patterns and project operational flexibility into the preferred alternative.
- Fund and initiate a program to promote long-term releases from New Melones Reservoir to protect fish and water quality.
- Continue commitment to water conservation and reclamation programs.
- Develop Delta wetlands.

South Delta Background

The South Delta area generally comprises the lands and channels of the Sacramento–San Joaquin Delta southwest of Stockton. Included in the study area is the SDWA, as defined in the Formation Act, California Statutes of 1973. Important features of the State Water Project (SWP) and Central Valley Project (CVP) are also located in the study area. The area is faced with complex issues, including water rights, water supplies, water quality, and the environment.

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The area within SDWA boundaries includes some 150,000 acres, of which 120,000 acres are used for irrigated agriculture. The remainder consists of waterways, berms, channel islands, levees, and lands devoted to homes and industries. About 450,000 acre-feet (AF) of water is diverted from the 75 miles of south Delta channels each year to irrigate the fully developed and highly productive agricultural land.

In July 1982, SDWA filed a lawsuit concerning the effects of SWP and CVP operations on the south Delta. The suit sought a declaration of the rights of the parties, a preliminary injunction, and a permanent injunction requiring that the projects be operated to protect the south Delta.

In past years, SDWA at times reported low water levels in local channels. Accordingly, DWR installed stage recorders, dredged the shallow spots, and modified Clifton Court gate operations to help alleviate the impact of SWP diversions on water levels. During a hot period in July 1985, when farmers claimed they were losing crops due to low water supplies, DWR installed three pumps to provide additional water in Tom Paine Slough.

In addition, DWR and Reclamation have begun interim actions to improve SDWA water conditions with positive results. DWR has modified operations at Clifton Court Forebay (Figure 2), constructed siphons and dredged in Tom Paine Slough, and constructed a weir in Middle River to mitigate the water level problems. Immediately after

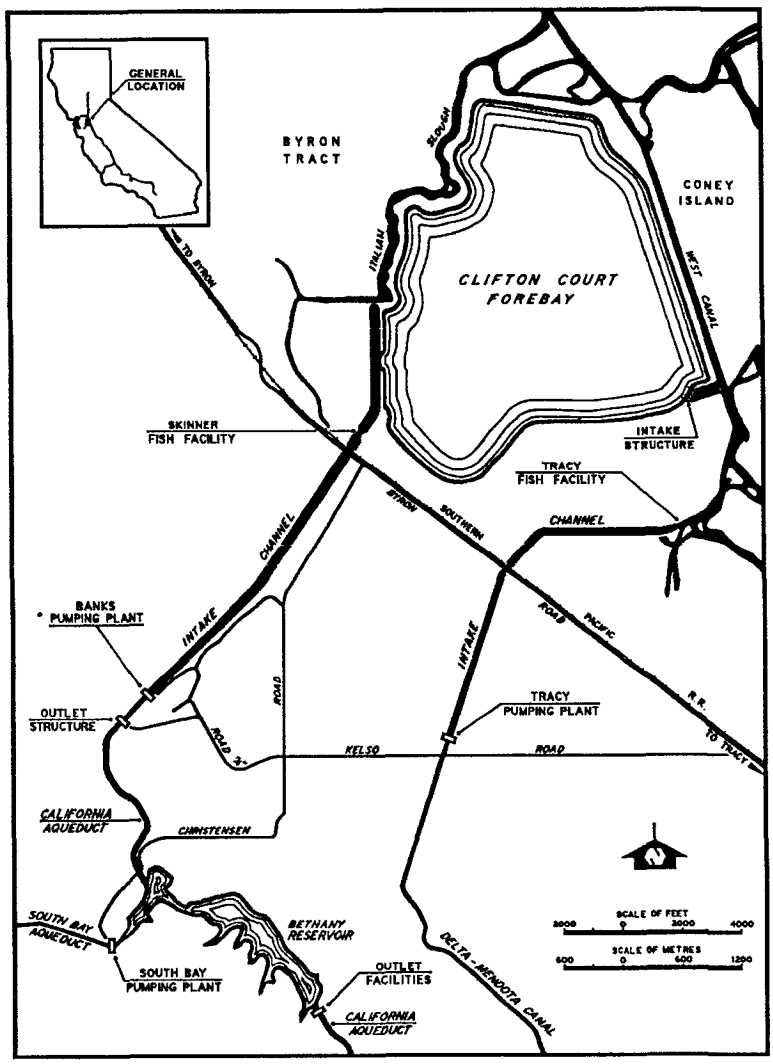

Figure 2. Clifton Court Forebay

Clifton Court Forebay, a key feature of the State Water Project, is located about 10 miles northwest of Tracy. The current surface area of the forebay is 2,180 acres; storage capacity is 31,260 acre-feet. The proposed South Delta Water Management Program would enlarge the forebay to at least 5,000 surface acres.

Together with the Skinner Fish Protective Facility and a connecting intake channel, Harvey O. Banks Delta Pumping Plant diverts water from the south Delta through Clifton Court Forebay for conveyance via the California Aqueduct and South Bay Aqueduct to contracting agencies in the south San Francisco Bay area, the San Joaquin Valley, and Southern California.

The purpose of the forebay is to allow operational flexibility for pumping at the Banks Pumping Plant. This flexibility is a key element of a future water banking program.

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the weir became operational, local farmers reported that water levels had improved.

In 1984, the Legislature authorized Los Banos Grandes Reservoir as part of the State Water Resources Development System. The purposes of the project are to develop additional water supplies, improve water quality, and provide additional flexibility for SWP. This additional flexibility could help protect and enhance fish and wildlife.

In DWR Bulletin 160-87, *California Water: Looking to the Future"* (November 1987), DWR evaluated statewide water conditions. In the bulletin, DWR concluded that meeting the water needs of California's rapidly expanding population will involve a variety of water management approaches, including 1) water conservation, 2) water salvage, 3) conjunctive use of surface and ground water, 4) water transfers, 5) water sharing, 6) waste water reclamation, and 7) water banking. The SDWMP is part of planned water banking to help meet California's future needs.

Program Need

The SDWMP action is in response to:

- an October 1986 framework agreement among DWR, Reclamation, and SDWA that committed all three parties to work together to develop mutually acceptable, long-term solutions to the water supply problems of water users within SDWA;
- 1984 legislation that authorized Los Banos Grandes Offstream Reservoir (LBG) south of the Sacramento-San Joaquin Delta, which would store winter flows; and
- a need to increase the operational flexibility and reliability of the SWP, to meet contractors' requests, which, more than half the time, exceed annual delivery capability, and to improve the quality of water supplies, thereby reducing future difficulties and costs of treating drinking water.

Program Objectives

The objectives of this action are to:

- improve and maintain water levels, circulation patterns, and water quality in the south Delta area for local agricultural diversions;
- improve SWP operational flexibility to help reduce fishery impacts and improve fishery conditions;
- improve SWP and CVP water supply reliability through enhanced capabilities for banking winter supplies and through improved water quality, which will reduce the cost of treating drinking water supplies;
- provide the opportunity to interconnect with Clifton Court Forebay and improve water quality for Contra Costa Canal deliveries to be treated for use as drinking water supplies;
- improve navigation and flood protection; and
- increase recreational opportunities.

Program Alternatives

The narrowing of alternatives utilized a broad range of information that is important to water resources planning. The selection process considered previous studies, activities implemented during droughts, legislative activities, statewide referendums, comprehensive water conservation and reclamation activities, the SDWMP objectives and project operational flexibility. Previous studies evaluated alternatives on the basis of such factors as economics, energy, water supply, fisheries, wildlife, recreation, water quality technological, legal, and institutional constraints, political issues, and compatibility with other proposals.

In general, previous studies showed that an isolated facility would provide favorable reliability, fishery protection, and improved water quality when compared to other alternatives such as a physical barrier or through-Delta facility. Recent updates of previous studies showed this same trend. However, the June 1982 voter rejection by State referendum indicated that an isolated Delta facility was unacceptable to the public.

The previous studies also showed that a through-Delta system compatible with the SDWMP would provide significant advantages over existing conditions. Also, extensive programs since 1975 to implement water conservation and reclamation have determined that statewide demands can be reduced by 1.3 MAF by 2010.

Two types of alternatives are evaluated in this report:

- South Delta Water Management alternative facilities.
- Water supply augmentation and demand-reduction alternatives, including such measures as water conservation and desalting.

Under the SDWMP, eight different alternatives and a no-action plan were evaluated. Each alternative evaluated is a combination of various project components, including: 1) mitigation and enhancement barrier-type facilities,

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2) an enlarged Clifton Court Forebay, 3) new intake structures, 4) channel improvements, and 5) related project modifications. The alternatives were formulated to evaluate the various project components and to show the widest range of impacts. Each alternative was evaluated under a wide range of monthly exports. The preferred alternative is to:

- enlarge Clifton Court Forebay to about 5,000 surface acres with new intakes at Old River and Middle River at the west and east ends of North Victoria Canal;
- enlarge some existing south Delta channels to improve conveyance and circulation;
- acquire a U.S. Army Corps of Engineers (Corps) permit to increase the pumping capability of the Banks Pumping Plant up to 10,300 cubic feet per second to allow for operational flexibility. This pumping rate will occur mainly during high-flow months. More than 80 percent of the time, pumping rates will be lower than 8,000 cfs; and
- construct up to four mitigation and enhancement barrier-type facilities in south Delta channels to directly improve water level and circulation. Implementation of these mitigation facilities can start, independent of the forebay expansion, as soon as an agreement is signed with SDWA. Summary Figure 3 shows the preferred alternative.

Water conservation and reclamation alternatives were also evaluated. Impacts associated with reclamation programs are generally insignificant unless construction is involved. Brine disposal and energy consumption are considered as water desalting impacts.

Water conservation and reclamation measures would help reduce the projected water delivery shortfalls. These measures, however, could provide only a part of the additional water needs. In addition, these measures, alone, will neither provide operational flexibility for the SWP nor improve water quality, water levels, and circulation patterns in the south Delta. Therefore, the SDWMP, in conjunction with continued and increased use of water conservation and reclamation measures for year 2000, is needed to meet the multi-objective goals planned for the Delta.

Extraordinary water supply and demand reduction alternatives were compared to the alternative operational plans with the SDWMP. These comparisons also provided the basis for defining the municipal and industrial yield benefits of the SDWMP in the economic evaluation.

These measures are in addition to water conservation and waste water reclamation measures included in statewide future water supply planning. Moreover, extraordinary water conservation alternatives will help offset the 400,000 acre-foot shortage that is expected to occur 10 percent of the time by 2010 with all currently planned expansions of the SWP, including the preferred alternative.

Program Benefits

The SDWMP will provide numerous benefits:

Delta Agricultural Use and Water Level. The SDWMP will improve conditions for agriculture in the south Delta by:

- installing and operating mitigation and enhancement barrier-type facilities to improve water levels and circulation in south Delta channels;
- operating barrier-type facilities in the south Delta to keep San Joaquin River water from directly entering the south Delta;
- improving the existing Clifton Court Forebay so that water can be released during the irrigation season, to enhance water quality in the south Delta channels; and
- making interim releases from New Melones Reservoir to improve water quality in the south Delta.

SWP Reliability. The SDWMP will increase the reliability of SWP deliveries by increasing wet-period diversions of unregulated flows when operated with additional storage capacity south of the Delta.

SWP Water Quality. Under the preferred alternative, water quality at the intake to Clifton Court Forebay will be improved. The preferred alternative's new intake gate location will divert from a source of better quality water. These improvements will reduce chloride, bromide, and total dissolved solids at the SWP intake. This will provide a better source of water to be treated for intended use as drinking water. Water quality can also be enhanced by the ability to take advantage of seasonal and short-term water quality improvements.

Delta Fisheries. Operation of a barrier at the head of Old River will improve flow patterns for San Joaquin River salmon and steelhead migrations. Improved circulation, water quality, and water temperature in the Delta will also have a positive impact on resident fish in south Delta channels. Levee setbacks would create added shoreline habitat.

The preferred alternative also provides the operational flexibility to shift exports away from critical periods for

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Operational Flexibility

The enlarged forebay, new intake gates, and 10,300 cfs pumping capacity can improve SWP operational flexibility to manage operations in a manner that will 1) improve project reliability, 2) reduce fishery impacts and 3) improve conditions for local agricultural diverters. With added operational flexibility, the project can bank water supplies south of the Delta during winter and high flow conditions, when the abundance of fish is lower. During periods of low inflow to the estuary, these supplies south of the Delta can be used to reduce the demand on Delta exports and reduce estuary impacts. Another operational advantage includes the ability to control the proportion of annual reserve storage in reservoirs north and south of the Delta. This could increase the frequency of refilling storage from varied runoff patterns.

Added operational flexibility can reduce the cost and difficulty of treating drinking water by improving the quality of delivered supplies. The flexibility to operate an additional intake on Middle River will reduce trihalomethane formation potential, total dissolved solids, and chlorides. Also, the increased ability to take advantage of seasonal and short-term water quality improvements could further improve the quality of delivered supplies. The project's ability to meet the increasingly complex water rights and water quality standards can be improved through greater flexibility to manage Delta salinity on a day-to-day basis during controlled flow conditions. Increased flexibility can reduce costs by allowing for the use of the bulk energy market to buy available short-term electrical power.

In addition to shifting exports away from periods of high fish abundance to periods of low abundance in connection with winter banking, project operational flexibility can reduce fish impacts in other ways. A larger forebay can increase the time in which the Delta cross-channel can be intermittently closed, thus improving conditions for fish migration in the Sacramento River. Fish loss due to predation in the forebay can also be reduced by providing for direct export capability from Italian Slough for short periods of time.

Local agricultural diverters can also benefit from added operational flexibility. A larger forebay with additional intakes can be operated during the irrigation season to release water to south Delta channels, thus improving water levels and circulation. The larger forebay can also reduce the frequency and duration of gate openings, thereby reducing the effects to surrounding diverters.

eggs, larvae, and juvenile striped bass. This can help reduce the direct loss of striped bass caused by SWP pumping. The preferred alternative can also improve western Delta flow patterns and Delta water quality, which will reduce adverse impacts on striped bass. To a limited extent, a larger forebay can also allow for intermittent closure of the Delta cross-channel to improve fish migration in the Sacramento River. During the periods of closure, exports can continue from the additional forebay volume.

New Melones interim releases will also provide instream fishery benefits in the Stanislaus River, San Joaquin River, and south Delta channels. A direct diversion option and measures to remove predation will reduce existing predation losses at the Delta complex.

Energy Requirement. The increased pumping capacity and enlarged forebay will allow SWP operators to lower energy costs by using the bulk energy market to buy available short-term electrical power.

Contra Costa Canal Drinking Water Supplies. An enlarged forebay would provide an opportunity to relocate the Contra Costa Canal intake to the forebay and improve the quality of water to be treated for household use in Contra Costa County.

Flood Control. The SDWMP includes levee improvements, channel dredging, and operation of Clifton Court Forebay to provide flood control benefits.

Navigation. Scenic channels not easily accessible to boating because of siltation can be dredged to improve navigation. Additional gate operational flexibility will reduce project drawdown effects.

Recreation. Proposed channel improvements could provide opportunities for additional recreational development. Dredging would make some scenic stretches of channels accessible. Levee setbacks could create berm islands and additional shoreline for riparian habitat and recreational opportunities. Barrier-type facilities would improve water levels for recreational boating in certain channels that are now shallow and stagnant. Any recreational development will avoid sensitive wildlife areas.

Wildlife. Additional lands will be acquired to enhance diverse species of Delta wildlife. Development of high-quality wetland habitat on these lands can provide significant enhancement opportunities. Alternative designs will also include provisions to acquire and create channel islands to produce additional attractive wildlife areas.

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Economic Assessment

The following table shows the estimated economic benefits the SDWMP will provide to various service areas without the additional water-supply benefits of Los Banos Grandes Reservoir and the Kern Water Bank (KWB). Total benefits of the SDWMP are estimated at $35 million per year. This level of benefits supports continuation of an enlarged forebay independent of LBG and KWB.

Region	Annual Benefit ($ million)
M&I	
South Coast	29.3
Central Coast	0.8
San Francisco Bay	2.3
Tulare Lake	0.6
Sacramento River	0.2
Subtotal	**33.2**
Agricultural	
Tulare Lake	1.3
Total	**34.5**

Environmental Assessment

Environmental assessments for the preferred alternative are shown in Table 1, which summarizes the combined impacts of the KWB, LBG, and SDWMP. Without KWB and LBG, the SDWMP will have lower total exports, which can reduce some of the impacts shown in Table 1. It will also provide lower total operational flexibility and will not achieve a level of benefits similar to that of the three projects combined.

Impacts under the preferred alternative were determined for the following:

Energy Impacts. To the extent that water deliveries through SWP facilities will increase due to implementation of the SDWMP, SWP energy requirements will also increase. The estimated average annual increase in energy requirements is about 800 GigaWatt hours (GWH). About 200 GWH of this would be recovered by SWP recovery generation on the aqueduct. Operational flexibility achieved by implementation of the SDWMP will also partially offset SWP energy requirements through use of both off-peak energy and short-term bulk power available in the market.

Construction Impacts. Impacts due to construction of the project components are temporary and consist of:

- increased traffic in the project area;
- increased noise levels;
- disturbed vegetation in the project area;
- possible disrupted local utilities; and
- increased dust and turbidity in the project area.

Impacts on Wildlife and Wildlife Habitat. Under the preferred alternative, Clifton Court Forebay will be enlarged by about 3,000 surface acres. Agricultural land in the project area will be purchased and converted for use in the forebay expansion. Channel enlargement will include design to provide berm habitat by levee setback. Losses of wildlife habitat will be fully mitigated through adoption of a wildife management plan for Sherman Island or for other appropriate locations.

Impact on Salmon and Steelhead. Under the preferred alternative, changes in Sacramento River flow and SWP exports may cause some negative impacts to migrating salmon and steelhead. The barrier on Old River at the confluence of the San Joaquin River will improve San Joaquin River salmon migration.

Direct impacts of the Delta complex on salmon are calculated by a fish loss model. The preferred alternative resulted in slightly greater losses of Chinook salmon compared to the no-action alternative.

Impact on Resident Fish. Direct impacts of the preferred alternative on resident game and non-game fish were evaluated. Two species of resident game fish (black crappie and bluegill), and two non-game fish (threadfin shad and yellowfin goby) were impacted. However, the impacts were found to be insignificant. All of the other resident fish evaluated, including Delta smelt, will benefit from implementation of the SDWMP.

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Potential Cumulative Effect

Table 2 shows the potential future cumulative effects of the SDWMP. Not all the water resources activities listed in this table will be implemented in the near future, and some will extend beyond the scope of current statewide water resources planning. Just how all these activities inter-relate is difficult to project. However, certain assumptions can be made to combine actions with mitigation and thus produce favorable effects on the cumulative impacts of the SDWMP. Other assumptions could combine actions without mitigation, thereby producing adverse impacts. Without mitigation, the SDWMP, along with LBG and KWB, could gradually reduce the fishery benefits that will be gained through implementing the SDWMP.

Mitigation Measures

Objectives of the SDWMP include improvement of existing conditions in the south Delta; therefore, mitigation and enhancement features are an integral part of south Delta planning. Other mitigation actions include:

Fish Agreement (Article VII). The existing "Agreement to Offset Direct Fish Losses in Relation to Harvey O. Banks Delta Pumping Plant" provides in Article VII for further negotiations to develop, continue, and improve mitigation measures for the Delta estuary. These negotiations, which have already begun, are between DWR, the Department of Fish and Game (DFG), and Reclamation. Negotiations are conducted publicly, and input from environmental groups and water users is encouraged. The operational flexibility provided by SDWMP will be addressed during the negotiations to formulate provisions that will help reduce fishery impacts.

The negotiations will include provisions for the Bay-Delta estuary along with mitigation measures that can be provided by SDWMP. Development of specific mitigation measures for SDWMP will be guided by the negotiating group. Protective measures for fish will also be designed to include measures for NDWMP and LBG, when implemented.

DWR and Reclamation are committed to the negotiation process and to the formulation of an acceptable mitigation plan for SDWMP.

SDWA Contract to Protect Local Agricultural Supplies. This contract will define specific protection measures, including installation of the mitigation and enhancement barriers shown in Figure 3. Interim releases from New Melones Reservoir are to be included.

Development of Wildlife Areas. Land acquisition and creation of channel islands will be included with this program. DWR is committed to the West Delta Water Management Program (WDWMP) to provide mitigation for the enlargement of Clifton Court Forebay. The WDWMP provides a vast wildlife habitat on Sherman Island as part of a wildlife management plan under consideration by DWR and DFG.

Interagency Programs. The Interagency Health Aspect Monitoring Program for the Sacramento-San Joaquin Estuary is partially funded by DWR. The Interagency Ecological Study Program involves funding by both DWR and Reclamation. Both organizations are committed to support studies conducted by the programs. These studies will provide a sound basis for mitigation measures.

Water Conservation, Water Reclamation, and Water Marketing Actions. These actions will be an integral part of all future water development. Significant reductions in demands have occurred from programs implemented since 1975. Additional programs will be implemented along with the SDWMP.

Mitigation for Energy Impacts. Increased SWP energy requirements will be partially offset by efficient energy consumption through use of off-peak energy.

Mitigation for Construction. Mitigation measures for construction consist of use of roads during off-peak hours, use of flagmen to direct traffic, and replanting of vegetation in the project area. Such mitigation actions can reduce or eliminate the impacts caused by construction.

Archeological and Cultural Resources. The design and specification of the project will include avoidance of known archeological and cultural resource sites. Also, if it is determined during construction that sites meeting the criteria of the National Register would be adversely affected, the State Historic Preservation Officer will be consulted to develop acceptable mitigation procedures.

Mitigation for cumulative impacts generally consists of:

- safeguards by laws, regulations, and water rights standards;
- actions to offset losses in the estuary, such as the Suisun Marsh protection agreement to provide protection for the Marsh;
- contracts between project operators and various interests such as Delta agricultural and industrial users; and
- physical measures such as habitat improvements, grow-out facilities, fish screens, and fish hatcheries.

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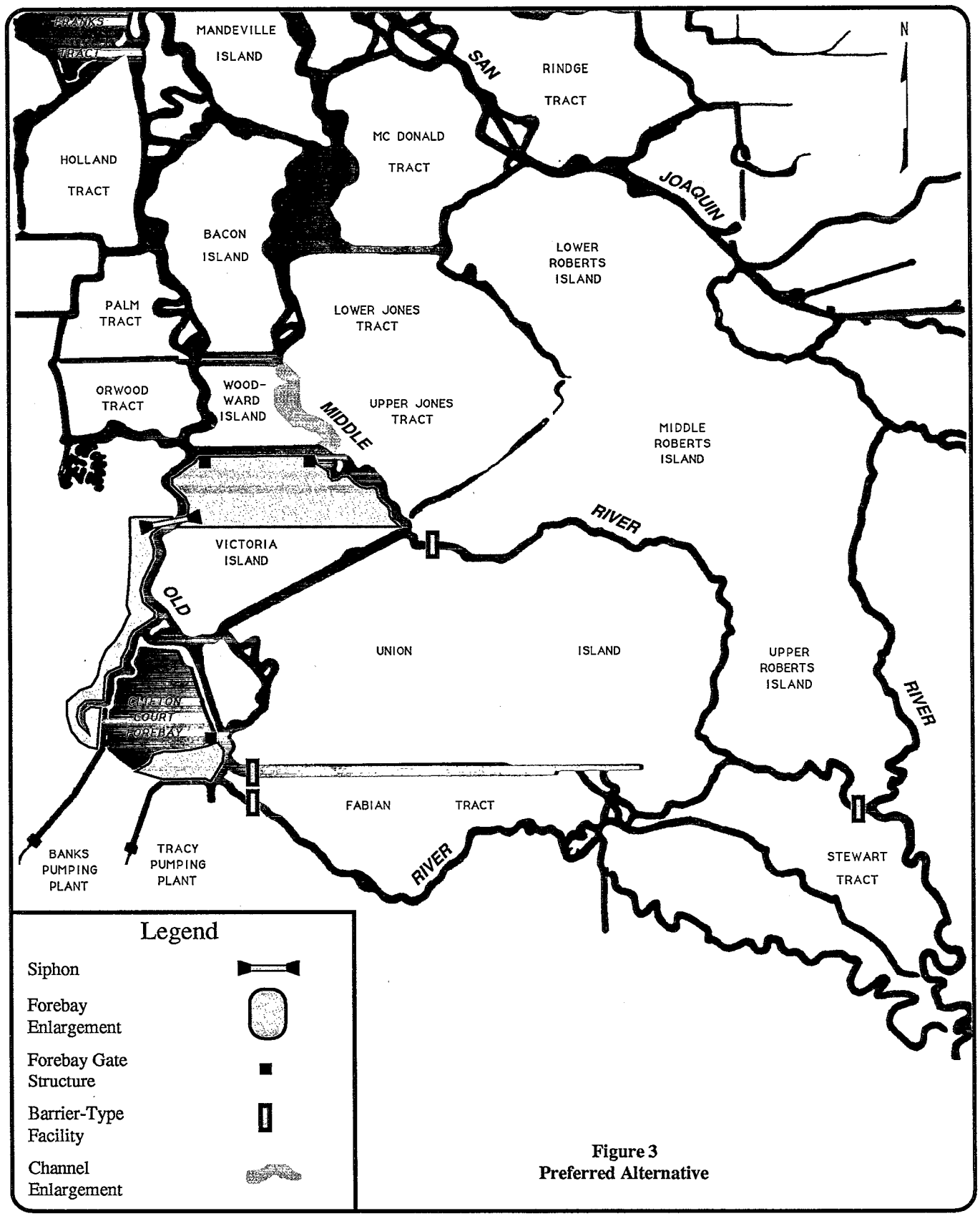

Figure 3
Preferred Alternative

Environmental Commitments

DWR or Reclamation are committed to the following:

- *negotiate with DFG according to Article VII of the existing Banks Pumping Plant Fish Agreement to identify additional protective measures for the Bay-Delta estuary.*
- *negotiate with SDWA to protect local agricultural water diversions, local water quality, and local water levels.*
- *seek Congressional authorization for construction of mitigation and enhancement facilities.*

DWR or Reclamation are committed to further define and implement the following as part of the SDWMP:

- *continue existing—and, if necessary, expand—monitoring programs for sedimentation, scouring, seepage, water quality, and the effectiveness of mitigation plans.*
- *mitigate for wildlife habitat losses by adopting a wildlife management plan on Sherman Island or other locations as appropriate.*
- *maintain existing channel berm habitat, and include design to provide additional berm habitat by levee setback.*
- *mitigate for construction impacts, including using flagmen and off-peak hours for transportation and replanting impacted vegetation.*
- *mitigate for energy impacts, including best use of off-peak energy supplies, and to mitigate for any new power facilities.*
- *perform comprehensive testing of dredged materials if used for enhancement of existing levees or construction of new levees.*
- *continue activities that contribute toward mitigation for cumulative impacts of the project.*
- *obtain necessary federal and State regulatory permits.*
- *make available the option for improved water supplies to the Contra Costa Water District through interconnections.*
- *operate SWP under the preferred alternative to not conflict with any requirements imposed on DWR by the State and federal Endangered Species Acts.*
- *operate the CVP in such a manner that it will not jeopardize the continued existence of any listed species.*
- *reduce predation in Clifton Court Forebay by removing predators and providing intermittent direct diversion from Italian Slough into the fish protective facility.*
- *complete the Class III Cultural Resources Survey for the selected alternatives. If any stites are found to be eligible for the National Register and cannot be avoided, a mitigation plan will be developed.*

DWR or Reclamation are also committed to:

- *provide improved forecasting for Delta water supply conditions for local agriculture.*
- *construct facilities to improve flows in the San Joaquin River to improve survival of young salmon.*
- *provide interim releases from New Melones Reservoir for improvement of both water quality and fisheries.*
- *advance statewide water conservation and reclamation programs that could lessen the demand on Delta water supplies.*
- *participate in a recovery team for winter-run salmon and obtain appropriate agreements or permits..*
- *comply with future Delta standards set by SWRCB as the result of its current hearings.*
- *operate the CVP in compliance with Delta water quality standards set by SWRCB as a result of its current hearings, provided that the required operatiion complies with Congressional directions.*

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Table 1 Summary of Environmental Assessment for the Preferred Alternative			
Subjects	**Physical Impact**	**Environmental Impact**	**Protection/Mitigation Measures**
Construction	Increase in noise, dust, truck traffic, and turbidity; disturbance of vegetation; minor disruption of services (cables, gas lines, etc.); and some minimal recreational inconveniences are expected. Some channel dredging in the South Delta.	Environmental impacts will be short-term. No significant long-term impact is expected from project construction. Local construction work force will be used for the Project.	CAL-OSHA regulations (noise); Regional Water Quality Control Board permit (turbidity); use of flagman and off-peak hours for transportation; replanting vegetation; Endangered Species Act of 1973; and State and federal dredging permits.
Delta Outflow	Slight decrease in Delta outflow in winter and during high flow conditions.	Shift in exports can have positive effect on fishery. Slight decrease in Delta outflow in winter and high-flow conditions will have minor impact on environment.	D-1485 protective outflow. standards. Existing and new fish protection agreements.
Delta Outflow Pulses	Minor decrease in number of pulses.	Unknown environmental impact.	San Francisco Bay Study funded (partially) by DWR.
Cross-Delta Flow	Minimal changes on Cross-Delta flow.	No impact is expected.	Existing and new fish protection agreements.
Local Municipal and Industrial Use	Possible future water quality improvement to the Contra Costa Canal with potential relocation. Reduced days of availability of offshore supply.	Potential water quality improvement and waters upply for municipal and industrial use in the Delta. Protective water quality standard for M&I will be met for all year types.	D-1485 protective standards. Various industrial water supply contracts.
SWP Water Quality	Reduced total dissolved solids, chlorides, bromides, and THMFP.	SWP water quality will be improved.	D-1485 protective standards. EPA and California Dept. of Health Services drinking water standards. SWP contract objectives.
Agriculture	Improve circulation, increase water levels.	Improve water supply and water quality for South Delta Water Agency agricultural users.	Delta Protection Act. South Delta agreements. Releases from New Melones.
Water Supply Reliability	Increase Banks Pumping Plant exports during winter and high-flow conditions. Increase capacity from 6,400 cfs to 10,300 cfs.	Provide more flexibility for operation of the SWP. Shift in export will have positive effect on environment.	D-1485 protective standards. Letter limiting exports. Existing and new fish agreements. U. S. Army Corps of Engineers Permit.
Sedimentation, Scouring, and Seepage	Increase velocity in Old River.	No scouring or sedimentation is expected.	Channel improvements and forebay intake design will prevent scouring and sedimentation. Existing scour monitoring program will be expanded. Seepage monitoring program will be established.

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Table 1 (Continued) Summary of Environmental Assessment for the Preferred Alternative			
Subjects	**Physical Impact**	**Environmental Impact**	**Protection/Mitigation Measures**
Navigation	Increased water levels, channel dredging and physical barriers.	Improved access to scenic channels.	Provision for boat passages and boater designation sites.
Wildlife	Inundation of 3,000 acres for forebay enlargement.	Loss of plant and wildlife habitat.	Implementation of a wildlife management plan. Creation of channel islands and additional shoreline.
Salmon and Steelhead	Construction and operation of barriers will improve San Joaquin River flows. Water quality, dissolved oxygen, and temperature will improve.	Improved flows in San Joaquin and Old River will have positive impact on San Joaquin River spawning. Minor impact on Sacramento River salmon.	D-1485 provides for flow and salinity standards in the Delta. SWP and CVP fish protective facilities. Existing and new fish protection agreements. Predation may decrease by using alternative Italian Slough diversion and expansion of forebay. Interim releases from New Melones.
General Impact on Striped Bass	Provide operational flexibility. Exports can decrease from .May through July. Flows in lower San Joaquin River can increase in May, June, and July. Increases in reverse flow August—November.	May and June export reduction and operational modification can improve conditions for striped bass during spawning and for young striped bass. Entrainment of young Sacramento River bass from Project exports would be less.	D-1485 (salinity and minimum flow standard for striped bass.) Existing and new fish protection agreements
Direct Impact on Striped Bass	Can shift export from summer to winter.	Shifting export can benefit striped bass during critical periods. 22% reduction in direct fish losses is expected.	D-1485 protective standards. Predation may decrease in forebay by increasing the volume and using Italian Slough intake periodically.
Resident Fish	Entrainment may decrease in spring and summer.Water quality, dissolved oxygen, and water temperature in south Delta channels can improve.	Minimum net impact on resident fish.	
Fish Food Resources	Can reduce exports in spring and increase exports in winter.	Shift in export can benefit *Neomysis*. More Sacramento River water with low plankton densities will flow to interior Delta.	D-1485 protective standards. Interagency ecological study program. Existing and new fish protection agreements.
Suisun Marsh	Delta outflow will decrease slightly.	No significant impact is expected because of: • little changes in outflow • physical protective facilities and • existing agreement to protect the Marsh.	Suisun Marsh Protection Agreement. Facilities and monitoring program.

Table 1 (Continued) Summary of Environmental Assessment for the Preferred Alternative			
Subjects	**Physical Impact**	**Environmental Impact**	**Protection/Mitigation Measures**
San Francisco Bay	Minor decrease in number of pulses, minor changes in Delta outflow.	Unknown impact.	D-1485 protective standards. Various studies of Bay resources funded partially by DWR.
SWP Service Area	Improve water supply reliability. No expansion of agricultural land is expected.	Primarily replacement supply. Not growth-inducing. Provide better quality of life with fewer water shortages.	Local regulations and mitigation actions. Zoning and planning.
Power Resources	Increase SWP power supply requirements. DWR is not planning to build a new power plant to meet increased load.	Potential increase of fossil fuel consumption.	Water conservation measures. Best use of off-peak power. Mitigation measures for existing plants.
Archeological and Cultural Resources	Some cultural sites are near the project area.	Sites to be avoided.	Design and specification of the project will include avoidance of known archeological and cultural resources sites. Construction consultation if needed.

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Table 2
Potential Future Cumulative Effects of South Delta Water Management Facilities and Potential Related Projects or Actions on Delta

Project or Action	Delta Inflow Changes	Delta Export Changes	Delta Outflow Changes	Delta Water Quality Changes	Potential Fish and Wildlife	Comments
South Delta Water Management Program	No change	Winter increases summer decreases	Winter decreases	Improvement in drinking water quality and agricultural water quality	Downstream San Joaquin River salmon migration improved. Water quality, dissolved oxygen, and temperature conditions for resident fish improved in south Delta channels; reduced entrainment losses. Negative minor impacts on Sacramento River salmon.	Ongoing fishery negotiations concurrently with south Delta water agency negotiations
North Delta Water Management Program	Summer and fall reductions	Drier year increases	Drier year decreases; water right protective outflows will be maintained	Drinking water protections from reduced chlorides, bromides, TDS and THMFP	Net fish migration improved with reduction of reverse flows. Potential reduction of screening losses. Some increase in young salmon in central Delta	Ongoing fishery negotiations concurrently evaluating this program with SDWMP
West Delta water management plan	No change	No change	No change	Protection against salinity intrusion resulting from flooding	Improvement in up to 10,000 acres of diverse wildlife habitat including wetlands	Improve Delta water supply reliability
Coordinated Operation Agreement and Section 10	Potential for increases	Potential for increases	Potential for decreases	Reduced protection without Delta improvements	Increased screening losses	COA requires Delta protection. Mitigation alternatives possible
H. O. Banks Delta Pumping Plant additional units	No change	Slight increase	Slight decrease	Slightly improved due to shifting to winter months	Slight increase in screening losses	Estimated yield increase of 60,000 AF. No further increases without Corps permit.
H.O. Banks Delta Pumping Plant Fish Agreement and Article VII					Significant corrective potential	Article VII negotiations continue

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Table 2 (Continued)
Potential Future Cumulative Effects of South Delta Water Management Facilities and Potential Related Projects or Actions on Delta

Project or Action	Delta Inflow Changes	Delta Export Changes	Delta Outflow Changes	Delta Water Quality Changes	Potential Fish and Wildlife	Comments
SB 34 Delta Flood Protection Act	No change	No change	No change	Protection against salinity intrusion from flooding	Act requires the planning for and enhancement of fish and wildlife	Improvement in Delta levees and resulting better reliability of the Delta
Delta wetlands project	No significant change	Potential for some increase	Winter months decreased	Minor winter month changes	Provides operation flexibility	Project planning being conducted by private corporation
Offstream storage south of the Delta	No change	Wetter year increases; minimum change in drier years	Wetter year reductions	Minor changes in winter months	Provides operational flexibility to reduce incremental screening losses	Los Banos and Kern included in Chapter 5 impact analysis
North of Delta additional storage development	Winter and spring reductions; summer and fall increases	Drier year increases	Winter and spring reductions and potential summer and fall increases	Improved drier year protections	Increase in flows and instream benefits/screening losses increased	Current planning on Auburn Dam and Red Bank Project
Central Coastal studies	No change	No change	No change	No change	No change	Slight increase in project deficiencies
Potential Conjunctive use programs upstream of Delta	Drier year increases	Drier year increases	Drier year increases	Improved quality in south Delta in drier years	Increased screening losses improve fishery flows in Stanislaus and San Joaquin rivers in drier years	Active planning for New Melones Reservoir; can provide significant south Delta benefits
Potential water conservation alternatives	No change	Potential reduction	Potential increase	Increased protection	Minimizes screening losses	Additional 200 TAF assumed in place by 2010
Water Transfers north of Delta	Drier year increases	Drier year increase	Drier year increases	Improvement	Screening losses increased	
Water transfers south of Delta	No change	Potential decrease	Potential increase	Improvement	Improvement	Reduced impact on Delta

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Table 2 (Continued)
Potential Future Cumulative Effects of South Delta Water Management Facilities and Potential Related Projects or Actions on Delta

Project or Action	Delta Inflow Changes	Delta Export Changes	Delta Outflow Changes	Delta Water Quality Changes	Potential Fish and Wildlife	Comments
Desalination	No change	Potential reduction	Potential increase	Increase protection	Minimizes screening losses	South of the Delta only.
Upstream watershed vegetation management	Winter and spring increases	Drier year increases	Drier year increases	Improved drier year protection	Increase in river flows and instream benefits/screening losses increased	Studies are continuing
Upstream weather modification	Winter and spring increases	Drier year increases	Drier year increases	Improved drier year protection	Increase in river flows and instream benefits/screening losses increased	Pilot program conducted in 1988
Reclamation water contracting programs	Potential for increases	Potential for increases	Potential for decreases	Reduced protection without Delta improvements	Increased screening losses	The environmental effects are similar to those discussed in the COA.
Reduced Colorado River supplies	Potential for increase	Potential for increase	Potential for decrease	Reduces protection without Delta improvements	Increased screening losses	Potential reduction could be 775 TAF
Reduced eastern Sierra supplies	Potential for increase	Potential for increase	Potential for decrease	Reduces protection without Delta improvements	Increased screening losses	Potential reduction 60,000 TAF.
Local upstream increased use	Reduction	No change	Reduction	D-1485	Some reduction in instream benefits	Protected by area of origin and water rights
Upper Sacramento River fisheries and riparian habitat management program	No change	No change	No change	Potential improvement	Improved: temperature, fish rearing, screening, fish ladders, spawning gravels	Federal legislation pending State legislation enacted
Mitigation Banking	No change	No change	No change	No change	Significant improvement in most cases	As now defined, applies to wetlands only
San Joaquin Valley agricultural drainage program	No change	No change	No change	Improved drainage water quality	Will revive and protect wetlands	Drainage management strategies being studied

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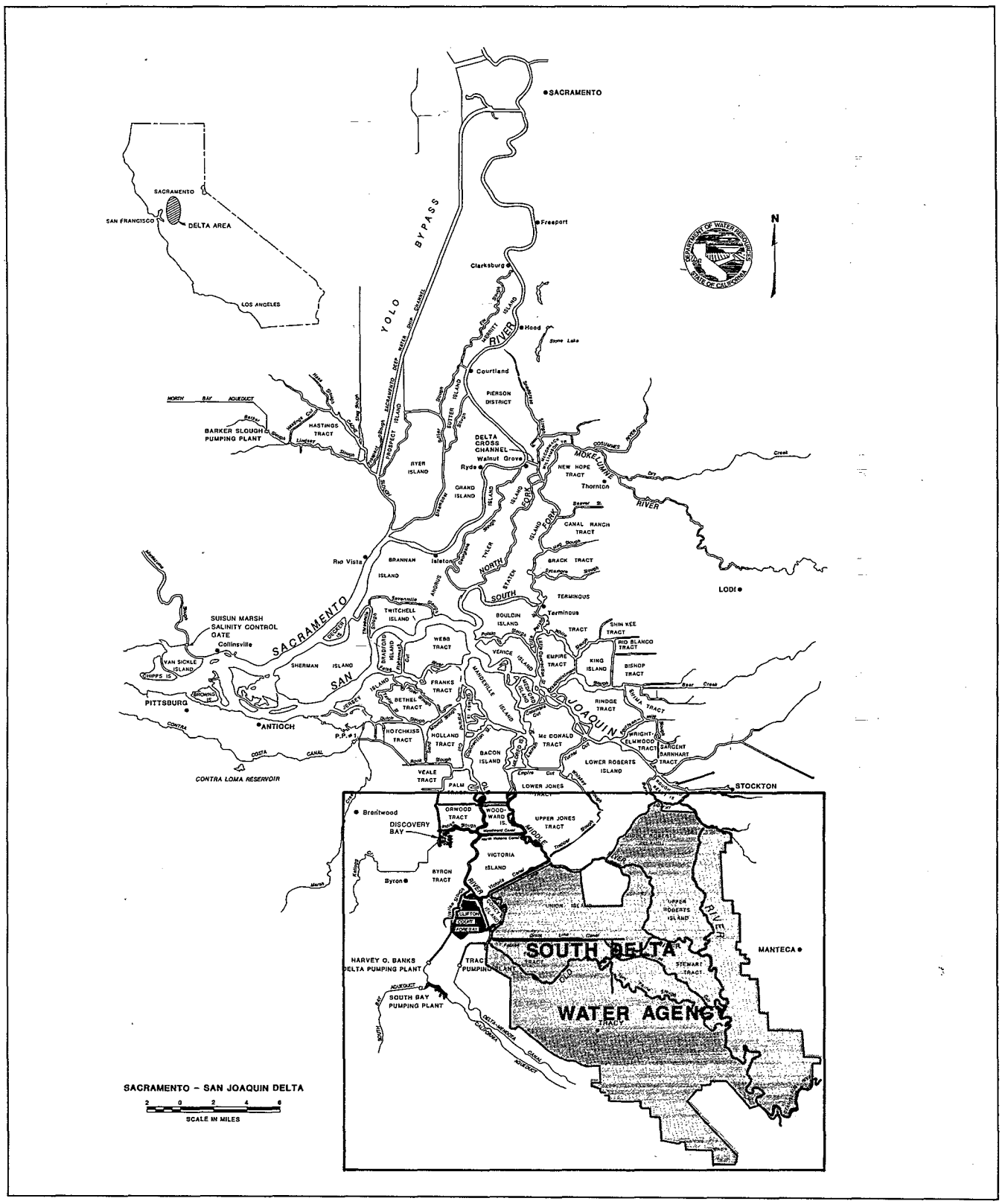

Figure 1–1. South Delta Water Management Study Area

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CHAPTER 1. INTRODUCTION

The California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation) propose to implement the South Delta Water Management Program (SDWMP). This program has multiple objectives: to help solve the problems of water levels, water circulation, water quality, project water supply reliability, and fishery impacts. The action is in response to:

1) an October 1986 framework agreement among DWR, Reclamation, and the South Delta Water Agency (SDWA) that committed all three parties to work together to develop mutually acceptable, long-term solutions to the water supply problems of water users within SDWA;

2) 1984 legislation that authorized Los Banos Grandes Offstream Reservoir south of the Sacramento-San Joaquin Delta, which would store winter flows; and

3) statewide projections showing future increased water needs.

South Delta Background

The south Delta study area generally comprises the lands and channels of the Sacramento-San Joaquin Delta southwest of Stockton (Figure 1-1). Included in this study area is the South Delta Water Agency, as defined in the Formation Act, California Statutes of 1973. In addition, important features of the State Water Project (SWP) and Central Valley Project (CVP) are located in the study area. This area is faced with complex water rights, water supply, water quality, and environmental issues.

The area within the SDWA boundaries includes about 150,000 acres, of which about 120,000 are used for irrigated agriculture. The remaining area consists of waterways, berms, channel islands, levees, and lands devoted to homes and industries. About 450,000 acre-feet (AF) of water is diverted from the 75 miles of south Delta channels each year to irrigate the fully developed and highly productive agricultural land.

Major channels and waterways in the south Delta study area include: San Joaquin River, Old River, Middle River, Woodward and North Victoria canals, Victoria and North canals, Grant Line Canal, Italian Slough, Indian Slough, Tom Paine Slough, and the adjoining SWP and CVP export facilities. SWP export facilities operated by DWR (Figure 1-2) consist of Clifton Court Forebay, John E. Skinner Delta Fish Protective Facility, the intake channel, Harvey O. Banks Delta Pumping Plant, and Governor Edmund G. Brown California Aqueduct. CVP export facilities, operated by Reclamation, consist of the Delta Mendota Canal, Tracy Fish Collecting Facility, and the Tracy Pumping Plant.

Some concerns in the south Delta are the water levels, quality, and circulation at certain times and locations. These concerns can be attributed, in varying degrees, to one or more of six basic causes:

- natural tidal fluctuation
- degraded San Joaquin River inflow
- local agricultural diversions and returns
- inadequate channel capacities
- State Water Project operations
- Central Valley Project operations

These factors affect water levels and water availability at some local diversion points. Local agricultural drainage returns, aggravated by poor water circulation, have affected channel water quality, particularly in shallow, stagnant, or dead-end channels. Channels that are too shallow and narrow also restrict flow and the volume of water available for export pumping. Chapters 2, 3, and 4 describe the hydrology and environment of the south Delta in more detail.

SDWA is a public agency formed for the purposes of entering into contracts with the United States and the State of California to protect the water supply of lands within the agency from salinity intrusion and to assure a dependable supply of water to meet needs of lands within the SDWA. In July 1982, SDWA filed a lawsuit over the effects of SWP and CVP operations on the south Delta. The suit sought a declaration of the rights of the parties, a preliminary injunction, and a permanent injunction requiring that the projects be operated to protect the south

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Delta. The complaint by SDWA alleged that:

- CVP operations on the San Joaquin River, primarily Friant Dam, unlawfully reduce the quantity and degrade the quality of water flowing in the San Joaquin River to the south Delta.

- Operations of SWP and CVP pumps violate south Delta rights by lowering water levels, reversing flows, and diminishing the influence of the tides.

- The Secretary of the Interior's designation of the Stanislaus River basin for allocation of water from New Melones Reservoir violates south Delta rights by not including the south Delta in the basin.

Direct involvement of DWR in the suit is due to the effect of its pumps on the south Delta. The other issues involve only Reclamation.

In the past several years, SDWA has at times reported low water levels in Tom Paine Slough and Middle River. As a result of the complaints, DWR installed stage recorders, profiled the bottom of Tom Paine Slough, dredged the shallow spots and modified Clifton Court gate operations to help alleviate the impact of SWP diversions on water levels. During a period of hot weather in July 1985, when the farmers claimed they were losing crops due to insufficient water supply, DWR installed three pumps to provide additional water into Tom Paine Slough.

Subsequently, DWR and Reclamation have taken further interim actions to improve SDWA water conditions with

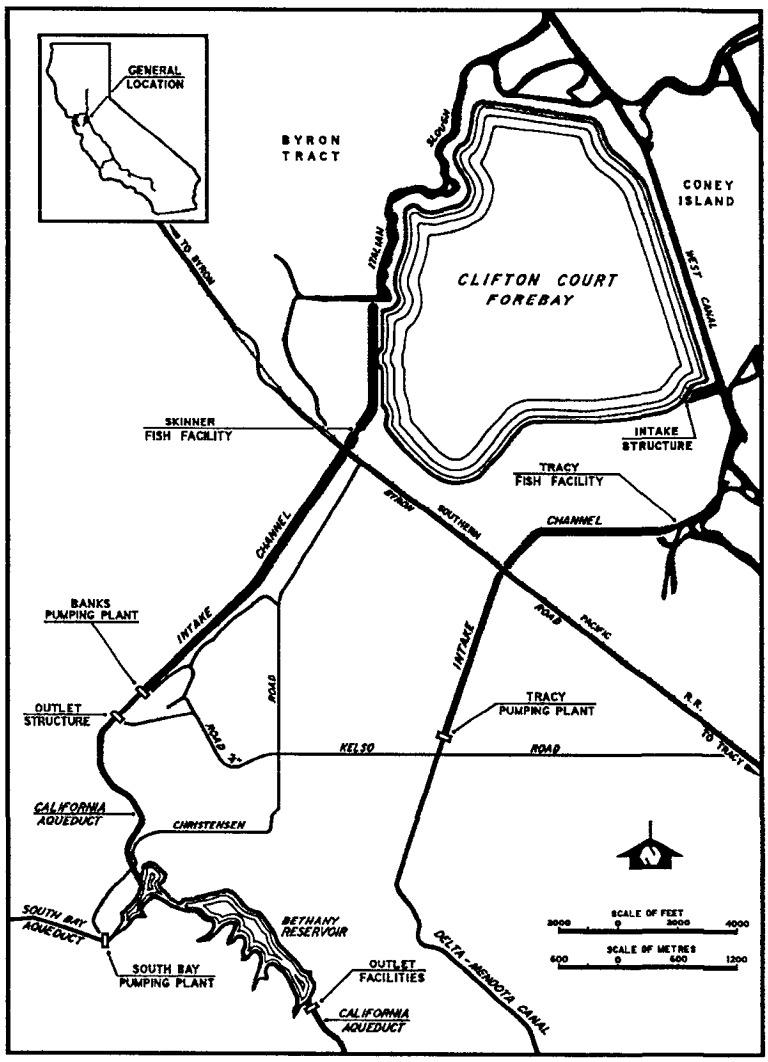

Figure 1–2. Location Map

Clifton Court Forebay, a key feature of the State Water Project, is located about 10 miles northwest of Tracy. The current surface area of the forebay is 2,180 acres; storage capacity is 31,260 acre–feet. The proposed South Delta Water Management Program would enlarge the forebay to at least 5,000 surface acres, with a storage capacity of about 75,000 acre–feet.

Together with the Skinner Fish Facility and a connecting intake channel, Harvey O. Banks Delta Pumping Plant diverts water from the south Delta through Clifton Court Forebay for conveyance via the California Aqueduct and South Bay Aqueduct to contracting agencies in the south San Francisco Bay area, the San Joaquin Valley, and Southern California.

The purpose of the forebay is to allow flexibility for pumping at the Banks Pumping Plant. Any of the South Delta Water Management Plans would enhance operational flexibility.

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positive results. DWR has modified operations at Clifton Court Forebay, constructed siphons and extensively dredged in Tom Paine Slough, and constructed a weir in Middle River to mitigate the water level problems. Immediately after the weir became operational, local farmers reported that water levels were improved

Reclamation has conducted pumping experiments at the Tracy Pumping Plant during low-low tides to examine the impacts of the CVP on the south Delta. No conclusive impacts were determined. Reclamation is also providing interim releases from New Melones Reservoir to improve water quality and quantity in the area.

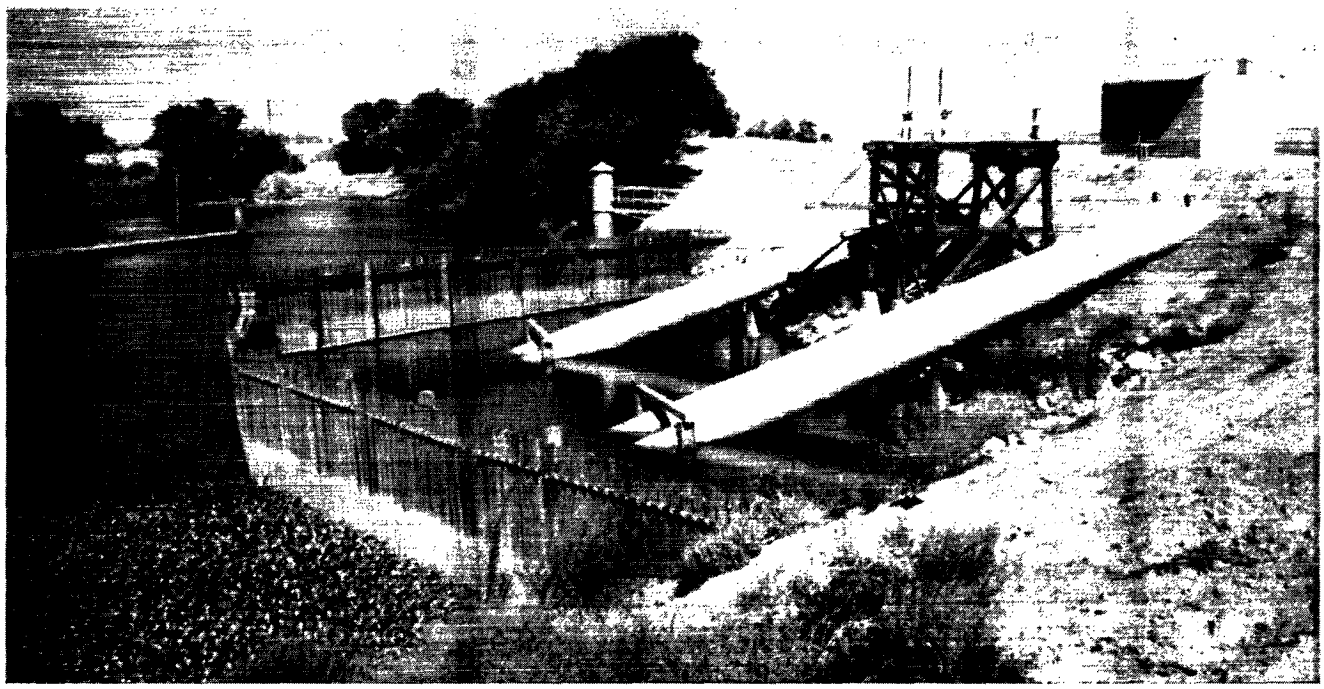
In October 1986, DWR, Reclamation, and SDWA entered into an agreement on a framework for settling the litigation brought by SDWA against DWR and Reclamation. All three parties agreed to work together to develop mutually acceptable, long-term solutions to the water supply problems of water users within SDWA. More details of agreements involving DWR and SDWA can be found in the next section. Table 1-1 is a chronology of events involving SDWA, DWR, and Reclamation.

South Delta Water Management actions will also involve an application to the U.S. Army Corps of Engineers (Corps) for a permit to increase SWP exports from 6,400 cfs to 10,300 cfs. Increased diversions would allow for winter banking in offstream storage south of the Delta. In 1984 the California State Legislature approved authorization of the Los Banos Grandes Offstream Storage Reservoir as a future SWP facility (AB 3792, Chapter 1656, 1984). Full benefits of Los Banos Grandes will only be realized with increased channel capacity in the south Delta and full operation of the Banks Pumping Plant. These and other projects, facilities, and programs for augmenting supplies will be needed to improve the water supply reliability of the SWP.

The present dependable supply for the State Water Project is about 2.3 million acre-feet (MAF). Projected requirements in 2010 are about 3.6 MAF, assuming 250,000 AF of water conserved in the Colorado River region becomes available for use in the South Coast region, and waste water reuse increases by 200,000 AF in SWP service areas. Under those assumptions, the existing SWP facilities would have a deficit in present dependable supplies in 2010 of some 1.3 MAF.

Planning Perspective

The development and use of water in California involves a system of State and federal laws. Many of these laws are very specific to the Sacramento-San Joaquin Delta and include protective measures. This system is not fixed, but



Tom Paine Siphon

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evolves year by year as new issues are raised that require changes and interpretations.

The current environmental regulatory process provides a useful forum for discussions which can lead to projects that benefit all users, including instream uses. The process encourages step-by-step negotiations. DWR has been successful in using this approach to identify concerns, interests, and alternative solutions and to move forward with projects to protect the Delta and meet future water needs of California.

The environmental documentation process provides the information necessary for federal and State regulatory permits and agreements. Federal regulatory permits are required to authorize implementation of any action or selected alternative regarding navigable streams and wetlands. This requirement assures involvement in and review of the planning process by key federal agencies such as the Corps, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, and the Environmental Protection Agency.

CEQA/NEPA Process

The SDWMP will comply with and utilize the guidelines established in the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) as part of the planning process.

The California Environmental Quality Act, Public Resources Code Section 21000 et seq., establishes a strong public policy for preservation and enhancement of the State's environment. It also provides that environmental factors should be considered in planning and feasibility studies. Any facility to be constructed by or under the authority of the State requires an environmental impact report if the facility may have a significant effect on the environment.

The National Environmental Policy Act, 42 U.S.C. Section 4321 et seq., contains a strong federal commitment to preserve and enhance the human environment. It provides for preparation of an environmental impact statement for facilities constructed by the federal government or its licensees or for facilities funded by the federal government or subject to federal government approval where the project would be a major action with significant impacts on the environment.

The environmental documentation process is used to gather information on impacts, alternatives, and mitigation. Information needed for federal, State, and local permits is also being incorporated into this process. Permits are discussed in more detail in the regulatory permits section. See Chapter 7 for a discussion of environmental documentation and public involvement.

Related Delta Protective Measures

The history of water resources planning in California shows many efforts, in addition to CEQA and NEPA, to organize and implement programs that include Delta protection. A number of these protective measures are discussed below:

- Delta Protection Act
- Area of Origin Protection
- South Delta Agreements
- Delta Water Contracts
- Federal Fish Agreements for Tracy
- Banks Pumping Plant Fish Agreement
- Suisun Marsh Protection Plan
- Porter-Cologne Water Quality Control Act
- Water Rights Protective Standards
- Coordinated Operation Agreement
- Delta Flood Protection Act
- Regulatory permits

Delta Protection Act. The Delta Protection Act, enacted in 1959, recognizes both the needs of the Delta and the needs for exportation of water from the Delta to other parts of the State. However, the first priority is the satisfaction of the reasonable needs for water in the Delta. The Delta needs protected by this Act include consumptive uses—such as agricultural, municipal, and industrial use—and in-place requirements such as those for fish, wildlife, recreation, and other environmental values.

Area of Origin Protection. The Area of Origin provisions of the Water Code set forth restrictions and limitations to protect the water requirements of the county of origin or the watershed in which water originates. Since the

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Table 1-1
Chronology of Events
Involving SDWA, DWR, and Reclamation

October 1973	SDWA created by act of Legislature.
January 1974	DWR and SDWA negotiations began.
July 9, 1982	SDWA filed suit against U.S. Department of Interior (Reclamation) and the State (DWR).
May 1984	DWR installed three stage recorders in response to SDWA's complaints of low water in Tom Paine Slough.
March 1985	DWR dredged Tom Paine Slough and modified Clifton Court Forebay gate operations to help relieve the impacts of SWP diversions on water levels.
July 1985	SDWA claimed farmers were losing crops due to hot weather and insufficient water supply. DWR took emergency action to alleviate the problem in Tom Paine Slough.
September 1985	DWR and SDWA signed a letter of intent on actions to improve water levels in the south Delta.
November 1985	Workplan issued for an interim program for mitigation of south Delta water level problems.
April 3, 1986	Corps issued Permit No. 9201 to dredge Tom Paine Slough.
April 17, 1986	DFG Streambed Alteration Agreement for Tom Paine Slough dredging.
May 6, 1986	Corps issued Permit No. 9204 to install siphons in Tom Paine Slough.
June 1986	DWR-SDWA Joint Powers Agreement regarding mitigation for the south Delta signed and approved.
June 1986	Joint Powers Agreement for Tom Paine Slough between DWR, SDWA, and Pescadero Reclamation District signed and approved.
October 1986	Framework agreement for settling SDWA litigation signed by Reclamation, DWR, and SDWA.
October 28, 1986	Dredging of Tom Paine Slough completed.
November 4, 1986	Corps issued Permit No. 9205 to construct Middle River Weir.
January 1987	South Delta agricultural water supply project 3-agency workplan published.
February 6, 1987	DFG Streambed Alteration Agreement for new Middle River Weir.
May 15, 1987	Seasonal Middle River Weir installed. (Weir removed in September 1987.)
December 17, 1987	Reclamation and DWR agree to investigate interim facilities to mitigate for impacts on Old River due to CVP and SWP pumps.
January 1988	Established Technical Advisory Committee to provide South Delta water management negotiators with technical evaluations and recommendations for improved water management.
May 1988	Seasonal Middle River Weir installed in accordance with interim agreement. (Weir removed in September 1988).
April 12, 1989	Seasonal Middle River Weir installed. (Weir removed in September 1989).
July 1989	Tom Paine Slough siphons completed.
October 1989	Negotiations continued with Reclamation, DWR, and SDWA.

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Interim Middle River Weir Near State Highway 4 (Looking North)

Burns–Porter Act declares the Delta to be part of the Sacramento River watershed, the Delta falls under area of origin protection. This protection grants the entities in areas of origin the right to construct projects or make diversions without being subject to the prior rights acquired under State applications for the SWP. It also grants the Delta, and all other areas of origin, certain preferential rights to contract for project water within the general framework established in the State water supply contracts.

South Delta Agreements. The effects of SWP and CVP operations have been studied as part of the discussions and negotiations between the SDWA, Reclamation, and DWR. The three agencies have been working together to develop long–term solutions to the water supply concerns of water users in the southern Delta.

To date, various agreements have been negotiated in connection with south Delta planning activities. Further negotiations are under way on a permanent agreement. The following describes the agreements, their relationship to one another, and the goals of each.

The "Agreement on Framework for Settling Litigation Brought by the South Delta Water Agency Against the United States and the California Department of Water Resources" (October 1986) established a process for DWR, Reclamation, and SDWA to resolve the litigation filed by SDWA on July 9, 1982. The agreement includes:

- a plan to determine and to implement long–term solutions to the water supply problems in the south Delta region.
- interim actions to be implemented while the long–term solutions are being developed. Reclamation is to provide water releases from New Melones Reservoir; DWR, Reclamation, and SDWA are to develop a method of forecasting low tide conditions; and Reclamation is to consider modifying export operations when necessary.

Interim actions to be carried out by DWR are delineated in the "Joint Powers Agreement Regarding Mitigation for the South Delta" (June 1986) between DWR and SDWA. The four interim measures are: 1) dredging Tom Paine Slough (1986); 2) installing Middle River Weir (1987); 3) constructing siphons in Tom Paine Slough (1989); and 4) restricting operations at Clifton Court Forebay. (These restrictions were relaxed when the first three measures were completed).

The "Joint Powers Agreement for Tom Paine Slough" between DWR, SDWA, and Pescadero Reclamation District #2058 established details of the process for dredging Tom Paine Slough and constructing the siphons.

Delta Water Contracts. Under State law, water users in the Delta are entitled to contract with the SWP for water or water quality protection. Under a SWP contract, water entities can receive water quality benefits beyond what they would receive by virtue of the Delta standards alone. DWR has negotiated long–term agreements with the North Delta Water Agency and the East Contra Costa Irrigation District to protect agricultural uses. DWR also has contracts with western Delta municipal and industrial water users. Negotiations with Central Delta Water Agency and South Delta Water Agency (see **South Delta Agreements**) are now proceeding. SWP contracts in the Delta are discussed below:

- *North Delta Water Agency.* DWR and the North Delta Water Agency signed a contract in 1981 to protect water supply and water quality in the agency's service area, including Sherman Island. Their agreement provided for a future overland water supply facility for the island in lieu of offshore water quality. This long–proposed facility and possible alternatives are presently under study. A possible alternative, which would convert the land to wildlife habitat is discussed in the planning report, *West Delta Water Management Program*, July 1988.

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- *Western Delta Municipal Water Users.* Two contracts are in effect for replacement of municipal water supplies in the Antioch–Pittsburg area. One is with the Contra Costa Water District (CCWD) for a municipal water diversion at Mallard Slough near Pittsburg; the second covers use by the City of Antioch. Each contract provides that DWR compensate each entity for its additional costs of purchasing a substitute water supply from the Contra Costa Canal to replace offshore supplies lost because of SWP operation.

- *Western Delta Industrial Water Users.* One contract is in effect with Fibreboard Corporation, a paper manufacturer at Antioch. DWR pays its share of the increased costs to purchase water from the Contra Costa Canal when the water quality of Fibreboard's San Joaquin River supply deteriorates below its industrial requirements. Negotiations are continuing on a similar contract with Gaylord Container Corporation for water used by its paper mill at Antioch. Gaylord has recently purchased the Fibreboard mill.

Federal Fish Agreement For Tracy. The Bureau of Reclamation has an agreement with DWR and the Department of Fish and Game (DFG) for the biological monitoring and overseeing of the operations of the Tracy Fish Collecting Facility (along with the State's John E. Skinner Fish Protective Facility). Through the agreement, Reclamation funds a biologist to collect data and monitor the operations to improve the screening and salvaging of fish. Currently, Reclamation and DFG are negotiating on improving the CVP fish screens and on compensating for fish losses.

Banks Pumping Plant Fish Agreement. The "Agreement between the Department of Water Resources and the Department of Fish and Game to Offset Direct Fish Losses in Relation to the Harvey O. Banks Delta Pumping Plant" was signed in December 1986. Direct losses are defined as losses of fish that occur from the time fish are drawn into Clifton Court Forebay until the surviving fish are returned to the Delta. These losses occur in spite of fish screens at the pumping plant.

The agreement sets up a procedure to calculate annually direct losses of striped bass, chinook salmon, and steelhead, and requires DWR to pay for mitigation projects that would compensate for or offset the losses. Losses of other species of fish will be mitigated as impacts are identified and appropriate mitigation measures are found. DWR also provided $15 million to initiate a program that will yield "quickly demonstrated results" for the fishery resources. The monies in this fund are in addition to the compensation for annual losses as outlined in the agreement.

Fish populations in the Delta are influenced greatly by a number of complex interactions, none of which has been identified as the principal environmental factor. Delta inflow, water exports,introduction of new species, power plants, consumptive uses, upstream and local diversions, tidal action, levee failures, pollution, agricultural return flows, and recreational and commercial activities are all recognized factors that to varying degrees affect the fish resources of the Delta.

Both departments, however, recognize that the overall fishery resources dependent upon the Delta have been adversely affected by the SWP, CVP, and other water resource development projects.

Article VII Negotiations. These negotiations are being conducted under the existing agreement between DWR and DFG to offset direct fish losses in relation to the Banks Delta Pumping Plant. Article VII of the agreement requires the parties to "...begin discussions on developing ways to offset the adverse fishery impacts in the SWP which are not covered in that agreement, including facilities needed to offset fishery impacts and provide more efficient conveyance of water." DWR and DFG wish to fulfill their obligations under Article VII of the agreement by committing to negotiations for entering into a Framework Agreement and subsequent agreement. This Framework Agreement will be designed to establish a procedural framework for commitment and execution of an agreement, or series of agreements, designed to identify, evaluate, and implement the measures necessary to improve fishery and wildlife resources in the estuary.

Reclamation has also determined that it is in its best interest to participate with DWR and DFG in the negotiations and be a signatory to the Article VII framework. After the framework agreement is finalized, the parties will evaluate the SDWMP and its potential impacts and will define special measures to mitigate and improve fishery conditions in the estuary. An agreement, or series of agreements, will be negotiated committing the parties to implementation of mitigation measures. It is expected that an agreement will be implemented prior to a final EIR/EIS. If not, DWR and Reclamation will develop a mitigation plan based on the issues discussed in this report and the comments received during the review period.

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Harvey O. Banks Delta Pumping Plant and Intake Channel with Fish Facilities and Forebay in Background

In addition to DWR, Reclamation and DFG, and other representatives from the environmental, water, and fishery communities are involved in the Article VII negotiations in an advisory capacity.

Suisun Marsh Protection Plan. The objective of this program is to develop and implement a plan to mitigate the adverse effects of the SWP, the CVP, and other upstream diversions on Suisun Marsh water quality. This program directly relates to Water Rights Decision 1485 issued by the State Water Resources Control Board (SWRCB) in August 1978.

The Suisun Marsh plan of protection was developed by DWR, Reclamation, DFG, and Suisun Resources Conservation District. First-stage implementation was accomplished with construction of the initial facilities in 1980. Following completion of these facilities, the four agencies worked toward an agreement that would moderate the adverse effects of all upstream diversions on the water quality in the marsh.

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The Four-Agency Suisun Marsh Preservation Agreement, as well as two auxiliary agreements, were signed in March 1987. Implementation of the plan is continuing.

The key facility of the plan, the Salinity Control Gates, was installed in 1988.

Porter-Cologne Water Quality Control Act. The Porter-Cologne Act gave State government the authority and organizational structure to regulate the quality of surface and ground water. The Act states that "...the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable...."

Enacted in 1969, the Porter-Cologne Act allows for each regional water quality control board to formulate and adopt water quality control plans for all areas within the region. Plans are adopted by the appropriate regional board to meet requirements of the Porter-Cologne Water Quality Control Act, are submitted to the SWRCB for approval, and are finally submitted to the Environmental Protection Agency for federal approval. Such plans become effective upon approval by SWRCB. Through this review and approval procedure, the plan becomes the official federal and State water quality control plan.

The federal Clean Water Bond Act was approved in 1970. This act provided funds to develop a water quality control plan, or Basin Plan, for each of the 16 planning basins in the state. The Basin Plans are prepared in accordance with the requirements of California's Porter-Cologne Water Quality Control Act and federal water pollution control laws and regulations.

Water Rights Protective Standards. In 1967 the water quality control and water right functions of the State were merged so that necessary interrelationships between water quality and availability of unappropriated water could be considered together by a single State agency.

The water quality control plans and the water right decisions adopted by the SWRCB for the Delta represent a unified effort by SWRCB to develop under its full authority water quality objectives and standards to protect beneficial uses of Delta water supplies, recognizing the respective rights of all users to such supplies.

SWRCB has issued water right permits to DWR and Reclamation to allow those agencies to withdraw water from the Delta and export it to areas of need. In issuing the permit, the Board must reconcile, according to the California Water Code, the withdrawal of water and the prevention of unreasonable use, unreasonable method of use, or unreasonable method of diversion of water.

Realizing the intricate interaction of factors such as Delta inflow, agricultural diversions, export diversions, and the environment, SWRCB has reserved continuing jurisdiction by issuing the permits with the right of subsequent amendment of permit conditions. Consequently, beginning in 1967, hearings have been called to periodically review and adjust permit conditions to reflect updated knowledge of the Bay-Delta area. The most recent review in this series is the ongoing San Francisco Bay/Sacramento-San Joaquin Delta Estuary hearing (Bay/Delta Hearing), which convened in July 1987.

The purpose of the Bay/Delta Hearing is to review, broaden, and refine the 1978 Water Quality Control Plan and Water Rights Decision 1485 so that reasonable levels of protection for beneficial uses, as affected by flow and water quality, are provided. Beneficial uses have historically been classified under three categories: (1) fish and wildlife, (2) agricultural, and (3) municipal and industrial. SWRCB addresses the protection of beneficial uses by setting water quality objectives and standards for each of the categories at various points in the estuary. SWP facilities must operate under the constraints of the standards set in its water rights permits.

Coordinated Operation Agreement. The CVP and the SWP simultaneously use the same channels of the Sacramento River and the Delta to convey water, drawing upon a common water supply in the Delta. The purpose of a coordinated operation agreement (COA) is to assure that each project obtains its share of water from the Delta and bears its share of obligations to protect other beneficial uses of water in the Delta and the Sacramento Valley. Coordinated operation by agreed-upon criteria can increase the efficiency of both projects.

On May 20, 1985, both agencies agreed to a COA designed to increase the efficient use of existing water supplies by defining a sharing process for the SWP and the CVP to meet in-basin use and exports. The sharing formula provides for CVP/SWP proportionate splits of 75/25 responsibility for meeting in-basin use from stored water releases and 55/45 for capture and export of excess flow.

The agreement also requires both DWR and Reclamation to meet a set of protective criteria for flow standards, water quality standards, and export restrictions taken from SWRCB Water Rights Decision 1485. The projects are not to be operated to meet predetermined yields, but

Table 1–2
Potential Permits

Agency	Permit Description	Permit Conditions
Corps of Engineers (in coordination with U.S. Fish and Wildlife Service and Environmental Protection Agency)	Dredging Permit (Section 404, Clean Water Act) Navigation Permit (Section10, Rivers and Harbors Act	Required for any proposal to locate a structure, excavate, or discharge dredged or fill material into waters of the United States or to transport dredged material for the purpose of dumping it into ocean waters. Required for any proposal to divert or alter navigable waters in the United States, including wetlands.
Department of Fish and Game	Navigation Dredging Permit	Required for any proposal to use suction or vacuum dredging equipment in any river, stream, or lake designated as open.
	Stream or Lakebed Alteration Agreement	Required for any activity that will change the natural state of any river, stream, or lake in California.
Caltrans	Encroachment Permit	Required for any proposal to do work or place an encroachment on or near a State highway or proposal to develop and maintain access to or from any State highway.
	Utility Encroachment Permit	Required for work done by public utility companies providing services, such as gas, electricity, telephone, for most work within the right of way of a State highway.
The Reclamation Board	Encroachment Permit	Required for any activity along or near the banks of the Sacramento and San Joaquin rivers or their tributaries. The Reclamation Board also issues encroachment permits for activity on any "designated floodway" or flood control plan adopted by the Legislature or the Board within the Central Valley.
Air Pollution Control District	Authority to Construct	Required for any proposal to construct, modify, or operate a facility or equipment that may emit pollutants from a stationary source into the atmosphere.
	Permit to Operate	Required for any proposal to operate equipment that emits pollutants into the atmosphere. A Permit to Operate must be obtained from the Air Pollution Control District (APCD) for the area in which the equipment is located. The project sponsor may apply for the permit only after obtaining an Authority to Construct from the APCD and completing the construction or modification according to the terms of the Authority to Construct.
State Water Resources Control Board, Division of Water Rights	Permit to Appropriate Water	Required for proposal to divert water from a surface stream or other body of water for use on nonriparian land or any proposal to store unappropriated surface water seasonally.
Department of Water Resources, Division of Safety of Dams	Approval of Plans and Specifications and Certificate of Approval	Required for any proposal to constrict or enlarge a dam or reservoir.

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rather to first meet the needs in the areas of origin, including the protective criteria. Only then is water exported from the Delta. The new protective criteria at 15 additional stations add to Reclamation's water quality requirements known as Tracy standards. During normal water-supply conditions, the agreement requires about 5 MAF of Delta outflow to meet the environmental and water quality protective needs of the Delta.

In addition, the agreement addresses each party's use of the other's facilities for exchanges, conveyance, and purchases of water. Section 10 (h) of the agreement provides that DWR and Reclamation promptly negotiate a contract for 1) the SWP to wheel water for the CVP on the basis of equal priority of SWP long-term contractors, and 2) for Reclamation to sell interim CVP water to the State with a priority similar to that of long-term CVP contractors. To satisfy the protective requirements of Decision 1485, the agreement provides for conveyance (wheeling) of CVP water through the California Aqueduct to the San Luis Reservoir to make up for CVP losses from curtailment of pumping during the striped bass spawning period. The agreement also adds protection for the CVP by assuring wheeling priority during periods of CVP and SWP scheduled and unscheduled maintenance.

Delta Flood Protection Act. This Act of 1988 creates the Delta Flood Protection Fund, which establishes Legislative intent to make $12 million a year available for 10 years for flood protection in the Delta. The act makes available $6 million annually for local assistance under the Delta Levee Maintenance Subventions Program. The remaining $6 million is for special flood control projects for eight western Delta islands and the towns of Walnut Grove and Thornton.

The Delta Flood Protection Act also requires investigation of other flood control measures, such as provisions to acquire easements up to 400 feet wide along levees to minimize tillage and to modify land management practices. DWR is directed to seek appropriate cost-sharing for flood control plans. Provisions for protection of fish and wildlife habitat, as determined by the DFG, are to be included in these plans. The Delta Master Recreation Plan also needs to be considered in this planning effort.

Regulatory Permits. The United States Congress enacted the Clean Water Act to ". . . Restore and Maintain the Chemical, Physical, and Biological Integrity of the Nation's Waters. Section 404 of the Clean Water Act regulates the discharge of dredged and fill material into waters of the United States, and establishes a permit program to ensure that such discharge complies with environmental requirements. The Section 404 program is administered at the federal level by the Corps and the U.S. Environmental Protection Agency (EPA). Activities regulated by Section 404 include port development; channel construction and maintenance; and water resources projects such as dams and levees.

Current hydraulic conditions in the Delta channels limit monthly maximum SWP exports. Export level is also limited by Corps' constraints, which are set forth in Corps Public Notice 5820A, Amended, issued October 1, 1981. Each SDWMP alternative consists of channel enlargement, Forebay modification, including construction of a new intake to Clifton Court Forebay, and obtaining a Corps permit to allow the pumping capacity of the Banks Pumping Plant to be increased up to 10,300 cfs. An application will be filed to obtain proper permits from the Corps after the EIR/EIS is circulated for public review.

Section 401 of the Clean Water Act requires any project with potential impact on water quality to obtain a certificate that it will not violate State water quality standards. DWR is planning to file documentation with the SWRCB to obtain 401 certification for the SDWMP.

In addition, numerous other State and local regulations also apply. Table 1-2 lists permits that will be considered during the planning process and specifies conditions and permitting agencies. Some will apply to this program and others will not. Permitting agencies will participate in developing environmental documentation to comply with CEQA and NEPA.

Several federal laws apply to most permits issued by agencies of the United States, including the Corps. Some that have not been discussed include the Endangered Species Act and the Fish and Wildlife Coordination Act. These laws also play an important part in the development and operation of water projects.

The Endangered Species Acts (federal and State) are designed to conserve ecosystems essential to endangered and threatened species and promote conservation of such species. The acts include animals, fish, insects (other than pests), and plants. An endangered species is one in danger of extinction in all or a significant portion of its range; a threatened species is one likely to become endangered. The acts protect endangered species through three major mechanisms: (1) listing of endangered or threatened species, (2) agency consultation and protection responsibili-

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ties, and (3) a prohibition of takings of endangered species. One of the major strategies of the acts is to preserve habitat that is critical to the survival of an endangered or threatened species. Any water project that requires a permit from the Corps would trigger the requirements of the Endangered Species Acts, if it were found to endanger a listed species or its critical habitat.

The Fish and Wildlife Coordination Act and related acts express the will of Congress to protect the quality of the aquatic environment as it affects the conservation, improvement, and enjoyment of fish and wildlife resources. Under this act, any federal agency that proposes to control or modify any body of water, or to issue a permit therefor, must first consult with the U. S. Fish and Wildlife Service, the National Marine Fisheries Service, and the California DFG. The Corps' informal practice is to refrain from acting on a permit until the applicant and the fish and wildlife agencies have attempted to identify appropriate mitigation measures.

Interagency Ecological Studies

In addition to the Delta protective measures discussed previously, an Interagency Ecological Study Program was created in 1970 to determine the effects of SWP and CVP operations on the Bay/Delta ecological system and to find a means of eliminating, reducing, or mitigating any adverse impacts.The program is being conducted by DFG, DWR, the U. S. Fish and Wildlife Service (USF&WS), Reclamation, the U. S. Geological Survey (USGS), and SWRCB. Ecological studies are an integral part of the mitigation needed for the estuary. In order to have an understanding of the best actions to be taken, continuous funding is provided. Under the terms of an Interagency Memorandum of Agreement executed on July 13, 1970, the agencies have agreed to jointly pursue activities that will provide the ecological studies necessary for a thorough understanding of the San Francisco Bay–Delta estuary. The program is divided into several parts:

Fish Studies. These studies provide information on the fisheries resources in the San Francisco Bay–Delta area. The primary focus of the studies have been striped bass and salmon. The current programs include:

- an annual egg and larvae survey to index numbers, growth, and survival of the striped bass spawn;
- a summer tow net program to index the number of striped bass in the Delta–Suisun Bay area when the average size is 1.5 inches;
- a mid–water trawl program to index the number of striped bass during the fall and winter of their first year;
- a mark–recapture program to develop estimates of the numbers of adult striped bass by sex and age; and
- a study of the numbers of striped bass egg and larvae entrained into Clifton Court Forebay.

Water Quality Studies. These studies consist of monitoring programs, mathematical modeling efforts, and special studies focusing on food relationships in the San Francisco Bay/Delta. Some current studies include:

- a routine sampling program for zooplankton and *Neomysis*; and
- the development and refinement of a mathematical model of phytoplankton dynamics in the Delta.

San Francisco Outflow Study. This is a study designed to characterize the aquatic biota and circulation patterns in San Francisco Bay. The data are being used in analyzing the impact of the timing, duration, and magnitude of fresh–water flows on San Francisco Bay. Activities include:

- a monthly tow net sampling program to sample the temporal and spatial distribution of various species in the Bay;
- a study to analyze the correlations between fresh water inflows and salinity at various locations in San Francisco Bay;
- field programs to collect velocity, salinity, temperature, water level, and wind data. These data will be used to calibrate and verify models of the hydrodynamics of San Francisco Bay; and
- a monitoring program designed to identify selenium sources and sinks in the San Francisco Bay–Delta.

Fish Facilities and Related Studies. These studies evaluate sources of fish losses at the Skinner Fish Protective Facility, Clifton Court Forebay, and other SWP facilities in the Delta. The data are used to develop measures to reduce losses. Current activities include:

- an evaluation of the Skinner Fish Facility operational criteria;
- evaluations of predation losses of striped bass and chinook salmon in Clifton Court Forebay; and
- work with DWR to develop new Delta fish protection facilities as needed, such as for the North Bay Aqueduct

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Other Studies

Studies other than those under the direction of the Interagency Ecological Study Program include:

D-1485 Water Quality Monitoring Program. DWR regularly conducts a compliance monitoring program to ensure that the protective standards in Water Rights Decision 1485 are met. DWR has collected data using this program since 1974. This has also provided important information for environmental assessment and understanding. The program has three components:

- Bay/Delta Compliance - A surface water quality monitoring program that includes the discrete sampling of a series of physical, biological, mineral, and chemical parameters. Approximately 30 stations are sampled once a month. If the Delta Outflow Index at Chipps Island is projected to fall below 10,000 cfs, the sampling rate is increased to a biweekly schedule. On the alternating week of the discrete program, a continuous monitoring run is made with a boat carrying flow-through water quality equipment. The data are recorded on a strip chart at the rate of one instantaneous reading per minute per parameter.

- Continuous Multiparameter Network - A surface water quality continuous monitoring program at six fixed sites in the Delta. Approximately 10 parameters are monitored at each site. Also, continuous monitoring of electrical conductivity is required at nine sites.

- Suisun Marsh Monitoring Plan - This program is designed to meet the monitoring requirements of D-1485 and Bay Conservation and Development Committee's Permit 35-78. The data generated by this program include continuous electrical conductivity, water stage data collected at seven channel stations, and soil salinity information from an electrical conductivity network at 18 diversion points in the marsh. The purpose of this program is to examine the relationship between the quality of the channel waters and salinity of the soil to which it is applied.

Banks Pumping Plant Mitigation Advisory Group. This is a group formed to address various aspects of the "Agreement Between the Department of Water Resources and the Department of Fish and Game to Offset Direct Fish Losses in Relation to the Harvey O. Banks Delta Pumping Plant." Its two main charges are to oversee annual costs and appropriate expenditure of the one-time payment of $15 million to initiate a program which will yield "quickly demonstrated results" for the fisheries resource. This sum will be expended over a minimum five-year span to a maximum ten-year span, beginning on December 30, 1986.

The Banks Pumping Plant Fish Agreement also led to formation of the Article VII Discussion Group, which is charged to develop methods to offset fisheries impacts not covered in the agreement, including new facilities and more efficient methods of water conveyance.

Salmon Management Planning Team. This task force was voluntarily established by DWR, DFG, USF&WS, Reclamation, and the National Marine Fisheries Service during Phase I of the SWRCB Bay-Delta Hearings to design an overall salmon management plan for the Central Valley. The group has been subdivided into three subcommittees, based on geographic areas. They are:

- Sacramento River Salmon Committee - This committee is charged with evaluating the upstream impacts on salmon smolts before reaching the Delta. Some of the current activities include:

  - completion of a salmon model to evaluate the impact of various environmental factors on the ocean salmon population;

  - evaluation of the benefits of a variety of projects that might result in enhanced production and survival of salmon in the upper Sacramento River and tributaries.

- Delta Salmon Committee - This committee is evaluating the impacts on salmon smolts when they are in the Delta. Some of the current activities include:

  - studies examining the relationship between survival of smolts and such factors as water temperature, flow, export pumping, reverse flows, and water diverted through the cross-channel;

  - studies examining the relationship between the survival rates of salmon smolts that migrate down the Sacramento River and the survival rates of those that pass through the Central Delta by way of the Walnut Grove Cross Channel;

  - evaluation of operational and physical means of reducing losses of salmon smolts.

- San Joaquin River Salmon Committee - This committee is evaluating the impacts faced by the smolts as they move down the San Joaquin River before reach-

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ing the Delta. Some of the current activities adjacent to the Delta include:

- a mark and recapture study designed to compare the survival rates of those salmon smolts drawn down Old River to those salmon smolts drawn down the San Joaquin River at the Mossdale split. These data will be directly applicable in the evaluation of facilities in the south Delta;

- development of a water operations model that would incorporate such factors as water availability, offstream water storage, agricultural, industrial, and municipal uses. The model would be used to assess benefits impacts and conjunctive use options of water manipulations on salmon;

- development of recommendations for levels of Delta inflow for various water year types that will be beneficial to smolt survival.

- evaluation of operational and physical means of reducing losses of salmon smolts.

EPA San Francisco Bay Estuary Project. As part of the federal Water Quality Act of 1987, the Environmental Protection Agency established the National Estuary Program to improve and protect the resources of the nation's estuaries. Within this program, the San Francisco Estuary Project (SFEP) addresses the specific needs of the San Francisco Bay/Delta area. SFEP objectives include:

- merging information about environmental and public health with social and economic factors;
- providing the impetus for developing united and effective management of the Bay/Delta;
- developing a "Comprehensive Conservation and Management Plan" to restore and maintain the chemical, physical, and biological integrity of the Bay/Delta; and
- developing a plan which addresses point and nonpoint sources of pollution, including a priority rating and a schedule of corrective actions.

To aid SFEP in reaching these objectives, a SFEP Technical Advisory Committee was formed to provide technical expertise.

Interagency Delta Health Aspects Monitoring Program. This program was developed in 1983 to address aspects of water quality in the Delta that were pertinent to public health. The objectives of the program include the development of data that will—

- be used in planning for control and treatment of the identified constituents by the State Water Contractors;
- evaluate the relative health benefits of various Delta alternative facilities;
- support various mathematical modeling activities; and
- support various water supply planning activities.

Central Valley Project History and Purpose

During the 1920s, a period of rapid growth in California, the State's political leaders recognized a need for large-scale water resources development to meet growing needs for flood protection and water supply. In 1921, the Legislature authorized a statewide water resources investigation, which 10 years later resulted in the State Water Plan. The plan contemplated transferring "surplus" water between the northern and southern portions of the Central Valley in a State Central Valley Project. This project, the initial feature of the State Water Plan, was approved, first by the Legislature and then by the voters of California. However, due to the Great Depression, bonds to finance the project could not be sold. Arrangements were subsequently made for federal authorization and financing as the Central Valley Project (CVP).

The purposes authorized by Congress for which the CVP may be operated are 1) improving navigation, 2) regulating river flows, 3) reclaiming arid and semi-arid lands, 4) controlling floods, 5) enhancing fish and wildlife, and 6) other beneficial uses. Congress has also authorized and directed Reclamation to operate the CVP, in conjunction with the SWP, in conformity with State water quality standards for the Delta and San Francisco Bay, unless such standards differ from the congressional directives applicable to the CVP.

The Existing Central Valley Project and Related Mitigation

The CVP, operated by Reclamation, consists of dams, reservoirs, and conveyance facilities in northern and central California. CVP reservoir systems providing Delta export supplies and augmenting low summer and fall flows to the Delta are: the Shasta Division, the Trinity River Division, and the Folsom Unit of the American River Division. The

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CVP exports about 3.4 MAF of water annually from the southern Delta at the Tracy Pumping Plant, at the head of the Delta-Mendota Canal, 2 miles east of the Banks Pumping Plant.

Major facilities of the CVP are shown in Figure 1-3. These facilities primarily regulate, store, or divert flows of the Trinity, Sacramento, American, Stanislaus, and San Joaquin rivers, all of which are tributary (by way of a diversion tunnel for the Trinity) to the Delta. The CVP pumps water from the Delta and exports it to the San Joaquin Valley via the Delta-Mendota and San Luis canals, to Santa Clara and San Benito counties via the San Felipe facilities, and to Contra Costa County via the Contra Costa Canal. The CVP also diverts and delivers water upstream from the Delta with facilities that include the Tehama-Colusa, Corning, and Folsom South canals. Water is delivered from Millerton Lake via the Madera and Friant-Kern canals.

The Contra Costa Canal, the first unit of the CVP, was completed in 1940. It conveys Delta water to Contra Costa County. In 1944, Shasta Dam and reservoir was completed as a key feature of the CVP, adding water to Delta channels during naturally dry periods.

In 1951, the Delta Mendota Canal became operational to deliver water from the Delta to the lower San Joaquin Valley. During that same year, the Delta Cross Channel was constructed near Walnut Grove in the north Delta to improve flow patterns for water transfer across the Delta.

The latest feature of the CVP, the San Felipe Division, was completed in 1987. It delivers water from San Luis Reservoir to Santa Clara and San Benito counties. About 60 percent of the water delivered to Santa Clara County will be used to recharge the ground water basin. Nearly all the water sent to San Benito County will be used to replace boron-contaminated ground water and to bring agricultural land into production. The project will not increase Delta exports, because water allocated to San Felipe Division was previously used for irrigation in the San Joaquin Valley.

In 1988, Reclamation issued a draft EIS for proposed water contracting programs. The proposed plan would allocate about 1.5 MAF of firm and intermittent water per year to meet the needs of municipalities, industries, wildlife refuges, and agriculture in the Sacramento River, American River, and Delta export service areas.

The CVP has developed facilities for mitigation of fish losses caused by the project. At Keswick Dam, downstream of Shasta Dam, salmon and steelhead are trapped and transported to Coleman Fish Hatchery. Farther downstream, at Red Bluff Diversion Dam, fish ladders on each side and in the center of the dam allow salmon and steelhead to migrate upstream. Improvements are planned for these facilities.

The Trinity River portion of the CVP has a fish hatchery below Lewiston Dam. The hatchery is being modified and modernized to better meet mitigation requirements. The fish ponds and water lines are being replaced and the water supply will be increased to 2.5 times its present quantity. In addition to the hatchery, the spawning beds downstream of the dam are being improved. Agreement has been reached to increase the flows in the Trinity River from 120,000 AF to between 287,000 and 340,000 AF per year. This increased flow is for fish habitat.

The Nimbus Fish Hatchery, downstream of Folsom Dam, was built to mitigate the spawning loss due to the dam.

Another fish mitigation measure of the CVP is the Tracy Fish Collecting Facility. This facility helps prevent fish from entering the Delta-Mendota Canal. The facility has a louvered fish screen that channels the fish into holding tanks. The fish are then trucked and released in other parts of the Delta.

Central Valley Project Supplies

Within its current contracts, the CVP is meeting a 1985 demand of 7.0 MAF. With no new contracts or new facilities, these contracts will build up to a demand of 7.8 MAF by year 2010. In addition to current contracts, Reclamation has conducted a needs analysis for the CVP service areas and has identified a further need for 3 to 4 MAF. Estimates of uncommitted CVP water supplies are less than half this need for water.

The magnitude of the CVP's projected water supply capability depends on reuse of initial deliveries. For example, after northern California growers use CVP water to irrigate their crops, excess water is returned to the Sacramento River and counted again as project yield available for rediversion or for meeting Delta outflow requirements. Thus, if expansion of CVP water use in the Delta's upstream service areas were not to occur as projected, or if improved irrigation efficiency reduced the volume of return flows, the CVP water delivery potential could be lower than anticipated.

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State Water Project History and Purpose

As the growth of California accelerated, particularly after World War II, State officials perceived a need for a water resources development system of far greater extent than was encompassed by the federal Central Valley Project.

By 1951, State water planners outlined the fundamental elements of what would become the State Water Project (SWP). Some important milestones in development of the SWP were passage of the Burns-Porter Act (authorizing the Project's initial facilities) in 1959, approval of the California Water Resources Development Bond Act in 1960, the beginning of construction of Oroville Dam in 1962, and the initial operation of the California Aqueduct in 1968.

The major facilities of the SWP, constructed mainly in the 1960s and early 1970s, are shown in Figure 1-3. Surplus water from the Feather River watershed and the Sacramento-San Joaquin River Delta is captured and conveyed

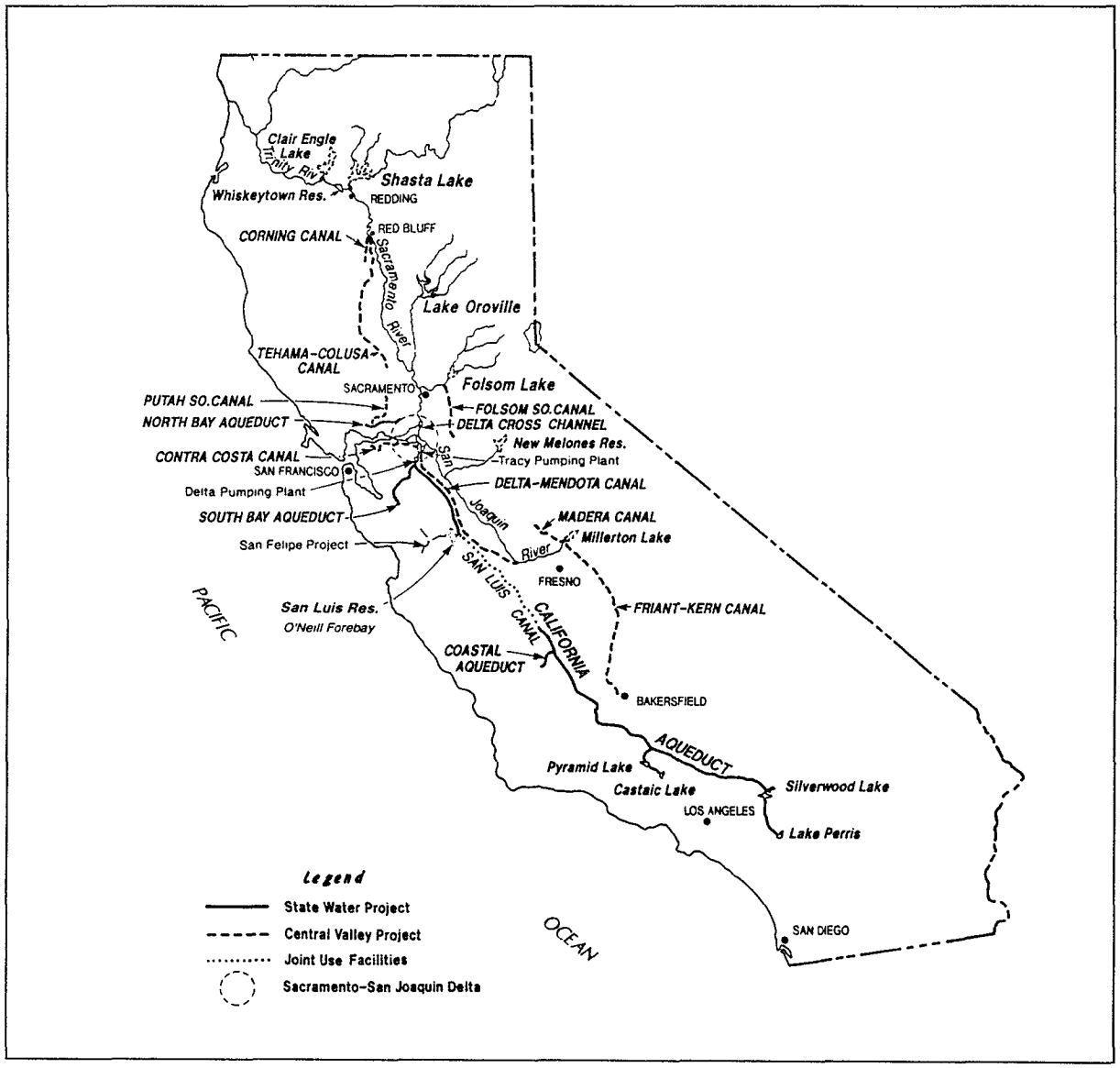

Figure 1-3. Major Features of the SWP and CVP

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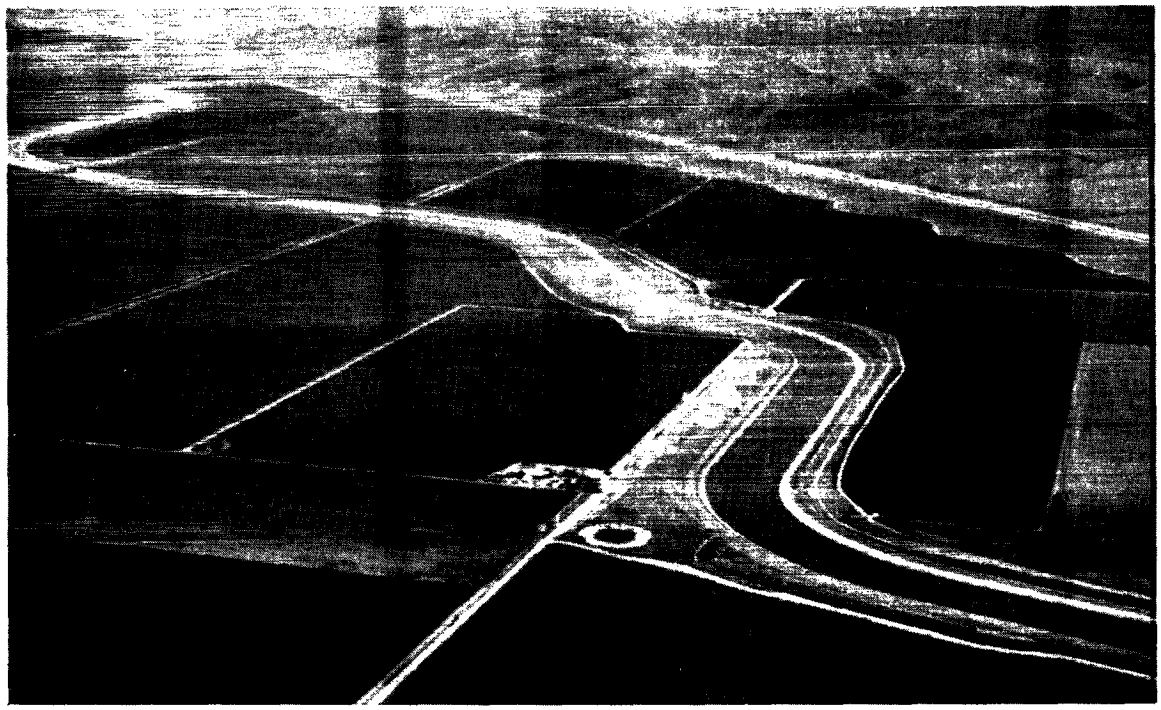

California Aqueduct near Stockton in the Sacramento–San Joaquin Delta

to areas of need in the San Francisco Bay area, the San Joaquin Valley, and Southern California.

Thirty agencies throughout the State have contracted to eventually receive 4.23 MAF of water a year, to be delivered as their needs develop. The existing facilities can supply about 2.3 MAF, enough to meet present needs. Additional facilities are planned to increase the supply.

Besides contractual obligations and agreements for water supply, the SWP is required by law to provide salinity control in the Delta. Recreation and fish and wildlife enhancement are also among the Project's authorized purposes.

The Existing State Water Project and Related Mitigation

The SWP provides numerous benefits to the people of California, including water supply, flood control, recreation, and energy production.

SWP recent entitlements and other deliveries have ranged from 2.0 to 3.0 MAF annually. In addition, the SWP has provided flood control, recreation, and hydroelectric benefits. Oroville Dam has prevented millions of dollars in flood damage. Recreational use continues to increase, including fishing in the California Aqueduct and the various SWP reservoirs. Today's annual recreation user days exceed 7 million. Hydroelectric power generation at SWP pumping–generating plants offsets the need to burn fossil fuels and reduces pollution. Some 3 million kWh are generated each year. Tables 1–3 and 1–4 summarize the benefits through 1987.

The California Aqueduct begins at the Banks Pumping Plant and extends 444 miles. It is the principal conveyance facility of the overall project, which now includes 22 dams and reservoirs, 8 hydroelectric power plants, and 17 pumping plants. Except for the Banks and Pearblossom pumping plants, all pumping plants along the California Aqueduct have the planned pumping units installed. Additional pumps at both plants are scheduled for operation in 1991. The Burns–Porter Act also authorized unspecified additional future storage facilities, facilities to transfer water across the Sacramento–San Joaquin Delta, and facilities to remove drainage water from the San Joaquin Valley.

As required by the California Water Resources Development Bond Act, Water Code Section 12934(d)(2), the California Aqueduct system has a capacity of not less than 2,500 cfs at all points north of the northern boundary of the County of Los Angeles in the Tehachapi Mountains near Quail Lake and a capacity of not less than 10,000 cfs at all points north of San Luis Reservoir.

Lake Oroville, the main storage facility, is situated on the Feather River in Butte County. SWP facilities at Oroville are operated for flood control, power generation, in-stream fisheries, along with water supply for local areas, the Delta, and export. Three upstream reservoirs on the headwaters of the Feather River are operated for local

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water supply, recreation, and instream fisheries. Water released for fish and the other purposes, together with irrigation return flows, goes down the Feather and Sacramento rivers and then into the network of channels in the Delta. Releases from the Oroville facilities contribute to Delta uses, Delta salinity control, and export needs out of the Delta.

Table 1–3
SWP Accomplishments Through 1987

Water Delivered (AF)							
	Entitlement Water			Other Deliveries			
				Surplus			
Year	Municipal & Industrial Use	Agricultural Use	Total	Municipal & Industrial	Agricultural	Other Water	Total Delivery
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1962						18,289	18,289
1963						22,456	22,456
1964						32,507	32,507
1965						44,105	44,105
1966						67,928	67,928
1967	5,747	5,791	11,538	0	0	53,605	65,143
1968	46,472	125,237	171,709	10,000	111,534	14,777	308,020
1969	34,434	158,586	193,020	0	72,397	18,829	284,246
1970	47,996	185,997	233,993	0	133,024	38,080	405,097
1971	85,286	272,054	357,340	2,400	293,619	44,127	697,486
1972	181,066	430,735	611,801	22,205	401,759	73,127	1,108,892
1973	293,824	400,564	694,388	3,161	293,255	43,666	1,034,470
1974	418,521	455,556	874,077	4,753	412,923	48,342	1,340,095
1975	641,621	582,369	1,223,990	21,043	601,859	67,170	1,914,062
1976	818,588	554,414	1,373,002	32,488	547,622	116,962	2,070,074
1977	280,919	293,236	574,155	0	0	390,176	964,331
1978	742,385	710,314	1,452,699	3,566	13,348	122,916	1,592,529
1979	690,659	969,237	1,659,896	66,081	582,308	189,396	2,497,681
1980	730,545	799,204	1,529,749	19,722	384,835	48,590	1,982,896
1981	1,057,273	852,289	1,909,562	12,000	896,428	283,849	3,101,839
1982	928,721	821,303	1,750,024	0	215,873	155,820	2,121,717
1983	483,499	701,370	1,184,869	0	13,019	188,596	1,386,484
1984	725,925	862,694	1,588,619	3,663	259,254	387,505	2,239,041
1985	992,538	1,002,915	1,995,453	9,638	298,034	408,904	2,712,029
1986	998,611	997,025	1,995,636	2,595	34,025	197,471	2,229,727
1987	1,096,368	1,033,718	2,130,086	6,949	107,958	385,264	2,630,257
Total	**11,300,998**	**12,214,608**	**23,515,606**	**220,264**	**5,673,074**	**3,462,457**	**32,871,401**

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Table 1–4
Recreation and Hydroelectric Accomplishments Through 1987

Year	Recreation Supported (Recreation Days)	Hydroelectric Energy Generated (kilowatthours)
1962	30,000	
1963	105,000	
1964	331,600	
1965	449,800	
1966	482,700	
1967	455,200	
1968	931,300	628,000,000
1969	1,554,800	2,614,000,000
1970	1,804,800	2,679,000,000
1971	2,085,900	3,302,000,000
1972	1,971,200	1,922,000,000
1973	2,502,000	3,298,000,000
1974	4,073,600	4,672,000,000
1975	4,189,300	3,159,000,000
1976	4,239,600	2,131,000,000
1977	3,951,900	958,000,000
1978	5,773,700	2,882,000,000
1979	5,298,700	2,485,000,000
1980	5,701,900	2,988,000,000
1981	6,017,800	3,358,000,000
1982	6,187,700	5,097,000,000
1983	5,838,200	5,419,000,000
1984	6,273,100	3,368,000,000
1985	6,639,800	3,227,000,000
1986	6,966,039	3,706,000,000
1987	7,228,815	2,707,000,000
Total	**91,084,454**	**60,600,000,000**

Salinity incursion into the Delta results from the flooding and ebbing of ocean tides through the San Francisco Bay and Delta system during periods when the fresh-water outflow from the Delta is insufficient to repel the saline water. The natural fresh water outflow from the Central Valley was historically inadequate to repel salinity during summer months of some years. The maximum recorded extent of salinity incursion happened in 1931, when ocean salts reached Stockton (Figure 1–4). With the development of the SWP and CVP, water quality standards have been adopted to protect Delta uses from excessive salinity intrusion.

Additional SWP storage is provided by the federal–State San Luis Reservoir in Merced County, a transportation facility reservoir in Alameda County serving the South San Francisco Bay area, and four transportation facility reservoirs in Southern California. Water diverted from the Delta at the Banks and Tracy plants is pumped into San Luis Reservoir during winter and early spring for release to the aqueducts during summer and fall.

Near the northern edge of the Delta, the North Bay Aqueduct delivers water to Napa and Solano counties. The aqueduct begins at Barker Slough south of Dixon and ends at the Napa Turnout Reservoir for use in Napa County. Along the way, water is delivered to Solano County users in Fairfield, Vallejo, and Benicia.

At the southern edge of the Delta, 15 miles southwest of Stockton, are Clifton Court Forebay, the John E. Skinner Delta Fish Protective Facility, Harvey O. Banks Delta Pumping Plant, and the intake channel to the pumping plant. Clifton Court Forebay, which has a capacity of 28,653 AF serves as a regulating reservoir. It ensures reliability and flexibility for pumping water at Banks Pumping Plant.

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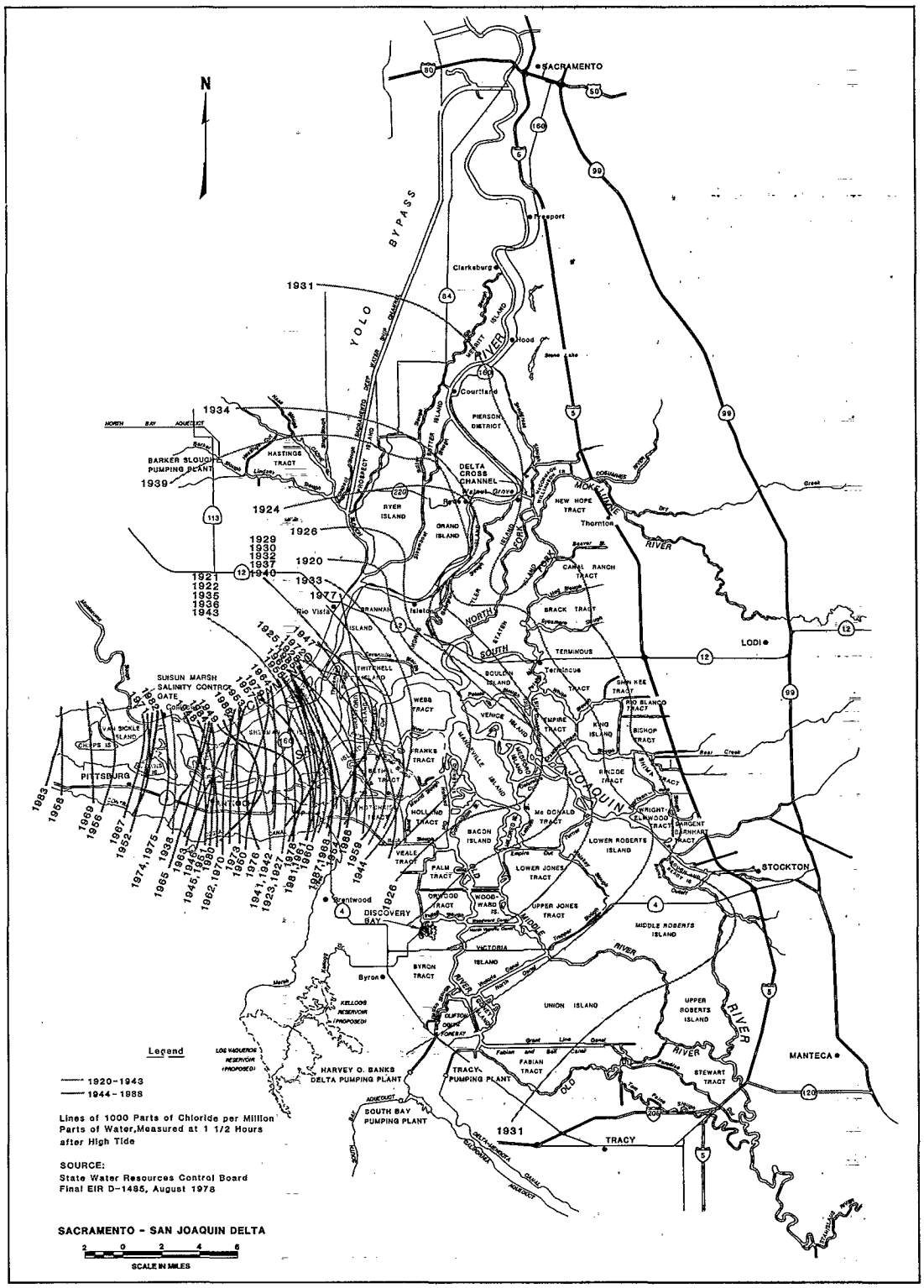

Fig 1–4. Location of Maximum Annual Salinity Intrusion

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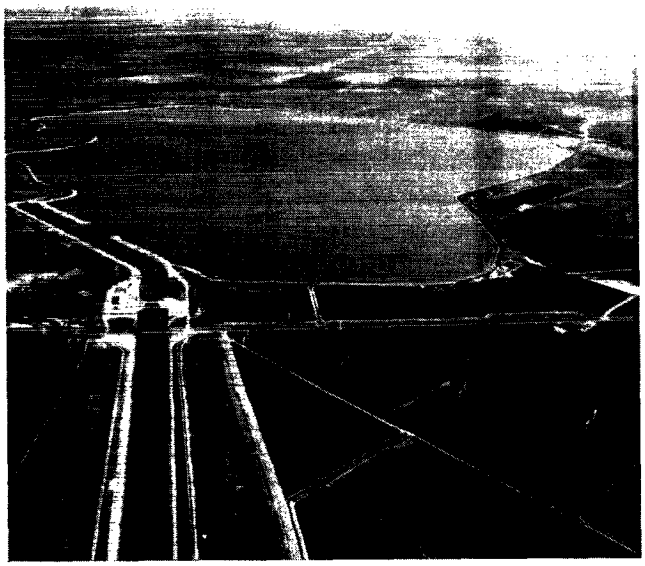


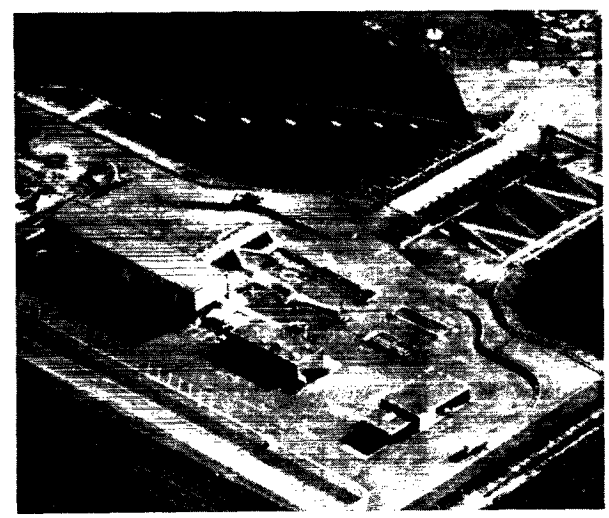
Clifton Court Forebay with Intake Channel and Fish Facilities in Foreground

Currently, seven pumps at Banks Pumping Plant (four additional pumps are under construction) lift as much as 6,400 cfs in the California Aqueduct. The South Bay Aqueduct branches at this point and delivers water to Alameda and Santa Clara counties. The 444-mile California Aqueduct conveys water to the San Joaquin Valley and Southern California.

At the northern base of the Tehachapi Mountains, the A.D. Edmonston Pumping Plant lifts California Aqueduct water nearly 2,000 feet. The water then crosses the mountains through a series of four tunnels. South of the Tehachapi Mountains, the aqueduct divides. The West Branch transports most of the water through Pyramid Lake to Castaic Lake, northwest of Los Angeles; the East Branch delivers water to the Antelope Valley and terminates at Lake Perris, in Riverside County.

Past and present fish and wildlife mitigation and enhancement for SWP facilities north and south of the Delta are summarized below.

- The Feather River Fish Hatchery was built to mitigate the loss of salmon and steelhead spawning beds resulting from construction of Oroville Dam. The hatchery can accommodate 9,000 adult salmon and 2,000 adult steelhead. In 1986, this hatchery provided 9,654,000 salmon and 1,379,000 steelhead for planting or transfer to other hatcheries.
- The fall run of salmon has increased from a preproject average of about 39,000 to about 49,000. The spring run has declined from a pre-project average of about 1,700 to an average of about 1,150. The steelhead run has decreased from a pre-project average of 600 to about 500. Approval and funds have been obtained to construct two additional salmon-rearing raceways to help overcome the threat of cold-water virus. These raceways should double the survival rate of young salmon. DFG is using the Oroville borrow areas, the source of material for construction of Oroville Dam, to enhance fish and wildlife.
- Wildlife habitat losses at San Luis Reservoir have been mitigated by purchase of an additional 900 acres. A fishery has also been established in the reservoir, enhancing this resource.
- The 398-acre Kettleman City Recreation Area has been established on the California Aqueduct about 50 miles south of Fresno. Part of this area is for wildlife enhancement and a pond was built for fishery enhancement.
- The fisheries established along the length of the California Aqueduct and in the four Southern California reservoirs provide recreational use and associated benefits.
- Wildlife habitat loss in the Southern California portion of the project is being mitigated in two parts. To mitigate for wildlife habitat loss on U. S. Forest Service land, DWR has agreed to purchase 1,500 acres of suitable lands for wildlife. These lands will be turned over to the Forest Service, along with a specified



John E. Skinner Fish Facilities at the Head of Intake Channel Adjacent to Highway J-4

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amount of funding for habitat development and operation. The total cost is estimated to be $1.1 million. Another agreement, with DFG, allocates 3,033 acres of SWP lands for wildlife mitigation, and Metropolitan Water District of Southern California has dedicated 2,565 acres at Lake Mathews for wildlife mitigation. DWR will also allocate $7 million of SWP funds and $1 million in other funds to DFG to develop, operate, and maintain the wildlife habitat. Some of these funds may be used to purchase lands in the San Jacinto Valley for wildlife mitigation.

State Water Project Supply Contracts. DWR has long-term water supply contracts to deliver specified annual amounts of water to each of 30 contracting agencies. These contractors are in the Feather River Basin, Bay area, San Joaquin Valley, central coastal area, and Southern California. The maximum annual entitlements for all contractors total about 4.2 MAF. This represents the maximum water that would be delivered by the State to its contractors under full contract conditions. To deliver this maximum amount of water would require the full capacity of 10,300 cfs at the Banks Pumping Plant, as well as other future water development features.

Water contracts establish annual entitlements and procedures for allocating deficiencies, surplus water deliveries, and payment. In general, the annual entitlements follow buildup schedules, increasing each year until the maximum annual entitlement is reached. A contracting agency may request that project water be made available in annual amounts greater or less than scheduled annual entitlements, but not greater than its maximum annual entitlement. Subject to approval by the State, the water delivery schedule is adjusted to the extent necessary to satisfy the request.

If, during any year, the supply of project water exceeds the total requested water deliveries for annual entitlements of all contractors and necessary carryover storage for that year, the State can sell and deliver such water as surplus water. Requests for surplus water have a lower priority than entitlement requests.

A temporary shortage of water supplies can occur in any year when a drought or other condition reduces project water available to less than the total requests for annual entitlements of all contractors for that year. In such an event, the State Water Project would be operated to reduce deliveries of that year's annual entitlement used for agricultural purposes by a percentage not to exceed 50 percent in any one year or a total of 100 percent of yearly annual entitlements in any seven consecutive years. If necessary, further reductions will be made to all deliveries, regardless of use, and the reduction will be in proportion to the entitlement.

The annual entitlements and the maximum annual entitlements of all contractors will be reduced proportionately under the following specific conditions:

- The State is unable to build enough additional conservation facilities to prevent a reduction in minimum yield.
- There is a reduction in the minimum project yield for any other reason. In both cases, preventive or remedial measures by DWR will be considered before the shortage is applied. If a shortage is applied, the sum of the revised maximum annual entitlements of all contractors will equal the reduced minimum project yield.

State Water Project Operation

Operation of the State Water Project is governed by physical and institutional constraints. Physical factors limiting SWP operations include:

- available water supply, SWP demands, and delivery capabilities
- power operations
- hydraulic constraints and Banks Pumping Plant capacity
- water conservation and water management plans

These governing factors are discussed in the following sections. Other institutional constraints were discussed in the Related Delta Protective Measures section.

Available Water Supply, State Water Project Demands, and Delivery Capabilities. Availability of water supplies at the Delta varies with natural conditions and upstream development. Natural hydrologic variations cause extreme fluctuations in monthly and yearly inflows. Winter floods produce Delta flow rates of several hundred thousand cfs, while summer conditions can decrease rates to a few thousand cfs. The total annual volume of inflow can also vary substantially. Unimpaired annual volumes range from less than 7 MAF in critical years to more than 70 million in wet years.

Upstream development has occurred from both local and project facilities. Use within the local area has priority

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over project use through area of origin laws; therefore, local development will directly decrease project supplies as it occurs. By 2000, existing project firm yield supplies are projected to decrease by 300,000 AF. Upstream development will contribute to future shortages if proper solutions are not found. However, other factors in the service areas will also add to the frequency and severity of such shortages. Even with extensive planned conservation efforts, urban water demands will increase, primarily because of population increases. This is further complicated by the fact that a portion of Colorado River supplies used by southern California for many years will be diverted to Arizona.

Dependable water supplies from SWP facilities are now about 2.3 MAF per year. About half this water comes from Lake Oroville on the Feather River; the rest is developed from surplus flows in the Delta, some of which are re-regulated in San Luis Reservoir.

The amount of surplus Delta water supplies is affected by the volume of outflow required to meet water quality standards in the Delta established by the SWRCB. Existing standards are specified in Decision 1485, adopted in 1978 (see discussion under Related Delta Protective Measures).

SWP contractors regularly make short-term and long-term projections for entitlement water use. These requested entitlement supplies are delivered in accordance with SWP contracts, discussed earlier in this chapter. DWR annually requests each long-term SWP contractor to prepare an estimate of near- and long-term SWP water requirements. These projections form the basis for DWR water planning and project operation studies in the upcoming year.

The measure of delivery capability for the SWP was founded on the concept of "firm yield" operation. Defined as "minimum project yield" in SWP water contracts, firm yield is the dependable annual water supply that can be made available without exceeding specified allowable reductions in deliveries to agriculture during extended dry periods.

Beginning in 1987, contractors requests for delivery of entitlement water exceeded the firm yield of existing facilities. Recently, DWR has worked with the major contractors to increase the SWP's average annual deliveries. This is done by relaxing its minimum reservoir carryover storage requirements to permit increased deliveries in all but the driest years.

Short-range decisions for the operation of SWP facilities are made with an annual "rule curve." The rule curve provides a rational means to decide how much water may be delivered in a given year and how much should be left in storage as insurance to protect against subsequent dry periods. Until recently, the procedure used to develop the annual rule curve was designed to assure a high probability of meeting future delivery schedules. This resulted in relatively high fall storage target levels for Lake Oroville and the State portion of San Luis Reservoir, and quite often delayed approval of water delivery requests until late in the water-producing season.

As the contractors' annual requests for entitlement water continued to rise, DWR became increasingly aware that alternative rule curve procedures could permit larger deliveries in average or wet years without substantially reducing delivery capability during dry years. With the concurrence of the SWP contractors, one such alternative rule curve procedure was adopted, on a trial basis, for use in 1986. The 1986 rule curve procedure relaxed the requirements for fall carryover storage somewhat, permitting larger deliveries in most types of years, but at the possible expense of reduced deliveries in the driest years. The modified rule curve permits approval of a reasonable annual delivery early in the water-producing season without jeopardizing the average dry-period supply that would be available during a recurrence of the historic 1928-34 drought period.

Further study and information provided by the water contractors led, in 1987, to a lower schedule of target storage, and in 1988 to a calculation of delivery by formula based on carryover storage only.

In 1989, the rule curve was renamed the "water delivery risk analysis" (WDRA); the "Four Basin Index, which is the unimpaired runoff from streams entering the Sacramento Valley became the "Sacramento River Index" (SRI); and "conservation storage" was interpreted to include: 1) Lake Oroville, 2) the State's share of San Luis Reservoir, and 3) the balance owed to DWR by Reclamation under the COA.

The 1989 WDRA used the same criteria as in 1988 for development of the risk analysis curve, but the procedure for determining delivery approvals was changed. Delivery approvals for 1989 were based on a forecast of the SRI, with a probability of exceedence of approximately 90 percent instead of 99 percent.

State Water Project Power Operations. DWR is one of the largest publicly-owned electric systems in the United States. Since April 1983, DWR has operated as a bulk

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power agency. As such, DWR operates a mix of owned, contracted, and purchased power resources to meet SWP needs via contracted transmission capacity. This requires that DWR maintain a reliable power system.

Due to DWR's unique ability to control its pumping loads, DWR will always be a major purchaser and seller of power in the west. Managing its water and power resources will result in lowering the cost of delivered water to the water contractors.

In addition to energy requirements, DWR must consider electrical capacity requirements—the maximum demands for electrical power during given periods of time. Since DWR has flexibility in regulating SWP electrical power load, the project is operated to minimize pumping requirements during on-peak periods, when capacity and energy costs are greatest. Thus, SWP maximum electrical capacity requirements occur during off-peak periods (nights, weekends, and holidays).

SWP power requirements can vary significantly, depending on the balance of water supply and water demand in a given year. Dry conditions in northern California reduce the supply of water available for delivery and decrease power requirements if the SWP cannot deliver full entitlement requests. Power requirements also decrease if hydrologic conditions or actions by local water agencies reduce demands in the San Joaquin Valley or Southern California.

Hydraulic Constraints and Banks Pumping Plant Capacity. Hydraulic constraints can limit monthly maximum exports of the SWP. The constraints are related to:

- volume of Clifton Court Forebay
- forebay inlet gate size and location
- capacity of southern Delta channels
- flows in the San Joaquin River
- tidal fluctuations at the inlet gate

Clifton Court Forebay storage enables a high use of off-peak power at the Banks Pumping Plant. Inflows to the forebay are governed by tidal fluctuations, which average 3.7 feet daily. Five radial gates at the southeastern corner of the forebay are open during high tides and closed during low tides. Operational procedures for the inlet gates consist of minimizing the drawdown effects of the diversions at all tide levels.

South Delta channels were not designed for project operations; therefore, they limit the amount of water that can be pumped from the south Delta without eroding the channels and levees. Water levels in south Delta channels are sensitive to SWP and CVP diversions. The drawdown effects are of concern to local agricultural diverters and have been studied as part of the discussions and negotiations between the SDWA, Reclamation, and DWR. Water supply and quality issues in the south Delta are discussed at the beginning of this chapter.

Banks Pumping Plant and Clifton Court Forebay play a key operational role because they are at the head of the aqueduct system.

The physical capability of the Banks Pumping Plant will increase from 6,400 to 10,300 cfs with the four additional pumps now under construction. However, the maximum monthly export rate will probably be less than 10,300 cfs because of hydraulic constraints. DWR estimates the maximum average monthly rate with these constraints to be about 6,680 cfs and 7,300 cfs in some winter months when San Joaquin River flows are high. The estimated yield increase of the four additional pumps with the 7,300 cfs maximum is 57,000 AF per year. This is an increase in yield of less than 3 percent over the existing project capability.

Implementing south Delta facilities would eliminate the physical constraints, allowing the Banks Pumping Plant to pump at its maximum capacity of 10,300 cfs. The added pumping capability would allow for winter water banking operations.

Water Conservation and Water Management Plans. Since the 1976-1977 drought, California's push toward water conservation has focused on plans and programs to encourage more efficient use of water. DWR, and most recently, local governments are actively conducting research, education, and implementation programs to reduce agricultural and urban water use. Water conservation and demand reduction alternatives are discussed in Chapter 3.

Efficient use of water supplies in California is an economic and environmental necessity. It will be important for water purveyors and State and local government to analyze the cost effectiveness of water conservation measures and to implement those that are appropriate.

Since water conservation involves issues of technology, public awareness and acceptance, and research and education, cooperation is needed between the public and private sectors, the urban and agricultural sectors, and State and local governments.

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CHAPTER 2. PROJECT DESCRIPTION

This chapter describes the purposes and project components of the South Delta Water Management Program (SDWMP). Alternative plans using the various components discussed in this chapter are described in Chapter 3.

Water Banking and South Delta Water Management Program

In 1984, the State Legislature authorized Los Banos Grandes (LBG) Reservoir as part of the State Water Resources development system. LBG will provide storage necessary for water banking. The purpose of water banking is to develop additional water supplies through conservation of excess winter flows, improve water quality, and provide additional flexibility for the State Water Project (SWP). This additional flexibility could help protect and enhance fish and wildlife while providing additional water supplies to help meet future needs.

Water banking is the concept of moving water into storage facilities south of the Delta during excess high-flow conditions to enhance supplies. The improved hydraulics, with a federal permit to increase diversions in the Delta, proposed by the SDWMP, would permit storage of these flows during the short period they are available.

Storage facilities such as the Kern Water Bank (KWB) ground water storage or the proposed LBG Reservoir would provide the storage capacity for this banking operation. The operational flexibility to fill reservoirs south of the Delta during winter periods of low fish abundance provides added supplies for use during drier periods, when Delta exports are not available.

The SDWMP draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS) is one of three major water resources planning programs under way to both evaluate possible solutions to Delta problems and implement water banking programs.

The two other draft EIR/EIS's that will be released to the public in 1990 include the North Delta Water Management Program (NDWMP) and the Los Banos Grandes off-stream storage reservoir. Tentative EIR/EIS schedules for these EIR/EIS's are shown in Figure 2-1. The SDWMP, the first phase of the water banking program, is also designed to resolve local south Delta water supply problems.

NDWMP will 1) improve reverse flows and water quality conditions in the Delta by improving cross-Delta flows, 2) provide additional yield for export, and 3) enhance the water banking program.

DWR has carefully selected individual Delta water management programs to provide independent utility. Each program can achieve significant benefits and is economically justified by itself or in combination with the others. However, LBG Reservoir is dependent on the SDWMP.

The EIR/EIS's have been carefully organized into individual reports guided by comprehensive statewide planning to improve the planning and decision-making process. The use of coordinated individual reports was selected to provide added attention to program evaluation, as well as flexibility in scheduling and program implementation. At the same time, the interrelationships between each program and their combined effects are addressed in detail by statewide planning documents, cumulative impact evaluations, comprehensive system operation studies, and Delta estuary mitigation activities.

Purposes

The purpose of the SDWMP is to develop mutually acceptable long-term solutions to the water supply problems currently experienced in the south Delta, while considering other objectives of the Department of Water Resources (DWR) and the U. S. Bureau of Reclamation (Reclamation).

The objectives of the SDWMP are to:

- improve and maintain water levels, circulation patterns, and water quality in the south Delta area for local agricultural diversions;
- provide the opportunity to interconnect with Clifton Court Forebay and improve water quality for Contra Costa Canal deliveries to be treated for use as drinking water supplies;
- improve SWP operational flexibility to help reduce fishery impacts and improve fishery conditions;

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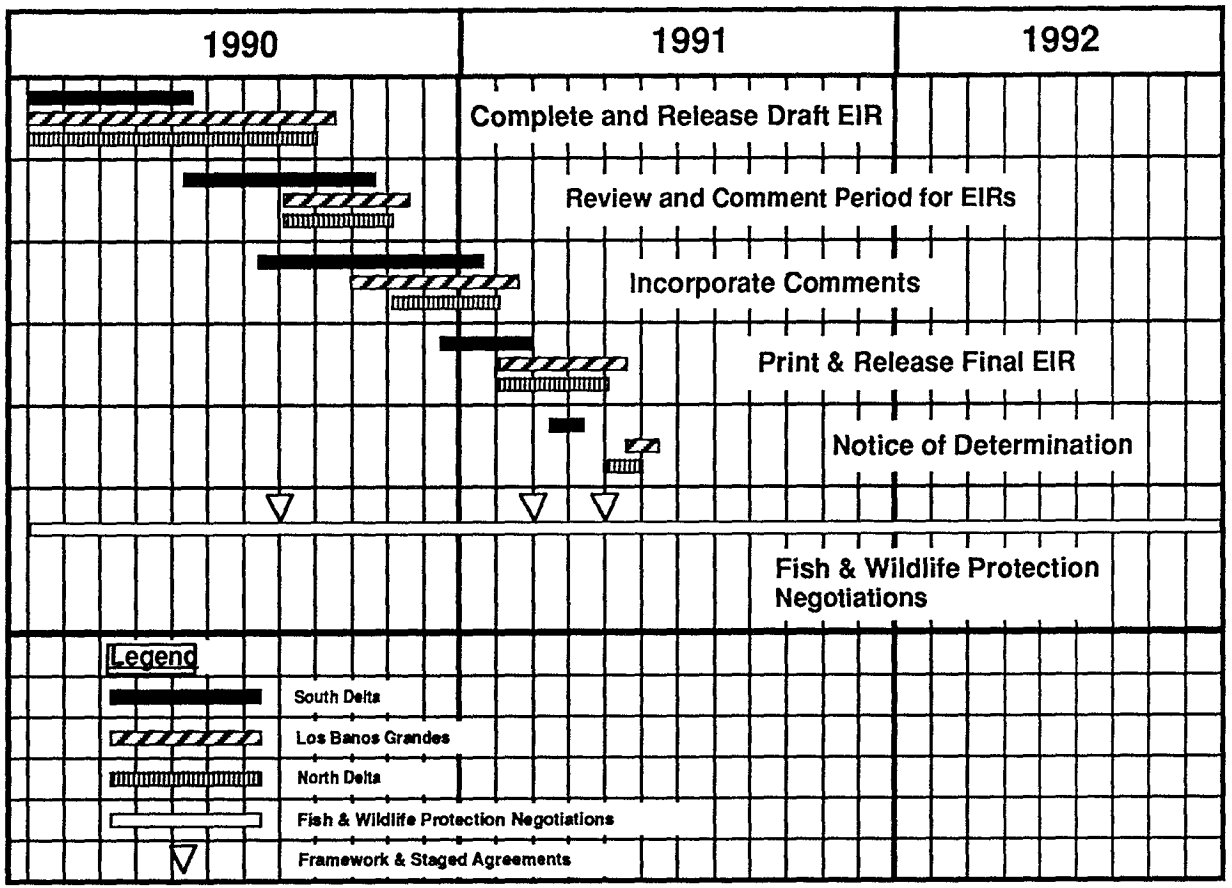

Figure 2–1. Water Banking and Delta Channel Improvements EIR/EIS Tentative Schedule

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- improve SWP and CVP water supply reliability through enhanced capabilities for banking winter supplies and through improved water quality, which will reduce the cost of treating drinking water supplies;
- improve navigation and flood protection; and
- increase recreational opportunities.

Improved South Delta Water Agency Water Supply

A principal objective of the SDWMP is to mitigate and enhance south Delta water supplies by improving water levels, circulation patterns, and water quality. To accomplish this, various measures can be implemented: 1) barrier-type facilities to improve water levels and circulation patterns; 2) a northern intake structure for Clifton Court Forebay to reduce SWP effects; 3) CVP tie-in to Clifton Court Forebay to reduce CVP effects; and 4) channel dredging to improve channel capacity.

Water for lands within the South Delta Water Agency (SDWA) boundaries is supplied almost exclusively from Delta channels. Water conditions in the area are influenced by San Joaquin River inflow, tidal action, project and local pump diversions, agricultural return flows, and channel capacity. Historically, there have been various complaints from SDWA that hydraulic capacity is insufficient to convey water to some points of diversion during the months of peak agricultural demand. Background on the events involving SDWA and DWR is discussed in Chapter 1.

The Tidal Cycle

The river systems of the Sacramento-San Joaquin Delta are open to the Pacific Ocean via the Golden Gate and are influenced by tides—two high tides and two low tides each day.

Each high-water stage raises water elevations and produces a flood tide that flows landward through Delta channels. As the tidal cycle continues, it reverses to a low water stage and produces an ebb tide that flows to the ocean and lowers water levels.

This regular cycle of changing flow directions and water elevations can be used to create desired hydraulic conditions by use of tide gates. These structures can be designed and operated to open and close on different phases of the tide, using natural forces to improve water levels and circulation.

Barrier-type facilities would be constructed and operated to regulate flows to improve water levels and circulation patterns. Facilities would be opened with the incoming tide and closed with the outgoing tide to retain higher water levels upstream of the facility. Operation of the facilities are discussed later in this chapter. Increasing water levels in south Delta channels would improve water circulation by putting more water into the system, especially in stagnant or dead-end channels.

The method of local agricultural diversion includes siphons and pumps, and a tidal pump control structure at Tom Paine Slough. Operation of both the siphon and the tidal pump control structure depends on adequate water levels within the supply channel. Pump energy requirements are affected by the water level elevation. Operating barrier-type facilities to capture high water levels upstream of the facilities can significantly improve water levels.

South Delta channels are used for both delivery of irrigation water and return of local agricultural drainage. Irrigation practices concentrate the salts of the applied water; the disposal of the irrigation drainage degrades the receiving water. The quality is seriously deteriorated in dead-end channels such as Tom Paine Slough and Paradise Cut, as well as reaches of Old River and the San Joaquin River, which have limited circulation. During the heavy irrigation season, this drain water is recycled several times when flows are insufficient to flush the channel. Proposed alternatives are all designed to improve circulation by improving flows in channels.

A second water quality factor that must be considered within the south Delta is high nutrient-loading, along with poor circulation, which can cause biostimulation for algal growth. The alternative solutions considered in this report could greatly reduce the effects of the biodegradation within the channels of the SDWA by improving circulation patterns.

Water movement affects circulation within the south Delta area, which in turn affects salinity levels. The distribution of water flowing into the SDWA is affected by the CVP and SWP pumping plants located near Tracy. Cross-Delta water distribution patterns and project diversions resulting from the CVP and SWP have provided better water quality to benefit the Delta and some parts of the

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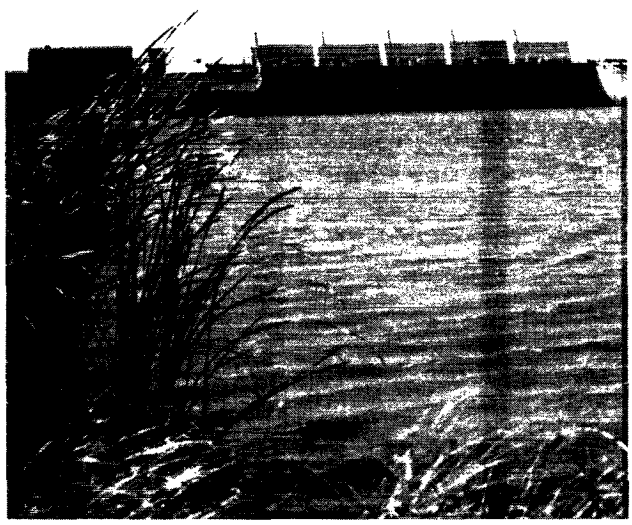
south Delta. The project's effect and the CVP effect on the inflow of the San Joaquin are quantified in the June 1980 report on the "Effects of the CVP upon the Southern Delta Water Supply."

Ocean tides affect water levels throughout the south Delta. It takes about 9 hours for the tide to reach Mossdale from the Golden Gate Bridge. The average daily range of water level elevations at Mossdale created by tides is approximately 2.4 feet. The tidal range within the south Delta is affected by the magnitude of export pumping. If water in the south Delta is diverted by the SWP during the rising tide, the incoming volume of water and its corresponding momentum would be diminished, attenuating the subsequent high tide upstream.

Each SDWMP alternative includes a forebay modification which would at least double the capacity of the existing intake gates by installing intake gates farther north of the existing gates.

Moving the forebay intake structure northward would improve water surface elevation in the south Delta because the point of SWP diversion is farther away from the south Delta channels. The Delta channels downstream and north of the existing intake gates tend to have larger cross-sectional areas. Water can be diverted from these channels with less impact upon water surface elevations than would be experienced at the present intake.



Clifton Court Intake Gate

Connecting the CVP to Clifton Court Forebay would also improve water levels in the south Delta. The CVP currently pumps continuously from Old River, which directly affects water surface elevations in south Delta channels. By pumping from the forebay, impacts on south Delta channels would be lower.

In most instances, the channels have aggraded since the first surveys were made in 1913 and in 1933–1934. Natural sediment deposition has decreased the capacity of most of the channels. Channel capacity can be increased by dredging. The increased capacity would both allow for better conveyance and improve water levels and circulation in the channels.

Improved Operational Flexibility and Reliability

In addition to the need for improved water supply conditions in the south Delta, south Delta hydraulic improvements will be needed to meet future local and statewide water demands. The State's yearly net water needs by 2010 are projected to reach 35.6 million acre-feet (MAF). Improved south Delta hydraulics, an enlarged forebay, and a permit for SWP to pump 10,300 cubic feet per second (cfs) would add operational efficiency, water supply reliability, and operational flexibility to both the SWP and the CVP.

Efficient operation of the SWP and CVP would optimize operations to best use the facilities of both projects. DWR and Reclamation are currently negotiating a contract for the SWP to wheel water for the CVP and for Reclamation to sell interim CVP water to DWR. Wheeling water, using the surplus capacity of the California Aqueduct, could increase the capability of the CVP to export water from the Delta, and any water the SWP might be able to purchase from the CVP would increase the SWP's ability to meet future obligations.

The combined capacity of SWP and CVP aqueducts leading from the southern Delta totals about 15,000 cfs—about 10,300 cfs for the California Aqueduct), and 4,800 cfs for the Delta-Mendota Canal. However, the combined export capacity today is limited to about 11,000 cfs to avoid scouring channels near the intake to Clifton Court Forebay during low inflow from the San Joaquin River.

The south Delta alternatives would improve the hydraulics in the south Delta to solve the current SDWA concerns and to allow the SWP to better use its full capability for storing surplus winter flows south of the Delta.

South Delta improvements are needed for offstream winter-banking storage projects. One such project is the Los

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Banos Grandes Reservoir, authorized by the Legislature in 1984. Studies thus far suggest that a reservoir with over 1 million acre-feet of storage capacity would increase dependable supply for the SWP by over 200,000 acre-feet (AF). The studies were based on long-term conditions and assumed the use of the four additional pumps at Banks Pumping Plant, south Delta improvements, as well as federal permits to increase SWP exports to 10,300 cfs. The use of winter banking will add to the reliability of the SWP and to the flexibility in operations to shift monthly export patterns to winter months, when fish are generally less abundant. It will also help limit Delta exports during dry years. If Reclamation participates in the Los Banos Grandes Project, the CVP will also receive added reliability.

Enlarging the forebay or the gate capacity would enable more unregulated flows to be diverted to off-stream storage in the wet season, generally from November through April. If diverted to surface storage, such as Los Banos Grandes, surplus water would either be retained for long-term, carryover storage or made available later in the same year on a normal delivery schedule. This potential for increased diversions during wet periods would increase SWP reliability during subsequent dry periods. The surplus water could also be stored in ground water basins such as the Kern Water Bank. Both of these projects are discussed in Chapter 6 under related projects.

A service area banking program of significant size would also provide more operational flexibility for SWP surface storage facilities north of the banking area, such as Oroville and San Luis reservoirs. During normal years, the drawdown level at Oroville is now limited to ensure sufficient carryover storage to protect the Delta and fulfill minimum delivery needs should the next year be dry. However, if insurance were provided for part or all of the minimum delivery needs through a banking program, this minimum could be lowered significantly and present facilities would provide greater long-term average water deliveries. This same principle could be applied to future SWP reservoirs north of the Delta.

SWP drinking water quality at the intake to Clifton Court Forebay would improve. Operational flexibility provided by the SDWMP will shift exports to the winter, when water quality is generally much better than during summer and fall. In addition, the preferred alternative new intake gate location will divert from a source of better quality water. These improvements will reduce chloride, bromide, and total dissolved solids at the SWP intake.

Water quality for CVP customers could also improve due to the better quality water in northern channels. A new intake at Clifton Court Forebay would also provide more flexibility and reliability for the CVP. The old intake at Old River can serve as a backup unit. If necessary, gates of the old intake can be opened to release water into Old River for agricultural interests.

Reclamation has petitioned the State Water Resources Control Board for a new diversion point at Banks Pumping Plant. With its approval and with DWR pumps operating at full capacity, DWR would be able to wheel more water for Reclamation from the Delta through the California Aqueduct. This would give Reclamation more flexibility.

Contra Costa Canal. Contra Costa Canal, a part of the CVP, is Contra Costa Water District's (CCWD) primary water source. The current intake diverts water from Rock Slough, where elevated salinity content presents water quality concerns for municipal and industrial users at certain times of the year.

Relocating the intake of the Contra Costa Canal from Rock Slough to Clifton Court Forebay is one way to improve the CCWD service area's water quality in the immediate future, in the absence of offstream storage. The relocation would reduce the concentration of sodium, chloride, total dissolved solids (TDS), and hardness in the water CCWD delivers to its customers. Benefits accruing from the improved water quality are measured as savings in costs imparted to residential customers, industrial customers, and municipal water treatment plants. In addition, the relocation would improve system reliability and complement future construction of a reservoir in the service area.

Improved Fishery Conditions

Implementation of the SDWMP would improve fishery conditions by 1) increasing flows down the San Joaquin River past the Old River flow split; 2) shifting exports to winter months; 3) improving the temperature, water quality, and dissolved oxygen in channels; and 4) adding shoreline and riparian habitat.

The present flow split of the San Joaquin River at its bifurcation with Old River during the summer season is approximately 25 percent down the San Joaquin River and

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Typical Rock Barrier

75 percent down Old River. The estimated flow split, when water is not diverted from the south Delta channels by the SWP and CVP pumping plants, is 45 percent down the San Joaquin River and 55 percent down Old River. This flow split is critical to the water distribution and water quality in the Old River area of the SDWA and in the lower San Joaquin River.

A barrier-type facility at the confluence of Old River and the San Joaquin River near Mossdale would reduce the loss of out-migrating salmon smolts by significantly decreasing their diversion down Old River and, hence, entrainment into the SWP pumps. These out-migrating salmon, which pass through this area between February and June, are from the spawn of the San Joaquin fall run. It is believed that once the juveniles are guided down the San Joaquin River past the Old River split at Mossdale, they will be aided by the increasing marine salts and tidal actions in overcoming the attraction of the reverse (north-to-south) flows in the central Delta area caused by SWP diversions, and will then proceed seaward.

The installation of barrier-type facilities at Middle River, Grant Line Canal, and Old River could decrease the entrainment of various resident fish that inhabit the south Delta area upstream of the barriers. This would be particularly beneficial to fish that would tend to move on the ebb tide when the gates were closed.

The ebb closing of the gates would also increase the residence time in the south Delta, possibly increasing short-term phytoplankton and zooplankton production in some areas. Phytoplankton and zooplankton are critical to the food chain. However, high levels of phytoplankton can lead to 24-hour cyclic dissolved oxygen extremes. During daylight hours, photosynthesizing phytoplankton increase oxygen levels in the water column, reaching peak levels in the late afternoons. During the night hours, the phytoplankton, in the absence of sunlight, begin to respire, converting dissolved oxygen to carbon dioxide. The depletion of dissolved oxygen continues through the night, with levels reaching a low in the predawn hours. The depletion of oxygen to levels stressful for resident and migrating fish have been documented in several Delta studies. The increases in water circulation patterns resulting from the operation of barrier-type facilities could help limit the buildup of phytoplankton concentrations in many of the currently stagnant channels.

Increased water circulation could also be a benefit in reducing salt levels in the south Delta by diluting and flushing agricultural return waters. Reduction of local water temperatures through increased circulation could be beneficial to some species of fish, primarily in the increased capacity of lower water temperatures for increased dissolved oxygen levels. The total benefits of increased water circulation would have to be weighed against the effects of altered phytoplankton production dynamics, the reduction of residence time and its effects on zooplankton production, and the impacts of possible increases in channel velocities.

The concept of winter banking could be realized with the full use of the four additional pumps at the Banks Pumping Plant, implementation of the south Delta improvements, and additional storage south of the Delta. This would allow management of export operations to pump when doing so would least affect fish. Fishery conditions could be improved by shifting some exports away from spring and summer months of high fish abundance to winter months of low fish abundance.

Fishery conditions could also be improved by constructing levee setbacks. The new levee would provide more shoreline, and the existing levee would be breached in some areas to create berms for additional riparian habitat.

Improved Navigation

Channel improvements could improve navigation by increasing channel depth. Interconnection of the CVP to Clifton Court Forebay, along with operational modifica-

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tions, could also improve navigation in south Delta channels during low tides.

Improved Flood Protection

The SDWMP will have several benefits to south Delta flood control. Levees affected by the facilities would be upgraded to accommodate the changes caused by construction of the facilities. The levees would be maintained to ensure integrity and safety. The facilities themselves would be designed so that the barrier portion can be partially removed from the channel, thereby freeing floodflows.

Channel improvements, whether by dredging or levee setbacks, would enlarge south Delta channel cross-sections and hence increase channel capacity. With increased capacity, the channels would be able to contain greater floodflows and provide greater protection from flooding. Additional flood control benefits could be realized if the dredged material were used to fortify levees.

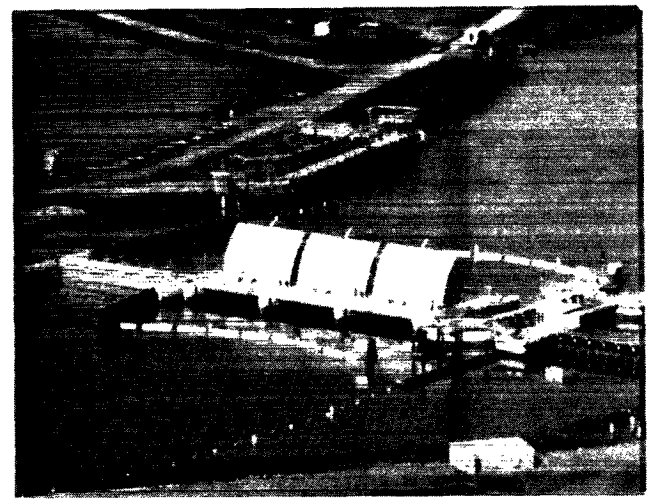
Enhanced Recreational Opportunities

Various components of the SDWMP would enhance recreational opportunities in the south Delta. Proposed channel improvements could lead to additional recreational development. Dredging would make accessible some scenic stretches of channels, such as Old River in the vicinity of Salmon Slough. Levee setbacks would create berm islands and additional shoreline for riparian habitat and recreation. Barrier-type facilities could improve water levels for recreation in some currently shallow or stagnant channels.

Details of potential recreation development can be found in the *Recreation Facilities Plan for North & South Delta* (Ebasco, March 1988). The study presents conceptual-level cost estimates for several suggested recreation areas that can be developed in conjunction with the SDWMP. The recreational development plans are consistent with provisions of the Davis-Dolwig Act, which requires consideration of recreation facilities as part of any new SWP facility.

Project Components

A discussion of the project components used in the alternative plans follows.



Montezuma Slough Gate

Mitigation and Enhancement Barrier-type Facilities

Barrier-type facilities would be installed to directly improve water levels and circulation patterns and meet other SDWMP objectives. The proposed sites are:

- on Middle River about 0.5 mile south of the confluence of Middle River, Trapper Slough, and North Canal;
- on Old River east of Delta-Mendota Canal (DMC) intake;
- on Grant Line Canal east of the SWP facilities; and
- on Old River west of its confluence with the San Joaquin River.

A contract is now being drafted with the SDWA to specify the process of testing and finalizing the mitigation and enhancement barrier-type facilities. An agreement with SDWA could include up to four barriers. In addition, a fishery mitigation agreement may specify a barrier.

Barrier-type facilities will be designed to regulate flows in the controlled channels in accordance with tidal elevation differences on either side of the structure. In general concept, the incoming tide (flood tide) would pass through the open gates of the structure until the tide peaks; then the gates would close to retain the higher water level in the controlled channel. The controlled channel would be the stretch of channel affected upstream of the barrier. For example, the controlled channel of the Old River east of DMC barrier is 18 miles of Old River upstream or east of the barrier.

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After construction, data will be collected regarding operation of the barriers, and water levels, flow patterns and water quality in the south Delta. The draft contract include committees that review and analyze these data and recommend changes in operations to continually improve operation of the barriers for both the project and south Delta local interests.

Different barrier-type facilities could be constructed. The following list describes the types that are being considered for construction. All these facilities could include boat locks.

- *Gated concrete barrier-type facility.* This facility would consist of a gate structure which houses one or more radial gates separated by piers. A flashboard structure would be constructed if needed. The facility would consist of electronic controls to automatically operate gates in response to changes in tides.

  A typical gate structure consists of up to four radial gates, each about 20 feet wide and 15 feet high. Each gate structure will be capable of passing a flood flow of 2,000-5,000 cfs at an average velocity of 6.7 feet per second.

  A typical boat lock structure has a lock chamber 20 feet wide and 70 feet long; a flashboard approximately 70 feet wide is usually provided for emergency access. The cost of such a concrete-barrier type facility with a boat lock structure is about $10 million.

Typical Rubber Dam

- *Inflatable barrier-type facility.* This facility would consist of an inflatable rubber dam anchored to a concrete raft. Electronic controls will be used to inflate and deflate the dam in response to tidal fluctuations or fishery concerns.

  A typical inflatable rubber dam varies from 5 feet to a maximum of 10 feet high and is usually attached to a lightweight concrete raft about 40 feet wide. If maintenance of the rubber dam is necessary, the concrete raft could be refloated. Following the repair work, the concrete raft and rubber dam must be ballasted into position by filling the raft cells with water. The cost associated with this facility is about $5 million.

- *Temporary rock barrier-type facility.* This facility would be similar to the existing weir in Middle River. The weir would be modified to continue operation on a year-to-year basis indefinitely, thereby reducing high capital costs. These modifications would include installing automatic controls for the flap gates, constructing a concrete portage ramp, and acquiring adjoining land to store rock. The annual cost of this facility would be about $100,000.

  These temporary facilities could be also used initially to provide necessary test data so that design and location of the final structures could be completed.

Clifton Court Forebay Modifications

All modifications to the forebay would involve changes in the location and size of the intake structure to the forebay. These changes would allow for more flexible daily SWP diversion patterns, which could improve water levels and circulation in south Delta channels.

The extent to which SWP diversions affect water levels and circulation patterns in the south Delta depends on such factors as the size of Clifton Court Forebay, the size of the forebay intake gates, the location of the intake gates, the daily operation of the forebay intake gates, and the pumping rate at Banks Pumping Plant, as well as the nature of the tidal variation in water surface elevation in the Delta channels, Delta inflows and exports, and local agricultural diversions.

Delta channels typically experience a 25-hour tidal cycle. The hourly distribution of diversions into the forebay during the 25-hour cycle can affect the impact of SWP diver-

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sions on south Delta channels. See Chapter 5 for a detailed discussion of tidal effects on intake gate operations.

The purpose of Clifton Court Forebay is to allow for continuous pumping at Banks Pumping Plant, while the actual diversions from the Delta channels can occur at times in the tidal cycle that minimize the impact to Delta channels. Therefore, Clifton Court Forebay intake gates are opened only periodically during the day in order to fill the forebay.

The daily pattern of diversion into the forebay is also determined by the pumping rate at Banks Pumping Plant. For the existing forebay configuration, the higher the pumping rate at Banks Pumping Plant, the more water that must be diverted into the forebay over a tidal cycle. Increased water diversions cause the forebay intake gates to be opened more often, reducing flexibility in operating the intake gates to lower the impacts of diversions on south Delta channels. Any of the proposed modifications to the forebay will provide more flexibility in operation of the intake gates. All changes to Clifton Court Forebay will increase the capacity of flow through the forebay intake gates.

The rate of flow of water into Clifton Court Forebay is determined by the size of the area of the intake opening and the difference in water surface elevations inside the forebay and outside the forebay in the Delta channel.

Moving forebay intake gates northward should also improve water surface elevations in the south Delta because the point of SWP diversion is farther from the south Delta channels. The Delta channels upstream and north of the existing intake gates tend to have larger cross-sectional areas than those in the south Delta. Water can be diverted from these channels with less impact on water surface elevations than would be experienced in the channels in the south Delta.

Improving the forebay and increasing the capacity of channels upstream of the intake gates should further increase the flexibility of gate operations, even with increased SWP diversions.

New intake. A new intake gate structure for the existing forebay installed at the north end would increase the intake capacity to the forebay and would reduce the impact of gate operations. An intake farther north would cause less channel constriction because it would be near channels with more capacity. The new gate structure would reduce impacts to south Delta water levels and assist in banking winter supplies. Channel enlargements would both improve conveyance and increase channel capacity.

The proposed intake structure is basically the same configuration as that of the existing Clifton Court Forebay intake structure. That facility consists of up to five gates, each about 20 feet wide and 30 feet high. The proposed intake will be sized to divert a peak flow of about 30,000 cfs. The costs associated with a typical intake structure having five radial gates is about $7 million.

Enlarged Clifton Court Forebay. Forebay enlargement options to be considered may include, but are not limited to, Byron Tract, Victoria Island, Coney Island, and the remaining area of Clifton Court Tract. The expansion option would include any combination of these areas that would increase the forebay area from its existing 2,100 surface acres to more than 5,000 surface acres. Some 80,000 lineal feet of levee will be needed for the forebay expansion. Construction costs would be about $1,500 per lineal foot. Any one of the options with a new intake north of the existing intake would minimize the impact of gate operations on water levels in the south Delta and increase winter banking capability. The hydraulic impacts of an enlarged forebay are based on the intake gate location and the surface area of the forebay—not on the configuration of lands used. The environmental assessment discussed in Chapter 5 is therefore applicable to any combined areas being considered to achieve the new forebay size. An evaluation of terrestrial impacts has been conducted for all the lands being considered.

Siphons. Siphons would be used to hydraulically connect the existing forebay to the areas used for the forebay expansion. Each siphon structure would be made up of cast-in-place reinforced concrete conduits about 700 feet long. Dimensions of the conduits would be about 25 feet wide by 25 feet high. Four of such siphons would be capable of conveying flows of 15,300 cfs at a velocity of about 6 feet per second. Provisions will be incorporated into the design to dewater each conduit individually to remove sediment deposits and for general maintenance. The costs associated with a siphon of 15,300-cfs capacity is about $47 million.

An enlarged forebay could allow for the CVP to tie in with the forebay, which would minimize CVP impacts on south Delta channels. The existing forebay with its 2,100 surface acres would make a tie-in with the CVP difficult. At times, the volume of water in the forebay would be insuffi-

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cient for both projects unless the intake gate operations were relaxed; this, however, might adversely affect water surface elevations in the south Delta.

Channel Improvements

A number of channels near the new forebay intake gate will be improved to increase channel capacity and to maintain water levels while meeting increased export rates. The channels considered include Middle River east of Woodward and Victoria islands, Woodward and North Victoria canals, Victoria and North canals. To achieve an adequate cross-sectional area of about 7,200 square feet, channels will be dredged; however, where significant impacts to riparian habitat on levee banks or channel islands would result from dredging, construction of levee setbacks will be considered. By constructing parallel levees and breaching existing levees, additional fish and wildlife habitat would be created.

Additional channels that may be dredged to improve circulation and provide recreational and navigational opportunities include Old River west of Sugar Cut and Middle River between Old River and Highway 4. Dredged material will not be disposed on wetlands.

Connection of CVP with Clifton Court Forebay

Connecting the CVP's Delta-Mendota Canal intake channel to the SWP's Clifton Court Forebay would minimize, if not eliminate, the impacts of CVP pumping at low tides. Four alternatives for the connection were evaluated and are discussed in the following paragraphs.

1. Alternatives 1 and 2. In these schemes, DMC and Clifton Court Forebay would be linked by a new intake channel along the shortest possible alignment to minimize excavation. A new fish screening and collecting facility would be constructed along this new reach of intake channel. Herdlyn Road would be rerouted over a new bridge crossing the new intake channel.

The existing intake channel between the intertie and the present Tracy Fish Facility would be abandoned. Flow from Old River would be blocked by construction of an earthen cofferdam.

Alternative 1 is distinguished from Alternative 2 in the type of fish screening facility used. Alternative 1 incorporates a positive barrier-type facility similar to the concept proposed for the Peripheral Canal in 1982. Alternative 2 uses a louver-type behavioral barrier similar to the existing John E. Skinner Fish Facility, constructed in the late 1960s. Both alternatives are assumed to employ the same type of fish collection facility.

2. Alternative 3. A connecting channel would be excavated south of and parallel to Byron-Bethany Road, downstream of the existing Skinner Fish Facility. With this alternative, the existing Skinner Fish Facility could be used by both projects. However, increased flows through the facility would necessitate an expansion of the facility to ensure proper flow characteristics.

3. Alternative 4. A new intake channel would be excavated to connect DMC to Clifton Court Forebay upstream of the existing Tracy Fish Facility. Modification of the existing fish facility was not included, despite the debate over its present effectiveness. This alternative presents certain construction difficulties. Flows from Old River would be blocked by a compacted dike embankment.

Related Project Components

The following two project components are related to the SDWMP but are not part of the SWP alternative plans. SDWMP will, however, coordinate with these projects to accommodate their needs.

Contra Costa Canal Relocation. Reclamation has been investigating three alternative canal locations that would impact the SDWMP alternatives to some degree. The locations include Clifton Court Forebay, the intake channel between the forebay and Banks Pumping Plant, or the discharge side of the pumping plant on the California Aqueduct. Details of the alternative can be found in the Kellogg Unit Reformulation Study Planning Report/Draft Environmental Statement.

Studies have revealed that a proposed Los Vaqueros reservoir in the Kellogg Creek watershed, in conjunction with an intake relocation, offers the most effective means of improving water quality and increasing system reliability.

Each potential intake location has many advantages. The advantages of relocation to any of them include better and more uniform water quality, close proximity to a larger power grid, and a redundant diversion point for CCWD in case of problems at the Rock Slough diversion point.

Advantages unique to relocating to the Banks Pumping Plant intake channel include close proximity to the proposed Los Vaqueros Reservoir, the possibility of taking

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unused pumping capacity at Banks Pumping Plant on an interim basis, and the possibility of using the Skinner Fish Facility.

Advantages unique to relocating to the discharge side of Banks Pumping Plant include 1) relatively easy construction of the intake to the diversion structure, 2) the possibility of using existing pumps at Banks Pumping Plant during the early years of Los Vaqueros Reservoir [instead of having to build a pumping plant initially], and 3) close proximity to Los Vaqueros Reservoir.

Disadvantages associated with relocating to either the intake channel or the discharge side of Banks Pumping Plant include the possibility of having to increase the capacity of Skinner Fish Facility and the intake channel.

Stanislaus and Calaveras River Basins Water Management Study. In early 1989, DWR, Reclamation, and 15 local water agencies (including SDWA) signed a Memorandum of Understanding to participate in studying the future demands for water in the Stanislaus and Calaveras River Basins Water Management study area and the most efficient means of meeting those demands.

The objectives of the program are to:

- accommodate future water needs of all the involved counties and agencies;
- improve instream flows for the Stanislaus, Calaveras, and San Joaquin rivers;
- improve water quality in the channels of the south Delta; and
- increase CVP and SWP water supplies in the Delta and help meet Delta outflow requirements.

As much as 155,000 AF of New Melones contract water could be released to the SWP in dry and critical years, which would improve water quality in south Delta channels.

Details of the Stanislaus and Calaveras River Basins Water Management Study and other projects that may affect the SDWMP or SWP operations are discussed in Chapter 6.

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Chapter 3. DESCRIPTION AND COMPARISON OF ALTERNATIVES

The narrowing of alternatives utilized a broad range of information that is important to water resources planning. The selection process considered previous studies, activities implemented during droughts, legislative activities, statewide referendums, comprehensive water conservation and reclamation activities, the South Delta Water Management Program (SDWMP) objectives and project operational flexibility. Previous studies evaluated alternatives on the basis of such factors as economics, energy, water supply, fisheries, wildlife, recreation, water quality technological, legal, and institutional constraints, political issues, and compatibility with other proposals. A summary of previous studies and the narrowing of alternatives is provided in Appendix M. Appendix M also contains detailed criteria and assumptions on which the alternatives were compared.

In general, previous studies showed that an isolated facility would provide favorable reliability, fishery protection, and improved water quality when compared to other alternatives such as a physical barrier or through-Delta facility. Recent updates of previous studies showed this same trend. However, the June 1982 voter rejection by State referendum indicated that an isolated Delta facility was unacceptable to the public.

The previous studies also showed that a through-Delta system compatible with the SDWMP would provide significant advantages over existing conditions. Also, extensive programs since 1975 to implement water conservation and reclamation have determined that statewide demands can be reduced by 1.3 million acre-feet (MAF) by 2010. DWR Bulletin 160-87, *California Water: Looking to the Future*, November 1987, as well as this EIR, shows that water development would still be required to accommodate conservation and reclamation, meeting future statewide needs and alleviating current Delta problems.

Figures 3-1 and 3-2 are block diagrams of the California Water Plan and the Preferred Alternative, respectively.

Two categories of alternatives are evaluated in this chapter:

- South Delta Water Management Program alternatives, and
- water supply augmentation and demand-reduction alternatives in project service areas.

Eight SDWMP alternatives and a no-action alternative (base case condition) are evaluated on the basis of overall operation of the State Water Project (SWP) and Central Valley Project (CVP), in compliance with operational considerations discussed later in this chapter. Also, 11 water supply and demand-reduction alternatives were incorporated into the economic analysis discussed later in this chapter. Environmental impacts are discussed in detail in Chapter 5 on the basis of comprehensive water supply, power, Delta water quality, and Delta hydrodynamic studies, assuming 3.3 MAF level of demand. Potential cumulative impacts of related water resources projects are discussed in Chapter 6.

For all alternatives, the four additional pumps are assumed to be installed by the end of 1991. Operation of the Banks Pumping Plant with the four additional units was approved according to U.S. Army Corps of Engineers (Corps) constraints established in Public Notice 5820A, Amended. This operation is discussed in the 1986 *Additional Pumping Units—Harvey O. Banks Delta Pumping Plant EIR*. The no-action alternative includes these constraints. All the SDWMP alternatives include increased export limits.

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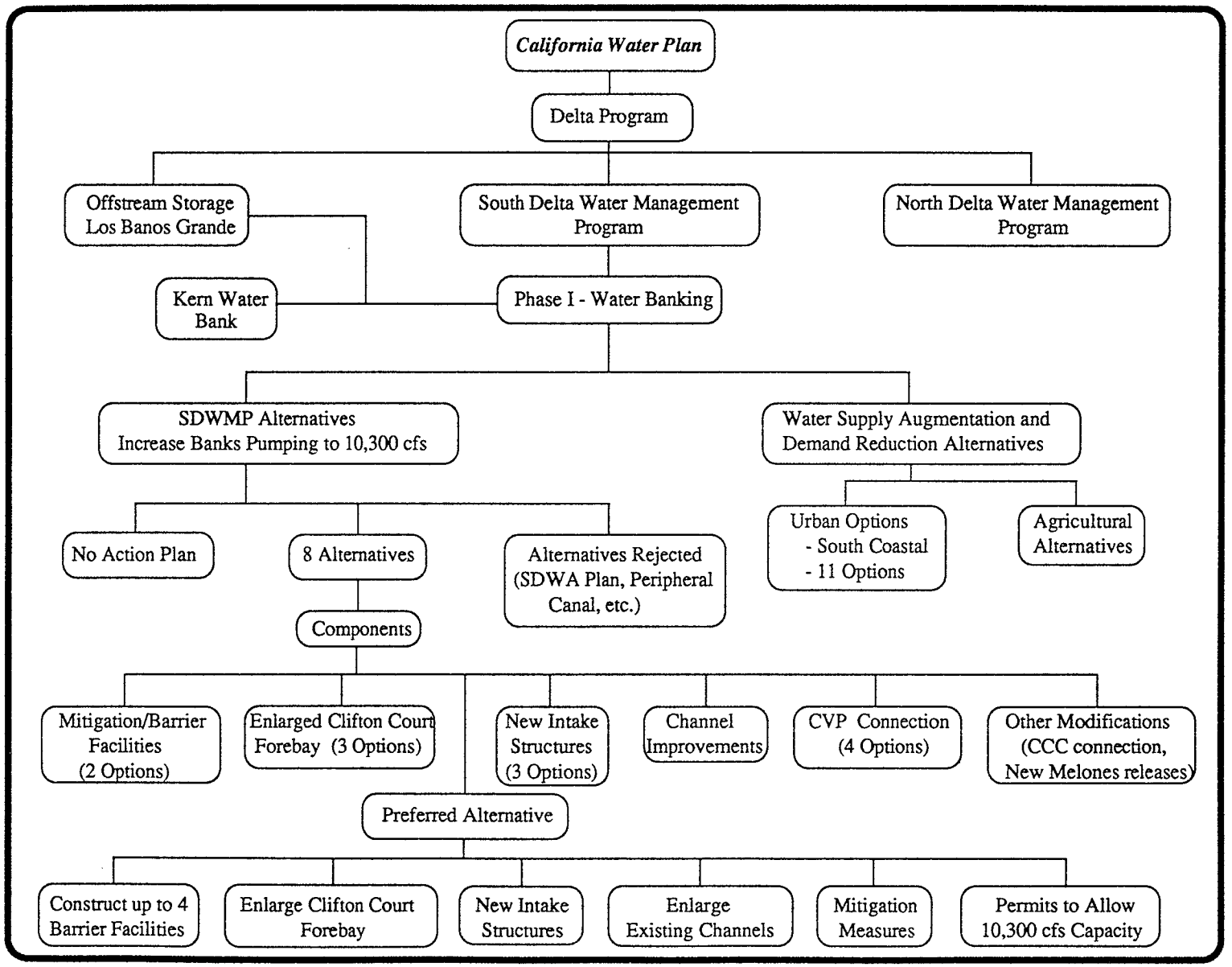

Figure 3-1. The California Water Plan—Block Diagram

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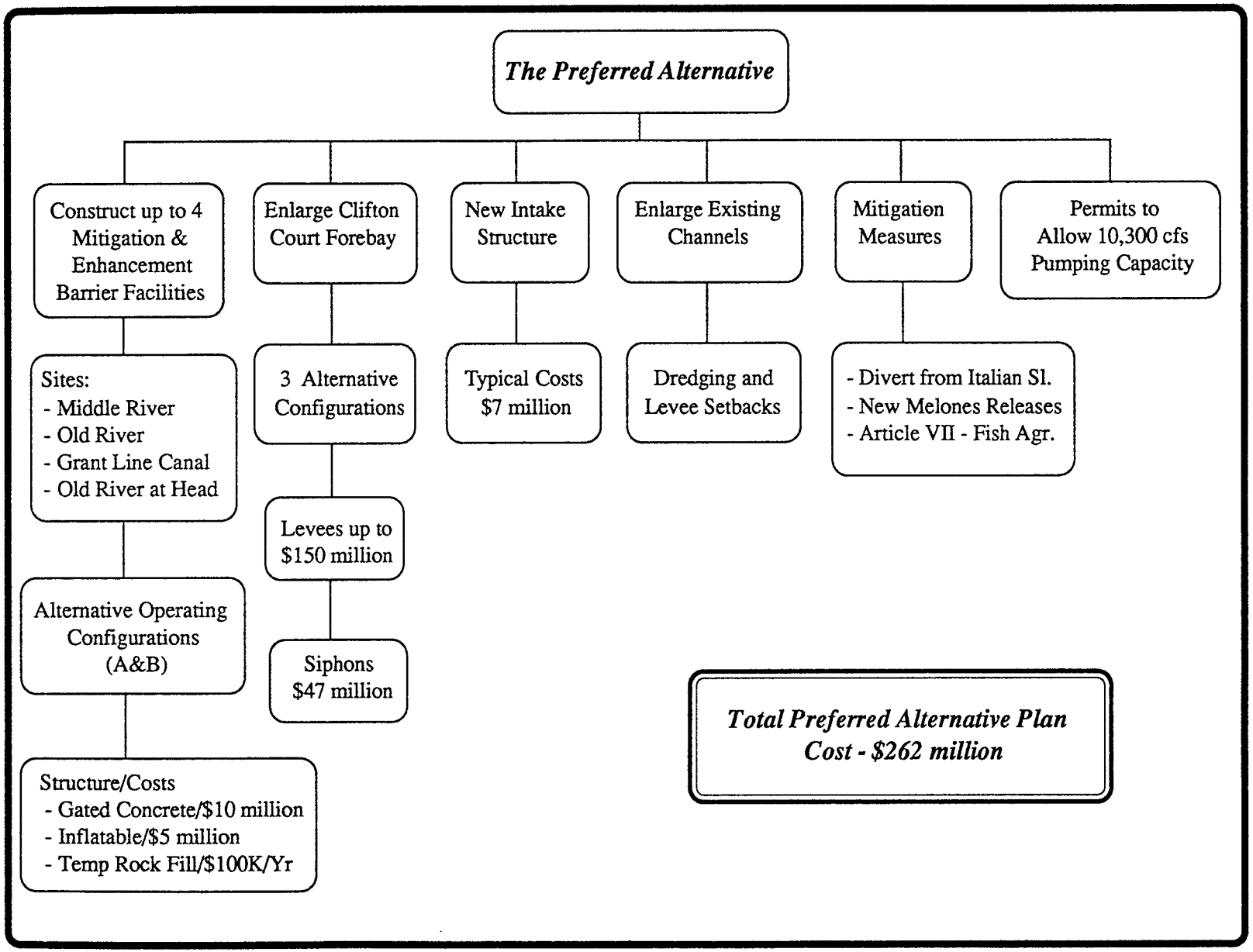

Figure 3–2. The Preferred Alternative—Block Diagram

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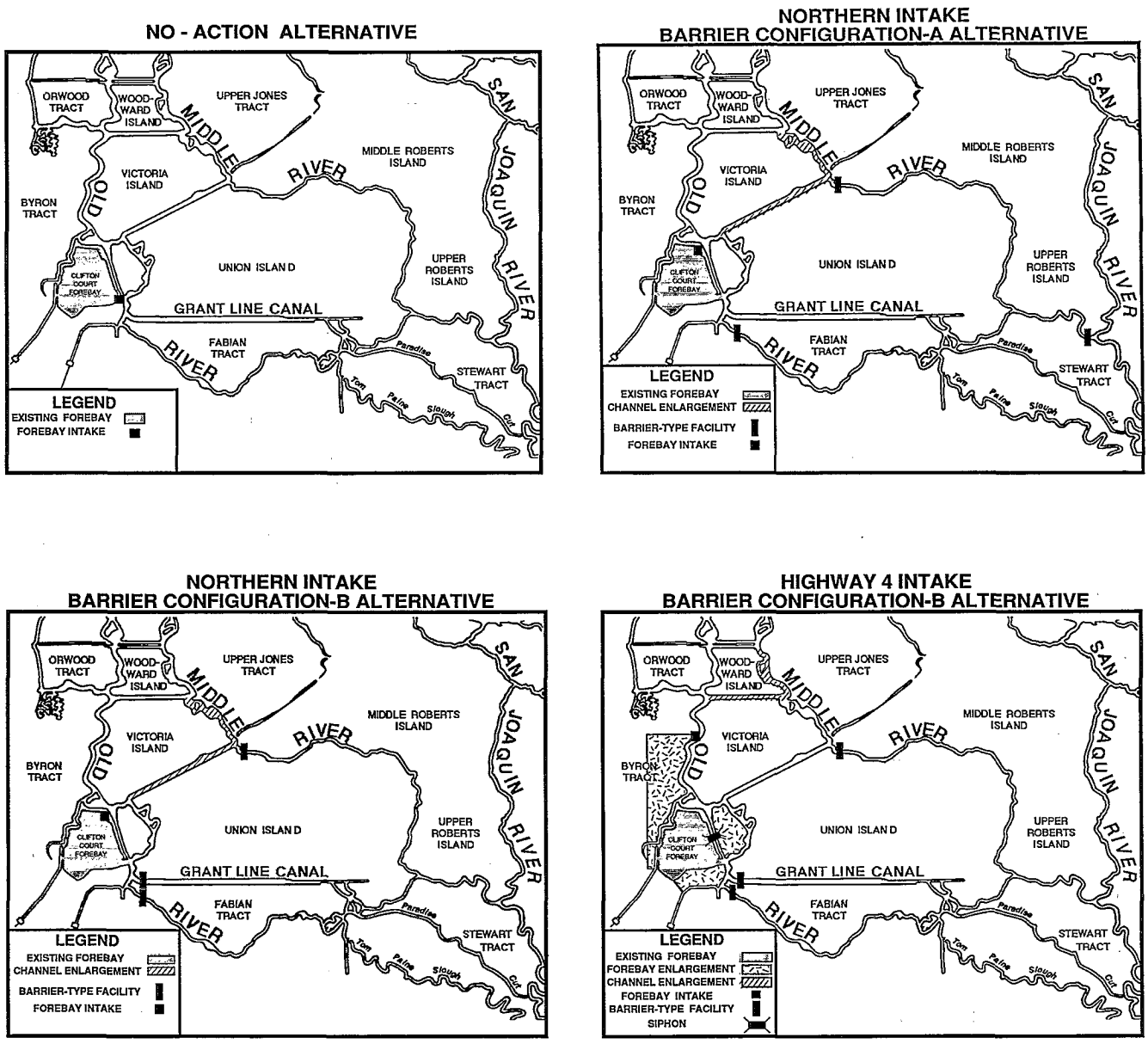

Figure 3–3. South Delta Water Management Program Alternatives

South Delta Water Management Program Alternatives

The no-action alternative (base case condition) represents SWP operations according to existing water rights permits and Corps constraints and without improvements to conveyance capacity in south Delta channels. The preferred alternative is to: 1) enlarge some existing channels to improve conveyance and capacity, 2) enlarge Clifton Court Forebay to more than 5,000 surface acres with new intakes at Old River and/or Middle River, 3) acquire a Corps permit to increase diversion capability to allow for the Banks Pumping Plant capacity of 10,300 cubic feet per second (cfs), and 4) install up to four mitigation and enhancement barrier-type facilities in south Delta channels. (Other aspects of mitigation are discussed in Chapter 5.)

Each SDWMP alternative evaluated is a combination of various project components. The components include mitigation and enhancement barrier-type facilities to directly improve water level and circulation, an enlarged Clifton Court Forebay, new intake structures, channel improvements, and related project modifications. Each of the alternatives analyzed would meet the objectives of the SDWMP. The alternatives were formulated to guarantee evaluation of all the different project components and to show the widest range of impacts. This is to ensure that, if a decision is made for a combination of facilities not discussed in this chapter, the impacts will be lower and the benefits greater than those described in Chapter 5.

The final decision on implementation of a SDWMP will involve contract agreements that will allow for some flexibility in the combination of final barrier-type facilities. The agreements include those with the South Delta Water Agency (SDWA), discussed in Chapter 1, and those with the Department of Fish and Game (DFG), discussed in Chapter 5. The impact analysis of the SDWMP alternatives was designed to consider the contribution of each facility and the impact of combinations of facilities.

In addition to the no-action alternative, the following SDWMP alternatives are being considered:

- Northern intake with barrier configuration A
- Northern intake with barrier configuration B
- Preferred alternative
- Enlarged Forebay - Highway 4 intake with barrier configuration B

Each SDWMP alternative was analyzed with and without the CVP tie-in to Clifton Court Forebay. All the alternatives comply with currently established water quality and outflow criteria. These alternatives are shown in Figure 3-3 and discussed in the section, "Comparison of Physical and Operational Features."

Configurations A and B were selected as conservative tests of water level, water quality, and circulation improvements. Ongoing negotiations for barrier configurations and operations have shown various other combinations and staging that may use all four barriers to provide further benefits beyond those described by configurations A and B. The two barrier configurations were used to analyze the incremental benefits of operating the barriers.

Barrier configuration A was considered in one of the alternatives. That analysis is applicable to the other alternatives as well.

All the SDWMP alternatives would improve water conditions in the south Delta and would require a federal permit for increased diversion capability to 10,300 cfs. With this capability, winter banking using Los Banos Grandes (LBG) would be feasible, reliability of the SWP would increase, and certain improvements for fisheries would also be possible. Analysis of the no-action alternative focused on the effects of continued operation of existing facilities (with the four additional pumps), without any improvements to the conveyance capacity of south Delta channels.

Operational Considerations

Operational considerations for Banks Pumping Plant and Clifton Court Forebay for the alternative evaluations include:

- Decision 1485 protective water quality, flow, and export standards;
- Coordinated Operation Agreement defining the federal commitment to Delta protective standards, and a State/federal sharing formula for water releases;
- power operations to maximize the use of off-peak power to best utilize existing power facilities and minimize costs;
- Corps constraints of historic maximum diversion rates for the no-action alternative;
- mitigation agreements that limit spring and summer export levels;

- increased export capabilities to 10,300 cfs for the SDWMP alternatives and for winter banking;
- future operation of the Kern Water Bank (KWB) and LBG; and
- future project demands, capability, and efficient operations.

These operational considerations are discussed in Chapter 1. More detailed information on hydraulic constraints, pumping plant capacity, and efficient operations is presented here.

Existing Hydraulic Constraints and Banks Pumping Plant Capacity

The existing Clifton Court Forebay provides the storage capacity needed to allow the Banks Pumping Plant to be operated up to its existing pumping capacity of 6,400 cfs, and avoid drawing water from nearby channels during low tides.

Clifton Court Forebay diversions vary in a daily cycle according to tidal fluctuations. Diversions are halted during the day to avoid low-tidal conditions, thus providing a buffer between Delta channels and the pumps.

The gated control structure for Clifton Court Forebay was designed for a maximum instantaneous of 12,000 cfs, but it can pass flows up to 16,000 cfs when a very high tide coincides with minimum water levels in the forebay. Design flow has occasionally been exceeded under conditions of very high flows in the San Joaquin River. During tests in 1974, the peak inflow was about 14,000 cfs.

A regularly changing water level differential between exterior tides and interior Clifton Court Forebay water levels causes daily diversion constraints when the differences converge during hourly operations. Other conditions for forebay gate operations involve minimizing drawdowns and controlling tidal currents and velocities in nearby channels to prevent erosion. Those constraints can restrict gate opening periods to appropriate high-tide conditions. A typical forebay gate operation in relation to tide conditions outside the forebay is shown in Figure 3-4. Daily forebay gate operations is discussed in Chapter 5.

Because of such constraints and the many complex hydraulic variables involved, it is difficult to define the present maximum pumping rate at Banks Pumping Plant that could be sustained on a monthly basis under high flow and tide conditions. However, under the Corps Public Notice 5820A, maximum diversion rates into the forebay would be limited to the historical maximum one-day and three-day diversion rates. That is, 1) DWR would limit operations so that daily diversions into the forebay would not exceed 13,870 acre-feet (AF), and 2) three-day average diversions would not exceed 13,250 AF.

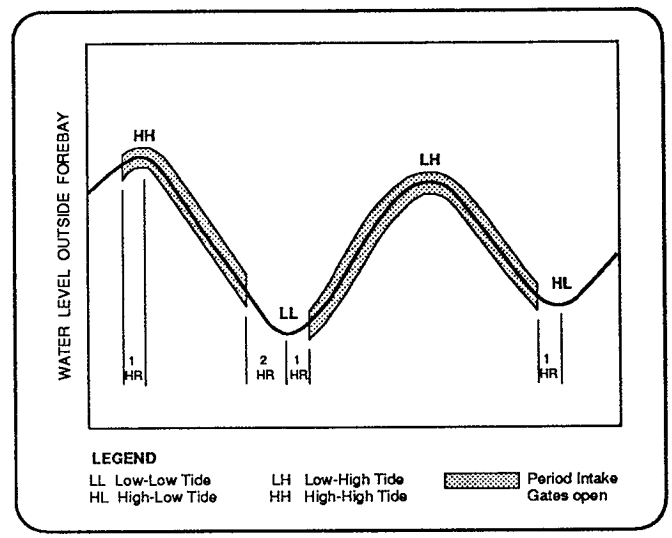

Figure 3-4. Forebay Gate Operation Schedule

With all the SDWMP alternatives, improvements would be made to permit inflow to the forebay of 15,000 cfs, with 30,000 cfs peak capacity. This could allow a monthly average Banks export capacity of 10,300 cfs when certain high-flow conditions exist. These conditions include: 1) water available after Delta protection standards have been met, 2) high demands, and 3) sufficient downstream storage. D-1485 standards would restrict May, June, and July exports. Monthly average exports exceeding 8,000 cfs would probably occur less than 20 percent of the time.

DWR will be applying for a permit to increase exports to 10,300 cfs, while CVP will be maintaining its existing maximum rate of 4,800 cfs.

Comparison of Physical and Operational Features

Each SDWMP alternative will be designated by the forebay intake structure location and the barrier-type facility configuration. The preferred alternative is the enlarged forebay with North Victoria intake, channel enlargement on Middle River east of Woodward Island, up to four barriers, and a permit to increase exports to 10,300 cfs for winter banking.

Tables 3-1 and 3-2 are summary comparisons of the SDWMP alternatives and water supply and demand reduction alternatives. Table 3-1 compares their objectives,

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Table 3–1
Summary Comparison of Alternatives

ALTERNATIVES	PROGRAM OBJECTIVE	COST	ENVIRONMENTAL CONCERNS	COMMENTS
WSDR Alternatives Water supply and demand reduction alternatives, including water conservation, reclamation, and desalination.	Improves water supply reliability	Unit costs listed in Table 3-3 are between $167 and $2,140 per acre feet.	No significant impacts, except for construction of reclamation projects and disposal of brine.	400,000 acre-feet additional water needed 10% of time by 2010 and will probably require implementation of some water supply and demand reduction alternative.
No Action	None	None	None	Impacts for fish not reduced
SDWMP Alternatives All SDWMP Alternatives are able to deliver a maximum of 10,300 cfs out of the Delta. These alternatives are as follow: 1. Preferred 2. Northern Intake Barrier-A 3. Northern Intake Barrier-4 4. Highway 4 Intake Barrier-B	a. Improve water levels and circulation b. Improve water quality c. Improve operational flexibility d. Improve SWP-CVP water supply f. increase recreational opportunities g. Improve fishery (a–g: 1 ++ ++ ++ ++ ++ ++ ++; 2 + + + ++ + + ; 3 + + + ++ + + ; 4 ++ + ++ ++ ++ ++ ++)	Unit costs associated with each SDWMP alternative is as follow: 1. $250/acre-foot 2. $54/acre-foot 3. $59/acre-foot 4. $195/acre-foot	All potential impacts of construction will be mitigated and contractor will be instructed to prevent any inconvenience for the public. Approximately 600 GWh would be an increment to SWP system power requirements. This figure s based on an increase of 172,000AF in pumping at the Banks Pumping Plant in a median year. USF&WS Habitat Evaluation Procedure was used to evaluate the wildlife impacts. Concerns on the losses and gains in Average Annual Habitat Units ,that would occur over the 30-year analysis period, were addressed and investigated. Shifting exports can benefit Striped Bass.	a. Meets California water plan b. Complies with 1984 legislation c. Operational flexibilities to reduce fishery impacts.
Mitigation and enhancement barrier 1. Middle River near Tracy road 2. Old River near DMC 3. Grant Line near DMC 4. Old River at S J. River	Improvements in south Delta channels a. Increase water level b. Improve water circulation c. Improve temperature for fisheries d. Water quality e. Improve Dissolved Oxygen (a–e: 1 ++ ++ + ++ ++; 2 ++ ++ + ++ ++; 3 ++ ++ + ++ ++; 4 + ++ ++)	Costs associated with the barriers are respectively as follow: 1. 10 Million Dollars 2. 10 Million Dollars 3. 10 Million Dollars 4. 5 Million Dollars	Barriers will have either permanent openings or boatlock to accomodate traffic, however; travel time may be increased for barges.	Addresses the law suit filed by South Delta Water Agency
Recreation Opportunities boat ramp picnic area camping area	To increase recreational opportunities concictent with local concerns.	Costs for the studied recreational facilities in the south Delta is approximately 1.5 million dollars.	SDWMP may impact recreational opportunities in Oroville Reservior. Since SWP exports could vary , there may be a minor change in the operation of Oroville and San Luis reserviors.	Potential increase in user days

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Table 3-2
Summary Comparison of Operational Flexibility

ALTERNATIVES	OPERATIONAL FLEXIBILITY
WSDR Alternatives Water supply and demand reduction alternatives, includingwater conservation, reclamation, and desalination	Could delay on reservior releases with ability to generate some monthly operational flexibility if added water supply reliability is not realized.
No Action	None
SDWMP Alternatives 1. Preferred 2. Northern Intake Barrier-A 3. Northern Intake Barrier-B 4. Highway 4 Intake Barrier-B	ALTERNATIVES

	1	2	3	4
a. water banking capability	++	+	+	++
b. intake location to reduce chlorides, TDS, and THMFP	++			+
c. ability to respond to increasingly complex protective standards.	++	+	+	++
d. ability to balance reserved storage between storage reserviors north and south of the Delta while operating tolevels establish-ed by operating rule curve.	++	+	+	++
e. ability to shift from on-peak to off-peak to save energy.	++	+	+	++
f. added storage to react to emergency condition.	++			++
g. ability to reduce impacts on fish by: enabling: 1) shifting of SWP export away from periods of high fish abundance, 2) more frequent closure of Delta cross channel to reduce entrainment of fish into the interior of the Delta, 3) direct SWP diversion from Italian slough in order to reduce predation losses.	++	+	+	++
h. frequency and duration of gate opening to reduce water level impact.	++	+	+	++
i. releases from the forebay to improve local agricultural condition.	++	+	+	++
j. use of the existing intake structure to improve local water quality condition.	+	+	+	+

Mitigation and enhancement barrier

1. Middle River near Tracy road
2. Old River near DMC
3. Grant Line near DMC
4. Old River at S J. River

ENHANCEMENT BARRIERS

	1	2	3	4
a. Barrier in Old River at S.J. River increases downstream flow in the San Joaquin River for salmon				++
b. operated according to tidal action to improve water level and circulation.	++	++	++	+
c. improve water quality, temperature, and dissolved oxygen for resident fish	++	++	++	++

Interim releases from New Melones	Improve water quality, water level, and the flow in San Joaquin River.

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costs, and benefits; Table 3-2 compares their operational flexibility.

Operation of the forebay intake gates varies on the basis of tidal fluctuations with respect to the water level inside the forebay. Flow through the intake gates is controlled by the gate openings. The intake gate operation is discussed in detail in Chapter 5.

To analyze the effect of the different barrier-type facilities, operation schedules were chosen for different water year types, and the impacts with and without the barriers were analyzed. For each SDWMP alternative with barrier configuration B, the barriers are operated on the same schedule for agricultural interests. For the alternative with barrier configuration A, the Old River at the confluence of the San Joaquin River barrier is operated differently for fish interests. Once the facilities are in place, the actual operation schedule can be determined or negotiated.

No-Action (Base Case Condition)

The no-action alternative (base case condition) assumes a 3.3 MAF level of SWP demands and existing SWP facilities, restrictions, and constraints. The hydrologic, hydraulic, and water quality conditions for the no-action alternative (base case) are listed in Appendix C. Fishery, wildlife, and other environmental issues are listed in respective sections of Chapter 5 under "No-Action Alternative."

Under this alternative, no action will be taken. No barriers would be installed, nor would modifications to Clifton Court Forebay and channel improvements be made. Therefore, water levels and water quality in south Delta channels would remain the same, as would reliability of the SWP. Operations will continue under the present Corps constraints, and south Delta concerns discussed in Chapter 1 would continue.

The no-action alternative also would not comply with the agreement between DWR, Reclamation, and SDWA to find a mutually acceptable solution to the SDWA water supply problems (see Appendix B), would not provide the operational capability to feasibly construct Los Banos Grandes, and would not meet future water needs of the State.

Preferred Alternative

The preferred alternative (Figure 3-5) is to enlarge the existing Clifton Court Forebay from 2,100 surface acres to more than 5,000 surface acres, using a portion of Victoria Island. One intake structure would be located at the confluence of North Victoria Canal and Middle River; a second intake structure would be located at the confluence of North Victoria Canal and Old River. About 5 miles of the Middle River east of Woodward Island would be enlarged, and up to four barrier-type facilities would be installed. The barrier-type facilities would be located at Middle River near Tracy Road, Old River near the Delta-Mendota Canal (DMC), Grant Line Canal near DMC, and Old River at the San Joaquin River confluence. The facilities and costs associated with the preferred alternative are shown in Appendix I.

The northern portion of Victoria Island will be used to enlarge the forebay, about 12 miles of levee will be required for the dam embankment, and portions of Byron Tract will be used to hydraulically connect the existing forebay to the new area. The remainder of Clifton Court Tract and Coney Island could also be used in combination with this plan to achieve the minimum 5,000 surface acres if necessary.

As discussed previously, flexibility is an important part of the selection process. For example, the forebay could be enlarged using Victoria Island, but with two intake structures—one on Old River and one on Middle River. Two intakes would have less impact than one because the volume of water entering the forebay from each intake would be lower than if only one was used. Therefore, the velocities and the corresponding impacts in the channels leading to the intake would be less. Details of impacts due to the various components such as intake gate location and barrier-type facilities are discussed in Chapter 5.

Northern Intake - Barrier A

Under this alternative, Clifton Court Forebay would retain its present surface area of 2,100 acres and would remain in its existing configuration. A new intake structure would be constructed at the northeastern corner of the forebay. This would reduce pumping impacts on water levels in the south Delta because of the larger capacity of channels. About 12 miles of the Middle River east of Victoria Island and Victoria and North canals would be dredged to increase channel capacity and conveyance capability. Pumping capacity would be increased to 10,300 cfs. Mitigation and enhancement barrier-type facilities would be installed at Middle River near Tracy Road, Old River near DMC, and Old River at the confluence with the San Joaquin River.

As a result of channel improvements in Middle River and Victoria and North canals, the water level and circulation

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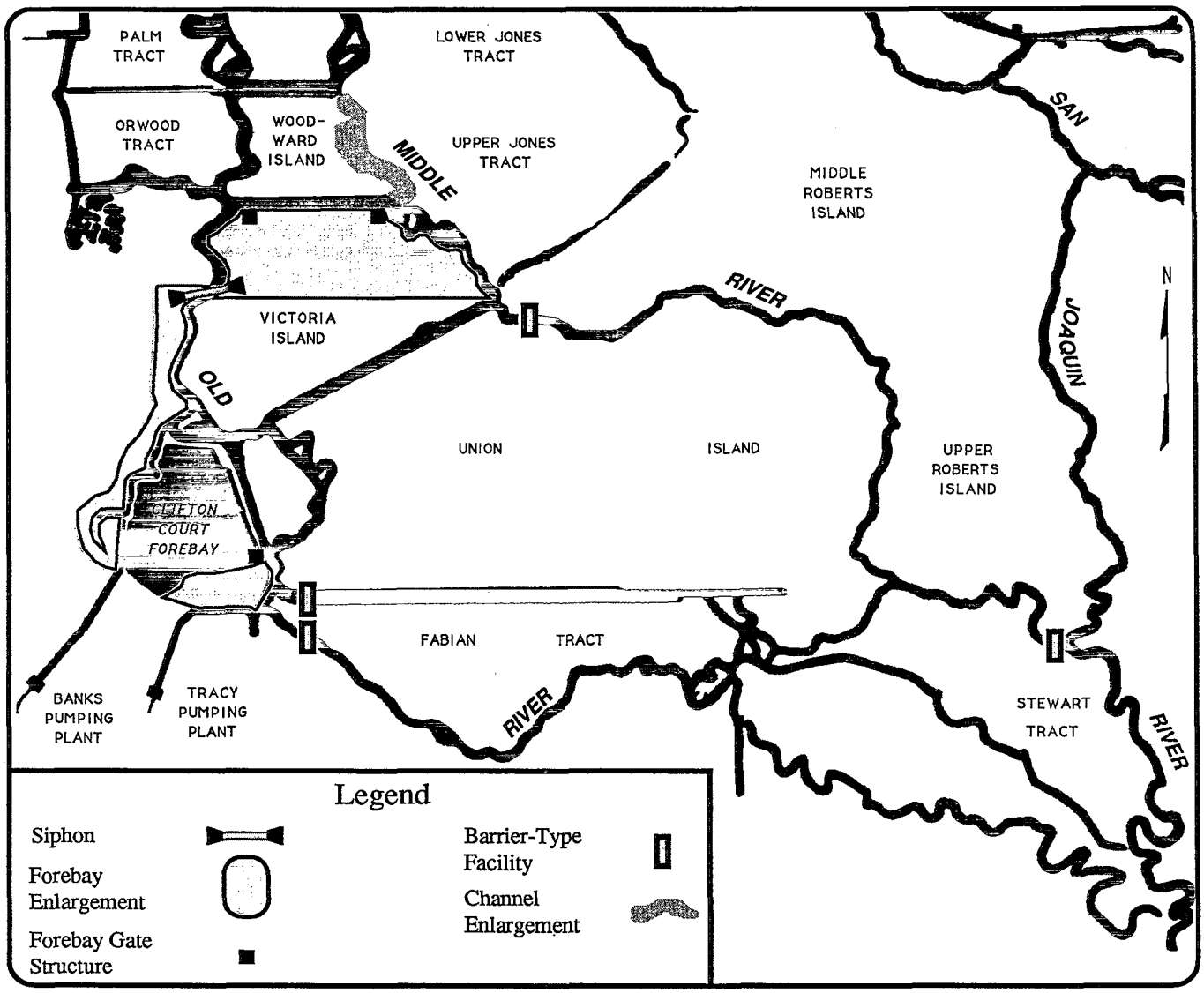

Figure 3-5. The Preferred Alternative

pattern will be improved. Channel improvements could also provide opportunities for additional recreational development and for increased fish and wildlife habitat.

A barrier-type facility on Old River at the San Joaquin River confluence will prevent San Joaquin River flows from entering Old River, thereby maintaining flows down the San Joaquin River. Maintaining flows in the San Joaquin River has historically benefited fisheries by improving the salmon migration route to the spawning grounds. Discussions of the operation of Middle River and Old River facilities and the interconnection with the CVP are presented in the "Project Components" section of Chapter 2. The facilities and costs associated with this alternative are shown in Appendix I.

Northern Intake – Barrier B

This alternative has the same channel improvements and forebay intake relocation as does the previous alternative. The difference is in the location of barrier-type facilities.

The facilities for this alternative would be installed at Middle River near Tracy Road, Old River near DMC, and Grant Line Canal near DMC.

With this plan, flow patterns in Grant Line Canal will change because of the barrier-type facility in Grant Line Canal. With this barrier in place, water levels are raised uniformly along Grant Line Canal. As opposed to Barrier Configuration A, which does not have the Grant Line Canal barrier, the water levels stay relatively unchanged in

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Grant Line Canal. The facilities and costs associated with this alternative are shown in Appendix I.

Highway 4 Intake – Barrier B

The existing forebay would be enlarged from 2,100 surface acres to more than 5,000 surface acres, using some combination of Byron Tract, Victoria Island, the remainder of Clifton Court Tract, and Coney Island. The intake structure would be located just south of Highway 4 on the northeastern corner of Byron Tract. About 10 miles of the Middle River east of Woodward Island and Woodward and North Victoria canals would be enlarged. Barrier-type facilities will be installed at Middle River near Tracy Road, Old River near DMC, and Grant Line Canal.

If Byron Tract were used for the forebay enlargement, the alignment of the new embankment would be Old River on the east, Highway 4 on the north, and Italian Slough on the south. The new embankment on the west will run north-south to yield 1,600 surface acres of additional forebay. The required dam embankment will be approximately 60,000 lineal feet. A siphon could be used to hydraulically connect Coney Island or Byron Tract to the forebay; another option would be to channel around the west end of Italian Slough.

Using Coney Island would add about 900 surface acres of forebay and would require about 28,000 lineal feet of dam embankment.

Enlargement into the remainder of Clifton Court Tract would add some 400 surface acres. The additional area is bordered by Byron Bethany Road on the west, Herdlyn Road on the south, and Reclamation transmission lines on the east. About 11,200 lineal feet of new embankment will be required. The height of the embankment will vary from 5 to about 15 feet. The facilities and costs associated with this alternative are shown in Appendix I.

Water Conservation And Demand Reduction Alternatives

California will meet its future water needs primarily through a wide variety of management actions designed to supplement, improve, and make better use of existing systems. These include reduction of demand for additional surface supplies through water conservation, water reclamation, and desalination.

For the SWP, the present dependable supply is about 2.3 MAF. DWR Bulletin 160-87, *California Water: Looking to the Future*, November 1987, projected water requirements for the SWP service area in year 2010 to be about 3.6 MAF, assuming: 1) 250,000 AF of water conserved in the Colorado River Region becomes available, 2) waste water reuse increases of 200,000 AF in SWP service areas, and 3) substantial urban water conservation measures are implemented through 2010. Under these assumptions, the SWP service area would have a deficit in dependable supplies in 2010 of some 1.3 MAF, in addition to ground water overdraft. This deficit prediction, however, has probably been underestimated for the following reasons:

- Population growth in the South Coastal Region has been much faster than was projected in Bulletin 160-87. To date, the population is about 0.5 million higher than was estimated for 1990.
- Los Angeles Department of Water and Power (LADWP) has been diverting up to 100,000 AF per year from the Mono Lake Basin. The average diversion from 1970 through 1988 was 84,000 AF per year. The recent Superior Court ruling, which mandated drastic cuts in the city's diversions, could reduce LADWP supplies by about 60,000 AF per year.
- Some ground water supplies have been lost due to chemical pollution of ground water basins.

Major water management actions that could offset the predicted deficit consist of:

- water supply additions consisting of the SDWMP, the North Delta Water Management Program (NDWMP), LBG , and KWB;
- increased water conservation measures; and
- other demand reduction measures.

Water Conservation

Following the statewide drought of 1976-77 and the subsequent formation of the Office of Water Conservation (OWC) in 1979, DWR began an aggressive water conservation program to help local agencies achieve efficient use of California's limited water resources through promotion of water conservation policies and practices that would have the greatest public benefit consistent with sound resource conservation principles. Through the OWC, DWR, has administered several plans and programs that encourage efficient use of water, and has focused on cost-effective urban and agricultural conservation programs carried out cooperatively with local agen-

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Table 3-3. Urban and Agricultural Water Conservation Programs

Urban Water Conservation Programs

Landscape Water Conservation. This program promotes water-efficient landscapes by co-sponsoring conferences, assisting water districts in promoting lawn-watering guides, providing information about water-conserving landscape guidelines, and offering training in landscape water management techniques. (1976)

Water Management Planning Assistance. Through this program, DWR has provided assistance to water agencies preparing water management plans. Assistance includes information on how to develop water management program,s, how to schedule the program implementation, and to write and adopt the plan itself. (1983)

Residential Retrofit Program. Technical assistance is provided on how to set up retrofit programs, and offers retrofit kits to communities facing a water emergency. (1977)

Low Interest Loan Program. This program assists local public agencies that can save water through capital improvements by providing low-interest loans for voluntary, cost-effective, capital outlay water conservation projects. Typical projects include lining or piping irrigation ditches and replacing water mains. (1984-1988)

Water Audits and Leak Detection. Saving water lost to underground leaks is the aim of this program. It offers technical assistance to water agencies for locating leaks and estimating losses from piped water distribution systems. Training and leak detection equipment that can be borrowed at no cost is provided by DWR headquarters and four district offices. (1982)

Conservation Information. Through this program, DWR develops water conservation materials and disseminates this information to various groups. It also assists water agencies, local government, and others in developing or expanding their water conservation public information programs. A news letter, *Water Conservation News,* is published quarterly, providing current information on water conservation programs to local, state, and national levels. (1979)

Water Education. The program works with local water purveyors to implement water education programs for children, offers curriculum materials for kindergarten through high school, and cooperates with local water agencies in sponsoring teacher training workshops. In addition, DWR staff members participate in education fairs, workshops, and conferences exhibiting materials and providing hands-on workshops at these events. (1977)

Industrial Water Conservation. The goal of this program is to develop and implement water saving techniques for industrial processes through identification of generic water use reduction measures that can be applied to industries and industrial processes throughout the State. (1986)

Water Reclamation. This new program is designed to facilitate the implementation of water reclamation programs. It emphasizes bringing potential buyers and sellers of reused water together with regulatory agencies to initiate more water reclamation projects. (1989)

Agricultural Water Conservation Programs

Agricultural Drainage Reduction Program. This program helps growers with improvements in irrigation practices on the west side of the San Joaquin Valley in order to reduce the volume of toxic drainage water, which has to be treated and/or discharged. It provides information to growers to help them determine when to irrigate and how much to apply; evaluates irrigation systems and suggests management changes to improve the efficiency of water applications; and demonstrates how irrigation technologies, such as subsurface drip irrigation and volumetrically controlled furrow irrigation. (1985)

Technical Assistance in Irrigation Management. This area has three basic programs: 1) *Irrigation Systems Evaluations* provide recommendations to irrigation managers on irrigation system management for more uniform distribution of applied water. Six teams of trained technicians travel to growers' fields in mobile labs and provide one-time evaluations of the management of the irrigation system. 2) *Cost-sharing grants* are also available to help water purveyors establish irrigation water management programs for their water users. 3) In addition, an *Irrigation System Evaluation Short Course*—attended by water/irrigation district staff members, growers, irrigation consultants, and turf managers—is given twice a year.

California Irrigation Management Information system (CIMIS). This program uses an automated electronic weather station network to provide real-time evapotranspiration (ET) information to growers statewide., Weather data are recorded by more than 50 weather stations throughout California and transmitted daily by telephone to the central CIMIS computer. The central computer estimates the ET rate of irrigated pasture at each weather station site. The ET rate multiplied by a crop coefficient results in an estimate of the crop's ET. Accumulated crop ET can be used to help make decisions on when to irrigate and the amount of water needed to replenish soil moisture. (1980)

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cies throughout the State. Legislation has also been adopted to encourage and improve water conservation in the State. The two most recent significant pieces of legislation are: 1) the Urban Water Management Planning Act of 1983 and 2) the Agricultural Water Management Planning Act of 1986. Both require the larger water suppliers, under certain conditions, to prepare water management plans.

More than 300 urban water suppliers have prepared water management plans under the Urban Water Management Planning Act. These plans identify many current and future water conservation programs. California's agricultural sector has also been developing and implementing ways to reduce on-farm water use. This conservation effort has been broad-based, involving various public institutions, private industries, and farmers. DWR has provided leadership, technical and financial assistance, publications, and supported legislation to promote water conservation in the State.

Table 3-3 summarizes current urban and agricultural water conservation programs in place in California. DWR is committed to continue and expand water conservation measures in the future. Current estimates indicate that statewide conservation will save 1.3 million AF of water annually by year 2010, including planned and potential Imperial Irrigation District water salvage of 450,000 AF. More than half of this savings (700,000 AF) would be in the SWP service area.

Other Demand Reduction Measures

The demand reduction measures discussed here are extraordinary conservation options. Extraordinary options are those that go beyond the conservation measures identified in DWR Bulletin 160-87. Shortage Management Contingency Options (Table 3-4), and long-term options (Table 3-5) are discussed in detail under "South Coast Region."

Demand reduction measures will help offset the 400,000 AF shortage that is expected to occur in dry years by year 2010, assuming that water supply additions and water conservation measures identified in DWR Bulletin 160-87 are in place.

Water conservation measures, in conjunction with existing and planned demand reduction measures, would help reduce the water delivery shortfalls projected for year 2010. However, these measures alone will not adequately address the water management issues surrounding the Delta or the projected needs of the State's growing population. In addition, water supply and demand reduction measures alone will not meet SDWMP objectives because:

- they will not provide for operational flexibility of the SWP. Additional operational flexibility of the SWP can achieve winter banking and provide for fishery benefits in the south Delta.
- they will not provide the required improvements in water quality, water level, or circulation patterns in the south Delta.

For these reasons, the SDWMP preferred alternative, in conjunction with continued and increased use of water conservation and reclamation practices, is needed to meet the multi-objective goals planned for the Delta.

Economic Analysis of Water Supply and Demand Reduction Alternatives

The analyses that follow were prepared by region. Because of the detailed information available for the South Coast Region and its relative importance, a sophisticated risk management analysis of this region was used and is described in detail. The approaches used for the other regions were less comprehensive and are therefore less detailed.

South Coast Region

South Coast Region alternatives were evaluated by predicting what reasonable water management programs in the region would look like both with and without the availability of the proposed facilities.

The approach taken in this analysis takes a comprehensive view of water supply reliability, incorporating key information on the frequency, size, and impacts of shortages. Local water managers (and users) must respond primarily to actual year-to-year fluctuations in water supply availability rather than to an average supply. As shortages increase in magnitude and regularity, shortage management becomes an increasingly important tool for the local water manager. Shortage management contingency options have been incorporated in the economic risk management analysis prepared for the SDWMP.

The analysis also incorporates a means to account for the value of avoiding extreme shortage events. Summary statistics, such as firm and average yield, do not reflect that one event of a specified shortage amount can be much

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Table 3-4
M&I Shortage Contingency Options in the South Coast Region
(In expected order of Use)

Option	Maximum Potential Effect	Use Constraints
1. Institute public relations campaign to heighten conservation awareness, use alternate-day watering, gutter-flooder patrols, etc.	7% of demand	Implementation limited if local stored water situation is excellent compared to shortage.
2. Cut back on deliveries to MWD member agencies for ground water recharge through spreading.	140 TAF[1]	Frequency of cutbacks affects participation in interruptible program.
3. Purchase emergency imported supply through long-term water marketing agreement.	50 TAF	Purchase frequency not to exceed once every five years.
4. Cut back on deliveries for ground water recharge through in-lieu agreement with with MWD member agencies.	35 TAF	Frequency of cutbacks affects participation in interruptible program.
5. Cut back on deliveries to MWD member agencies for reservoir carryover storage.	175 TAF	Frequency of cutbacks affects participation in interruptible program.
6. Use local reservoir carryover storage.	As available	Rule curve limits use.
7. Use local ground water banked within the service area in previous year.	As available	Rule curve limits use.
8. Use local ground water banked through an exchange agreement with another agency.	As available	Rule curve limits use.
9. Cut back on deliveries to MWD member agencies made under the interruptible agricultural delivery program.	74 TAF	Cut back only after shortage in previous year and 3-year cumulative cut not to exceed 100%.
10. Cut back on deliveries to MWD member agencies made under the interruptible sea water intrusion barrier program.	50 TAF	3-year cumulative cut not to exceed 100%
11. Institute a rationing program designed to minimize adverse economic impacts (provide for business exemptions based on economic hardship).	NA	Not imposed unless 20% shortfall remains after foregoing measures.

[1]thousand acre-feet

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Table 3-5
Local Long-Term Options — South Coast Region

Order of Use	Local Option Type	Product (TAF)	Cum. Product (TAF)	Unit Cost ($/AF)	Total Annual Cost ($1,000)	Cum. Cost ($1,000)
1*	Water reclamation (set 1)	51.8	51.8	167	8,654	8,654
2	Ultra low flush toilet retrofit	290.0	341.8	287	83,230	91,884
3	Residential water audits	94.7	436.5	291	27,558	119,442
4*	Water reclamation (set 2)	50.3	486.8	389	19,591	139,033
5	Riverside County drainage desalting	42.0	528.8	532	22,344	161,377
6	South Coast Ground water desalting	78.0	606.8	579	45,162	206,539
7	San Joaquin Valley drainage water desalting	375.0	981.8	580	217,500	412,039
8*	Water reclamation (set 3)	25.4	1,007.2	625	15,870	429,909
9	Imperial drainage water desalting	302.0	1,309.2	674	203,548	643,457
10*	Water reclamation (set 4)	19.0	1,328.2	785	14,909	658,366
11	Seawater desalting	4.8	1,333.0	2,140	10,272	668,638

*These groupings are based on unit cost; for more details, see Appendix E.

more damaging than two events of half that magnitude, for example. This is particularly true when there are intervening years of no shortfall in the latter situation and when shortage management can mitigate some of the impacts of the smaller shortages.

Looking at year-to-year water supply availability in the context of what local shortage management contingency options can and cannot do to mitigate adverse impacts, and relating those impacts to shortages of specific sizes, is critical to assessing the value of enhanced reliability. This is especially important in light of the increasing environmental and economic costs of enhancement. The economic risk analysis evaluates the economic feasibility of the level of reliability enhancement provided by any combination of facilities in light of the shortage management techniques locally available.

Local water management program options were divided into three categories:

- shortage contingency demand management and supply enhancement options;
- long-term demand management and supply enhancement options; and
- risk management

Shortage Management Contingency Options. Contingency water management options are measures implemented during shortages only (although they may be based on long-term plans and/or agreements) and are intended to minimize the impacts of those shortages. Such measures include: 1) use of banked local ground water, 2) use of local carry-over surface storage, 3) reduction of water deliveries to interruptible programs, 4) purchasing water to augment normal sources of supply, 5) instituting extraordinary conservation measures, and 6) rationing.

The extraordinary conservation measures include: alternate-day watering, water patrols, emergency water pricing programs, and intensive public education campaigns. Rationing is assumed to include the setting of allowable use quantities and the provision for exemptions due to extraordinary hardship for residential users and adverse economic impact (e.g., forced layoffs) for businesses due to the severity of the shortage.

See Table 3-4 for a list of shortage management contingency options, the limit of their effect on demand, and their expected order of use. These options are assumed to be available in the South Coast Region throughout the study period.

Long-Term Options. Local long-term water management options to increase reliability that were considered included: 1) waste water reclamation, 2) desalinization of

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brackish drainage and ground water, 3) desalinization of sea water, and 4) the development of water by importation, using long-term conservation facilities in other geographic areas. Also included was the retrofit with ultra low-flush toilets and leak detection programs in the service area. All these programs are extraordinary measures; i.e., they are beyond those assumed to be used in DWR Bulletin 160-87 and are intended to develop and/or conserve water continuously.

Table 3-5 is a summary list of local long-term options available in the South Coast Region. The options are ranked in the assumed order of implementation (based on using those with the lowest unit cost first). Unit cost, total cost, and water produced or conserved by each option, and both cumulative costs and quantities are also shown in Table 3-5. The water reclamation options are weighted average values for individual projects. The options are described in the following paragraphs and are also described in detail in Appendix E.

1. *Water Reclamation (Set 1). See Appendix E.* Includes 10 projects producing a total of 51.8 thousand acre-feet (TAF) at a weighted average cost of $167 per AF.

2. *Ultra-low-flush toilets* use 1.6 gallons per flush (gpf), compared to about 5.5 gpf for conventional toilets installed before 1978 and 3.5 gpf (low-flush) toilets installed beginning in 1978. (State legislation requires the installation of 3.5 gpf toilets after 1977.) For Bulletin 160-87, it was assumed that 1.6 gpf toilets would be required in all new construction after January 1, 1995. State legislation is pending. If most 5.5 gpf toilets were replaced with 1.6 gpf toilets, at a minimal savings of 0.018 AF per person per year, the potential savings is 290,000 AF per year. This program would require a 10-year conversion period.

3. *Residential water audits* would be conducted by water agency representatives as a result of aggressive promotional campaigns by the water agency. The audits are free to the property owner but they are voluntary; thus the number of households benefiting from the audit was estimated at 50 percent. Under the program: 1) water uses are identified and discussed with householders, 2) low-flow shower heads,toilet tank displacement dams, and faucet aerators are offered for installation by the agency, 3) toilet leaks are repaired, and 4) advice on reducing landscape and other exterior water uses is provided. Water savings are estimated to be 94,700 AF per year.

4. *Water Reclamation (Set 2). See Appendix E.* Includes 17 projects producing a total of 50.3 TAF at a weighted average cost of $389 per AF.

5. *Riverside County Drainage Water Desalting.* Water provided from this source was assumed to be available directly for urban use. The quality penalty (substitution of 500 milligrams per liter [mg/l] total dissolved solids desalted water for 280 mg/l SWP water) was considered in estimating the cost. Estimated yield is 42,000 AF/YR by 1990 and thereafter.

6. *South Coast Region Ground Water Desalting.* Locations and quantities of desalted water available from this source are:

County	Annual Yield (AF)
Ventura	10,000
Los Angeles	12,000
Riverside	17,000
San Diego	20,000
San Bernardino	19,000
Total	**78,000**

7. *Drainage Desalting.* A program of desalting brackish agricultural drainage water would allow further local reuse of that water as a substitute for water imported from the Delta so that more water would be available to Southern California. Whereas the quality of imported water (280 mg/l TDS) would differ from that of the desalting product water (500 mg/l TDS), blending small desalting product water flows with the very much larger imported water flows would make little difference until the amounts of desalting product water reached very high levels.

Due to the complexity of the water transfer facilities, no attempt has been made to calculate those differences, even with the maximum potential flows of desalting product water. The estimated potential annual yield of desalted drainage water is 375,000 AF/YR. This assumes that only drainage water from the Tulare Lake Basin is totally captured for desalting. Drainage water in the San Joaquin Basin will probably continue to be discharged to the San Joaquin River as long as water quality objectives in that river are met.

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8. *Water Reclamation (Set 3). See Appendix E.* Includes 8 projects producing a total of 25.4 TAF at a weighted average cost of $625 per AF.

9. *Imperial Drainage Water Desalting.* Imperial Irrigation District could use desalted agricultural water in lieu of Colorado River deliveries. As with the Imperial Valley conservation and transfer alternative, Metropolitan Water District would then divert a corresponding amount from the Colorado River Aqueduct. The costs of desalting and transportation through the aqueduct, as well as the cost of substituting poorer quality Colorado River water for urban use, was taken into account.

   The small benefit to irrigated agriculture of using higher quality desalted water (500 mg/l TDS) rather than Colorado River water (700 mg/l TDS) was not subtracted from the cost of this alternative because of complexities such as leaching requirements. Estimated yield is 302,000 AF by 1990 and thereafter.

10. *Water Reclamation (Set 4). See Appendix E.* Includes 6 projects producing a total of 19.0 TAF at a weighted average cost of $785 per AF.

11. *Sea Water Desalting.* In sea-water desalting, reverse osmosis (RO) is now competitive with more traditional forms of desalination, even in the case of a dual-purpose project involving both power production and desalting. In the past, desalting combined with power production almost automatically meant a distillation process using waste heat from the power plant. This is no longer true for the current RO plant designs with improved membranes and energy recovery turbines.

Risk Management. Another long-term management strategy evaluated was the explicit evaluation of risk with regard to the optimal level of use of the long-term management options. Using this strategy calls for explicitly evaluating the economic cost of shortages based on their expected frequency and magnitude and in the light of available contingency shortage management measures. The results of that evaluation are then used in conjunction with an analysis of the cost and effectiveness of available long-term water management measures to determine which of these measures are reasonable from an economic standpoint. DWR provided testimony regarding the benefits of using this approach during the recent SWRCB Bay-Delta Hearings (DWR 460).

Tulare Lake Region

Agricultural Users. For individual farmers using SWP agricultural deliveries in this region, local options for water supply and demand management include:

- Pump ground water (if farm overlies a ground water basin).
- Increase on-farm water application efficiency.
- Exchange supplies within the local water agency from areas with alternative supplies to those without.
- Stress crops by not meeting full evapotranspiration requirements.
- Reduce planted acreage of annual crops.

Based on the 1976-77 drought experience, which included the drilling of many additional wells, it is reasonable to expect that any additional increment to SWP delivery curtailments due to the absence of the SDWMP will be compensated by local ground water pumping. For areas that do not overlie ground water, the 1976-77 experience demonstrated local water agency flexibility in setting up contingency exchanges with those areas with available supplies.

Reinforcing this expectation is the fact that potential net water savings from increased on-farm efficiency in the Tulare Lake region are small to non-existent because of already high on-farm and basin efficiencies. In addition, crop stressing is a high-risk strategy and leaving non-program farmland idle is costly.

The cost of using ground water as an alternative in the Tulare Lake Region includes the cost of energy for the additional pumping in the year of curtailment related to the absence of the SDWMP and the cost of managing any exchange programs necessary to get additional water to areas without ground water pumping capability. Also, because the Tulare Lake Region is in a condition of long-term ground water overdraft, the additional pumping in any single year will cause an increase in pumping depth, which will result in a long-term increase in all pumping costs. A conservative estimate of these pumping costs impacts made for this report is $75 per AF. This estimate was based on a March 1985 DWR San Joaquin District Memorandum Report, *A Method for Estimating the Value of Surface Water in Conjunctive Use Areas.*

Because of the long-term overdraft, the absence of the SDWMP will accelerate the point at which agricultural

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ground water pumping becomes uneconomical, or water quality becomes unacceptable for crop production. The net economic cost of the future loss of irrigated acreage was assumed to be at least as costly as the ground water pumping alternative described above.

Municipal and Industrial Users. SWP M&I users in the Tulare Lake Region were assumed to have the same capability for ground water pumping and/or contingency exchange as the agricultural users in the region. The cost of these alternatives to the M&I users was assumed to be at least as high at the current cost of the M&I supply minus the cost of local treatment and delivery. This value was estimated to be $230/AF based on a DWR water price survey.

Sacramento River Region

The M&I water users in this region are assumed to have access to local surface water as a supply management option. Using the weighted average SWP equivalent unit water cost of $21 per AF as a conservative alternative cost, DWR assumes that the cost of using the alternative supplies is at least as great as the cost of the current SWP supply. DWR Bulletin 132-89, *Management of the California State Water Project,* November 1989, was the source of the equivalent unit cost.

South Lahontan Region

SWP deliveries are made to this region for both agricultural and urban uses. Because of the rapid urbanization taking place and the absence of supply options, urban users depend on both the phasing out of local agriculture and an increase in SWP deliveries to meet their future needs. Even with the use of additional local water exchanges and extraordinary shortage-management programs, the growth in urban demands will result in even more frequent and severe economic losses due to shortages. Without the SDWMP, this situation would be worsened.

Colorado River Region

Water management options in this region include additional waste water reclamation and water sharing with agricultural users on a contingency basis. The frequency and extent of sharing would have to be restricted to avoid unacceptable economic impacts within the agricultural sector. The acceptance of additional economic risk would also be a likely consequence of the absence of the SDWMP.

San Francisco Bay Region

Water management options in this region include additional wastewater reclamation, water exchange agreements among local water agencies, and the acceptance of additional economic risk. It is reasonable to assume that the value of the alternatives will exceed the current value of urban water of about $440 per AF. This value was obtained from a DWR water price survey.

Central Coast Region

The situation in this region is characterized by costly water supply options in the face of increasing use due to population pressure. After assuming extraordinary conservation measures, consisting of an ultra-low flush toilet retrofit program and residential water audits, a combination of local water supply options will be required to meet urban demands. These options include reservoir construction ($800 per AF), pipeline construction ($435 per AF) and sea-water desalinization ($2,140 per AF). This conclusion was the result of research conducted for the Coastal Aqueduct EIR being prepared by DWR. In light of those costs, it seems reasonable to assume that shortage contingency demand and supply management strategies similar to those used for the South Coast Region analysis would be applicable to this region. Accordingly, the cost of local alternatives in this region were assumed to be proportional to those determined for the South Coast Region—about $800,000 annually.

Analytical Approach for South Coast Region

For the purpose of evaluating the alternatives to the SDWMP, it was assumed that the shortage management contingency options available would be those which could reasonably be expected to be available during the study period using the criteria of physical and political feasibility. Because the same options would be used under conditions both with and without the SDWMP—their use dictated by the severity and duration of shortages—they can be considered as alternatives to the SDWMP only in terms of the frequency and extent of their use. It was also assumed that a risk management strategy, as described above, would be applied, whether or not the SDWMP was in place.

This approach required the use of a simulation model that would approximate, to a reasonable degree, the use of lo-

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cal contingency measures which would actually be seen in response to shortages of various sizes and durations. The economic cost of shortages could then be determined by tying implementation costs to the use of these meaures and adding these to an estimate of the economic losses which would be incurred by water users after all reasonable mitigation measures were employed. For this study, the value of losses to users was derived from the current marginal cost of water to residential users and a recent residential user survey on the willingness to pay to avoid water shortages.

Figure 3-6 is a flow chart of the Economic Risk Model. Appendix E contains a detailed description of the logic of the model, the parameters used, and the general assumptions.

In brief, the model was run on the 57-year hydrologic record for both year-2000 level demands and year-2035 level demands. The operational considerations cited previously, with the exception of the future operation of KWB and LBG, were applicable. Two sets of runs were made at each demand level; the only difference was the existence of the SDWMP: one set assumed their existence, whereas the other set did not. Within each set, runs differed only by the amount of additional water made available by the use of local extraordinary long-term water supply enhancement and demand management options. Runs were made using increments of 20 TAF of additional local water up to a total of 1 million acre-feet.

For each of these runs, an expected economic loss was computed and compared to the cost of the local extraordinary long-term water management options used. On this basis, an optimal use of these options could be established using the risk management criterion. Because risk mitigation is not costless, this level of optimal use of local management options still allows for an associated level of expected losses. Any further reduction in expected losses would not be cost-effective compared to the higher cost of the remaining options.

At the 2000 level of demand and without the SDWMP, a decision based on risk management calls for implementing local options up to and including 268 TAF from the ultra-low flush toilet retrofit program, producing a total of 320 TAF. With the SDWMP in place, only the options up to and including 228 TAF from the ultra-low flush toilet retrofit program would be used. The 40 TAF from this program that would no longer be used with the SDWMP in place is properly considered as the water management alternative. Also, because the economic risk—costs of contingency measures employed and economic losses—without the SDWMP would be greater, the increased risk must be considered as part of the alternative.

At the 2035 level of demand and without the SDWMP, local options producing a total of 560 TAF would be needed to meet the risk management criterion. This would be provided by those options up to and including 31 TAF from South Coast Region ground water desalting. With the SDWMP in place, only the options up to and including 13 TAF of Riverside County drainage water desalting would be used. Those options no longer used with the facilities in place are (along with greater economic risk) properly designated as alternatives. These alternatives include 29 TAF of Riverside County drainage water desalting at $532 per AF, and 31 TAF from South Coast Region ground water desalting at $579 per AF.

Economic Benefits

Economic benefits of the proposed SDWMP were determined by using the Economic Risk Model directly for the South Coast Region and SWP agriculture contractors in Kings and Kern counties. The model results were used indirectly for the Central Coast Region. Current water costs were used to estimate willingness to pay for water in the San Francisco Bay, Tulare Lake, and Sacramento River regions.

South Coast Region Benefits

The benefits of the SDWMP for the South Coast Regions depend on the extraordinary local water supply and demand management options that would be employed under conditions with and without the proposed SDWMP. Either the costs of the options which could be displaced by the existence of the proposed SDWMP, the expected economic losses which would be avoided with the proposed SDWMP, or both (if appropriate), could then be properly attributed to the SDWMP facilities as benefits.

Table 3-6 was developed by using the procedure described above for determining the optimal employment of local options and noting the expected loss values associated with each of the options.

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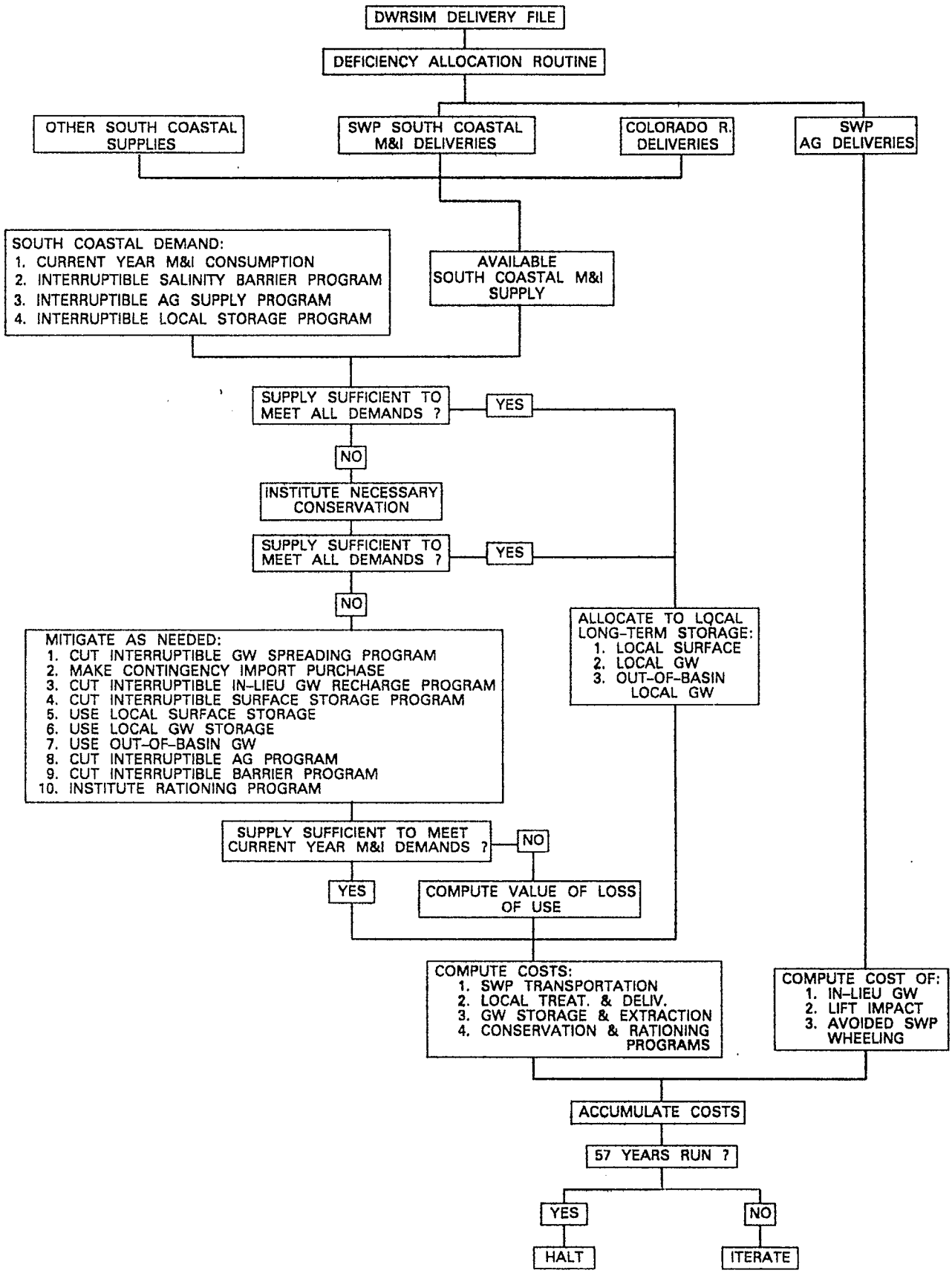

Figure 3–6. Economic Risk Model

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Table 3-6
Annual Economic Benefits of South Delta Water Management Program, South Coast Region
($1,000)

Benefit	Demand Level 2000	2035
Change in avoided losses due to reduction in use of local options	-12,473	-42,934
Avoided local option costs	11,480	33,387
Net gain from reduction in use of local options	-993	-9,547
Benefit of SDWMP at optimum local option use	14,029	64,781
Adjusted benefit of SDWMP	13,036	55,234

For the 2000 demand level, because the use of local options is greater without the SDWMP, the decrease in economic losses due to the SDWMP had to be adjusted by the effect of the change in use of the local options. This was done by calculating the increase in expected losses due to the reduction in use of the local options (a cost) and adjusting it by the avoided cost of the options no longer needed (a benefit). This value was then added to the avoided losses due to the SDWMP to obtain an adjusted expected annual benefit value of about $13.0 million. For 2035, this benefit was calculated to be about $55.2 million.

It is important to note that the lower the use of the local options, the higher the value of the SDWMP for reducing risk. The avoided economic loss benefit of the SDWMP would be more than proportionally greater to the degree that the extraordinary local options are not available or are more costly than assumed—an important observation because of the uncertainty about the environmental, legal, and health aspects problems associated with some of the options.

The analysis, based on marginal value of expected losses avoided equated to marginal costs of local water supply/demand management options, is a conservative way of interpreting the model results with respect to estimating the benefits of the SDWMP. If local water managers (and users) are more risk-adverse than indicated by this type of analysis—which is a reasonable assumption—the benefits will be higher than indicated. Under the assumption of greater risk-aversion, the avoided cost of the local options that would be displaced by existence of the facilities becomes more important. Because it is the increasingly costly options that would be displaced, the cost savings (i.e., benefits) arising from use of the facilities to attain the desired level of risk become very large.

The conservative assumption of a linear build-up in demand between year-2000 and year-2035 demand levels was made to facilitate the computation of the equivalent annual benefits over the study period. This value was determined to be $29.5 million for the South Coast Region. The linear build-up is assumed to be conservative because of the nature of population growth in the area.

Agricultural Benefits for SWP Service Areas in Kings and Kern Counties

The Risk Model results were used directly for this benefit computation because of the conservative simplifying assumption that benefits are constrained to the alternative cost of pumping in lieu of SWP agricultural deliveries.

This was felt to be conservative because facilities to bring ground water through intra-agency exchanges are not available for all areas which do not overlie ground water. In addition, the consequences of relying on in-lieu pumping in areas with critical overdraft problems were not addressed by this analysis.

The model runs produced the following results for agricultural losses adjusted for the avoided SWP transportation costs (Table 3-7).

Table 3-7
Annual Agricultural Benefits ($1,000)

	Year 2000	2035
Expected agricultural losses		
without South Delta SDWMP	12,742	21,633
with South Delta SDWMP	11,617	20,054
Avoided losses	1,125	1,579

Based on this approach, the expected equivalent annual benefits were calculated to be $1.3 million.

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Benefits in Other SWP M&I Service Areas

The Economic Risk Model has not been applied directly to other SWP municipal and industrial areas because the necessary information on either the reliability or cost of local supplies, the availability and effectiveness of local water supply, and demand management options was unavailable. The following regions were those in which the major portion of the SDWMP benefits were expected to occur.

Central Coast Region. The situation in this area is characterized by costly water supply options in the face of rising use due to population pressure. On the basis of this knowledge, it was felt to be conservative, with respect to the value of the proposed SDWMP, to apply the benefits and results determined for the South Coast Region to this area. This was done by assuming benefits in proportion to relative entitlement. This amount was determined to be about $800,000 annually.

San Francisco Bay Region. Average urban water rates in the North Bay SWP service area are presently about $445 per AF. For the South Bay this figure is about $415 per AF. Adjusting these values for local treatment and delivery cost plus SWP conveyance, would translate them to about $390 and $360 per AF, respectively, at the Delta. Assuming these values to be year 2000-level values is conservative. For 2035, it was assumed that they would rise linearly from year 2000 to $500 per AF, less than is currently being paid in Southern California high-cost areas. Using an average increment of yield from the proposed project to this area of 4.8 TAF in 2000, rising to 7.4 TAF in 2035, the benefit value was computed to the equivalent of about $2.3 million annually.

Tulare Lake Region. The average urban water rate presently being paid for urban water in this area is $268 per AF. Adjusting this for SWP conveyance cost and local treatment and distribution results in a net value of $230 per AF. This value was assumed to remain constant throughout the study period. An average increment of yield from the proposed facilities to this area of 2.1 TAF in 2000, and rising to 3.9 TAF in 2035, was used to estimate benefits. Based on this, an equivalent annual value of $600,000 was obtained.

Summary of Annual Benefits

The compilation in the following column shows the benefits derived with the procedures described above. Total benefits of the SDWMP were estimated to be about $35 million annually.

Alternatives Rejected From Further Consideration

This section discusses the alternative plans investigated in the past to meet some SDWMP objectives.

South Delta Alternatives

A number of physical solutions to the south Delta problems have been proposed in the past, but were not adopted by DWR or SDWA. Some of the alternatives would not be effective without the Peripheral Canal. Since the Peripheral Canal was defeated overwhelmingly by the public, these alternative plans were not considered further. The five alternatives described are: the Middle River, Roberts Island Canal, Delta-Mendota Canal, Old River, and the SDWA plans. Details of these alternatives can be found in *Alternative Solutions To Southern Delta Water Problems,* published by Reclamation, September 1980.

The **Middle River Plan** consists of a 1,200-cfs pumping plant in Middle River, reworking of Middle and San Joaquin rivers and control structures in Middle, Old, and San Joaquin rivers. Without the Peripheral Canal, however, this plan would not significantly improve water quality.

The **Roberts Island Canal Plan** consists of a 1,200-cfs pumping plant in Middle River. Under the plan, 600 cfs would have been conveyed through the Roberts Island Canal and flood control structure to the San Joaquin Riv-

Region	Annual Benefit ($ million)
M&I	
South Coast	29.5
Central Coast	0.8
San Francisco Bay	2.3
Tulare Lake	0.6
Sacramento River	0.2
Subtotal	**33.4**
Agricultural	
Tulare Lake	1.3
Total	**34.7**

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er, and 600 cfs would flow south in Middle River through a flood control structure into Old River. The plan also included a reworking of Middle River and a flow control structure in the San Joaquin River downstream from its bifurcation with Old River. The Roberts Island plan would have obtained its project water from Middle River in conjunction with the rejected Peripheral Canal. Without the canal, the flows in Middle River would only improve water circulation; no new water would be brought into the SDWA service area. Because water quality and quantity would not improve significantly, further studies concerning alternatives without the Peripheral Canal were not considered.

The **Delta–Mendota Canal Plan** consists of a 400–cfs pumping plant in Middle River, reworking of Middle River between the old Peripheral Canal site and the pumping plant site, a flow control structure in the San Joaquin River, and re–channelization of the end of Westley Wasteway to provide 1,100 cfs from the Delta–Mendota Canal. Again, without the Peripheral Canal, the service to Middle River from Victoria Canal to Old River would be quite limited. The existing channel would be cleaned out and opened up to permit increased floodflows and irrigation flows from Old River to move down Middle River. A control structure in Middle River would be required south of Victoria Canal.

The **Old River Plan's** principal features consists of pumping plants, control structures, re–channelization, a discharge canal, and a connector canal. Near the existing Tracy Pumping Plant intake channel, a Delta–Mendota intake pumping plant, Delta–Mendota discharge canal, and Old River control structure would be constructed to pump and divert 800 cfs of water from the intake channel into Old River. Four alternatives considered for the Old River plan included: 1) with Peripheral and Delta–Mendota canals; 2) with Peripheral Canal; 3) with Delta–Mendota Canal; and 4) with Peripheral Canal and New Melones Reservoir.

The **South Delta Water Agency Plan** consists of three control structures on Old, Middle, and San Joaquin rivers; channelization of Old, Middle, and San Joaquin rivers, and Tom Paine Slough; and diversion of up to 500 cfs through Tom Paine Slough into the San Joaquin River or supplemental releases from New Melones Reservoir for water quality maintenance in the San Joaquin River at Vernalis.

In each of the plans, an isolated cross–Delta facility, such as the rejected Peripheral Canal, could serve as a water conservation facility by more efficiently distributing the water throughout the Delta. Such a facility would divert water from the Sacramento River near Hood, routing it along the eastern Delta to the Clifton Court Forebay terminus. Releases made along the route would improve water quality and flow distributions within the Delta.

Peripheral Canal

The Peripheral Canal was proposed in the late 1960s as a joint–use facility of the SWP and CVP. The objective of the project was to convey good quality water from the Sacramento River to the existing SWP and CVP pumping plants for export and to 12 release facilities to distribute water from the canal to Delta channels to maintain water quality within prescribed criteria and to improve the Delta aquatic environment and the resources and economies it supports. However, voters rejected Proposition 9 (Senate Bill 200) in June 1982, making advocacy of the plan impractical.

Some of the benefits the canal could have had on the south Delta are discussed here. Additional information can be found in the *Draft Environmental Impact Report, Peripheral Canal Project, DWR,* August 1974.

As it crossed the San Joaquin, Middle, and Old rivers, the Peripheral Canal would have released good quality water into each of them. This would have provided water of adequate quality in the south Delta in coordination with the environmental needs of the fishery.

In addition, the Peripheral Canal would have eliminated direct pumping from the south Delta channels in all but periods of high San Joaquin River flows. Thus, the adverse impacts of SWP and CVP operations on water levels in the south Delta would have been eliminated.

Other Alternatives

In Bulletin 76, *Delta Water Facilities,* DWR, July 1978 a long list of suggested alternatives was analyzed. Subsequently when the Peripheral Canal was defeated, DWR published a report in 1983 focusing on alternative solutions to the Delta water transfer problems. Some of the alternatives analyzed in the 1983 report *Alternatives For Delta Water Transfer* are applicable to the SDWMP objectives, and they have been considered in some of the SDWMP alternatives.

One alternative in the 1983 report that was not considered here is the dual transfer system. A dual transfer system would be a compromise for the many beneficial users of Delta water. Under this concept, about half the water be-

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ing exported by the SWP and CVP would flow through existing channels and half in a new channel. A new channel would have been built from Hood to Clifton Court Forebay to transfer all SWP flows in all but the high-flow, high-diversion months. This facility could have followed the same alignment as the Peripheral Canal but with only one-third the capacity. Except for small areas to the east, Delta water needs would have been met from flow through existing channels rather than canal releases.

In recent years, drinking water quality has become a growing concern. Organic contaminants have also become an important issue. A May 1989 report, *Delta Drinking Water Quality Study* (Brown and Caldwell, Consulting Engineers), identified water quality problems and management strategies to deal with drinking water quality. The alternatives analyzed ranged from minor modification of water project operations to major modifications of water project facilities. The results of the study show that alternatives that receive water upstream of the Delta would provide drinking water of higher quality than that of the existing supply. The report provides updated information for the Peripheral Canal assessment. In addition, recent analysis by DFG through negotiations (Article VII) has shown favorable aspects for an isolated transfer system.

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Chapter 4. ENVIRONMENTAL SETTING

This chapter describes the geographic areas related to the South Delta Water Management Program (SDWMP). Because of the interdependence of water supplies and uses in the State, such areas cover a large part of California. The areas described are:

- South Delta Region.
- Delta Region.
- Suisun Marsh Area.
- San Francisco Bay Area.
- Sacramento Valley.
- San Joaquin Valley.
- State Water Project (SWP) service areas in North and South San Francisco Bay, Central Coast, San Joaquin Valley, and Southern California.
- Central Valley Project (CVP) Service Areas in the Central Valley and Contra Costa County.

The SDWMP directly involves the Sacramento-San Joaquin Delta, which is the eastern part of an interconnected estuary system that includes the Suisun Marsh and the San Francisco Bay complex. An overview of the estuary is presented below, followed by specific discussions of each of the areas listed above.

Overview

The 12 counties surrounding the Bay/Delta estuary encompass a diversified and vital metropolitan and agricultural region. The population in these counties is increasing. The estuary supports one of California's most important aquatic ecosystems. The mild temperatures and ample waterways also make it one of the most popular sports fishing and recreational boating areas in California.

The Delta is situated near the center of the Central Valley at the confluence of the Sacramento and San Joaquin rivers. The Delta is a unique and valuable resource that provides important environmental, economic, and water supply benefits to many Californians.

Tributary inflow provides for local consumptive use, protective Delta outflow requirements, and exports for use elsewhere in the State from the Bay area to Southern California. Outflows continue westward out of the Delta and through a gap in the Coast Range at Carquinez Strait into San Francisco Bay and the Pacific Ocean. Suisun Marsh and adjoining bays are the brackish transition between the fresh water flowing from the rivers and the salt water of the bay and ocean.

The estuary water quality and tidal hydraulics are complex. The factors involved are river inflow, tidal action, channel depth, wind conditions, barometric pressure, local and project diversions, outflows, local agricultural drainage, and pollutant discharges. However, the primary controls of hydraulic conditions in the Bay system are tides and fresh-water inflow. Tides originating in the Pacific Ocean enter San Francisco Bay through the Golden Gate, where the average tidal range is 5.7 feet. The volume of water entering and leaving the Bay system during each 6.2-hour flood or ebb tide averages about 1.1 million acre-feet (AF).

South Delta Region

The south Delta study area is the portion of the Delta approximately southwest of Stockton. Included in this area are the South Delta Water Agency (SDWA) and the export facilities of the SWP and the CVP. The area within the SDWA's boundaries comprises about 150,000 acres; 120,000 acres are used for agriculture. The remainder of the area consists of waterways, levees, and residential, industrial, and municipal lands.

In the south Delta, the Department of Water Resources (DWR) operates Clifton Court Forebay, John E. Skinner Fish Protective Facility, Harvey O. Banks Delta Pumping Plant, and South Bay Pumping Plant. Clifton Court Forebay presently has a surface area of 2,180 acres. The forebay gates operate tidally with the gates generally closed during low tide. The fish protective facility, located between the forebay and Banks Pumping Plant, consists of primary and secondary louver systems to divert fish into holding tanks, from which they are returned to Delta waters by special tank trucks. The seven existing pumps at the Banks Pumping Plant can divert up to 6,400 cubic feet per second (cfs) from the forebay. With four additional pumps under construction, the physical pumping capacity will increase to 10,300 cfs. South of the Banks Pumping Plant, the South Bay Pumping Plant pumps a maximum flow of 300 cfs to various south Bay areas. The California

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Aqueduct has the capacity to carry the remaining 10,000 cfs south to San Luis Reservoir.

Also in the study area, CVP exports water from its Rock Slough and Tracy pumping plants. The two plants have pumping capacities of 300 cfs and 4,600 cfs, respectively. At Rock Slough, water is diverted into the Contra Costa Canal to serve municipal and industrial users in Contra Costa County. Farther south, water is diverted directly from Old River by the Tracy Pumping Plant into the Delta-Mendota Canal, which exports water to the Central Valley. Fish are salvaged at the Tracy Fish Collecting Facility.

In addition, more than 500 unscreened pumps and siphons divert water directly from channels to south Delta agricultural water users. The peak summer monthly agricultural diversions in the area total about 1,000 cfs.

Recreation

There are about 15 existing recreational facilities in the south Delta, including several large marinas. The south Delta channels are heavily used for boating and other water activities. A survey taken on a summer holiday in 1988 showed more than 1,100 boats passing four survey sites. It is estimated that about 25 percent of the recreation in the Delta occurs in the south Delta area.

Issues involving recreation in the south Delta are discussed in detail in Chapter 1. A detailed discussion and recommendations for recreational facilities are presented in Appendix L.

Cultural Resources

The Indians who lived in the south Delta area at the time of European contact are known as the Nochochomne North Valley Yokuts. The approximate area they inhabited was between the San Joaquin River on the east; Old River on the west; south of the confluence of the Old, Middle, and San Joaquin rivers at the north; and to about the branching of these three rivers in the south.

The first contact with Europeans was made by Spanish expeditions in the first decade of the 19th century. Many of the Indians were drawn into the missions. This, coupled with the effects of European diseases and the onslaught of settlers after the 1849 gold rush, effectively destroyed the aboriginal way of life before much ethnographic information could be obtained.

A Class I archeological survey, consisting of a records search of previous surveys in the area, was conducted. Fifteen archeological sites and one historic location were identified in the study area.

A Class II sample survey was conducted to determine the resources present in the study area that may be affected by the project. As part of the Class II survey, records of the sites identified in the Class I survey were identified in an effort to determine the relationship between sites and landforms.

It has been established that areas of higher relief, those presently above sea level, have a high probability for the presence of prehistoric sites. Areas that prior to reclamation were uninhabitable tidal marsh are defined and excluded from further surveys. Areas of high relief are located and surveyed.

Research of historic documents indicates that the first canals and levees were built in the 1850s. The records indicate that most of the area was in agricultural use by the late 1800s. Further historic research and field investigations are part of the Class II sample survey.

Findings of the Class II sample survey will help determine whether, and where, a Class III intensive survey is needed.

Fish and Related Habitat

Several species of anadromous and resident fish found in the Delta are also present in south Delta channels. The principal species are Chinook salmon, striped bass, steelhead, American shad, sturgeon, catfish, and sunfish. The Delta fisheries are affected by the dissolved oxygen, water quality, and temperature in the channels.

These and other biological resources are discussed in Chapter 5.

Wildlife and Related Habitat

Nearly all the land on the islands in the south Delta consists of irrigated agriculture. The natural vegetation on the river banks has been modified in most places due to construction and maintenance of levees. Habitat or cover

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types in the south Delta are agriculture, forest, riparian forest, riparian scrub-shrub, emergent freshwater marsh, and heavily shaded riverine aquatic.

The California Natural Diversity Data Base (CNDDB) classifies the emergent freshwater marsh as part of the Coastal and Freshwater Marsh plant community. The CNDDB has assigned this community one of its highest priority classifications because agricultural and urban development has destroyed more than 90 percent of the original acreage of this community in the Central Valley. The CNDDB classifies the forest and riparian forest as Great Valley Oak Riparian Forest. The CNDDB has also assigned this community one of its highest priority classifications because nearly 90 pèrcent of the acreage of this community has been destroyed and only 2.5 percent of the remaining habitat is in an apparently unaltered condition.

The heavily-shaded riverine aquatic habitat is a relatively scarce but important habitat in the south Delta. It occurs where substantial woody vegetation overhangs a slough or river with continuously or periodically moving water. The following describes the habitat of the project areas:

Old River. The levee banks and islands of Old River support fragments of riparian forest. The riverbank has been cleared of vegetation in places, but in other less disturbed reaches of the river are some very large valley oaks, mixed with cottonwoods, and tree and shrub willows. There is an understory of wild rose, poison oak, and wild grapes. Significant stands of willow thickets were cleared from the Victoria Island levee in 1987. Patches of fresh-water marsh also occur along Old River, primarily along the upstream reaches. Ten low-lying instream islands occur in the reach of Old River on the east side of Coney Island. These islands, mostly heavily vegetated with willows and tules, range in size from 3 to 40 acres.

Kings, Eucalyptus, and Widdows islands lie on the west side of Old River north of Coney Island. Kings Island is occupied by cabins. Widdows and Eucalyptus islands are flooded due to levee breaks. Heavy growths of bulrush and willows occur in backwaters of this area, and Eucalyptus Island also has a row of 100-foot tall eucalyptus trees. A heron and egret rookery with at least eight active nests occurs in trees on this island.

West Canal. This is a 2-mile excavated channel which cuts off an oxbow of the Old River. Except for a few widely scattered valley oaks, the west side levee is mostly clear of vegetation. The east side levee on Coney Island supports blackberry and willow thickets.

Salmon Slough. This narrow waterway supports dense marsh with little open water.

Middle River. The levees of the portions of the Middle River within the study area are mostly rip-rapped and support only small areas of blackberry thickets, pampas grass, and other introduced weeds. The channels are bordered mainly with thin strips of emergent vegetation dominated by bulrush, cattails, and shrub willows. About 130 acres of islands of dense bulrush and cattail occur throughout the canals and Middle River, representing the highest-quality habitat in the study area. Some of the larger islands have scrub-shrub and forest habitats consisting mainly of young willow and cottonwood stands.

Victoria and North Canals. These are parallel dredged channels partially separated by an old berm down the center. The center berm is inundated to varying degrees, and supports a substantial growth of tules. The bordering levees are partially vegetated with willows, blackberries, and grasses.

Woodward and North Victoria Canals. These are parallel dredged channels similar to Victoria and North canals, except that the levees are almost entirely cleared of vegetation.

Byron Tract and Coney, Union, and Victoria Islands (Clifton Court Forebay Expansion Area). These lands are almost entirely devoted to agriculture. Scattered patches of blackberry, cattail, and bulrush occur occasionally along the small irrigation canals and drainage ditches which cut across the fields. At Byron Tract, there is a small stand (less than one acre) of young willows and cottonwoods in one ditch south of Discovery Bay.

Rare, Threatened, and Endangered Species

Rare, threatened, and endangered plant and animal species which may occur in the project area are shown in Table 4-1. The table also lists species which are candidates for listing as rare, threatened, or endangered by the U.S. Fish and Wildlife Service (USF&WS) and the Department of Fish and Game (DFG).

Field surveys for rare, threatened, and endangered species were done in 1987 and 1988. The surveys are discussed in more detail in Appendixes F and H.

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Table 4–1
Rare, Threatened, and Endangered Species Potentially Occurring in the South Delta Project Area

Common Name	Scientific Name	Status*	Distribution	Habitat
		PLANTS		
Suisun Marsh aster	*Aster chilensis lentus*	C2	San Pablo Bay, Suisun Marsh, western Delta	Dense vegetation, stabilized substrate
Delta button celery (Delta coyote thistle)	*Eryngium racemosum*	C2, SE	San Joaquin, Stanislaus, & Calaveras counties	Seasonal wetlands
Slough thistle	*Cirsium crassicaule*	C2	Delta; Kern & Kings counties	Upland areas
Mason's lilaeopsis	*Lilaeopsis masonii*	C2, SR	Delta	Mudbanks
California hibiscus	*Hibiscus californicus*	C2	Delta & Central Valley up to Butte County	Freshwater marsh
Delta tule pea	*Lathyrus jepsonii jepsonii*	C2	Delta	Freshwater marsh
		ANIMALS		
San Joaquin kit fox	*Vulpes macrotis mutica*	FE, ST	From South San Joaquin Valley foothills north through undeveloped valley & foothill lands into southern Contra Costa County	Grasslands in north; alkali sink in south
California black rail	*Laterallus jamaicensis coturniculus*	C2, ST	Coast from Marin County to north Mexico; inland marshes	Fresh and salt water marshes
Tricolored blackbird	*Agelaius tricolor*	C2	Central Valley & Sierra Nevada foothills	Marshes, flooded lands, margins of ponds, grassy fields
Swainson's hawk	*Buteo swainsoni*	ST	Lower Sacramento and San Joaquin valleys; Klamath Basin; Siskiyou County. Winters in South America	Grasslands, irrigated pastures, and open fields near trees for nesting
Giant garter snake	*Thamnophis couchi gigas*	C2, ST	Fresno County north through the Central Valley; east Delta	Freshwater marsh, riparian areas, rice fields, canals
Western pond turtle	*Clemmys marmorata*	C2	Throughout California west of Cascade–Sierra crest	Ponds and waterways lined with emergent vegetation

(Continued on next page)

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Table 4–1 (Continued)
Rare, Threatened, and Endangered Species Potentially Occurring in the South Delta Project Area

Common Name	Scientific Name	Status*	Distribution	Habitat
		ANIMALS (continued)		
California tiger salamander	*Ambystoma tigrinum californiense*	C2	Sonoma to Santa Barbara counties	Reservoirs, ponds, pools, lakes, and slow-flowing streams in grasslands and open woodlands
California red-legged frog	*Rana aurora draytoni*	C2	Coast, Transverse, Cascade, and Sierra Nevada ranges	Quiet, permanent water in woods, forest clearings, riparian areas, grasslands
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	Lower Sacramento Valley north to Red Bluff	Elderberry bushes in riparian areas
Sacramento anthicid beetle	*Anthicus sacramento*	C2	Yolo, Solano, Butte, & Sacramento counties	Sand dunes near rivers
Curved-footed hygrotus diving beetle	*Hygrotus curvipes*	C2	Contra Costa County	Shallow ponds
Delta smelt	*Hypomesus transpacificus*	C1, SC	Suisun & San Pablo Bays in early fall; spawns in channels & dead-end sloughs, December through April	Salinities usually less than 2 parts per thousand
Sacramento splittail	*Pogonichthys macrolepidotus*	(C2)	Suisun Bay from February—April; spawns in upstream deadend sloughs Jan-July	Slower currents; tolerates brackish water
Sacramento perch	*Archoplites interruptus*	(C2)	Sacramento-San Joaquin Delta; Russian River; Scattered lakes & reservoirs	Needs beds of rooted & emergent aquatic vegetation; tolerates alkaline water
Chinook salmon (winter-run)	*Oncorhynchus tshawytscha*	FT, SE	Sacramento River system	Cool fresh water with access to ocean

*Status: FT = federal threatened; FE = federal endangered; C1 = federal candidate with sufficient data to support federal listing; C2 = federal candidate currently without sufficient data to support federal listing; ST = State threatened; SE = State endangered; SR = State rare; SC = State candidate for protected status; (C2) = Currently being recommended by the Sacramento Endangered Species Office that the species be proposed as a C2.

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Plants. Twenty-one populations of Mason's lilaeopsis were found in the project area, growing mainly on eroded mudbanks. The greatest density occurred on islands in Middle River. An extensive colony was also found on a tule island at the north end of West Canal. All other populations were isolated patches of less than three square feet.

California hibiscus was found at 18 locations scattered throughout the project area. Large and continuous populations of California hibiscus were found in Middle River. Individual plants were found in other locations.

Two populations of Delta tule pea were found in Middle River on tule islands.

No populations of Suisun Marsh aster, Delta Coyote thistle, or slough thistle were found.

Animals. Spotlighting and track plates were used to search for San Joaquin kit fox in the proposed forebay expansion area north and west of Clifton Court Forebay. No kit fox were observed in the study area, nor did the track plates reveal any canid tracks. One kit fox was observed about 2 miles south of Byron Tract near Bethany Reservoir, an area occupied by kit fox in 1982.

Four active Swainson's hawk nests were found in trees along Old River in the study area. A non-nesting pair of Swainson's hawks was also seen along Old River. Nesting habitat in the project area is generally of poor quality because riparian trees are limited in number and size. At least one pair of red-tailed hawks (which begin nesting earlier than Swainson's hawks) nests in the project area, further limiting nesting habitat available for Swainson's hawks.

Black rails were heard calling from two islands within the project area in Middle River north of Woodward Ferry. The habitat on the islands consists of dense cattails and tules on relatively firm soil apparently inundated only by the highest tides. In the project area, this habitat type only occurs along Middle River. Emergent marsh in other parts of the study area grows from inundated substrate probably not suitable for black rails. Previously, cattail/tule marsh was not regarded as appropriate habitat for black rails.

No tricolored blackbird individuals or nesting colonies were observed in the project area. Tricolored blackbirds can shift their nesting locations from one year to the next. The nearest known nesting colony is about 5 miles east of the project area. Habitat which may be suitable for nesting is found in cattail/tule stands along the watercourses and in scattered areas of mustard bordering agricultural fields. Removal of extensive blackberry and riparian thickets along the levees of Victoria Island in 1987 reduced the amount of potential nesting habitat available for this species. The amount of emergent marsh vegetation in the project area is probably not large enough for winter roosting.

No giant garter snakes were observed in the project area. However, a suitable habitat consisting of marsh and streamside riparian vegetation is widespread in the project area. Areas of suitable habitat include vegetated levees, vegetated islands and mid-channel berms, and vegetated irrigation canals and drains within agricultural lands. Virtually all islands and channels in the study area contain some suitable habitat. There are records of giant garter snakes from similar habitats in the Delta. Because this snake is very wary and difficult to census, it may occur in the project area despite the lack of sightings.

Western pond turtles were observed in Old and Middle rivers. Suitable habitat occurs along all watercourses in the project area.

No California tiger salamanders or California red-legged frogs were found nor does suitable habitat exist in the project area. These species require quiet, still water for breeding. The major waterways in the project area are too deep and swift and many of the irrigation ditches are kept clear of aquatic vegetation. The surrounding lands are intensively cultivated.

No field surveys were conducted for the winter run Chinook salmon, the Delta smelt, or the Sacramento splittail. These fish are present in the project area, as evidenced by their regular appearance in fish diversion facilities at Clifton Court Forebay. The winter run Chinook salmon has recently been listed as an endangered species by the State, and has a federal emergency listing as threatened.

No field surveys were conducted for the Sacramento perch. Sacramento perch have not been seen in the Delta since the 1970s. DFG biologists regard the species as possibly extirpated from the Delta.

A few isolated patches of elderberry shrubs, host plant to the Valley elderberry longhorn beetle, were found in the riparian woodland along Old River, downstream from its

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confluence with Salmon Slough. No larval exit holes were found in the stems. The nearest known locality of the beetle is about one mile east of the project area.

No Sacramento anthicid beetles were observed in the project area. No loose sand dune habitats appropriate for this species were seen. However, an island under private ownership in Middle River off the southeast corner of Woodward Island may have a suitable dune habitat for this beetle.

No curved-footed hygrotus diving beetles or appropriate habitat were observed in the project area. This species has only been found once, in a pool near Oakley, about 13 miles from the project area. It is possible that suitable habitat exists in small drainages in agricultural areas on the islands considered for forebay expansion.

Delta Region

The Delta has legal boundaries established in California Water Code Section 12220 and shown on Figure 4-1. The Delta is generally bordered by the cities of Sacramento, Stockton, Tracy, and Pittsburg. The 738,000 acres in the Delta are part of the largest estuary in California. The former wetlands have been reclaimed into more than 60 islands and tracts, largely devoted to farming (about 520,000 acres), which produce an average gross income of about $375 million. The Delta is interlaced with about 700 miles of waterways. The network of levees totals about 1,100 miles and protects the islands and tracts, almost all of which lie below sea level.

Protection of certain islands from flooding is particularly important because of the threat to life and property, the presence of utilities and highways, and water quality degradation from the sudden intrusion of brackish water from the Bay. Long-term water supply problems could occur should a Delta levee break, particularly if an island were allowed to remain flooded and no remedial action were taken. Evaporation from a flooded island exceeds the consumptive use of an equivalent area of irrigated farmland by about one or two feet per year. This increase would require the State and federal water projects to release more upstream water from storage to repel salinity intrusion. Permanent flooding of certain islands in the western Delta (where brackish water and fresh water meet) could increase the upstream movement of ocean salts, requiring the projects to provide more outflow to repel the salts and maintain water quality in the Delta and at the pumps.

Although no major cities are entirely within the Delta, it does include a portion of Stockton, Sacramento, West Sacramento; the small cities of Antioch, Brentwood, Isleton, Pittsburg, and Tracy; plus about 14 unincorporated towns and villages. The population in the legal Delta is about 200,000, most of it in upland areas on the eastern and western fringes. The Stockton area, on the east, and the Antioch-Pittsburg area, on the west, have undergone steady industrialization and urbanization. Most Delta islands are sparsely populated; some, however, including Byron Tract and Bethel Island have large urban communities.

Several municipal and industrial water users in the western Delta maintain dual supply systems for fresh water -- off-shore diversion and the Contra Costa Canal. Offshore water is used when the quality is adequate for the intended use, and Contra Costa Canal supplies are used when offshore quality is degraded below acceptable limits due to low Delta outflows. The Contra Costa Canal is the sole source of municipal water for other Contra Costa Water District customers.

Delta agricultural water users divert directly from the channels, using more than 1,800 unscreened pumps and siphons, which vary from 4 to 30 inches in diameter, and with flow rates of 4 to about 200 cfs. Total diversions vary between 2,500 and 5,000 cfs during April through August, with maximum rates in July.

The climate of the Delta area is Mediterranean with warm, rainless summers and cool, moist winters. The annual rainfall varies from about 18 inches in the eastern and central parts to about 12 inches in the southern part. Ocean winds enter the Delta through the Carquinez Strait and are very strong at times in the western Delta.

The Delta is basically a fresh-water environment, which serves as a migratory route and nursery area for Chinook salmon, striped bass, sturgeon, American shad, and steelhead trout. Numerous resident warmwater fish include catfish, sunfish, and minnows. White catfish are heavily fished by anglers casting from the banks.

The Delta also supports many animals and birds in the riparian and upland habitats. The Delta contributes about 20 percent of the pheasant population taken by California hunters each year. The area also serves as a feeding and resting area for millions of ducks, geese, swans, and other migrant waterfowl.

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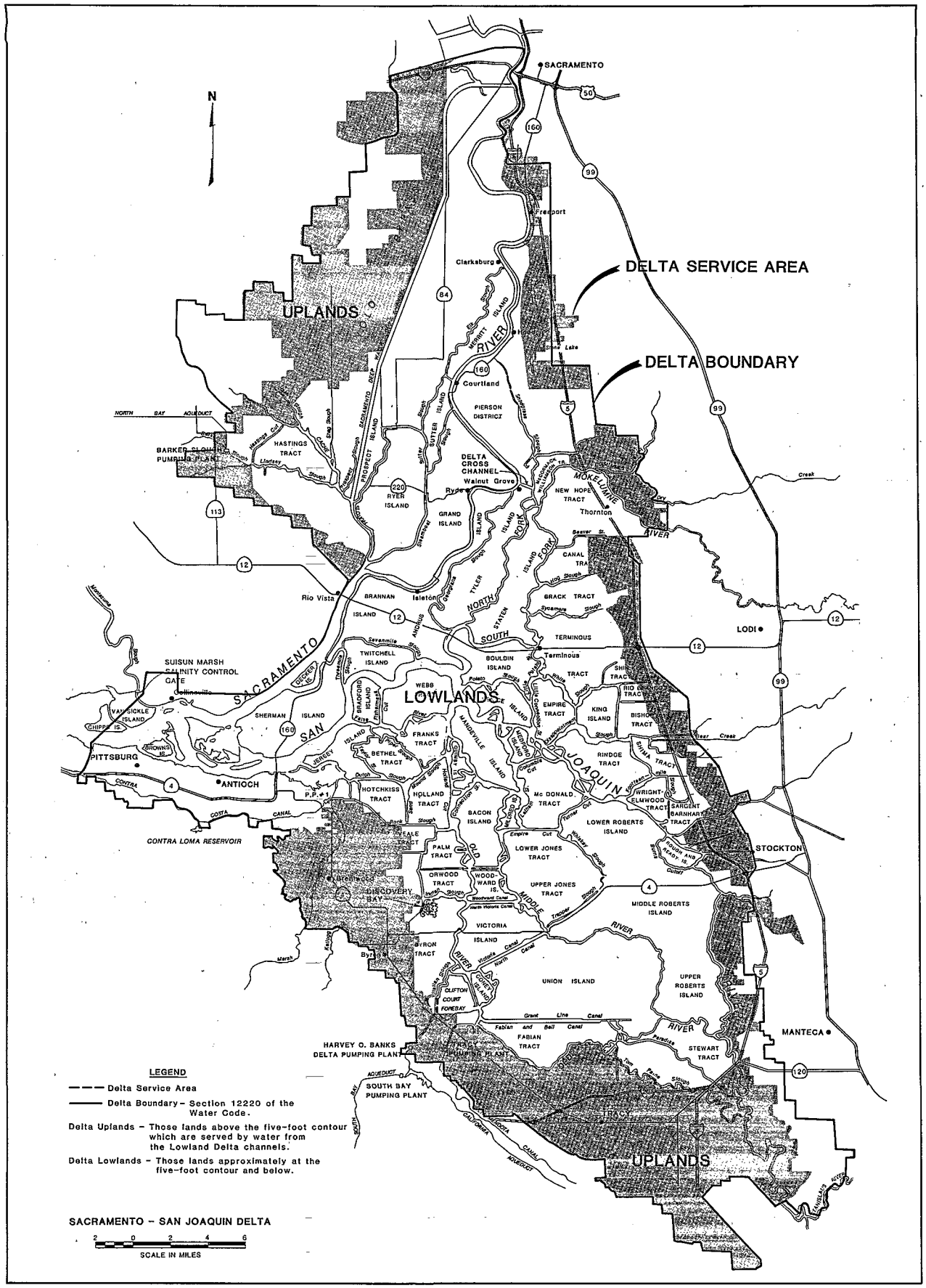

Figure 4–1. Statutory Delta Service Area

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Ten listed rare, threatened, or endangered vertebrate species are known to live in the Delta, but none is confined exclusively to that area. Six are birds—the bald eagle, American peregrine falcon, Swainson's hawk, California black rail, Aleutian Canada goose, and California yellow-billed cuckoo. Two are mammals—the saltmarsh harvest mouse and the San Joaquin kit fox. One—the giant garter snake—is a reptile, and one—the winter run Chinook salmon—is a fish. There are three endangered or threatened invertebrate species in the Delta: the Valley elderberry longhorn beetle, Lange's metalmark butterfly, and the Delta green ground beetle. Twelve rare or endangered plant species, most of which are associated with fresh water marshes, can also be found in the Delta.

A complete list of Delta plant and animal species is contained in *Sacramento/San Joaquin Delta Wildlife Habitat Protection and Restoration Plan*, California DFG and U. S. Fish and Wildlife Service, December 1980.

The Delta's abundant water, fish, wildlife, cultural, and historical resources make it a major recreation area. There are about 20 public and more than 100 commercial recreation facilities in the Delta. Demand for and use of these facilities continue to grow.

Suisun Marsh

Suisun Marsh, one of the few major marshes remaining in California, is at the northern edge of Suisun Bay, just west of the confluence of the Sacramento and San Joaquin rivers and south of the City of Fairfield. The primary managed area contains 58,600 acres of marsh, managed wetlands, and adjacent grasslands, plus 29,500 acres of bays and waterways. An additional 27,900 acres of varying land types acts as a buffer zone.

Most of the managed wetlands are enclosed within levee systems, and about 70 percent are privately owned by more than 150 duck clubs. The California DFG owns and manages 14,000 acres. Another 1,400 acres on the channel islands is owned by the federal government.

Waterfowl are the marsh's major wildlife. Ducks, geese, swans, and other migrant waterfowl use the marsh as a feeding and resting area. As many as 25 percent of California's wintering waterfowl inhabit the marsh in dry winters. The marsh also supports 45 species of mammals, 15 species of reptiles and amphibians, and 230 species of birds. Two endangered species, the salt marsh harvest mouse and the California clapper rail; one rare species, the California black rail; and one species being proposed for protection, the Suisun song sparrow, probably occur in the Marsh.

Most fish in marsh channels are striped bass. Other anadromous species sometimes found in the marsh include Chinook salmon, sturgeon, American shad, and steelhead trout. The marsh is also an important nursery area for striped bass. Catfish also support a sport fishery.

Waterfowl are attracted to the marsh by the water and the abundance of natural food plants, most valuable of which are alkali bulrush, fat hen, and brass buttons. Growth of such plants depends on proper soil salinity, which is affected by salinity of applied water. Freshwater flows from the Delta into Suisun Bay and Marsh channels from October through May affect marsh salinities and waterfowl food production.

The Suisun Marsh is protected by several standards, agreements, and facilities. Among them is Water Rights Decision 1485, which requires the SWP and CVP to mitigate their impacts on the marsh by meeting specific standards for the Sacramento River at Collinsville and seven other stations in the marsh. As allowed by Decision 1485, facilities have been constructed to provide water from internal channels to certain wetland areas. In addition, DWR, Reclamation, the DFG, and the Suisun Resource Conservation District signed a Suisun Marsh Preservation Agreement in 1987 to assure that a dependable water supply will be maintained in the marsh to produce duck food and to preserve other habitat.

Migrating Birds

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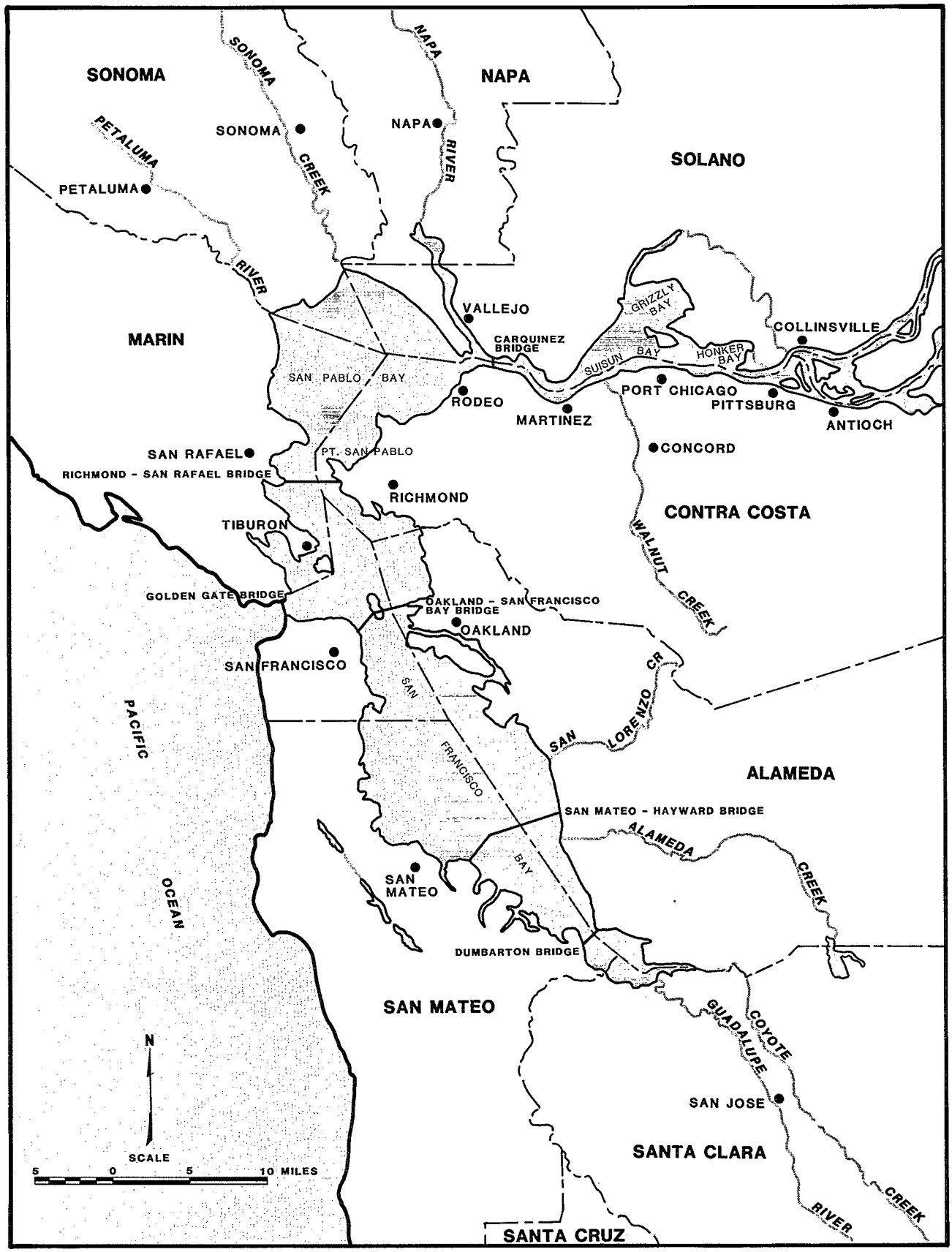

Figure 4–2. San Francisco Bay Complex

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San Francisco Bay Area

San Francisco Bay -- including Suisun, San Pablo, Central, and South bays -- extends about 85 miles from the east end of Chipps Island, near the City of Antioch westward and southward to the mouth of Coyote Creek, near the City of San Jose (Figure 4-2). The Golden Gate connects San Francisco Bay with the Pacific Ocean.

The surface area of San Francisco Bay is about 400 square miles at mean tide, about a 40 percent reduction from its original size. The reduction is due to fill. Most of the Bay's shoreline has a flat slope, which causes the intertidal zone to be relatively large. The volume of water in the bay changes by about 21 percent from mean higher-high tide to mean lower-low tide. The depth of the bay averages 20 feet overall.

The principal source of fresh water in San Francisco Bay is outflow from the Delta. Delta outflows vary greatly according to month and hydrologic year type. Historic Delta outflow has dropped to zero during critically dry periods such as 1928 and 1934. Present summer Delta outflows are maintained by upstream reservoir releases. Although annual Delta outflow has averaged 24 million acre-feet (MAF) from 1977 to 1986, it has varied from less than 2.5 MAF in 1977 to more than 64 MAF in 1983.

Other significant sources of fresh-water inflow to San Francisco Bay are Alameda Creek, Napa River, Petaluma River, Coyote Creek, Guadalupe River, Walnut Creek, and Sonoma Creek. These tributaries make up a total average annual inflow of about 350,000 AF. Streamflow is highly seasonal, with more than 90 percent of the annual runoff occurring during November through April. Many streams often have very little flow during mid- or late summer.

Nine counties surround the San Francisco Bay: Marin, San Francisco, San Mateo, Santa Clara, Alameda, Contra Costa, Solano, Napa, and Sonoma. In 1987 the Bay area became the fourth largest metropolitan area in the United States. The total 1988 population was about 5.8 million and is projected to reach 6.2 million by 1995 and 6.7 million by 2005.

Water requirements in the Bay area are met by 1) local surface and ground water supplies, and 2) imported surface water. The conveyance systems that bring the area the majority of its water are: Hetch Hetchy, South Bay, North Bay, Mokelumne, Petaluma, and Santa Rosa-Sonoma aqueducts; Contra Costa and Putah South canals; Cache Slough Conduit; and the San Felipe Project. More than 60 percent of the water is imported from Delta supplies.

City of San Francisco

The bays and surrounding lands support a wide variety of fish, migratory birds, and mammals. The anadromous species of fish include Chinook salmon, striped bass, sturgeon, American shad, and steelhead trout. Marine fish, found mainly in the lower bays, include flatfish, sharks, and surf perch. Shellfish in the San Francisco bays include mussels, oysters, clams, crabs, and shrimp. Seasonal variations in salinity in the bays, due to varying Delta outflows, affect the seasonal distribution of fish and invertebrates.

Several rare and endangered animal species found in the area include the Alameda striped racer, salt marsh harvest mouse, San Francisco garter snake, California clapper rail, California black rail, and California yellow billed cuckoo.

Mild temperatures and brisk winds make San Francisco Bay one of the world's favorite recreational boating areas. More than 150,000 recreational boats were registered in the Bay Area in 1987. Other water-oriented recreation includes sight-seeing, picnicking, fishing, nature walking, and camping.

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Sacramento Valley

The Sacramento Valley encompasses the drainage areas of California's largest river, the Sacramento. Valley lands comprise the western drainage of the Sierra Nevada and the Cascade Range, the eastern drainage of the Coast Ranges, and the valley floor (34 percent of the basin). The overall valley includes the McCloud and Pit River basins, the portion of Goose Lake Basin within California, and the American River and Putah Creek drainage. Other major river basins are those of the Feather, Yuba, and Bear rivers (which flow from the Sierra Nevada) and Cottonwood, Stony, and Cache creeks (which drain the Coast Ranges).

Ground water is pumped from 21 principal basins, most of which underlie the valley floor. The safe ground water yield is about 1.6 MAF per year, and the annual overdraft is about 140,000 AF.

The 1985 population for the Sacramento Valley region exceeded 1.8 million. Urban areas include Sacramento, West Sacramento, Redding, Chico, Davis, Placerville, Woodland, Roseville, Yuba City, Auburn, Marysville, Oroville, Willows, Red Bluff, Quincy, Nevada City, and Alturas.

Agriculture (primarily irrigated) is the major economic activity in the Sacramento Valley and surrounding foothills. Industrial activity is closely allied with agriculture and, more recently, with national defense. Population growth has given rise to many service industries. Lumbering and timber industrial installations are centered in the Sierra Nevada, Cascade Range, Modoc Plateau, and a portion of the Coast Ranges. Plants that process logging and milling residues to form timber byproducts are located throughout the valley. Other industries are engaged in extraction or mining and production of natural gas, clay, limestone, sand, gravel, and other minerals.

Water resources in the valley have been developed extensively for a wide range of purposes. Water is also imported into the valley from the Truckee and Cosumnes rivers and from the Trinity River Division of the CVP. The first two importations are small, but the third is substantial.

The environment in the estuary is directly affected by industrial and agricultural growth in the Sacramento Valley and the accompanying reduction in both quantity and quality of water flowing into the Delta. Several species of anadromous fish, including the endangered winter-run Chinook salmon, migrate through the Delta to use Sacramento Valley streams for spawning.

Eight terrestrial habitat types are found within the Sacramento Valley, including coniferous forests, hardwood forests, chaparral and mountain brush, pinion and juniper, grass and forbs, desert shrubs, cultivated and pasture lands, and barren ground. Interspersed with the terrestrial habitats are four aquatic habitat types: the Delta, riparian, marshland, and open water. These habitats support hundreds of species of mammals, amphibians, reptiles, birds, and plants, including rare and endangered species.

For more information on plant and animal life in the Sacramento Valley, see the *Water Quality Control Plan Report for Basins 5A and 5B*, State Water Resources Control Board (1975).

San Joaquin Valley

The San Joaquin Valley, the largest single block of irrigated land in California, comprises two hydrologic regions: the San Joaquin River and Tulare Lake. The San Joaquin River Basin, located just south of the Sacramento River basin, comprises the northern part of the San Joaquin Valley, whereas the Tulare Lake Basin, essentially a closed basin, comprises the southern part of the valley.

The San Joaquin River basin portion of the valley is drained by the San Joaquin River, which flows into the Delta and San Francisco Bay. Principal tributaries of the San Joaquin River include the Stanislaus, Tuolumne,

Agriculture in the San Joaquin Valley

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Merced, Chowchilla, and Fresno rivers, all originating in the Sierra Nevada. In the Delta, the Cosumnes, Mokelumne, and Calaveras rivers—which also originate in the Sierra—become part of the San Joaquin River before it joins the Sacramento River.

These Sierra streams provide the northern part of the San Joaquin Valley with high-quality water and most of its surface water supplies. Most of this water is regulated by reservoirs and used on the east side of the valley, but some is diverted across the valley to the Bay area via the Mokelumne Aqueduct and the Hetch Hetchy Aqueduct. The streams flowing into the valley from the west are intermittent, often highly mineralized, and contribute little to water supplies.

The Tulare Lake Basin, at the southern half of the San Joaquin Valley, comprises the Kings, Kern, Tule, and Kaweah river basins. These four rivers drain westward from the southern Sierra Nevada and terminate in the Tulare Lake or Buena Vista Lake beds. Dams on each of these rivers provide flood control and water supply for ground water recharge and for urban and agricultural uses.

The valley's long growing season, mild and semi-arid climate, good soils, and available water provide conditions suitable for a wide variety of crops. Major crops include cotton, grapes, tomatoes, hay, sugar beets, and various orchard and vegetable crops. Agriculture and closely related industries provide the economic base that supports a large and growing population. The population in the valley grew from 1.7 million in 1970 to 2.5 million in 1985. Urban areas include Fresno, Bakersfield, Visalia, and Modesto.

Water to the valley from the Sierra Nevada is limited and there is an annual overdraft of ground water. Imported water, generally ranging from 200 to 500 mg/l total dissolved solids, is used mainly on the west side. Water used on the east side is generally of better quality than that used on the west side and in the valley trough areas. In most parts of the valley, irrigation water is reused at least once, and water quality worsens progressively with each reuse.

Types of habitat in the San Joaquin Valley are similar to those of the Sacramento Valley. More information on plant and animal life in the San Joaquin Valley is contained in the *Water Quality Control Plan Report for Basins 5B, 5C, and 5D*, State Water Resources Control Board.

SWP Service Areas

The 30 long-term water supply contractors of the SWP are organized into six service areas: Feather River, North Bay, South Bay, Central Coast, San Joaquin Valley, and Southern California (Figure 4-3). These areas vary widely in size, location, climate, and population.

The Feather River service area has area-of-origin priorities for SWP supplies. The other service areas are described briefly in this section. Detailed environmental and socioeconomic profiles of these areas may be found in the *SWP Service Area Impact Study,* May 1985.

North Bay Service Area

The North Bay service area is located at the northern end of San Francisco Bay. Napa and Solano counties make up the total service area and encompass 1.1 million acres. About 64,000 acres were in urban use in 1980.

An estimated 95,000 people live in Napa County, primarily in the Napa Valley communities. The population of Solano County is about 303,500 and is distributed among seven cities and scattered rural areas. The California Department of Finance has projected that Solano County population will grow 10 percent between 1988 and 1990.

Napa County is well known for its production of wines and brandies. There is also a substantial livestock and dairy industry. Solano County agriculture centers on field crops, with substantial values of fruit and nut crops and a significant livestock industry. Heavy water-using industries include two meat packing companies and a cannery in Dixon, a refinery in Benicia, a brewery in Fairfield, and two food processors in Vacaville. Two major defense facilities are located in the region: Mare Island Naval Shipyard and Travis Air Force Base.

Napa County's water supply comes from the North Bay Aqueduct, several small reservoirs, and a number of springs and wells.

Sources of water for Solano County include the North Bay Aqueduct, surface water from Lake Berryessa—the principal storage facility of the federal Solano Project— Lake Solano, and several small reservoir and stream projects, plus ground water, agricultural return flows, and reclaimed waste water.

North Bay Aqueduct water delivered to Napa County is used in the City of Napa and by exchange in American

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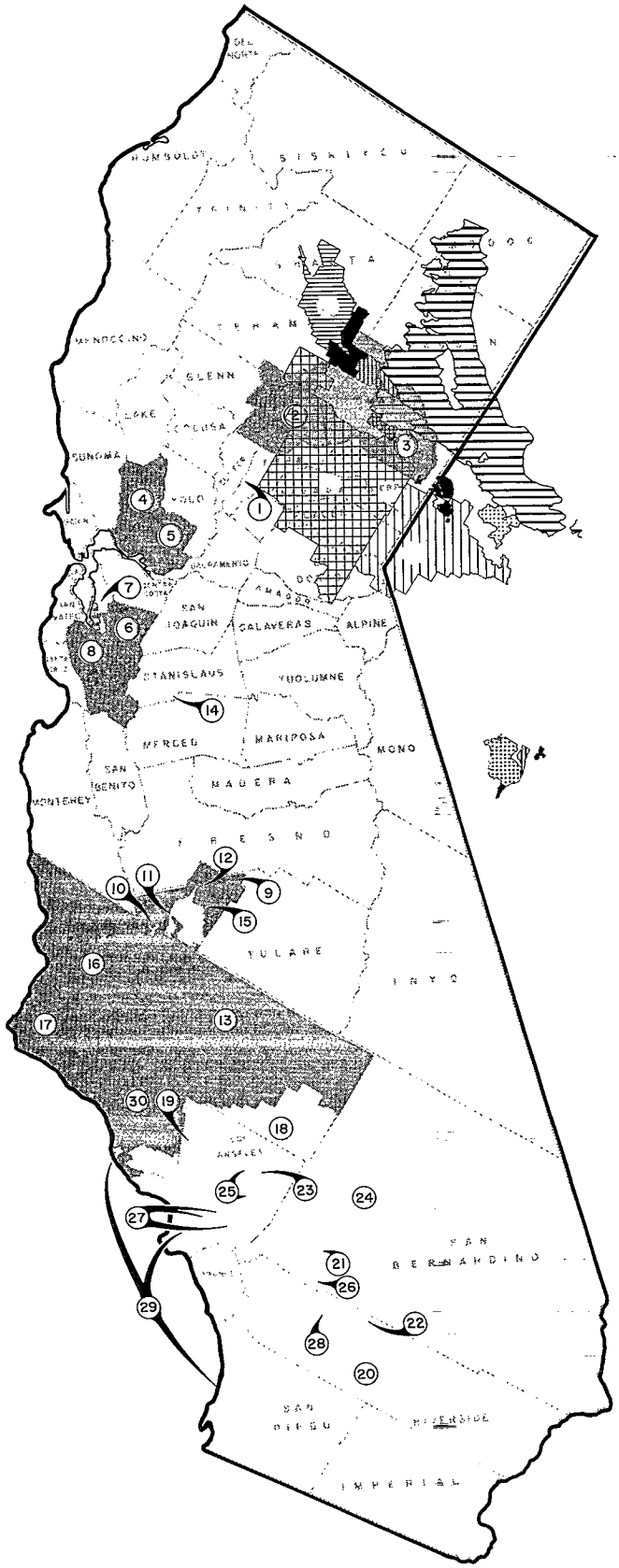

Location No.	Contracting Agency	Maximum Annual Entitlement (acre-feet)
	UPPER FEATHER AREA	
1	City of Yuba City	9,600
2	County of Butte	27,500
3	Plumas County Flood Control and Water Conservation District	2,700
	Subtotal	39,800
	NORTH BAY AREA	
4	Napa County Flood Control and Water Conservation District	25,000
5	Solano County Flood Control and Water Conservation District	42,000
	Subtotal	67,000
	SOUTH BAY AREA	
6	Alameda County Flood Control and Water Conservation District, Zone 7	46,000
7	Alameda County Water District	42,000
8	Santa Clara Valley Water District	100,000
	Subtotal	188,000
	SAN JOAQUIN VALLEY AREA	
9	County of Kings	4,000
10	Devil's Den Water District	12,700
11	Dudley Ridge Water District	57,700
12	Empire West Side Irrigation District	3,000
13	Kern County Water Agency	1,153,400
14	Oak Flat Water District	5,700
15	Tulare Lake Basin Water Storage District	118,500
	Subtotal	1,355,000
	CENTRAL COASTAL AREA	
16	San Luis Obispo County Flood Control and Water Conservation District	25,000
17	Santa Barbara County Flood Control and and Water Conservation District	45,486
	Subtotal	70,486
	SOUTHERN CALIFORNIA AREA	
18	Antelope Valley-East Kern Water Agency	138,400
19	Castaic Lake Water Agency	41,500
20	Coachella Valley Water District	23,100
21	Crestline-Lake Arrowhead Water Agency	5,800
22	Desert Water Agency	38,100
23	Littlerock Creek Irrigation District	2,300
24	Mojave Water Agency	50,800
25	Palmdale Water District	17,300
26	San Bernardino Valley Municipal Water District	102,600
27	San Gabriel Valley Municipal Water District	28,800
28	San Gorgonio Pass Water Agency	17,300
29	The Metropolitan Water District of Southern California	2,011,500
30	Ventura County Flood Control District	20,000
	Subtotal	2,497,500
	TOTAL STATE WATER PROJECT	4,217,786

Figure 4-3. SWP Service Areas and Contracting Agencies

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Canyon, Yountville, and Calistoga. Deliveries to Solano County supply municipal and industrial uses in five cities: Benicia, Fairfield, Suisun, Vacaville, and Vallejo.

A major restriction on the use of ground water, particularly for municipal and industrial needs, is the variable and uncertain quality in both counties. In Napa County, ground water quality is generally poor north of St. Helena and south of Napa. Because most of any additional demand for water in Napa County would be for municipal and industrial use, where both quality and quantity are crucial, ground water will probably continue to be used as a supplemental local source, mainly for agriculture. In any case, usable ground water storage capacity is restricted to the area between Napa and St. Helena, and the safe yield is currently overdrafted.

Solano County contains two major ground water basins—Putah Plain and Suisun-Fairfield Valley—and several smaller basins. Most ground water supplies are used for irrigation, although Vacaville, Rio Vista, and Dixon rely on ground water for domestic supplies.

Principal native plant communities include hardwood forest, chaparral, blue oak and digger pine forest, grassland, riparian habitat, and marshlands. The prairie grasslands are now mostly cultivated, but dense and varied riparian vegetation still exists along most rivers and streams. The marshes are mostly in the south-central portion of Solano County and the southern portion of Napa County. In addition to the principal plant communities, unique flora occur in vernal pools in the Jepson Prairie area of Solano County.

Game fish abound in the Sacramento River and in the salt and brackish water marshes on the borders of the two counties. Migrating waterfowl use the marshes as stopovers and winter habitat.

South Bay Service Area

The South Bay service area includes portions of Alameda and Santa Clara counties around the southern half of San Francisco Bay. Alameda County has some natural runoff from Alameda Creek, but only Santa Clara County has significant surface water supplies.

In this service area, ground water basins have been intensively developed for domestic, industrial, and irrigation uses and have been overdrawn, with resultant sea-water intrusion and land-subsidence problems. Extensive recharge programs using local and imported water supplies have allowed substantial recovery of the ground water basins. Water is imported from the Tuolumne River via the Hetch Hetchy Aqueduct, and from the Delta via the South Bay Aqueduct and the San Felipe Project.

Counties in the South Bay service area encompass 1,184,000 acres. About 305,000 acres were in urban use in 1980. The 1986 population was 1,638,000.

The South Bay is Northern California's leading business center. The economy of the area is diversified, with manufacturing, commerce, services, and government sectors employing significant numbers of people.

Historically, Santa Clara County's economy was dominated by agriculture. However, the rapid urban development of the county has displaced much of the farming, which is now carried out in the less populated southern part of the county.

Some rare or endangered species exist in the marshes in and around San Francisco Bay. Their habitat has been significantly reduced by bay filling and diking. Undisturbed areas are now protected by various State, federal, local, and private interests.

Central Coast Service Area

The Central Coast Service area, consisting of San Luis Obispo and Santa Barbara counties, encompasses about 3.9 million acres. Service to this area involves construction of Phase II of the Coastal Branch of the California Aqueduct. The Phase II facilities will transport up to 70,486 AF of water to the area. The 70,486 AF per year (AF/YR) represents current entitlements held by San Luis Obispo and Santa Barbara counties; however, Santa Barbara County has the option to buy back an additional 12,214 AF/YR of SWP water. Alternative route studies for the pipeline are completed. An Environmental Impact Report and an advance planning study are scheduled for completion in September 1990. The two counties will use those reports in deciding whether to construct the facilities.

The Santa Ynez, Santa Maria, and Salinas rivers constitute the major drainages of the Central Coastal service area. Dams and canals have been constructed on those rivers to conserve runoff. No water is imported into the area. Ground water is the main source of water supply. Over-use of the ground water resources has led to overdrafting and water-quality problems in some locations,

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such as the Santa Maria Valley and southern coastal Santa Barbara County.

Total population in San Luis Obispo and Santa Barbara counties grew from 103,700 in 1940 to 540,000 in 1987. Santa Barbara County is the larger of the two counties. The economy of this area depends on agriculture and related activities. In the coastal lowlands, there is considerable high-value fruit and vegetable farming. In the drier lowlands, inland from the coast, livestock and dry-farmed grains are produced. Manufacturing is limited, but heavy water-using industries—such as petroleum production, food processing, and stone, clay, and glass products—are present. Some mining and military installations also contribute to the region's economy. Recreation and retirement activities are increasing in the coastal communities.

The agricultural preserve program, under the Williamson Act, has helped limit urbanization of agricultural lands in Santa Barbara County. Land committed to public purposes includes Vandenberg Air Force Base, Los Padres National Forest, and other U. S. Forest Service land.

Much of the natural vegetation in the two counties remains relatively undisturbed. Those areas that have been developed have mainly been the valleys, alluvial fans and plains, and terraces.

Due to the wide variety of plant communities in the area, animal populations are extremely diversified. Some of the more common animal species, which occur in most communities throughout the service area, include the mourning dove, the red-tailed hawk, the white-crowned sparrow, the side-blotched lizard, and the western rattlesnake. Because of the overlap between the northern and southern floristic elements, many rare and endangered species inhabit the Central Coastal service area.

San Joaquin Valley Service Area

The San Joaquin Valley service area, which occupies the southern part of the San Joaquin Valley, is situated primarily in Kern and Kings counties and includes a very small area in Stanislaus County.

This service area is in one of the most productive agricultural regions in California. In part of the area on the west side of the valley, the quantity and quality of ground water supplies are poor, and local surface streams are practically nonexistent. With water, however, and the favorable climate, much of the area is conducive to production of a wide variety of orchard, vineyard, and truck and field crops. The two major river drainages in the service area are the Kings and the Kern.

Vast amounts of good quality ground water in the southern end of San Joaquin Valley provide the major water supply for this service area. A large portion of the SWP service area in the San Joaquin Valley overlies the intensively developed San Joaquin Valley ground water basin. The basin extends from the Delta to the Tehachapi Mountains. Parts of the basin have been in overdraft since the 1920s, resulting in land subsidence, increased pumping lifts, and water quality problems.

Water is imported to the southern San Joaquin Valley via the Friant-Kern Canal (CVP) and by the SWP. CVP water is also transported through the California Aqueduct to Kern County under an agreement between Reclamation and the State of California.

The San Joaquin Valley service area is generally arid, sparsely populated, and characterized by large farms. In 1986, the population in the San Joaquin Valley service area was 576,850.

Agriculture and the oil industry are the primary economic activities in this region. Crops raised in the San Joaquin Valley service area include alfalfa, barley, safflower, sugar beets, fruits, vegetables, nuts, cotton, sweet potatoes, cantaloupe, and grapes. Beef cattle, dairy products, and poultry are also significant. Other sources of income include manufacturing, trade, services, and government.

Despite substantial variations in annual SWP deliveries, total irrigated acreage in the service area does not normally fluctuate. Farmers rely heavily on ground water pumping in dry years and local surface water diversions in wet years to maintain the same irrigated acreage.

Details on crop production values, crop labor requirements, and employment and economic trends in this area are available in DWR Bulletin 132-88, Appendix F, *San Joaquin Valley, Post-Project Economic Impact, 1986 and 1987*, December 1988.

Much of the native vegetation in the service area has been replaced by introduced species or disturbed by cultivation or grazing. Major natural vegetation classes found within the valley include grassland, sagebrush shrub, coastal shrub, and hardwood forest-woodland.

Despite the conversion of much of the area to agricultural uses, the wildlife populations of the service area remain

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extremely diversified. Sizable populations of wildlife can be found in the fringe areas of the service area. Most native fish populations, however, have been eliminated by drainage projects and modifications of natural watercourses. They are now confined to farm ponds, drainage canals, and aqueducts.

Two animals whose native habitats have been reduced considerably by agricultural development are the endangered blunt-nosed leopard lizard and the San Joaquin kit fox. Recovery plans have now been prepared for both species. These are described in *Blunt-Nosed Leopard Lizard Recovery Plan*, Blunt-Nosed Leopard Lizard Recovery Team, January 1980 (draft), and *San Joaquin Kit Fox Recovery Plan*, Thomas P. O'Farrell, U. S. Fish and Wildlife Service, Endangered Species Program, 1983 (draft).

Southern California Service Area

The Southern California service area includes Ventura, Los Angeles, and Orange counties and parts of San Diego, Riverside, Imperial, San Bernardino, and Kern counties.

There are no major rivers in the desert plateau region of this service area. The intermittent streams that flow from the mountains primarily percolate into ground water basins. A limited surface water supply has been developed, and most local water supplies are fully used. In the coastal portion of the basin, most local surface supplies have been developed for flood control, ground water recharge, and water supply.

Ground water supplies a significant portion of the water in this service area. The South Coastal hydrologic basin, which encompasses this service area, has at least 44 major ground water basins. Although further development is possible in a few local areas, some of the basins have been over-used. In 1974, an annual ground water overdraft of 160,000 AF led to sea-water intrusion problems in some areas along the coast. Sea-water barrier and artificial recharge programs have been developed to correct these situations.

In Ventura and Los Angeles counties, some SWP supplies are released into natural stream channels. Piru Creek, a tributary to the Santa Clara River, serves as a conveyance to Ventura County users. In Los Angeles County, SWP water is released into Gorman Creek for recreational use as part of the Hungry Valley recreational area. Additional opportunities exist for streamflow augmentation where the East Branch of the California Aqueduct crosses natural streams.

Supplemental water is being imported from three sources:

- Los Angeles Aqueduct from the Owens Valley and Mono Lake Basin, on the east side of the Sierra Nevada, to the City of Los Angeles.
- Colorado River via the Colorado River Aqueduct.
- SWP.

Many water quality problems exist in this service area. In the coastal area, thermal discharges from electrical generation plants and nutrient overloading of streams cause local problems. In the desert areas, the problems are more general and relate to increasing salinity of both ground water and lakes such as the Salton Sea.

The quality of imported water ranges from less than 220 mg/l total dissolved solids for SWP supplies to 750 mg/l for Colorado River water. In some areas, SWP water is blended with imported Colorado River water to provide a better overall quality.

Land use in the Southern California service area has changed dramatically since the early part of the century, when the citrus industry dominated the economy. Several factors have led to the changes: discovery of oil, construction of the Los Angeles and Colorado aqueducts, increase of port facilities to accommodate shipping and trade brought about by the Panama Canal, location of the 11th Naval District in San Diego, the movie and entertainment industry, and location of heavy industry (especially aircraft and ship building). Together, these factors have caused a shift from agricultural to urban and suburban development.

Since the 1940s, Southern California has changed from a largely rural lifestyle with an agricultural economy to a highly urban-industrial society. The estimated population in 1986 was over 15 million. The rapid economic growth that Southern California experienced during the 1950s and 1960s has slowed, but diversification of the economy continues. This region is the State's leading center of business. Southern California contains the State's largest concentration of manufacturing activity, particularly the aerospace industry. Other major industries include petroleum, fabricated metals, chemical production, food processing, and paper production.

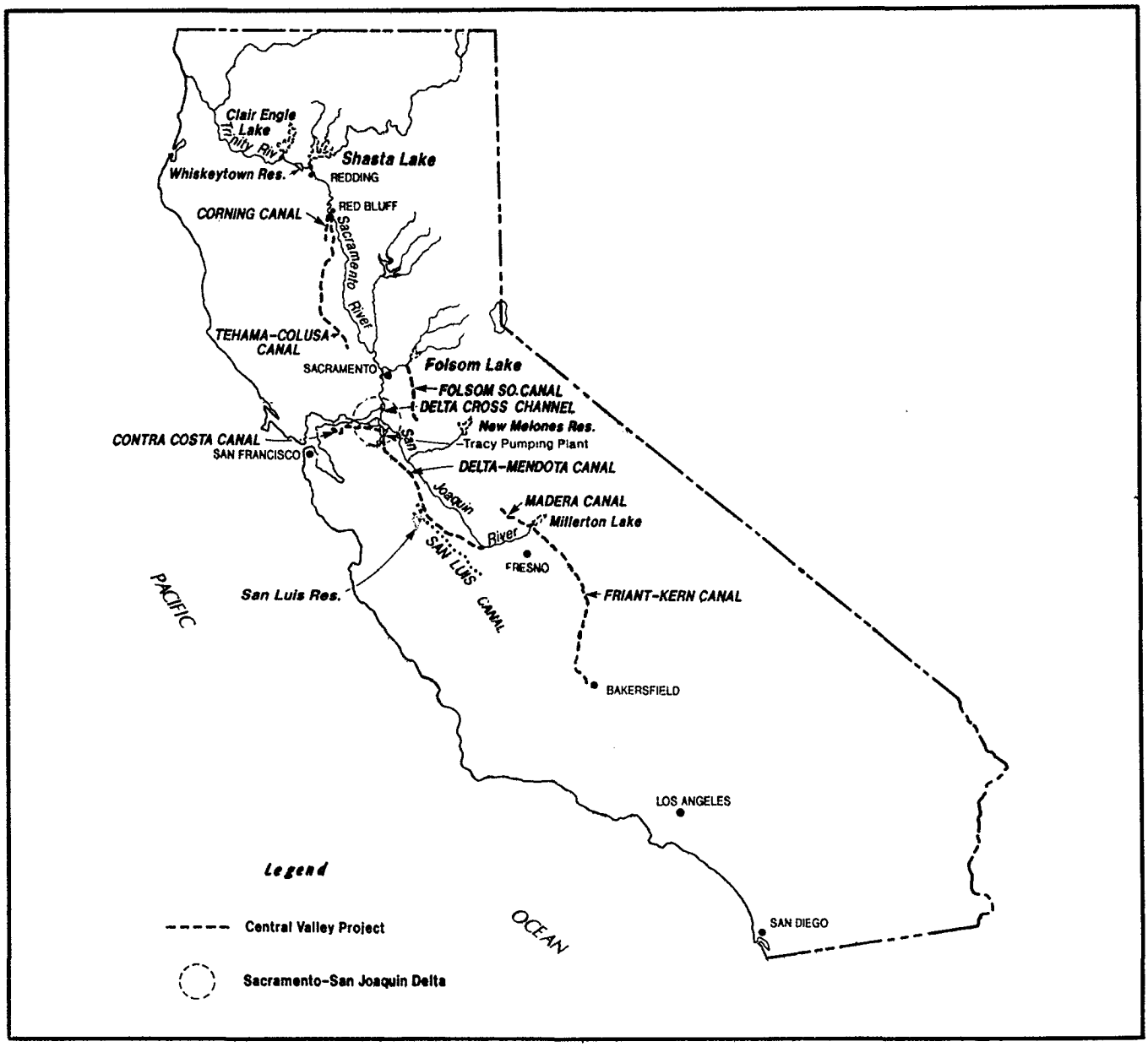

Figure 4-4. The Central Valley Project and its Service Areas

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In the coastal areas of Southern California, agriculture remains important economically, despite urbanization. Farms generally produce high value crops on small irrigated parcels. Agriculture is also important in the Colorado Desert, especially in the Coachella and Imperial valleys. Livestock, field crops, truck crops, sugar beets, and cotton are important. Poultry, livestock, and field crops are produced in the Mojave Desert.

While some of the naturally occurring vegetation in the Southern California service area has been altered significantly by urban and agricultural development, a large part of the region (mostly uplands) retains its native cover. The principal vegetation includes chaparral, scrub, grassland, woodland, and forest.

The Southern California service area supports a great diversity of wildlife. The diversity of habitats available in the area, combined with the impacts of a rapidly developing human population, has resulted in a large number of rare and endangered plant and wildlife species. Steps have been taken to preserve habitats that have unique biological significance. One endangered fish, the unarmored three-spine stickleback, occurs in the service area but is no longer found in the Los Angeles, San Gabriel, and Santa Ana rivers. The fish population in the Santa Clara River is threatened by increased recreational use and development.

CVP Service Areas

The CVP service areas extend for some 430 miles through much of California's Central Valley, from Clair Engle and Shasta reservoirs in the north to Bakersfield in the south (Figure 4-4). The CVP service areas also include the San Felipe Unit, which is located in the adjacent coastal valley. Much of the environmental setting in the CVP service areas is presented in the previous discussions of the Sacramento and San Joaquin valleys.

At present, Reclamation has contracted to deliver about 8.6 MAF of CVP water, including the sale of interim water. (This includes water for Contra Costa County and from Millerton Reservoir.) CVP water supply contracts have build-up provisions identifying periods during which the contractors may use less than their full entitlement. In 1985, the CVP delivered some 7.4 MAF. Reclamation estimates that, by 2020, nearly all the contracted amount of water will be delivered each year.

The CVP provides water to over 2.8 million acres of agricultural land. Crops grown on California lands irrigated by the CVP had a gross value of about $2.4 billion in 1981.

In addition to irrigation water, the CVP provides water for municipal and industrial use. Nearly 193,000 AF of water was delivered for such uses in 1985. The largest share of this water was delivered through the Contra Costa Canal, as described in the next section. The cities of Redding, Roseville, Placerville, Sacramento, Fresno, and Coalinga also receive all, or a portion of, their water from the CVP.

Contra Costa Water District Service Area

The Contra Costa Water District Service Area, shown on Figure 4-5, is in transition from a rural area to an area dominated by suburban and commercial development. In the 1940s, when the Contra Costa Canal came on line as the first unit of the CVP, 38 percent of the water conveyed went to agriculture and 62 percent to municipal and industrial users. Today, the latter receives 95 percent of the water, with only 5 percent going to agriculture. The county ranks second after Los Angeles among California counties for total fresh water use.

A diversity of industry is located in the county. With its miles of waterfront—linking ocean, river, and overland transportation facilities—the area offers many advantages to heavy industries requiring large supplies of cooling and processing water, large land areas, and access to a deep-water ship channel. Major industry groups in the county requiring the greatest amounts of water are petroleum and coal products, paper and allied products, chemicals and allied products, primary metal industries, and food and related products. Presently, the exceptionally high water needs of the petroleum refineries are largely met with brackish supplies from the south shores of San Pablo and Suisun Bays.

Today, Contra Costa Water District provides for the municipal water needs of about 300,000 county residents. Of the nine Bay area counties, Contra Costa is projected to experience the most rapid future population growth.

The growing trend toward municipal water use increases the need for both improved water quality to meet State and federal standards and improved system reliability to meet peak water demands.

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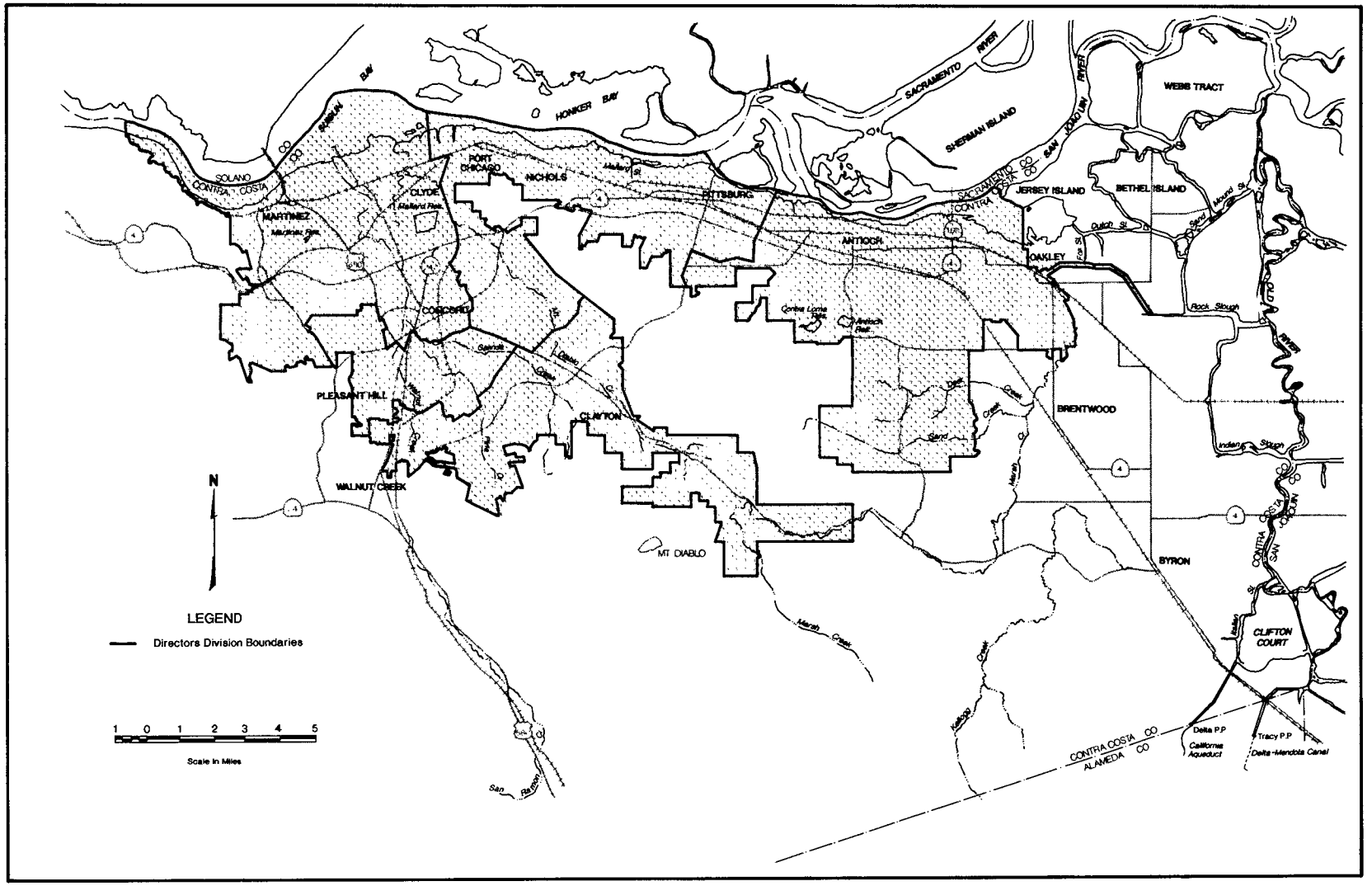

Figure 4–5. Contra Costa Water District Service Area

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CHAPTER 5. ENVIRONMENTAL IMPACTS

This chapter analyzes potential environmental impacts from implementation of the South Delta Water Management Plan (SDWMP). The analysis includes potential impacts due to construction of the south Delta facilities, as well as potential impacts due to changes in SWP operations that may result from implementation of the SDWMP. Subjects covered include potential impacts to: 1) SWP operations and reliability, 2) SWP energy consumption, 3) Delta outflow characteristics, 4) patterns of Delta flow and salinity, 5) the Bay-Delta fishery, 6) municipal and industrial uses of Delta water, and 7) Delta agricultural activities. Also discussed are potential impacts to project service areas.

Fishery biologists and environmental specialists of the Department of Water Resources (DWR), the U.S. Bureau of Reclamation (Reclamation), the Department of Fish and Game (DFG), and the U.S. Fish and Wildlife Service (USF&WS) assisted in formulating and evaluating incremental impacts of the SDWMP. Habitat Evaluation Procedures (HEP), which have been standardized, were also used in the evaluation. Where more information was required, additional field studies were also conducted.

During preparation of this EIR, coordination between local, State, and federal agencies has been extensive. Local land owners have been contacted, and their concerns have been considered.

Three types of engineering studies were used to evaluate impacts: 1) water supply studies using the DWRSIM model were conducted, based on 57-year historic hydrology from 1922 to 1978, in which SWP demands were assumed to be 3.3 million acre-feet (MAF); 2) Delta hydrodynamics studies using the DWR/RMA Model and water quality studies using the Fischer Delta Model; and 3) long-range studies used to evaluate project energy and capacity requirements, based on median water supply conditions and gradually increasing project demands.

The water supply studies were used to evaluate potential contributions of the SDWMP to SWP reliability. Contribution of the project to the dry-period delivery capability was based on the system's performance during the historical critical period 1928 through 1934. Results of this study were used in both the economic analysis of the project and the service area impact analysis. Water supply studies were also used to develop hydrologic conditions for which Delta water quality and hydraulic conditions could be assessed.

Mathematical modeling of Delta hydrodynamic and water quality conditions was used to evaluate potential SDWMP impact to Delta flows, stages, velocities, and salinities. Appendix C consists of the important assumptions and results of the mathematical modeling conducted in support of the SDWMP. Documents describing the mathematical models in more detail, along with their verification, are available for viewing at DWR.

Mathematical modeling of water levels, flows, velocities, and salinity in the Delta channels has greatly aided water resources planning of the Delta. However, some care is required when interpreting the results of such modeling. The mathematical modeling conducted to aid in the evaluation of potential environmental impacts caused by the SDWMP was generally not intended to provide absolute predictions of future Delta hydrodynamic and salinity conditions. Results of mathematical modeling of Delta conditions under various alternative actions planned are often interpreted in terms of the direction and relative magnitude of changes in such variables as water levels and salinity. For this reason, the analysis of how the SDWMP may affect Delta water levels, flows, velocities, and salinity was based primarily on how the values of these parameters changed under the preferred alternative and other alternatives with respect to the base no-action alternative. Much of the Delta modeling results in Appendix C and in this chapter are therefore provided in terms of changes or improvements in water levels and salinity when compared to the no-action alternative.

Basic assumptions used for the No-action alternative (base case) and other alternatives, including the preferred alternative, are listed in Table C-1, Appendix C.

Table 5-1
Summary of Environmental Assessment for the Preferred Alternative

Subjects	Physical Impact	Environmental Impact	Protection/Mitigation Measures
Construction	Increase in noise, dust, truck traffic, and turbidity; disturbance of vegetation; minor disruption of services (cables, gas lines, etc.); and some minimal recreational inconveniences are expected. Some channel dredging in the south Delta.	Environmental impacts will be short-term. No significant long-term impact is expected from project construction. Local construction work force will be used for the Project.	CAL-OSHA regulations (noise); Regional Water Quality Control Board permit (turbidity); use of flagman and off-peak hours for transportation; replanting vegetation; Endangered Species Act of 1973; and State and federal dredging permits.
Water Supply Reliability	Increase Banks Pumping Plant exports during winter and high-flow conditions. Increase capacity from 6,400 cfs to 10,300 cfs.	Provide more flexibility for operation of the SWP. Shift in export will have positive effect on environment.	D-1485 protective standards. Letter limiting exports. Existing and new fish agreements. U. S. Army Corps of Engineers Permit.
Delta Outflow	Slight decrease in Delta outflow in winter and during high flow conditions.	Shift in exports can have positive effect on fishery. Slight decrease in Delta outflow in winter and high-flow conditions will have minor impact on environment.	D-1485 protective outflow standards. Existing and new fish protection agreements.
Delta Outflow Pulses	Minimal changes in outflow pulse characteristics.	Unknown environmental impact.	San Francisco Bay Study funded (partially) by DWR.
Local Municipal and Industrial Use	Possible future water quality improvement to the Contra Costa Canal with potential relocation. Reduced days of availability of offshore supply.	Potential water quality improvement and water supply for municipal and industrial use in the Delta. Protective water quality standard for M&I will be met for all year types.	D-1485 protective standards. Various industrial water supply contracts.
SWP Water Quality	Reduced total dissolved solids, chlorides, bromides, and THMFP.	SWP water quality will be improved.	D-1485 protective standards. EPA and California Dept. of Health Services drinking water standards. SWP contract objectives.
Agriculture	Improve circulation, increase water levels.	Improve water supply and water quality for South Delta Water Agency agricultural users.	Delta Protection Act. South Delta agreements. Releases from New Melones.
Sedimentation, Scouring, and Seepage	Increase velocity in Old River.	No scouring or sedimentation is expected.	Channel improvements and forebay intake design will prevent scouring and sedimentation. Existing scour monitoring program will be expanded. Seepage monitoring program will be established.
Cross-Delta Flow	Minimal changes on Cross-Delta flow.	No impact is expected.	Existing and new fish protection agreements.

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Table 5-1 (Continued)
Summary of Environmental Assessment for the Preferred Alternative

Subjects	Physical Impact	Environmental Impact	Protection/Mitigation Measures
Navigation	Increased water levels, channel dredging, and physical barriers.	Improved access to scenic channels.	Provision for boat passages and boater designation sites.
Salmon and Steelhead	Construction and operation of barriers will improve San Joaquin River flows. Water quality, dissolved oxygen, and temperature will improve in south Delta channels.	Improved flows in San Joaquin and Old River will have positive impact on San Joaquin River spawning. Minor impact on Sacramento River salmon.	D-1485 provides for flow and salinity standards in the Delta. SWP and CVP fish protective facilities. Existing and new fish protection agreements. Predation may decrease by using alternative Italian Slough diversion and expansion of forebay. Interim releases from New Melones.
General Impact on Striped Bass	Provide operational flexibility. Exports can decrease from May through July. Flows in lower San Joaquin River can increase in May, June, and July. Increases in reverse flow August—November.	May and June export reduction and operational modification can improve conditions for striped bass during spawning and for young striped bass. Entrainment of young Sacramento River bass from Project exports would be less.	D-1485 (salinity and minimum flow standard for striped bass.) Existing and new fish protection agreements
Direct Impact on Striped Bass	Can shift export from summer to winter.	Shifting export can benefit striped bass during critical periods. 22% reduction in direct fish losses is expected.	D-1485 protective standards. Predation may decrease in forebay by increasing the volume and using Italian Slough intake periodically.
Resident Fish	Entrainment may decrease in spring. and summer.Water quality, dissolved oxygen, and water temperature in south Delta channels can improve.	Minimum net impact on resident fish.	
Fish Food Resources	Can reduce exports in spring and increase exports in winter.	Shift in export can benefit *Neomysis*. More Sacramento River water with low plankton densities will flow to interior Delta.	D-1485 protective standards. Interagency ecological study program. Existing and new fish protection agreements.
Wildlife	Inundation of 3,000 acres for forebay enlargement.	Loss of plant and wildlife habitat.	Implementation of a wildlife management plan. Creation of channel islands and additional shoreline.
Suisun Marsh	Delta outflow will decrease slightly.	No significant impact is expected because of: • little changes in outflow • physical protective facilities and • existing agreement to protect the Marsh.	Suisun Marsh Protection Agreement. Facilities and monitoring program.

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Table 5-1 (Continued) Summary of Environmental Assessment for the Preferred Alternative			
Subjects	**Physical Impact**	**Environmental Impact**	**Protection/Mitigation Measures**
San Francisco Bay	Minor decrease in number of pulses, minor changes in Delta outflow.	Unknown impact.	D-1485 protective standards. Various studies of Bay resources funded partially by DWR.
SWP Service Area	Improve water supply reliability. No expansion of agricultural land is expected.	Primarily replacement supply. Not growth-inducing. Provide better quality of life with fewer water shortages.	Local regulations and mitigation actions. Zoning and planning.
Power Resources	Increase SWP power supply requirements. DWR is not planning to build a new power plant to meet increased load.	Potential increase of fossil fuel consumption.	Water conservation measures. Best use of off-peak power. Mitigation measures for existing plants.
Archeological and Cultural Resources	Some cultural sites are near the project area.	Sites to be avoided.	Design and specification of the project will include avoidance of known archeological and cultural resources sites. Construction consultation if needed.

The analysis in Chapter 6 assumes SWP demands exceeding 3.3 MAF. The cumulative impact review in Chapter 6 is broader in scope, and more general than the impact evaluation in this chapter.

This chapter concludes with a summary of significant operational impacts under the preferred alternative, mitigation options, temporary impacts, and other information required by the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA).

Operational Impacts

Operation studies and Delta hydrodynamic and water quality studies were used to evaluate potential environmental impacts of the nine south Delta alternatives.

These studies provided information for evaluating both the potential environmental impact of the operation of the alternatives as well as the potential environmental impact of the subsequent changes in operation of the Banks Pumping Plant. Monthly water supply studies of the overall SWP and CVP system for the 57-year period 1922 through 1978, with SWP demands assumed at 3.3 MAF, were used to establish the no-action State water supply conditions and Delta hydrologic conditions. A second operation study was made at the same level of SWP demands, which assumed Los Banos Grandes Reservoir (LBG), Kern Water Bank (KWB), and SDWMP to allow for a Banks Pumping Plant capacity of 10,300 cfs.

The no-action Delta hydrologic conditions were used in Delta models to establish the no-action Delta hydrodynamic and water quality conditions for five of the water years out of the 57-year study period. These five water years were selected because they contained Delta inflows and diversions representative of those observed for each of the five water year types. This ensured that the no-action Delta hydrodynamic and water quality conditions were determined under a wide range of realistic hydrologic conditions. The Delta hydrologic conditions reflecting operation of SDWMP and the assumption of LBG and KWB were used, along with a description of the components of each alternative, to establish the Delta hydrodynamic and water quality conditions for each alternative.

The format for discussing operational impacts is explained as follows:

- Background: Information pertinent to the impact under discussion.
- No-Action Alternative: A brief review of past, present, and anticipated conditions under the no-action alternative.
- Preferred Alternative: An assessment of incremental impacts based on a comparison with the no-action alternative to quantify impact differences.
- Other alternatives: A similar assessment of incremental impacts compared with the no-action alternative.

Impacts on fish, an important part of this analysis, are generally covered in two parts:

- A qualitative discussion of general impacts, by species, of the effects on migration, survival, and entrainment. Delta inflow and diversions from operational studies, and Delta flows and salinities from Delta modeling, are presented to assess these effects. Fish examined include striped bass, Chinook salmon, sturgeon, American shad, and various resident fishes.
- A quantitative analysis and discussion of direct losses and salvage of screenable-size fish at the Delta Complex, which consists of Banks Pumping Plant, the John E. Skinner Fish Protective Facility, and Clifton Court Forebay.

Direct losses of striped bass and Chinook salmon were estimated on the basis of estimated entrainment losses, including salvage, predation losses, and handling and hauling losses. This method used historic loss data, and SWP diversion records from 1980—1987, to estimate losses that might occur under future SWP diversion rates described in operation studies reflective of the no-action, preferred, and other alternatives assumptions.

Estimated salvage of screenable-size American shad, sturgeon, and resident fish are also presented. This analysis is based on the historical (1968-1980) number of fish salvaged at the screen and assumes that the average population of those fish will remain constant. A lower population value used in the assessment of fish impacts would result in lower fish impacts.

Other operational impacts on the estuarine environment that are evaluated or discussed include aquatic invertebrates and Suisun Marsh.

Monthly Operational Changes

Factors which dictate the monthly operation of the SWP include 1) flood management; 2) electrical load management; 3) flow, exports, and quality measures; 4) natural hydrologic and tidal variations; 5) state water contractors' requests; 6) existing channel configuration; 7) upstream and in-Delta water users; and 8) operational risk analysis.

The CVP has operational constraints similar to those of the SWP listed in the preceding paragraph. CVP diverts water directly from Old River, which affects water conditions in the south Delta and possibly affects SWP operation.

During wet years, SWP storage facilities designated for flood control store flood waters and make controlled releases that reduce or eliminate the potential for flooding in downstream areas. When water surface elevations in the storage facilities encroach into the flood reservation zone, operation of the storage facility is governed by Corps of Engineers (Corps) flood control regulation.

Although the SWP produces a large amount of hydroelectric energy, it consumes even more energy at the various pumping stations located throughout its system. To reduce SWP impacts on the statewide electrical power grid, pumping is conducted during low-demand periods of the day and week to take advantage of the availability and low cost of energy during those periods.

Various protective measures for the Delta have required specific flow and quality measures: 1) Decision 1485 establishes minimum Delta flow, water quality standards, and export limitations to protect fish, municipal, industrial and agricultural uses of the Delta water supply. 2) The Coordinated Operating Agreement (COA) obligates the SWP and the CVP to meet water quality and outflow standards established in Decision 1485 to protect the beneficial uses of the Delta water supply. 3) Agreements and contracts with local Delta interests to provide water users in the Delta with water and water quality standards above the existing Delta standards. 4) A temporary agreement between DWR and DFG to offset direct losses of striped bass, Chinook salmon and steelhead in relation to the Harvey O. Banks Pumping Plant by further limiting export pumping in May and June from 3,000 cfs to no more than 2,000 cfs based on storage withdrawals from SWP facilities upstream of the Delta.

These and other Delta protective measures are discussed in detail in Chapter 1.

In August 1983, DWR and DFG signed the "Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife." The agreement set releases into the Feather River from Thermalito Diversion Dam for fishery purposes. DWR will continue to operate the SWP under this agreement.

System hydrology helps dictate the amount of SWP diversions throughout the year. Decision 1485 establishes five water-year classifications based on channel hydrology in the Sacramento Valley (Table 5-2). These water year classifications help define water quality standards and the availability and allocation of water to water agencies serviced by the SWP.

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Table 5-2
Decision 1485 Water Year Classification

Year classification shall be determined by the forecast of Sacramento Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year) as published in California Department of Water Resources Bulletin 120 for the sum of the following locations: Sacramento River above Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River at Smartville; American River, total inflow to Folsom Reservoir. Preliminary determinations of year classification shall be made in February, March and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

YEAR TYPE[1]	Unimpaired Runoff, Millions of Acre-feet (MAF)				
All Years for All Standards Except	10.2	12.5	15.7	19.6	
	Critical	*Dry*	*Below Normal*	*Above Normal*	*Wet*

	Unimpaired Runoff, MAF			
Year Following Critical Year[1]	*12.5*	*15.7*	*22.5*	
	Critical	*Dry*	*Above Normal*	*Wet*

Wet[2]	Equal to or greater than 19.6 MAF (except equal to or greater than 22.5 MAF in a year following a critical year)[3]
Above Normal[2]	Greater than 15.7 MAF and less than 19.6 MAF (except greater than 15.7 MAF and less than 22.5 MAF in a year following a critical year)[3]
Below Normal[2]	Equal to or less than 15.7 MAF and greater than 12.5 MAF (except in a year following a critical year)[3]
Dry[2]	Equal to or less than 12.5 MAF and greater than 10.2 MAF (except equal to or less than 15.7 MAF and greater than 12.5 MAF in a year following a critical year)[3]
Critical[2]	Equal to or less than 10.2 MAF (except equal to or less than 12.5 MAF in a year following a critical year)[3]

[1]*The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.*

[2]*Any otherwise wet, above normal, or below normal year may be designated a subnormal snowmelt year whenever the forecast of April through July unimpaired runoff reported in the May issue of Bulletin 120 is less than 5.9 MAF.*

[3]*"Year following critical year" classification does not apply to Agricultural, Municipal, and Industrial standards.*

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The SDWMP alternatives have been tested under varying monthly export levels, which vary according to the operational considerations listed in Chapter 3. These considerations restrict May, June, and July exports according to D-1485. During high-flow periods, exports are increased; however, monthly average exports exceeding 8,000 cfs occur less than 20 percent of the time. During the spring, average export rates for different years had a range of 2,000 cfs, with corresponding variations on impacts to fish. For example, over the 57-year study period, striped-bass losses in May would be reduced by about 5 percent when exports are reduced by 200 cfs. Different levels of export and associated fishery impacts can be determined by comparing monthly operational SWP data to fishery analysis.

Alternative export levels also affect operational flexibility. For example, greater flexibility in operating the SWP can be achieved if maximum daily average SWP exports can periodically reach 10,300 cfs instead of being limited to 6,400 cfs. Current negotiations for fishery protection will consider operational flexibility.

Tidal variations also affect SWP operation. During high tides, diversions into Clifton Court Forebay are usually increased to take advantage of the abundance of water in the Delta channels while still adhering to established water quality requirements.

DWR has contractual agreements with various agencies to deliver water for municipal, industrial, and agricultural uses. Contracted agencies submit their requests to DWR for the upcoming year's water delivery schedule, which depends on water year type, water users request, and the predicted water availability.

The existing Delta channel configuration impairs water movement and circulation patterns in certain areas of the south Delta. Reduction in water circulation tends to degrade water quality and availability, thus impacting export pumping schedules.

Many of the major upstream and in-Delta water users have water right contracts with DWR to request and divert a specified quantity of water. These diversions vary from month to month, which forces upstream storage releases in order to compensate for minimum water quality downstream.

Currently, contracts for water delivery requests exceed the firm yield of the SWP. To alleviate the shortfall, SWP operations are determined by present water conditions and by the established acceptable level of risk that balances the quantities of water delivered to contractors this year against the ability of the SWP to fulfill future water deliveries. The SWP operational level of risk is determined by use of the "rule curve," which is discussed in Chapter 1, under "State Water Project Operations."

Operation of the SWP and CVP has affected the seasonal and monthly pattern of Delta inflows, exports, and outflows. Generally, winter and spring inflows and outflows have been decreased, while summer and early fall inflows and outflows have been increased. Upstream of the Delta, the projects and local facilities have altered flow regimes, habitat, and fish populations on the Sacramento, San Joaquin, and Trinity river systems. These past effects are summarized in the final environmental impact report on the Banks Pumping Plant expansion, dated January 1986, and the COA, dated April 1986.

Table 5-3 presents the average projected pumping rate for all of the varying year types. In the table, the columns "No-Action-CVP," "Preferred Alternative-CVP," and "Other Alternatives-CVP" reflect the monthly export rates from the federal pumps for the no-action, preferred, and other alternatives. Values in these three columns are the same because it is assumed that any south Delta improvement will not affect CVP operation. The average monthly Banks Pumping Plant pumping rates for the columns "No-Action-SWP," "Preferred Alternative-SWP," and "Other Alternatives-SWP" include CVP exports pumped by the Banks Pumping Plant in accordance with various agreements, including the COA and the Wheeling and Purchase Agreement.

The Banks Pumping Plant pumping rates for the no-action, the preferred, and the other alternatives are based on 3.3 MAF SWP water demands. All of the alternatives meet the water quality standards established in Decision 1485, but the pumping rates are not all the same. The pumping rate for all of the other alternatives is the same as that for the preferred alternative because each alternative provides increased flexibility in SWP operation while still meeting water quality standards. The no-action alternative limits pumping flexibility to a daily average of 7,300 cfs during wet periods compared to daily average of 10,300 cfs during wet periods for the preferred alternative.

Table 5-4 shows the average monthly SWP exports for the preferred alternative and the no-action alternative for the five main water year types and also the monthly difference between the two.

Table 5-3
Average of Monthly CVP and SWP Exports over 57-Year Study Period
(Values in cubic feet per second)

	No-Action		Preferred Alternative		Other Alternatives		Percent
	CVP Cfs	SWP[1] Cfs	CVP Cfs	SWP[2] Cfs	CVP Cfs	SWP[2] Cfs	Change[3] %
January	4,228	6,702	4,228	7,636	4,228	7,636	13.9
February	4,283	6,476	4,283	7,095	4,283	7,095	9.6
March	4,165	4,931	4,165	6,695	4,165	6,695	35.8
April	4,284	4,504	4,284	5,518	4,284	5,518	22.5
May	2,980	2,880	2,980	2,730	2,980	2,730	-5.2
June	2,937	2,704	2,937	2,388	2,937	2,388	-11.7
July	4,300	2,869	4,300	2,067	4,300	2,067	-28.0
August	4,361	1,722	4,361	1,617	4,361	1,617	-6.1
September	4,478	2,343	4,478	2,556	4,478	2,556	9.1
October	4,161	3,881	4,161	4,698	4,161	4,698	21.1
November	4,254	4,915	4,254	6,087	4,254	6,087	23.9
December	4,261	6,134	4,261	7,232	4,261	7,232	17.9
Totals[4]	**2.94**	**3.01**	**2.94**	**3.39**	**2.94**	**3.39**	**12.6**

[1]Includes CVP exports using the Banks facility as per the COA, 3.3 MAF SWP demands.
[2]Includes CVP exports using the Banks facility as per the COA, 3.3 MAF SWP demands, and compensation for evaporation losses at LBG Reservoir.
[3]Difference between the Preferred and No Project alternatives.
[4]Values expressed in million acre feet

No-Action Alternative. Yearly SWP water exports from the Delta will approach 3.01 MAF. Most of the pumping will occur during the wet season from October to April. The 57-year average of monthly SWP exports during this period will range from 3,881 cfs to 6,702 cfs with an average of 5,363 cfs. During the drier part of the year (May to September), the 57-year average of monthly exports will range from 1,722 cfs to 2,880 cfs with an average of 2,504 cfs.

Preferred Alternative. Under the preferred alternative, the distribution of monthly SWP operation changes so that more water is exported during the winter and spring and less in the summer and early fall. The analysis includes impacts of the LBG and KWB projects on SWP operation. Overall, SWP exports will increase over 12% from the no-action alternative. Except for the months of May through August, the average monthly pumping rate increases about 15.7% over the no-action alternative. The average seasonal changes in exports between the preferred and the no-action alternatives are:

- August - November +12.0%;
- December - March +19.3%;
- April - July -5.6%

This redistribution of monthly export pumping allows for increased water storage at the project facilities, while still maintaining Delta outflow, water quality, and exports at the required levels throughout the year.

Other Alternatives. All other alternatives assume the same Delta inflows and the same maximum export rate as the preferred alternative. Therefore the monthly export operation of the other alternatives will be the same as the preferred alternative shown in Table 5-3.

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Table 5-4
Average of Monthly and Annual Exports at Banks Pumping Plant over 57-Year Study Period By Year Type

(Monthly Values in Cubic Feet per Second)

Year Type	Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual[1]
Critical	No Action	3,401	3,443	4,167	4,999	5,096	4,574	3,704	2,598	2,187	1,639	1,218	1,229	2,301
	Preferred	4,432	4,216	3,867	4,668	5,431	4,895	2,872	2,057	2,241	1,110	862	1,372	2,284
	Difference	1,031	773	-300	-331	335	321	-832	-541	54	-529	-356	143	-17
Dry	No Action	3,160	4,294	5,928	7,114	6,988	5,801	3,544	2,666	2,173	1,280	651	1,439	2,705
	Preferred	3,449	5,116	6,416	8,405	8,059	8,472	5,069	2,696	2,143	1,042	839	1,430	3,192
	Difference	289	822	488	1,291	1,071	2,671	1,525	30	-30	-238	188	-9	487
Below Normal	No Action	4,220	5,294	6,422	6,809	6,635	5,248	5,018	2,992	2,884	3,118	1,709	1,907	3,144
	Preferred	5,191	5,912	7,236	7,432	7,962	6,980	6,131	2,703	2,524	2,724	2,098	2,039	3,543
	Difference	971	618	814	623	1,327	1,732	1,113	-289	-360	-394	389	132	400
Above Normal	No Action	3,732	4,611	6,222	6,580	6,866	5,416	4,991	2,992	2,953	3,536	1,802	2,109	3,116
	Preferred	4,403	6,099	7,372	8,286	7,069	8,013	7,351	2,893	2,736	2,864	2,373	2,190	3,712
	Difference	671	1,488	1,150	1,706	203	2,597	2,360	-99	-217	-672	571	81	596
Wet	No Action	4,363	5,824	6,872	7,210	6,499	4,200	4,819	2,992	2,975	3,741	2,464	3,640	3,346
	Preferred	5,364	7,471	9,004	8,246	6,846	5,673	5,581	2,960	2,324	2,243	1,693	4,111	3,703
	Difference	1,001	1,647	2,132	1,036	347	1,473	762	-32	-651	-1498	-771	471	357

[1] Annual values are in thousands of acre-feet.

Daily Operational Changes at Clifton Court Forebay

The SDWMP will allow for more flexibility in the daily operation of the Clifton Court Forebay gates. This increase in flexibility may allow for daily operational changes at Clifton Court Forebay to provide for more benefits to water levels and circulation in south Delta channels.

Clifton Court Forebay diversions vary on a daily cycle according to tidal fluctuations. Diversions are stopped during the day to avoid low tide conditions, providing a buffer between Delta channels and the pumps.

The effects of tide on water levels in south Delta channels typically causes two high tides: a higher-high and a lower-high tide, and two low tides: a higher-low and a lower-low tide, over approximately 25-hours (Figure 5-1). Delta water is diverted through forebay intake gates during this 25-hour cycle to moderate the impact of SWP diversions on channels upstream and downstream of the point of diversion. Water in the south Delta is diverted by the SWP to avoid low tide. This minimizes subsequent drawdown of minimum water levels in south Delta channels that otherwise could impact nearby agriculture diversions. Forebay gate operations also avoid diversions during the rising tide, minimizing the reduced momentum of incoming water and the subsequent impact to circulation in south Delta channels upstream of the point of SWP diversions. In addition, the forebay gates are operated to moderate reductions in maximum water surface elevations at the mouth of Tom Paine Slough, which otherwise might impact the flow of Delta water into the slough.

Figure 5-1 shows four strategies for SWP diversion of Delta water. Figures 5-1A, 5-1B, 5-1C, and 5-1D would progressively reduce impacts to south Delta water levels and circulation patterns.

Table 5-5 shows the potential for the preferred alternative to improve the flexibility in daily Clifton Court Forebay intake gate operations over the no-action alternative during summer conditions.

Table 5-5
Percentage of Time During Summer That Various Forebay Strategies Shown in Figure 5-1 Can be Used

Gate Operation	No-action	Preferred
Figure 5-1B	100	100
Figure 5-1C	100	100
Figure 5-1D	0	52

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No-Action Alternative. Under present conditions, physical restrictions on intake gate capacity prevent the most advantageous forebay operations for water levels and circulation in the south Delta. This is expected to continue under the no-action alternative.

Preferred Alternative. Under the preferred alternative, it is expected that daily Clifton Court Forebay operations will change to further benefit south Delta water levels and circulation.

As discussed in Chapter 2 under "Project Components," several alternative plans for the SDWMP, including the preferred alternative, will increase the capacity of the forebay intake gates and enlarge the forebay water surface area to about 5,000 acres. These improvements will increase the flexibility of daily forebay operation. An enlarged forebay increases the storage of water available and reduces the number of times the intake gates would have to be opened each day.

Table 5-5 shows that the preferred alternative allows the forebay gates to be operated with the strategy shown in Figure 5-1D, whereas the no-action alternative does not. The strategy shown in Figure 5-1D provides substantial protection to south Delta water levels and circulation by severely restricting when and how long the forebay intake gates can be open. The preferred alternative has greater flexibility in its gate operation than does the no-action alternative because it can operate with this strategy, whereas the no-action alternative requires the intake gates to be opened more frequently.

Other Alternatives. The other alternatives will also increase the flexibility of forebay gate operations. However, alternatives with the CVP tie-in to the forebay, but without an enlarged forebay, will not provide the same degree of improved flexibility as will the preferred alternative.

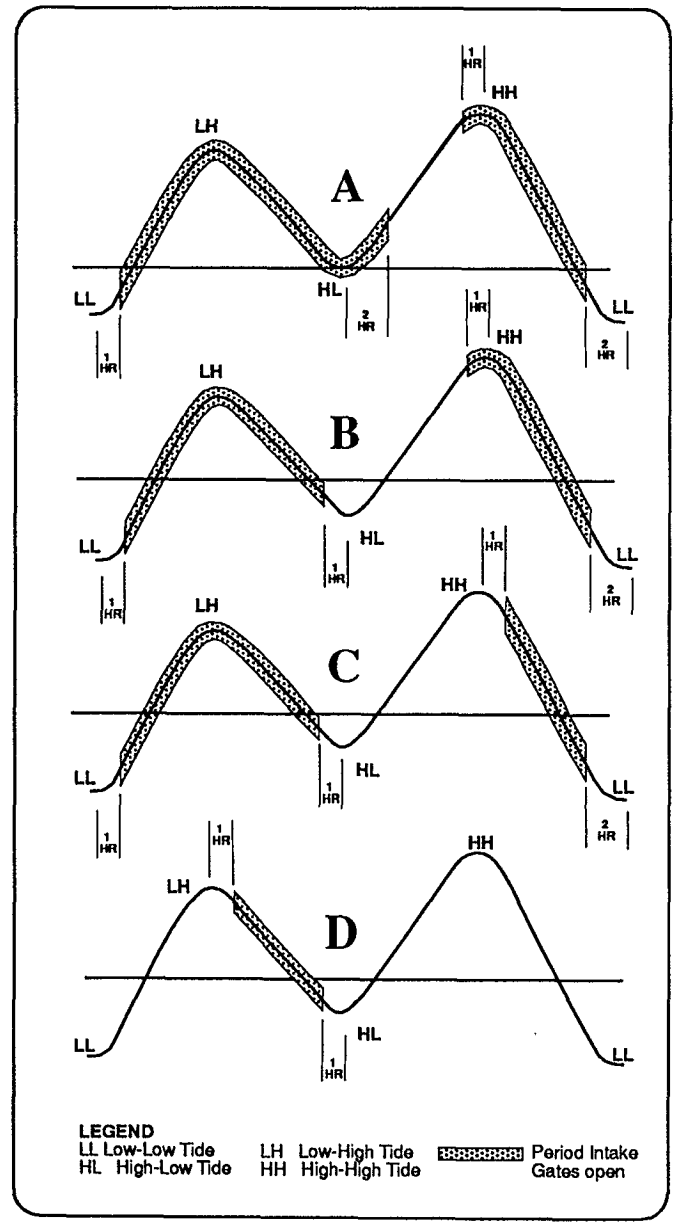

Figure 5-1. Typical Strategies for Forebay Intake Gate Operation

State Water Project Reliability

The SDWMP will increase the reliability of SWP deliveries in three ways: 1) by increasing wet-period diversions for storage south of the Delta, thus improving the percentage of time that project demands can be met; 2) by providing for more water during critically-dry periods; and 3) by improving the flexibility of seasonal SWP diversions. This will be accomplished by improving south Delta hydraulics and obtaining a permit from the Corps to divert up to 10,300 cfs.

SWP's capability for providing water deliveries is determined by the same factors which determine the SWP monthly operational patterns (see "Monthly Operational Changes" in this chapter).

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Total annual unimpaired Delta inflows can range from less than 7 MAF to more than 70 MAF. Storage facilities north and south of the Delta help stabilize the annual water supply, but hydraulic constraints and Delta protective criteria restrict diversions. Delta protective standards in Decision 1485, as well as mitigation agreements and other contracts, restrict diversions and reserve surplus water supplies for Delta protection. These factors, which affect the SWP delivery capability, are discussed in greater detail in Chapter 3 under "Operational Considerations."

The operational strategy of SWP reservoirs also helps determine SWP supplies. SWP facilities operations require a decision of how much water to release now for delivery and how much water to store for insurance against unknown subsequent water conditions. There is a trade-off between the level of current deliveries and the acceptable level of risk that there will be insufficient future water supplies. Short-range decisions for the operation of SWP facilities are made with an annual "rule curve." The rule curve is further discussed in Chapter 1 under "State Water Project Operations."

The nature of the factors for SWP delivery capability mentioned in the preceding paragraph means that the amount of water the SWP can deliver to its water contractors will vary yearly. Future entitlement requests by water contractors may not always be met, even in non-critical years. Table 5-6 shows the total annual entitlement water requested by water contractors and delivered by SWP from 1967 through 1988. Data for Table 5-6 was extracted from the DWR Bulletin 132 series (*Management of the California State Water Project)*, published annually.

The SDWMP, discussed at length in Chapter 3 under "Comparison of Physical and Operational Features," will enable maximum SWP diversions from the Delta to increase from a daily average of 6,400 cfs (7,300 cfs under conditions determined by the Corps) to 10,300 cfs. In addition, these plans will make such projects as LBG and KWB feasible.

Increasing maximum SWP diversion capacity and storage south of the Delta will enable: 1) increased diversions from the Delta during periods of high Delta flow, 2) storage of this surplus water, and 3) subsequent use during dry or critical periods. As shown under "Monthly Operations," any of the alternatives presented, with respect to the no-action alternative, tend to cause fewer SWP exports during spring and summer and increased SWP exports in winter months during high Delta flows. Over-

South Delta Water Management Facilities

The enlarged forebay, new intake gates, and 10,300 cfs pumping capacity can improve SWP operational flexibility to manage operations in a manner that will 1) improve project reliability, 2) reduce fishery impacts, and 3) improve conditions for local agricultural diverters. With added operational flexibility, the project can bank water supplies south of the Delta during winter and high flow conditions, when the abundance of fish is low. When inflow to the estuary is low, these supplies south of the Delta can be used to reduce the demand on Delta exports and reduce estuary impacts. Another operational advantage includes the ability to control the proportion of annual reserve storage in reservoirs north and south of the Delta. This could increase the frequency of refilling storage from varied runoff patterns.

The water quality of delivered supplies can also be improved with added operational flexibility to reduce the cost and difficulty of treating drinking water supplies. The flexibility of an additional intake on Middle River will reduce trihalomethane formation potential, total dissolved solids, and chlorides. Also, the ability to take advantage of seasonal and short-term water quality improvements could further improve the quality of delivered supplies. The project's ability to meet increasingly complex water rights and water quality standards can be improved by better flexibility to manage Delta salinity on a day-to-day basis during controlled flow conditions. Energy costs can also be reduced by a more flexible operation to buy available short-term electrical power.

In addition to shifting exports away from high periods of fish abundance to periods of low abundance in connection with winter banking, project operational flexibility can reduce fish impacts in other ways. A larger forebay can increase the time in which the Delta Cross-Channel can be intermittently closed to improve conditions for fish migration in the Sacramento River. Fish loss due to predation can also be reduced by providing for direct export capability from Italian Slough for short periods of time.

Local agricultural diverters can also benefit from added operational flexibility. A larger forebay with additional intakes can be operated during the irrigation season to release water to south Delta channels for improving water levels and circulation. Also the larger forebay can reduce the frequency and duration of gate openings and thereby reduce the effects to surrounding diverters.

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Table 5-6. Annual SWP Entitlement Water Delivered (Acre-feet)		
Year	Requested[1]	Delivered[2]
1967	11,888	56,763
1968	267,000	294,457
1969	248,800	268,104
1970	252,787	369,459
1971	375,590	654,442
1972	820,640	1,031,770
1973	984,700	737,604
1974	1,146,650	878,947
1975	1,311,260	1,230,830
1976	1,488,870	1,380,124
1977	1,660,538	582,381
1978	1,828,624	1,458,733
1979	1,855,003	1,666,457
1980	1,880,386	1,530,256
1981	1,876,707	1,918,563
1982	2,342,576	1,750,680
1983	2,365,818	1,187,156
1984	1,567,520	1,591,416
1985	1,891,849	1,990,279
1986	2,364,193	1,999,155
1987	2,760,920	2,131,608
1988	2,625,328	2,383,570

[1]Requested amounts taken from DWR Bulletin 132 series and do not include requests for surplus water.
[2]Delivered amounts from Table B-5B in Bulletin 132-89.

all, total SWP diversions for the year for each alternative tend to exceed total SWP diversions for the no-action alternative. Increasing annual SWP exports usually increases the frequency with which project demands can be met in noncritical periods.

Since SWP deliveries are variable, the reliability of SWP deliveries is always of great importance to SWP water contractors. The reliability of SWP deliveries may be demonstrated by the frequency, duration, and magnitude of deficiencies in deliveries. It may be represented by the frequency with which entitlement requests are met or by the ratio of the volume of delivered water to requested water over an extended study period. Reliability may also be indicated by the average annual SWP delivery over an extended study period or by the SWP delivery during dry periods. However it is examined, the reliability of SWP deliveries is directly related to the capability of SWP to deliver water to entitlement holders and to the flexibility with which the SWP can store surplus water over a season.

The water supply capability of the SWP has traditionally been expressed in terms of its "firm yield." Firm yield is the dependable annual water supply that can be made available during extended dry periods without exceeding specified allowable reductions in deliveries to agriculture. The firm yield of the SWP is influenced by the same factors that determine SWP delivery capability.

Table 5-7 shows the SWP firm yield for the no-action, preferred, and other alternatives. Table 5-7 also shows values of other parameters which help describe the reliability of SWP deliveries for each alternative. These values are derived from the operation studies conducted in support of the SDWMP. The operation studies, discussed in detail in Appendix C, simulate the operation of the SWP during the 57-year study period of 1922 through 1978 under various assumptions.

Under the no-action alternative (Run 340B) and the preferred alternative and other alternatives (Run 327B), entitlement requests are 3.3 MAF each year for the 57-year period. Delta inflow, outflow, and diversions comply with Decision 1485 Delta water quality and flow standards and agreements. The monthly average values for the preferred alternative and other alternatives reflect the assumptions of LBG and KWB, which together add 2 to 3 MAF storage to SWP, and the capability of SWP to divert 10,300 cfs from the Delta. The operation studies for both the no-action alternative and the preferred and other alternatives use the concept of the 1987 SWP water delivery rule-curve to establish strategy for SWP operations.

Referring to Table 5-7, dry period delivery capability of the SWP can be measured using the indices of "Firm Yield" and "Average Annual Dry Period Supply." As used in these studies, the "Firm Yield" value represents the level of annual SWP delivery that can be achieved during the historical 1928-1934 dry period, without exceeding the allowable agricultural deficiencies specified in the water supply contracts. For these studies the "Firm Yield" agricultural deficiency criteria of 100 percent accumulated deficiency over any 7-year period was achieved by assuming 33.3 percent agricultural deficiencies in each of the three years 1931, 1933, and 1934.

The "Firm Yield" is of limited use in the analysis of results, because SWP requests are now much higher than the "Firm Yield" level of delivery (Table 5-7). Thus when the SWP is operated to meet SWP requests (according to the water-delivery rule curve), the required agricultural

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Table 5-7
Summary of SWP Delivery Capability Analysis

	Parameter	No-Action Alternative	Preferred Alternative	Other Alternatives
1[1]	Entitlement Request (excluding losses), TAF/Year	3,289	3,289	3,289
2	Number of Years Entitlement Request not met (out of 57 years in study)	38	17	17
3[2]	Frequency of Shortages in SWP Deliveries	67%	30%	30%
4	Firm Yield (excluding losses), TAF/Year	2,221	2,631	2,631
5[3]	Average Annual Dry Period Supply, TAF/Year	2,200	2,535	2,535
6	57-Year Average Annual Delivery, TAF	2,770	3,104	3,104
7[4]	Volumetric Reliability	84%	94%	94%
8	Lowest 1-Year Delivery, TAF (in 1977)	795	2,327	2,327
9[5]	Minimum Required Carryover Storage for Entitlement Request Delivery, TAF	2,730	3,980	3,980

[1]Feather River Service Area requests and California Aqueduct losses are not included.
[2]Number of years entitlement requests not met divided by 57 delivery years.
[3]Total deliveries from March 1928 through February 1935, divided by 7 delivery years in the long-term (57 years) study.
[4]Total volume (over 57 years) of deliveries, divided by total volume (over 57 years) of entitlement request.
[5]Measured as September end-of-the-month storage in Lake Oroville plus SWP portion of San Luis Reservoir, plus storage in proposed SWP reservoirs (LBG or KWB) when included.

deficiencies during the 1928–1934 dry period greatly exceed total agricultural demands, and deficiencies in municipal and industrial demands are also required. Accordingly, "Firm Yield" is currently used only as a general indicator of dry-period delivery capability.

A more realistic indicator of SWP dry period delivery capability is the "Average Annual Dry Period Supply," which is the average annual delivery during the 7-year critical period in long-term studies (1922—1978). An increase in the "Average Annual Dry Period Supply" represents an alternative's enhancement of dry-period delivery capability of the SWP in long-term studies. In long-term studies, higher deliveries may be made in years prior to the outset of the drought, which can reduce the SWP carry-over storage and thus reduce deliveries during the 1928–1934 dry period. The "Average Annual Dry Period Supply" is generally considered the most realistic expression of the capability of the SWP to deliver water during extended dry periods.

The "57-Year Average Annual Delivery" index in Table 5-7 shows the average delivery capability of the SWP under the wide range of hydrologic conditions characteristic of the historical 57-year period of 1922 through 1978.

The parameters mentioned above, as well as others shown in Table 5-7, together indicate the nature of the reliability of each alternative. As the indices, "Firm Yield," "Average Annual Dry Period Supply," and "57-Year Average Annual Delivery," increase in value, the reliability of the alternative's capability to provide SWP deliveries increases.

No-Action Alternative. Under the no-action alternative, the Average Annual Dry Period Supply will be 2200 TAF/year. Annual SWP deliveries will fall short of entitlement requests 67 percent of the time. The volumetric reliability

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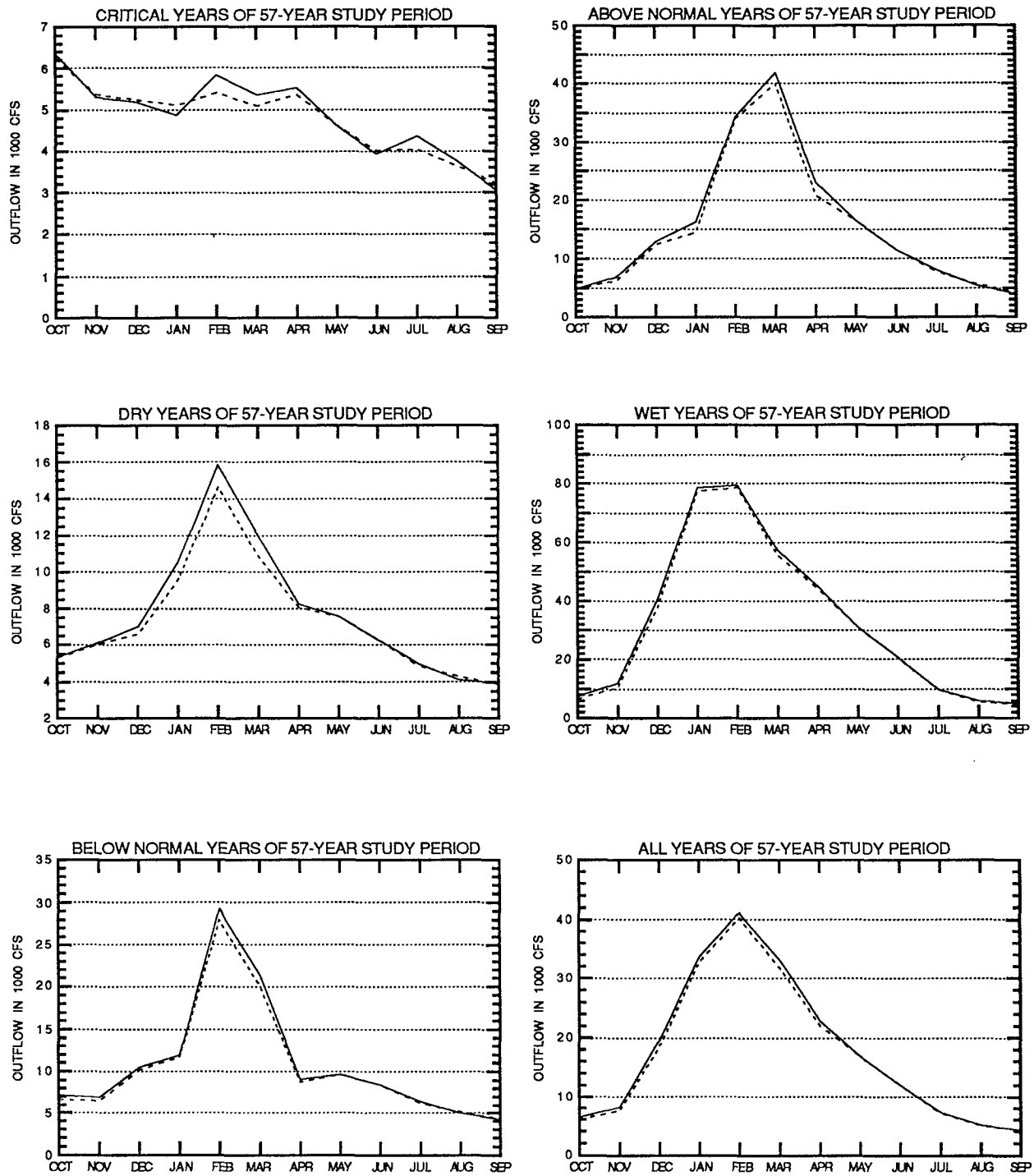
Figure 5-2
Monthly Average Net Delta Outflow



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(total volume of deliveries over the 57-year study period divided by total volume of entitlement request over the 57-year study period) will be 84 percent.

Preferred Alternative. Under the preferred alternative, the values of all of the indices indicating SWP delivery reliability significantly improved over the no-action alternative. Indices indicate that the SWP's delivery capability during dry periods is particularly enhanced. The "Average Annual Dry Period Supply" increased 335 TAF/year. The frequency with which annual entitlement requests could not be met decreased from 67 percent down to 30 percent, while the volumetric reliability over the 57-year study period increased from 84 percent to 94 percent.

Other Alternatives. The other alternatives improve SWP reliability over the no-action alternative to the same degree as the preferred alternative. The alternatives under the SDWMP, with the exception of the no-action alternative, include the same features as the preferred alternative to increase SWP reliability: LBG, KWB, and maximum SWP diversion capacity of 10,300 cfs.

Impacts on Delta Outflows

Delta outflow is the water that flows through the Delta and past Chipps Island to San Francisco Bay. Delta outflow averages about 13.0 MAF per year. The magnitude of this flow depends on Delta inflow, export, and depletions of channel water within the Delta. Major Delta inflow consists of the Sacramento River, San Joaquin River, and the Eastside Stream Group. The Sacramento River flow is categorized into the five main water year types as identified in Decision 1485 (wet, above-normal, below-normal, dry, and critical). Delta exports consist of CVP, SWP, North and South Bay Aqueduct, and Contra Costa Canal (CCC) pumping. Channel depletions occur due to crop irrigation, evaporation, and channel seepage. During normal water years, Delta outflow is higher in winter and spring and decreases during summer and early fall.

Fresh water Delta outflow establishes a hydraulic barrier to prevent ocean water from intruding deep into the Delta and affecting municipal and agricultural water supplies. The hydraulic barrier, where fresh water gradually mixes with ocean water, is located near Chipps Island during moderate Delta outflow periods. Delta flows provide a nutrient-rich environment for the multitude of organisms that are an integral part of the Bay-Delta food chain. Figure 5-2 displays the Delta outflow characteristics during varying hydrologic conditions. Changes in Delta outflow due to the SDWMP would not substantially change the hydraulic barrier under any of the alternatives being considered.

No-Action Alternative. Delta outflow will vary, depending on project pumping restrictions, water quality standards, and hydrologic conditions in the Delta. The highest outflows will occur during the winter and spring (December to June). During these months, the average daily outflow is almost 25,500 cfs. During the drier months (July to November), outflows average about 6,270 cfs. Monthly Delta outflows range from a minimum of about 3,044 cfs during critical years to a maximum of 79,439 cfs during wet years. Table 5-8 shows the average monthly Delta outflows for the no-action condition over the 57-year study period.

Preferred Alternative. The annual Delta outflow for the preferred alternative is slightly smaller than that for the no-action alternative (depending on year type, from 1.3 percent to 4.3 percent reduction). Reductions of this magnitude do not appear to affect beneficial uses in the Delta, as discussed in later sections of this chapter. Net Delta outflow varies between a minimum of 3,224 cfs during critical years and a maximum of 78,530 cfs during wet years.

Other Alternatives. Except for the no-action alternative, all the alternatives were evaluated using the same assumptions and values for Delta inflows and outflows. Therefore, the net Delta outflow is the same for the preferred alternative as for all the other alternatives.

Impacts on Delta Outflow Pulses

Delta outflow pulses are flows past Chipps Island that exceed the base flows. Pulses can occur throughout the year but usually occur during late fall and winter due to lower elevation precipitation runoff and in the spring from the Sierra snowmelt and project water releases.

The impacts of pulse flows on the Delta and Bay estuary are still not completely understood. The current SWRCB Bay-Delta Hearings are trying to evaluate this impact through testimony presented by public agencies, local entities, and private interest groups.

Delta outflow pulse volumes are used to classify pulses into four categories: a) over 25,000 cfs; b) over 50,000 cfs; c) over 75,000 cfs; and over 100,000 cfs (Table 5-9). An outflow pulse is measured from the time when outflow increases sharply on the hydrograph curve to the time when the outflow levels off. The flow difference between the two times on the curve is the magnitude of the pulse and is

Table 5-8
Monthly Average Net Delta Outflows, 1922-1978
(Values in cubic feet per second)

No Action Alternative						
	Water Years					
Mon.	Crit.	Dry	B/nor.	A/nor.	Wet	All
Oct	6,355	5,354	7,146	4,921	7,562	6,469
Nov	5,296	6,132	6,897	6,969	12,024	8,260
Dec	5,190	7,037	10,519	13,009	40,977	19,750
Jan	4,877	10,532	11,892	16,259	78,687	33,700
Feb	5,825	15,833	29,305	34,388	79,439	41,249
Mar	5,347	11,962	21,321	41,852	57,431	33,076
Apr	5,521	8,250	9,114	23,012	44,873	22,816
May	4,639	7,579	9,685	16,423	30,923	16,869
Jun	3,935	6,262	8,433	11,503	20,555	12,000
Jul	4,379	4,972	6,411	8,088	9,797	7,296
Aug	3,767	4,133	4,986	5,469	5,910	5,058
Sep	3,044	3,916	4,222	4,048	5,097	4,264

Preferred and Other Alternatives						
	Water Years					
Mon.	Crit.	Dry	B/nor.	A/nor.	Wet	All
Oct	6,229	5,315	6,606	4,918	6,690	6,059
Nov	5,371	6,042	6,484	6,260	10,626	7,592
Dec	5,245	6,609	10,176	12,427	38,052	18,545
Jan	5,109	9,573	11,702	14,442	77,333	32,761
Feb	5,400	14,610	27,983	34,062	78,530	40,383
Mar	5,099	10,854	20,014	39,992	55,675	31,705
Apr	5,357	8,062	8,784	20,817	44,067	22,048
May	4,639	7,579	9,685	16,421	30,924	16,869
Jun	4,019	6,262	8,433	11,502	20,555	12,012
Jul	4,056	4,860	6,204	7,821	9,749	7,132
Aug	3,637	4,310	5,164	5,725	5,504	5,011
Sep	3,225	3,904	4,322	4,156	4,892	4,256

classified into one of the four categories mentioned above.

Duration and *frequency* are other aspects of outflow pulses that the considered alternatives can impact. Duration is the length of time the pulse flow occurs. A pulse must occur a minimum of five days to be counted as a pulse flow. Pulse duration and volume are interrelated: the higher the volume, the longer the duration time. Frequency is the rate at which a certain flow interval occurs. Historically, smaller pulses tend to have higher frequencies than do large pulses.

Table 5-9 shows the historical condition, the no-action, and the preferred alternative condition for water years 1955 through 1978. The table categorizes pulses into volume ranges, where in each range the average modeled flows in 1,000 cfs and the number of pulses are identified. The no-action condition corresponds to the "existing facilities" category, whereas the preferred alternative and the other alternatives correspond to the "proposed facilities" category.

No-Action Alternative. Under the no-action alternative, SWP exports will be limited to a maximum of 6,680 cfs daily average diversion. The number of pulses for outflows below 100,000 cfs will remain the same or increase by one or two, compared to the historical condition. Flow averages also will not change significantly. For Delta outflows exceeding 100,000 cfs, the number of pulses decreases by three, compared to the historical condition, while the average magnitude of the pulses increases by 3,000 cfs.

Preferred Alternative. Table 5-9 shows the outflow pulse variations between the no-action SWP and the preferred alternative facilities. Overall, the preferred alternative produces minimal changes in outflow pulse characteristics compared to the no-action condition. The average magnitude of the pulses varies slightly, with the largest variation occurring in the 50,000 to 75,000 cfs category, where the average magnitude increases by 1,000 cfs.

Other Alternatives. The impact of all the alternatives on Delta outflow surges will be the same as that of the preferred alternative.

Impacts on Delta Municipal and Industrial Uses

The water quality of SWP diversions during dry periods can be substantially improved under the SDWMP. There is also a potential for significant improvements to the water quality of Contra Costa Water District (CCWD) and CVP diversions.

Major diversions from the Delta for municipal and industrial uses, other than the Delta-Mendota Canal (DMC) and California Aqueduct diversions, are the Contra Costa Canal (CCC) intake on Rock Slough, the North Bay Aqueduct intake on Barker Slough, and offshore diversions in the western Delta from Antioch to Crockett. Decision 1485 municipal and industrial standards for the CCC intake and for Antioch are similar, but they allow use of CCC supplies as a substitute for those at Antioch when offshore water quality is inadequate for the intended use. The 250 mg/l maximum mean daily chlorides must always be met at the CCC intake. Also, a 150 mg/l maximum mean daily chloride standard must also be met for a specified portion of the year, depending on the water

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Table 5-9
Comparison of Number of Pulses of Large Delta Outflows, 1955-1978

Condition	Delta Outflow (cfs) 25,000 to 50,000 (avg of 34,500)	50,000 to 75,000 (avg of 62,500)	75,000 to 100,000 (avg of 93,000)	> 100,000 (avg of 167,000)
Historical	29	9	9	20
No-action alternative (no South Delta improvements; outflows adjusted to reflect 3.3 MAF SWP demands)	27	9	11	18
Preferred and other alternative (Delta improvements, Los Banos Grandes Reservoir, Kern Water Bank; outflows adjusted to reflect 3.3 MAF SWP demands	27	9	11	18

year classification. The quality of these supplies is affected by Delta outflows, reverse flows of the San Joaquin River at Antioch, and local agricultural return flows.

DWR has contracts with the City of Antioch, the Fibreboard Corporation, and CCWD that establish formulas for State reimbursement for the additional cost of substitute water from the Contra Costa Canal. The contracts are discussed in Chapter 1 under "Delta Water Contracts."

Decision 1485 municipal and industrial standards for the Clifton Court Forebay intake and the DMC also specify a maximum of 250 mg/l mean daily chlorides. SWP export quality objectives at Clifton Court Forebay are 100 mg/l chlorides on a monthly average basis.

Table C-12 in Appendix C shows projected salinities for various locations during the representative critical, dry, below normal, above normal, and wet years. However, since Delta inflows and exports can vary, monthly salinities of the no-action and the other alternatives can vary substantially.

The monthly average salinities comply with Decision 1485 municipal and industrial standards, with Antioch at times needing to obtain supplies from Rock Slough. Table C-12 shows salinities for the various alternatives for Old River at Rock Slough, about 2.5 miles east of the Contra Costa Canal intake. The Decision 1485 standards shown are for the intake. At times, salinities at the two locations are different; some degradation is caused by local agricultural return flows and surface runoff. The salinities shown at Old River at Rock Slough meet Decision 1485 standards for all year types and should be met at the intake.

No-Action Alternative. Under the no-action alternative, Decision 1485 municipal and industrial standards would always be met, with the Contra Costa Canal used at times by the city of Antioch.

Preferred Alternative. Under the preferred alternative, Decision 1485 municipal and industrial standards would be met for all years. Water quality conditions at Antioch would be improved in spring and summer months during the representative critical and dry years. In general, under the preferred alternative, the stations in the west Delta for Decision 1485 municipal and industrial standards would experience moderate to substantial improvements in salinity in spring and summer during the representative dry and critical years, and slight to moderate increases in salinity in winter during the representative above-normal and wet years. These trends reflect the difference in Sacramento River flows, Delta exports, and net Delta outflow between the preferred alternative and the no-action alternative.

Under the preferred alternative, the water quality at the intake to Clifton Court Forebay and the DMC intake would substantially improve from March through August during the representative critical year. Salinity at the DMC intake would increase slightly during the representative dry and above- normal years. At Old River at Rock Slough, Decision 1485 standards would always be met.

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Water quality would improve from February through September during the representative critical year. Salinity here would increase slightly during the representative dry, below-normal, and above-normal years, but still remain within Decision 1485 standards.

Dependable water quality in municipal and industrial water supplies is an important component of water supply reliability. The preferred alternative's impact upon SWP reliability, discussed in Chapter 5 under "SWP Reliability," focused on water volume. However, reliability is also affected by water quality. Because the water quality of SWP diversions is substantially improved during dry and critically-dry periods under the preferred alternative, the reliability of the SWP is improved. Additional work by DWR to protect the State's drinking water supply is discussed in Chapter 6.

Salinity levels in the Delta channels are also important to municipal and industrial water users. Chloride, one of the salts found in Delta water, is monitored and controlled through drinking water standards. Sodium in Delta water is also of health interest because of suspected effects on the human circulatory system.

Bromides, salts that enter the Delta from the ocean, can combine to form suspected cancer-causing chemicals called trihalomethanes (THMs). During the treatment of drinking water, the chlorine used as a disinfectant contacts the naturally occurring dissolved organic chemicals resulting from plant decay. The reaction forms chloroform, a type of THM containing chlorine and carbon. When bromides are also present, these salts enter the chemical reaction, creating THMs that contain bromine in addition to chlorine and carbon. (Brown and Caldwell Consulting Engineers report, *Delta Drinking Water Quality Study,* May 1989).

The bromine-containing THMs present a number of problems in drinking water. Their presence complicates treatment processes because they react differently to treatment methods than does chloroform. Since bromide has twice the molecular weight of chlorine, the presence of bromide-containing THMs increases the difficulty of meeting the weight-based drinking-water standard for THMs. There is also evidence that bromide-containing THMs may be more carcinogenic than chloroform.

The potential of Delta water to form bromide-containing THMs is related to the concentration of bromides in the water and, thus, to the ocean-derived salinity level entering the Delta from the Bay estuary. The concentration ratio of bromide to chloride in sea water is about 1:300. Measurements of Delta water indicate the relationship is similar, thus demonstrating that salinity intrusion from the Bay is a major source of bromides in the Delta.

The preferred alternative will improve water quality (reduce TDS, chloride, and bromide levels), thus reducing the formation of THM precursors in the south Delta. Figure 5-3 shows that for the wet water year that followed two critically dry years, and the critically dry water year, the preferred alternative substantially improves TDS levels at the SWP intake gates.

South Delta improvements include enlarging Clifton Court Forebay into agricultural land on Victoria Island. The agriculture drainage water from this area tends to have high amounts of humic acids and organic compounds (trihalomethane formation potential [THMFP]) due to the water's contact, mixing and dissolution with the organic soil. This drainage water is pumped back into the Delta channels. Changing the land use from agriculture to water storage should help reduce the amount of THMFP released into the south Delta channels.

During the initial filling of the proposed enlarged forebay, THMFPs may significantly increase in the forebay due to the abundance of undissolved organic soils. It is expected that after a short period, the soluble precursors at the interface between the soil and water should be rapidly exhausted, and the THMFP level should subside to normal channel concentrations. THMFP extraction from deeper organic soils will be slower due to restricted water movement through the soil capillaries. Also, constant silt deposition will produce a boundary between the organic soil and water, slowing THMFP production even more. The net result is that the enlarged forebay will probably incrementally decrease the amount of THMFPs in both the forebay and south Delta.

Other Alternatives. Under the other alternatives, with the exception of *Northern Intake with Barrier Configuration A* and *Northern Intake with CVP Tie-in and Barrier Configuration A,* water quality at the various Decision 1485 municipal and industrial stations would be improved in the same manner as under the preferred alternative. Decision 1485 municipal and industrial standards would be met; however, water quality would generally not be improved as greatly as with the preferred alternative.

Under the alternatives Northern Intake with Barrier Configuration A and Northern Intake with CVP Tie-in

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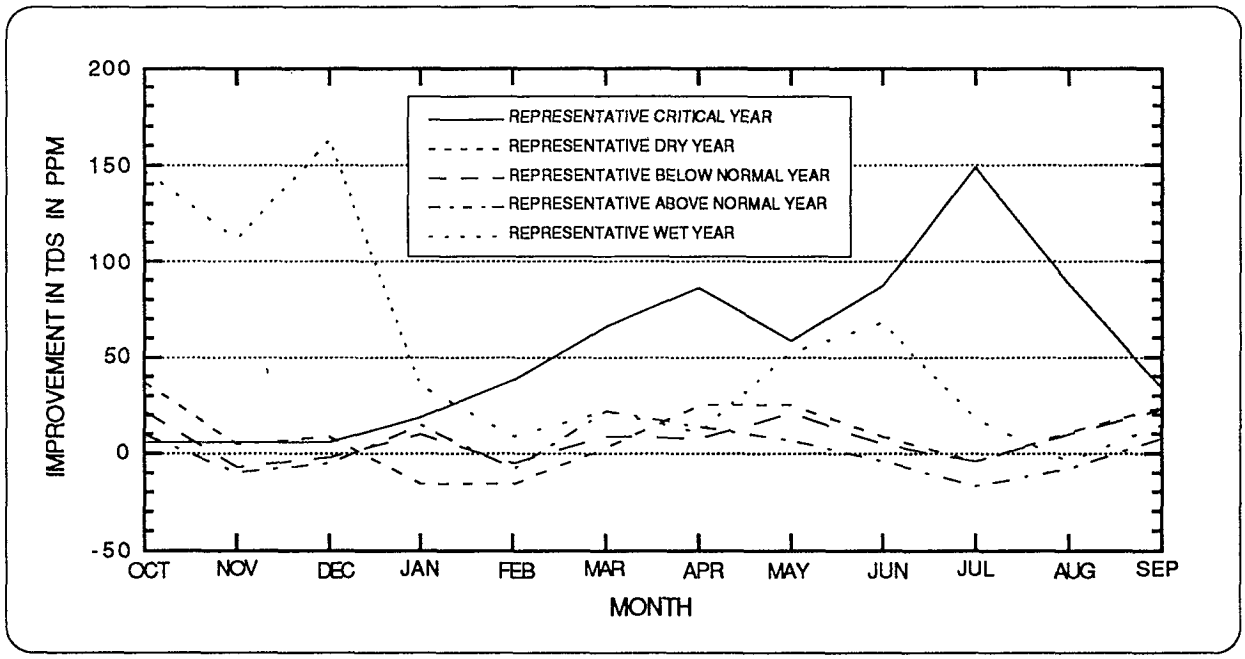

Figure 5-3. Improvement to Monthly Average Salinity at SWP Intake for Preferred Alternative

and Barrier Configuration A, water quality at Decision 1485 municipal and agricultural standards locations would not significantly improve from that observed with the no-action alternative during times when the preferred alternative caused the greatest improvements. Specifically, these two alternatives would cause slight increases in salinity at the locations of Decision 1485 municipal and industrial standards in spring and summer during the representative critical and dry years; However, Decision 1485 standards would be met.

Impacts on Delta Agricultural Uses and Water Levels

The SDWMP will improve conditions for agriculture in the south Delta by improving water levels in south Delta channels during the irrigation season and by helping to protect south Delta water quality.

The SDWMP alternatives provide for the planning and operation of barrier-type facilities in order to raise the water levels in south Delta channels during the irrigation season. The SDWMP also provides for forebay improvements to reduce the drawdown on south Delta channels and allow for more flexible intake gate operation during times of critically low tides. The forebay improvements include moving the location of SWP diversions farther north; that, in itself, will improve water levels in the south Delta.

The SDWMP will help protect south Delta water quality by the following measures:

- Reclamation will continue to abide by the provisions in the Settlement Framework Agreement of October 10, 1986 pertaining to water flows and quality in the San Joaquin River at Vernalis.
- DWR and Reclamation propose to operate barrier-type facilities in the south Delta to restrict San Joaquin River water from entering the south Delta.
- DWR and Reclamation will use the existing SWP and CVP intakes with the new intakes to help maintain the water quality benefits provided by existing operations and to lower flood water levels in the south Delta.
- DWR will plan and design improvements to the SWP forebay with the capability of releasing water of quality equal to SWP exports during the irrigation season from the existing Clifton Court Forebay gates to improve water quality at the western side of the barrier-type facilities in the south Delta.
- The barrier-type facilities will be operated to improve circulation of water through south Delta channels.

Analysis shows that the SDWMP alternatives can improve south Delta water levels, circulation, and water quality, while causing no significant negative impacts on water levels in the central Delta downstream of the proposed barrier-type facilities or in the vicinity of the proposed forebay intake structures.

Figures 5-4, 5-5, 5-6, 5-7, and 5-8 show the extent of improvement in water levels and water quality possible under the preferred SDWMP alternative. The information in Figures 5-5, 5-6, and 5-7 comes from simulation of the representative dry year (1964 in operation study 327B).

Figures 5-5 and 5-6 show that the preferred alternative can significantly improve both water levels and water quality upstream of the barrier-type facilities when they are operated (in this case from February through August). Figure 5-7 shows how improvement in water levels tends to vary along Old River, Middle River, Grant Line Canal, and the upper San Joaquin River when the barrier-type facilities operate during the representative dry year.

Figure 5-8 shows that the preferred alternative can also improve water levels in the south Delta when the barrier-type facilities are not operating, even if SWP exports should increase.

Improvements will exist both for periods when SWP exports up to 10,300 cfs and for periods with high summer channel depletions and low San Joaquin River flows. These improvements are documented by mathematical modeling and are corroborated by field experience during the 1976-1977 drought and by interim measures in the Delta. For the representative dry year simulation mentioned above, SWP exports under the preferred alternative ranged from about 10,200 cfs in January to about 1,000 cfs in August.

In the west and interior Delta, agricultural uses of Delta water supplies can be affected by varying Delta outflows and the corresponding variations in salinity concentrations, and by the buildup of saline agricultural return flows. In the south Delta, agricultural uses are affected less by salinity intrusion from the ocean and more by highly saline concentrations from the San Joaquin River and agricultural return flows.

South Delta users have expressed concern about possible impacts to water levels as a result of the facilities proposed in the SDWMP. Drawdown near the new forebay intake gates is of concern, especially with the proposed increased SWP daily average pumping capacity to 10,300 cfs and a possible CVP tie-in to the forebay. Concern has also been expressed about possible impacts to water levels downstream of the proposed barrier-type facilities. Potential problems of channel scouring near the proposed forebay intake gates and siltation in south Delta channels are evaluated in this chapter under the section, "Scouring and Siltation."

Tables and figures projecting changes in water levels and salinity in the west, interior, and south Delta are provided in Appendix C. The analysis in this section on impacts to Delta agricultural uses is based on how water levels and salinity concentrations change under each alternative, compared to conditions under the no-action alternative.

Factors important to the incremental analysis include:

- Alternatives with south Delta improvements and a maximum of 10,300 cfs SWP pumping tend to decrease exports in summer months. This, in itself, tends to improve water levels in the south Delta during the irrigation season (see Chapter 5, "Monthly Operational Changes").
- Incremental analysis was performed under a wide range of hydrologic conditions by using five water years out of the 57-year study period from the statewide operation simulation.
- The forebay intake gates were operated to avoid diverting Delta water at low tide. For alternatives with an enlarged forebay, there would have been increased flexibility in daily intake operations for additional improvements to agriculture conditions, but this was not considered in the analysis.
- For each alternative, except for the no-action alternative, the siphons at the mouth of Tom Paine Slough were assumed to be installed and operating.

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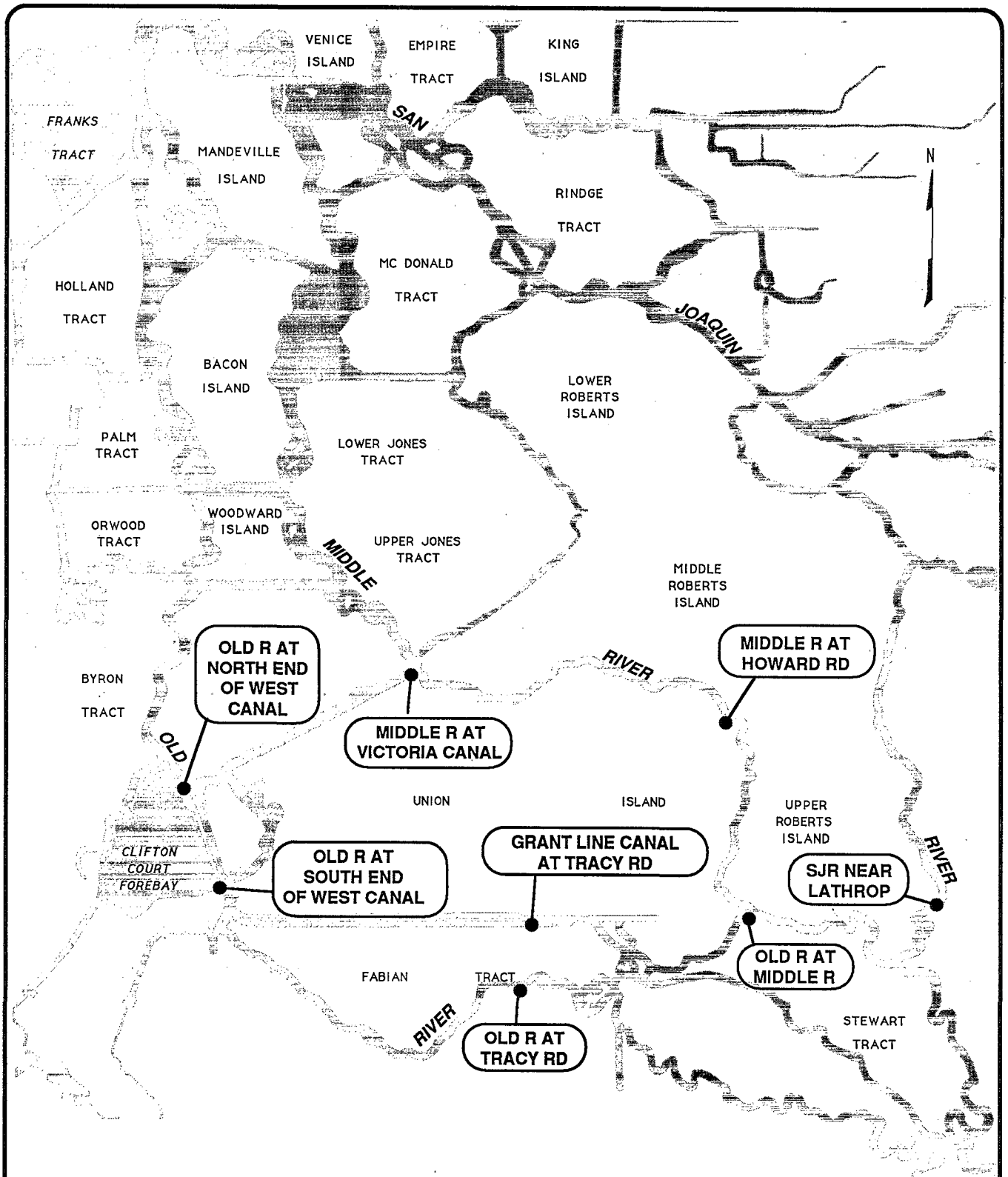


Figure 5-4. Locations Where Improvements in Delta Agricultural Conditions are Presented

Figure 5-5
Improvement in Water Levels in the South Delta under the Preferred Alternative
Representative Dry Year

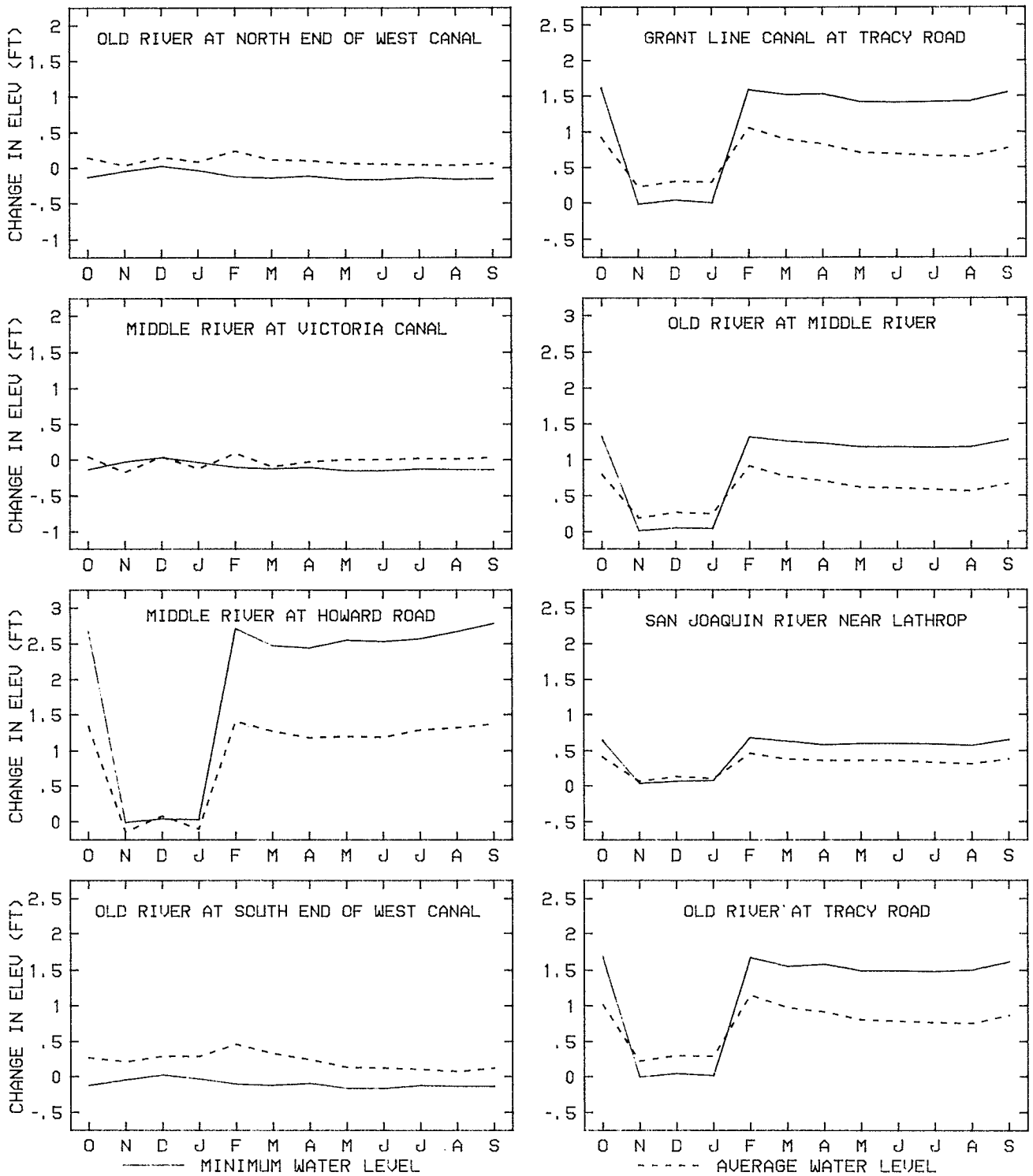
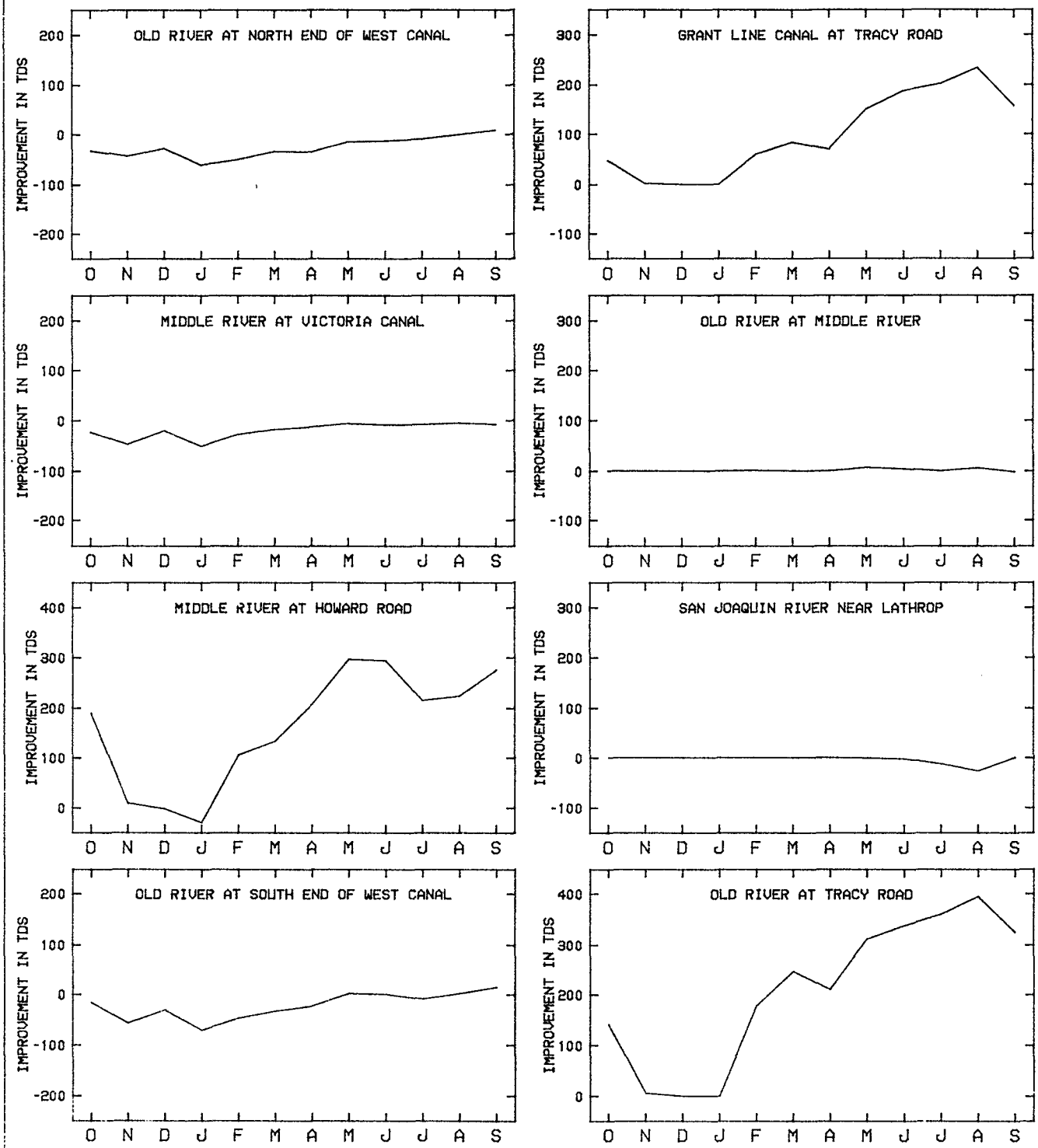


Figure 5-6
Improvement in Monthly Average Salinity in the South Delta under the Preferred Alternative
Representative Dry Year



Note: During some months, salinity improvement does not occur at isolated loctions. It is anticipated that the new facilities will allow for the operational flexibility to provide for improvement in salintiy in these months and locations.

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Figure 5-7
Profiles of Improvement in Water Levels in the South Delta under the Preferred Alternative when Barriers are Operating
Representative Dry Year

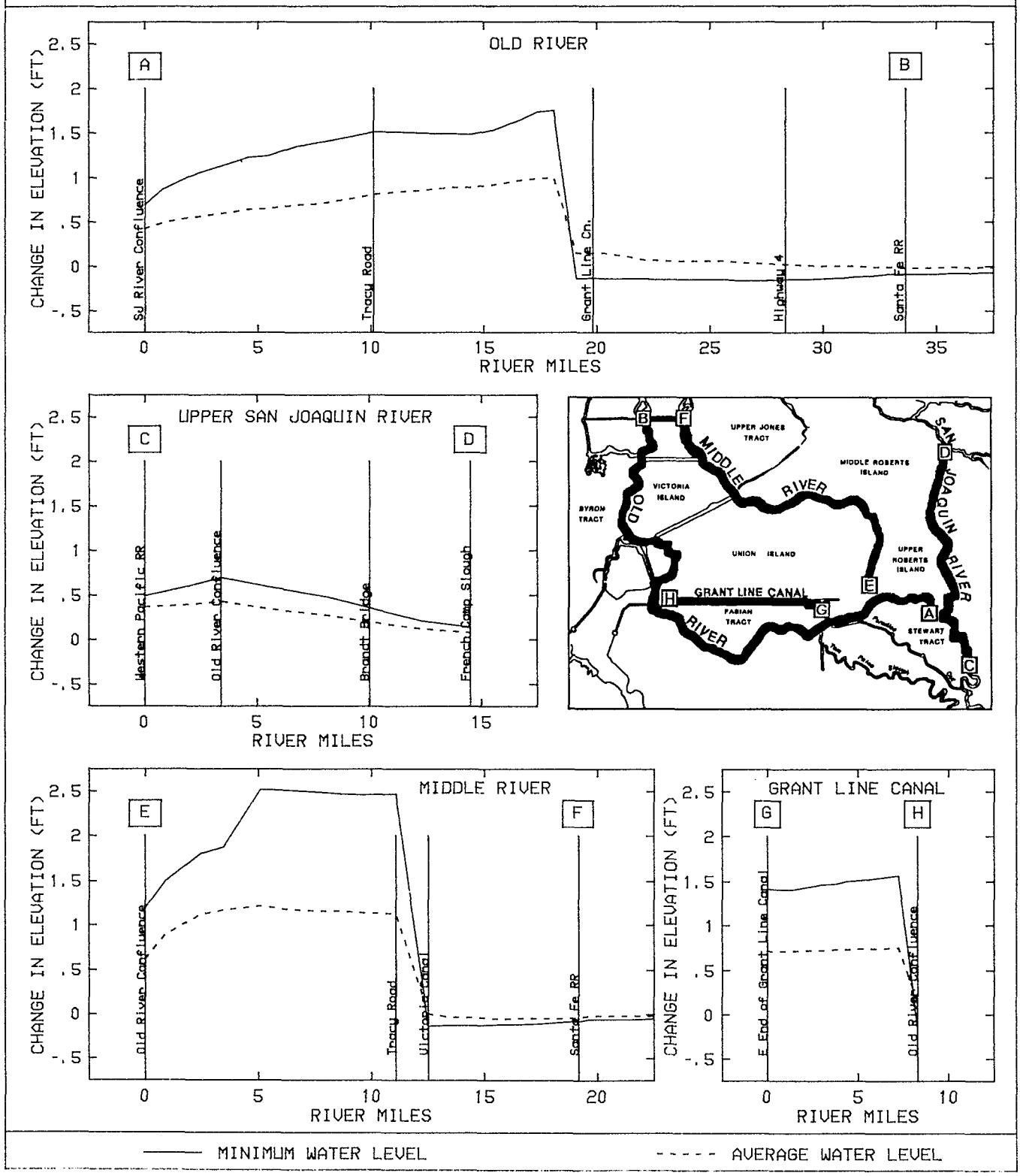

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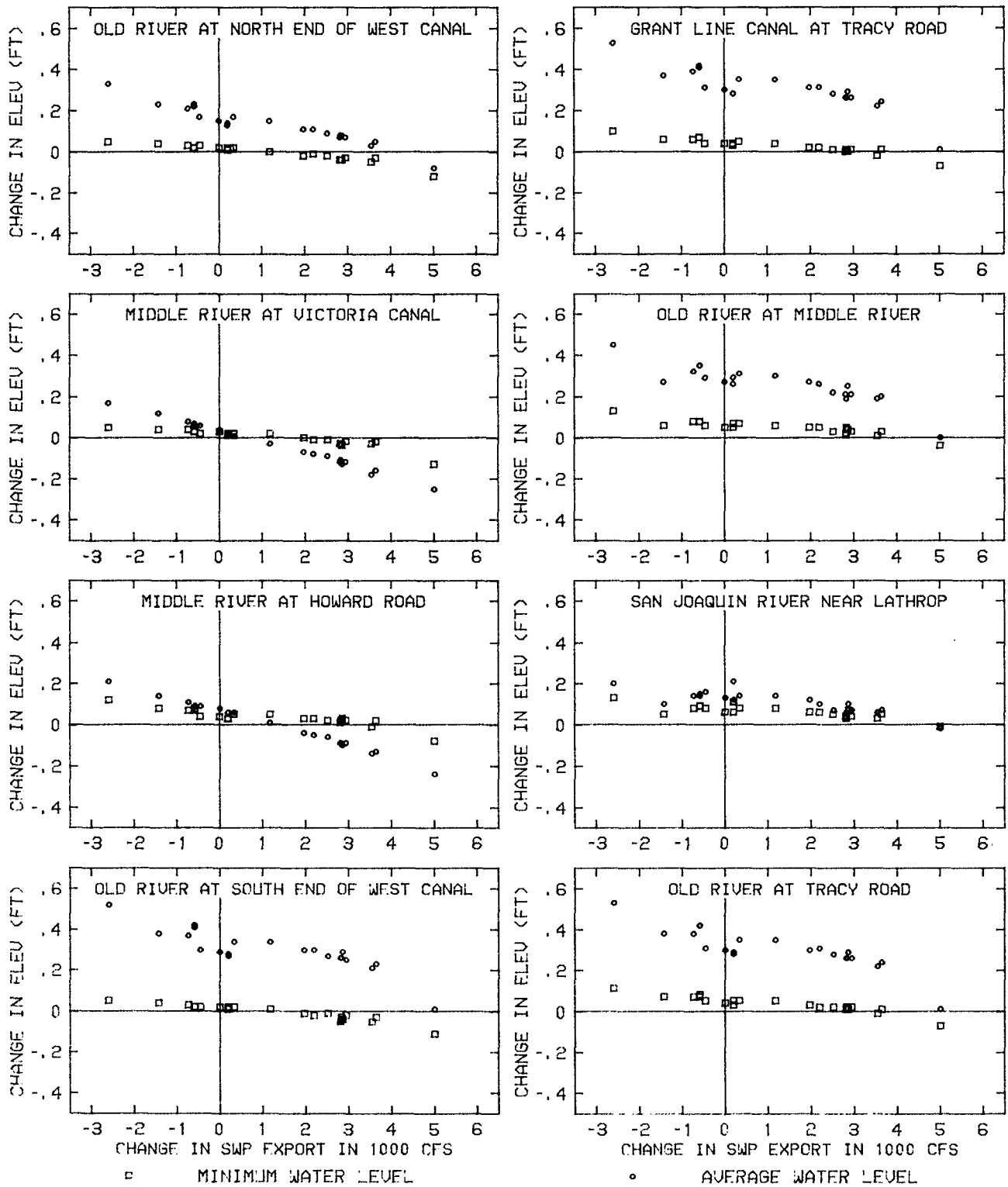
Figure 5-8
Improvement in Water Levels in the South Delta under the Preferred Alternative Due to Forebay Improvements Alone When SWP Diversions in the No-Action Alternative Exceed 4,500 CFS



Consultants for SDWA, through negotiations, have had considerable input in the evaluation of barrier-type facilities for agriculture.

Water Levels

Tables C-15, C-16, C-17, and C-18 in Appendix C show changes in monthly average and minimum water levels for the five representative water years at 11 locations in the south Delta. This provides a comprehensive summary of incremental improvements to water levels. The remaining information concerning the impacts on water levels was taken from these tables.

Figure C-14 shows the information from Tables C-15 through C-18 for the preferred alternative for the representative dry year. The barrier operation and State and federal exports vary for each water year studied, but the degree of improvement to water levels caused by both the operation of barrier-type facilities and the forebay configuration are consistent from year to year. The dry year is presented as indicative of the magnitude of the improvements in water levels in the Delta possible with the SDWMP alternatives during any year. Figure C-14 shows that, for locations upstream of the barrier-type facilities, the improvement to water levels with the barrier-type facilities in operation differs significantly from times when they are not operating.

Figure C-15 in Appendix C shows, for the preferred alternative, profiles of improvements to average and minimum water levels along Grant Line Canal, Old River, Middle River, and the upper San Joaquin River when barrier-type facilities are operating during the five representative water years.

Figure C-16 shows, for the preferred alternative, projected improvements to water levels at 16 south Delta locations caused by forebay improvements alone. The improvements to water levels are projected as a function of changes from the no-action alternative in SWP exports, and the forebay configuration (and hence forebay intake location). Figure C-16 shows times when the SWP export in the no-action alternative is above 4,500 cfs. Incremental improvements to water levels in the south Delta caused by the improved forebay alone was highest when SWP exports in the no-action alternative exceeded 4,500 cfs.

Table C-16 in Appendix C shows changes in average and minimum water levels near the proposed forebay intake gates. Table C-16 indicates that drawdown of average and minimum water levels during the irrigation season is limited to about 0.2 feet and should rapidly diminish within a short distance downstream of the barrier. Therefore, drawdown near the proposed intake gates is not expected to be significant.

Table C-17 shows changes in average and minimum water levels downstream of the barrier-type facilities. This table shows that average and minimum water levels caused by State and federal operations and the operations of barrier-type facilities on Old River, Middle River, and Grant Line Canal can be lowered about 0.2 foot. It is expected that this impact will rapidly diminish within a short distance downstream of the barrier. Therefore, the impact of operating the barrier-type facilities on average and minimum water levels downstream of the facilities is not expected to be significant.

Table 5-10 summarizes the trends, presented in Tables C-15 through C-18 and Figures C-14 through C-17 for the eight SDWMP alternatives to the no-action condition, of improvements in south Delta water levels due to the forebay configuration and barrier operation.

The following paragraphs discuss specific trends in water level impacts by location (*downstream* of barrier-type facilities versus *upstream* of barrier-type facilities) and by whether or not the barrier-type facilities are operating:

Impacts Upstream of Barrier-Type Facilities in the South Delta:

A. Effect of Forebay Configuration Alone

1) Without a CVP tie-in to the forebay, average water levels in Old River and Grant Line Canal are improved 0.2 to 0.4 foot. Minimum water levels in Old River, Middle River, and Grant Line Canal are unchanged from the no-action alternative.
2) With a CVP tie-in to the forebay, average water levels in Old River and Grant Line Canal are improved 0.2 to 0.6 foot. Minimum south Delta water levels are improved approximately 0.2 to 0.4 foot.
3) Without a barrier-type facility operating on Middle River, water levels in Middle River are unaffected by a CVP tie-in to the forebay.
4) Improvements to south Delta water levels increase as the forebay intake location is moved farther north.

Table 5–10
Typical Improvements in Water Levels in South Delta Channels for Various Combinations of Barrier–Type Facilities (Values in feet)

	Average Water Levels Combination of Barrier Facilities in Operation				Minimum Water Levels Combination of Barrier–Type Facilities in Operation			
Alternative	None operating	Old R. Middle R.	Old R. Middle R. Old R. at Head	Grant Line Cn. Old R. Middle R.	None operating	Old R. Middle R.	Old R. Middle R. Old R. at Head	Grant Line Cn. Old R. Middle R.
Old River at Tracy Road Bridge								
1	0.2	0.5	0.3	*	0.0	0.8	0.5	*
2	0.2	*	*	0.8	0.0	*	*	1.6
3	0.4	*	*	0.9	0.0	*	*	1.6
4	0.2	*	*	0.8	0.0	*	*	1.5
5	0.3	0.5	0.3	*	0.3	0.8	0.5	*
6	0.3	*	*	0.8	0.3	*	*	1.6
7	0.6	*	*	1.0	0.4	*	*	1.7
8	0.4	*	*	0.8	0.3	*	*	1.6
Old River at Middle River								
1	0.2	0.3	–0.2	*	0.0	0.2	–0.7	*
2	0.2	*		0.7	0.0	*	*	1.2
3	0.3	*	*	0.7	0.1	*	*	1.2
4	0.2	*	*	0.6	0.0	*	*	1.2
5	0.2	0.3	–0.1	*	0.2	0.4	–0.5	*
6	0.2	*	*	0.6	0.2	*	*	1.3
7	0.5	*	*	0.8	0.3	*	*	1.3
8	0.3	*	*	0.6	0.2	*	*	1.2
Middle River at Howard Road								
1	0.1	1.5	1.2	*	0.0	2.6	2.3	*
2	0.1	*	*	1.4	0.0	*	*	2.5
3	0.1	*	*	1.3	0.0	*	*	2.6
4	0.1	*	*	1.3	0.0	*	*	2.5
5	0.1	1.6	1.2	*	0.2	2.7	2.2	*
6	0.1	*	*	1.4	0.2	*	*	2.4
7	0.1	*	*	1.2	0.3	*	*	2.4
8	0.1	*	*	1.3	0.2	*	*	2.4
Grant Line Canal at Tracy Road								
1	0.2	0.2	0.0	*	0.0	0.1	–0.2	*
2	0.2	*	*	0.8	0.0	*	*	1.5
3	0.4	*	*	0.8	0.0	*	*	1.5
4	0.2	*	*	0.7	0.0	*	*	1.5
5	0.3	0.3	0.1	*	0.3	0.2	–0.1	*
6	0.3	*	*	0.7	0.3	*	*	1.5
7	0.6	*	*	0.9	0.4	*	*	1.6
8	0.4	*	*	0.7	0.3	*	*	1.5

Note: Asterisk signifies that this combination of facilities not evaluated.
Alternatives:
1 Northern Intake with Barrier Configuration A
2 Northern Intake with Barrier Configuration B
3 Preferred Alternative
4 Enlarged Forebay – Highway 4 Intake with Barrier Configuration B
5 Northern Intake with CVP Tie–in and Barrier Configuration A
6 Northern Intake with CVP Tie–in and Barrier Configuration B
7 Enlarged Forebay with CVP Tie–in – North Victoria Intake with Barrier Configuration B
8 Enlarged Forebay with CVP Tie–in – Highway 4 Intake with Barrier Configuration B

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5) Improvements to south Delta water levels are greatest when the no-action alternative has high SWP exports.

6) As SWP exports increase over those in the no-action alternative, improvements to south Delta water levels diminish.

B. Effect of Forebay Configuration and Barrier-Type Facilities

1. Middle River

a) Operating a barrier-type facility on Middle River improves average water levels in Middle River from about 0.7 foot at the confluence with Old River to approximately 1.4 feet at the barrier. Minimum water levels are improved from approximately 1.2 feet at the confluence with Old River to about 2.5 feet at the barrier.

b) The improvements to water levels in Middle River are relatively independent of whether there is a CVP tie-in to the forebay and are relatively independent of the changes in SWP exports from the no-action alternative.

c) The improvements to water levels in Middle River are not significantly affected by the operation of a barrier-type facility on either Grant Line Canal or Old River near the DMC Intake.

d) The operation of an additional barrier-type facility at the head of Old River has the potential to reduce the improvements to water levels along Middle River. With the barrier-type facilities at the head of Old River and on Middle River continuously operating, improvements to average water levels on Middle River range from approximately zero at the confluence with Old River to 1.2 feet at the barrier-type facility. Improvements to minimum water levels would now range from about -0.5 foot at the confluence with Old River to approximately 2.2 feet at the barrier-type facility. Actually, the barrier-type facility at the head of Old River would not be left open if operation would adversely impact water levels in the south Delta. Operation of the barrier-type facility at the head of Old River to optimize improvements to water levels will be included in actual operations.

2. Old River

a) Operation of a barrier-type facility on Old River near the DMC Intake alone improves average water levels in Old River from about 0.2 foot at the confluence with the San Joaquin River to approximately 0.6 foot at the barrier-type facility. Minimum water levels are improved from about -0.2 foot at the confluence with the San Joaquin River to about 0.7 foot at the barrier-type facility.

b) The improvements to water levels in Old River when a barrier-type facility is operating on Old River near the DMC Intake, are also affected by the operation of a partial barrier-type facility on Grant Line Canal and a full barrier-type facility at the head of Old River.

c) When a partial barrier-type facility on Grant Line Canal is operating, along with the facility on Old River near the DMC Intake, average water levels in Old River tend to improve about an additional 0.3 foot over that when the barrier on Old River near the DMC Intake operates alone. Minimum water levels improve approximately an additional 0.9 foot. Overall, when compared to the no-action alternative, operating a partial barrier-type facility on Grant Line Canal and a full barrier-type facility on Old River near the DMC Intake improves average water levels in Old River from about 0.5 foot at the bifurcation with the San Joaquin River to approximately 0.9 foot at the barrier-type facility. Minimum water levels are improved from about 0.7 foot at the bifurcation with the San Joaquin River to approximately 1.6 feet at the barrier-type facility.

d) Operating the barrier-type facility at the head of Old River has the potential to significantly decrease the improvements to water levels in Old River induced by the operations of the Old River near the DMC Intake and Grant Line Canal barrier-type facilities. When the barrier-type facilities at the head of Old River and in Old River near the DMC intake are simultaneously and continuously operated, improvements to average water levels in Old River range from approximately only -0.5 foot at the bifurcation with the San Joaquin River to about 0.5 foot at the barrier-type facility. Minimum water levels are improved from about -1.0 foot at the bifurcation with the San Joaquin River to approximately 0.9

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foot at the barrier-type facility. Actually, the barrier-type facility at the head of Old River would not be left open if operation would adversely impact water levels in the south Delta.

e) Improvements to water levels on Old River due to the operation of barrier-type facilities are relatively independent of both forebay intake location and to any changes in SWP export levels.

f) Improvements to upstream water levels in Old River due to the operation of barrier-type facilities are relatively unaffected by whether or not there is a CVP tie-in to the forebay.

3. Grant Line Canal

a) Operating a barrier-type facility in Old River near the DMC Intake alone slightly (0.1 foot) improves average and minimum water levels in Grant Line Canal beyond what could be expected due to just moving the forebay intake location farther north. These improvements to water levels in Grant Line Canal due to a barrier-type facility in Old River near the DMC Intake also depend on 1) whether there is a CVP tie-in to the forebay, 2) the location of the forebay intake, and 3) the change in SWP export rate from the no-action alternative.

b) When a partial barrier-type facility is operated on Grant Line Canal in conjunction with a barrier-type facility on Old River near the DMC Intake, water levels in Grant Line Canal substantially improve. Average water levels in Grant Line Canal improve about 0.8 foot while minimum water levels improve about 1.5 feet.

c) Operating a barrier-type facility at the head of Old River has the potential to significantly decrease improvements to water levels in Grant Line Canal induced by the operations of the Old River near the DMC Intake and Grant Line Canal barrier-type facilities. When the barrier-type facilities at the head of Old River and in Old River near the DMC Intake are simultaneously and continuously operated, improvements to average water levels in Grant Line Canal are negated and minimum water levels are lowered about 0.1 to 0.2 foot with respect to the no-action alternative. Actually, the barrier-type facility at the head of Old River would not be left open if operation would adversely impact water levels in the south Delta.

d) Improvements to water levels in Grant Line Canal due to the operation of a barrier-type facility on Grant Line Canal are relatively independent of both forebay intake location and to any changes in SWP export levels.

e) Improvements to water levels in Grant Line Canal due to the operation of a barrier-type facility on Grant Line Canal are relatively unaffected by whether or not there is a CVP tie-in to the forebay.

Impacts Downstream of the Barrier-Type Facilities in the South Delta

A. <u>Effect of Forebay Configuration Alone</u>

1) Water levels in the immediate vicinity of the proposed intake gates may be lowered approximately 0.2 foot. It is expected that this impact will rapidly diminish with distance and will not be significant.

2) Without a CVP tie-in to the forebay, minimum water levels are unaffected by the alternatives.

3) With CVP tie-in to the forebay, minimum water levels along Old River from Clifton Court Ferry to Highway 4, along Victoria Canal, and along Middle River from Victoria Canal to Woodward Canal will improve from 0.0 to 0.4 foot. The degree of improvement depends on the forebay intake location and how SWP exports vary from the no-action alternative.

4) Average water levels tend to improve 0.0 to 0.6 foot for the same areas mentioned in 3) above. These improvements are greater for the alternatives with a CVP tie-in to the forebay. The magnitude of the improvements to average water levels depends on both the forebay intake location and how SWP exports vary from the no-action alternative.

B. <u>Effects of Forebay Configuration and Barrier-Type Facilities</u>

1) Water levels in the immediate vicinity of the proposed intake gates may still be lowered about 0.2 foot. It is expected that this impact will rapidly diminish with distance and will not be significant.

2) Lowering of average and minimum water levels immediately downstream of the barrier-type facilities on Middle River, Old River near the DMC Intake and Grant Line Canal tend to be

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limited to about 0.2 foot. This decrease in water level will rapidly diminish with distance and will not be significant.

Water Quality

SDWMP impacts on Delta water quality, and hence, on Delta agricultural and instream use, are shown in Tables C-13 and C-19 and Figure C-18 in Appendix C, and in Tables 5-11 and 5-12 of this section.

Table C-13 shows the projected monthly average salinity at the Decision 1485 locations for agricultural standards for each of the representative year types. Table C-13 shows that Decision 1485 standards are met at each location for each year. Table C-13 also shows that water quality at the Decision 1485 agriculture standards locations tend to be improved over the no-action alternative during the irrigation season.

Table C-19 provides estimates of improvements in the monthly average salinity at 16 south Delta locations. These improvements are based on comparisons to the estimated monthly average salinity for the no-action alternative. Table C-19 shows salinity improvements in terms of both total dissolved solids and percentage of change of the total dissolved solids.

Figure C-18, for the preferred alternative, displays the improvements to salinity during the representative dry year. The dry year is presented as indicative of the magnitude of the percentage of improvement in Delta water quality caused by the SDWMP alternatives. The improvement to water quality in total dissolved solids during the dry year tends to be greater than the improvements during the wet year but less than the improvements during the above-normal year. However, the percent improvement in total dissolved solids tends to be similar from year to year.

The information in Tables C-13 and C-19, in Figure C-18, and in Tables 5-11 and 5-12 in this section, shows that in general, the SDWMP alternatives can significantly improve water quality in South Delta channels upstream of the proposed barrier-type facilities. The alternative plans can have minimal impact on water quality in the interior Delta in Old and Middle rivers downstream of the barrier-type facilities, depending on forebay operation. Water quality tends to improve in the west Delta, depending on operation of the barrier-type facilities.

Specific trends of water quality impacts are discussed by 1) location (the West Delta and Central Delta along Old and Middle rivers downstream of Woodward Canal, along Old and Middle rivers from the proposed barrier-type facilities to Woodward Canal, and along Old and Middle rivers and Grant Line Canal upstream of the proposed barrier-type facilities) and by 2) whether the barrier-type facilities are operating:

Western and Central Delta (Including Old and Middle River downstream of Woodward Canal)

1) Water quality at Decision 1485 agricultural stations tends to improve during the irrigation season. These changes reflect changes in SWP diversions with respect to the no-action alternative. Monthly average SWP diversions tend to increase in wet months and decrease during the irrigation season (see Chapter 5, "Monthly Operational Changes").
2) Salinity changes are not affected by a CVP tie-in to the forebay or location of the forebay intake structure.
3) The degree of improvement to salinity is highly variable from year to year.
4) Improvements to salinity in lower Old and Middle rivers are affected by operation of the barrier-type facility at the head of Old River. This facility has the potential, if continuously operated, to reduce the improvements to salinity in the west and interior Delta, which might otherwise be caused by reduced SWP diversions. Actually, the barrier-type facility at the head of Old River would not be left open if operation would adversely affect water quality in the Delta. Operation of the barrier-type facility at the head of Old River to optimize water quality improvements will be part of the on-going testing and modification of barrier operation.

Old and Middle River from the Proposed Barrier-Type Facilities to Woodward Canal

1) Without the CVP tie-in to the forebay option, the water quality is not significantly affected in these reaches of Old and Middle rivers unless the barrier-type facility at the head of Old River operates. When the barrier-type facility at the head of Old River is continuously operating in the summer, salinity in Old and Middle rivers between the forebay intake gates and the barrier-type facilities can rise.
2) With the CVP tie-in to the forebay option, salinity in these reaches of Old and Middle rivers may or may not be adversely impacted, depending on location of

Table 5–11
Typical Improvements in Total Dissolved Solids in South Delta Channels
(values in parts per million)

Alternative	Critical Year		Dry Year		Below Normal Year		Above Normal Year		Wet Year	
	without barriers	with barriers	without barriers	with barriers	without barriers	with barriers	without barriers	with barriers	without barriers	with barriers
Old River at Tracy Road Bridge										
1	*	186	*	322	16	274	12	365	2	82
2	*	258	*	345	15	292	11	374	2	47
3	*	248	*	337	15	288	10	369	1	30
4	*	265	*	347	16	294	11	375	2	42
5	*	103	*	211	12	164	7	246	–3	5
6	*	9	*	47	1	18	–2	75	–2	–12
7	*	–43	*	–43	–7	–39	–9	–26	–1	–19
8	*	–7	*	30	–2	7	–4	46	–2	–15
Old River at Middle River										
1	*	–54	*	76	–1	8	0	117	0	–111
2	*	0	*	2	–2	1	–2	10	0	1
3	*	0	*	4	–1	2	0	4	1	1
4	*	1	*	4	1	2	1	4	1	1
5	*	–62	*	60	–5	–5	–2	94	–6	–115
6	*	–1	*	8	–5	0	–2	17	–5	1
7	*	–3	*	–6	–4	–4	–2	–12	–3	1
8	*	2	*	8	–3	2	–1	12	–2	1
Middle River at Howard Road										
1	*	169	*	238	10	201	–65	57	–8	94
2	*	212	*	269	15	233	–56	74	–3	121
3	*	213	*	269	–7	236	–86	74	–20	117
4	*	213	*	270	18	234	–56	74	7	120
5	*	169	*	238	–12	201	–93	57	–28	93
6	*	212	*	270	–8	234	–84	75	–23	121
7	*	–11	*	–94	–104	–88	–186	–248	–77	4
8	*	210	*	268	–42	232	–120	72	–43	108
Grant Line Canal at Tracy Road										
1	*	143	*	267	11	215	7	365	0	43
2	*	123	*	184	6	127	3	374	0	7
3	*	118	*	180	6	127	2	369	0	5
4	*	121	*	179	6	124	2	375	0	7
5	*	86	*	190	9	141	5	246	–2	–11
6	*	29	*	59	2	34	–1	75	0	–1
7	*	–21	*	–31	–4	–24	–7	–26	1	–7
8	*	21	*	51	1	29	–2	46	0	–2

Note: An asterisk signifies that the change in total dissolved solids is not expected to be significant.
Note: "Without Barriers" is average of August and September values. "With Barriers" is average of May, June, and July values.

Alternatives:

1 Northern Intake with Barrier Configuration A
2 Northern Intake with Barrier Configuration B
3 Preferred Alternative
4 Enlarged Forebay – Highway 4 Intake with Barrier Configuration B
5 Northern Intake with CVP Tie–in and Barrier Configuration A
6 Northern Intake with CVP Tie–in and Barrier Configuration B
7 Enlarged Forebay with CVP Tie–in – North Victoria Intake with Barrier Configuration B
8 Enlarged Forebay with CVP Tie–in – Highway 4 Intake with Barrier Configuration B

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Table 5–12
Typical Improvements in Total Dissolved Solids in South Delta Channels (values in Percent)

Alternative	Old River at Tracy Road Bridge		Old River at Middle River		Middle River at Howard Road		Grant Line Canal at Tracy Road	
	without barrier near DMC Intake	with barrier near DMC Intake	without barrier near DMC Intake	with barrier near DMC Intake	without barrier	with barrier	without barrier	with barrier
1	2	52	0	–3	–8	42	1	41
2	2	55	0	1	–6	51	1	27
3	2	53	0	1	–14	51	0	26
4	2	55	0	1	–5	51	0	26
5	1	30	–1	–6	–16	42	1	25
6	0	5	–1	1	–14	51	0	8
7	–1	–7	–1	–1	–44	–35	–1	–4
8	–1	2	–1	1	–24	50	0	7

NOTE: "Without Barriers" is average of August and September values. "With Barriers" is average of May, June, and July values. Negative sign indicates that salinity increased with respect to the no-action alternative.

Alternatives:
1 Northern Intake with Barrier Configuration A
2 Northern Intake with Barrier Configuration B
3 Preferred Alternative
4 Enlarged Forebay – Highway 4 Intake with Barrier Configuration B
5 Northern Intake with CVP Tie-in and Barrier Configuration A
6 Northern Intake with CVP Tie-in and Barrier Configuration B
7 Enlarged Forebay with CVP Tie-in – North Victoria Intake with Barrier Configuration B
8 Enlarged Forebay with CVP Tie-in – Highway 4 Intake with Barrier Configuration B

the forebay intake gates with respect to the river reach. Salinity at locations in Old and Middle rivers downstream of the forebay intake gates is not significantly affected by the alternatives. However, salinity at locations upstream of the proposed forebay intake gates and downstream of present CVP diversions, tends to increase for each alternative with a CVP forebay tie-in.

In the no-action alternative, CVP and SWP diversions draw good quality water down to the South Delta, improving the water quality in Old and Middle rivers and Victoria Canal. When the forebay gates are moved farther north, and both SWP and CVP diversions come from the forebay, good quality water is no longer drawn to the present location of CVP diversions. Hence, the salinity in channels upstream of the new forebay intake and downstream of the CVP diversion in the no-action alternative, is somewhat higher. Thus, for the alternatives with CVP forebay tie-in, salinity in Delta channels upstream of the proposed forebay intake gates can potentially increase with respect to the no-action alternative. In actuality, the existing SWP and CVP diversion facilities could be operated, along with the new forebay intake gates, to prevent increases in salinity in south Delta channels. Operation of SWP diversion facilities to help improve water quality will be part of the ongoing testing of diversion facilities.

Grant Line Canal and Old and Middle Rivers Upstream of Barrier–Type Facilities

A. Effects of Forebay Configuration Alone

1) Without barrier–type facilities operating, little change in south Delta salinity occurs. The salinity in the south Delta is partly determined by the salinity in the San Joaquin River and by the flow patterns in Old and Middle rivers and in Grant Line Canal. The salinity of the San Joaquin River at Vernalis is assumed to be the same for all alternatives, and no significant changes in flow

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patterns occur in the south Delta without the operation of barrier-type facilities.

2) The location of proposed forebay intake structure and whether or not there is CVP tie-in to the forebay do not affect salinity in the south Delta when barrier-type facilities are not operating. One exception to this trend is in Middle River upstream of Victoria Canal for the alternative, "Enlarged Forebay - North Victoria Canal Intake, Barrier Configuration B with CVP tie-in." As discussed before, for this alternative, the salinity upstream of the forebay intake structure along Middle River (from Victoria Canal to Woodward Canal) can potentially worsen if no diversions are made from existing SWP and CVP facilities. Higher concentrations of TDS in Middle River could be propagated upstream to impact Middle River at Howard Road. Actually, existing SWP and CVP diversion facilities could be operated to prevent increases in south Delta salinity.

B. Effects of Forebay Configuration and Barrier Type Facilities

Grant Line Canal

1) Water quality in Grant Line Canal during the irrigation season can be significantly improved by operating barrier-type facilities in Old River near the DMC Intake, Grant Line Canal, and at the head of Old River.

2) Operating the barrier-type facility in Old River near the DMC Intake alone significantly improves water quality in Grant Line Canal when there is no CVP tie-in to the forebay. The barrier-type facility on Old River near the DMC Intake improves south Delta flow patterns. Good-quality water, brought to the vicinity of the barrier-type facility via CVP diversions, is moved up Old River by the barrier-type facility to then flow down Grant Line Canal. This freshens the water in Grant Line Canal as compared to its quality under the no-action alternative. Engineering studies indicate that improvements to TDS in Grant Line Canal during the irrigation season can exceed 250 ppm when the barrier-type facility on Old River near the DMC Intake operates and CVP diverts at its present location.

3) Operating the partial barrier-type facility in Grant Line Canal simultaneously with the Old River facility near the DMC Intake provides for little additional improved water quality in Grant Line Canal over that observed when the barrier-type facility in Old River near the DMC Intake operates alone.

4) Operating the barrier-type facility at the head of Old River tends to provide additional improved water quality in Grant Line Canal. Engineering studies indicate that this additional improvement can reach approximately 100 ppm TDS during the irrigation season, when the concentration of TDS in the San Joaquin River is high.

5) With a CVP tie-in to the forebay, improvements to water quality in Grant Line Canal are relatively small when barrier-type facilities operate, unless the facility at the head of Old River also operates to keep San Joaquin River water out of the south Delta. When the CVP tie-in to the forebay option is assumed and all SWP and CVP is diverted through the forebay intake gates, relatively good quality water is no longer brought up Old River past Victoria Canal to a point near the barrier-type facilities in Old River near the DMC Intake and Grant Line Canal. Although operating barrier-type facilities on Old River near the DMC Intake and Grant Line Canal improves circulation in the south Delta, there are probably only small improvement to water quality in the south Delta unless good-quality water is available at the downstream side of the facility on Old River near the DMC Intake. Actually, the existing SWP and CVP diversion facilities could be operated, along with the new forebay intake gates, to bring good-quality water to the vicinity of the barrier-type facilities.

6) Water quality in Grant Line Canal can be significantly improved for the forebay option with a CVP tie-in if the barrier-type facility at the head of Old River is operated simultaneously with the Old River facility. The improvements to water quality in Grant Line Canal are then approximately equivalent to those when a barrier-type facility operates in Old River near the DMC Intake, and the CVP continues to divert directly from Old River at its current location.

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7) Improvements to water quality in Grant Line Canal are relatively unaffected by the operation of a barrier-type facility in Middle River.

Old River From the Proposed Barrier-Type Facility near the DMC Intake to Tracy Road

1) Without the CVP forebay tie-in option, operating a barrier-type facility in Old River near the DMC Intake substantially improves the water quality in Old River from the facility to Tracy Road. Engineering studies indicate that improvements in TDS during the irrigation season can exceed 300 ppm in this reach of Old River.

2) Without the CVP forebay tie-in option, the improvements to water quality in Old River for this reach are relatively unaffected by operation of a barrier-type facility at the head of Old River.

3) With the CVP forebay tie-in option, improvements to water quality in Old River for this reach become minor unless the barrier-type facility at the head of Old River is operated to keep San Joaquin River water out of the south Delta. Salinity in this reach of Old River can potentially worsen, as shown for the preferred alternative, and CVP tie-in. When the barrier-type facility at the head of Old River is operated in conjunction with the barrier-type facility in Old River, water quality in Old River for the CVP forebay tie-in option improves, but only to 25 to 50 percent of the improvements to water quality provided without the CVP forebay tie-in option. Actually, the existing SWP and CVP diversion facilities could be operated, along with the new forebay intake gates, to bring good- quality water to the vicinity of the barrier-type facility on Old River, and hence up Old River.

4) The improvements to water quality in Old River for this reach are relatively unaffected by the operation of a partial barrier-type facility in Grant Line Canal.

5) The improvements to water quality in Old River for this reach are unaffected by the operation of a barrier-type facility in Middle River.

Old River Near Paradise Cut

1) Operating a barrier-type facility in Old River near the DMC Intake can significantly improve the water quality in Old River near Paradise Cut. Engineering studies indicate that improvements to TDS during the irrigation season can exceed 100 ppm in this part of Old River when the barrier-type facility on Old River near the DMC Intake operates alone .

2) Operating a barrier-type facility at the head of Old River can substantially improve water quality in Old River near Paradise Cut. When the barrier-type facility at the head of Old River is operated in conjunction with the barrier-type facility in Old River near the DMC Intake, improvements to water quality in Old River can be approximately twice those obtained by only operating the barrier-type facility on Old River near the DMC Intake.

3) Improved water quality in Old River near Paradise Cut caused by operating the barrier-type facility at the head of Old River and in Old River near the DMC Intake tend to be slightly reduced when the CVP forebay tie-in option is used. An exception to this trend is the preferred alternative and CVP tie-in. Under this alternative, salinity in this reach of Old River can potentially be higher than under the same alternative but without the CVP forebay tie-in option. Actually, the existing SWP and CVP diversion facilities could be operated, along with the new forebay intake gates, to bring good-quality water to the vicinity of the barrier-type facility on Old River, and hence up Old River.

4) The improvements to water quality in Old River near Paradise Cut are relatively unaffected by the operation of a barrier-type facility in Middle River.

5) The improvements to water quality in Old River near Paradise Cut are relatively unaffected by the operation of a partial barrier-type facility in Grant Line Canal.

Old River from Middle River to the San Joaquin River

1) Operating the barrier-type facility in Old River near the DMC Intake produces no significant improvements to water quality in Old River upstream of Middle River.

2) Water quality in Old River for this reach is unaffected by the operation of the partial barrier-type facility in Grant Line Canal.

3) Water quality in Old River for this reach is unaffected by the operation of the barrier-type facility in Middle River.

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4) Water quality in Old River for this reach is unaffected by whether or not there is CVP tie-in or by the location of the intake structure.

5) Operation of the barrier-type facility at the head of Old River can moderately improve water quality in this reach of Old River. Engineering studies indicate that if the San Joaquin River flow is below about 1500 cfs, the concentration of TDS in the San Joaquin River is high enough to impair South Delta water quality. Water quality in this reach of Old River is improved if San Joaquin River water is kept out of Old River. However, if the San Joaquin River flow is above 1,500 cfs, the TDS concentration in the San Joaquin River is low enough to freshen the water in Old River. Blocking this flow into Old River by continuously operating the barrier-type facility can cause the TDS concentrations in Old River to rise when compared to the effects of the no-action alternative.

Middle River

1) Operation of a barrier-type facility in Middle River can significantly improve water quality in Middle River. Engineering studies indicate that TDS can be reduced as much as 250 ppm during May and June.

2) Improvements in water quality in Middle River due to the operation of a barrier-type facility in Middle River are usually independent of use of a CVP forebay tie-in option. An exception to this trend is the alternative, Enlarged Forebay - North Victoria Intake with Barrier Configuration A and CVP tie-in, which can potentially cause salinity to increase over the no-action alternative, providing that SWP and CVP diversion facilities are not operated to bring good-quality water to the vicinity of the Middle River barrier-type facility. Without a CVP tie-in to the forebay, relatively good-quality water is brought to Middle River to a point near the barrier-type facility in Middle River, and subsequently is moved further upstream via the facility. When the CVP forebay tie-in option is used and the forebay intake is downstream of the Middle River barrier-type facility (that is, on Middle River at Woodward Canal) the relatively good-quality water no longer is drawn to the barrier-type facility.

3) Improvements in water quality in Middle River are relatively unaffected by the operation of the partial barrier-type facility in Grant Line Canal.

4) Improvements in water quality in Middle River are relatively unaffected by the operation of the barrier-type facility at the head of Old River. The salinity at the junction of Middle River and Old River may be affected by operation of the barrier-type facility at the head of Old River (as described above), but any changes in Middle River quickly diminish downstream from this location.

The exact operation of the barrier-type facilities will be determined through negotiations. However, certain general trends associated with the operation of the barrier-type facilities can be listed:

- **Operation of Middle River Barrier-Type Facility:**
  1) significantly improves water levels in Middle River;
  2) can be operated independently of Old River and Grant Line Canal facilities.
- **Operation of Barrier-Type Facility on Old River near the DMC Intake:**
  1) moderately improves water levels in Old River;
  2) moderately improves water quality in Old River near Paradise Cut;
  3) does not significantly affect water levels or water quality in Old River from Middle River to the San Joaquin.
- **Operation of Grant Line Canal Barrier-Type Facility:**
  1) significantly improves water levels in Old River;
  2) significantly improves water levels in Grant Line Canal;
  3) does not alone significantly improve water quality in Old River and Grant Line Canal.
- **Operation of Old River at Head Barrier-Type Facility:**
  1) generally does not improve water levels in South Delta;
  2) can improve water quality in the reach of Old River from the San Joaquin River to Middle River;
  3) does not significantly improve water quality elsewhere unless the CVP forebay tie-in option is considered.

No-Action Alternative. Under the no-action alternative, current agricultural concerns would continue to be low water and salinity intrusion.. Decision-1485 agricultural standards would continue to be met, but the current problems for agriculture in the south Delta would remain. Agricultural concerns in the south Delta would continue to be periodically impacted by low water levels and high salinity concentrations.

Preferred Alternative. Under the preferred alternative, conditions for agriculture use in the south Delta will substantially improve. The operation of barrier-type facilities will prevent some poor-quality San Joaquin River water from entering the south Delta. Moving the SWP diversion to Middle River and Old River at Woodward Canal would substantially improve south Delta water levels. The barrier-type facilities in Old River near the DMC Intake, in the west end of Grant Line Canal, in Middle River upstream of Victoria Canal, and at the head of Old River can be operated to provide significant additional improvements to water levels and substantially improve south Delta water quality during the irrigation season. These facilities will also generally improve the water circulation in Middle River, Old River, and Grant Line Canal by bringing good-quality water to these channels.

The enlarged forebay in the preferred alternative will allow for more flexible forebay intake structure operation to improve water levels in the south Delta.

The preferred alternative's enlarged forebay can also be operated to divert additional Delta water, to be subsequently released through the existing forebay gates in Old River at the south end of West Canal. It is expected that this will provide additional improvement to water quality in the south Delta. The preferred alternative, with intake gates on Middle River and Old River, provides for the greatest improvement to the water quality of SWP diversions and hence should provide the best quality water for release in the south Delta.

Under the preferred alternative, Delta agricultural use downstream of the proposed barrier-type facilities and near the forebay intake structures will not be significantly impacted.

Under the preferred alternative, conditions for agricultural use in the west Delta will improve because of improved water quality. The improved water quality is due primarily to reduced SWP diversions during spring and summer. The preferred alternative generally provides the greatest improvement to water quality in the west Delta of any of the alternatives considered.

Other Alternatives. Under the other alternatives, substantial improvement to agricultural conditions in the south Delta is possible. Improvements to water levels and water quality in south Delta channels caused by operation of the barrier-type facilities should be equal for all the alternatives. The additional improvement to agricultural conditions caused by forebay configuration will vary.

As in the preferred alternative, the Enlarged Forebay - Highway 4 Intake alternative would enable forebay intake operations to further benefit water levels and water quality by 1) allowing for increased flexibility in diversions and 2) enabling good-quality water to be released through the existing intake structure into Old River. The overall performance of this alternative should be approximately equal to that of the preferred alternative.

Both alternatives—Enlarged Forebay-Highway 4 Intake with CVP tie-in, and Enlarged Forebay-North Victoria Intake with CVP tie-in—can be operated to provide additional benefits to agriculture. These alternatives substantially improve water levels but could also degrade water quality in channels upstream of the intake structure. It is expected that either 1) periodic diversions of either CVP water or SWP water from the present locations, or 2) releases of forebay water through the existing forebay intake structure could offset the impacts on water quality caused by the CVP tie-in.

If the CVP tie-in option is to be used, the northern intake alternatives may not allow for increases in flexibility of forebay operation. Further restricting the times of diversions into the forebay and possibly diverting water through northern gates to then be released through the existing forebay gates may not be possible without an enlarged forebay.

All other alternatives should improve water quality in the west Delta and at Decision-1485 agricultural stations similar to the preferred alternative. The alternative, Northern Intake - Barrier Configuration A, could improve water quality in the west Delta to a level comparable with the other alternatives if its barrier operation is modified. None of the other alternatives will significantly impact water levels near the forebay intake structures or immediately downstream of the barrier-type facilities.

Impacts on Channel Velocities, Scour, and Siltation

Some scouring and siltation has been occurring in the south Delta channels and may be caused in part by current

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export facilities. The main causes of scouring and siltation are flow velocities and sediment size, shape, and density. Since the construction of upstream storage facilities on the major tributaries feeding the Delta, sediment and channel bed material have grown significantly finer. This change has allowed channel velocities to play a more important role in determining scouring and siltation.

Delta field observations have shown that flow velocities below 3 feet per second (fps) will probably not cause scouring. The only known location in the south Delta where scouring is definitely occurring is at the intake gates to Clifton Court Forebay.

Currently 3 to 5 million tons of sediment enter the Delta annually, about 80 percent of which is transported in the winter during high flows. Between 10 percent and 30 percent of the 3 to 5 million tons of sediment is deposited in the Delta channels, with about 5 percent entering Clifton Court Forebay and the aqueduct, the rest being transported to San Francisco Bay. The 5 percent deposition occurring in the Forebay and aqueduct accounts for the 97 acre-feet (AF) of the storage lost annually in the Forebay. There are no major channels in the south Delta where siltation is significant. Delta landowners have indicated that siltation has been occurring in some of the minor channels but the cause is unknown.

The South Delta Scouring Monitoring Program was initiated in 1969 to determine whether SWP operations are significantly altering channel geometries in the south Delta. Over 35 channel cross sections are currently being monitored semi-annually to record scouring and deposition action (Figure 5-9). An annual report is published documenting these results (see *Southern Delta Scour Monitoring—1988 Update,* DWR, September 1988.)

Since 1969, there appear to be no dramatic changes to channel geometries in the south Delta other than channel dredging. Seasonal scouring and deposition occur in the south Delta but changes in cumulative channel geometry are negligible.

There is concern that the proposed improvements in the SDWMP may increase scour and siltation due to operation of the barrier-type facilities and forebay improvements. Operation of the south Delta facilities will change flow patterns in the central and south Delta. There is also concern that scour will increase at the proposed intake gates to the forebay, especially considering increases in SWP export capacity to 10,300 cfs daily average flow and, perhaps, a CVP tie-in to the forebay. There is further concern that decreased velocities may cause siltation in the south Delta channels upstream of the proposed barrier-type facilities.

The alternatives with CVP tie-in to the forebay will likely produce higher velocities near the intake gates to Clifton Court Forebay. With the CVP tie-in pumping to the forebay, a higher volume of water will be required to fill the forebay when the intake gates are open. The higher volume through a fixed intake gate size will create higher instantaneous velocities at the intake and also higher velocities in the adjacent channels leading to the intake gates.

Siltation occurs when channel velocities decrease, causing the suspended sediment to be deposited on the channel bed. The alternatives considered include barrier-type facilities in the south Delta to raise water surface elevations upstream, thus increasing water storage in the channels. The barriers may reduce the upstream channel velocities, thus increasing the potential for deposition.

Table 5-13 summarizes Table C-20 in Appendix C, which shows monthly maximum upstream and downstream channel velocities where scour or siltation could be of concern for various alternatives. These tables were derived from hydrodynamic modeling using assumptions presented under "Impacts on Delta Agricultural Uses and Water Levels" and in Appendix C. Flow direction can be both upstream and downstream, depending on tidal cycle and export pumping schedule

High velocities in Delta channels can occur due to either high inflows from large storms or high export rates in the south Delta. High velocities caused by high export rates tend to be localized in the immediate vicinity of the intake gates. Table 5-13 shows the range of increases in maximum velocity in channels adjacent to proposed intake gate locations. Channel sections where maximum velocities increase to over 3 fps or decrease to under 3 fps are highlighted in the table.

Table 5-14 shows the upstream and downstream velocity ranges for all of the alternatives for the channels upstream of the proposed barriers. This table was derived from Table C-20. Table 5-14 was constructed to display velocity changes due to the barriers. It shows the changes in flow velocity and in upstream and downstream velocity ranges with reference to zero fps.

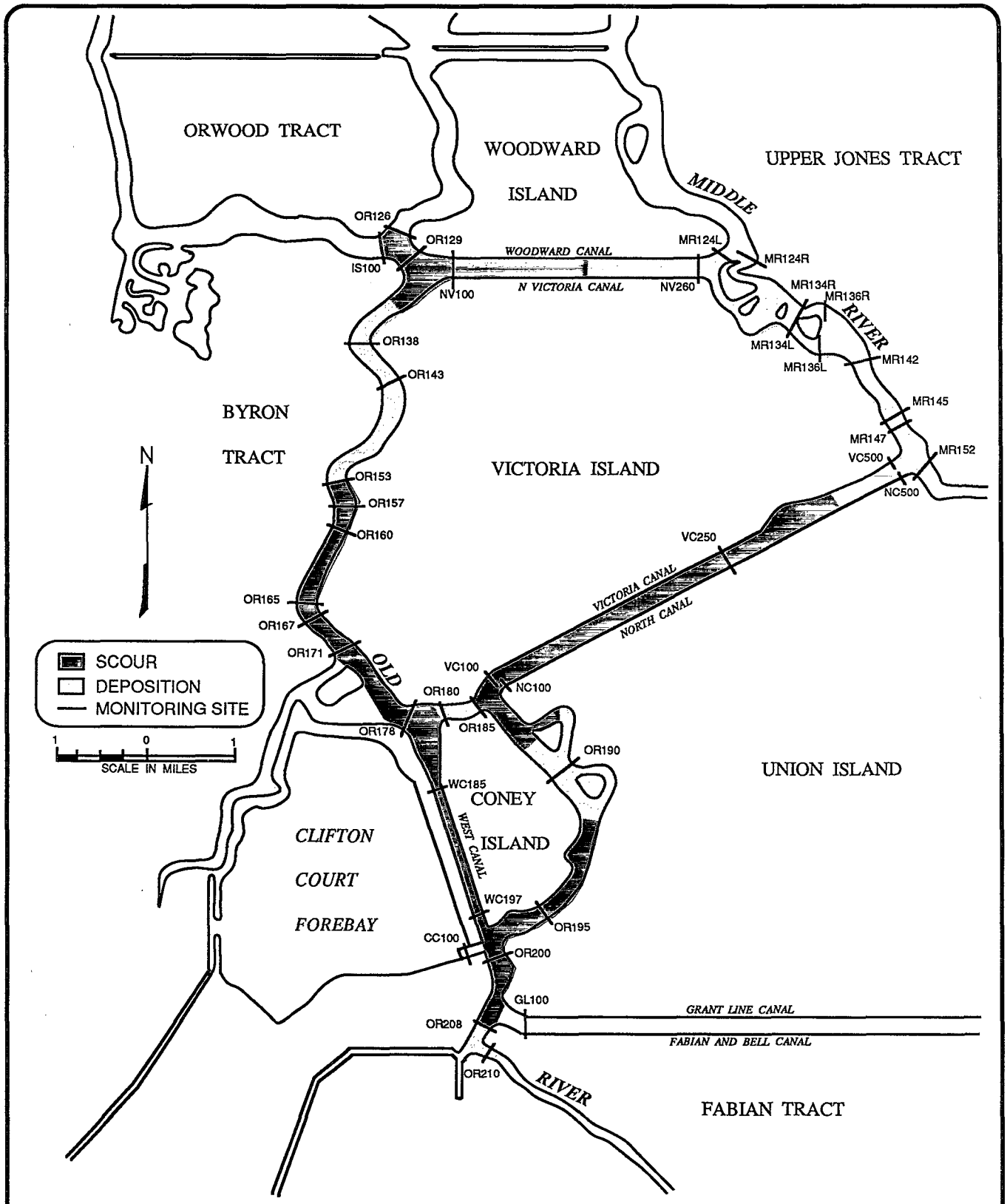

Figure 5-9. Scour and Siltation Patterns and Monitoring Locations

Table 5-13
Typical Range of Increase in Maximum Velocity Near Proposed Forebay Intake Structures
(values in feet per second)

Alternatives	1	2	3	4	5	6	7	8
Vicinity of Northern Intake Gate								
Old River just upstream of intake	1.2–1.4	1.2–1.4	1.0–1.3	1.0–1.8	2.1–2.3	2.1–2.3	1.4–1.7	1.6–2.1
Old River just downstream of intake	0.6–1.0	0.6–0.9	0.0–0.2	0.0–0.6	1..1–1.4[1]	1.0–1.4[1]	0.1–0.5	0.8–1.4
West Canal just upstream of intake	0.1–0.7[2]	0.0–0.7[2]	0.0–0.3[2]	0.0–0.2[2]	0.9–1.5[2]	1.2–1.5[2]	0.4–0.8[2]	0.4–0.8[2]
Vicinity of Highway 4 Intake								
Old River just upstream of intake at Highway 4	0.2–0.5	0.2–0.5	0.0–0.3	0.0–0.7	0.6–0.7	0.5–0.8	0.2–0.5	1.0–1.5
Old River just downstream of intake at Highway 4	0.2–0.4	0.2–0.3	0.0–0.3	1.3–1.8[1]	0.5–0.7	0.5–0.7	0.2–0.6	1.8–2.1[1]
Vicinity of North Victoria Intake								
Middle River just upstream of intake at Woodward Canal	0.3–0.6	0.2–0.6	0.1–0.6	0.0–0.2	0.4–0.7	0.4–0.7	0.5–1.2	0.0–0.2
Middle River just downstream of intake at Woodward Canal	0.2–0.5	0.1–0.5	1.5–1.9[1]	0.2–0.4	0.2–0.6	0.3–0.6	2.1–2.5[1]	0.2–0.4
Middle River just upstream of Santa Fe Railroad	0.2–0.5	0.2–0.5	1.4–1.6[1]	0.1–1.4	0.3–0.6	0.3–0.6	1.8–2.1[1]	0.2–0.4
Middle River just downstream of Santa Fe Railroad	0.2–0.7	0.3–0.7	0.8–1.1	0.2–0.6	0.4–0.7	0.4–0.7	1.1–1.4[1]	0.2–0.6
Woodward Canal just west of intake	0.1–0.1	0.1–0.1	1.4–2.9	0.8–1.0	0.1–0.1	0.1–0.1	2.2–2.6	1.1–1.3

[1]Denotes increase in maximum velocity to over 3 fps.
[2]Denotes decreases in maximum velocity from above 3 fps to below 3 fps.

Alternatives:

1 Northern Intake with Barrier Configuration A
2 Northern Intake with Barrier Configuration B
3 Preferred Alternative
4 Enlarged Forebay – Highway 4 Intake with Barrier Configuration B
5 Northern Intake with CVP Tie-in and Barrier Configuration A
6 Northern Intake with CVP Tie-in and Barrier Configuration B
7 Enlarged Forebay with CVP Tie-in – North Victoria Intake with Barrier Configuration B
8 Enlarged Forebay with CVP Tie-in – Highway 4 Intake with Barrier Configuration B

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Velocity increases near and at the intake gates will increase the potential for scouring. These velocities will be higher with a CVP tie-in to the forebay.

No-Action Alternative. Under the no-action alternative, Delta flows and velocities would be similar to those which occur today. Channel velocities in the south Delta tend to be under 3 fps except in the West Canal at the intake gates for Clifton Court Forebay. Maximum velocities in the Delta typically occur during above-normal or wet years, when inflows are high and the export pumping rate is also high. Operation of the SWP is most likely causing the higher velocities near the forebay intake gates. These velocities contribute to minor scouring identified through the Scouring Monitoring Program in this channel and in Old River and Victoria Canal. These characteristics will probably persist for the no-action alternative.

Preferred Alternative. Under the preferred alternative, maximum channel velocities near the forebay intake gates will tend to be slightly higher, possibly causing localized scouring. Velocities will be reduced for the channels just upstream of the tide barriers, increasing the potential for localized deposition.

The maximum and minimum flow velocities in the channels north of Victoria Island are influenced by the forebay configuration. The two separate gate locations on Victoria Island, one at Old River and one at Middle River, cause the effects of increased diversions into the forebay to be shared by Old and Middle rivers. A single gate located at Middle River and Woodward Canal would increase flow velocities in Middle River downstream of the gate by over 100 percent, possibly inducing localized channel scouring. (Table 5-13 shows a 1.5 to 1.9 fps increase over the no-action alternative.)

With a second intake gate located on Old River and Woodward Canal confluence, velocities in Middle River will drop below 3 fps, whereas velocities in Old River will increase to over 3 fps about 15 percent of the time. Velocities in the West Canal will drop significantly (by over 33 percent compared to the no-action alternative), reducing the potential for scouring. The localized increase in Old River velocities can be mitigated by channel improvements.

Under the preferred alternative, siltation is not expected to be a significant problem. Downstream of the barriers, flow patterns may change, but siltation does not appear to be a problem. In the channels immediately upstream of the intake gates, there appear to be minimal changes to downstream velocities. Although water circulation patterns in the south Delta will be altered by the barriers, most channel velocities should not change drastically. Table 5-14 shows that the range in monthly upstream and downstream velocities for channels upstream of the proposed barriers do not significantly decrease from the no-action alternative. When the gates are closed, water upstream of the barriers tends to move upstream in both Old and Middle rivers and then flow downstream in Grant Line Canal with the ebb tide.

There will be constant water movement in the channels, which will help eliminate additional siltation. Operation of the barriers could include periodic opening of the gates to flush the south Delta channels, thus helping improve local water quality. This flushing action would also help reduce siltation. If siltation does become a problem and barrier operation cannot alleviate it, dredging may also be used as a mitigation measure.

Other Alternatives. For other alternatives, concern has been shown over the potential for scouring in the channels near the intake gates and siltation upstream of the barriers.

Table 5-13 shows that the impacts on velocity caused by both the Northern Intake with Barrier Configuration A and the preferred alternative are similar. There is also little difference in changes to the velocities between these two alternatives when the CVP tie-in is considered. The Northern Intake with Barrier Configuration A and Configuration B alternatives will cause minor increase in the potential for scouring in both North Canal and Old River just downstream of the intake gate, compared to the no-action alternative. It is expected that velocities in West Canal will decrease below 3 fps.

Both the Northern Intake with Configuration A and Configuration B alternatives will produce greater scouring potential in North Canal and Old River with a CVP tie-in than without it. Table 5-13 shows that in Old River immediately downstream of the intake gate, monthly maximum velocities will significantly increase (1.1 to 1.4 fps) to more than 3 fps when the intake gates are open. In Old River immediately upstream of the intake gate, it is expected that maximum velocities will increase over 2 fps but will not exceed 3 fps.

The Enlarged Forebay, North Victoria Intake with Barrier Configuration B with CVP tie-in alternative will impact channel velocities to a greater extent than will the

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Table 5–14
Range of Upstream and Downstream Velocities in the South Delta Channels for Representative Below–Normal Water Year
(values in feet per second)

	Alternatives								
Channel	**No Action Up/Down***	**1 Up/Down**	**2 Up/Down**	**3 Up/Down**	**4 Up/Down**	**5 Up/Down**	**6 Up/Down**	**7 Up/Down**	**8 Up/Down**
Old River immediately upstream of DMC intake	1.0/0.9	1.0/1.0	1.0/0.9	0.9/0.9	0.9/0.9	1.4/1.0	1.4/1.0	.0.8/0.9	1.0/1.0
Range	**1.9**	**2.0**	**1.9**	**1.8**	**1.8**	**2.4**	**2.4**	**1.7**	**2.0**
Old River downstream of Tom Paine Slough	0.4/0.1	0.4/0.8	0.4/0.5	0.4/0.5	0.4/0.5	0.4/0.8	0.4/0.6	0.4/0.4	0.4/0.4
Range	**0.5**	**1.2**	**0.9**	**0.9**	**0 .9**	**1.2**	**1.0**	**0.8**	**0.8**
Grant Line Canal just upstream of Clifton Court Forebay	1.5/1.1	1.3/1.2	1.3/1.1	3/1.0	1.3/1.0	1.4/1.3	1.4/1.2	1.2/1.2	1.2/1.2
Range	**2.6**	**2.5**	**2.4**	**2.3**	**2.3**	**2.7**	**2.6**	**2.4**	**2.4**
Grant Line Canal	1.3/1.0	1.2/1.1	1.2/0.9	1.2/0.9	1.2/0.8	1.5/1.2	1.5/1.0	1.1/1.0	1.1/1.0
Range	**2.3**	**2.3**	**2.1**	**2.1**	**2.0**	**2.7**	**2.5**	**2.1**	**2.1**
Old River upstream of Paradise Cut	1.7/0.7	1.7/1.0	1.7/0.7	1.7/0.6	1.7/0.6	1.7/1.1	1.7/1.1	1.6/1.0	1.6/0.9
Range	**2.4**	**2.7**	**2.4**	**2.3**	**2.3**	**2.8**	**2.8**	**2.6**	**2.5**
Middle River just upstream of Highway 4	0.6/0.7	0.6/0.7	0.6/0.7	0.9/0.7	0.6/0.7	0.9/0.7	0.9/0.7	1.1/0.7	0.7/0.7
Range	**1.3**	**1.3**	**1.3**	**1.6**	**1.3**	**1.6**	**1.6**	**1.8**	**1.4**
Middle River just downstream of Old River	0.4/0.5	0.4/0.7	0.6/0.6	0.4/0.5	0.4/0.6	0.4/0.7	0.4/0.7	0.6/0.6	0.4/0.6
Range	**0.9**	**1.1**	**1.2**	**0.9**	**1.0**	**1.1**	**1.1**	**1.2**	**1.0**
Old River just upstream of Middle River	1.8/0.4	1.7/0.6	1.7/0.4	1.7/0.4	1.7/0.4	1.6/0.7	1.6/0.7	1.6/0.6	1.6/0.6
Range	**2.2**	**2.3**	**2.1**	**2.1**	**2.1**	**2.3**	**2.3**	**2.2**	**2.2**
Old River just downstream of San Joaquin River	2.3/0.3	2.0/0.2	2.1/0.5	2.0/0.6	2.0/0.6	2.1/0.7	2.1/0.7	2.0/0.6	2.0/0.6
Range	**2.6**	**2.2**	**2.6**	**2.6**	**2.6**	**2.8**	**2.8**	**2.6**	**2.6**

*Up refers to upstream flow
Down refers to downstream flow.

Alternatives:

1 Northern Intake with Barrier Configuration A
2 Northern Intake with Barrier Configuration B
3 Preferred Alternative
4 Enlarged Forebay – Highway 4 Intake with Barrier Configuration B
5 Northern Intake with CVP Tie–in and Barrier Configuration A
6 Northern Intake with CVP Tie–in and Barrier Configuration B
7 Enlarged Forebay with CVP Tie–in – North Victoria Intake with Barrier Configuration B
8 Enlarged Forebay with CVP Tie–in – Highway 4 Intake with Barrier Configuration B

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preferred alternative. Channel velocities in Old and Middle rivers will incrementally increase.

The Enlarged Forebay, Highway 4 Intake with Barrier Configuration B with and without a CVP tie-in alternatives show increased channel velocities in Old River compared to the no-action alternative. Maximum velocities for the Highway 4 Intake alternative without a CVP tie-in are significantly lower than the alternative with a CVP tie-in (about 20 percent) but both exceed 3 fps in Old River downstream of the intake gates.

The siltation potential for all the alternatives will be similar to that under the preferred alternative and will use the same mitigation techniques as the preferred alternative.

Impacts on Cross-Delta Flows and on Levees

Changes in cross-Delta flows for the alternative operational plans have been evaluated. Increased flows in the Delta Cross Channel (Reclamation facility) and in Georgiana Slough are related primarily to Sacramento River inflows and are therefore affected by upstream releases and natural flow conditions.

The operation of the Delta Cross Channel gates is dictated by Decision-1485 restrictions to protect salmon and striped bass. For all the alternatives, gate operations remain the same. From January 1 to April 15, the Delta Cross Channel gates are closed whenever the daily Delta outflow exceeds 12,000 cfs. From April 16 to May 31, the Delta Cross Channel gates are closed for no more than two of four consecutive days for up to 20 total days, based on input from DFG. The gates also are closed when Sacramento River flow at the I Street Bridge in Sacramento is greater than 30,000 cfs. Otherwise, the gates remain open except for testing.

The efficiency of the Delta Cross Channel in diverting Sacramento River flow to the central Delta is expressed by a value called the "transfer coefficient" (in Table 5-15, rows labeled "Ratio"). The transfer coefficient is the cross-Delta flow (Cross Channel flow plus the Georgiana Slough flow) divided by the Sacramento River flow at the I Street bridge. The higher the value, the more efficiently the Delta Cross Channel can divert Sacramento River flow. Table 5-15 shows that during January through May for below- normal, above-normal, and wet years, the transfer coefficient is much lower than during other months. During these months, the Delta Cross Channel gates are closed in accordance with Decision 1485, and the cross-Delta flow is reduced to only the Georgiana Slough flow, which significantly reduces the transfer coefficient.

Table 5-15 shows the ratio of cross-Delta flows to Sacramento River flows for five representative water years. Each water year in Table 5-15 represents an actual water year that most closely resembles one of the five main water year types.

Table C-21 (in Appendix C) shows the monthly maximum upstream and downstream channel velocities for Snodgrass Slough, Dead Horse Cut, and North and South Fork Mokelumne Rivers. These velocity values are categorized into the no-action and the eight SDWMP alternatives for the five main water year types.

Flows in the north Delta are not high enough to significantly harm levees. Field tests indicate that channel erosion will likely occur in the Delta when the flow is greater than 3 fps. Table C-21 shows that the maximum upstream and downstream channel velocities downstream of the Delta Cross Channel do not exceed 3 fps. This is because during high flows, when Sacramento River flow is greater than 30,000 cfs, the Cross Channel gates are closed, reducing the flow entering the north Delta channels. This is evident in Table C-21, which shows that velocities are significantly reduced during the high-flow period of January through May, when the gates are normally closed.

Levee erosion due to right angle flows has been identified at two locations. On Staten Island, the levee at the south end of Dead Horse Cut receives perpendicular flow from Dead Horse Cut and has required extensive rock protection.

On McCormack-Williamson Tract, the levee at the confluence of the Delta Cross Channel and Snodgrass Slough has recently been stripped of vegetation and rock protection emplaced due to erosion possibly caused by incoming flows and wave action from the Delta Cross Channel.

No-Action Alternative. For the representative wet year, the combined Delta Cross Channel and Georgiana Slough flow transfer coefficient ranges from 0.16 to 0.584, with a maximum channel velocity ranging from -1.4 to 1.97 fps. For the representative below-normal year, the transfer coefficient ranges from 0.178 to 0.517; and for the representative critical year from 0.394 to 0.524, with channel velocities ranging from -1.24 to 1.95 and -1.25 to 2,0, respectively.

The transfer coefficient for the critical year is not as low as in the other water year types because the Delta Cross

Table 5-15
Ratio of Cross-Delta Flows to Sacramento River Flows
(Monthly average flows in cubic feet per second)

Representative Critical Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No-Action	Sacramento R.	20,309	18,054	16,585	12,325	13,644	11,772	14,305	11,561	12,120	13,837	11,805	10,792
No-Action	Cross-Delta	7,969	7,873	7,379	6,181	6,639	5,997	6,783	5,807	6,064	6,656	5,983	5,615
No-Action	Ratio	0.394	0.438	0.448	0.504	0.491	0.517	0.477	0.516	0.517	0.492	0.512	0.524
1	Sacramento R.	23,577	19,382	16,569	12,325	13,644	11,772	12,994	11,561	11,767	12,325	11,805	10,792
1	Cross-Delta	8,931	8,330	7,384	6,192	6,665	6,000	6,334	5,812	5,937	6,134	5,987	5,620
1	Ratio	0.380	0.432	0.448	0.505	0.493	0.517	0.491	0.516	0.522	0.511	0.512	0.524
2	Sacramento R.	23,577	19,382	16,569	12,325	13,644	11,772	12,994	11,561	11,767	12,325	11,805	10,792
2	Cross-Delta	8,930	8,330	7,384	6,192	6,661	5,991	6,331	5,808	5,930	6,124	5,974	5,605
2	Ratio	0.380	0.432	0.448	0.505	0.493	0.516	0.490	0.516	0.521	0.511	0.511	0.523
3	Sacramento R.	23,577	19,382	16,569	12,325	13,644	11,772	12,994	11,561	11,767	12,325	11,805	10,792
3	Cross-Delta	8,953	8,354	7,403	6,207	6,672	5,999	6,339	5,815	5,937	6,136	5,985	5,612
3	Ratio	0.381	0.433	0.449	0.506	0.494	0.517	0.491	0.516	0.522	0.511	0.512	0.524
4	Sacramento R.	23,577	19,382	16,569	12,325	13,644	11,772	12,994	11,561	11,767	12,325	11,805	10,792
4	Cross-Delta	8,935	8,335	7,385	6,193	6,660	5,990	6,333	5,808	5,932	6,138	5,980	5,607
4	Ratio	0.380	0.432	0.448	0.505	0.493	0.516	0.491	0.516	0.522	0.511	0.511	0.523

Representative Dry Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No-Action	Sacramento R.	13,301	23,601	13,252	21,268	15,876	16,179	15,852	13,626	13,734	13,447	10,488	10,456
No-Action	Cross-Delta	6,463	9,155	6,454	4,134	7,327	7,439	7,204	6,405	6,519	6,523	5,472	5,473
No-Action	Ratio	0.488	0.388	0.489	0.193	0.462	0.462	0.458	0.477	0.480	0.493	0.528	0.528
1	Sacramento R.	13,301	23,601	13,252	22,439	14,256	19,967	18,121	14,211	14,423	13,821	11,691	10,439
1	Cross-Delta	6,485	9,279	6,485	4,321	6,844	8,555	7,891	6,616	6,767	6,656	5,924	5,469
1	Ratio	0.490	0.393	0.492	0.192	0.481	0.430	0.439	0.472	0.474	0.49	0.513	0.529
2	Sacramento R.	13,301	23,601	13,252	22,439	14,256	19,967	18,121	14,211	14,423	13,821	11,691	10,439
2	Cross-Delta	6,478	9,279	6,485	4,321	6,841	8,555	7,901	6,611	6,761	6,648	5,912	5,454
2	Ratio	0.490	0.393	0.492	0.192	0.481	0.430	0.439	0.472	0.474	0.489	0.512	0.527
3	Sacramento R.	13,301	23,601	13,252	22,439	14,256	19,967	18,121	14,211	14,423	13,821	11,691	10,439
3	Cross-Delta	6,488	9,301	6,502	4,331	6,854	8,577	7,912	6,618	6,769	6,658	5,922	5,465
3	Ratio	0.490	0.394	0.493	0.192	0.482	0.432	0.440	0.472	0.475	0.49	0.513	0.528
4	Sacramento R.	13,301	23,601	13,252	22,439	14,256	19,967	18,121	14,211	14,423	13,821	11,691	10,439
4	Cross-Delta	6,477	9,285	6,485	4,323	6,839	8,558	7,898	6,611	6,762	6,654	5,920	5,460
4	Ratio	0.490	0.394	0.492	0.192	0.481	0.431	0.439	0.472	0.474	0.489	0.513	0.513

[1]See footnotes on page 125.

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Table 5–15 (continued)
Ratio of Cross–Delta Flows to Sacramento River Flows
(Monthly average flows in cubic feet per second)

Representative Below–Normal Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
No–Action	Sacramento R.	16,927	16,070	20,553	18,975	21,474	27,691	15,179	14,049	15,616	17,805	12,179	11,195
No–Action	Cross–Delta	7,241	7,324	8,309	3,848	4,136	4,914	6,895	6,586	7,164	7,877	6,106	5,750
No–Action	Ratio	0.430	0.458	0.405	0.203	0.193	0.178	0.457	0.474	0.464	0.448	0.508	0.517
1	Sacramento R.	17,951	17,365	21,886	18,975	21,474	27,691	16,289	13,658	15,263	16,667	12,406	11,195
1	Cross–Delta	7,606	7,744	8,739	3,849	4,118	4,947	7,260	6,456	7,058	7,556	6,203	5,772
1	Ratio	0.426	0.448	0.400	0.203	0.192	0.179	0.448	0.479	0.468	0.46	0.506	0.519
2	Sacramento R.	17,951	17,365	21,886	18,975	21,474	27,691	16,289	13,658	15,263	16,667	12,406	11,195
2	Cross–Delta	7,606	7,744	8,739	3,849	4,118	4,947	7,270	6,453	7,054	7,554	6,203	5,772
2	Ratio	0.426	0.448	0.400	0.203	0.192	0.179	0.449	0.478	0.468	0.46	0.507	0.519
3	Sacramento R.	17,951	17,365	21,886	18,975	21,474	27,691	16,289	13,658	15,263	16,667	12,406	11,195
3	Cross–Delta	7,629	7,766	8,761	3,858	4,125	4,953	7,282	6,460	7,061	7,561	6,210	5,781
3	Ratio	0.427	0.449	0.401	0.203	0.192	0.180	0.449	0.479	0.468	0.46	0.507	0.52
4	Sacramento R.	17,951	17,365	21,886	18,975	21,474	27,691	16,289	13,658	15,263	16,667	12,406	11,195
4	Cross–Delta	7,610	7,746	8,743	3,850	4,119	4,947	7,268	6,454	7,055	7,554	6,205	5,771
4	Ratio	0.426	0.448	0.400	0.203	0.192	0.179	0.448	0.478	0.468	0.46	0.506	0.519

Representative Above–Normal Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No–Action	Sacramento R.	16,309	17,348	18,520	18,211	55,818	70,959	22,290	31,707	22,677	20,390	16,000	15,095
No–Action	Cross–Delta	6,991	7,605	7,876	7,823	8,820	10,905	4,189	5,420	8,635	8,512	7,342	6,842
No–Action	Ratio	0.431	0.440	0.427	0.430	0.158	0.154	0.188	0.172	0.384	0.422	0.463	0.456
1	Sacramento R.	18,959	18,928	18,601	18,211	55,818	70,959	22,290	31,707	22,677	17,496	13,512	15,936
1	Cross–Delta	7,839	8,146	7,907	7,849	8,817	10,910	4,202	5,424	8,650	7,689	6,566	7,123
1	Ratio	0.415	0.432	0.426	0.431	0.158	0.154	0.189	0.172	0.385	0.445	0.491	0.449
2	Sacramento R.	18,959	18,928	18,601	18,211	55,818	70,959	22,290	31,707	22,677	17,496	13,512	15,936
2	Cross–Delta	7,839	8,146	7,907	7,849	8,817	10,910	4,202	5,423	8,647	7,686	6,566	7,123
2	Ratio	0.415	0.432	0.426	0.431	0.158	0.154	0.189	0.172	0.385	0.444	0.491	0.449
3	Sacramento R.	18,959	18,928	18,601	18,211	55,818	70,959	22,290	31,707	22,677	17,496	13,512	15,936
3	Cross–Delta	7,866	8,171	7,925	7,861	8,820	10,912	4,209	5,425	8,654	7,692	6,572	7,142
3	Ratio	0.417	0.433	0.427	0.432	0.158	0.154	0.189	0.172	0.385	0.455	0.491	0.451
4	Sacramento R.	18,959	18,928	18,601	18,211	55,818	70,959	22,290	31,707	22,677	17,496	13,512	15,936
4	Cross–Delta	7,847	8,151	7,908	7,849	8,817	10,910	4,203	5,423	8,648	7,688	6,567	7,124
4	Ratio	0.416	0.432	0.426	0.431	0.158	0.154	0.189	0.172	0.385	0.444	0.491	0.449

[1]See footnotes on page 125.

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Table 5-15 (continued)
Ratio of Cross-Delta Flows to Sacramento River Flows
(Monthly average flows in cubic feet per second)

Representative Wet Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
No-Action	Sacramento R.	5,301	8,060	13,870	32,894	40,284	48,374	38,996	18,764	18,441	16,862	14,195	12,759
No-Action	Cross-Delta	3,044	4,515	6,704	5,711	6,682	7,779	6,394	3,741	7,727	7,433	6,775	6,314
No-Action	Ratio	0.584	0.564	0.484	0.172	0.165	0.160	0.164	0.201	0.423	0.447	0.483	0.499
1	Sacramento R.	5,967	13,515	13,886	32,894	40,284	42,813	35,402	18,764	16,491	15,106	13,284	12,759
1	Cross-Delta	3,428	6,603	6,744	5,746	6,712	7,032	5,917	3,742	7,107	6,857	6,487	6,340
1	Ratio	0.583	0.491	0.486	0.173	0.166	0.164	0.167	0.201	0.436	0.461	0.494	0.501
2	Sacramento R.	5,967	13,515	13,886	32,894	40,284	42,813	35,402	18,764	16,491	15,106	13,284	12,759
2	Cross-Delta	3,428	6,603	6,744	5,746	6,712	7,032	5,917	3,740	7,096	6,850	6,487	6,340
2	Ratio	0.583	0.491	0.486	0.173	0.166	0.164	0.167	0.200	0.435	0.46	0.494	0.501
3	Sacramento R.	5,967	13,515	13,886	32,894	40,284	42,813	35,402	8,761	6,491	15,106	13,284	12,759
3	Cross-Delta	3,432	6,618	6,761	5,754	6,719	7,038	5,921	3,744	7,109	6,858	6,494	6,352
3	Ratio	0.583	0.493	0.487	0.173	0.166	0.164	0.167	0.201	0.436	0.461	0.495	0.502
4	Sacramento R.	5,967	13,515	13,886	32,894	40,284	42,813	35,402	18,764	16,491	15,106	13,284	12,759
4	Cross-Delta	3,425	6,603	6,744	5,748	6,714	7,033	5,917	3,740	7,110	6,854	6,488	6,340
4	Ratio	0.582	0.491	0.486	0.173	0.166	0.164	0.167	0.200	0.436	0.461	0.494	0.501

[1]Cross-Delta flows are the sum of flows in Delta Cross Channel and Georgiana Slough. Flows in the Cross Channel reflect flow control operations and Decision 1485 constraints from January 1 to May 31 to minimize cross-Delta movement of salmon and diversion of young striped bass into central Delta.

Alternatives:
1 Northern Intake with Barrier Configuration A
2 Northern Intake with Barrier Configuration B
3 Preferred Alternative
4 Enlarged Forebay - Highway 4 Intake with Barrier Configuration B

Channel gates remain open throughout nearly the entire year, thus maintaining flow in the Delta Cross Channel. This produces a more consistent channel velocity in the north Delta for the entire year.

Preferred Alternative. This alternative will have little if any effect on the cross-Delta flow compared to the no-action alternative. Table 5-15 shows that the differences in transfer coefficient between the preferred and no-action alternatives range from 0 to .06, with most of the differences (over 80 percent) less than .01. The yearly average flows for all water year types increases an average of 1.4 percent over the no-action alternative. The maximum and minimum flows will increase an average of 2.9 percent over the no-action alternative. Breaking down the flows into periods when gates are open and closed produces a 1.8 percent flow increase when the gates are open, and a 0.3 percent flow increase when the gates are closed, compared to the no-action alternative. These minimal effects are consistent with the slight differences in channel velocities between the two alternatives shown in Table C-21. These minor variations show that the south Delta alternatives will have a minimal impact on cross-Delta flow.

Other Alternatives. The different alternatives have minimal or no effect on flow rates, splits, and velocities in the north Delta, based on analyses of the flow rates, transfer

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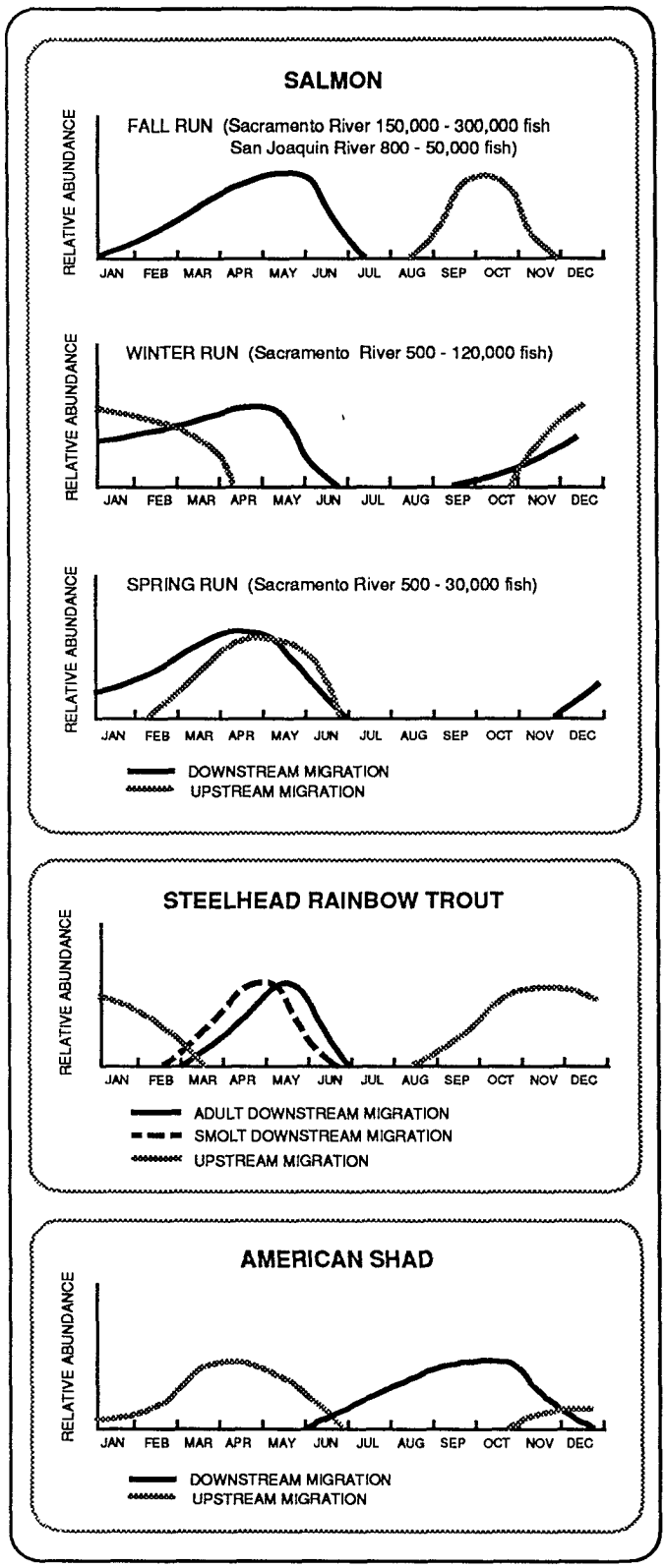

Figure 5-10. General Migration Patterns of Salmon, Steelhead Rainbow Trout, and American Shad in the Sacramento-San Joaquin Estuary

coefficients, and channel velocities shown in Table 5-15 and Table C-21.

General Impacts on Salmon and Steelhead

Chinook salmon and steelhead trout are the principal salmonids that migrate through the Sacramento-San Joaquin estuary to and from upstream spawning grounds. Over 80 percent of the Central Valley salmon and virtually all its steelhead are produced in the Sacramento River system.

The biology, life history, and environmental requirements for steelhead are similar to those of salmon, except that many adult steelhead return to the ocean after spawning. Figure 5-10 shows the general migration patterns of the various salmon and steelhead runs using the estuary and the range in the number of fish in the salmon runs. The salmon runs are for upstream migration of mature adults and downstream migration of juveniles. Although most downstream migration occurs in the spring, out-migrants can be found in the Delta during most of the year.

Numerous facilities have been developed in the Sacramento-San Joaquin river system to maintain anadromous fishery resources. These include hatcheries, spawning channels, fish screens, and fish ladders. Salmon and steelhead hatcheries constructed to mitigate the loss of spawning area include Coleman, Nimbus, and Feather River hatcheries; the Merced River Fish Facility; and the Mokelumne River Fish Installation (consisting of salmon spawning channels and a steelhead hatchery). Such mitigation measures have had variable results. The combination of hatcheries and trucking production around the Delta has successfully mitigated fall-run salmon overall. However, numbers of spring, late fall, winter, and upper Sacramento River fall-run salmon have been reduced significantly during the last 20 to 30 years

Since the early 1970s, juvenile Chinook salmon produced at the Feather River, Nimbus, and Mokelumne River hatcheries have been trucked downstream and released in the Sacramento River at Rio Vista or adjacent to Carquinez Strait. Since these fish are not exposed to in-river and Delta hazards, their contribution to the ocean fishery and to subsequent spawning runs is often high. Chinook salmon from Coleman and Merced River hatcheries are released in up-river areas near the hatcheries to prevent the straying of returning spawners, which occurs when juvenile salmon from up-river are released in the estuary. Strays from hatcheries have helped provide instream spawners to tributaries other than the ones on which the

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hatcheries are located. The release of hatchery fish in the lower estuary has enabled an intense ocean fishery to remain stable, concurrent with reduced natural salmon populations. However, since natural and hatchery salmon occur together in the ocean, commercial and sports fishing regulations on mixed stocks could result in over-harvesting of natural stocks. It is estimated that the commercial and recreational fishery in the ocean harvests 70 to 80 percent of the adult salmon that were destined to spawn in Central Valley streams.

Environmental requirements of salmon and steelhead adults migrating upstream include adequate temperature and dissolved oxygen levels, sufficient flows, and net downstream flow of home-stream water. Juvenile salmon migrating to the ocean also depend on adequate water temperature and dissolved oxygen. Net downstream flow in the Sacramento River and upper estuary is important for juvenile salmon migration.

Decision 1485 requirements to protect salmon consist of:

- flow to maintain adequate food supplies for juvenile out-migrating salmon;
- minimum flow for the Sacramento River at Rio Vista to facilitate upstream and downstream migration;
- closure of Delta Cross Channel gates from January 1 to April 15 when Delta outflows exceed 12,000 cubic feet per second. (Similar requirements for young striped bass extend this to May 31); and
- operating criteria for the SWP and CVP fish protective facilities.

Also, export limits for striped bass in May, June, and July reduce exposure of young salmon and steelhead to the screens. There are no San Joaquin River flow standards for smolt survival in Decision 1485.

Sacramento River. The Sacramento River once provided four strong seasonal runs of spawning Chinook salmon. All four runs have declined, with the late fall and spring runs decreasing to fairly stable levels of a few thousand adult spawners. The winter run, which showed a dramatic increase after Shasta Dam was built, has declined during recent years (from 40,000 to 2,000 spawners in the past 20 years) and may be in danger of disappearing entirely. In 1989, estimated winter run spawners numbered 550, which necessitated their inclusion in the State endangered wildlife list. Only the early fall run is still substantial, and its spawning numbers have also declined— from 425,000 (1959) to 185,000 (1987). Consistent with the salmon trends, steelhead spawning in the upper Sacramento River has dropped from an estimated 17,500 to 2,000 during the past 20 years.

Potential Factors Affecting Chinook Salmon Abundance

Toxics (from urban, industrial, mining, agricultural, and other sources)
- Treated waste
- Untreated waste
- Point runoff
- Non-point runoff

Entrainment
- State Water Project
- Central Valley Project
- Delta agriculture diversions
- Delta Cross Channel
- Upper Sacramento River agricultural diversions

Spawning Habitat
- Temperature and dissolved oxygen levels
- San Joaquin River flows
- Blockage of passage in upper Sacramento River
- Mining, logging, and agriculture activities in upper Sacramento River tributaries

Diversions in the south Delta by SWP and CVP, combined with flows through the Delta Cross Channel, increase the proportion of Sacramento River water present in the interior Delta. Also, south Delta diversions frequently cause reverse flows in the lower San Joaquin River during August through November, the period when most Sacramento River adult salmon and steelhead migrate upstream. Some of these fish use the lower San Joaquin River and Mokelumne River on their way upstream, returning to the Sacramento River through the Delta Cross Channel and Georgiana Slough. Altered flow patterns cause the migrating fish to stray and be delayed. This results in some fish not reaching the spawning grounds and others straying into areas unsuitable for spawning. The magnitude of these effects on the population as a whole is unknown.

The ability of Sacramento River juveniles to take the most direct route through the estuary is affected by flows diverted from the Sacramento River into the interior Delta through the Delta Cross Channel and Georgiana Slough. Study results suggest that mortality is 50 percent higher for fish entering the interior Delta than for fish remaining in the Sacramento River in the drier years. Smaller juvenile salmon (fry) migrating in January through March de-

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pend more on food produced in the estuary than do larger juveniles (smolts) migrating in spring. Fry use the estuary as nursery habitat, while smolts pass through rapidly.

San Joaquin River. Salmon runs in the San Joaquin River system have declined to less than a tenth of their abundance of 40 years ago. Upstream spawning and rearing habitat have been lost due to 1) mining, logging, and agricultural and urban activities in the watershed; 2) blockage of upstream areas by dams; and 3) water quality degradation caused by waste discharges and warmer water. The major change in the total San Joaquin Salmon run has been the elemination of the spring run by Friant Dam. The San Joaquin River system, in particular, also suffers from low flows in the mainstream and tributaries that restrict its suitability as salmon habitat.

In the Delta, local diversions and export pumps tend to entrain young salmon. Flows that support fall-run salmon in the San Joaquin River and its tributaries (Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers), particularly spring flows, may contribute to the number of juvenile salmon produced and the number of adults that return, although data on smolt survival are not adequate to establish a flow-survival relationship. Flow patterns in the Delta and the amount of water of San Joaquin River origin that is exported at SWP and CVP diversions in the south Delta also affect San Joaquin River salmon. Studies of tagged juvenile salmon indicate that the majority collected at SWP and CVP fish screen originate in the San Joaquin River.

Low dissolved oxygen levels occur during the fall of most years in the San Joaquin River near Stockton. This may delay and thus interfere with successful salmon migration. The low dissolved oxygen levels are associated with San Joaquin River flows, organic loading by the City of Stockton, and oxygen depeletion due to organic deposits. Although the City of Stockton has improved its sewage facilities, it is still a source of substantial organic loading in the fall.

Mitigation for this condition has included installation of a temporary barrier in Old River to create a downstream flow in the San Joaquin River past Stockton. DWR has done this every fall since 1963, except in a few years when San Joaquin River flows and dissolved oxygen levels were adequate for fish passage. Reclamation is also providing interim releases from New Melones Reservoir to provide additional downstream flow in the San Joaquin River.

Several SDWMP alternatives include a barrier on Old River at Head, which will increase downstream flow in the San Joaquin River. It is expected that this will help increase dissolved oxygen levels in the San Joaquin near Stockton during the fall, when levels are low. This would lessen the impacts to salmon migration.

South Delta exports affect adult San Joaquin River salmon by reducing the amount of San Joaquin River water in the west Delta. The proportion of San Joaquin River water in the Delta was low before project export pumping, and SWP and CVP operations have further decreased this proportion of flow.

The number of juvenile San Joaquin River salmon exposed to project fish screens during spring is related to the proportion of San Joaquin River inflows drawn through the upper end of Old River by the export facilities. This proportion varies considerably with San Joaquin River flows and, to a lesser extent, with export rates during spring, but in all years most San Joaquin River flow is drawn to the pumps. In drier years, all water from the San Joaquin River enters the head of Old River and water from this source not used for local irrigation is diverted by the SWP and CVP.

Impact of SDWMP. Tables 5-15 and 5-16 show monthly flows and ratios diverted from the Sacramento and San Joaquin rivers during months of high salmon abundance. A higher ratio indicates greater potential for displacement of salmon from normal migration routes. The San Joaquin River flow ratio can be very low for alternatives with barrier configuration B because these alternatives at times operated a full barrier on Old River at Head from April through July.

Table 5-17 summarizes seasonal Delta flows and relationships under alternative plans that could affect salmon and steelhead migration. This information, as well as that provided in Tables 5-15 and 5-16, are derived from monthly average flows from five water years chosen as representative of the five water year types. These five water years were selected from the 57-year study period from the operation studies described in Appendix C. The monthly average flows simulated were in the lower San Joaquin River, Georgiana Slough, the Delta Cross-Channel, and in Old River at Head. Ratios of flows diverted toward the export pumps from the San Joaquin and Sacramento rivers were calculated on the basis of model results derived from hydrodynamic modeling described in Appendix C.

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Table 5–16
Ratio of Old River Flows to San Joaquin River Flows
(Monthly average flows in cubic feet per second; 3.3 MAF SWP Demands)

Representative Critical Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No–Action	San Joaquin R.	2,710	3,101	2,908	1,776	942	1,768	1,991	1,672	1,121	966	918	1,413
No–Action	Old R. at Head	2,240	2,433	2,340	1,660	1,122	1,622	1,770	1,465	1,097	990	935	1,322
No–Action	Ratio	0.827	0.785	0.805	0.935	1.191	0.917	0.889	0.876	0.979	1.02	1.02	0.936
1	San Joaquin R.	2,710	3,101	2,908	1,776	942	1,768	1,991	1,690	1,122	966	919	1,413
1	Old R. at Head	2,166	2,401	2,235	1,545	949	1,457	0	0	0	0	789	1,170
1	Ratio	0.799	0.774	0.769	0.870	1.007	0.824	0.000	0.000	0.000	0	0.858	0.828
2	San Joaquin R.	2,710	3,101	2,908	1,776	942	1,767	1,991	1,690	1,121	966	919	1,413
2	Old R. at Head	1,878	2,401	2,235	1,545	747	1,231	1,319	1,120	750	586	569	925
2	Ratio	0.693	0.774	0.769	0.870	0.793	0.697	0.662	0.663	0.669	0.606	0.619	0.655
3	San Joaquin R.	2,710	3,101	2,908	1,776	941	1,767	1,990	1,688	1,120	965	918	1,411
3	Old R. at Head	1,795	2,312	2,173	1,497	675	1,186	1,289	1,075	705	606	555	898
3	Ratio	0.662	0.746	0.747	0.843	0.717	0.671	0.648	0.637	0.629	0.628	0.605	0.636
4	San Joaquin R.	2,710	3,101	2,908	1,776	941	1,766	1,990	1,687	1,119	965	917	1,410
4	Old R. at Head	1,900	2,398	2,240	1,555	764	1,246	1,333	1,125	754	629	588	935
4	Ratio	0.701	0.773	0.770	0.876	0.812	0.706	0.670	0.667	0.674	0.652	0.641	0.663

Representative Dry Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No–Action	San Joaquin R.	1,707	2,074	2,179	1,861	1,519	1,521	1,706	1,162	988	966	918	1,413
No–Action	Old R. at Head	1,603	1,893	1,902	1,776	1,560	1,558	1,615	1,097	980	912	809	1,142
No–Action	Ratio	0.939	0.913	0.873	0.954	1.027	1.024	0.947	0.944	0.992	0.944	0.881	0.806
1	San Joaquin R.	1,707	2,074	2,179	1,861	1,519	1,521	1,706	1,162	989	966	919	1,413
1	Old R. at Head	1,439	1,876	1,804	1,745	1,362	1,474	0	0	0	0	722	991
1	Ratio	0.843	0.905	0.828	0.938	0.897	0.969	0.000	0.000	0.000	0	0.786	0.701
2	San Joaquin R.	1,706	2,074	2,179	1,861	1,519	1,521	1,706	1,162	988	966	919	1,413
2	Old R. at Head	1,190	1,876	1,804	1,745	1,122	1,251	1,278	783	664	590	506	755
2	Ratio	0.698	0.905	0.828	0.938	0.739	0.822	0.749	0.674	0.672	0.611	0.551	0.534
3	San Joaquin R.	1,706	2,074	2,178	1,861	1,518	1,521	1,706	1,160	987	965	918	1,411
3	Old R. at Head	1,141	1,772	1,752	1,638	1,063	1,154	1,218	726	603	581	501	741
3	Ratio	0.669	0.854	0.804	0.880	0.700	0.759	0.714	0.626	0.611	0.602	0.546	0.525
4	San Joaquin R.	1,705	2,074	2,178	1,861	1,518	1,521	1,706	1,160	986	965	917	1,410
4	Old R. at Head	1,208	1,873	1,813	1,742	1,150	1,277	1,304	785	662	613	531	774
4	Ratio	0.709	0.903	0.832	0.936	0.758	0.840	0.764	0.677	0.671	0.635	0.579	0.549

[1]See footnotes on page 131.

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Table 5-16 (Continued)
Ratio of Old River Flows to San Joaquin River Flows
(Monthly average flows in cubic feet per second; 3.3 MAF SWP Demands)

Representative Below-Normal Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No-Action	San Joaquin R.	1,884	1,831	2,248	2,913	2,890	1,394	2,112	1,800	1,198	1,098	1,061	2,249
No-Action	Old R. at Head	1,783	1,744	1,995	2,315	2,333	1,363	1,861	1,552	1,173	1,211	1,051	1,878
No-Action	Ratio	0.946	0.952	0.887	0.795	0.807	0.978	0.881	0.862	0.979	1.10	0.991	0.835
1	San Joaquin R.	1,884	1,831	2,248	2,913	2,890	1,394	2,112	1,800	1,198	1,098	1,061	2,249
1	Old R. at Head	1,732	1,675	1,953	2,202	2,178	1,331	0	0	0	0	0.967	1,795
1	Ratio	0.919	0.915	0.869	0.756	0.754	0.955	0	0	0	0	0.911	0.798
2	San Joaquin R.	1,884	1,831	2,248	2,913	2,890	1,394	2,112	1,800	1,198	1,098	1,061	2,249
2	Old R. at Head	1,732	1,675	1,953	2,202	2,178	1,331	1,490	1,172	804	833	967	1,795
2	Ratio	0.919	0.915	0.869	0.756	0.754	0.955	0.705	0.651	0.671	0.759	0.911	0.798
3	San Joaquin R.	1,884	1,831	2,248	2,912	2,890	1,394	2,112	1,799	1,196	1,096	1,061	2,249
3	Old R. at Head	1,641	1,590	1,858	2,151	2,136	1,271	1,438	1,130	750	779	954	1,770
3	Ratio	0.871	0.868	0.827	0.739	0.739	0.912	0.681	0.628	0.627	0.711	0.899	0.787
4	San Joaquin R.	1,884	1,831	2,248	2,912	2,890	1,394	2,112	1,798	1,195	1,096	1,060	2,249
4	Old R. at Head	1,734	1,679	1,952	2,209	2,187	1,343	1,516	1,179	806	841	985	1,807
4	Ratio	0.920	0.917	0.868	0.759	0.757	0.963	0.718	0.656	0.674	0.767	0.929	0.803

Representative Above-Normal Year

Alternative[1]		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
No-Action	San Joaquin R.	2,597	3,128	2,962	2,000	6,939	3,073	2,263	642	675	1,199	1,014	2,016
No-Action	Old R. at Head	2,178	2,444	2,369	1,776	4,361	2,367	1,964	768	809	1,313	1,143	1,856
No-Action	Ratio	0.839	0.781	0.800	0.888	0.628	0.770	0.868	1.227	1.199	1.09	1.12	0.921
1	San Joaquin R.	2,597	3,128	2,962	2,000	6,939	3,073	2,263	644	675	1,199	1,024	2,016
1	Old R. at Head	2,166	2,420	2,265	1,680	4,293	2,297	1,871	0	0	0	959	1,763
1	Ratio	0.834	0.774	0.765	0.840	0.619	0.747	0.827	0	0	0	0.937	0.875
2	San Joaquin R.	2,597	3,128	2,962	2,000	6,939	3,073	2,263	644	675	1,198	1,024	2,016
2	Old R. at Head	2,166	2,420	2,265	1,680	4,293	2,297	1,871	437	471	861	959	1,763
2	Ratio	0.834	0.774	0.765	0.840	0.619	0.747	0.827	0.679	0.698	0.719	0.937	0.875
3	San Joaquin R.	2,597	3,128	2,961	1,999	6,939	3,072	2,263	642	674	1,197	1,023	2,016
3	Old R. at Head	2,067	2,329	2,203	1,634	4,268	2,267	1,821	369	403	817	941	1,699
3	Ratio	0.796	0.745	0.744	0.817	0.615	0.738	0.805	0.575	0.598	0.683	0.92	0.843
4	San Joaquin R.	2,597	3,128	2,961	1,999	6,939	3,072	2,263	642	673	1,196	1,021	2,016
4	Old R. at Head	2,162	2,417	2,269	1,689	4,297	2,310	1,880	432	466	870	974	1,771
4	Ratio	0.832	0.773	0.766	0.845	0.619	0.752	0.831	0.673	0.692	0.727	0.954	0.879

[1]See footnotes on page 131.

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Table 5–16 (Continued)
Ratio of Old River Flows to San Joaquin River Flows
(Monthly average flows in cubic feet per second; 3.3 MAF SWP Demands)

		Representative Wet Year											
Alternative[1]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
No–Action	San Joaquin R.	1,461	926	557	3,199	4,871	9,508	11,405	3,621	2,905	3,182	1,186	2,352
No–Action	Old R. at Head	1,125	895	865	2,508	3,294	5,770	6,863	2,527	2,088	2,316	1,192	1,971
No–Action	Ratio	0.770	0.967	1.553	0.784	0.676	0.607	0.602	0.698	0.719	0.728	1.01	0.838
1	San Joaquin R.	1,462	927	557	3,199	4,871	9,508	11,405	3,638	2,905	3,182	1,186	2,352
1	Old R. at Head	1,108	951	737	2,478	3,269	5,793	6,869	0	0	0	1,063	1,881
1	Ratio	0.758	1.026	1.323	0.775	0.671	0.609	0.602	0.000	0.000	0	0.896	0.80
2	San Joaquin R.	1,462	927	557	3,199	4,871	9,508	11,405	3,638	2,905	3,182	1,186	2,352
2	Old R. at Head	1,108	951	737	2,478	3,269	5,793	6,869	2,145	1,606	1,867	1,063	1,881
2	Ratio	0.758	1.026	1.323	0.775	0.671	0.609	0.602	0.590	0.552	0.587	0.896	0.80
3	San Joaquin R.	1,461	926	556	3,199	4,871	9,508	11,405	3,637	2,904	3,181	1,185	2,352
3	Old R. at Head	1,078	879	652	2,383	3,200	5,749	6,842	2,120	1,604	1,848	1,047	1,847
3	Ratio	0.738	0.949	1.173	0.745	0.657	0.605	0.600	0.583	0.552	0.581	0.884	0.786
4	San Joaquin R.	1,461	926	556	3,199	4,871	9,508	11,405	3,637	2,904	3,181	1,184	2,352
4	Old R. at Head	1,111	954	735	2,473	3,269	5,789	6,867	2,155	1,626	1,876	1,078	1,892
4	Ratio	0.760	1.030	1.322	0.773	0.671	0.609	0.602	0.593	0.560	0.59	0.911	0.804

[1]Old River flows in Alternative "Northern Intake, Barrier Configuration A reflect the operation of full tide barrier on Old River at Head to minimize the movement of salmon towards Banks Pumping Plant.

Note: Ratio can exceed 1.0 when Upper San Joaquin River experiences reverse flow.

Alternatives:
1 Northern Intake with Barrier Configuration A
2 Northern Intake with Barrier Configuration B
3 Preferred Alternative
4 Enlarged Forebay – Highway 4 Intake with Barrier Configuration B

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Table 5–17
Summary of Seasonal Delta Flows Affecting Salmon and Steelhead
(Monthly average flows in cubic feet per second; 3.3 MAF SWP Demands)

	Lower San Joaquin River Flows[1]		Upper San Joaquin River Flows[2]	Average Flow Ratios	
				Sacramento R.[3]	San Joaquin R.[4]
	Aug–Nov	May–Jul	Nov	Oct–Jun	Oct–Jun
Alternative			**Representative Critical Year**		
No–Action	699	–643	658	0.478	0.911
Northern Intake, Barrier Config. A	–215	–520	690	0.478	0.562
Northern Intake, Barrier Config. B	–227	–533	690	0.478	0.732
Preferred Alternative	–267	–635	778	0.479	0.700
Enlarged Forebay., Highway 4 Intake	–270	–665	693	0.478	0.739
			Representative Dry Year		
No–Action	438	805	173	0.433	0.958
Northern Intake, Barrier Config. A	–261	583	190	0.429	0.599
Northern Intake, Barrier Config. B	–272	571	190	0.429	0.780
Preferred Alternative	–346	491	294	0.430	0.735
Enlarged Forebay, Highway 4 Intake	–355	487	193	0.429	0.788
			Representative Below–Normal Year		
No–Action	–303	422	76	0.362	0.900
Northern Intake, Barrier Config. A	–770	637	145	0.360	0.575
Northern Intake, Barrier Config. B	–770	627	145	0.360	0.799
Preferred Alternative	–788	584	230	0.361	0.766
Enlarged Forebay, Highway 4 Intake	–798	559	141	0.360	0.804
			Representative Above–Normal Year		
No–Action	–95	1,455	674	0.309	0.889
Northern Intake, Barrier Config. A	–1,004	1,791	698	0.307	0.602
Northern Intake, Barrier Config. B	–1,004	1,779	698	0.307	0.754
Preferred Alternative	–1,005	1,731	790	0.307	0.715
Enlarged Forebay, Highway 4 Intake	–1,016	1,714	702	0.307	0.754
			Representative Wet Year		
No–Action	424	3,163	22	0.324	0.819
Northern Intake, Barrier Config. A	296	3,762	–34	0.319	0.641
Northern Intake, Barrier Config. B	296	3,750	–34	0.318	0.767
Preferred Alternative	253	3,627	37	0.319	0.733
Enlarged Forebay, Highway 4 Intake	248	3,606	–38	0.318	0.769

[1]San Joaquin River at Antioch. Negative sign indicates reverse flows.

[2]San Joaquin River below Old River. Negative sign indicates reverse flows.

[3]Cross–Delta flows are the sum of flows in Delta Cross Channel and Georgiana Slough. Flows in the Cross Channel reflect flow control operations and Decision 1485 constraints from January 1 to May 31 to minimize cross–Delta movement of salmon and diversion of young striped bass into Central Delta.

[4]Old River flows in Alternative "Northern Intake, Barrier Configuration A" reflect the operation of full tide barrier on Old River at Head to minimize the movement of salmon towards Banks Pumping Plant.

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Table 5–18
Estimated Mortality of Fall–Run Sacramento River Salmon Smolts Emigrating Through the Delta for the Five Representative Water Years

Alternative	CVP + SWP Exports (cfs)			Cross Delta Flow Ratio[1]			Mortality[2]			Season[3]
	April	May	June	April	May	June	April	May	June	
Representative Critical Year										
No–Action	8,371	5,659	5,497	0.477	0.516	0.517	0.744	0.796	0.876	0.812
Preferred	7,043	5,626	5,127	0.491	0.516	0.522	0.719	0.796	0.871	0.807
Difference	–1,328	–33	–370	——	——	——	–0.025	0.0	–0.005	–0.005
Representative Dry Year										
No–Action	8,775	5,203	5,161	0.458	0.477	0.480	0.746	0.780	0.866	0.801
Preferred	10,355	5,776	5,816	0.440	0.472	0.475	0.771	0.790	0.875	0.813
Difference	1,580	573	655	——	——	——	0.025	0.010	0.009	0.012
Representative Below–Normal Year										
No–Action	9,010	5,984	6,018	0.457	0.474	0.464	0.749	0.794	0.877	0.812
Preferred	10,103	5,984	6,018	0.449	0.479	0.468	0.769	0.796	0.878	0.817
Diference	1,093	0	0	——	——	——	0.020	0.002	0.001	0.005
Representative Above–Normal Year										
No–Action	9,582	5,984	6,018	0.188	0.172	0.384	0.614	0.710	0.866	0.742
Preferred	9,783	5,984	6,018	0.189	0.172	0.385	0.616	0.710	0.866	0.743
Difference	201	0	0	——	——	——	0.002	0.0	0.0	0.001
Representative Wet Year										
No–Action	7,665	5,984	3,479	0.164	0.201	0.423	0.585	0.718	0.838	0.734
Preferred	10,271	5,984	1,529	0.167	0.201	0.436	0.607	0.718	0.810	0.728
Difference	2,606	0	–1,950	——	——	——	0.022	0.0	–0.028	–0.006

[1]Ratio of sum of Delta Cross Channel and Georgiana Slough flows to Sacramento River flow.

[2]Water temperatures assumed for this table: April – 62° F, May – 65° F, June – 68° F. Negative value for difference indicates that smolt mortality decreases under the preferred alternative.

[3]Weighted average of April (15%), May (55%), and June (30%) mortality values based upon estimated percentage of smolts migrating through the Delta in each month.

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USF&WS has developed a Delta survival model for juvenile fall-run salmon from the Sacramento River drainage. This model relates survival of fall-run smolt emigrating from Sacramento to Chipps Island to Sacramento River temperature, diversion of Sacramento River flow into the central Delta, and SWP/CVP export level. Fall-run smolt survival appears to be very sensitive to Sacramento River water temperature. SDWMP should not affect Sacramento River water temperature.

Table 5-18 presents projected fall-run salmon smolt mortality [estimated using the USF&WS model] for the five representative water years for typical temperature conditions. These water temperatures are assumed to be the same under the no-action and preferred alternatives.

Possible impacts to winter-run salmon are discussed later in this chapter in the section, "Impacts on Rare, Threatened, and Endangered Species."

No-Action Alternative. With the existing facilities in the Delta, flow patterns would remain similar to those occurring today. Thus, current undesirable conditions for salmon and steelhead in the estuary would at best remain unchanged. Net August-through-November flows in the lower San Joaquin River are positive in the representative critical, dry, and wet years but may be negative for extended times within this four-month period. The average flow ratios from the San Joaquin River and Old River split are high and indicate possibly high juvenile salmon displacement towards the CVP and SWP pumps.

Table 5-18 indicates that under the no-action alternative, mortality of juvenile salmon emigrating from Sacramento to Chipps Island could range from 68.5 percent (April of representative wet year) to 87.7 percent (June of representative below-normal year).

Preferred Alternative. Under the preferred alternative, as in any of the alternatives to the no-action alternative, SWP pumping would tend to be higher than with the no-action alternative during October through April, and lower from May through August. Sacramento River flows would tend to increase as SWP pumping increased and decrease as SWP pumping decreased. Thus, the annual net Delta outflow with any of the alternatives, including the preferred alternative, would remain about the same or decrease slightly, depending on the water year type.

The substantial increases in SWP exports during the months when the peak of the upstream migration of fall-run adults occur (October through December) will not substantially affect distribution of Sacramento River water in the Delta, and thus should not further inhibit the upstream migration of adults through the Delta.

The change in Sacramento River inflow and SWP pumping from the no-action alternative to the preferred alternative would probably increase the incidence and severity of reverse flows in the lower San Joaquin River. This may cause some negative impacts to migrating salmon and steelhead. This could be corrected with North Delta Water Management facilities.

There would be very little change in the average ratios of Sacramento to cross-Delta flows, and salmon migration is not expected to be affected here. Table 5-18 indicates that under the preferred alternative, changes in mortality of salmon smolts from Sacramento River drainage would range from an increase of 2.5 percent (April of representative dry year) to a decrease of 2.5 percent (April of representative critical year). The estimated seasonal mortality for the five year types exceeded that for the no-action alternative by 0.1 percent.

The average ratios of Old River to San Joaquin River flows would decrease substantially. If the barrier on Old River at head is operated in the preferred alternative, these ratios would decrease to, or below, those listed under the Barrier Configuration A alternative.

Thus, the preferred alternative should substantially reduce the number of migrating salmon drawn towards the State and federal pumps via the upper San Joaquin River. Exposure of juvenile salmon to the fish screens would probably differ from the no-action alternative, although how it might vary is unclear. SWP exports would increase, thus drawing more salmon up Middle and Old Rivers to the pumps; however, fewer San Joaquin River salmon would be drawn to the pumps via Old River. It is thus also unclear whether more or fewer salmon would be entrained in the Delta.

It is expected that the changes in flow patterns discussed above and the improved circulation caused by the preferred alternative will improve dissolved oxygen, water temperatures, and nursery areas in south Delta channels.

Other Alternatives. The other SDWMP alternatives would probably affect salmon similarly to the effects of the preferred alternative. The Northern Intake with Barrier Configuration A, Northern Intake with Barrier Configuration B, and Enlarged Forebay with Highway 4 Intake alternatives would impact 1) lower San Joaquin River re-

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verse flows and 2) ratios of cross-Delta flows to Sacramento River flows similarly to the impacts of the preferred alternative.

SWP diversions and related salmon losses would be the same under the other alternatives as with the preferred alternative. The barrier-type facility at the head of Old River may be operated to protect migrating adult salmon on the San Joaquin River. Mortality of salmon smolts from Sacramento River drainage would be similar to that estimated for the preferred alternative.

General Impacts on Striped Bass

The striped bass, *Morone saxatilis*, was introduced to the Bay/Delta in the late 1800s, when a few hundred juvenile fish collected from the Navesink and Shrewsbury rivers in New Jersey were planted. By the 1890s the introduced fish had done so well that a commercial fishery had been established—hundreds were caught within the first 10 years. More than 1 million pounds were landed in California 20 years after the transplant, and from 1916 to 1935, the annual commercial catch ranged from 500,000 to 1 million pounds. Commercial fishing continued until 1935, when it was stopped to reduce salmon losses and to provide a better striped bass sports fishery. There has been a recent general decline in angler success, the direct result of a substantial decline in the adult striped bass population during the 1970s.

The SDWMP has the potential to impact the striped bass population in the Bay/Delta system. This section provides a general description of striped bass life history, current status of the population, a description of the factors thought to be controlling striped bass abundance, and an analysis of the impacts of the SDWMP.

Much of the detailed information regarding striped bass has been collected as part of a 1960s DFG/DWR cooperative study and an interagency (DWR, DFG, SWRCB, USGS, Reclamation, USF&WS) study (1971 to date) of the Bay/Delta. Striped bass are collected and abundance indices developed for various life stages from eggs through adults. Information is also collected on food supply, entrainment, and such environmental variables as the water's oxygen content, clarity, and salinity.

Life History. Unlike many East Coast populations, especially those from the Chesapeake Bay, California striped bass apparently spend most of their life cycle in the Bay/Delta and in the coastal ocean within a few miles of the Golden Gate. Striped bass have been caught as far south as Redondo Beach (Los Angeles County) and as far north as the State of Washington, indicating that some limited ocean migration has occurred. A small self-sustaining population was established in the Coos River in southern Oregon; however, their numbers have decreased dramatically in recent years.

During the fall, adult striped bass generally move into the Delta, where some overwinter and the remainder return to San Francisco Bay. In the spring, adults undergo a spawning migration to the lower San Joaquin River and the Sacramento River between Isleton and Butte City. The exact breakdown in percentage spawning in the two rivers is difficult to estimate; however, apparently more fish spawn in the Sacramento River than in the lower San Joaquin River.

For purposes of this analysis, adult bass are defined as those exceeding the minimum legal catchable size of 18 inches. About half of the bass reach this size at 3 years of age. Although some 3-year-old bass may be sexually mature, only bass 4 years and older contribute significantly to the spawn. The number of eggs per female (fecundity) varies directly with size and age and can range from a few hundred thousand for a young female to a few million for females older than 10 years.

Since spawning is regulated to a large degree by water temperature during the April-June period, the time of peak spawning varies from year to year and may show several peaks within a year. Spawning may also be limited by salinity; most spawning occurs at salt concentrations of less than 200 mg/l total dissolved solids (TDS).

The female broadcasts the eggs into the water, and after fertilization the developing embryos drift with the current. At this life stage the larvae are small (3-5 mm) and depend on food originally available in the egg. Mortality from all sources during this period is very high, at times in excess of 50 percent per day. The larvae begin to feed at the 5-7 mm stage (about 10 days to 2 weeks after fertilization). Survival at this time depends on whether the larvae are transported to an area where food of the right size and concentration is available. Larval bass initially depend on small crustaceans (part of the zooplankton) for food. As the bass grow, they are able to capture larger zooplankton, such as the mysid shrimp (*Neomysis* mercedes) and later small fish.

By the end of July, the juvenile bass have grown to the 30-40 mm size range and are found mostly in the Delta, Suisun Bay, and Montezuma Slough (in Suisun Marsh).

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Potential Factors Affecting Striped Bass Abundance

Food Supply
- Lower algal levels
- Change in algal bloom species
- Introduction of non-native invertebrates
- Lower levels of important native invertebrates

Egg Supply
- Lower numbers of fish
- Lower numbers of older fertile females

Adult Mortality
- Natural (including old age, disease, poaching, and toxics)
- Fishing

Toxics (from urban, industrial, mining, agricultural, and other sources)
- Treated waste
- Untreated waste
- Point runoff
- Non-point runoff

Entrainment
- State Water Project
- Central Valley Project
- Delta agriculture diversions
- Pacific Gas and Electric Company
- Delta Cross Channel

Outflow and Diversion Rates

Most of the young bass remain in the upper estuary (San Pablo Bay through the Delta) during their first two years of life.

Environmental Concerns. Water management in the Delta presents several problems to the survival and maintenance of the striped bass resource. These problems may be related to:

1. ***Using Delta channels as conduits to transport water from the Sacramento River across the Delta to the export pumps of Reclamation and DWR.*** The Delta is an important spawning and nursery area, but water project operations cause the net direction of flow to reverse from the norm in west and south Delta channels. In addition, the Delta Cross Channel diverts water into the Central Delta. Striped bass eggs, larvae, larger young, and their food organisms can become entrained in these reverse flows and, thus diverted from their normal migratory paths and nursery. In addition, water project operations may increase flow velocities in the major transport channels, reducing water residence times and perhaps the production of invertebrates, which young bass eat.

2. ***Entrainment of young fish and their food supplies in the SWP and CVP diversions and agricultural and industrial diversions.*** Striped bass eggs, larvae and juveniles are removed from the Delta channels and Suisun Bay through various diversions. These young striped bass are lost to local agricultural diversions when Delta islands are irrigated or flooded for leaching. They are lost at Antioch and Pittsburg, where Delta water is pumped for PG&E powerplant cooling systems.

   Some young striped bass are pulled into the forebay, where predation, fish screens, handling, and hauling may cause losses. Other young striped bass are pumped into the SWP and CVP water transport systems, where they support a striped bass population in both San Luis Reservoir and the California Aqueduct. In each case, the young striped bass entrained are considered total losses to the potential Delta striped bass population.

3. ***The amount of outflow present to transport young fish away from water diversions in the Delta and to maintain the striped bass nursery and the entrapment zone in Suisun Bay, where it is most productive.*** Striped bass eggs and larvae, drifting with the current in the lower Sacramento and San Joaquin rivers depend on the downstream movement of water to transport them to Suisun Bay, where conditions may be suitable for their growth and survival. The same moderately high outflows necessary to transport young bass downstream may also enhance production of their food organisms by keeping the entrapment zone in Suisun Bay.

4. ***Salinity intrusion.*** Striped bass require water that is fresh or only slightly saline in which to spawn. In the Delta, spawning occurs mainly in the San Joaquin River from Antioch to Venice Island. Salinities in that reach are lowest just downstream from the mouth of the Mokelumne River. Here fresh water from the Mokelumne and Sacramento systems dilutes the water from the upper San Joaquin River, which is saltier because of agricultural return flows. Farther west, the river gradually becomes more saline due to the intrusion of ocean water.

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Bass apparently react to this salinity regime while on their spawning migration. They generally do not migrate up the San Joaquin River beyond the point where salinity exceeds 350 mg/l TDS (550 electrical conductivity [EC]). In relatively dry years, this salinity blockage occurs a few miles upstream from Venice Island. Typically, spawning occurs between Antioch Point and Venice Island, where TDS is less than 200 mg/l (310 EC), but water that fresh is not essential for egg survival. Laboratory studies have indicated that salinities up to 1,000 mg/l TDS (1560 EC) do not affect egg survival.

Whereas salinity up to 1,000 mg/l TDS apparently does not increase egg mortality and has, at most, a limited short-term effect on the location of spawning, the long-term effect of salinities above 200 mg/l TDS is uncertain. Striped bass have a pronounced tendency to return to the same spawning area each year and occasional less-than-optimum salinity conditions may not deter this migration.

SWRCB Decision 1485 salinity standards protect striped bass spawning in the west Delta. The spawning standards (salinities and minimum Delta outflows) are effective April 1 through May 5; the survival standards (minimum Delta outflows) are effective May 6 through July 31. These standards have a relaxation provision when the projects impose deficiencies in firm supplies. These deficiencies occur when, due to a water supply shortage, water users are denied the full amount of water that they would otherwise be entitled.

Status of the Stock. Indices of striped bass abundance have been obtained at the egg and larval stage, at 38 mm, during the fall and early winter of their first year of life, and as adults on their annual spawning migration. The period of record for the four indices is variable, with the longest period of record being for the 38 mm index (also called the townet index), the fall index (also called the mid-water trawl index), and adult population size and age distribution. The discussion of trends in abundance focuses on these three indices.

The townet index is designed to represent the number of striped bass in the upper estuary when the average size of the juveniles collected is 38 mm. Sampling limitations such as the use of less than 100 percent efficient nets, patchiness, and annual fluctuation in spatial distribution are severe enough to prevent the calculation of absolute numbers of juvenile striped bass. Nevertheless, the townet index provides a good relative measure of survival of each year class to 38 mm. In extremely wet years, such as 1983, the index is probably biased low since flows may wash the small bass downstream of the sampling area.

The townet index has varied from a low of about 4 in 1988 to a high of about 117 in 1965 (Figure 5-11). The 1976-77 drought seems to be a break-point in the curve, with the pre-1977 index averaging about 67 and the post-1977 index (through 1989) averaging about 22. Since the drought, only 1986 resulted in a year-class comparable to those in

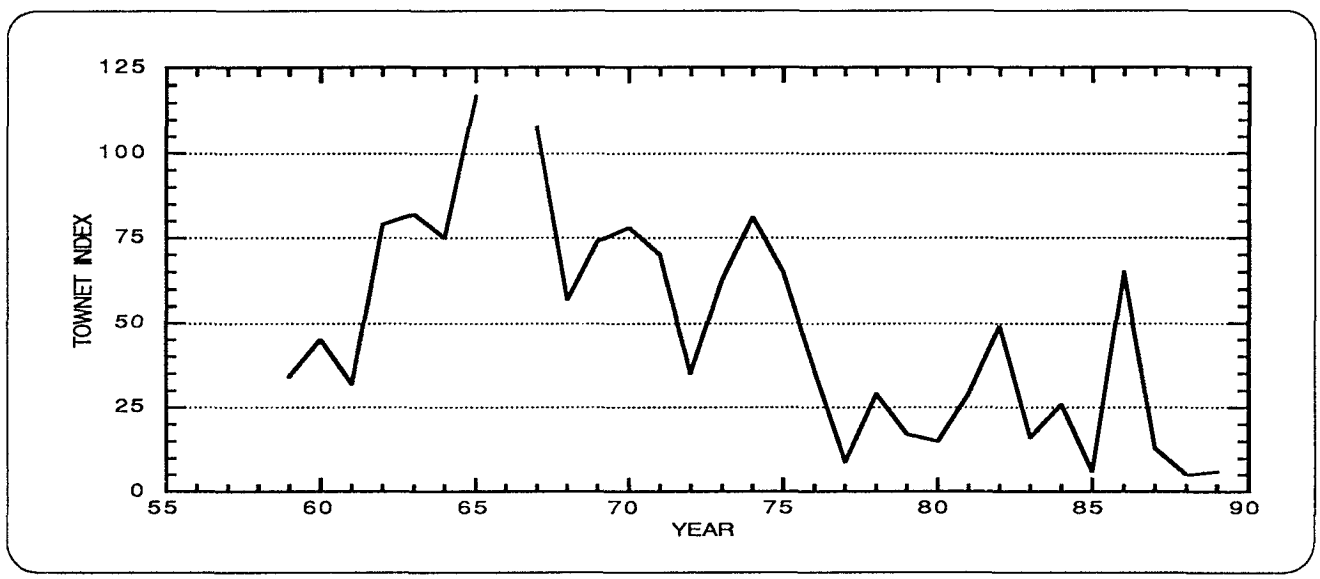

Figure 5-11. Striped Bass Summer Townet Index, 1959-1989

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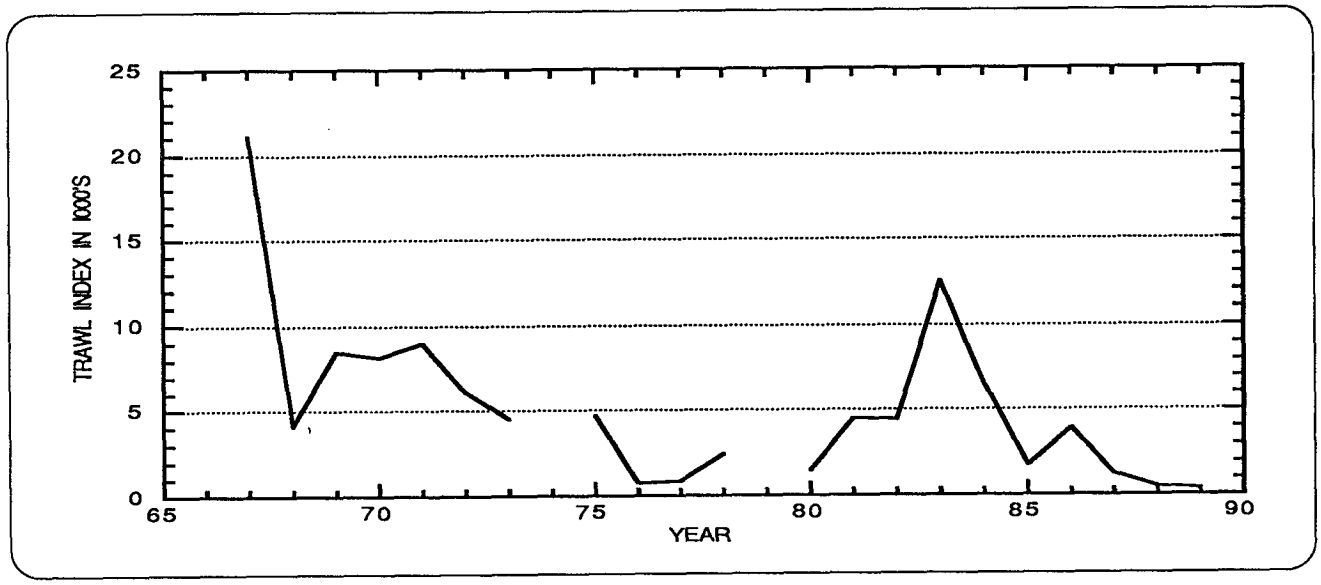

Figure 5-12. Fall Total Mid-water Trawl Striped Bass Index, 1967-1989

the 1960s and early 1970s. These data demonstrate that the number of juvenile striped bass has been much lower during the past decade than before the 1976-77 drought.

The total fall mid-water trawl indices from 1967 through 1989 are plotted in Figure 5-12. Individual indices are determined for the months of September, October, November, and December; however, only the total index is plotted. This index cannot be numerically compared with the townet survey index since the collection and computational methods are different. Although numerically larger, the fall index represents fewer fish due to substantial mortality between summer and fall surveys. The fall index is more erratic than the townet; however, after 1977 the index has been about half of what it was before the drought.

Another index of striped bass abundance is obtained as the adult bass migrate up the Sacramento and San Joaquin rivers on their spawning runs. Adult fish are captured by nets and traps, and tags are applied to fish of legal size. Also, age of the fish is determined by analyzing growth rings on their scales. Through creel census and subsequent tagging operations, some tagged fish are recovered. By use of computations involving the number of tags applied, the number recovered, and the ages of the tagged fish (plus several assumptions), an annual age-specific estimate of the adult population size is obtained. Because of sampling problems (especially related to low numbers of tags applied to older fish), these estimates have fairly large margins of error.

As shown in Figure 5-13, the adult striped bass population was relatively stable at about 1.5 to 2 million fish from 1969 through 1976. In 1977 the population appeared to drop precipitously to about 1 million fish and again has remained fairly stable. Given the wide variability before and after 1976, it is impossible to determine if there was actual year-to-year variation in numbers of fish. There is no doubt, however, that there have been significantly fewer adult fish since 1977 than there were in the early 1970s.

Factors Controlling Stock Size. In 1987, several agencies submitted evidence to the SWRCB concerning the striped bass decline and factors that may control their distribution and abundance at different life stages in the Bay/Delta.

Important points are listed below:

- *Delta Outflow and Diversions.* Prior to 1977, a regression equation developed by DFG explained most of the annual variation in the summer townet index. In this equation, outflow at Chipps Island during May and June explained most of the variability, with diversions accounting for an additional percentage. Figure 5-14 contains a plot of the measured abundance index and the index predicted by the regression.

  After 1976 (with the exception of 1986), the regression equation consistently overestimates the number of young yearling striped bass (Figure 5-14). (The 1983 year class should not be considered in this comparison, because high spring flows washed fish out of the sampling area.)

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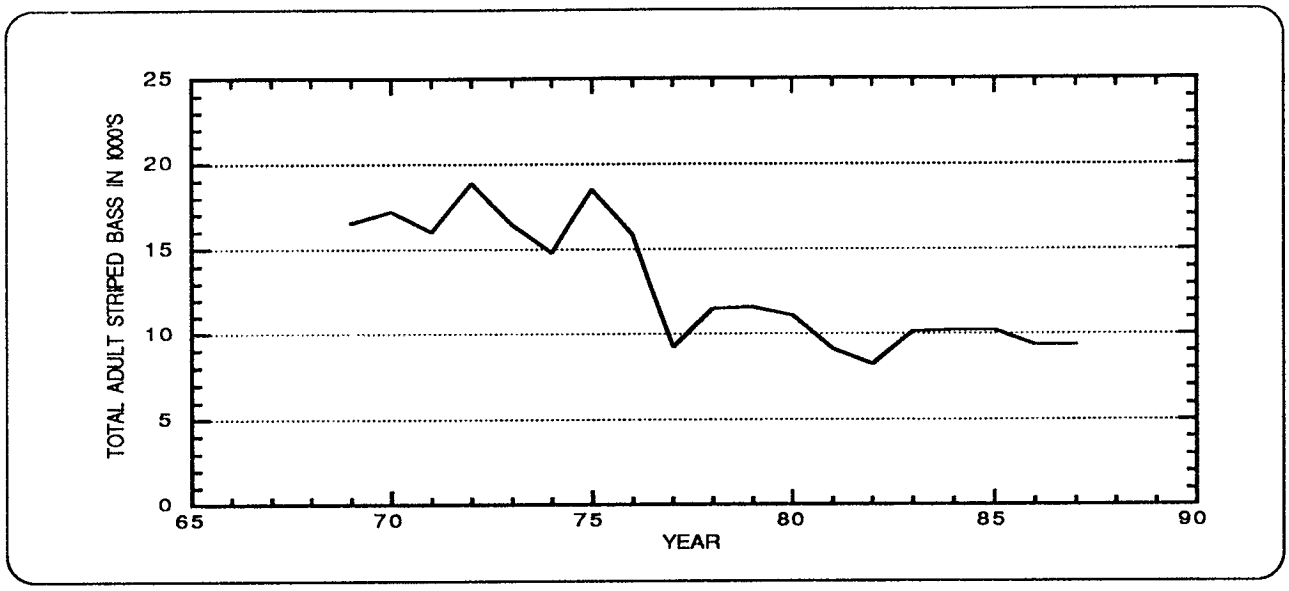

Figure 5-13. Total Number of Adult Striped Bass 1969-1989 as Estimated by the Peterson Mark-Recapture Method

The data indicate that some fundamental change in system productivity may have occurred after the 1976-77 drought because flows and diversion rates similar to those before the drought do not result in as many fish.

- *Food Supply.* One possible explanation for recent low production of juvenile striped bass is that there may be less total food or less high-quality food available for the larval and juvenile bass. This hypothesis is supported in part by the following general observations:

(1) Since 1976, there has often been lower algal standing crop in such striped bass nursery areas as Suisun Bay and the central, west, and south Delta. However, as yet there has been no relationship demonstrated between the algal standing crop and striped bass year-class strength.

(2) Since 1976 many of the Delta phytoplankton blooms have been dominated by a chain diatom, *Melosira granulata*, which may not be as available for use in the striped bass food web as previously dominant

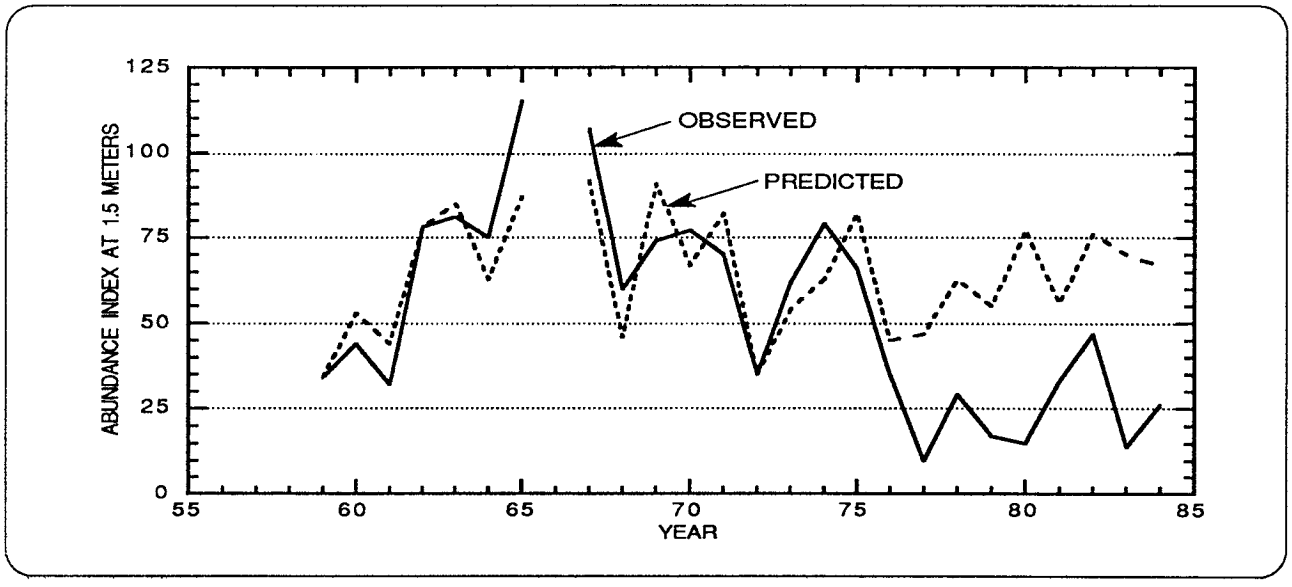

Figure 5-14. Observed and Predicted Indices of Striped Bass Abundance at 1.5 Meters, 1959-1984

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algal species. However, there is no strong evidence to show that increased *Melosira* abundance has restricted the food supply available to young striped bass.

(3) Several introduced species of invertebrates have recently become established in the Bay/Delta, which have either displaced other animals common in the diet of young striped bass or which may be competing with them for food. Two foremost examples of these accidental introductions, both from Asia, are a copepod, *Sinocalanus*, and a clam, *Potamocorbula. Sinocalanus* has apparently largely displaced (out-competed) a native copepod *Eurytemora*, which was extensively fed upon by larval striped bass (Figure 5-15).

Laboratory studies have shown that *Sinocalanus* is better able to avoid capture by young bass than Eurytemora. The small clam, *Potamocorbula,* was first observed in 1987 and appears to be dominating the bottom-dwelling community in San Pablo Bay, Suisun Bay, and the west Delta. This clam is an effective filter feeder and may be removing significant amounts of algae and zooplankton from the water column.

During the drought, USGS hypothesized that observed low algae and zooplankton in Suisun Bay and the west Delta was due to grazing by other clams, *Mya arenaria* and *Macoma bathica,* which temporarily invaded Suisun Bay and the west Delta due to increased seawater intrusion. *Potamocorbula* is tolerant of a wider salinity range and could become a permanent member of the benthic community, with long-term effects on production of pelagic fish, such as striped bass, in the system.

(4) Since the 1976-77 drought, *Neomysis*, a key food organism for striped bass (and other Bay/Delta carnivorous fish) has been found at consistently low population levels (Figure 5-16).

In summary, there is some evidence indicating that food supply may be limiting survival of larval and juvenile striped bass. However, there is no direct evidence that such limitations have actually affected the ability of striped bass to survive during their first few weeks. The Interagency Ecological Studies Program has initiated studies that use such measures as daily growth rate, body measurements (morphometrics), and tissue development (histology) to assess the condition of young striped bass in the Sacramento-San Joaquin estuary.

Preliminary results indicate that selected measures of morphology and histology of wild striped bass larvae do not significantly differ from well-fed hatchery striped bass. This indicates that the captured striped bass were apparently well fed in 1988. However, starved bass may have died and were not available to be captured in the field program. A wider variety of sites were completed in 1989; however, the data are not yet available.

DFG reported that there is some evidence that adult striped bass from the estuary are not food limited, or

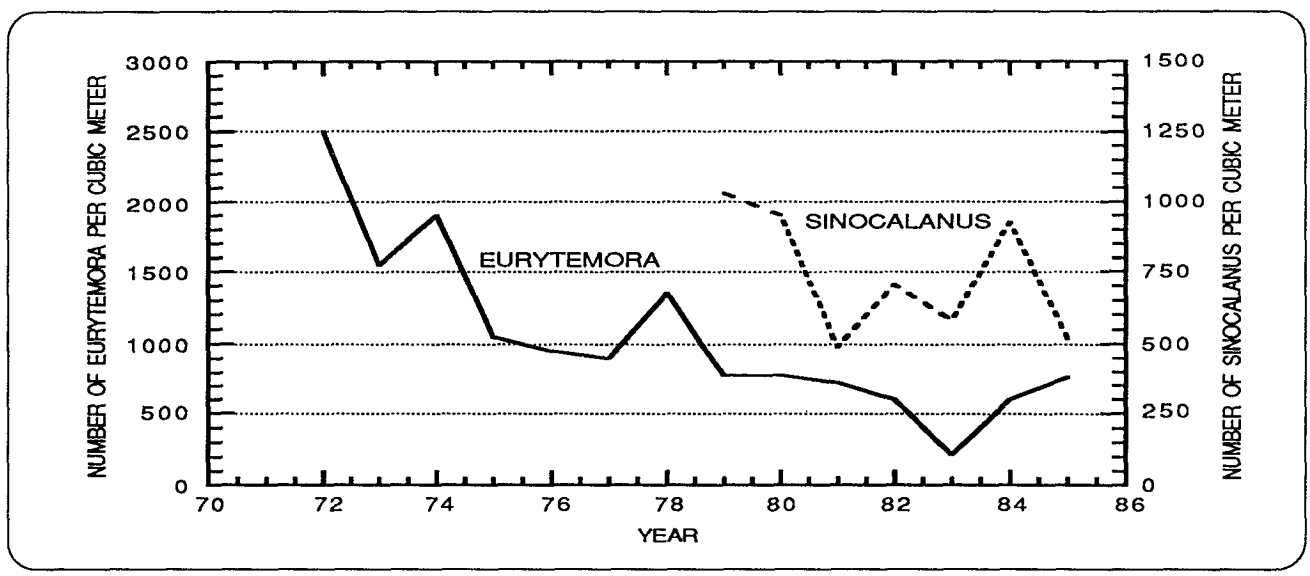

Figure 5-15. Densities of Eurytemora and Sinocalanus, All Areas, 1972-1985 (Adopted from DFG, 1987)

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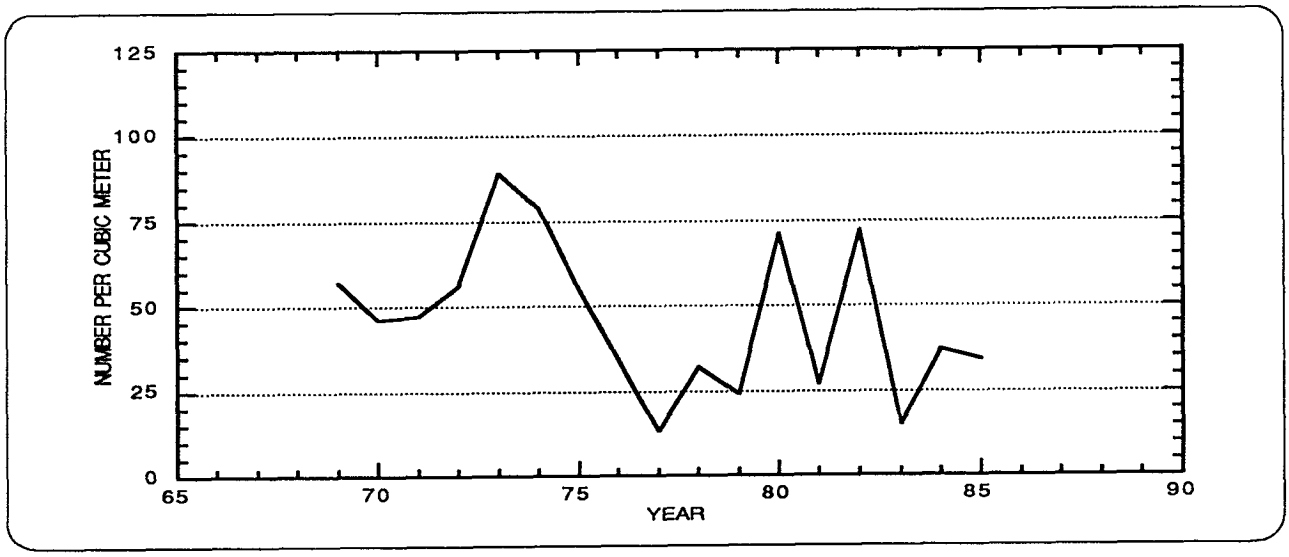

Figure 5-16. Mean March–November *Neomysis* Abundance from western Suisun Bay to Rio Vista on the Sacramento River, and to the mouth of Old River on the San Joaquin River, 1969–1985. Adopted from DFG 1987b

at least that the adults captured do not exhibit symptoms associated with insufficient food.

- *Egg Supply.* One explanation for low indices of juvenile abundance since the 1976–77 drought has been the lack of eggs to "saturate" the environment. According to this theory, when conditions are optimum, good year classes are produced because egg supply is not limiting. In a system with less than optimum environmental conditions and high larval mortality, a larger egg supply is needed to ensure that enough juveniles remain after the period of high initial mortality to produce a good year class. The egg limitation hypothesis is supported by the lower adult population abundance since the drought and the sharply reduced numbers of older, highly fecund, females in the population. Because of these two factors, the present egg supply is probably less than one-third of that found in the early 1970s.

  That the present striped bass population can produce a relatively strong year class was demonstrated in 1986. The 1986 townet index was about 65, the best since the drought and similar to those produced before the drought with the same general environmental conditions. This good year class was in spite of the fact that there was no apparent change in numbers of spawners in 1986.

- *Adult Mortality.* Adult mortality is assumed to occur after striped bass reach legal size and may be characterized as fishing and natural mortality. Natural mortality includes those adult fish dying from old age, disease, poaching, and toxics. Fishing mortality is due to legal take by anglers. The total annual mortality of adult striped bass in the Bay/Delta system has shown an upward trend from 1969 through 1984 (Figure 5-17). This upward trend is due to higher mortality of those fish 5 years and older (Figure 5-17), with mortality of 3- and 4-year-old fish being relatively stable at about 50 percent.

  Although total annual mortality exhibited an upward trend, the expected similar trend in either natural mortality or legal take did not occur (Figure 5-18). DFG believes that the striped bass populations should be able to sustain the 15 to 30 percent harvest rate found in the Sacramento-San Joaquin system.

  Although overall fishing mortality is relatively low compared to values for other populations such as in Chesapeake Bay, there has been a decrease in the average age of Bay/Delta striped bass population. One result of decrease in average age is that the population now contains a significantly lower percentage of older females (7 years old and older) than it did in the early 1970s. Fish 7 years and older averaged 13 percent during the 1969 through 1976 period, compared to an average of 5 percent in the 1977 through 1987 period. As mentioned earlier, the older larger females carry relatively more eggs than younger ones. Thus, the combined effect of lower overall population, plus the decrease in older females, is to cause a greater loss of egg

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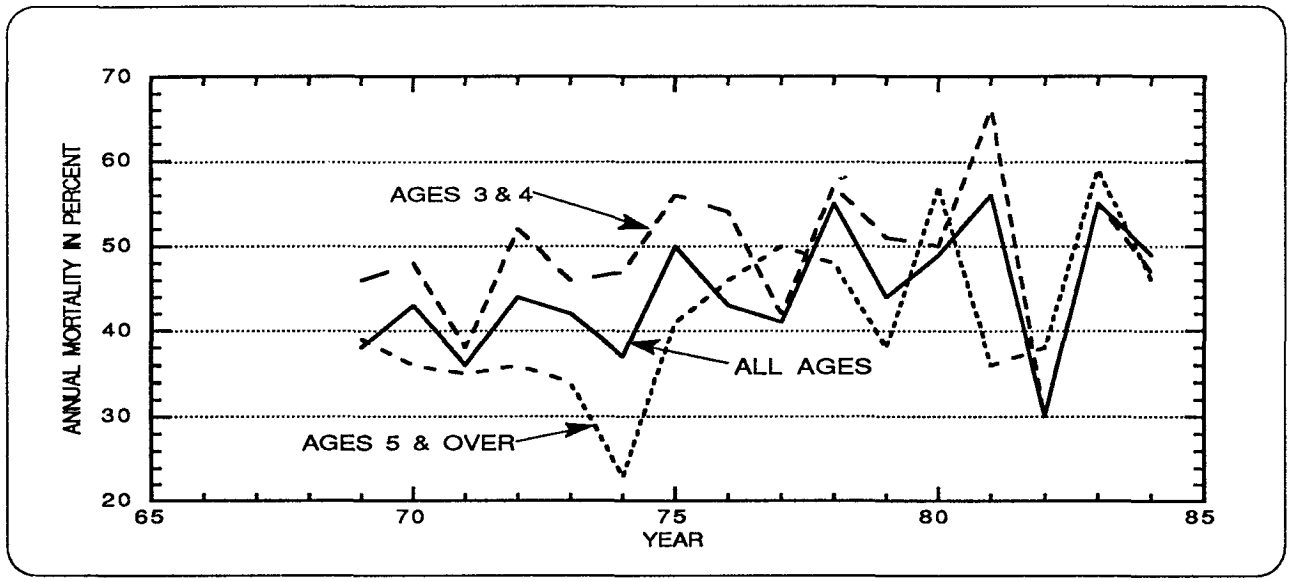

Figure 5-17. Estimates of Total Annual Mortality Rates for Striped Bass in the Sacramento-San Joaquin Estuary from 1969-1984

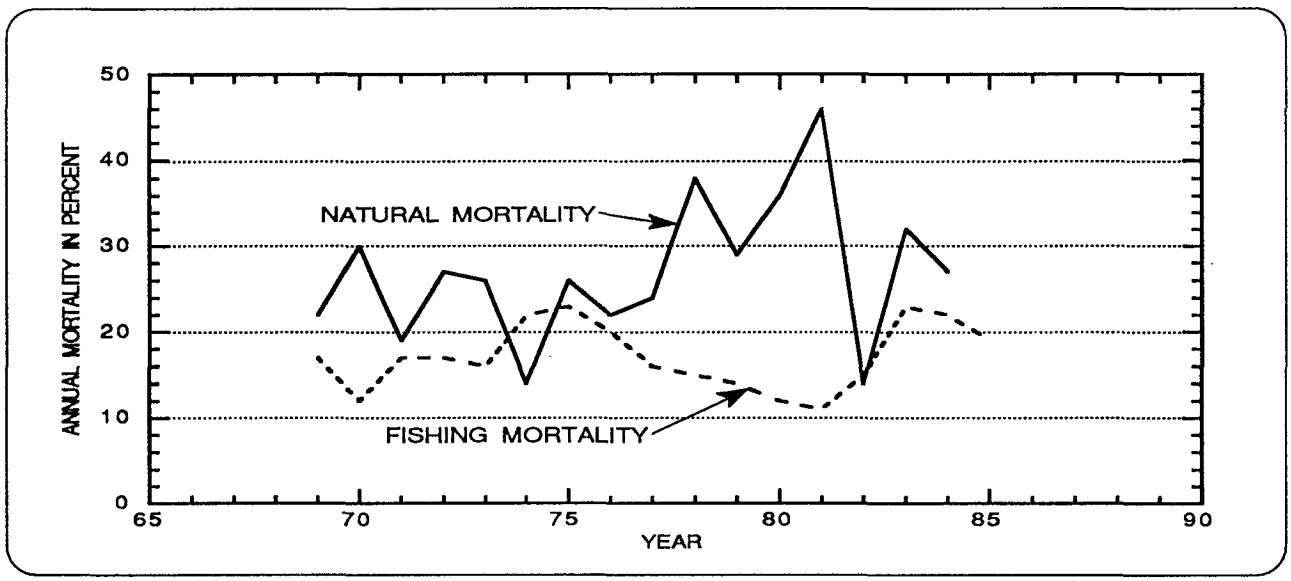

Figure 5-18. Estimates of Fishing and Natural Mortality Rates for Striped Bass in the Sacramento-San Joaquin Estuary from 1969-1984

production capacity than would be indicated by population numbers alone.

- *Toxics*. The Bay/Delta and its surrounding watershed receive treated and untreated waste water and point and nonpoint runoff from urban areas, mines, and agricultural lands. These waters often contain materials such as trace metals, pesticides, and organic materials that can potentially adversely affect the survival of striped bass and their food organisms.

Studies by the National Marine Fisheries Service (NMFS) conducted in the late 1970s and early 1980s

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indicated that striped bass in this estuary exhibited symptoms typical of those induced by pollutants. These symptoms included high egg resorption rates and the presence of extensive parasite infections. Adult striped bass from the Bay/Delta were generally found to be in poorer health than fish of similar age and sex collected in Oregon, Lake Mead, or the East Coast. Unfortunately, changes of program priority within NMFS resulted in their research being terminated before the necessary cause-effect studies were completed.

A Citizens for a Better Environment report *Toxic Hot Spots in San Francisco Bay,* August 1987, identified 39 toxic hot spots where toxic chemicals have reached threatening levels in the sediments, shellfish, ducks and waters of the San Francisco Bay estuary. The report states:

> ". . .The toxic hot spots pose serious, poorly controlled risks to aquatic life and human health, and are adversely affecting the beneficial uses of Bay waters. Pollutants such as pesticides, petrochemicals, PCBs, selenium, mercury and other toxic heavy metals exceed available environmental health effects criteria or standards at the identified toxic hot spots. At some sites, toxic pollutants have bioaccumulated in edible shellfish to levels amongst the highest detected in any estuary in the world. At some sites, the toxicity of Bay sediments to aquatic organisms has been demonstrated by laboratory tests, and field studies have documented localized biological degradation."

The report went on to recommend that fresh water diversions be evaluated and modified to reduce the potential for toxic hot spots to increase, especially in the South Bay. DWR believes that any dependency on outflow to control toxics is not only ineffective but also of questionable legitimate beneficial use. High flows do dilute pollutants in the Bay. However, minimum summer flows, with or without fresh water diversions dilute pollutants in San Francisco Bay very little. Low flows continue for a long enough period in most years for an equilibrium to be established between pollutant concentrations and dilution due to tidal action. Adequate quality at that equilibrium depends on sufficient waste treatment, not on fresh water flow levels. The South Bay in particular is hydraulically isolated from flows, to control pollution during much of the year. San Francisco Bay receives large inputs of ocean water (approximately 2.1 million cfs during flood tide).

DFG, with technical assistance from NMFS and financial support from the SWRCB, has carried on a limited version of adult striped bass "health" monitoring. The present monitoring consists of collecting 40 adult prespawning females from the Sacramento and San Joaquin Rivers (20 each) and analyzing them for a variety of chemical residues and measurements of egg resorption, parasite infestation, length, and weight. In their 1987 progress report, DFG staff concluded:

(1) The health of the Bay/Delta striped bass population is being impacted by toxics.

(2) Egg resorption rates may still be at levels that adversely impact egg production.

(3) Research to date has not been able to draw strong direct relationships between specific pollutants and striped bass health.

(4) The health monitoring program should be thoroughly reviewed and restructured so that it will more effectively index striped bass health and lead on to cause-effect relationships.

(5) The report also recommended that only limited field sampling and analysis be conducted in 1989 so that time would be available for program review. DFG has assembled a panel of outside experts to help in this review.

The Central Valley Regional Water Quality Control Board has recently released results of toxicity bioassays which indicate that the Colusa Basin Drain and other agricultural and municipal drains may be discharging materials to the Sacramento and San Joaquin rivers that makes them acutely toxic to striped bass and fathead minnow larvae, an invertebrate (*Ceriodaphnia*), and algae.

Although the extent to which toxic substances may contribute to the continued decline of striped bass has not been determined, there is reason for general concern in this area.

- ***Spawning Habitat.*** There is no evidence that spawning habitats have been damaged. SWRCB standards have sufficiently protected them.
- ***Larval Survival Rates.*** The rate at which striped bass survive their first few months is critical to subsequent juvenile bass abundance. Larval bass survival varies greatly from year to year. Years that have produced the least fish have also had extremely low survival of larvae. The cause is not yet known.

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- *Entrainment.* The Sacramento–San Joaquin Delta, the lower San Joaquin River, and Suisun Bay have numerous diversions that can entrain striped bass eggs, larvae, and juveniles. Following are the major diversions causing entrainment losses, along with a brief description of any fish protection facilities, and where possible, some idea of the actual numbers lost.

(1) State Water Project. SWP presently diverts up to about 6,400 cfs of water from the south Delta near the town of Byron. Extensive fish protective facilities have been constructed to minimize fish losses. Figure 5–19 is a plot of the total numbers of striped bass collected at the Skinner Fish Facility during 1968 through 1989. These screens are not effective for striped bass less than about 20 mm long; in 1985, 1986, 1987, 1988 and 1989, separate surveys were made to estimate losses at these stages. At the SWP intake, estimated losses of striped bass eggs and larvae less than 20 mm long (converted to yearling equivalents) were:

1985 – 68,488

1986 – 37,109

1987 – 43,846

1988 – 59,625

1989 – 56,309

The analysis of direct impacts, discussed later in Chapter 5 under "Direct Impacts of the Delta Complex on Striped Bass, Including Eggs and Larvae," includes a more detailed description of the losses at the intake to Banks Pumping Plant and a description of the agreement to offset the impacts.

SWP recently began diverting about 120 cfs out of Barker Slough in the north Delta. This diversion was not in effect during the period of decline. State-of-the-art fish screens (wedge wire with 5/32-inch openings) were installed to protect juvenile striped bass and other fish. Surveys have shown that very few striped bass eggs and larvae are found in this area.

(2) CVP intake near Tracy. The CVP has the capacity to divert up to 4,600 cfs from the south Delta. The screening system is similar to that used by SWP except that the primary system is one long louver instead of a series of bays. Striped bass salvage for 1968–1988 is shown in Figure 5–20.

(3) Contra Costa Canal. The Contra Costa Canal diverts an average of about 200 cfs through an unscreened intake near Rock Slough. DFG estimated that as many as 5 million young-of-the-year striped bass were entrained in the Contra Costa Canal during 1972 and 1973.

(4) Delta Agricultural Diversions. There are approximately 1,800 small agricultural diversions, which take about 3,000 to 4,000 cfs of water from Delta channels during spring and early summer, when striped bass eggs and larvae are most vulnerable to entrainment. None of these diversions is screened or otherwise operated to prevent or minimize entrainment.

Although reliable numbers of striped bass lost to the Delta agricultural diversions are difficult to obtain,

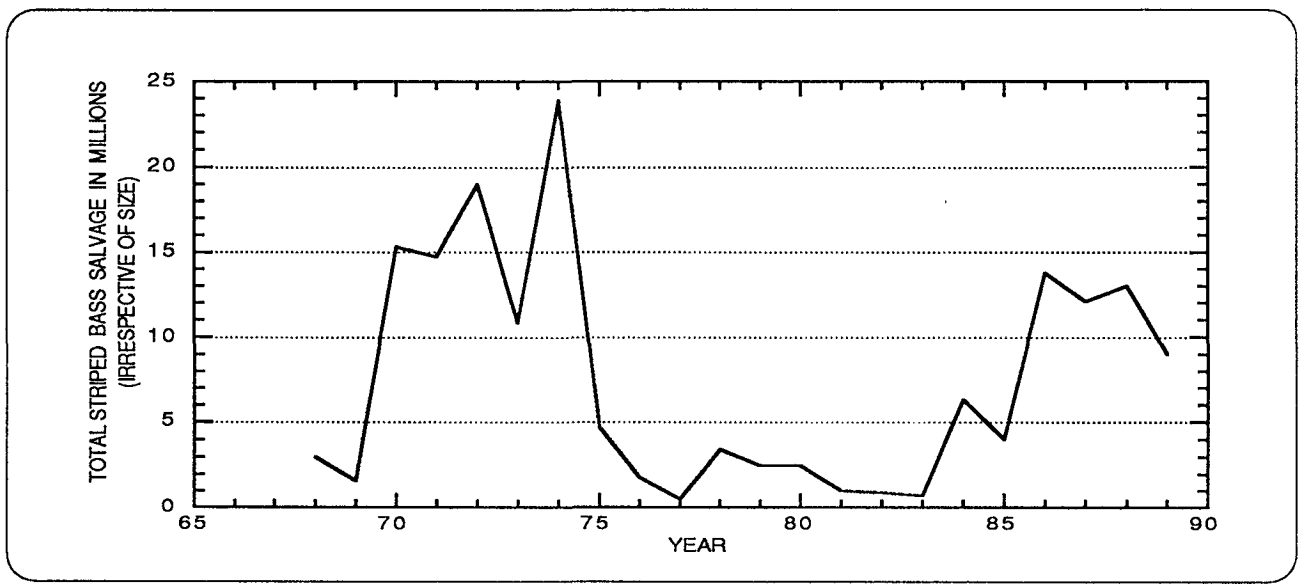

Figure 5–19. Striped Bass Salvage at the Delta Intake to the SWP, 1968–1989

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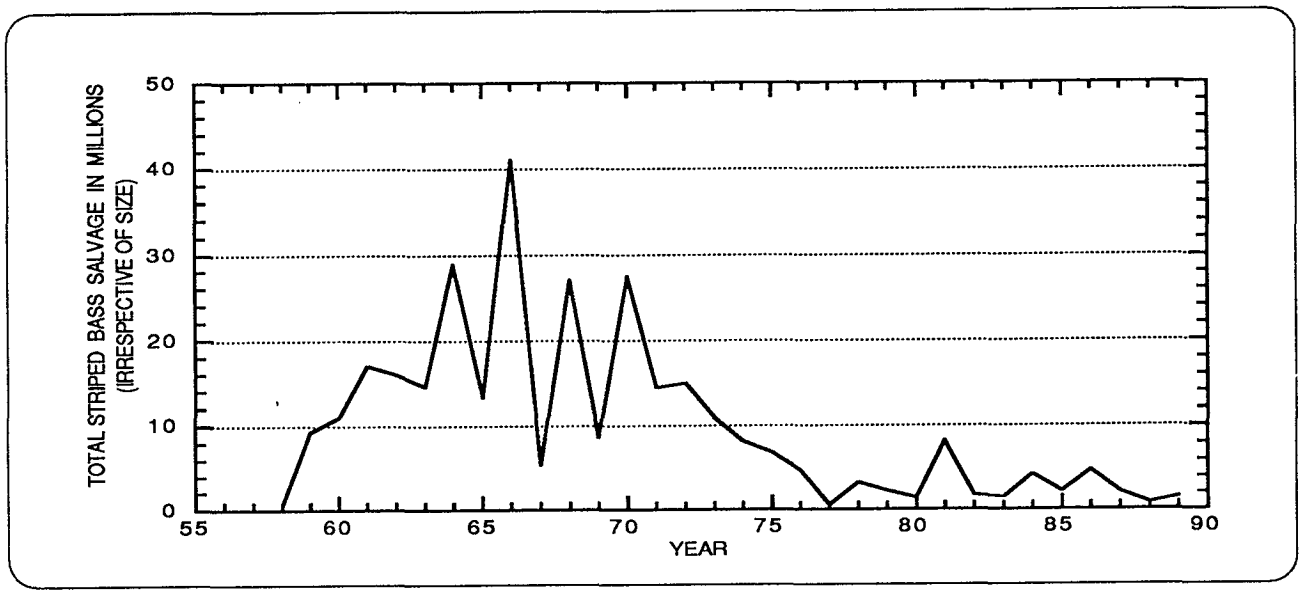

Figure 5–20. Striped Bass Salvage at the South Delta Intake to the CVP, 1958–1989

DWR estimated that 1978 and 1979 egg and larval losses to such diversions were about 600 million per year, or about the same order of magnitude as those lost to SWP and CVP diversions.

(5) Pacific Gas and Electric (PG&E). PG&E operates two power plants (Antioch and Pittsburg) which divert cooling water from the striped bass nursery area. Juvenile striped bass entrained in these intakes can be killed due to temperature changes. Between March 1978 and March 1979, it was estimated that about 144 million striped bass were entrained and killed by the Pittsburg Power Plant. Fewer striped bass were lost through the Contra Costa Power Plant. Recent changes in operation plus lower striped bass abundance have apparently reduced these losses considerably.

(6) Miscellaneous Other Diversions. In addition to diversions for Delta agriculture, water is diverted at numerous locations in and below striped bass spawning areas in the Sacramento and lower San Joaquin rivers for agricultural, municipal, and industrial uses. There has been no analysis of the numbers of striped bass lost to these diversions. In 1990, DFG will initiate a major study of unscreened diversions in the Central Valley, with particular reference to salmonid. Information in this study may also be relevant to striped bass.

(7) Delta Cross Channel and Georgiana Slough. Although not a diversion in the typical sense, the diversion of water from the Sacramento River to the interior Delta via the Delta Cross Channel and Georgiana Slough has the potential to adversely impact striped bass. This conclusion comes from analyses showing that in recent years the Delta has become a less hospitable nursery area for young striped bass. It appears that projects resulting in more eggs and larvae drawn to the Delta could adversely impact year-class strength.

As is apparent from the preceding discussion, hundreds of millions of juvenile striped bass are lost annually to diversions from the Sacramento River, the Delta, and Suisun Bay. The impact of these losses on adult population numbers is difficult to determine. Because striped bass are prolific spawners, the species has evolved in a manner that allows for over 99 percent mortality between eggs and adults while still maintaining a level population.

Some mechanism is probably present to maintain adult population stability in spite of variations in year class strength since there is an apparent lack of correlation between the 38 mm index and subsequent abundance of 4 year olds from the same year class (Figure 5–21). This differentiation between juvenile and adult abundance is also demonstrated by the indices themselves; i.e., the 38 mm index varied about tenfold (from 117 to 9) during 1965 through 1983, whereas the population of 4 year olds only varied by a factor of 3 (from about 600,000 to 200,000).

The above discussion does not mean that juvenile production is unimportant to adult striped bass abundance. DFG believes that entrainment losses are hav-

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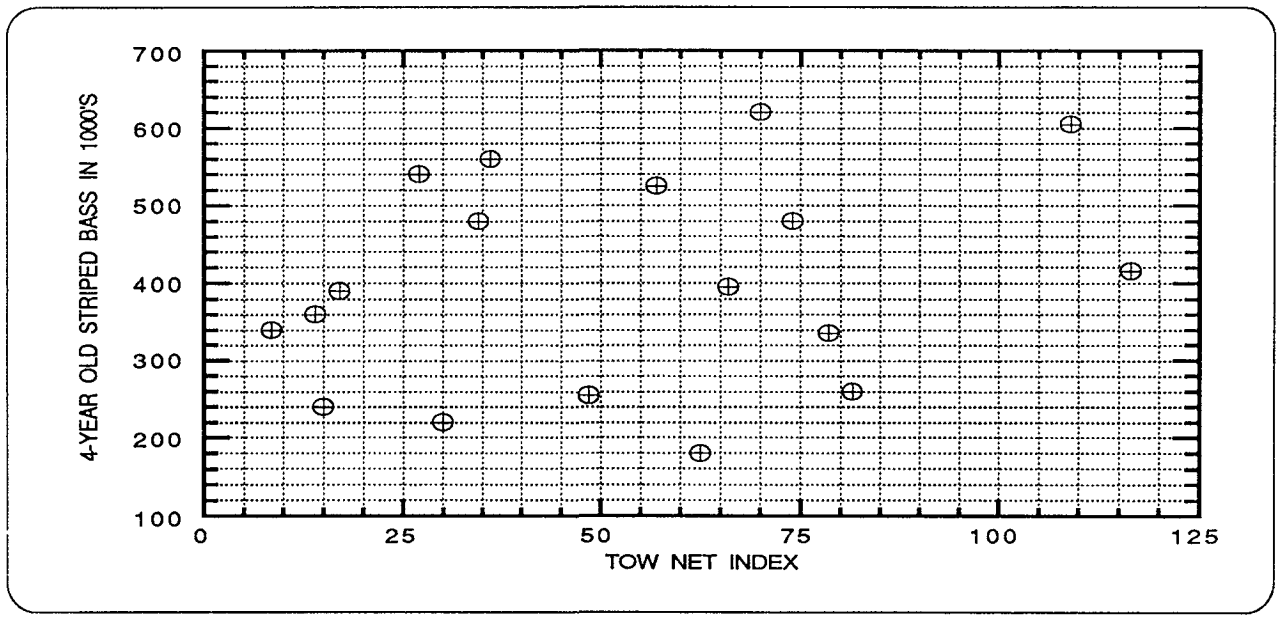

Figure 5-21. Townet Index vs Subsequent Number of 4-year-old Adult Striped Bass

ing an impact on egg production through cumulative effects on the numbers of adults.

Impacts of SDWMP. Uncertainties about factors affecting striped bass complicate analysis of the striped bass impacts associated with the change of export pumping and Delta flow and salinity patterns caused by the SDWMP alternatives. Impacts on the food supply for young striped bass cannot be analyzed completely because information and understanding are lacking.

Important factors that could be quantified and that were considered in the analysis of general impacts on young striped bass survival and abundance under the SDWMP alternatives are:

1. *Salinities (TDS) in the west Delta during spawning (April and May).* High salinities could be detrimental to spawning and egg survival. The D-1485 water quality standards to protect striped bass spawning call for specific conductance not to exceed 0.550 mmhos during April 1 to May 5 at Prisoner's Point on the San Joaquin River. This standard equates to approximately 350 mg/l total dissolved solids (TDS).

Table 5-19 summarizes monthly average salinities at Antioch and Prisoner's Point in the San Joaquin River for the five water years chosen out of the 57-year study period to be representative of each water year classification.

2. *Flows in the lower San Joaquin River during May, June, and July.* Reverse flows in the lower San Joaquin River can adversely affect striped bass by pulling eggs, larvae, and juveniles from the Sacramento River and Suisun Bay toward the Delta. Once in the Delta, these life stages are subject to increased diversion by local agricultural intakes and by the State and federal pumps.

Table 5-20 summarizes projected seasonal flows in the San Joaquin River at Antioch under the SDWMP alternatives. The two periods shown are May through July and August through November. The May through July period is most critical for the larval and early juvenile stages. During August through November, young-of-the-year are still subject to entrainment and reverse flows can contribute to increased entrainment losses.

3. *Delta outflow and SWP exports in May, June, and July.* During May, June, and July, striped bass eggs, larvae,

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Table 5-19
Mean Monthly Salinities in Lower San Joaquin River During Striped Bass Spawning
For the Five Representative Water Years
(Values in milligrams per liter of total dissolved solids)
[3.3 MAF SWP Demands]

San Joaquin River at Antioch

	Critical		Dry		Below Normal		Above Normal		Wet	
Alternative	April	May	April	May	April	May	April	May	April	May
NA	3,041	3,158	1,680	1,250	399	823	110	107	124	119
1	2,705	3,025	1,457	1,156	426	837	111	107	117	117
2	2,282	2,460	1,238	907	385	695	111	107	117	116
3	2,246	2,439	1,211	885	377	679	110	107	117	116
4	2,280	2,466	1,250	910	384	693	111	107	117	112
5	2,737	3,066	1,464	1,166	426	839	111	107	117	117
6	2,295	2,491	1,214	888	378	695	111	107	117	116
7	2,210	2,412	1,193	865	374	672	111	107	117	116
8	2,296	2,492	1,232	893	385	695	111	107	117	116

San Joaquin River at Prisoners Point

	Critical		Dry		Below Normal		Above Normal		Wet	
Alternative	April	May	April	May	April	May	April	May	April	May
NA	180	155	131	115	104	106	101	100	153	113
1	160	146	144	118	104	110	101	101	146	119
2	142	131	131	113	104	106	101	100	146	112
3	140	130	131	112	104	106	101	100	145	112
4	141	131	133	113	104	106	101	100	146	117
5	161	146	145	118	105	110	101	101	147	119
6	142	131	130	112	104	106	101	100	147	113
7	140	130	130	112	104	107	101	100	145	112
8	142	131	131	112	104	106	101	100	147	112

Alternatives:

NA No-action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Preferred
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with North Victoria Intake, Barrier Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barrier Config. B, CVP tie-in

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Table 5–20
Mean Monthly Flows in Lower San Joaquin River[1]
Affecting Striped Bass Spawning
For the Five Representative Water Years
(Values in cubic feet per second)
[3.3 MAF SWP Demands]

	Critical		Dry		Below Normal		Above Normal		Wet	
Alternative	Aug–Nov	May–Jul	Aug–Nov	May–Jul	Aug–Nov	May–Jul	Aug–Nov	May–Jul	Aug–Nov	May–Jul
NA	699	–643	438	805	–303	422	–95	1,455	424	3,163
1	–215	–520	–261	583	–770	637	–1,004	1,791	296	3,762
2	–227	–533	–272	571	–770	627	–1,004	1,779	296	3,750
3	–267	–635	–346	491	–788	584	–1,005	1,731	253	3,627
4	–270	–665	–355	487	–798	559	–1,016	1,714	248	3,606

[1]San Joaquin River at Antioch. Negative sign indicates reverse flows.

Alternatives:
NA No-action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Preferred
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

Note: These alternatives are without CVP tie-in. Adding CVP tie-in does not significantly change the results.

and juveniles are probably most vulnerable to envitronmental stresses.

Table 5–21 summarizes May, June, and July Banks Pumping Plant diversions and April–July Delta outflow by Decision 1485 water year types over the 57-year study period for the no-action alternative (Operation Study 340B) and the other SDWMP alternatives (Operation Study 327B).

4. Flows through the Delta Cross Channel and Georgiana Slough during May and June. There is some evidence that actions causing more bass to reach the central Delta can adversely affect the production of juvenile striped bass. During the past several years the central Delta has become a less hospitable nursery area for young striped bass. For example, during 1960 through 1965, the Delta contributed an average of about 60 percent of the juvenile striped bass index. Twenty years later, from 1980 through 1985, the average contribution by the Delta stations had dropped to less than 30 percent. It is not clear why the central Delta no longer produces as many juvenile bass as before.

Table 5–22 shows the monthly average May through July ratios of cross-Delta flows to Sacramento River flows (Delta Cross Channel and Georgiana Slough flows divided by Sacramento River flows) during the five representative water years.

There is disagreement whether changes in these conditions will significantly affect the numbers of adult striped bass in the Bay/Delta; however, these conditions are the ones most often included on lists of important factors for striped bass abundance. Where possible, the analysis includes information bearing on potential impacts of changes in Delta conditions on adult numbers. This analysis is limited to the impact of SDWMP. Possible cumulative impacts of other projects are described in Chapter 6.

Several SDWMP alternatives have been described in early sections of this report. The following discussion of potential environmental impacts on striped bass focuses on

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Table 5–21
Banks Delta Pumping Plant Diversions and
Delta Outflow During Periods of Striped Bass Abundance
(Monthly average flows in cubic feet per second over 57–year study period)
[3.3 MAF SWP Demands]

	Banks Pumping Plant			Delta Outflow			
Alternative[1]	May	June	July	April	May	June	July
Critical Year							
No–Action	2,598	2,187	1,639	5,521	4,639	3,935	4,379
Preferred	2,057	2,241	1,110	5,357	4,639	4,019	4,056
Other	2,057	2,241	1,110	5,357	4,639	4,019	4,056
Dry Year							
No–Action	2,666	2,173	1,280	8,250	7,579	6,262	4,972
Preferred	2,696	2,143	1,042	8,062	7,579	6,262	4,860
Other	2,696	2,143	1,042	8,062	7,579	6,262	4,860
Below Normal Year							
No–Action	2,992	2,884	3,118	9,114	9,685	8,433	6,411
Preferred	2,703	2,524	2,724	8,784	9,685	8,433	6,204
Other	2,703	2,524	2,724	8,784	9,685	8,433	6,204
Above Normal Year							
No–Action	2,992	2,953	3,536	23,012	16,423	11,503	8,088
Preferred	2,893	2,736	2,864	20,817	16,421	11,502	7,821
Other	2,893	2,736	2,864	20,817	16,421	11,502	7,821
Wet Year							
No–Action	2,992	2,975	3,741	44,873	30,923	20,555	9,797
Preferred	2,960	2,324	2,243	44,067	30,924	20,555	9,749
Other	2,960	2,324	2,243	44,067	30,924	20,555	9,749

[1]The No–Action alternative represents Operation Study 340B, the Preferred and Other alternatives represents Operation Study 327B (KWB, LBG, south Delta improvements, and SWP diversions of up to 10,300 cfs).

"Other" alternatives represents all of the SDWMP alternatives other than the preferred and no–action alternatives.

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Table 5–22
Ratio of Cross Delta Flow[1] to Sacramento River Flow
For Months of High Young Striped Bass Abundance
For the Five Representative Water Years
(3.3 MAF SWP Demands)

	Critical			Dry			Below Normal			Above Normal			Wet		
Alternative	May	Jun	Jul	May	Jun	Jul	May	Jun	Jul	May	Jun	Jul	May	Jun	Jul
NA	0.52	0.52	0.49	0.48	0.48	0.49	0.47	0.46	0.45	0.17	0.38	0.42	0.20	0.42	0.45
1	0.52	0.52	0.51	0.47	0.47	0.49	0.48	0.47	0.46	0.17	0.39	0.45	0.20	0.44	0.46
2	0.52	0.52	0.51	0.47	0.47	0.49	0.48	0.47	0.46	0.17	0.39	0.45	0.20	0.44	0.46
3	0.52	0.52	0.51	0.47	0.47	0.49	0.48	0.47	0.46	0.17	0.39	0.45	0.20	0.44	0.46
4	0.52	0.52	0.51	0.47	0.47	0.49	0.48	0.47	0.46	0.17	0.39	0.45	0.20	0.44	0.46

[1]Cross–Delta flows are the sum of flows in Delta Cross Channel Georgiana Slough. Low ratios in May of Above Normal and Wet Years reflect closure of Delta Cross–Channel according to Decision 1485 constraints to minimize cross–Delta movement of salmon and diversion of young striped bass into central Delta.

Alternatives:
NA No-action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Preferred
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

Note: These alternatives are without CVP tie–in. Adding CVP tie–in does not significantly change the results.

how the preferred and other alternatives compare to the no–action alternative. No new fish screens are included in the preferred alternative or other alternatives in the analysis, and the operation of the Forebay is relatively unchanged from the present. A more complete description of the preferred alternative is found in Chapter 3. All impact assessments for the preferred alternative and other alternatives, except entrainment losses, include projected water diversions for Los Banos and Kern Water Bank.

All alternatives benefit from the December 1986 "Agreement Between the Department of Water Resources and the Department of Fish and Game to Offset Direct Fish Losses in Relation to the Harvey O. Banks Delta Pumping Plant." This agreement, described in Chapter 1, provides for money, ecological studies, and operational changes to offset losses to fish.

No–Action Alternative. Engineering studies indicate that under the no–action alternative, striped bass spawning standards would be met in all years. In the Sacramento River, salinities are maintained during critical years by project reservoir releases. Striped bass in the Sacramento River spawn upstream of the salinity interface.

The lack of consensus regarding delineation of an entrapment zone precludes the use of Delta outflow values and surface salinity estimates to determine the location of the entrapment zone for the no–action alternative. It would presumably be the most beneficial to young bass if the entrapment zone consistently occurred within Suisun Bay during May through July; however, it is unknown how often this will occur.

Preferred Alternative. The preferred alternative would generally improve conditions for striped bass during spawning and during periods of young striped bass abundance, as summarized in Table 5–23.

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Table 5-23
Preferred Alternative Benefits for Striped Bass
(Compared to the No-Action Alternative)

No. of Striped Bass Yearling Equivalent	Reverse Flow	Water Quality for Spawning	Delta Outflow	SWP Exports	Delta Cross Channel Flow
22% reductiion in fish losses; average annual saving of 156,261 fish, based on years 1980 through 1987 (see Table 5-26)	No significant change; May-June = less reverse flow; Aug-Nov = greater reverse flow.	10% improvement for April-May.	No significant change for April, May June, July	14% reduction over May-July period.	No significant change for May, June, July.

Table 5-19 indicates that under the preferred alternative, Decision 1485 standards for striped bass spawning at Prisoners Point would be met for all years. The preferred alternative would substantially improve water quality at Antioch in the representative critical year and dry years. It is therefore anticipated that the preferred alternative would benefit striped bass spawning in critical and dry years, and cause little or no impact in other water-year types.

Table 5-20 shows that under the preferred alternative, flows in the lower San Joaquin River from May through July would tend to be somewhat higher than for the no-action alternative. Reverse flows in the representative critical year during this period would still occur and at about the same magnitude. However, during August through November, the preferred alternative would cause increased reverse flows in all water-year types. The preferred alternative thus would have some benefits in the vital spring to early summer months, but would probably lead to increased movement of young striped bass into the central Delta during August through November. It is expected that the improved lower San Joaquin River flows during May through July would cause a net decrease in movement of young striped bass into the central Delta since their abundance is highest during this period.

Table 5-21 indicates that under the preferred alternative, projected SWP pumping during May through July would either remain essentially unchanged or be reduced. The largest reductions would occur in July of each of the five representative years. It is thus anticipated that the preferred alternative can be beneficial and will have no significant adverse general impact due to SWP diversions as compared to the no-action alternative. Direct striped bass losses are further discussed later in this chapter under "Direct Impact of the Delta Complex on Striped Bass, Including Eggs and Larvae."

Table 5-21 also contains projected April through June Delta outflows past Chipps Island. Delta outflows during this period would not be significantly changed under the preferred alternative; therefore, the location of the entrapment zone probably would not change.

Table 5-22 indicates that the preferred alternative would not significantly change the amount or proportion of water leaving the Sacramento River via Georgiana Slough and the Delta Cross Channel. It is not anticipated that the preferred alternative would cause any significant adverse impacts to striped bass attributable to increased diversion into the central Delta.

The preferred alternative, as well as the other alternatives, has the advantage over the no-action alternative in that pumping directly out of Italian Slough would be possible. Pumping out of Italian Slough avoids losses to fish from predation in Clifton Court Forebay.

Other Alternatives. The other alternatives—Northern Intake with Barrier Configuration A, Northern Intake with Barrier Configuration B, the Enlarged Forebay-Highway 4 Intake with Barrier Configuration B (all with and without CVP tie-in), and the Enlarged Forebay-North Victoria Intake with Barrier Configuration B and CVP tie-in—would improve conditions affecting bass spawning and the abundance of bass similar to the preferred alternative. The other alternatives assume the same SWP diversions and Delta outflows as would occur under the preferred alternative and engineering studies show that similar salinities in the west Delta would result.

Salinities in the west Delta during spawning would improve as in the preferred alternative, except for the alternatives Northern Intake with Barrier Configuration A - with and without a CVP tie-in, which show a more modest reduction in salinity (Table 5-19). Under the other alter-

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natives, young bass entrainment into the interior Delta would probably decrease from May through July but then increase from August through November. It is expected that the improved lower San Joaquin River flows during May through July would cause a net decrease in entrainment of young striped bass similar to that caused by the preferred alternative.

General Impacts on American Shad

American shad were first introduced into the Sacramento-San Joaquin River System in 1871, when the system was still largely in its native state. The initial plant of about 10,000 young-of-the-year was followed by additional plantings, totaling 819,000 young fish from 1873 to 1881.

The American shad population exploded and soon supported a major commercial gill net fishery in the estuary during the spawning runs. American shad were sold in San Francisco markets by 1879. Catches regularly exceeded 1 million pounds from 1900 to 1945; about 5.6 million pounds were taken in 1917. After 1945 the fishery diminished, and in 1957 it was terminated by legislation due to public concern about the impact of the gill nets on striped bass.

Shad are anadromous, living primarily in the Bay and ocean as adults but using fresh water for spawning and nursery grounds. Historically, shad spawned throughout Delta fresh waters and upstream into both the Sacramento and San Joaquin rivers, but spawning has declined in the San Joaquin system, leaving the north Delta and Sacramento system upstream from Hood as the primary spawning areas.

River flow may affect the distribution of American shad on their initial spawning runs in the Sacramento River system. The percentage of the runs formed by virgins in the American, Yuba, and mainstream Sacramento rivers tends to increase with the contribution of a stream to the flow immediately downstream from its confluence with adjacent river branches. The Feather River may not exhibit this tendency because of a longer residence period for young fish in the Feather River, allowing them to become imprinted for homing on their maiden returns.

The shad fishery is affected by the distribution of adult fish. Hence, low spring flows in the most accessible tributaries, the American, Feather, and Yuba rivers, not only reduce their shad runs, but also angling opportunities.

Most repeat spawners in the Sacramento River system probably home to the tributary where they have spawned previously. Sampling of American shad eggs with nets set in the Feather River indicates that spawning occurs predominantly from May to July at temperatures of 63° to 75° Fahrenheit.

In wet years, young shad are less likely to use the Sacramento River and more likely to use the north Delta than in dry years. This difference probably reflects the transport of young fish by river flow and suggests that annual-flow differences cause the precise location of major concentrations of fish to vary.

Food habits of juvenile American shad in California are not well known. *Neomysis*, copepods, larval fish and *Corophium* sp. are probably the primary food preferences.

Abundance of young American shad in the Sacramento-San Joaquin estuary varies annually by more than an order of magnitude, and the strongest year classes occur in the years with the highest river flows during the spawning and nursery period. Flows during April—June appear to be most important in explaining year-to-year variation in abundance. Table 5-24 provides the estimated average monthly Delta outflows from January through June for the no-action, preferred, and other alternatives.

Young American shad are vulnerable to diversion by the State and federal pumping plants in the south Delta. Juvenile shad spawned in the south Delta and Mokelumne River channels would be drawn to the pumps as larvae and newly metamorphosed small fish, whereas Sacramento system juveniles tend to be drawn through the Delta Cross Channel and across the Delta during their downstream migration. From 1968 through 1985, American shad have been the third most common fish at the SWP screen, with annual recoveries as high as 3 million. In 1967, CVP recoveries exceeded 8 million.

No-Action Alternative. Under the no-action alternative, it is expected that American shad populations will be similar to those currently found. Delta exports will increase, resulting in some increase in American shad loss, but Delta outflow and entrainment losses associated with cross-Delta flows should remain similar to current conditions.

Preferred Alternative. Under the preferred alternative, it is not expected that the American shad population will be significantly affected. Table 5-24 shows that Delta outflow would tend to decrease from the no-action alternative in April an average of 3.4%, remain the same in May,

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Table 5-24
Average Late Winter And Spring Monthly Delta Outflows
Over The 57-year Study Period By Year Type
(in cubic feet per second)

Year Type	Alternative	Jan	Feb	Mar	Apr	May	Jun
Critical	No-Action	4,877	5,825	5,347	5,521	4,639	3,935
	Preferred	5,109	5,400	5,099	5,357	4,639	4,019
	Other	5,109	5,400	5,099	5,357	4,639	4,019
Dry	No-Action	10,532	15,833	11,962	8,250	7,579	6,262
	Preferred	9,573	14,610	10,854	8,062	7,579	6,262
	Other	9,573	14,610	10,854	8,062	7,579	6,262
Below Normal	No-Action	11,892	29,305	21,321	9,114	9,685	8,433
	Preferred	11,702	27,983	20,014	8,784	9,685	8,433
	Other	11,702	27,983	20,014	8,784	9,685	8,433
Above Normal	No-Action	16,259	34,388	41,852	23,012	16,423	11,503
	Preferred	14,442	34,062	39,992	20,817	16,421	11,503
	Other	14,442	34,062	39,992	20,817	16,421	11,503
Wet	No-Action	78,687	79,439	57,431	44,873	30,923	20,555
	Preferred	77,333	78,530	55,675	44,067	30,924	20,555
	Other	77,333	78,530	55,675	44,067	30,924	20,555
All Years	No-Action	33,700	41,249	33,076	22,816	16,869	12,000
	Preferred	32,761	40,383	31,705	22,048	16,869	12,012
	Other	32,761	40,383	31,705	22,048	16,869	12,012
Percent Change	Preferred	-2.8	-2.1	-4.1	-3.4	0	0.1
From No-Action	Other	-2.8	-2.1	-4.1	-3.4	0	0.1

and slightly increase in June. Hence, the one factor known to be associated with the year-to-year variability in American shad abundance only slightly changes from the no-action alternative.

It is expected that entrainment losses due to cross-Delta flows will not significantly change under the preferred alternative since cross-Delta flows will not change (see Table 5-15). Direct losses of American shad will probably increase due to increased winter SWP diversions. Table 5-28 shows that under the preferred alternative, salvage of American shad at Skinner Fish Facility will increase 3.7%. Fish loss and salvaged are positively related, but the relationship for American shad is unknown. However, since the estimated increase in American shad salvage is small, the increase in American shad losses is expected to also be small.

Other Alternatives. Since Delta outflow, SWP diversions, and cross-Delta flows are very similar or the same as under the preferred alternative, the other alternatives are expected to have little or no impact upon American shad populations as would the preferred alternative.

General Impacts on Sturgeon

Both white and green sturgeon are found in the estuary. The habits of the two species are similar in that they are both anadromous, but less is known about the green sturgeon, which is less common than the white sturgeon and often undertakes coastal migrations to estuaries in Oregon and Washington. Because white sturgeon grow larger, are more abundant, and spend a greater portion of their lives in the estuary, they are more important as a sport fish. In 1984, the legal-sized (over 40 inches) white sturgeon population was estimated at 140,000 and was the target of an increasingly popular sport fishery.

Tag returns from adult white sturgeon indicate they primarily inhabit the lower estuary. In late winter and spring—primarily in March and April—some sturgeon

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(mostly white) migrate to the Sacramento River between Knights Landing and Hamilton City for spawning. After spawning, adults move back downstream. Sturgeon eggs become adhesive after being fertilized and adhere to vegetation and rocks. They generally hatch in five to ten days. The nursery area is apparently formed both by the river near and below the spawning area and by the Delta and bays downstream. The timing and size at which young sturgeon move downstream are not well understood. Some newly hatched young have been collected downstream in the Delta and Suisun Bay in years with high runoff, but they are scarce there in years of low runoff.

Neomysis and *Corophium* make up most of the food of juvenile sturgeon in the Delta. Larger sturgeon feed primarily on small crabs, bay shrimp, clams, and small fish.

There is little knowledge of factors controlling the abundance of sturgeon in either the Bay–Delta area or the other river systems of the west coast. San Pablo Bay, an important feeding area in the fall and winter, is characterized by salinities ranging from 6,000 to 16,000 mg/l TDS during this period, depending upon outflow. White sturgeon also frequent San Francisco Bay, where surface salinities may range from 11,000 to 31,000 mg/l TDS. The principal shared features of these important sturgeon feeding areas appears to be the broad mudflats supporting large populations of invertebrates.

Environmental factors, such as photo-period, temperature, and heavy winter and spring flows, could be important stimuli for sturgeon spawning. Because yolk sac larvae have negligible swimming capabilities, they are probably susceptible to removal by water diversions. Early transport to the Delta depends on river flows, but the importance of early transport to the overall production of young is unknown. Juvenile sturgeon in the estuary depend on adequate populations of *Neomysis* and *Corophium* for food. Therefore, optimum conditions for these invertebrates, particularly *Neomysis*, will likely enhance survival and growth of both young-of-the-year and juveniles.

White sturgeon year class strength in the Sacramento River–San Joaquin River estuary may be partially determined by the levels of fresh water outflow in late winter and spring.

Also, the year classes produced in the wet years 1982 and 1983 produced above normal numbers of juveniles, as indicated by DFG trawl surveys. Although there is evidence that sturgeon production benefits from high levels of outflow, the mechanism(s) behind this possible relationship has not been determined.

No–Action Alternative. Under the no–action alternative, it its expected that white and green sturgeon populations will be similar to those currently found. Delta exports will increase, resulting in some increase in white and green sturgeon losses, but Delta outflows should remain similar to current conditions.

Preferred Alternative. Current understanding of sturgeon biology is too limited to make reliable assessments of project impacts. However, it appears that the preferred alternative is unlikely to have any major impacts to sturgeon and it is not expected that the white and green sturgeon populations will significantly change. As shown in table 5–24, Delta outflow in the late winter and spring will tend to decrease, but on the average only 2 to 4%. This decrease is not expected to result in significant decreases in white and green sturgeon populations. Under the preferred alternative, late March and April flows in the Feather River would increase in the dry and below normal years, perhaps encouraging more sturgeon to migrate up the Feather River instead of the Sacramento River.

Direct losses of white and green sturgeon will probably increase due to increased winter SWP diversions. Table 5–28 shows that under the preferred alternative, the estimated salvage of white sturgeon at Skinner Fish Facility will increase 0.3% while the estimated salvage of green sturgeon will increase 5.8%. Fish loss and salvaged are positively related, but the relationship for white and green sturgeon is unknown. However, since the estimated increase in white and green sturgeon salvage is small, the increase in direct white and green sturgeon losses is expected to also be small.

Other Alternatives. Since Delta outflow and SWP diversions are the same as under the preferred alternative, the other alternatives are expected to have little or no impact upon white and green sturgeon populations as would the preferred alternative.

General Impacts on Resident Fishes

Resident fishes are nonmigratory species, which spend their entire lives in the Delta and Suisun Bay during high flows. Three families of fishes dominate the Delta's resident fish assemblages: *centrarchid, cyprinid, and ictalurid.* Delta smelt, while not a member of these families, occur in significant numbers.

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The *centrarchid* family is composed of the black basses and various sunfishes. They are all introduced species, except for the Sacramento perch, which is native to the Delta but rarely caught, according to recent extensive DFG surveys.

Largemouth bass, the most abundant of the black basses in the Delta, are solitary carnivores whose adult diet consists mainly of other fish species and crayfish, along with secondary amounts of insects and small quantities of various larger species of zooplankton. Largemouth bass spawn in spring when water temperatures rise above 57 to 61°F and continue to spawn through June temperatures up to 75°F. Largemouth bass build nests in shallow water near submerged objects though not in colonial aggregations as do other sunfishes.

Sunfish species are also opportunistic carnivores, feeding on insects, aquatic crustaceans, snails, clams, and fish (to a lesser extent than largemouth bass). Bluegill also consume significant amounts of aquatic vegetation. Most are solitary feeders as adults with the exceptions of white and black crappie and bluegill, which form schools. They all spawn in shallow water during spring and summer when temperatures reach 57° to 75° F. Their spawning behavior is roughly similar that of the largemouth bass; they build nests near submerged objects or aquatic vegetation. Except for the warmouth, they tend to form nesting colonies. Their eggs are adhesive and sink, attaching to the substrate. After the young hatch, they are guarded for a while, after which they disperse to the shallows.

A second group is the cyprinid or minnow family, which includes five native species. However, the most abundant cyprinids are introduced species: carp, goldfish, and golden shiner. The splittail is the native minnow of special concern because its distribution is currently restricted to the Sacramento–San Joaquin estuary. Throughout most of the year, splittail are most abundant in the north and west Delta in association with other native species. They can also be found much of the year in Suisun Bay, year-round in the sloughs of the Suisun and Napa marshes, and in upper San Pablo Bay and Carquinez Strait during high spring flows. In the spring they are abundant in the east Delta, where they congregate in dead-end sloughs, probably to spawn over beds of aquatic or flooded terrestrial vegetation.

The third dominant group is the *ictalurid* or catfish family, all of which are introduced. White catfish, the most abundant, are more than 35 times as abundant, on average, as any other catfish species in the Delta. White catfish are carnivorous bottom feeders, consuming aquatic crustaceans, mollusks, insects, and fish; amphipods and *neomysis* are the most important food items for both juveniles and adults. White catfish spawn in the summer when water temperatures exceed 70° F. The female uses her fins to fan out a shallow nest depression in the substrate; then the breeding pair spawns and the adhesive eggs settle and stick to each other, forming an egg mass. One or both parents guard the eggs and the hatched young for a few weeks until the young disperse in schools.

Although channel catfish and brown and black bullheads are much less abundant than white catfish, they have similar breeding behavior and food preferences, with the exception that channel catfish probably consume more crayfish, clams, and fish than do the other species.

The Delta smelt (Hypomesus transpacificus) is a candidate species for listing by the California Fish and Game Commission. This small (maximum size of 2 to 3 inches) fish is native to the Sacramento–San Joaquin Delta and Suisun Bay and is not found in other estuarine systems. Since 1983, the smelt population has remained at consistently low levels as compared to the 1967 through 1983 period. Although little is known about this fish's environmental requirements, its one-year life span makes it vulnerable to extinction.

Factors controlling Delta smelt abundance may be similar to those for survival of larval striped bass. Possible reasons for the decline in Delta smelt include inadequate food supply and entrainment. There is some belief that spring outflows may be important to Delta smelt abundance since certain Delta outflows maintain the entrapment zone in Suisun Bay. The location of the entrapment zone is believed to be a factor of food supply for juvenile and adult fish. Unlike striped bass however, it is believed that both high and low Delta outflows could be detrimental to Delta smelt survival. An entrapment zone location in San Pablo Bay under high Delta outflows does not provide suitable habitat for Delta smelt.

Given the small amount of information available regarding Delta smelt, it is difficult to assess impacts of the SDWMP on their abundance. The incremental impacts of the SDWMP should be minimal since April through June conditions (outflow, reverse flows, diversion through the Delta Cross Channel, CVP and SWP pumping) change little from the no-action alternative. (See "General Impacts on Striped Bass.") SDWMP causes some shifting of SWP exports from spring to winter. This shift should re-

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duce entrainment losses at Banks Pumping Plant since May and June Delta smelt salvage totals are typically higher than those occurring in winter months. There is currently no way to quantify the benefits of this potential improvement since the information needed to translate Delta smelt salvage numbers into losses (that is, screen efficiency, handling and hauling losses, and losses in Clifton Court Forebay) is unavailable.

Sunfishes, catfish, and bass—the principal resident gamefish of the Delta—support an important recreational fishery and are, respectively, the second, third, and fourth most commonly caught groups of gamefish in the State. White catfish are probably the resident gamefish most often caught in the Delta. Largemouth bass are a major gamefish throughout the State, and in recent years large fishing tournaments have been organized expressly for them. The harvest rate for bass in the Delta (29 percent) is somewhat lower than in fresh water reservoirs (50 percent), but it is still substantial, indicating the existence of an important and thriving largemouth bass sport fishery.

Although they are not commonly sought by anglers, the nongame fish of the Delta still fulfill important roles. Some serve as forage for gamefish, while others compete with or prey on gamefish. Each of the native resident nongame fish has intrinsic ecological value, and in general, our knowledge of their life histories, population dynamics, and role in the community ecology of the Delta is limited. There formerly was a small commercial fishery for splittail, while another Delta native, the Sacramento blackfish, is still harvested commercially from Clear Lake. Both species have some potential for aquaculture.

DFG has recently completed a study of abundance, distribution, and habitat preferences of resident fish in the Delta. The following findings of this study are relevant to assessments of the impacts of the SDWMP:

- Riprap banks are favorable habitat for only a few of the less desirable resident fish species in the Delta.
- Instream vegetation is favorable for largemouth bass, white catfish, and redear sunfish, three of the most recreationally important resident fishes.
- Transport and nontransport channels differ in their species assemblages. Whereas catfish and black crappie were among those fish abundant in nontransport channels, largemouth bass and redear sunfish were more abundant in transport channels.
- Dead-end sloughs, oxbows, channels behind berm islands, and small embayments had the highest densities of fish and variety of species.

Together, these findings suggest that generally the most favorable condition for resident fish in the Delta is a diverse environment consisting of a highly vegetated shoreline with ample backwater and shallow areas.

The white catfish is of special concern because of its popularity in sport fishing, and because many young-of-the-year are carried past the screens into the export canals. The abundance of white catfish at the screens is greatest from May through August.

A DFG tagging study of white catfish shows them to be most abundant in the south Delta, somewhat less abundant in the central and east Delta, and least abundant in the north and west Delta. The white catfish population for the entire Delta is an estimated 4.5 million. No information on abundance is available for white catfish prior to operation of the CVP and SWP; therefore, effects of the projects on their abundance are difficult to determine. The distribution of white catfish now approximates that found in the early 1960's before SWP exports began; therefore, changes in flow patterns induced by export operations and recent local diversions appear not to have affected white catfish distribution.

No-action Alternative. Operation of the projects has affected resident fish by: 1) altering flow patterns, which determine net channel velocities and distribution; 2) salinity control, which has influenced salinity levels and the abundance and distribution of food organisms; and 3) entraining fish at export facilities.

Of these effects, only entrainment and losses can be analyzed with present knowledge. Salinity control probably has been beneficial for resident fish that prefer a fresh water environment.

Under the no-action alternative, losses of young white catfish from the Delta will increase as exports increase, as will losses of most resident fish. The relationship between screen losses and total Delta population is not known.

Preferred Alternative. Under the preferred alternative, summer exports would be lower, with some overall reduction in screen exposure. Some increases in fish entrainment into Clifton Court Forebay could be expected from winter export increases, but salvage records show very low levels of entrainment during these months for most

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resident fish species. Therefore, overall impacts on resident fish are expected to be reduced. (See "Direct Impacts of the Delta Complex on Other Fish Species.")

The preferred alternative would improve shallow water levels, improve circulation and overall water quality, move the Clifton Court Forebay Intake north into deeper, wider channels, and reduce the impact of exports on the south Delta channels. This would likely benefit most resident fish.

Other Alternatives. All alternatives use the same monthly export rates as the preferred alternative. Therefore, impacts would be similar to those identified for the preferred alternative. Overall effects on resident fish are expected to be reduced.

Overview of Fish Food Supply Impacts

The food web for fish consists of phytoplankton (algae), invertebrates, vertebrates, and detritus. The food web is dynamic; one organism feeds on another, and one food source is replaced by another with changes in season and the abundance and distribution of the food supply. Conditions that affect abundance and distribution of one link in the food web can affect the entire food web.

In the Sacramento–San Joaquin Delta, daily and seasonal changes in fresh and sea water, tides, winds, and currents interact with the food web. The complex interaction of these factors with the food web is difficult to understand; hence, how the SDWMP may impact food supplies is mainly unknown.

Phytoplankton. The abundance of phytoplankton is affected by many interacting factors, including light penetration, residence time, water temperature, salinities, nutrients, and grazing by invertebrates. Attempts have been made to develop mathematical models for evaluating phytoplankton levels in the Delta and Suisun Bay region. Each model calculation uses input describing interrelationships among the physical, chemical, and biological factors that affect phytoplankton. Some of these inputs are channel geometry, flow distribution, dispersive transport characteristics, water quality variables, waste discharges, biological kinetic parameters such as phytoplankton growth rates, and physical parameters. Currently, the models are not sufficiently well developed to predict changes from water project operation.

Impacts on phytoplankton are unknown for the project alternatives because of lack of knowledge of the cause-and-effect relationship of export pumping, and the uncertainty of the mathematical models in projecting abundance levels.

Invertebrates. Numerous invertebrate species of zooplankton (animals drifting in the water column or with limited swimming capacity) and zoobenthos (animals living on or in the substrate) inhabit the estuary. Both are important as food for many fish, including the juveniles of many gamefish.

High crustacean zooplankton abundance (*copepods* and *cladocerans*) is associated with low salinities, high chlorophyll (a phytoplankton), and low net velocities in Delta channels. *Copepods* are also associated with high salinities. Zooplankton populations are highest during summer. The opossum shrimp, *Neomysis mercedis*, an important part of the estuary's food web, is a food of young striped bass. Normally, more than 60 percent of the *Neomysis* population of the estuary is found in the Suisun Bay area, with much of the remainder found in the west Delta. Since the 1976–1977 drought, *Neomysis* populations in Suisun Bay have partially responded to the increased Delta outflows that have occurred in recent wet years. However, outflows from 1978 to 1981 have had little positive effect on *Neomysis* in the San Joaquin River.

Two amphipods, *Corophium stimsoni* and *Corophium spinicorne*, are important constituents of Delta zoobenthos. They are the principal food for sturgeon, white and channel catfish, tule perch, and small black crappie, and are also the second most important food of young striped bass. Other abundant benthic organisms are the Asiatic clam, tendipedid larvae, oligochaete worms, and crayfish. All are eaten by Delta fish, but none is as important as *Corophium.*

Important elements of the Interagency Ecological Study Program for the Sacramento–San Joaquin Estuary are:

- monitoring the abundance of *Neomysis* and other zooplankton in the Delta and Suisun Bay.
- analyzing factors affecting their abundance.

The analysis has focused on *Neomysis* because of its importance and because a larger data base is available.

DFG biologists have developed a multiple regression for calculating a *Neomysis* abundance index that explains about 96 percent of the *Neomysis* abundance during the medium- and low-flow years 1972 to 1981. However, in the very high-flow year of 1983, the predictions were much higher than the levels observed. The multiple re-

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gression parameters and their importance are shown in Table 5-25.

Table 5-25 Characteristics of Regression of *Neomysis* Abundance Index	
Variable	**Percentage of Variance Explained**
Salinity	71.3
Abundance of *Eurytemora*	21.4
Chlorophyll a	3.4
Water Diversions	1.5

Invertebrates can be impacted not only by natural means and water diversion projects but also by the introduction of non-native species through ballast water discharged from ships. Each native species has its own place in the food web. The appearance of non-native species can disrupt the food web to an extent that the normal food supply of many species is depleted. Figure 5-22 shows the mean March to November abundance of *Eurytemora*, *Sinocalanus*, and *Pseudociaptomus* from 1972 to 1989. *Eurytemora* is a native species and the principal food for the youngest striped bass. *Sinocalanus* and *Pseudociaptomus* are recent introductions.

The following assessment of effects of the alternative operational plans on aquatic invertebrates is based on present knowledge of their abundance and distribution, and of the effects of water project operation.

No-Action Alternative. Aquatic invertebrates are affected by water diversions by altering outflows, salinities, and tidal flows and velocities in Delta channels. Flows in Delta channels are affected by operation of the Delta Cross Channel gates. Some general effects follow:

- Project operations reduce fresh water zooplankton in the reach of the San Joaquin River below the Mokelumne River by introducing Sacramento River water with low plankton densities into this area.
- Salts drawn into this reach of the San Joaquin River by pumping tend to depress fresh water plankton and increase the abundance of brackish water species, especially *Eurytemora*, a copepod. *Neomysis* graze on *Eurytemora*.
- Pumping entrains aquatic invertebrates.

Under the no-action alternative, the pattern of exports will not change. The extent of the effect of these exports on invertebrates is not clear. Water export diversions are the least important of four factors affecting overall *Neomysis* abundance.

Preferred Alternative. Exports under this alternative are reduced from May through August and increased for the remaining months. This change in the timing of exports should be beneficial to *Neomysis*. With reduced exports during the summer, incremental effects on tidal flows and velocities in Delta channels should not be adverse.

Other Alternatives. Average monthly exports for other alternatives are the same as for the preferred alternative. Impacts to invertebrates are expected to be the same as under the preferred alternative.

Overview of Direct Impacts of the Delta Complex on Fish

Direct impacts of the Delta Complex on fish cannot be closely correlated to overall Bay-Delta fish impacts because of a lack of information on losses that normally occur during all life cycle stages. Direct impacts are only one component of an overall assessment. The previous general impact assessment for overall fish impacts was made qualitatively and considered direct impacts.

Direct impacts are considered to begin when SWP diversions entrain fish into Clifton Court Forebay. Fish more than about 1 inch long are subject to screening from the export water at the John E. Skinner Delta Fish Protective Facility and are captured, transported, and released back to the west Delta, generally beyond the influence of the project diversions. Fish too small to be screened, such as eggs and larvae of striped bass, and fish not effectively screened pass into the California Aqueduct with the export water.

Those fish not diverted by the primary louvers either die passing through the pumping plants or survive in the aqueduct system and reservoirs. A substantial fishery is supported by the aqueduct and reservoir system and is an acknowledged benefit. The fishery is a combination of stocked fish and fish exported from the Delta.

Direct Losses of Eggs, Larvae, and Juvenile Striped Bass due to SWP Pumping

Pumping from the south Delta by the SWP results in the direct loss of striped bass and other fish due to entrainment, predation, handling, and hauling. This section describes analyses related to the potential impacts of con-

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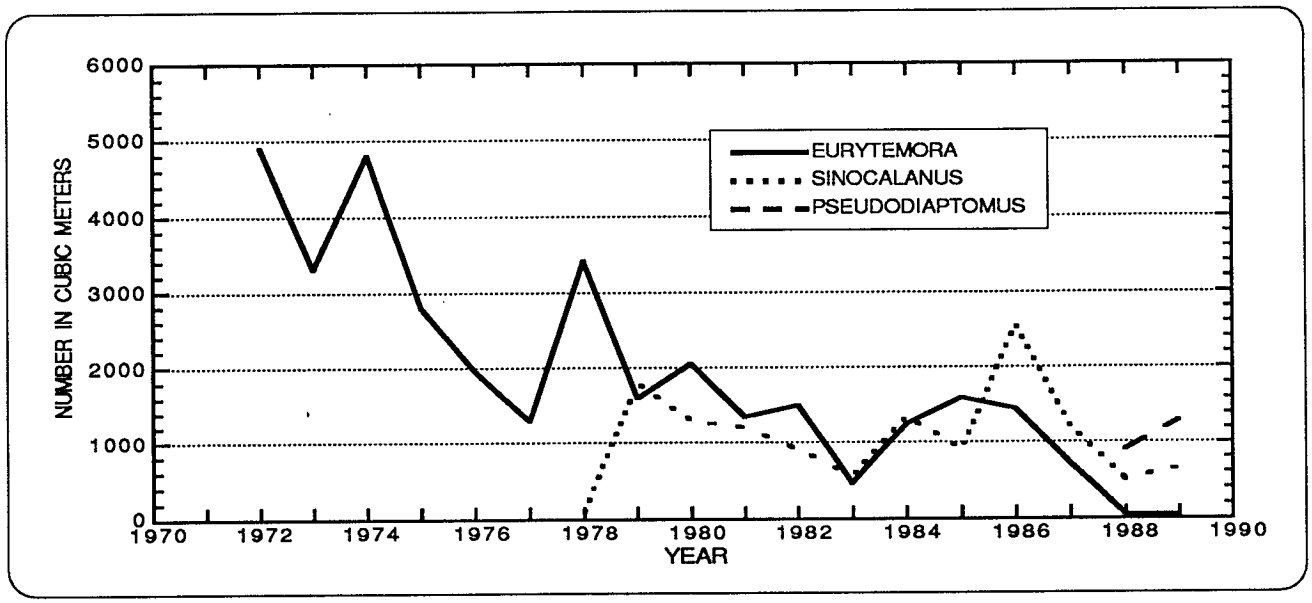

Figure 5–22. Mean March to November Abundance of *Eurytemora, Sinocalanus, and Pseudodiaptomus* from 1972 to 1989

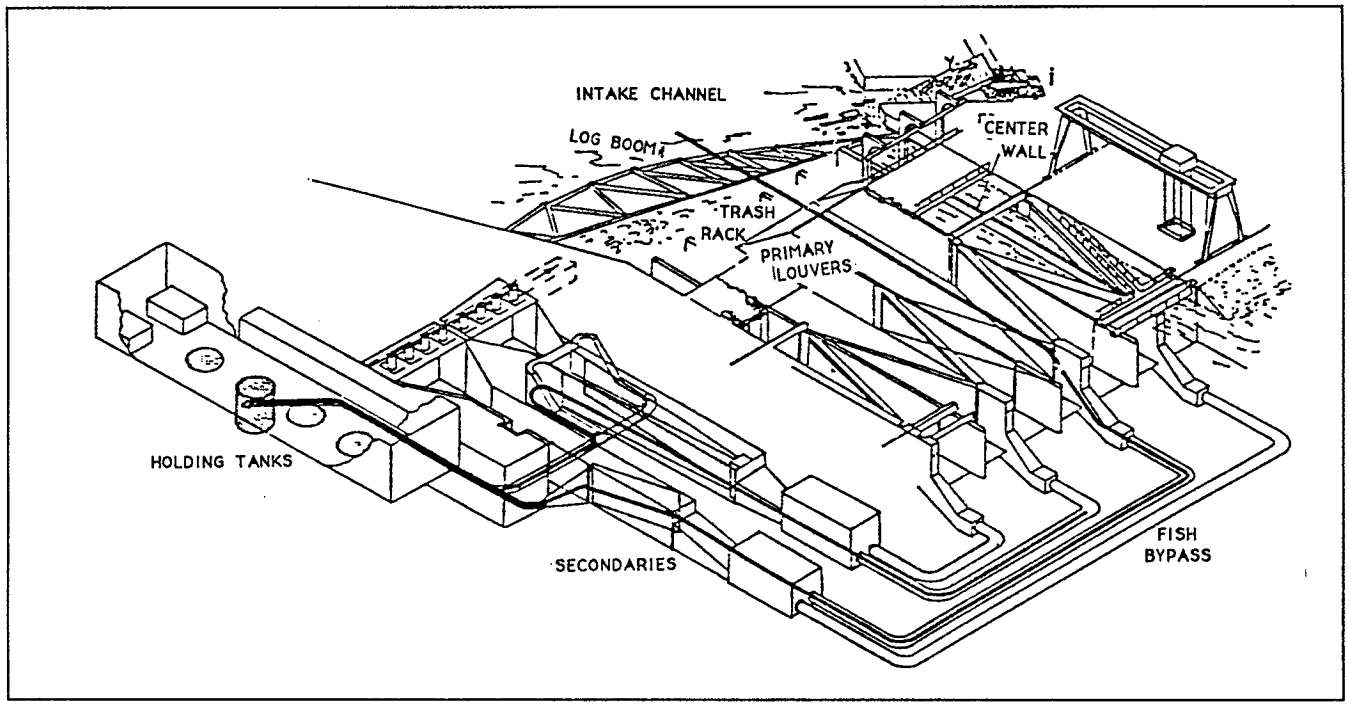

Figure 5–23. Schematic Diagram of the John E. Skinner Fish Protective Facility

structing and operating South Delta facilities on these losses.

Before discussing the analyses themselves, it may be helpful to provide a brief background on how losses occur at the facility and what has been done to minimize or offset these losses. Figure 5–23 is a schematic diagram of the Skinner Fish Facility.

Fish enter the Forebay through the radial gates which are opened periodically near high tide to maintain water levels in the 31,000–AF regulatory reservoir. Some preda-

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tion occurs as the fish move across the Forebay to the Canal intake. A set of primary louvers guides fish to bypasses leading to secondary screening systems. These devices separate fish from water and move the screened fish into holding tanks. Efficiency of the screening process depends on such factors as channel velocity and fish size. Fish going through the louvers into the aqueduct are lost to the Bay/Delta but do help support extensive fishery in the aqueduct and project reservoirs.

The holding tanks are used to collect and count fish. When enough fish have accumulated in the tanks, they are transferred to fish hauling trucks and transported to the Sacramento River for release at locations away from the draft of the pumps. Losses of striped bass occur in the holding tanks and in the transport trucks.

Over the years, but especially in 1982 and 1983, changes in facilities and operations have been made to increase the efficiency of fish protective measures at the facility. Among these measures are:

- establishing velocity and bypass ratio operational criteria to maximize screening efficiency (these criteria are different for chinook salmon and striped bass);
- opening more channels and installing center dividers in all channels to improve striped bass screening efficiency;
- adding a new perforated plate secondary system to improve screening efficiency in the secondary and to allow for better velocity control in the primary louvers;
- rescreening holding tanks with finer mesh to reduce losses in the tanks; and
- reducing hauling-related stress through better aeration and the addition of small amounts of salts to the water.

In addition, DWR is proceeding with the construction of three more holding tanks, which will be used to reduce velocities in the tanks (and reduce losses), help make better use of both secondaries, and help improve the accuracy of the counts of salvaged fish.

The daily fish salvage counts have been used in conjunction with estimates of screen efficiency, handing, hauling losses, and losses through Clifton Court Forebay to estimate the numbers of striped bass lost directly due to operation of the Delta pumps. DFG made the first calculation of total direct losses in establishing the method for calculating losses for chinook salmon, striped bass, and steelhead trout as called for in the DWR/DFG Delta Pumping Plant Mitigation Agreement.

The calculation procedures have been converted into a machine language model format. A detailed description of the model is found in Appendix G. The model uses the salvage data and assumed values for handling and hauling and predation losses in the forebay. The model maximizes screen efficiency by selecting the number of bays needed to provide near optimum channel velocities. Actual screening efficiency is calculated as a function of channel velocity and fish length. All fish losses are reported in terms of yearling equivalents using survival data developed by DFG. Figure 5-24 shows the annual cycle of striped bass salvage, in yearling equivalents, during the period 1979 through 1987. There are several assumptions and data inputs required to use this model in calculating fish losses and to evaluate impacts of new facilities and operations. A brief review of the assumptions and data sets will help in interpreting analytical results.

- Assumptions

  --The density of striped bass entering Clifton Court Forebay in the future will be similar to densities which occurred during the 1979-1987 period. Under this assumption, more pumping means proportionally more fish enter the forebay.

  --Predation losses in an enlarged Clifton Court Forebay would not differ significantly from those occurring in the present forebay. DWR believes that an enlarged forebay should help young striped bass escape from predators thus decreasing predation loss; however, the loss model does not take this into account.

- Data Sets

  --*The 1979-1987 Salvage Data*. Information from this period provides the most reliable estimates of number of fish salvaged. Even with these data, daily salvage numbers have errors of ± 50 to 100 percent, depending on the total number salvaged.

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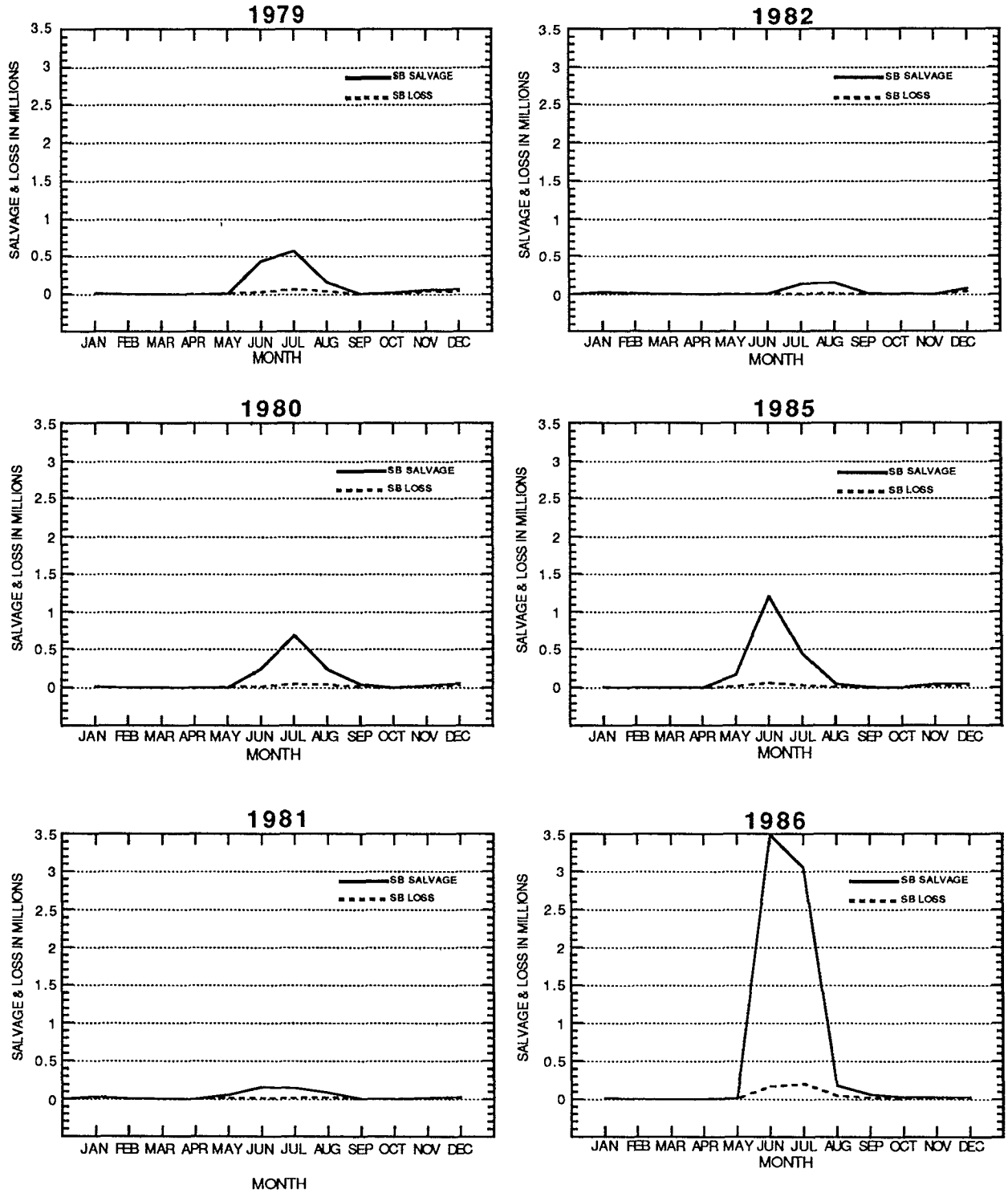
Figure 5-24
Annual Cycle of Striped Bass Salvage in Yearling Equivalents
Various Years from 1979 through 1986



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—*Screen Efficiency.* Efficiencies are based on the DFG/DWR evaluations conducted in the late 1960s and do not reflect changes made in the 1980s which probably led to improved efficiency. Improved screen efficiency may cause the currently-used relationship between salvage and loss to overestimate current direct losses. However, the use of this model for a comparison of how the preferred SDWMP alternative varies from the no-action alternative with respect to direct striped bass losses is considered adequate.

—*Handling and Hauling Losses.* These loss rates are provided by DFG and are based on recent studies.

—*Predation Losses.* The model uses the relation between size and percent lost (Figure 5-25) as developed by DFG to calculate losses due to predation in Clifton Court Forebay. DWR and DFG are presently developing studies which should help provide more insight into this important factor. Predation losses in the forebay are a major concern, and studies aimed at reducing losses are currently being conducted under the Article VII negotiations.

Actual striped bass losses during the water years from 1980 through 1987 were used as the basis for calculating losses for the no-action and preferred alternatives. Pumping rates were those from average dry, wet, and critical years pumping from the 57-year period in operations studies.

Table 5-26. Comparison of Calculated Losses of Striped Bass Yearling Equivalents During the 1980—1987 Water Years Under the No-Action and Preferred Alternatives

Water Year	Classification	Yearling Equivalents Lost	
		No-Action[2]	Preferred[3]
1980	Dry	525,165	500,781
1981	Dry	1,429,079	550,904
1982	Wet	332,847	341,074
1983	Wet	208,362	239,333
1984	Wet[1]	707,168	607,614
1985	Dry	418,686	435,575
1986	Wet[1]	1,043,451	860,305
1987	Critical	1,003,416	882,499
Total		5,668,174	4,418,085

[1]Subnormal snowmelt.
[2]3.3 MAF SWP demands—Operation Study 340B.
[3]3.3 MAF SWP demands—with proposed south Delta Facilities—Operation Study 327B.

As an example of the use of this method, water year 1980, a dry year, is discussed. During 1980, the historic average-monthly pumping rates are known, as is the striped bass salvage for those months. The model recalculates the salvage based on the change in pumping. If pumping were to average 3,000 cfs in May and salvage were 100,000 yearling striped bass equivalents, a pumping rate of 1,500 cfs in the base case would result in a salvage of 50,000 equivalents. The extent to which pumping was shifted away from peak periods of striped bass abundance would determine whether or not there would be a significant change in total striped bass losses.

Table 5-26 is a comparison of estimated striped bass losses using the no-action and preferred alternatives' pumping scenarios for the eight water years examined. Although there was considerable variation in annual losses, the calculations indicate that the preferred alternative would result in significantly fewer striped bass lost as compared to the no-action alternative. This reduction was due to some shifting of pumping from spring to winter months.

As described elsewhere in this report, in 1986 DWR signed an agreement with DFG to offset the direct losses of striped bass, chinook salmon, and steelhead rainbow trout at the intake to the California Aqueduct. Under terms of this agreement, DWR is implementing programs that result in increased numbers of yearling striped bass in the Bay/Delta.

Projects approved to date include purchase of hatchery striped bass, growing wild fish salvaged at the screens to yearling size, and screening a diversion in Suisun Marsh. To the extent that the decline in striped bass abundance is due to the physical process of entrainment (and not to changes in habitat), significant increases in the number of yearlings should result in an increase in numbers of adults. Early results indicate that yearlings planted in the Suisun-San Pablo Bay area are experiencing good survival to adults.

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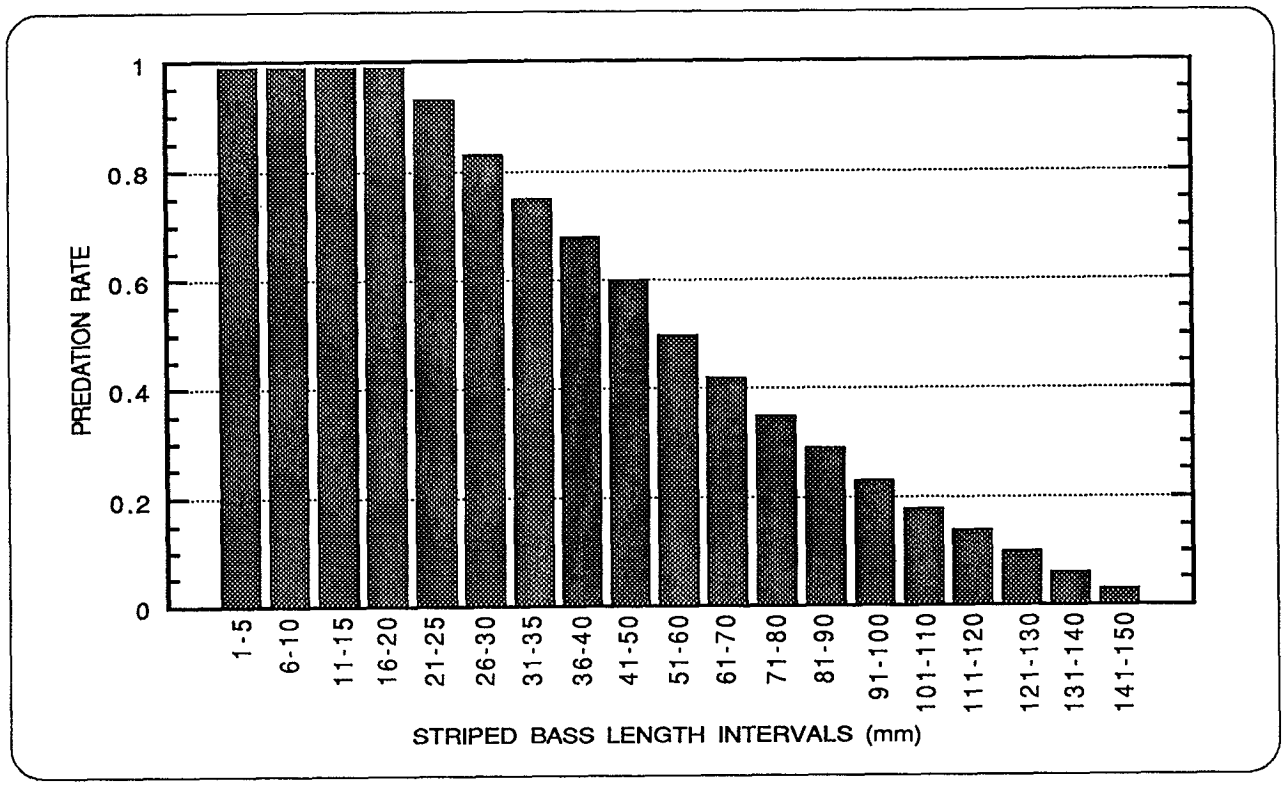

Figure 5-25. DFG's Estimated Loss Rate for Juvenile Striped Bass in Clifton Court Forebay due to Predation and Other Factors

Direct Impacts of the Delta Complex on Chinook Salmon

The fish loss model described previously for striped bass was used to compare projected Chinook salmon losses under the no-action and preferred alternatives. As with striped bass, the model uses salvage numbers and system losses (trucking, handling, losses through louvers and predation in Clifton Court Forebay) to calculate total fish losses. A major difference in the assumptions in the model when used to estimate salmon losses as opposed to striped bass losses is that the assumed Clifton Court predation loss for salmon is 75 percent for all sizes, while it is size-dependent for striped bass. Also, trucking losses are assumed to be near zero for Chinook salmon. When using the model to estimate either striped bass or salmon losses, estimates of losses should be used only to assess relative differences in losses between alternatives.

All four races of Chinook salmon are included in these estimates. Although the majority of downstream migrants are typically captured in the April through June period, some salmon are salvaged during all months of the year. The different races of salmon cannot be differentiated at this time; however, it can be assumed that the majority of fish being salvaged are from the fall run given the relative size of the four salmon runs. Also, it is likely that most of the fish are from the San Joaquin system, although the exact breakdown varies annually and seasonally.

As shown in Table 5-27 the preferred alternative resulted in slightly greater calculated Chinook salmon losses as compared to the no-action alternative. Considering the degree of accuracy of the assumptions involved in the modeling, the losses due to preferred and no-action alternatives are essentially the same. For comparison purposes, the calculated historic total loss during the 1979 - 1987 period was 4,321,898 yearling equivalent Chinook salmon.

It is expected that the operation of the barrier-type facility at the head of Old River will cause most of the downstream migrating San Joaquin River Chinook salmon to move down the San Joaquin River passed Stockton into the central Delta instead of being drawn across Old River or Grant Line Canal. While some of these salmon will be entrained by the cross Delta transfer of water back toward the pumping plants, it is expected that the strong tidal action into the central Delta channels will draw a large number of smolts toward the downstream bays and the ocean.

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Table 5-27
Calculated Losses of Juvenile Chinook Salmon
at the Intake to the California Aqueduct, 1979–1987, Under Two Pumping Scenarios
(all losses expressed as yearling equivalents)

Losses Year	Year Type	No-Action Alternative	Preferred Alternative	Percent Change
1979	Dry	365,321	461,531	26.3
1980	Wet	734,297	780,502	6.3
1981	Dry	268,640	331,762	23.5
1982	Wet	1,522,659	1,493,793	1.9
1983	Wet	855,166	913,644	6.8
1984	Wet	304,049	324,357	6.7
1985	Dry	386,499	435,789	12.6
198	Wet	1,366,676	1,397,315	2.2
1987	Critical	350,196	302,087	13.7
Total		6,153,503	6,440,788	4.7

Direct Impacts of the Delta Complex on Other Fish Species

Estimates of direct impacts for species other than salmon and striped bass were based on historical salvage data. Average annual salvage estimates were derived by multiplying projected monthly average exports by historical monthly average salvage densities. Such estimates account for monthly abundance, but not for the many other factors considered in the analyses of striped bass and Chinook salmon, such as fish screen efficiency and losses from predation, handling, and hauling.

Calculated salvage numbers of other fish species are shown in Table 5-28. As salvage estimates increase, total direct losses also increase since the salvage process is less than 100 percent efficient. As salvage estimates decrease, total direct losses also decrease.

No-Action Alternative. Under the no-action alternative, the total computed salvage for selected anadromous fish other than striped bass and salmon is 1,298,021, of which 99 percent are American shad. The total for resident game fish is 1,339,250, of which about 95 percent are white catfish. The total for resident nongame fish is 4,194,427, of which about 65 percent are threadfin shad.

Preferred Alternative. Under the preferred alternative, exports would be shifted from the months of higher fish abundance to winter months of lower abundance. If exports are shifted, even with an annual average increase in exports of about 12.5 percent, the total change in fish salvage would not be significant (less than .05 percent). Salvage would be increased by 3.7 percent for anadromous fish, reduced by 2.3 percent for resident game fish, and reduced by 0.3 percent for resident nongame fish.

Delta smelt, a species of concern due to their recent decline in numbers, would benefit as indicated by a reduction of over 5 percent in salvage.

Other Alternatives. Average monthly exports for other alternatives would be the same as for the preferred alternative. Therefore, direct impacts on fish are expected to be the same as under the preferred alternative.

Perspective. For any of these species, it is difficult to equate salvage and loss estimates to impacts on the population as a whole. This is due to normal losses occurring during the life cycle from other causes or to possible compensatory mechanisms that allow these losses to be negated. Also, virtually no data are available on juvenile populations for these species.

Some species, such as sturgeon, Pacific lamprey, and tule perch, are salvaged rather infrequently, although they are

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TABLE 5-28
Calculated and Direct Average Annual Salvage of Screenable Size Fish Other than Striped Bass and Chinook Salmon at the Delta Complex[1]

Species	No Action	Preferred and Other Alternatives	Percent Change Over No Action[2] (negative values beneficial)
Anadromous Fish			
Steelhead Rainbow Trout	7,199	8,545	+ 18.70%
American Shad	1,286,696	1,333,669	+ 3.65%
White Sturgeon	2,965	2,974	+ 0.30%
Green Sturgeon	1,161	1,228	+ 5.77%
Resident Game Fish			
White Catfish	1,267,316	1,236,217	- 2.45%
Channel Catfish	32,990	32,821	- 0.51%
Black Crappie	23,900	23,959	+ 0.25%
Bluegill	10,331	10,919	+ 5.69%
Starry Flounder	4,713	4,041	- 14.26%
Resident Non-Game Fish			
Threadfin Shad	2,713,313	2,774,787	+ 2.27%
Sacramento Splittail	185,738	177,225	- 4.58%
Hardhead	22,125	19,499	- 11.87%
Carp	28,139	22,544	- 19.88%
Bigscale Logperch	9,457	8,377	- 11.42%
Longfin Smelt	111,574	98,832	- 11.42%
Delta Smelt	878,849	828,543	- 5.72%
Prickly Sculpin	136,506	129,225	- 4.33%
Yellowfin Goby	108,726	121,436	+ 11.69%

[1] Calculations of annual fish losses changing with salvage, based on data from DFG report, *The John E. Skinner Delta Fish Protective Facility, 1968–1980, A Summary of the First Thirteen Years of Operation*, October 1981. Values are in fish per year and reflect reduced impacts in many cases.

[2] Positive numbers indicate an increase in fish losses with the proposed action; negative numbers indicate a decrease in fish losses with the proposed action.

present in fair numbers in the Delta. Others, such as starry flounder and brown bullhead, are salvaged infrequently because the south Delta is not their preferred habitat. Species such as American shad, white catfish, and threadfin shad maintain high populations in the Delta despite significant annual entrainment.

Based on the minimal increase in salvage numbers and the continued high numbers of most fish species, direct impacts on fish were judged to be insignificant.

Impacts on Wildlife and Wildlife Habitat

Wildlife impacts and compensation needs of the SDWMP from channel enlargements and Forebay enlargement by 3,000 surface acres were evaluated, using the USF&WS Habitat Evaluation Procedures (HEP), a methodology that can be used to document the quality and quantity of available habitat for selected wildlife species.

HEP is endorsed by DFG as a means of rating the quantity and quality of habitat to evaluate proposed mitigation.

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HEP provides information for two general types of wildlife habitat comparisons:

- the relative value of different areas at the same point in time;
- the relative value of the same area at future points in time.

By combining the two types of comparisons, the impact of proposed or anticipated land and water use changes on wildlife can be quantified.

The application of HEP is based on the assumption that habitat for selected wildlife species or communities can be described by a model that produces a Habitat Suitability Index (HSI). The HSI value, from 0.0 to 1.0, is multiplied by the area of available habitat to obtain Habitat Units (HUs), which are used in the comparisons described above.

One feature of the preferred alternative is to enlarge Clifton Court Forebay to at least 5,000 surface acres by flooding various combinations of parts of nearby Delta agricultural islands or tracts.

Various forebay alternatives, consisting of all or parts of Coney Island, Byron Tract, Victoria Island, and Clifton Court Tract, as discussed in Chapter 2, were evaluated by assuming they could be constructed by either—

- building up existing island levees where possible, with totally new levees constructed only where none presently existed;
- constructing all new levees for Forebay containment, including set-back levees next to any existing island levees along the Forebay boundaries.

Mitigation. Sherman Island, which is the preferred location for the mitigation of impacts from an enlarged forebay, comprises about 10,400 acres of mainly agricultural land. A wildlife management plan for the island calls for a mixture of the following habitats:

- permanently flooded wetland or emergent marsh,
- upland,
- goose habitat, and
- riparian.

The number of acres for each of the above habitats has not been agreed upon. DWR and Reclamation will be working closely with DFG and the USF&WS in developing a suitable plan for mitigation of impacts.

Impacts on Wetlands

The SDWMP will not impact any natural occurring wetlands. The Habitat Evaluation Procedure analysis did find wetland-type vegetation along many of the artificial agricultural drainage ditches in areas that were identified as possible sites for an expansion of Clifton Court Forebay. The soils adjacent to these drainage ditches are not characteristic of those associated with wetlands. The presence of wetland vegetation is due to the irrigation and drainage of agricultural fields. This vegetation is removed periodically as a result of ongoing ditch maintenance. This vegetation along the drainage ditches ranges from 5 to 8 acres, depending on various forebay alternatives, and could be classified as emergent marsh.

Enlargement of selected channels, using setback levees, will greatly increase the amount of habitat that can be listed as artificial wetland or emergent wetland. The additional channels created by the new setback levees will mitigate for: 1) loss of vegetation along drainage ditches in areas where Clifton Court Forebay expands, and 2) any inadvertent loss that may result from construction of the new levee.

Impacts on Rare, Threatened, and Endangered Species

The results of field surveys for rare, threatened, and endangered plant and animal species are described in Chapter 4. The following species of plants may be affected:

- Mason's *lilaeopsis*,
- California hibiscus,
- Delta tule pea.

Those three species of plants are found in the project area. However, except for a new intake for an expanded Clifton Court Forebay and barrier-type facilities, all construction will be in areas where these water-dependent plants are not found. The new forebay intake will remove from 200 to 400 linear yards of existing levee, and the barrier-type facilities will alter about 50 yards of levee on both sides of the channel. When the exact location of these structures has been identified, results of the plant surveys will be checked to determine whether any protected plants are affected. Any significant impacts will be mitigated.

Barrier-type facilities will raise water levels in several places in the south Delta (see the section, "Mitigation And Enhancement Barrier-type Facilities" in Chapter 2).

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The rise in mean water levels during low-flow periods will alter the vegetation in the narrow strip of land between the historic mean water level and the new higher mean water level. Plants in this zone are subjected to daily and seasonal fluctuations in water levels.

Mason's *lilaeopsis*, an intertidal plant which, by means of rhizomes, colonizes new habitats, will re-establish itself quickly in the new intertidal zone. California hibiscus, occupying a broader and slightly higher zone than Mason's *lilaeopsis*, should also re-establish itself in a short time. The ability of both of these species to re-establish themselves will depend on the water level and duration of inundation at the new levels, which will be monitored. Mitigating actions will be taken as needed. The two populations of Delta tule pea will not be affected by any of the barrier-type facilities.

Swainson's hawk is the only terrestrial protected animal which may be disturbed by construction activities. Active nests will be avoided during the nesting period.

Three fish species merit special concern:

- Delta smelt, recommended for protection by California and the federal government;
- Sacramento splittail, recommended for protection by California and the federal government; and
- winter-run Chinook salmon, listed as endangered by California and as threatened by the federal government.

The preferred alternative benefits both the Delta smelt and the Sacramento splittail. Direct average annual salvage of Delta smelt is reduced by over 5 percent and the Sacramento splittail is reduced by over 4 percent.

Impacts to the winter-run Chinook salmon are discussed in the following section.

Winter-Run Salmon Impacts. The winter run of Sacramento River chinook salmon has been listed as endangered by California and as threatened by the federal government. It is a unique race of salmon which spawns in the May-August period in the upper Sacramento River between Red Bluff and Keswick Dam. Spawning, incubation and juvenile rearing take place during summer months when water temperatures are typically warm in the upper Sacramento River. Before the construction of Shasta Reservoir, the winter run spawned in the cool reaches of the McCloud River. Early operation of Shasta Reservoir caused colder temperatures in the upper Sacramento River and the spawning population of winter-run salmon increased to about 170,000 in 1969.

In 1989, the winter-run size was about 550 spawners. Many biologists believed that the dramatic decrease over the past 20 years has been due to the construction and operation of the Red Bluff Diversion Dam and an increase in spring/summer temperatures in the upper Sacramento River. The Dam itself caused delays in migration of adults upstream and juveniles downstream. Delayed migration of adults can result in less-than-optimum spawning, and a delay of downstream migrants leads to increased predation by squawfish and other fish. In addition, inadequate screens at the intake to the Tehama-Colusa Canal resulted in juvenile entrainment. Temperature problems were particularly severe in dry years when water released from Shasta Reservoir came from the warm upper layer.

Other factors that have been identified as adversely impacting populations include:

- impacts of acid mine drainage into the upper Sacramento River from the inactive Iron Mountain mine site in the Spring Creek watershed, which enters the Sacramento River immediately upstream of Keswick Dam;
- limited spawning gravels in the upper Sacramento River;
- fish losses due to entrainment at the Glenn-Colusa intake and other water diversion structures in the Delta; and
- commercial and sport harvest.

An interagency winter-run team has been established to develop a recovery plan. Much of this plan will be built around a cooperative agreement developed before the listing. This cooperative agreement was to implement actions to improve the status of winter-run chinook salmon. The cooperating agencies are DFG, USFWS, Reclamation, and NMFS.

The agreement contains the following actions:

- raise the Red Bluff Diversion Dam from December 1 through April 1;
- develop better water temperature control at the outlet from Shasta Reservoir;
- develop measures to control squawfish predation at Red Bluff Diversion Dam;
- correct Spring Creek pollution problem;
- restore spawning habitat in the Redding area;

- correct salmon related problems at Anderson-Cottonwood Irrigation District Diversion Dam;
- restrict in-river harvest of winter-run chinook salmon;
- develop a winter-run chinook salmon propagation program at Coleman National Fish Hatchery;
- modify the Keswick fish trap to prevent mortality to winter-run chinook salmon;
- continue and expand studies on winter-run chinook salmon; and
- develop fish ladders as an alternative to raising the Red Bluff Diversion Dam gates.

The potential impacts of SDWMP on winter-run salmon would occur during their passage through the Delta as downstream migrants. The time when winter-run outmigrants are in the Delta is not well defined but DFG believes that peak abundance is in the January through March period. During the winter months, river flows are generally high, temperatures cold, the Delta Cross Channel gates are closed, and local agricultural diversions are minimal. Although this combination of factors should generally result in good through-Delta survival, there have been no studies specifically designed to estimate survival of winter-run smolts.

During dry, critical, and below normal years, river flows are generally low even during winter months. SWP and CVP pumping may result in some winter-run juveniles being lost at the pumps. There is no definitive means of distinguishing a winter-run juvenile from one of the other three races of salmon present in the Central Valley system. DFG has developed a size relationship which may help differentiate the salmon.

The probability of entraining winter-run juveniles during critical, dry, and below normal years increases as pumping increases during the January through March period. Table 5-29 shows that under the preferred SDWMP alternative, increases in January through March SWP pumping would tend to occur during dry and below normal years. However, only a minor increase in SWP pumping would tend to occur in critical years under the preferred alternative.

The recovery plan now being developed will help with implementation of both the federal and State acts. The recovery team has met only once so far. DWR is to be a member of the team. In addition, DWR has initiated a consultation process with NMFS and DFG on the potential impact of the Banks Delta Pumping Plant on winter-run salmon. DFG will be consulted for written findings on the impact of the preferred alternative on the continued existence of the winter-run salmon, as required by CEQA and CESA. If it is determined that that SWP pumping results in a taking that is not permitted under either the federal or State act, DWR will work with the agencies to develop appropriate mitigation. Actions being considered include 1) participation in upstream measures that are critical to survival of the winter run, and 2) operational restrictions at the pumping plant when the juveniles are most vulnerable. Operation under the preferred alternative will not be conducted in a manner that would conflict with any requirements imposed on DWR by the State and federal acts.

Table 5-29
Projected Average Monthly Diversion (cfs) over the 57-Year Study Period During January and March (3.3 MAF SWP Demands)

Alternative	Year Type		
	Critical	Dry	Below Normal
No-Action	4,889	6,634	6,230
Preferred	4,998	8,312	7,454
Others	4,998	8,312	7,454

Impacts on Tracy Pumping Plant Operations

The SDWMP is not expected to affect operation of the Tracy Pumping Plant. Two previously identified potential problems to the plant operation are water hyacinth and water surface elevations.

Water hyacinth has historically been a problem in the south Delta, limiting boating and interfering with both CVP and SWP export operations by obstructing the intake gates. A successful effort by both federal and state agencies was conducted in the 1980s to reduce the water hyacinth influence on pumping, especially at the Tracy Pumping Plant. Currently water hyacinth is contained to a manageable level, and the south Delta improvements are not expected to accelerate its growth.

Evaluation of the effects of the alternatives on energy requirements for the Tracy Pumping Plant due to water surface elevation changes was based on Reclamation's estimate of increased energy requirements of 1.25 kilowatt-

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hours per foot of drawdown in the channels adjacent to the pumping plant.

No-Action Alternative. Tracy Pumping Plant operations will not be impacted.

Preferred Alternative. Changes in energy requirements at the Tracy Pumping Plant will be insignificant. Table C-18 in Appendix C shows the average water surface elevation differences between all of the alternatives and the no-action alternative. The preferred alternative raises average water surface elevations from 0 to 0.5 foot. The higher average water surface elevation is caused by relocating Clifton Court Forebay intake gates farther north toward the central Delta.

Table C-18 shows that at the Delta-Mendota Canal intake during low-low tides, water surface elevation differences will range from 0.1 to -0.2 foot, compared to the no-action alternative for all water years. These differences occur during low-low tides, which represent a small portion of a tidal cycle, and is negated by the overall increase in average water surface elevation. The potential minor negative effects of the tide barriers on minimum water surface elevations are also compensated by the overall improvement to water levels. The increased water surface elevation will possibly lower CVP's energy requirements.

Other Alternatives. Tracy Pumping Plant operations will benefit significantly from any alternative that incorporates a CVP tie-in to Clifton Court Forebay. By connecting into the forebay, the Tracy Pumping Plant will be less prone to water quality, drawdown, and tidal impacts. For the alternatives without a CVP tie-in, impacts on Tracy Pumping Plant operations will be similar to those for the preferred alternative.

Impacts on Suisun Marsh

DWR and Reclamation planning includes protective measures for Suisun Marsh to mitigate for project development, including the SDWMP. With or without the proposed project, DWR and Reclamation will protect Suisun Marsh habitat with Delta outflow, physical facilities, a monitoring program, and a management program. The most important protective facility, the Suisun Marsh Salinity Control Gate Structure is already in operation.

Chapter 4 contains information on Suisun Marsh's physical characteristics, environmental importance, and multi-agency preservation agreements. Protection for the marsh is designed to compensate for future projects, such as the proposed project. Evaluation of this protection can be found in the *Plan of Protection for the Suisun Marsh including Environmental Impact Report,* DWR, February 1984.

In the past, SWP and CVP operation and other upstream water use adversely affected the Suisun Marsh during dry and critical years. The reduction in outflow caused by upstream use and by export during October through May increased channel salinity within the marsh, which affected the composition and productivity of plant communities that are important food sources for waterfowl. Soil salinities in pond areas must remain within certain limits or habitat quality will deteriorate. If no action was taken, the duration of salinity intrusion into the marsh channels would increase as greater amounts of water were diverted upstream and within the Delta. Seed production in the marsh would decrease, and less food would be available for waterfowl.

During the 1988-1989 water year, the Suisun Marsh Salinity Control Gates operated for 157 days (October 31, 1988 through April 7, 1989). Because of intermittent equipment problems, operations were recorded for 132 of the 157 days. During the 132-day period, the gates opened 268 times, for a total duration of 1,182 hours. Based on the recorded data, the gates tidally pumped 479,105 AF of water (averaging 3,630 AF, or 1,830 cfs per 24-hour day) into Suisun Marsh for the control season. During this same period, measured salinity levels in Suisun Marsh channels were lower than in any recorded similar hydrologic period.

The Suisun Marsh salinity control gates worked better than expected during this dry period. The 1987-88 water year had a Sacramento River Index of 9.2 MAF and was classified, according to Decision 1485, as critical. The 1988-89 Sacramento River Index was 15 MAF; therefore, this control season was considered a dry year for fish and wildlife standards. Channel water quality improved significantly as far west as the Volanti monitoring site on Suisun Slough. The improvements at Volanti occurred about seven days after the control gates began tidal pumping.

Figure 5-2 illustrates the percent change of monthly net Delta outflow of the south Delta alternatives, compared to the base condition. The graph shows little change in monthly net Delta outflow, compared to the base. The SDWMP will have no significant impact on Suisun Marsh, because the Suisun Marsh program will protect the delicate balance of brackish water by a combination of Delta

outflow, physical facilities, a monitoring program, and a management program.

Impacts on San Francisco Bay Aquatic Resources

Downstream of the Delta is a series of embayments linked by narrow channels. Together these embayments—Suisun, San Pablo, Central, and South bays—form a complex estuarine environment. The analysis and determination of fresh water impacts on San Francisco Bay is a complicated process. There is a complex interaction of fresh and sea water, tides, winds, and currents. Since these factors are difficult to measure or characterize, their complex interaction with San Francisco Bay biota must also be understood, as well as the interactions among different trophic levels of the biota.

Complex estuarine factors in combination with the Bay's geomorphology offer a diverse array of environments for use by aquatic organisms. This complex environment makes it very difficult to determine whether changes in fresh water flow due to water development will result in conditions that will adversely impact beneficial uses—particularly fish and wildlife habitat.

The impact of SDWMP on flow pulses, and changes in Delta outflow, both of which are considerations for the San Francisco Bay environment, are discussed earlier in this chapter.

Environmental concerns for San Francisco Bay are recognized by the SWRCB. In the Bay-Delta hearing testimony on fresh water inflow to the San Francisco Bay, recommendations concerning Delta outflow, the health of San Francisco Bay, and the effect of pollution on San Francisco Bay's health, varied considerably. Most individuals agreed, however, that more information must be collected.

How differences in Delta outflows under the SDWMP will affect San Francisco Bay biological resources is unknown. However, if San Francisco Bay resource levels are related to the quantities of fresh water inflows, the incremental effects of the SDWMP can also be expected to be minimal, because outflow changes for the preferred plan would be minor. The relationship between Delta outflow and fish, water quality, and wildlife resources in San Francisco Bay is the subject of ongoing studies and monitoring that DWR and Reclamation help fund. The following discussion involves impacts to plant production, zooplankton, and fish.

Primary (plant) production. A major issue regarding San Francisco Bay is the possible impact of water development on the ability of the system to produce enough food at the base of the food web to support a diverse assemblage of higher animals, including fish. Fresh water flow 1) contributes plant nutrients to the estuary; 2) reduces salinity, which can influence phytoplankton abundance; and 3) is responsible for the establishing an entrapment zone and other hydraulic features such as stratification, which can promote production. Nutrient sources other than fresh water flows include waste discharge, regeneration from bottom sediments, the ocean, and direct input from the atmosphere from precipitation or particulates. Primary production includes a variety of such plant groups as phytoplankton, benthic microflora, macroalgae, and emergent vegetation.

Levels of primary production necessary to support fish populations are not well understood. Fishery yields vary widely at any given level of plant production. In San Francisco Bay, data are insufficient to characterize the total primary production from all the plant communities in the system. Therefore, a fishery yield/plant production curve cannot be estimated.

The complex nature of San Francisco Bay obscures both the effect of various factors on production and the effect of fresh water flows on those factors.

Zooplankton. The effects of fresh water flow on abundance and distribution of zooplankton in San Francisco Bay are not well understood. Hearings on San Francisco Bay by SWRCB presented evidence that after 3-1/2 years of studying South San Francisco Bay, the USGS could not find a relation between Delta outflow and zooplankton abundance. DFG studies indicate that the abundance of Bay shrimp, *Crangon franciscorum*, is associated with fresh water flows from the Delta. The abundance of this shrimp, however, does not always show the same relationship to outflow, depending on life stage. The small fishery for Bay shrimp is probably not limited by current population levels, and optimum levels of shrimp have not been determined. During the late 1920s and early 1930s, a period with the longest sustained drought, commercial fisherman were harvesting 2 to 3 million pounds of shrimp annually from the San Francisco Bay.

Fish. Detailed studies of the effects of fresh water inflow on San Francisco Bay fish began in the early 1980s. Of the more than 120 species of fish captured by DFG, detailed analyses were made of 69 species, according to their response to water year types. The results showed that flow

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had no apparent effect on 42 species, 20 species were more abundant in wet or above-normal years, and 7 species responded to dry or critically-dry years. Two species in particular, the longfin smelt and the introduced yellowfin goby, showed a positive correlation between fresh water flow and abundance.

The above correlations are based only on observed flows and fish abundance. A data base is not available to show what flow-related phenomenon might have caused the relationship, or whether the relationships were biologically relevant. In addition, the data base is relatively short and limited. The limitation is especially apparent when compared to that for striped bass, a species still not well understood despite a 29-year study of a large number of potential controlling factors.

Impacts of Construction

Table 5-30 summarizes the local impacts of barrier-type facilities installation, Clifton Court Forebay expansion, intake structure construction, siphon construction, Highway 4 modification, and channel improvements. The project components are discussed in Chapter 2. The impacts due to construction of the project components are temporary and are discussed in this section. This section also discusses the methods of construction and needed mitigation measures.

Preliminary quantity estimates of earthwork and other major materials needed for project construction are summarized in Table 5-31. To minimize impacts on the roadway traffic in the project area, imported materials (embankment and riprap) could be barged to the site. Concrete may be batched near the project site on dry land.

Barrier-Type Facilities Installation

Barrier-type facilities will be constructed to improve water levels and circulation patterns in the south Delta. These structures will be operated so that the flood tide could enter the upstream channel through the open gates. At ebb tide, the gates would close to help maintain higher water levels upstream of the structure. If construction is carried out by staging, the first stage may include a temporary barrier-type structure. This will allow time to evaluate the effectiveness of the structure under different hydraulic and hydrodynamic conditions. This type of evaluation will facilitate more effective design, operation, and maintenance of the temporary structure and those constructed in later stages.

It is estimated that construction of barriers may required excavation of 200,000 cubic yards of materials, 8,000 cubic yards of concrete, and 45,000 tons of riprap materials.

The different types of barrier-type facilities that could be installed are described in detail in Chapter 2.

Clifton Court Forebay Expansion

The alignment of the embankment for the enlarged Clifton Court Forebay alternatives will be located on weak deltaic deposits characterized by poor foundation conditions. These deposits are organic and vary in thickness from a few feet to about 20 feet. The organic soil deposits consist of peat, organic silt, and clay of low density, low shear strength, and high moisture content.

Under the preferred alternative, the enlarged forebay would require an estimated 150,000 cubic yards of excavation, 6 million cubic yards of embankment, and 600,000 tons of riprap materials.

A common method of constructing an embankment where organic soil is encountered is to remove the organic material and replace it with a mineral soil. It is assumed that the new embankment can be safely built on the existing foundation material, since the adjacent existing levees have been constructed on the same foundation with steeper side slopes. It is planned that the material dredged from the channels be placed in the embankment area. However, in addition to the dredged materials, about 6 million cubic yards of borrow materials will be imported for the construction. The borrow materials will be hauled by trucks with a capacity of about 10 cubic yards, and approximately 580,000 trips will be required. The estimated quantity of borrow for the embankment has been increased by 15 percent to account for the expected settlement.

Reinforcement of the existing levees to serve as the forebay embankment is not feasible, since the strength of the existing levees and their foundations are indeterminate. Therefore, a new embankment was assumed to be constructed adjacent to the existing levees. A paved operating road will be constructed on the crest of the embankment. Wave protection will be provided by a filter blanket and overlying riprap. Embankments will be provided with a toe drain to tie into the existing drainage system on the islands. Wells will also be set up to monitor potential seepage.

Embankments around the forebay are under the jurisdiction of DWR's Division of Dam Safety. The design con-.

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Table 5–30. Summary of Environmental Impacts Caused by Construction

	Yes	Maybe	No
1. Earth. Will the proposal result in:			
a. Unstable earth conditions or in changes in geologic substructure?	—	—	X
b. Disruptions, displacements, compaction, or overcovering of the soil?	X	—	—
c. Changes in topography or ground surface relief features?	X	—	—
d. Destruction, covering, or modification of any unique geologic or physical feature?	—	—	X
e. Any increase in wind or water erosion of soil, either on or off the site?	—	X	—
f. Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion that may modify the channel of a river or stream or the bed of the ocean or any bay, inlet, or lake?	—	—	X
g. Exposure of people or property to geologic hazards, such as earthquakes, landslides, mudslides, ground failure, or similar hazards?	—	—	X
2. Air. Will the proposal result in:			
a. Substantial air emissions or deterioration of ambient air quality?	—	—	X
b. The creation of objectionable odors?	—	—	X
c. Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?	—	—	X
3. Water. Will the proposal result in:			
a. Changes in currents, or the course or direction of water movements, in either marine or fresh water?	—	—	X
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface water runoff?	—	—	X
c. Alterations to the course or flow of flood waters?	—	—	X
d. Change in the amount of surface water in any water body?	X	—	—
e. Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen, or turbidity?	X	—	—
f. Alteration of the direction or flow rate of ground water?	—	—	X
g. Change in the quantity of ground waters, either through direct additions or withdrawl, or through interception of an aquifer by cuts or excavations?	—	—	X
h. Substantial reduction in the amount of water otherwise available for public water supplies?	—	—	X
i. Exposure of people or property to water-related hazards such as flooding or tidal waves?	—	—	X
4. Plant Life. Will the proposal result in:			
a. Changes in the diversity of species, or number of any species of plants (including trees, shrubs, grass, crops, and aquatic plants)?	—	—	X
b. Reduction of the number of any unique, rare or endangered species of plants?	—	—	X
c. Introduction of new species of plants into an area, or barrier to the normal replenishment of existing species?	—	—	X
d. Reduction in acreage of any agricultural crop?	X	—	—
5. Animal Life? Will the proposal result in:			
a. Change in the diversity of species, or numbers of any animal species (birds, land animals, including reptiles, fish and shellfish, benthic organisms or insects)?	—	—	X
b. Reduction in the number of any unique, rare, or endangered species of animals?	—	—	X
c. Introduction of new species of animals into an area, a barrier to the migration or movement of animals?	—	—	X
d. Deterioration of existing fish or wildlife habitat?	—	—	X
6. Noise. Will the proposal result in:			
a. Increases in existing noise levels?	X	—	—
b. Exposure of people to severe noise levels?	—	—	X
7. Light & Glare. Will new light and glare occur?	—	—	X
8. Land Use. Will the proposal result in substantial alteration of the present or planned land use of an area?	X	—	—
9. Natural Resources. Will the proposal result in:			
a. Increase in rate of use of any natural resources?	—	—	X
b. Substantial depletion of any nonrenewable resource?	—	—	X
10. Risk of Upset. Will the proposal involve:			
a. Risk of explosion or release of hazardous substance (including but not limited to oil, pesticides, chemicals, or radiation) in the event of an accident or upset?	—	—	X
b. Possible interference with an emergency response plan or an emergency evacuation plan?	—	—	X
11. Population. Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?	—	—	X
12. Housing. Will the proposal affect existing housing or create a demand for additional housing?	—	X	
13. Transportation/Circulation. Will the proposal:			
a. generate substantial additional vehicular movement?	—	—	X
b. affect existing parking facilities or demand for new parking?	—	—	X
c. Substantially impact existing transportation systems?	—	—	X
d. Alter present patterns of circulation or movement of people and/or goods?	—	—	X
e. Alter waterborne, rail, or air traffic?	—	—	X
f. Increase traffic hazards to motor vehicles, cyclists, or pedestrians?	—	—	X
14. Public Services. Will the proposal affect or result in a need for new or altered governmental services in these areas:			
a. Fire protection?	—	—	X
b. Police protection?	—	—	X
c. Schools?	—	—	X
d. Parks or other recreational facilities?	—	—	X
e. Maintenance of public facilities, including roads?	—	—	X
f. Other governmental services?	—	—	X
15. Energy. Will the proposal result in:			
a. Use of substantial amounts of fuel or energy?	—	—	X
b. Substantial increase in demand on existing sources of energy, or require development of new energy sources?	—	—	X
16. Utilities. Will the proposal result in a need for new systems or substantial alterations to the following utilities:			
a. Power or natural gas?	—	—	X
b. Communications systems?	—	—	X
c. Water?	—	—	X
d. Sewer or septic tanks?	—	—	X
e. Storm water damage?	—	—	X
f. Solid waste and disposal?	—	—	X
17. Human Health. Will the proposal result in:			
a. Creation of any health hazard or potential health hazard (excluding mental health)?	—	—	X
b. Exposure of people to potential health hazards?	—	—	X
18. Aesthetics. Will the proposal result in obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?	—	—	X
19. Recreation. Will the proposal affect the quality or quantity of existing recreational opportunities?	—	—	X
20. Cultural Resources. Will the proposal:			
a. result in alteration or destruction of a prehistoric or historic archeological site?	—	—	X
b. result in adverse physical or aesthetic effects to a prehistoric or historic building, structure, or object?	—	—	X
c. have the potential to cause a physical change that would affect unique ethnic cultural values?	—	—	X
d. restrict existing religious or sacred uses within the potential impact area?	—	—	X
21. Mandatory Findings of Significance.			
a. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number of or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory?	—	—	X
b. Does the project have the potential to achieve short-term—to the disadvantage of long-term—environmental goals? (A short-term environmental impact is one that occurs in a relatively brief, definitive period, whereas long-term impacts will endure well into the future.)	—	—	X
c. Does the project have impacts that are individually limited but cumulatively considerable? (A project may impact two or more separate resources where the impact on each is relatively small but where the effect of the total impacts on the environment is significant.)	—	—	X
d. Does the project have environmental effects that will cause substantial adverse effects on human beings either directly or indirectly?	—	—	X

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Table 5–31. Summary of Estimated Major Material Quantities Needed for Construction of South Delta Water Management Facilities

Item	Unit	Tide Gate Barriers				Intake Structure	Siphon Structure	Preferred Forebay Enlargement	Channel Dredging				
		Old River Control Structure, Boat Lock & Flash-board Structure	Old River Control & Boat Lock	Grant Line Canal Control Structure	Middle River Control Structure				Middle River South	Victoria—Old River	N. Victoria—Woodward	Santa Fe Cut	Old River South
Excavation (Channel, Structure, Cofferdam & Levee Breach)	CY	85,420	85,100	19,810	22,800	73,000	341,000	152,000	1,175,000	625,000	1,203,700	375,000	2,048,870
Embankment (Compacted, Barrier)	CY	35,400	37,100	—	—	—	—	5,835,100	—	259,000	—	555,560	—
Backfill (Compacted, Structure, Cofferdam)	TON	6,300	6,720	83,200	86,500	2,000	205,000	—	—	—	—	—	—
Riprap	TON	19,300	19,300	1,710	4,500	9,000	22,300	573,000	10,920	51,650	23,350	21,940	107,800
Aggregate Base	TON	1,260	1,260	—	—	—	—	29,000	1,660	6,670	3,850	2,220	13,840
Sand & Pervious Material	TON	2,500	2,500	910	2,530	11,000	185,500	153,000	4,620	21,880	10,730	9,290	45,670
Toe Drain	CY	—	—	—	—	—	—	17,420	70,000	40,440	23,330	145,290	
Concrete	CY	2,310	2,250	1,680	1,450	3,100	34,000	—	—	—	—	—	—
Reinforcing Steel	LB	622,500	608,200	433,260	378,290	320,000	1,432,000	—	—	—	—	—	—
Sheet Piling, (Steel Cofferdam)	SF	13,700	26,400	199,610	208,110	—	16,000,000	—	—	—	—	—	—
Piles (Timber & Precase Concrete)	LF	600	1,150	1,320	1,200	—	14,000	—	—	—	—	—	—

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siderations for an enlarged forebay would include anticipated earthquake loading.

A potential cause of levee failure that has not been documented in the Delta is liquefaction of the foundation due to earthquakes. Liquefaction is a phenomenon whereby during shaking from an earthquake, saturated sands lose strength and flow like a liquid. The Corps completed a report on liquefaction in the Delta titled, *Sacramento–San Joaquin Delta Liquefaction Potential* (Appendix J), U. S. Army Corps of Engineers, April 1987.

A preliminary seismic risk assessment of levees within thesouth Delta can be found in a study, *Preliminary Seismic Risk Analysis*, Reclamation, February 1989. The study, which is summarized in Appendix J, indicates that there is risk of failure due to earthquake loads in the south Delta.

Intake Structure. The method for construction of a new intake structure to the forebay has not yet been established. A typical construction method for a concrete control structure with one or more gates is to build the structure on dry land near the site and float the structure into the project area.

Construction of the forebay intake will require about 3,000 cubic yards of concrete and 9,000 tons of riprap materials.

Siphon. The construction of a siphon may require extensive foundation excavation methods, such as use of a braced cofferdam, cellular cofferdams, and a dewatering system.

The large reinforced concrete siphon barrel will be constructed in drydock and floated into place. A gravel bedding of 4 to 5 feet will be placed on the trenched area. When properly positioned on the water surface above the foundation, the barrel will be filled with water and sunk into place onto piling supports. The excavation under the barrel will then be backfilled with jetted sand. When the space under the barrel has been filled, the barrel will be jacked down from the piling supports to rest on the sand. Riprap will be placed on the river invert to prevent the siphon from being uncovered and displaced by streambed scour. Some 34,000 cubic yards of concrete will be needed for construction of the siphon.

Channel Improvements

Channel improvements may include dredging or levee setback. For any channel improvements, levees would be riprapped from 1 foot below mean lower low-water (MLLW) to the top of the levee.

Channel Dredging. Necessary channel improvements will be accomplished by dredging in areas with wide channels. Dredging can be accomplished by the use of a barge-mounted clamshell or dragline suction. Suction dredging will be used for the wide areas. The materials to be excavated from the existing channel bottom will either be placed on the backside of the existing levee or be used for construction of the new levees. The dredged material will not be placed on wetlands.

The dredged material and its sediments discharged at the disposal and dredging operation sites will be tested to predict the amount of contaminants, if any, in compliance with the SWRCB and the Regional Water Quality Control Boards. These materials will also be analyzed for selected constituents of potential concern.

In areas where the foundation consists of mineral soils, the spoil material may be placed as high as the existing levee. In areas where organic material exists in the foundation, the height of the spoil pile will be limited to half the height of the existing levee. The spoil embankment will be reshaped after it has dried sufficiently.

About 6-million cubic yards of materials could be excavated if all the proposed channel improvements are implemented.

Levee Setback. All newly constructed levees will be in compliance with Bulletin 192–82 standards, as well as any federal standards that may be adopted.

Settlement of the organic soil foundation under the newly constructed levee is among the problems associated with levee setback. Settlement can be as much as 50 to 60 percent of the depth of the organic material. About half of the total settlement is expected to occur quite rapidly, within two to three months; another fourth is expected within three years after placement; and the remainder over a long period of time. Since organic materials are not likely to be uniformly deep, differential settlement could cause tension cracking within the levee and subject the levee to piping and subsequent failure. Levees will be constructed to allow pore pressure dissipation to minimize the effects of differential settlement. Levee design will

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ensure that all adjacent materials are compatible so that piping will not occur. Consequently, the construction will take longer and be more expensive than with conventional methods.

Highway 4 Modification

DWR will work very closely with the California Department of Transportation (Caltrans) on possible modification to Highway 4. All plans and activities will be coordinated with engineers from both the District 4 (San Francisco) and District 10 (Stockton) offices of Caltrans.

One of the alternatives considered is to construct a roadway parallel to the existing roadway alignment. The relocation will consist of about 1,500 lineal feet of embankment and a 628-foot-long multi-span, reinforced-concrete bridge near the eastern portion of Byron Tract.

The roadway section will be 14.0 feet above mean sea level (MSL) and will consist of two 12-foot-wide traffic lanes with 8-foot shoulders for emergency parking.

The bridge will be a slab bridge with pile supports spaced at 32 feet and 26 feet. It is estimated that 80-foot-long precast prestressed concrete piles will be needed for the pile supports.

During modification and restoration, Highway 4 will be detoured; for a period of 18 to 24 months, motorists can expect delays of about 5 minutes. This inconvenience will be handled in compliance with Caltrans regulations.

Temporary Impacts of Construction

Construction of the project would necessarily cause some short-term effects on the environment. The environmental control measures would be detailed in the special provisions of each contract document.

The relocation of structures, the possible modification of highways and bridges, and the use of county roads for hauling would cause some delays and inconveniences to local residents due to detours and rerouting of traffic in the affected areas. However, the contractor will be instructed to have a flagman on the road and to avoid traffic peak hours as much as possible.

Increased noise due to construction traffic and pile driving equipment at some sites would be unavoidable, but this effect would be localized and will have minor impacts on the public. The project area is not immediately adjacent to any metropolitan areas. These activities may have some effect on local wildlife. The contractor will have to meet the requirements of the California Occupational Safety and Health Administration (CALOSHA), which should preclude unacceptable noise level.

Since the project is in a rural area, dust would not become a serious problem during excavation and hauling. The contractor will be required to minimize the dust by watering or other means of control. The dust that cannot be controlled is not expected to exceed that caused by normal farming activities. The contract specifications may also require the contractor to apply dust palliates as necessary on detours and operating roads.

Local water quality problems, such as increased turbidity, can be expected for a short time in some channels due to construction of bridge piers, siphon structures, cofferdams, and dredging. This impact will be extended through the construction period only, and will end once the project is operational. DWR will obtain permits from the Regional Water Quality Control Board, DFG, and the Corps for all operations that would cause turbidity.

A minimal amount of inconvenience to recreational activities on Old River and/or Middle River during project construction and channel dredging is expected. All the necessary permits will be obtained from proper governmental authorities.

Utilities, if any, such as gas and water supply lines, power and telephone cables, underground cables, and wells that would be disrupted by the project would be replaced or relocated at project expense. To minimize disruption of service, the relocation of such facilities would be handled by the utility company involved. Utility cables or pipelines in the project area will be either overhead or underground, as appropriate. Wells within the right-of-way boundary would be either plugged and abandoned, replaced, or otherwise compensated for.

Where land acquisition is part of a project component, DWR and Reclamation will assist each person, family, business, farm, or nonprofit organization to relocate or find an equivalent property. Every effort will be made to keep inconvenience to a minimum and to allow the party sufficient time to relocate. If necessary, a local office will be established for better service. Since this is a rural area devoted to agriculture, very few homes will be affected.

Impacts on fish migration from the construction of the intake structures, barrier-type facilities, and siphons will be

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minimal. Cofferdams, built to divert water from construction sites, will extend slightly into the river and cause temporary increases in turbidity. The changed flow pattern from the cofferdams may adversely affect fish migration, depending on timing and construction methods used.

Vegetation between the construction easement area of the canal embankment will be disturbed by construction equipment, resulting in the dislocation of wildlife. DWR has planned a mitigation program in compliance with HEP. As discussed under "Impacts on Wildlife and Wildlife Habitat" on page 159, HEP was developed by USF&WS to rate the quality and quantity of habitat so that the impacts of changes made through land and water development projects can be quantified.

The USF&WS will make certain that the Endangered Species Act of 1973 is fully administered. The act will ensure that the proposed project is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat for such species, unless an exemption of the project has been granted by the Endangered Species Committee established by the act. DFG will also ensure full protection of species on the State endangered list.

Impacts on SWP Service Areas

Improvements resulting from the SDWMP will beneficially affect the water quality and reliability of SWP supplies delivered to the SWP service areas. As a result, these improvements will have favorable socioeconomic impacts in the service areas, which could 1) include less disruption of water supplies and fewer shortages, and 2) provide less expensive source of water. In addition, the project will enable water users in the area to maintain their present quality of life. The project is not considered to be growth inducing.

Socioeconomic Impacts

Most of the impacts discussed above are difficult to quantify. However, the provision of less-expensive supplies can be measured by comparing the cost of the project with the cost of alternatives that would otherwise have to be implemented in the absence of the project. This analysis was presented in Chapter 3. The cost of options that would be displaced by the existence of the proposed facilities and the expected economic losses that would be avoided with the proposed facilities were analyzed. The total annual economic impact was estimated to be a benefit of about $28.1 million, with $23.5 million in the South Coastal service area alone.

Water Supply and Growth

This section discusses the relationship between the proposed project and socioeconomic growth in the SWP service areas. The location, timing, and magnitude of economic and population growth within a region are determined by a multitude of interrelated economic, social, and political factors, including:

- employment opportunities;
- availability and cost of natural resources, including land, water, and energy;
- availability and cost of housing;
- adequacy of community infrastructure (transportation facilities, fire and police protection, schools, recreational facilities, etc.); and
- local government policy concerning growth issues (zoning ordinances, general plans, etc.).

Since each of those variables influences growth, it is very difficult to ascertain if a change in one of them is sufficient to cause a significant change in community growth rates.

DWR's planning activities are designed to accommodate existing and planned growth—not control it. The provision of water, by itself, is not considered as stimulating growth if all the other factors listed above are not conducive to that growth.

Several complex factors must be examined to determine growth inducement. First, are there alternatives (both demand management and supply augmentation) that could be implemented in the absence of the project? If alternatives are available (even if they are more expensive than the proposed project), it can be assumed that they would be implemented in the absence of the project. Hence, with or without the project, growth will occur; the only effect of the project is a less expensive source of water.

Another factor that needs to be considered is local government policy regarding growth. Most communities in the State have implemented land use policies through their general plans and zoning ordinances that attempt to manage growth in conjunction with their available resources. These plans address population growth, land use, circulation, public services, and environmental resources. The strength of these plans in managing growth varies from community to community.

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Finally, the determination of whether a particular water supply project induces growth depends on how it is used. For example, if the project's yield is used in addition to current surface and ground water supplies, then the resulting growth-inducing impacts could be different than if the yield were used to replace existing supplies (such as overdrafted ground water basins). Also, because many existing supplies in the Southern California service area will be reduced in the future (due to decreased Colorado River entitlements resulting from increased diversions to the Central Arizona Project and the lower Colorado River Indian tribes, as well as reductions in Owens Valley supplies), supplies from the proposed project are necessary merely to maintain current water supplies.

Without LBG and KWB, The SDWMP will provide about 66,000 AF of yield to the SWP per year. If it is assumed that this water would be distributed to the SWP service areas in proportion to the service areas' total entitlement, the distribution would be as follows:

Area	Acre-feet
North Bay	1,100
South Bay	3,000
Central Coastal	1,300
San Joaquin Valley	21,300
Southern California	39,300
Total	**66,000**

The Feather River service area is excluded because, as an area of origin, it will receive its full entitlement, with or without the proposed project. The Central Coastal entitlement assumes construction of the Coastal Aqueduct. In the San Joaquin service area, about 88 percent of the entitlement will be used for agriculture, leaving a remainder of about 2,600 AF for urban uses.

For the Southern California service area, the additional supplies provided by this project should not be considered as "new." In this service area, current entitlements to the Colorado River will be reduced 775,000 AF by year 2000 because of 1) increased diversions to the Central Arizona Project, and 2) increased water rights awarded to the lower Colorado River Indian tribes. In addition, a recent Superior Court ruling mandating drastic cuts in diversions from the Owens Valley into this service area may also cause a reduction of up to 60,000 AF from the current water supplies, bringing the total possible reduction to 835,000 AF. Thus, the 39,300-acre-foot allotment that would go to Southern California would be required to partially offset this loss of supplies.

Although population growth is not directly related to water supplies, the relationship between the two can be estimated. For example, if estimates of the population supported by the project's supplies can be derived on the basis of the physical relationship between water supply and per-capita use, the above deliveries could physically support the following population:

Area	Population
North Bay	5,500
South Bay	15,000
Central Coastal	6,500
San Joaquin Valley	7,400
Southern California	0
Total	**34,400**

Because deliveries to the Southern California service area are needed to partially offset future losses of water supplies, they would not be considered as supporting "new" population.

Underlying this approach are a number of assumptions. First, it must be assumed that water supply from the project is the only constraint to growth, and that without the project, growth would not occur. This implies that there are no alternatives that could be implemented in the absence of the project. Also assumed is that all other resources (such as land and energy) and community infrastructure (roads, schools, police and fire protection, etc.) are adequate to accommodate growth.

These assumptions seem tenuous. The assumption that growth would not have occurred without the project may not be reasonable because there may be alternatives, such as waste water reclamation and desalination, that could be implemented in the project's absence. These alternatives may be very expensive, but they may be available. Also, even if the project's supplies are delivered, other resource constraints in the service areas may limit population growth. Examples include air and waste-water quality standards, traffic congestion, local government, and fiscal constraints. Given these limitations, this scenario does not provide a reasonable estimate of growth-inducing impacts. However, these numbers are provided for reference only and could be viewed as the estimated maximum growth.

A proposed water supply project should be considered to be growth-inducing only if it results in an increase in pop-

ulation projections compared with what would have occurred without the project. However, if population projections can be expected to remain the same with the project, the project can not be considered to be growth inducing.

A test of whether a project will be growth inducing depends on the availability and cost of alternatives that could be implemented in the absence of the project. If feasible alternatives are available, it must be assumed that they would be implemented in the absence of the project; thus, population growth will remain unchanged with or without the project. However, if feasible alternatives are not available, then the project would in fact remove a barrier to growth, thereby allowing it to occur.

Alternatives are available in all of the service areas. Some of these alternatives may be very expensive (such as desalination in coastal areas), but they are available. Because they are available, it can be assumed that population growth would continue with or without the project; hence no growth-inducing impacts would occur. This approach provides an estimate of minimum growth. The actual growth inducing impact may lie somewhere in between the two estimates.

The economic impact assessment follows a similar procedure; that is, it assumes that alternatives are usually available to meet projected population and economic growth, and that if the proposed project is not built, then alternatives (demand management and/or supply augmentation) will be implemented. If these alternatives are more expensive than the proposed project, the impact of the project is the avoidance of these higher costs (see Chapter 3).

SWP Cumulative Growth-Inducing Impacts

The preceding discussion focused on the growth-inducing impacts of the SDWMP without KWB or LBG. If LBG and KBG are assumed added to the SDWMP, along with a wheeling-purchase agreement with Reclamation, the SDWMP would yield about 900,000 AF.

If it is assumed that the yield of these projects is distributed in proportion to the service areas' total SWP entitlement, the distribution would be as follows:

Area	Acre-feet
North Bay	14,400
South Bay	40,500
Central Coastal	18,000
San Joaquin Valley	290,700
Southern California	536,400
Total	**900,000**

The Feather River service area is excluded because, as an area of origin, it will receive its full entitlement with or without the proposed projects. The Central Coastal entitlement assumes construction of the Coastal Aqueduct. Of the total for the San Joaquin service area of 290,700 AF, the urban allotment would be about 34,900 AF. And, as mentioned previously, the additional supplies provided by these projects should not be considered as "new" supplies in the Southern California service area because they are less than the amount required to compensate for future reductions in current supplies (835,000 AF).

As with the SDWMP, numerical estimates of population supported by these supplies can be derived:

Area	Population
North Bay	72,000
South Bay	202,500
Central Coastal	90,000
San Joaquin Valley	99,700
Southern California	0
Total	**464,200**

Deliveries to the Southern California service area are needed to offset losses of current water supplies, hence they would not be considered as supporting "new" population. Because of the limitations of such a numerical approach, these numbers are provided for reference only and could be viewed as the estimate of maximum growth. Water supply and growth-inducing impacts are discussed in detail under "Water Supply and Growth."

Local Government Policies and Impact Mitigation

Approval of any growth in the service areas is the responsibility of county or city governments. If local government decision makers in the service areas decide to allow additional urban expansion as a direct result of the project, a number of environmental impacts may occur. However, without control over the use of the delivered water, DWR has no means to accurately predict the magnitude of these

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impacts. These impacts are more properly addressed in local general plans, comprehensive plan EIRs, and specific project EIRs.

Although the decision to allow urban expansion is under local control, DWR would offer the following suggestions to local planning agencies to mitigate the impacts from this expansion:

(1) Identify and inventory quality agricultural lands, sensitive habitats, and wildlife corridors within their jurisdictions. Determine the priority of the inventoried lands, based on habitat quality and development pressures.

(2) Reserve a portion of the additional revenue from development projects and increased tax base for acquiring sensitive habitats and wildlife corridors.

(3) Provide tax incentives for maintaining agricultural lands in production.

(4) The impacts of habitat isolation and fragmentation may be alleviated by the maintenance of large contiguous habitat areas interconnected by a network of unbroken wildlife corridors. These should be coordinated with adjacent counties and incorporated into the general plans.

(5) Identify areas of marginal agricultural and environmental value. Encourage high-density development in such areas through the use of fee incentives. Such distribution of development will allow projected population increases with minimal environmental or agricultural impacts.

Impacts on Central Valley Project Service Areas

The Central Valley Project service areas are discussed in Chapter 4, "Environmental Setting." Any impacts the SDWMP may have on the CVP service areas will depend on Reclamation's participation in both the CVP tie-in and LBG Reservoir, the extent of which is unknown. Assessed impacts to SWP service areas will shift, depending on Reclamation's participation in the LBG project.

Impacts on Contra Costa Water District

It is expected that the SDWMP may benefit Contra Costa Water District (CCWD), which was formed in 1936 to contract with Reclamation for Contra Costa Canal deliveries. In 1951, CCWD entered into a long-term contract with Reclamation for 86,000 AF per year. Since then, CCWD has contracted for greater amounts to meet its growing needs. The existing contract provides for an ultimate quantity of 195,000 AF per year, commencing in 1991. The environmental setting of CCWD is presented in Chapter 4.

CCWD, which currently diverts Delta water at Rock Slough, has been investigating alternative diversion locations. These are discussed in Chapter 2 under "Related Project Components."

Impacts of the SDWMP alternatives on water quality in the Contra Costa Canal are discussed under "Impacts on Delta Municipal and Industrial Uses." The analysis showed that, under the preferred and other alternatives, Decision-1485 municipal and industrial standards are met at Rock Slough at all times. Engineering studies show that water quality in Rock Slough will probably improve during dry and critically-dry periods, compared to the no-action alternative.

If CCWD should tie into Clifton Court Forebay, engineering studies show that water quality in the Contra Costa Canal could be improved substantially.

Relationship of the Proposed Action to Land Use Plans

The SDWMP would be coordinated with land use plans in the six Delta counties: Solano, Sacramento, San Joaquin, Yolo, Contra Costa, and Alameda.

The Council on Environmental Quality and the Farmland Protection Act of 1981 require federal agencies to assess, in their EIS's, the impacts of their actions on prime or unique farmland and to consider alternative actions that could lessen those impacts. As negotiations for the SDWMP near completion, this analysis will be accomplished. The Soil Conservation Service will be contacted to identify whether the proposed action or alternatives would impact any lands classified as prime and unique farmland.

Energy and Capacity Impacts

The impacts of SDWMP on energy and capacity; total generation of a plant in a given period; and maximum output from the plant at any given time were reviewed in recognition of the following:

- The points of analysis for energy conservation set forth in Appendix F of the California Environmental Quality Act guidelines.

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- The purposes of SDWMP include the flexibility to allow for electrical load management, enabling the SWP to take advantage of short-term bulk power market opportunities.
- DWR's long-range energy resources and mitigation program.
- SDWMP facilities and additional storage south of the Delta will enable the SWP to meet the gradual increase in demands.
- Operation studies and economic analysis (see Chapter 3, "Physical and Operational Comparison of Alternative" and "Economic Analysis").

To the extent that water deliveries through SWP facilities will increase due to the implementation of a SDWMP, SWP energy requirements will also increase. However, inefficient, wasteful, or unnecessary energy consumption will be avoided by measures such as water conservation, energy recovery along the system, cost effective improvement in machinery, and minimal use of on-peak energy. Such measures are included in DWR's energy program and were incorporated in the economic analysis, which also considered the high costs of energy and capacity.

The estimated average annual increase in energy requirements, assuming 3.3 MAF SWP demands and construction of LBG and KWB, is about 800 gigaWatt hours (GWh) in SWP pumping load. About 200 GWh of this would be recovered by SWP recovery generation on the aqueduct. The remaining 600 GWh would be an increment to SWP system power requirements. These figures are based on an increase of 172,000 AF in pumping at the Banks Pumping Plant in a median year. The 600 GWh is approximately equivalent to the annual energy that would be used by 65,000 homes, or the annual output of a 100-megawatt (MW) base load power plant operating at 68 percent of its maximum output rate. A base load plant is one that is intended to run almost continuously. Examples of such plants are Pacific Gas and Electric Company's Diablo Canyon nuclear plant on the central coast or Portland General Electric Company's Boardman coal plant in Oregon.

The specific source of 600 GWh cannot be determined at this time; it could come from any combination of existing power resources to which DWR has access; with interconnections, these could number in the hundreds. DWR does not plan to develop any new resources to meet this increase in project load. However, DWR anticipates future purchases of 100-MW blocks of unspecified baseload. For purposes of cost analysis, these purchases can be represented as shares in existing or future power plants. A 100-MW purchase is assumed to provide 800 GWh of energy annually, half on-peak and half off-peak. The potential impacts of 100 MW share of some typical energy resources are shown in Table 5-32.

A generic coal plant would probably be similar to the existing Reid Gardner coal plant in Nevada, in which DWR is a participant.

Mitigation measures used in constructing and operating a typical coal plant include:

- a sulfur dioxide scrubber to remove at least 85 per cent of the sulfur dioxide in the flue gas,
- an electrostatic precipitator to remove virtually all fly ash from the flue gas,
- boiler design to limit nitrous oxide emissions to a maximum of 0.6 lbs/1,000,000 BTU, and
- dust abatement provisions for the coal handling and storage system.

Overall mitigation for increased power requirements is incorporated into: (1) environmental impact reports and design features for specific water and power facilities, (2) coordination of power sources and uses between utilities, (3) efficient use of water supplies, and (4) best use of off-peak power supplies to delay construction of new generating facilities.

Impacts on Navigation, Recreation, and Flood Control

Components of the SDWMP will have some effect on navigation, recreation, and flood control. Benefits and possible impacts are discussed in this section.

Navigation

Delta channels support growing commercial and recreational traffic. About 5 million tons of cargo is handled annually by inland ports, which serve ships coming up deep-water channels from San Francisco Bay. The popularity of recreation is indicated by about 10,000 berths and over 100,000 pleasure boat registrations in five Delta counties.

Most Delta waterways are navigable by small craft, and the Sacramento River is maintained by the Corps as navigable for 145 miles between Suisun Bay and Colusa under the Sacramento River Shallow Draft Channel Project.

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Table 5-32
Potential Impacts of Energy Resources

	Conventional Oil	Conventional Coal	Nuclear[1]
Land use			
square kilometers	1	1	1.5
(acres)	25-100	1,00-2,00	3,00-5,00
Cooling water required[1,2]			
cubic hectometres	2	2	3
(acre-feet)	1,380	1,380	2,330
Air emissions[3]			
(tons/year)			
nitrus oxide	1,880	2,070	—
sulphur dioxide	4,210	11,290	
particulates	143	18,434	
hydrogen sulfide	—	—	

[1]The larger land area (5,000 acres) is required if evaporation ponds are used for blowdown.
[2]For evaporative cooling towers.
[3]Annually.

Depths of 10 feet are provided below Sacramento, 6 feet from Sacramento to Colusa, and 5 feet from Colusa to Chico Landing. In addition, the authorizing document for Shasta Dam provides minimum releases of 5,000 cfs to maintain navigation depths; however, releases for other CVP uses generally exceed this minimum requirement

The SDWMP will have negligible effect on deep-water channels, and therefore will not impact most of the commercial navigation. There is, however, a potential to affect a very small amount of commercial navigation, consisting of such traffic as sugar refinery barges and equipment and material barges for construction and repair. Barges will still have access to the same areas, but travel time may increase. The barrier-type facility on Grant Line Canal will have either a permanent opening or boat locks to accommodate this type of traffic.

Some channels in the south Delta have inadequate water levels, thereby exposing shoals, mud flats, and submerged debris. This restricts recreational use and can cause hazards for boaters in the area. Impacts on recreational use are discussed in greater detail in the following section. The SDWMP has the potential to significantly improve recreational boating.

The benefits and possible impacts to navigation are summarized below.

Benefits:

- Water levels are raised in south Delta channels.
- Channels are deepened and widened.
- Summer-time channel velocities are reduced near the forebay intake gates.

Impacts:

- Temporary closing of certain reaches of channels and rerouting due to construction.
- Some loss of travel time due to boat locks.

Recreation

The SDWMP will provide for increased recreational opportunities in the Delta. Increased channel access through higher water levels and increased channel surface area through channel improvements will add to the areas available for boating and fishing. Construction of barrier-type facilities and an improved forebay may enable greater public access to the Delta waterways.

The Delta provides a variety of public recreational opportunities including fishing and motor boating (see discus-

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sion in Chapter 4, "Environmental Setting"). A draft report by Reclamation titled *Draft South Delta Recreation Study*, 1988, estimates that more than 14,000 people use the south Delta region on a typical summer Sunday. Appendix L contains a summary of this report.

However, the report also states that public recreational opportunities in the south Delta are limited because of insufficient facilities. Such public facilities as parking, boat launch ramps, camp units, and picnic areas are very limited in the south Delta, causing the demand for public recreation in the south Delta to far exceed the supply.

Water-related Delta activities depend on adequate water levels in the Delta channels; however, Delta water levels tend to be fairly consistent from year to year. During the drought of 1976-1977, while reservoirs throughout the State were extremely low, the Delta maintained about the same water levels and recreational opportunities as in other years. However, some areas in the south Delta are generally inaccessible to motor boating because of constricted channels.

The SDWMP includes proposed barrier-type facilities on Old River, Grant Line Canal, and Middle River, and an improved forebay. The construction and maintenance of these facilities may provide opportunities for the installation of such recreational facilities as overnight sites, picnic areas, boat ramps, and beach areas. The operation of the barrier-type facilities will raise water levels in the south Delta, perhaps allowing greater boat access to constricted side-channels.

The facility on Grant Line Canal will allow the passage of boat traffic in either direction. This may be accomplished through a boat lock or by a permanent opening in the structure. This will maintain accessibility to Old and Middle rivers, but may require additional boat travel time and cause delays. Operation of a boat lock would be in concert with the barrier-type facility (which operates on tidal fluctuations) and may affect the timing of recreational activities.

The most popular recreational activities in the south Delta, motor boating and fishing, at times conflict. This can result in unpleasant experiences, safety problems, and the endangering of private property. By restricting boat passage, the barrier-type facilities may provide opportunities to create special areas for compatible recreation uses by separating conflicting activities. This might also make possible a greater diversity of recreational activities in the south Delta, but recreationists would have reduced mobility and those in the similar groups would be limited to participating in compatible activities. Existing commercial and private developments might have to adapt their operations to new recreational patterns. Visitors would have to be educated on the proper uses of any special areas, and law enforcement might be needed for regulation.

The SDWMP may impact recreational opportunities in Oroville Reservoir. Since SWP exports vary under the no-action alternative and other alternatives, including the preferred alternative, the operation of Oroville and San Luis reservoirs changes. This variation in reservoir operation will be reflected in changes in water surface elevations and the subsequent changes in recreational opportunities. Recreation use in these reservoirs is directly related to water levels, boating being one of the most popular activities. In 1987, Oroville Reservoir had over 800,000 recreation days of use, while San Luis Reservoir had almost 350,000 recreation days of use.

There are two marinas and four boat ramps at Oroville Reservoir and two boat ramps at San Luis reservoir. The water surface elevation required for these facilities to be usable and the frequency at which they could be used from June through September under the no-action, the preferred, and the other alternatives is shown in Table 5-33. The table indicates that recreational opportunities at San Luis reservoir will be unaffected, but those at Oroville Reservoir for the preferred alternative and the other alternatives will decrease.

No-Action Alternative. Under the no-action alternative, recreational opportunities in the south Delta will remain sharply limited. Demand for recreation in the Delta, currently exceeding supply, will continue to increase as the population of the Delta area grows.

The boat ramps at San Luis Reservoir will continue to be usable in almost all years. The boat ramps at Oroville Reservoir at Bidwell Canyon, Lime Saddle, Loafer Creek, and the spillway will be usable approximately 85, 86, 86, and 92 percent of the time, respectively, during June through September. The marinas at Bidwell Canyon and Lime Saddle will be usable some 85 and 86 percent of the time, respectively, during the March through October.

Preferred Alternative. Under the preferred alternative, recreational opportunities in the south Delta will increase. Channel improvements in Middle River from Woodward Canal to the Santa Fe Railroad will provide for

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Table 5-33
Impact of Alternatives on Boating in Lake Oroville and San Luis Reservoir
(Based on 57-Year Study with 3.3 MAF SWP Demands)

Facility	Required Water Level (ft)	Percentage of Time Facilities Usable (June—Sept)		
		No-Action	Preferred	Other
Oroville Reservoir				
Boat Ramps				
Bidwell Canyon	781	85	73	73
Lime Saddle	775	86	74	74
Loafer Creek	775	86	74	74
Spillway	725	92	89	89
Marinas				
Bidwell Canyon	781	85	73	73
Lime Saddle	775	86	74	74
San Luis Reservoir				
Boat Ramps				
Dinosaur	325	100	100	100
Basalt	350	100	100	100

more boating and fishing. The construction and operation of barrier-type facilities and an improved forebay may provide increased access to the Delta waterways.

The barrier-type facilities may allow for special recreation areas, which might increase the enjoyment and safety of recreation in the south Delta. The operation of the barrier-type facilities will raise the water levels in the southern channels, perhaps allowing increased boating access to some side channels. Boats in Grant Line Canal may be required to pass through a boat lock, perhaps impacting motorboat mobility and causing some travel delays, but it is expected that the overall effect on recreation in the south Delta will be positive.

Under the preferred alternative, boating access at San Luis Reservoir will be unaffected since the boat ramps should remain accessible in virtually all years. At Oroville Reservoir, however, access to the boat ramps will be reduced. The boat ramps at Bidwell Canyon, Lime Saddle, Loafer Creek, and the spillway will be accessible some 73, 74, 74, and 89 percent of the time, respectively, during June through September. The marinas at Bidwell Canyon and Lime Saddle will be accessible about 73 and 74 percent of the time, respectively, during March through October.

Other Alternatives. All the other alternatives will have recreational impacts on the Delta, Oroville, and San Luis reservoirs similar to those for the preferred alternative.

Flood Control

The SDWMP will not have negative effects on flood control in the south Delta. Although local velocities may at times increase near the intake gates, levees are not expected to erode (see discussion under "Impacts on Channel Velocities, Scour, and Siltation," and "Impacts on Cross-Delta Flows and on Levees.") The program will, however, provide the following significant flood control benefits:

- Channel enlargements will provide better capacity for flood flows.
- New levees will be constructed to higher standards; existing levees affected by the SDWMP will be upgraded.

Other Considerations

The analysis of environmental impacts in this chapter used statewide operation studies and Delta studies, which assumed cumulative storage in LBG Reservoir and KWB of 2 to 3 MAF for the SDWMP alternatives. If storage south of the Delta should increase with no assumption of Delta facilities beyond those in the various alternatives,

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the statewide operation studies and Delta studies would yield results similar to those completed. It is expected that the analyses of environmental impacts would yield results close to those discussed in this chapter. If additional storage south of the Delta were assumed, operational considerations to protect fish could be implemented to provide additional benefits for fish. If LBG and KWB are not constructed, the SDWMP could still provide additional operational flexibility for SWP diversions that could be used to benefit Delta fisheries. However, this benefit would be less than that resulting from construction of KWB and LBG.

The statewide operation studies and Delta studies used in the analysis of environmental impacts in this chapter assumed SWP demands of 3.3 MAF. As SWP demands increase with time, without mitigation, the SDWMP, along with LBG and KWB, could gradually reduce the fishery benefits that will be gained through implementing the SDWMP.

Summary of Impacts Under the Preferred Alternative

Impacts under the preferred alternative were determined for the following:

Energy Impacts. To the extent that water deliveries through SWP facilities will increase due to implementation of the SDWMP, SWP energy requirements will also increase. The estimated average annual increase in energy requirements is about 800 GigaWatt hours (GWh). About 200 GWh of this would be recovered by SWP recovery generation on the aqueduct. Operational flexibility achieved by implementation of the SDWMP will also partially offset SWP energy requirements through use of both off-peak energy and short-term bulk power available in the market.

Construction Impacts. Impacts due to construction of the project components are temporary and consist of:

- increased traffic in the project area;
- increased noise levels;
- disturbed vegetation in the project area;
- possible disrupted local utilities; and
- increased dust and turbidity in the project area.

Impacts on Wildlife and Wildlife Habitat. Under the preferred alternative, Clifton Court Forebay will be enlarged by about 3,000 surface acres. Agricultural land in the project area will be purchased and converted for use in the forebay expansion. Channel enlargement will include design to provide berm habitat by levee setback. Losses of wildlife habitat will be fully mitigated through adoption of a wildife management plan for Sherman Island or for other appropriate locations.

Impacts on Salmon and Steelhead. Under the preferred alternative, changes in Sacramento River flow and SWP exports may cause some negative impacts to migrating salmon and steelhead. The barrier on Old River at the confluence of the San Joaquin River will improve San Joaquin River salmon migration.

Direct impacts of the Delta complex on salmon are calculated by a fish loss model. The preferred alternative resulted in slightly greater losses of Chinook salmon compared to the no-action alternative.

Impacts on Resident Fish. Direct impacts of the preferred alternative on resident game and non-game fish were evaluated. Two species of resident game fish (black crappie and bluegill), and two non-game fish (threadfin shad and yellowfin goby) were impacted. However, the impacts were found to be insignificant. All of the other resident fish evaluated, including Delta smelt, will benefit from implementation of the SDWMP.

Impacts Evaluated with Insufficient Information to Determine Significance

Impacts on Archeological and Cultural Resources. There are a great many archeological sites within the legal Delta. Many exist in agricultural areas where it is considered impracticable to avoid a site when conducting farming operations. The channelization of the Delta waterways, the extensive levee system, and intensive agricultural practices disturbed many areas before any archeological surveys could be conducted.

Archeological sites are characterized as mounds of soil on natural levees containing a variety of artifacts, including unbaked clay shards, fresh water fish bones, stone chips, and human burials.

Archeological and cultural resources information centers for San Joaquin and Contra Costa counties were contacted. In San Joaquin County, seven cultural resources are located within one mile of the project area. In Contra

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Environmental Commitments

DWR or Reclamation are committed to the following:

- *negotiate with DFG according to Article VII of the existing Banks Pumping Plant Fish Agreement to identify additional protective measures for the Bay-Delta estuary.*
- *negotiate with SDWA to protect local agricultural water diversions, local water quality, and local water levels.*
- *seek Congressional authorization for construction of mitigation and enhancement facilities.*

DWR or Reclamation are committed to further define and implement the following as part of the SDWMP:

- *continue existing—and, if necessary, expand—monitoring programs for sedimentation, scouring, seepage, water quality, and the effectiveness of mitigation plans.*
- *mitigate for wildlife habitat losses by adopting a wildlife management plan on Sherman Island or other locations as appropriate.*
- *maintain existing channel berm habitat, and include design to provide additional berm habitat by levee setback.*
- *mitigate for construction impacts, including using flagmen and off-peak hours for transportation and replanting impacted vegetation.*
- *mitigate for energy impacts, including best use of off-peak energy supplies, and to mitigate for any new power facilities.*
- *perform comprehensive testing of dredged materials if used for enhancement of existing levees or construction of new levees.*
- *continue activities that contribute toward mitigation for cumulative impacts of the project.*
- *obtain necessary federal and State regulatory permits.*
- *make available the option for improved water supplies to the Contra Costa Water District through interconnections.*
- *operate SWP under the preferred alternative to not conflict with any requirements imposed on DWR by the State and federal Endangered Species Acts.*
- *operate the CVP in such a manner that it will not jeopardize the continued existence of any listed species.*
- *reduce predation in Clifton Court Forebay by removing predators and providing intermittent direct diversion from Italian Slough into the fish protective facility.*
- *complete the Class III Cultural Resources Survey for the selected alternatives. If any stites are found to be eligible for the National Register and cannot be avoided, a mitigation plan will be developed.*

DWR or Reclamation are also committed to:

- *provide improved forecasting for Delta water supply conditions for local agriculture.*
- *construct facilities to improve flows in the San Joaquin River to improve survival of young salmon.*
- *provide interim releases from New Melones Reservoir for improvement of both water quality and fisheries.*
- *advance statewide water conservation and reclamation programs that could lessen the demand on Delta water supplies.*
- *participate in a recovery team for winter-run salmn and obtain appropriate agreements or permits..*
- *comply with future Delta standards set by SWRCB as the result of its current hearings.*
- *operate the CVP in compliance with Delta water quality standards set by SWRCB as a result of its current hearings, provided that the required operatiion complies with Congressional directions.*

Costa County, four prehistoric archeological sites are in the project area.

The design and/or specifications of the alternative actions will include avoidance of known archeological and cultural resources sites. A Class II archeological and cultural resources survey by specialists from Reclamation field surveys is now under way. An investigation is being conducted to evaluate specific cultural resources in the project area. Very possibly, undisturbed archeological and historical cultural resources are within or near the proposed project area. The law requires that if cultural resources are found during project-related activities, all work is to cease and the lead agency and a qualified archeologist are to be contacted for an evaluation of the find.

Sites that cannot be avoided should be evaluated for their significance and eligibility for listing in the National Register of Historic Places, pursuant to Section 106 of the National Historic Preservation Act. If it is determined that adverse effects will occur to sites which meet the criteria of the National Register, the State Historic Preservation Officer will be consulted so that acceptable mitigation procedures can be developed.

Impacts on San Francisco Bay. The impacts of pulse flows and Delta outflow on the San Francisco Bay estuary are still not completely understood. Overall, the preferred alternative produces minimal changes in outflow pulse characteristics and slightly decreases annual Delta outflow as compared to the no-action condition. How Delta outflows under the preferred alternative affect San Francisco Bay biological resources is unknown.

Mitigation Measures

Objectives of the SDWMP include improvement of existing conditions in the south Delta; therefore, mitigation and enhancement features are an integral part of south Delta planning.

Mitigation for Delta Estuary Impacts

A major purpose of the SDWMP is to improve and maintain water levels, circulation patterns, and water quality in the south Delta.

This section discusses the various categories of Delta mitigation applicable to the SDWMP. These are in addition to the Delta protective measures discussed in Chapter 1 and other mitigation measures discussed in Chapetr 6.

Included in the purpose of the SDWMP are objectives to improve Delta conditions; therefore, mitigation and enhancement features are an integral part of this planning. Coordination between this program and other DWR planning activities, such as North and West Delta Water Management Programs, will provide environmental benefits. To further environmental protection, DWR and Reclamation are also negotiating an agreement with DFG to provide Delta mitigation and various measures. Although this agreement has not yet been completed, a list of potential mitigation measures has been identified.

Other aspects of mitigation discussed for this project include measures for short-term construction impacts and energy impacts.

Mitigation for cumulative impacts related to the Delta is discussed in Chapter 6. This includes such measure as compliance with Decision D-1485 protective standards, federal protection under the COA, Suisun Marsh Protection, funding for the Interagency Ecological Study Program, and implementation of the Banks Pumping Plant Fish Agreement for the Harvey O. Banks Pumping Plant.

The SDWMP will correct the low-water problems that the SDWA experiences a few times during each irrigation season. The proposed method of project operation will also correct the existing circulation problems. Proposed integrated facilities that will provide for mitigation measures are as follows:

- Mitigation and enhancement barriers are proposed at four locations to improve water levels and circulation for local agricultural use and to improve water quality, temperature, dissolved oxygen, and flow patterns for fish. These patterns, discussed in Chapter 2, are included in the preferred alternative.
- The barriers are a major portion of the proposed agreement between SDWA, DWR and Reclamation. A temporary rock barrier installed in Middle River during the irrigation seasons of 1988 and 1989 has improved both water levels and water quality. A new siphon was constructed and dredging completed for Tom Paine Slough as a mitigation measure.
- The ability to relocate the federal intake to Clifton Court Forebay and increasing the size of the existing forebay will improve water levels in the south Delta channels.
- A forebay modification for intermittent diversions from Italian Slough directly into the fish protective facility will significantly reduce present striped bass

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and salmon predation impacts within the existing forebay.

- Levee setbacks will be used to provide channel enlargements. A new levee will be constructed and the old levee will be breached and made into a new channel island. Levee setbacks will provide new high-quality fish and wildlife habitat, added shoreline, shaded riverine habitat, additional local flood protection, and increased channel capacity.

- The analysis of impacts caused by the SDWMP assumed the construction and operation of the proposed LBG Reservoir and KWB as part of the SDWMP. The results showed reduced project impacts to striped bass by 1) reducing reverse flows and export in May, June, and July, and 2) improving water quality in April and May. If LBG and KWB are not constructed, the SDWMP will still provide increased operational flexibility.

- Interim New Melones releases will provide improved water quality for south Delta agriculture and fish, along with important instream fishery benefits in the Stanislaus and San Joaquin rivers. These releases are proposed as part of the SDWA contract. A long-term program to provide for New Melones releases into the south Delta is being studied under the Stanislaus and Calaveras Conjunctive Use Program, which is described in Chapter 6.

- Proposed acquisition and development of wildlife areas in the west Delta will result in better land use management and reduce or stop island land subsidence. This will permit rehabilitation of poor levees and make the island more secure. This will also increase the reliability of Delta water quality.

- Water management activities are to reduce SWP export buildup rates. By 2010, DWR expects that extraordinary conservation water management actions will be needed to reduce demand 400,000 AF to account for shortages that may occur 10 percent of the time. Water reclamation is assumed to add 200,000 AF of supply. Also, water savings by lining of the entire All American Canal and the remaining unlined portion of the Coachella Canal should make up to 117,000 AF available annually to the South Coast Region. All of these measures will reduce the demand for water from the Delta. In addition to these measures, DWR is continuing to advance the major water conservation programs discussed in Chapter 3.

- Negotiations to expand the existing Banks Pumping Plant Fish Agreement for the Banks Pumping Plant are in progress under Article VII of that agreement.

  The principal negotiators are DWR, DFG, and Reclamation. To date, the negotiators have identified a number of promising mitigation ideas, which are listed below. Some may be funded to add to the mitigation provision for the SDWMP.

- Study and test Delta Cross Channel gate closures to move striped bass down the Sacramento River.

- Study and test the concept of using pulse flows from Shasta, Oroville and Folsom lakes to move both striped bass and salmon downstream.

- Continue support for studies on the effect of temperature and flows and how project operations might be improved to benefit fish and wildlife.

- Install temporary barriers and monitor benefits to fish and wildlife.

- Improve existing fish facilities at Tracy and Banks Pumping Plants.

- Study the feasibility of relocating and consolidating Delta agricultural diversions. The proposal for a wildlife management plan on Sherman Island with potential different water demands may allow curtailed dversion during the striped bass spawning period. With possible changes in land use, other islands might curtail diversion.

- Support increased State and federal funding for mitigation studies and projects.

- Transport young fish by truck or barge to increase survival. Eliminate reverse flow in the Lower San Joaquin River during the striped bass spawning period by implementing the North Delta Water Management Program.

- Support the feasibility of installing fish screens on other large Delta diversions.

- Continue to improve striped bass hatchery populations and expand stocking program.

- Continue to improve grow-out facilities at the Skinner Fish Facility.

- Support studies to improve techniques to better detect large masses (clusters) of striped bass eggs and larvae as they drift downstream and approach major water intakes.

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Energy Mitigation

To the extent that water deliveries through the SWP system are increased by implementation of the SDWMP, State Water Project energy requirements will also increase. Inefficient, wasteful, or unnecessary energy consumption will be avoided by such measures as water conservation, energy recovery (estimated at 700 GWh) along the system, cost-effective improvement in machinery, and minimal use of on-peak energy. Such measures are included in DWR's energy program, and were incorporated in the economic analysis, which also considered the high costs of energy and capacity.

The remaining 600 GWh required would be an increment to SWP system power requirements. These figures are based on an increase of 172,000 AF in pumping at the Banks Pumping Plant in a median year. The 600 GWh is approximately equivalent to 100 MW of base load power plant running at 65 percent capacity.

The specific source of 600 GWh cannot be determined at this time. It could come from any combination of existing power resources to which DWR has access, which, with interconnections, could number in the hundreds. DWR plans no new resource to meet this increase in project load. In its resource planning, however, DWR projects future purchases of 100-MW blocks of unspecified generic baseload. For costing purposes, these blocks represent shares in existing or future coal plants.

Mitigation measures employed in constructing and operating a typical coal plant include:

- A sulfur dioxide scrubber to remove at least 85 percent of the sulfur dioxide in the flue gas.
- An electrostatic precipitator to remove virtually all of the fly ash from the flue gas. Improve the boiler design to limit nitrous oxide emissions to a maximum of 0.6 lbs/1,000,000 BTU.
- Dust abatement provisions for the coal-handling and storage system.

Overall mitigation for increased power requirements is incorporated into: 1) environmental impact reports and design features for specific water and power facilities, (2 coordination between utilities of power sources and power uses, 3) efficient use of water supplies, and 4) best use of off-peak power supplies to delay construction of new generating facilities.

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Chapter 6. CUMULATIVE IMPACTS

This chapter discusses cumulative impacts on the San Francisco Bay–Delta estuary, including the South Delta Water Management Program (SDWMP), cumulative impacts of State Water Project (SWP) deliveries in the service areas, and potential mitigation measures for cumulative impacts. Federal, State, and local planning, as well as other projects related to the Delta, are also discussed.

In general, *cumulative impacts* refer to two or more individual effects that are significant when considered together, or that compound or increase other environmental impacts. Cumulative impacts from several projects are changes in the environment that result from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor, but collectively significant, projects taking place over time.

General Impacts of Past and Present Development

Many forces affect the complex Bay–Delta estuary environment. Changes have occurred in six general areas:

- Bay and Delta land changes, reclamation, and flooding;
- population;
- pollution and water quality;
- recreation;
- fish and wildlife; and
- Delta and Bay hydrology.

Implementation of the SDWMP would be associated primarily with cumulative effects on the last three areas; however, all six areas are discussed, because the relationships between them are complex and interwoven. Table 6–1 summarizes general effects on the San Francisco Bay–Delta Estuary that would result from implementation of the program.

Table 6–1
General Effects of SDWMP on Past and Present Bay–Delta Estuary Cumulative Impacts

General Area Affected	Effects of SDWMP
Reclamation	Provides for added wetlands through design modifications and mitigation.
Delta flooding	Some regulation of flood flows and increased channel capacity.
Population	No change.
Pollution and water quality	Improved local and SWP water quality from interim New Melones releases. Also improved circulation.
Recreation	Increased recreational opportunities and access.
Fish & wildlife	Reduced impacts to striped bass; better flow patterns for downstream San Joaquin River migrating salmon.
Delta hydrology	Improved water levels. Minor changes to outflow.
Bay hydrology	Minor effect on outflow surges.

Reclamation. In 1850, there were about 300 square miles of marshlands and more than 250 square miles of tidal and submerged lands in San Francisco Bay area. Due to reclamation, little more than 75 square miles of marshland, and only about 150 miles of tidal and submerged lands remain unchanged. Of this, almost half, mostly along the southern sections of San Francisco Bay, was originally reclaimed for salt ponds. Large areas in the north and south bays have been reclaimed for airports. Thus, reclamation has cumulatively reduced valuable riparian and wetland habitat for many Bay–Delta species.

The SDWMP will provide a more valuable natural riparian and wetland habitat by the following three methods: First, the design of facilities will recognize the importance of natural habitat. Channels will be enlarged by constructing new setback levees on agricultural lands, and maintaining the old levee as a new channel island. This will provide numerous miles of new habitat, as well as a new channel and water areas.

Second, as facilities are designed, recreational needs will be considered, and both the land and opportunity for additional recreational uses will be available. New channels

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and berm islands will also provide opportunities for natural areas and recreation.

Third, the proposed mitigation land areas on Sherman Island will restore part of a large Delta island to more natural vegetation and wetlands.

Delta Flooding. In its natural environment about 140 years ago, the Delta consisted of tidal swamp, overflow lands, and grasslands covered with dense growths of tules and other water-loving vegetation. It was subject to intermittent intrusion of ocean salts during the dry summer months of lean water years and to uncontrolled flooding during winter and spring.

Over the years, the former swamplands of the Delta have been transformed into some 50 man-made reclaimed islands and tracts, largely devoted to farming. By 1930, all swamplands considered feasible for reclamation had been leveed and were being farmed.

The fertile Delta islands are defined by more than 1,000 miles of levees that protect nearly 500,000 acres of productive farmland. Maintaining this fragile levee system has been a continuous problem since the original reclamation began in the 1890s; more than 100 levee failures have occurred since then. Even with today's construction equipment and improved governmental assistance, there have been 24 levee failures since 1980. Reclamation of inundated islands has become so expensive that in some cases they have been left flooded (Franks Tract, lower Sherman, Little Franks Tract, Big Break, and Mildred Islands). To date, State and federal disaster assistance have provided $65 million to repair levee breaks. Some adverse effects of levee failures include:

- degradation of Delta water quality;
- loss of agricultural production;
- major disaster fund expenditures;
- loss of wildlife habitat and effects on fish;
- urban damage; and
- disruption of utilities, gas well production, and highway traffic.

The SDWMP facilities will provide for increased channel capacities and levee improvements in some areas. The enlarged forebay, with winter banking operations, will be capable of accepting flood water, thereby reducing flood flows.

Population. Population of the San Francisco Bay-Delta area has risen from 5.8 million in 1980 to 6.3 million in 1985, an 8 percent increase. An increase to 7.9 million in 2010 has been forecasted—a growth of 26 percent. This population growth will affect, water supply and demand, water quality, air quality, plant and animal life, noise pollution, land use, housing, and esthetics. Population increases in local service areas are discussed in Chapter 5. None of the SDWMP facilities or proposed operations will affect population forecasts.

Pollution and Water Quality. Overall, the Interagency Delta Health Aspects Monitoring Program studies have shown the Delta to be an acceptable source of water, which, when treated, meets existing drinking water standards. In the future, however, water exported from the Delta may be more difficult and expensive to treat if expected new water quality standards are adopted. Also, export water quality could possibly be improved by certain proposed new construction, such as enlargement of Clifton Court Forebay, and by water project operations in the Delta.

The major source of Delta inflow is the Sacramento River, which drains the Sacramento Valley. This includes rice field drainage containing pesticides. During the rice-growing season, up to one-third of the Sacramento River inflow can consist of rice field drain water, and during very wet years, Valley drainage can enter the Delta and Cache Slough via the Yolo Bypass system.

The San Joaquin River is the second major tributary providing Delta inflow. The river carries considerable salts from irrigation drainage and other sources in the San Joaquin Valley.

The San Joaquin River has been the subject of recent concern regarding its effect on Delta water supplies. Data collected by the Department of Water Resources (DWR) and from other sources indicate that San Joaquin River water is not higher in pesticide concentrations than that of other streams tributary to the Delta, such as the Sacramento River. Pesticide levels in water samples from all streams measured were far below established drinking water limits. Selenium data collected by DWR and the U.S. Geological Survey (USGS) demonstrate that the San Joaquin River is not now significantly degrading Delta water supplies, although the possibility of future adverse impacts cannot be dismissed.

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Near the Delta, more than 50 municipal and industrial waste dischargers release about 453,000 acre-feet (AF) of waste water annually. In addition, drainage from Delta agriculture totals over 1 million acre-feet (MAF) annually.

The rate of flow of uncontrolled direct surface runoff entering San Francisco Bay is nearly the same as the flow rate of municipal and industrial waste water (975 cubic feet per second [cfs] vs 790 cfs). However, several times as much pollution enters San Francisco Bay via direct surface runoff; therefore, this is the largest single source of pollution. On the other hand, certain parameters, such as 5-day biological oxygen demand (BOD) and nitrogen loadings, are, as expected, much higher from waste water sources.

Sound water resources management requires comprehensive data collection to enable understanding of factors that can adversely affect water quality. Toward this goal, DWR, in cooperation with other agencies, initiated the Interagency Delta Health Aspects Monitoring Program in 1983.

This program is vital to fulfillment of DWR's mission of water resource planning and drinking water protection in California. The program was developed in response to recommendations by a scientific panel appointed by the DWR Director to assess the quality of Delta water supplies as it affects human health. The program focuses on sodium, bromide, selenium, asbestos, trihalomethane precursors, and pesticides, all of which are important because of their potential effects on public health.

The SDWMP will provide flow control structures to increase operational flexibility and improve Delta water quality. In addition, cumulative programs, such as interim releases from New Melones Reservoir, will help improve water quality through increased flow and circulation.

Additional discussion of toxics and pollution is presented in the section, "Fish and Wildlife."

Drinking Water Quality. The preferred alternative in conjunction with other programs will have additional water quality benefits for drinking water supplies. The interrelationship of water supply planning and the Delta as a source of drinking water is recognized by DWR and other water agencies. Numerous water resources programs and studies have been initiated to understand this relationship and to implement projects that will improve both supply and quality of water. The following programs and studies describe the efforts being made to assure water quality protections and water supply benefits.

The SDWMP will help improve water quality in the south Delta and at the export pumps by moving Clifton Court Forebay intake gates further north to Middle River. This will result in a greater portion of SWP export coming from the Sacramento River. According to the DWR report *The Delta as a Source of Drinking Water: Summary of Monitoring Results 1983 to 1987,* dated January 1989, the Sacramento River, upstream of the Delta Cross Channel, has a lower THMFP and lower brominated formation potential than any other monitored location in the Delta. Flexibility to take advantage of short-term and seasonal availability of good-quality water can also enhance water quality.

The West Delta Water Management Program (WDWMP) will improve the levees protecting Sherman Island, thus reducing the possibility of salinity intrusion into the Delta due to island flooding. WDWMP also proposes to change the land use of Sherman Island from agriculture to wildlife habitat. This change would reduce or eliminate subsidence, helping to reduce island flooding potential. THMFPs in the west Delta would also be reduced because: 1) the potential for salinity intrusion from the Pacific Ocean (a source of THMFPs) due to Sherman Island flooding will be less and, 2) less agricultural drainage water, which has a high concentration of THMFPs, would be released into the Delta channels due to the change in land use.

The North Delta Water Management Program (NDWMP) will reduce reverse flow in the Delta. This will improve water quality in the Delta by directing more Sacramento River water directly through the central Delta to the export pumps instead of around the western end of the Delta where it mixes with saline ocean water before flowing into the central Delta. This will reduce TDS, Cl, and THMFP of exported supplies.

Under low-flow conditions, the Sacramento River has about 215 ppb THMFP, with a brominated fraction of about 6 percent. Water in the western Delta near Sherman Island has about 1,000 ppb THMFP, with a brominated fraction of 90 percent.

Senate Bill 34 (SB 34) allocates funds to protect Delta islands from flooding and provides protection against short- and long-term water quality degradation in the Delta. If a levee fails and a large Delta island becomes flooded during an extended low-flow period, salty water

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from Suisun Bay could be drawn into the Delta. This would adversely affect Delta water quality and diversions for the SWP and the CVP, and extra releases from upstream reservoirs would be required to flush out the salts. If the levee is repaired and the flooded island pumped out, effects on project operation would be short term. Such short-term water quality problems do not occur if a levee breaks during periods of high winter flows, which would keep salt water out of the Delta.

If a flooded island is not reclaimed, long-term water problems could affect the SWP and the CVP. Evaporation from a flooded island exceeds the consumptive use of agriculture by up to 2 feet per year. Permanent flooding of certain western Delta islands could increase salinity intrusion and cost the projects additional water to maintain water quality.

A Contra Costa Canal interconnection with Clifton Court Forebay would provide better quality water to Contra Costa County. The additional benefits described for the SDWMP could also be made available to the Contra Costa Canal intake.

The New Melones Conjunctive Use Program will help improve water quality in the south Delta by increasing flows in the San Joaquin River during dry and critically-dry years. Two central valley water agencies have firm water rights to 49,000 AF of New Melones water and 106,000 AF of interim water. Current negotiations between these two agencies and DWR involve release of this water into the San Joaquin River during dry and critically-dry years in return for state cost sharing in building water transfer facilities to transport the water from New Melones Reservoir to the two water agencies during normal and wet years. The increased San Joaquin River flows will dilute the concentration of contaminants in the San Joaquin River and Delta, thus improving water quality.

The Interagency Delta Health Aspects Monitoring Program (IDHAMP) was created to obtain water quality information that will help in making decisions about water quality and to assess potential water treatment methods in the Delta. IDHAMP has been collecting data at 20 locations in and near the Delta since 1983. The major findings and conclusions listed below are extracted from IDHAMP's report *The Delta as a Source of Drinking Water: Summary of Monitoring Results 1983 to 1987,* January, 1989.

- Studies have shown that the Delta is an acceptable water source. Once treated, Delta water meets all current water quality standards.
- Proposed drinking water standards for THMs and disinfection by-products may necessitate modifications in drinking water treatment processes or in the operation of Delta export facilities.
- Data from a few Delta island agricultural drains suggest that peat soils contain high concentrations of organic THM precursors. Organic THM precursors are also carried into the Delta by river inflows and saltwater intrusion.
- Bromides enter the Delta during episodes of saltwater intrusion and increase brominated THM production. The San Joaquin River is a fresh water source of bromides, the origin of which is unknown. Brominated THMs can be difficult to treat because they readily form during conventional disinfection processes.
- Pesticides and industrial chemicals are infrequently detected in Delta water. When detected, concentrations have been very low and do not exceed drinking water standards.
- Sodium is rarely a problem in Delta export water, except to people on very strict low-sodium diets. However, during low Delta outflows, sodium concentrations may rise to levels of concern to those with moderate sodium restrictions.
- Asbestos fiber counts are often high in Delta water. However, properly operated water treatment facilities can meet the proposed drinking water standard for asbestos.
- Selenium is barely measurable in Delta export water. The San Joaquin River does contain measurable amounts of selenium, but it does not exceed drinking water standards. During a sampling study period from 1984-1987, selenium values never exceeded the drinking water standard of 10 mg/l at any of the IDHAMP stations. Of 257 total samples taken at 18 locations over the study period, selenium was undetectable at the 1 mg/l detection limit 199 times. Selenium was never observed to exceed 3 mg/l.

In 1987, an Agriculture Drainage Investigation was added to IDHAMP to determine the influence of agriculture drainage on Delta water quality. The preliminary results of the investigation indicate that THMFP concentrations are influenced by soil type, crop production and crop type, soil leaching practices, and flow volume in the Delta channels. An enlarged monitoring program was recommended as necessary to characterize the variability of THMFP and flows of Delta agricultural drainage.

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Additional future studies recommended by IDHAMP include:

- sources of THMFP and bromides in the San Joaquin River and the San Joaquin River influences on water quality in the Delta;
- algal production as a potential source of organic THMFP in the Delta, Suisun Marsh, and SWP;
- relationship between THMFPs present at the Banks Pumping Plant and in the water delivered to Southern California; and
- effects of proposed water facilities and operational changes of existing water facilities on water quality in the Delta.

The California Urban Water Agencies (CUWA) recently financed a study to determine changes in operation of the existing water facilities or construction of new facilities that will allow the Delta to remain as a viable future source of drinking water. The study, reported in *Delta Drinking Water Quality Study,* May, 1989, by Brown and Caldwell Consulting Engineers, outlines current water quality in the Delta with the present water facilities, and the possible water quality improvements if other previously and currently considered water resources facilities are implemented. This study shows that these Delta facilities could improve water quality in the Delta. Higher quality Delta water would reduce the cost and complexity of treating drinking water to meet standards and increase the possibility that treatment plants could reliably remove contaminants from the water.

In anticipation of EPA's probable further restrictions on drinking water quality standards, MWD initiated a two-year study of three water treatment processes: 1) granular activated carbon (GAC), 2) ozone, and 3) peroxone, which is a combination of ozone and hydrogen peroxide. Preliminary results indicate that peroxone provides the best results in reducing THM levels (below 2 or 3 parts per billion). Demonstration-scale tests of both ozone and peroxone, the two best and least-costly processes, should be conducted by MWD in 1991.

DWR is upgrading its Delta water quality modeling to include simulation of the dynamics of TDS loading by Delta agriculture drainage returns. This effort will enable DWR to improve its evaluation of salinity patterns in the interior Delta, particularly the south Delta.

Assembly Bill 955 (AB 955) instructed DWR to coordinate with Reclamation to develop emergency plans to quickly resume exports by the SWP, CVP, EBMUD, and Contra Costa Water District in the event of a levee failure in the Delta. The emergency plans—which are outlined in a December 1986 DWR report, *Sacramento–San Joaquin Delta Emergency Water Plan: Report to the Legislature*—prescribe various procedures that, if enacted, would maintain adequate Delta water quality and resume export operations.

Recreation. Along with population, water-oriented recreation in the Delta has increased to some 12 million visitor-days in 1980 and is expected to reach almost 14 million in 2010. This will increase fishing pressure and boating. The SDWMP will provide both land and opportunity for increased recreation and access.

Fish and Wildlife. During the past century, the estuary has undergone some dramatic changes. Land reclamation, dredging, water development projects, introduction of new species, water pollution, and excessive fishing have caused some resources to decline. Many of the commercial fisheries began to diminish before the turn of the century. Since 1970, a portion of the Interagency Ecological Studies Program's work in San Francisco Bay–Delta has been to distinguish the impacts of State and federal water projects from the impacts of other natural and cultural factors, such as flood and drought, pollutants, and introduced species.

Introduced species fall into two categories—intentional and accidental. Many species were introduced in the late 1800s and early 1900s to provide fish that would be recognized by recent immigrants. Striped bass, carp, goldfish, catfish, sunfish, largemouth bass, and American shad were brought into California. In many cases, these fish displaced native species and are now accepted by most Californians. Project operations are often modified to protect them, particularly striped bass and American shad. On the other hand, current DFG policy is to severely restrict the introduction of further new species into California. Still, accidental introductions of other various organisms are continuing in the estuary, which may affect the estuary's ability to provide suitable habitat for game fish.

Recently, large numbers of a small clam, two small fish food organisms called copepods, and a small fish called the chameleon goby have been found in a portion of the upper estuary that has long been the nursery grounds for young striped bass. These new arrivals apparently came from the Orient by way of ballast water pumped from

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ships into San Francisco Bay–Delta. The food chain of striped bass and other fish can be disrupted by competition from the clam and the goby or by displacement by the copepod of a native species that has been the preferred food for recently hatched larval bass. The appearance of these new organisms may be one of a number of reasons why fewer young striped bass are produced now than during the 1960s and early 1970s.

The plant and animal community in San Francisco Bay–Delta is constantly changing. Natural resource and regulatory agencies must be made aware of these changes when they try to assess project impacts and define reasonable levels of protection. If these introductions have caused changes in basic system productivity, it may be impossible to determine historic population levels.

In May 1989, the California Fish and Game Commission listed the winter–run Chinook salmon as endangered, based in part on estimates by DFG that the population of the run was under 600, down from what had appeared to be a stable 2,000. Under State law, after the Commission determines the basis for listing a species, it must adopt a regulation to that effect.

The National Marine Fisheries Service (NMFS) listed their winter run as threatened under an emergency listing in August 1989.

The basic provisions of both sets of regulations prohibit "takings" of listed species and require an agency involved in activities that could jeopardize the listed species to consult with the appropriate fishery agency. Taking is defined very broadly. Violations can lead to civil and criminal actions. DWR will be working closely with DFG and NMFS to determine exactly how the listings will affect DWR and Reclamation Board activities and programs.

An extensive hearing procedure aimed at developing new water quality objectives for San Francisco Bay–Delta estuary and the means to achieve them began in July 1987. During phase one of the hearings, considerable disagreement arose over the impact of water development on the health of San Francisco Bay–Delta fisheries. Declining striped bass populations also received considerable attention.

Salmon populations have been relatively stable. Hatchery production has increased, and thus is compensating for the decline in natural production.

Reverse flows, which can occur under controlled flow situations, also contribute to the fishery decline. Reverse flows consist of export water flowing down the Sacramento River to the vicinity of Sherman Island and then upstream (hence the term *reverse flow)* in the San Joaquin River to State and federal pumps. This route results in many young salmon and bass being either directly drawn into the pumps or disoriented from their historical migration paths.

Some reports have concluded that changes in fresh water outflow cause significant biological changes in estuaries of all types. Changes result, in most cases, from responses by organisms to physical conditions such as altered circulation patterns, increased salinities, and reduced nutrient input. The ecological significance of these changes is not completely defined in most systems. In some cases, the same flow change favors some organisms and adversely affects others. Biological responses to flow are difficult to document because the cause–and–effect relationship between flows and organism abundances generally operates through a chain of events rather than direct effects of flow alterations on abundance.

Historical biological resources in the Delta were quite different from the existing resources. Upstream dredging and hydraulic mining in the 19th century deposited large amounts of sediment and debris throughout the Delta, burying biological communities and changing hydrologic and hydraulic characteristics.

Agricultural development in the late 1800s and early 1900s resulted in major habitat modifications. As early as 1920, nearly all the Delta marshlands had been diked and converted to farmland. Less than 10 percent of the original bay marshlands remain. Physical, chemical, and biological processes were dramatically changed.

Historically, natural levees formed along the edges of many of the Delta's tule islands and supported woody riparian vegetation. Historical navigation charts show tall trees and shrubs along the banks of major Delta channels.

Presumably, most of the Delta's woody riparian vegetation was eliminated many years ago to provide waterfront–access farmland, and wood for fuel and construction. Maintenance of present–day levee banks prevents the growth of most large trees and shrubs.

Wildlife habitat or cover types in the south Delta are agricultural, forest, riparian forest, riparian scrub, emergent fresh water marsh, and heavily shaded riverine aquatic. The California Natural Diversity Data Base has assigned both the riparian forest and fresh water marsh its highest priority because of its almost complete destruction in the Central Valley.

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Rare, threatened, and endangered plant and animal species that may be found in the project area are discussed in Chapters 4 and 5. The SDWMP will also:

- add wetlands as stated above under "Reclamation";
- reduce impacts to striped bass;
- improve migratory paths for San Joaquin River salmon;
- create improved conditions for resident fish in south Delta channels;
- provide mitigation to reduce current predation;
- provide for mitigation in connection with negotiations for a Delta fish protective agreement;
- provide additional shoreline and habitat; and
- reduce predator problems.

Delta Hydrology. Natural features of San Francisco Bay-Delta estuary affecting the environment are ocean tides and salinities, inflows of fresh water, and interior Delta flow patterns. Ocean salinity intrusion varies with fresh water inflow rates. Tidal fluctuations occur in regular cycles throughout the year. Natural tributary inflow to the Delta is controlled by the climate and varies greatly from season to season and from year to year. Before major upstream regulation, low dry-season inflow often allowed ocean salt water to intrude far into the estuary. In 1924, 1926, 1931, 1934, and 1939, chloride concentrations in nearly all Delta channels exceeded 1,000 milligrams per liter (mg/l).

Control and development of Central Valley streams to reclaim land and to produce the power and water needed for California's farms, homes, and industries have altered the seasonal pattern of river flows and reduced the amount of water reaching the ocean by way of the Delta. Wet-season flows are reduced principally by storage in upstream reservoirs and by exporting Delta inflows. Dry season flows are reduced by upstream uses, but releases from project reservoirs maintain Delta outflows at or above minimum protective levels specified by the State Water Resources Control Board (SWRCB). In the Central Valley, local water uses and exports for use elsewhere have reduced the unimpaired runoff from a 57-year historical annual average of 28 MAF to an annual Delta outflow of 13 MAF per year, a reduction of 15 MAF per year. Unimpaired runoff represents the natural water production of a river basin, unaltered by upstream diversions, storage and exports, or imports, but assuming existing channelization.

Delta outflow in an average year is the sum of:

- 5 MAF required to meet Decision 1485 requirements and to protect water quality at project export pumps, and
- 8 MAF of unregulated Delta outflow in excess of minimum requirements.

The 15 MAF-per-year reduction in unimpaired runoff includes:

- 1.6 MAF of local Delta use.
- 5.9 MAF of combined SWP and CVP water exported directly from the Delta for use both inside and outside the Central Valley.
- 7.5 MAF of upstream uses, including exports from the Central Valley via the Hetch Hetchy Aqueduct, Mokelumne River Aqueduct, Friant-Kern Canal, and other local projects.

The SDWMP, along with the Los Banos Grandes (LBG) and Kern Water Bank (KWB) programs, will increase average annual SWP exports by some 250 TAF. This is about 1 percent of the historic average annual Delta outflow.

Bay Hydrology and Circulation. San Francisco Bay is often referred to as an "urbanized estuary" because of its proximity to such a large population center. Water circulation in San Francisco Bay is of major importance for many human uses of San Francisco Bay. Water movements disperse and eventually remove unwanted materials from the system.

Bay circulation is driven by three main factors: tides, estuarine circulation, and wind-induced mixing. Most water motion in San Francisco Bay is the result of tides. Filling and diking along San Francisco Bay over the years have changed the tidal range, which in turn has affected tidal flushing of San Francisco Bay. The average volume of water passing the Golden Gate during a single flood or ebb tide is about 1.1 MAF, which is about 20 percent of San Francisco Bay's total volume.

Estuarine circulation created by fresh water inflow from the Sacramento River system is also being studied as a factor affecting net transport into and out of San Francisco Bay. Estuarine circulation is driven by the difference in density between fresh water and salt water, which is related to Delta outflow. The importance of estuarine circulation, and its association with the effect of winter storms on salinity distribution in the southern reaches of

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San Francisco Bay, is being investigated in connection with flushing the South Bay and controlling long-term buildup of toxic materials. Fresh water inflow to San Francisco Bay also provides large amounts of suspended sediments and nutrients, which contribute to San Francisco Bay's ecological balance. The SDWMP will have minor effects on inflow and outflow surges to the Bay.

Information presented by the State Water Contractors at San Francisco Bay-Delta Hearings suggests new and different evaluations of fresh water inflow to San Francisco Bay under natural conditions. The new factors considered in the evaluation of inflow have been popularly referred to as the "Tule Theory."

The Tule Theory. Before the Central Valley was developed, the valley trough functioned as a holding basin, filling and draining every year. Tule marshes choked these natural reservoirs, and riparian forests lined the stream channels along the Valley floor. This natural vegetation took advantage of the plentiful supply of water, using far more than the irrigated crops that replaced them.

According to the "Tule Theory," fresh water inflow to San Francisco Bay from the Delta is presently about the same, on an annual basis, as it was under natural conditions. Drainage, reclamation, flood control, and water development in the Central Valley have not significantly affected the quantity of fresh water reaching San Francisco Bay.

The principal result of upstream development has been: 1) replacement of the natural valley holding basins with man-made upstream storage reservoirs, and 2) replacement of the evaporative water losses by natural vegetation with consumptive use by crops and humans.

Early development in the Valley increased outflows while subsequent development reduced them to about their initial level. Evaporative water losses from the original marshes and riparian forests in the Central Valley exceeded present in-basin use and exports by about 110 percent. The monthly distribution of flow into San Francisco Bay was much more uniform under natural conditions than now, and winter and spring pulse flows that are common today were probably rare under natural conditions.

The timing of previous flow conditions can affect the type and magnitude of biological responses to outflow-related effects. These considerations make it difficult to establish statistically sound and predictable cause and effect relationships between outflow and biological parameters.

Other Factors. Many factors contribute to change in the San Francisco Bay-Delta estuary system. Some of these will continue to affect the estuary, with or without SDWMP. Others will be cumulatively impacted by incremental changes caused by the program. Some incremental changes may be beneficial, such as reduced reverse flows in the lower San Joaquin River in accordance with the North Delta Water Management Program (NDWMP). Past, present, and future factors which have impacted, or will impact, the estuary include:

- land reclamation;
- sediment load from early hydraulic gold mining activities;
- waste water effluent and surface runoff from local and upstream urban development;
- oil spills;
- drainage and leaching water discharge from Delta and upstream agricultural water use;
- commercial, sport, and illegal fishing;
- construction and maintenance of deep water shipping channels;
- use of natural inflows by agricultural and urban development;
- changes in amount and variation of outflow;
- upstream storage and regulation of natural inflows by the CVP, SWP, Hetch Hetchy Aqueduct Project, Mokelumne Aqueduct Project, and other local projects;
- Delta diversions by the CVP, SWP, local municipal and industrial water users, and Delta agricultural water users;
- levee failures in the Delta; and
- some positive beneficial effects due to improved environmental factors.

The SDWMP will add cumulatively to the regulation of Delta exports and outflows. The program will have an unknown effect on San Francisco Bay, but will add cumulatively to the environmental stress caused by other factors. Other moderating unknown effects are filling and reclamation.

SWP Planning and Related Projects

DWR planning programs for the Delta and related projects are discussed in this section.

North Delta Water Management Program

The NDWMP represents parallel planning and environmental documentation to improve existing conditions in the northern portion of the Sacramento-San Joaquin Delta. The program includes a public review of problems, alternative solutions, impacts, and mitigation to provide information for selecting corrective action. This process brings to light the many interests and their valid concerns related to water resources planning in the Delta. The program will also include investigation of the cumulative effects of any corrective action when coupled with other facilities statewide and in the Delta.

Multipurpose objectives will be considered to meet the broad range of water management issues surrounding the Delta. Primary objectives of this program are to help alleviate flooding in the north Delta area, reduce reverse flow in the lower San Joaquin River, improve water quality, reduce fishery impacts, and improve water supply reliability. Secondary objectives are to improve navigation and enhance recreational opportunities.

The planning process allows flexibility in formulating and selecting project alternatives and mitigation measures, and facilitates coordination of related local, State, and federal planning. The process will also investigate the cost-sharing allocation among Delta interests, water users, and other beneficiaries. Related planning programs will be coordinated to reinforce benefits and minimize costs.

The environmental documentation process is required for federal and State regulatory permits and agreements. Federal regulatory permits are required to authorize any selected alternative. Also, numerous State and local regulations apply. This assures involvement by key agencies, such as the NMFS, the U.S. Fish and Wildlife Service (USF&WS), EPA, and DFG.

DWR is working closely with the U.S. Army Corps of Engineers (Corps) to determine the Corps possible involvement through existing or newly authorized flood control programs. The Corps has already held a preapplication meeting regarding DFG and its regulatory permit authority.

The program will be implemented in phases. A probable alternative being considered for the first phase is to increase hydraulic capacity of the South Fork Mokelumne River by dredging, levee setbacks, and levee improvements. The present channel cross-sectional area varies from about 2,000 square feet near the Delta Cross Channel to more than 8,000 square feet near Terminous. The area to be investigated for the first phase extends generally from Interstate 5 to the San Joaquin River. Enlarging the cross sectional area would provide significant flood-control, water-quality, and reliability benefits.

Also to be considered will be modification of the Delta Cross Channel gates to prevent Sacramento River floodwaters from flowing into the Mokelummne River system, as happened for a short period during the February 1986 storms.

Preliminary analysis indicates that dredging the South Fork Mokelumne River could provide a 5 to 10 percent reduction of these flood elevations and that dredging accompanied by levee setbacks could result in reductions of well over 10 percent. Also, reverse-flow changes occur because improvement of the South Fork Mokelumne River provides better hydraulics for water to follow the desirable path rather than the undesirable, reverse-flow path in the lower San Joaquin River. As a consequence of this reverse-flow reduction, the quality of Delta and export water supplies would be improved, fishery impacts resulting from reverse flows would be diminished, and water supply would be more reliable because of more efficient management of reservoir storage. However, the diversion potential would be greater.

After completion of phase one of NDWMP, operational experience will have been gained, and monitoring will be conducted before further phases are considered. If monitoring shows that additional work is needed to further reduce reverse flow and to furnish further benefits, later phases will be evaluated. Additional phases of the NDWMP now being considered are described in following paragraphs.

A second phase might consist of partial tide gate structures in the Sacramento River downstream from the Delta Cross Channel. The structures would raise water levels slightly in the Sacramento River during low-flow conditions so that more water would flow through the Delta Cross Channel and Georgiana Slough into the

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Mokelumne River system, a more desirable flow path for export supplies. This also would diminish the amount of water following the undesirable reverse flow path around Sherman Island in the west Delta.

These structures would be open during flood conditions and would be designed not to interfere with flood flows. The structures would have permanent openings in the center to minimize impacts on navigation and fish, and they would be operated to comply with SWRCB's protective standards. Gates would be opened to let the incoming tides pass and would be closed to restrict the ebb, or declining, tides. The specific location and design of these structures has not yet been determined.

A third phase to reduce reverse flow might be a partial tide gate structure in Three-Mile Slough. A fourth phase might be a new Sacramento River connecting channel near Hood or Isleton to further improve efficiency of water transfer through the Delta. A new connecting channel would allow more water to be conserved in reservoirs to increase water supply reliability.

The general relationship between flow in the Sacramento River and water movement through the Delta for existing conditions, South Fork Mokelumne River enlargement, and other possible phases shows that each phase provides increased capability to transfer more water from the Sacramento River into the Mokelumne River system.

West Delta Water Management Program

The West Delta Water Management Program (WDWMP) is centered on four major issues: flood control, water quality, wildlife concerns, and water supply reliability. The importance of these issues to the west Delta, and to the Delta as a whole, has necessitated a broadened scope of planning, including development of a wildlife management plan for Sherman Island.

Because of its location, the 10,000-acre Sherman Island is important in: 1) protecting the reliability and quality of the Delta water supply, 2) providing wildlife habitat, and 3) protecting highways and utilities. The island is the focus of the WDWMP. Its objectives are to:

- improve levees for flood control;
- protect Delta water quality;
- implement the wildlife plan, which will include acquisition of island properties for development of diverse waterfowl and wildlife habitats;
- meet water supply and water quality needs of Sherman Island;
- provide habitat for waterfowl and wildlife;
- minimize oxidation and land subsidence;
- protect the reliability of the SWP and CVP;
- identify potential wildlife habitat mitigation opportunities for present and future water development projects;
- protect highways and utilities; and
- provide additional recreational opportunities.

Alternatives for the WDWMP have been designed to allow a phased approach and flexibility in implementation. Phasing provides for lower initial costs and an opportunity to modify future phases based on information gained during initial phases. The process is being guided by the objectives discussed above, plus other considerations such as:

- maintaining the integrity of the island by reducing the rate of land subsidence, which is largely caused by present farming practices. The Farm Securities Act of 1987, administered by the U.S. Soil Conservation Service, mandates that soil conserving management practices must be developed to minimize soil erosion and loss.
- providing cost-sharing opportunities for special Delta flood control projects identified in Senate Bill 34;
- emphasizing development of wetland and riparian habitat. Senate Concurrent Resolution 28 emphasizes the importance of wetland habitat in California and mandates that DFG increase wetland habitat in the State;
- managing consumptive water use, while effectively providing habitat for wildlife;
- providing for flexibility in acquisition of lands or land use easements;
- providing flexibility in land use management options;

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- providing an opportunity to incorporate habitat mitigation for SWP and CVP water management programs; and
- minimizing costs by using existing island water distribution systems.

The WDWMP is still in the implementation stage. Many factors are being considered to provide benefits and as much flexibility as possible. These include phased planning, land acquisition, cost sharing, nonproject levee rehabilitation, and mitigation banking. A necessary part of any program in the west Delta will be rehabilitation of the nonproject levees.

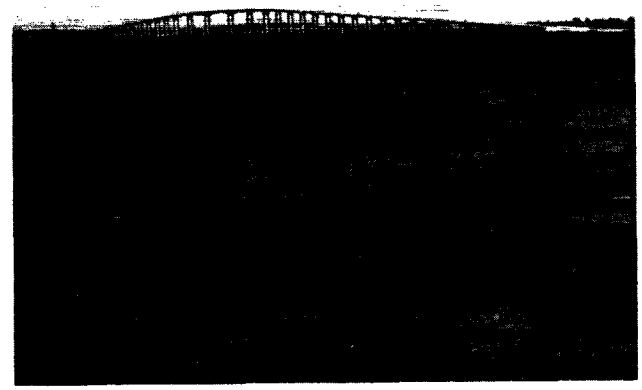
A phased planning approach can provide flexibility. Development of wildlife and wetland habitat can be accomplished progressively, and any of the alternatives discussed could be the starting point, possibly culminating in a full or partial wetland development plan. Phased planning also provides for a minimum acquisition plan, which initially would involve only a portion of the island. This concept allows a project to be initiated at the lowest possible cost.

Land acquisition options include direct purchase or some type of purchased easement that will ensure land management practices that benefit wildlife. Easements of this type have been successfully negotiated for similar wildlife management projects in California. In any case, acquisition of parcels will involve negotiations with the landowners. Selection of acquisition options will depend on landowners' needs and the type of alternative selected for implementation.

To protect any water management program investment for Sherman Island, nonproject levees on the island must be rehabilitated. This investment would also protect State Highway 160, utilities, Delta water quality, and reliability of project water supplies.

The degree to which these levees would be improved is not yet established. However, standards will be consistent with implementation of Senate Bill 34, a program of levee protection recently signed into law by the Governor. Rehabilitation of these levees will be common to all proposed water management program alternatives and will have high priority.

To provide an opportunity to incorporate habitat mitigation for SWP and CVP projects, including NDWMP and SDWMP, a mitigation banking concept may be applied to



View of the Senator John A. Nejedly Bridge Connecting Sherman Island to the City of Antioch

any of the wildlife management alternatives. In a mitigation banking plan, portions of Sherman Island would be developed as needed to mitigate habitat impacts from future water development projects. This would allow "in-kind" mitigation for project impacts.

The value of habitats established on the island as mitigation would depend on the type of habitat developed. Objectives can be established to achieve maximum benefits for wildlife. The mitigation bank would develop in an orderly fashion, with habitat types developed adjacent to each other rather than at random throughout the island. As with any of the alternatives, areas with common irrigation and drainage systems would be developed simultaneously to avoid duplication of construction efforts.

Coordination With D-1485 Rehearings

Decision 1485 focused solely on the water rights and operations of the two largest water projects, the SWP and the CVP (decision issued April 13, 1984, by Superior Court Judge Richard Figone). Reclamation and DWR were required to maintain Delta water quality according to standards based on "without project" conditions, as if the projects had never been built.

Lawsuits by various water users and the federal government challenged Decision 1485, which was overturned in 1984. However, the standards remained in force until a decision was issued by the Court of Appeal. In 1986, the appellate court broadly interpreted SWRCB's authority to establish and enforce water quality objectives that assure reasonable protection of beneficial uses of Delta water, as well as protection for San Francisco Bay. The ruling also ordered SWRCB to consider the effects of all upstream water uses, not just those of the SWP and CVP

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(ruling issued May 28, 1986, by presiding Judge John Rancanelli).

In July 1987, SWRCB opened Phase I of San Francisco Bay-Delta hearings to gather evidence on the beneficial uses of Bay-Delta water. After 54 days of testimony, cross examination, and rebuttal on 14 subjects, Phase I concluded in late December 1987.

A work plan guided the hearing process during the last couple of years. However, after SWRCB concluded Phase 1 and released its draft water quality and pollutant policy documents, it became clear that some provisions of the overall work plan needed revising. SWRCB requested staff to remove consideration of flow-only objectives from the water quality control phase (old Phase II) and defer this consideration to the water rights decision phase (Old phase III). It also asked staff to allow for greater development of implementation alternatives to water rights regulation. SWRCB indicated that the work plan should set forth an open and thorough process for the water quality control phase.

Initial drafts of the revised work plan include many opportunities for input from the hearing participants on the work plan, the revised water quality control plan, the pollutant policy document, and on other nonregulatory methods of protecting beneficial uses in the San Francisco Bay and Sacramento-San Joaquin Delta. With regard to the nonregulatory measures, the draft work plan allows for a scoping hearing on physical facilities, negotiated settlements, legislative action, and other agencies' responsibilities before the water rights phase begins. The draft work plan also specifically allows for input from technical work groups and DWR water planning efforts.

The first series of technical work groups deals with operation studies to analyze the impacts of the draft plan on the availability, allocation, and use of Central Valley water supplies. The second series of work groups deals with supply, demand, and water conservation evaluations. Urban and agricultural issues are considered in separate work groups Also established are a Delta agricultural work group and a public trust work group, a conjunctive use work group and economics work group.

Recently, the Metropolitan Water District of Southern California (MWD) and other major urban water users around the State requested and were granted a workshop series on trihalomethanes (THMs) and other constituents found in Delta drinking water supplies.

This open process should provide an improved plan but will take longer. Tentatively, SWRCB will adopt the water quality control plan in June or July 1990, and the hearing on water rights will begin after extensive scoping hearings, which have not yet been specifically scheduled.

Coordinated Operation Agreement

The essence of the Coordinated Operation Agreement (COA) is the sharing formula, which provides a CVP/SWP proportionate split of 75/25 responsibility for meeting in-basin use from stored water releases, and a 55/45 responsibility for the capture and export of excess flow. Both parties also agree to meet a specified set of Delta water quality standards (Exhibit A of the May 20, 1985, Agreement) from SWRCB Decision 1485. Exhibit A standards are a set of water quality standards and export and flow restrictions that define the Delta portion of in-basin use requirements.

These standards provide more environmental protection than the Reclamation's present water quality requirements, known as "Tracy Standards," by adding about 100 new protective criteria at 15 additional Delta locations. This agreement also requires a commitment of about 2.3 MAF from both projects during a critical water supply period to meet Delta outflow and quality protective needs.

Careful evaluation of all comments received on the Draft EIR/EIS revealed that no significant impacts would be caused by implementation of the COA; therefore, no mitigation was recommended. Also, many of the commenting agencies and individuals favored implementation of the COA.

The project has the potential to increase Delta inflow and export, and decrease Delta outflow. However, fish screening losses can potentially increase. The COA requires Delta protection, and there are possible mitigation alternatives.

The agreement was signed November 24, 1986, and is being implemented as required.

Wheeling-Purchase Negotiations Under Section 10 (h) of the Coordinated Operation Agreement. Current negotiations commenced in June 1987 and negotiators have met approximately 25 times. The negotiations are conducted in public, and public comment is permitted during the progress of the negotiations. This negotiating format has been most helpful in allowing an interchange of ideas during the negotiating process.

The USF&WS, DFG, and SWRCB have been represented at the negotiating sessions and have made significant contributions. State and federal water contractors and various fishery and environmental groups have also been represented and have provided useful input.

The negotiators recognize the need for compliance with State and federal laws requiring environmental documentation. DWR and Reclamation initiated the EIR/EIS process in August and September 1989 by issuing a Notice of Preparation and Notice of Intent, respectively. Five scoping sessions were held in September 1989. Comments on the scope of the EIR/EIS were received and will be presented in a Scoping Report (now in preparation). A draft EIR/EIS is tentatively scheduled for release in late 1990.

The negotiators are concerned about the best method of meeting the requirements of federal reclamation law. The three following alternatives have been identified as workable:

- Allocate the water to municipal and industrial uses which are not subject to the acreage limitations

- Use the agricultural commingling provisions of federal law and meet the reporting requirements of federal law on sufficient land to match the total quantity of CVP water taken for SWP use. Studies by the Kern County Water Agency (KCWA) indicate that sufficient acreage lies within the SWP service area to meet the requirements to cover the amount of CVP water the SWP is likely to purchase.

- Devote the CVP water purchased to Delta outflow, which would also be a purpose exempt from the federal acreage limitations.

All three methods appear viable, and DWR will be able to show Congress and the public that any one of them could be used. However, the DWR negotiators and the SWP contractors strongly favor the Delta outflow approach. Recently, the Reclamation negotiators have indicated their willingness to accept this approach, and DWR is currently drafting a proposed contract based on the outflow approach.

The negotiators are not entirely in agreement on a schedule. DWR negotiators take a position that environmental documentation of this proposal should proceed, but not be presented to Congress until Reclamation receives approval from SWRCB to divert from Clifton Court Forebay. The Board is currently scheduling this as part of the water rights decision phase of its Delta hearings, which are now several years away.

Harvey O. Banks Delta Pumping Plant, Additional Units

The Banks Pumping Plant was built to accommodate 11 units, but only 7 were initially installed. On December 30, 1987, a Notice of Determination was signed, and the installation schedule for the four additional units shifted from the planning phase to the design and construction phase. The new units, each with a design capacity of 1,067 cfs, are scheduled to be operational in 1991.

Completion of the Banks Pumping Plant will increase SWP delivery reliability and efficiency by increasing standby capacity for the existing units and by permitting a larger share of the pumping to be done with off-peak power. The new units will also allow a small amount of additional pumping to be shifted to the winter months. The additional units will only slightly change export, outflow, water quality, and fish and wildlife effects. The SDWMP will add slightly to the cumulative effects of this project.

The last four units of the Banks Pumping Plant will increase the total capacity of the pumping plant to 10,300 cfs, bringing the California Aqueduct up to its full design capacity between the Banks Pumping Plant and Bethany Reservoir. To protect the navigable capacity of the Delta waterways near the pumps, the Corps limited diversions into Clifton Court Forebay to historical levels (Public Notice 5802A, amended October 1981). As long as the SWP follows the operational criteria published in Public Notice 5802A, no Corps permit is needed. However, if diversions into Clifton Court Forebay are to be increased beyond historical rates, a Corps permit will be required (under Section 10 of the River and Harbor Act of 1899).

Installation of the additional units will also increase the reliability of SWP water supply deliveries. Under the Corps constraints, the additional pumps could increase firm deliveries during critical water supply periods by about 60,000 AF annually. This water, pumped during high-flow winter months, will partially offset the frequency and severity of projected shortages.

The additional pumping units will allow more pumping to be shifted to off-peak hours, when energy costs are lower. This will provide cost savings to SWP water contractors, as

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well as possibly delay the need to buy additional power or to construct additional power generating facilities.

Before the Notice of Determination could be signed, environmental concerns regarding the additional units at Banks Plant had to be addressed. A fishery agreement between DWR and DFG, signed on December 30, 1987, allowed work to continue on the final four units. The agreement spells out the steps needed to offset adverse fishery impacts by SWP Operations.

Harvey O. Banks Delta Pumping Plant Fish Agreement

DWR and DFG signed an agreement in December 1986 to mitigate direct fish losses at the Banks Pumping Plant complex. The agreement provides for DWR to make funding available for projects which will help to increase the survival of Chinook salmon, steelhead, and striped bass. The agreement requires two types of payment by DWR: 1) $15 million to initiate a program to quickly replenish fish populations depleted by SWP pumping and 2) annual payments based on the calculated numbers of fish lost at the complex.

DFG has estimated DWR mitigation responsibility for 1) about 544,000 striped bass, 631,000 Chinook salmon, and 22,000 steelhead in 1986; 2) 684,000 striped bass, 492,000 Chinook salmon, and 12,000 steelhead in 1987; and 3) 850,000 striped bass, 1,610,000 Chinook salmon, and 16,000 steelhead in 1988. All these figures are preliminary, and DWR has not agreed to any numbers until more is learned of predation in Clifton Court Forebay.

DWR's goal is to produce enough fish to replace those lost at the Banks Pumping Plant complex. Replacing the lost fish with hatchery fish would cost DWR about $1.4 million per year for 1986, 1987, and 1988. Other ways of replacing the fish—through development of spawning grounds or other environmental improvements—are preferred and might cost less, depending on the number of fish produced.

Replacement Purchases. Payments for 1986 losses are being used in part to purchase yearling striped bass from private aquaculture firms. However, obtaining enough fish has proved difficult. Although aquaculture firms contracted in 1987 to supply about 550,000 yearlings for planting in 1988, the actual supply was only about 345,000. Currently, eight aquaculture firms are licensed to rear striped bass, and they have experienced problems during the sensitive spawning and early-life stages of the fish.

Skinner Fish Facility. To provide another source of yearling striped bass, DWR and DFG are operating a newly constructed fish rearing facility on the grounds of the Skinner Fish Facility. Fish salvaged at the facility screens were reared in tanks for release in spring 1989. About 117,000 fish from this project were planted in San Pablo Bay at Rodeo and in the Sacramento River at Rio Vista.

It appears that striped bass from the salvage operation can be grown successfully at the Skinner Fish Facility, but some modifications in plumbing and water supply were needed to ensure fish survival during hot weather. After the fish rearing facility has operated for two years, DWR will determine whether the State should continue to operate growout ponds in the Delta or other locations, or whether private growers should assume this task.

Streambed Improvements. Gravel was placed in Mill Creek (Upper Sacramento River) in time for the 1988 spawning season of fall Chinook salmon. Although it is difficult to quantify the benefits of such projects, Chinook salmon were observed spawning in the improved riffles.

Hatchery Improvements. Approximately $850,000 has been allocated to improving DFG's Merced River Fish Facility. The rebuilt facility will produce more Chinook salmon that are in better condition than those produced by the present operation. DWR will receive an annual credit of about 40,000 yearling Chinook salmon (at the Delta) as a result of this project.

Fish Screen. DWR and DFG have approved an expenditure of about $40,000 to install a screen on an existing small diversion in Suisun Marsh. The screen will benefit both Chinook salmon and striped bass, as well as other fish in marsh channels. The installation will also help evaluate the potential of screening the hundreds of similar small diversions scattered throughout the Delta.

Steelhead. DFG, under contract to DWR, will allocate part of the production capacity of their Mokelumne River Hatchery to about 30,000 yearling steelhead. Because steelhead released into the Mokelumne River return at extremely low rates, yearlings from this program will be released into the American River.

New and Potential Projects. These include:

- extra striped bass stockings,

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- Sacramento River spawning gravel improvements,
- Partial funding of new or improved hatcheries,
- flow augmentation on streams tributary to the Sacramento River,
- flow augmentation on streams tributary to the San Joaquin River, and
- construction of a permanent Old River barrier.

Testing. The 1989 San Joaquin salmon tests involved the coordination of several upstream water operators to concentrate fish mitigation releases from various tributaries, in one week, to produce flows of 2,000 to 2,500 cfs timed to arrive at Vernalis together. (DWR and Reclamation will reduce exports or increase upstream releases to equal this inflow.) Tagged salmon released from several locations will be counted again in early 1992 to define the benefits that can be attained by constructing a barrier or installing a fish diversion on Old River at the confluence of the San Joaquin River.

Temperature testing in the north Delta will involve releasing three batches of salmon from various locations on the Sacramento River between Sacramento and Ryde at water temperatures of about 60, 65, and 70 degrees Fahrenheit. The objective of these tests is to determine whether water temperature is more important to fish survival than river flows.

Article VII Negotiations. On execution of the Banks Pumping Plant Fish Agreement, the parties began discussions, as stated in Article VII, of developing methods to offset the adverse fishery impacts of SWP that are not covered by the agreement. Included are facilities needed to offset fishery impacts and more efficient conveyance of water.

DWR and DFG are continuing to examine and evaluate potential striped bass and Chinook salmon projects as they are developed. An advisory committee representing fishery, environmental, and water user interests has been established to assist in evaluating and selecting projects. The agencies are also evaluating the factors used to calculate mitigation losses and will make adjustments as needed.

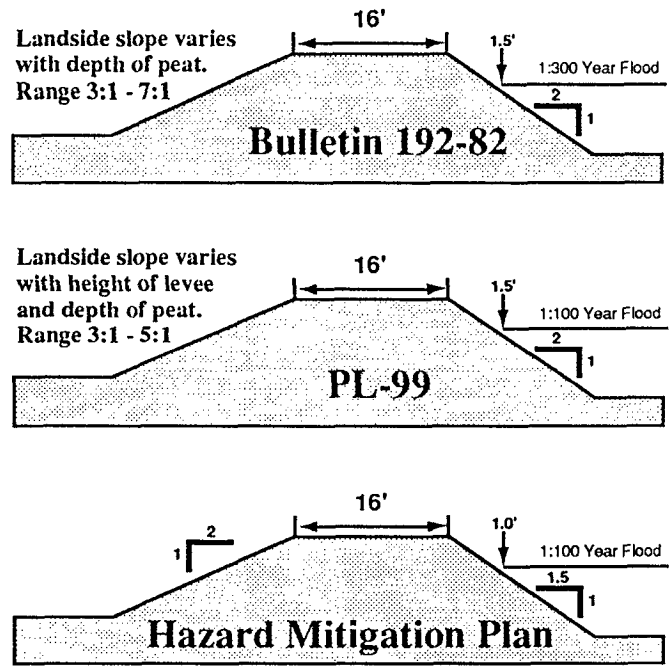

Figure 6–1. Agricultural Levee Standards

SB 34—Delta Flood Protection Act

Senate Bill 34, enacted in 1988, creates the Delta Flood Protection Fund, to be funded from tidelands revenues currently designated by statute for the California Water Fund. The Bill authorizes $12 million a year for appropriation by the Legislature for a ten-year period of flood protection in the Sacramento–San Joaquin Delta. Specifically, $6 million is allocated to the Delta Levee Maintenance Subventions Program, and the remaining $6 million is for special flood control projects for eight western Delta islands and the towns of Walnut Grove and Thornton.

Delta Levee Subvention Program. Most newly rehabilitated levees will be in compliance with Bulletin 192–82. The Delta Flood Protection Act of 1988 proposed new standards as well as any federal standards or criteria that may be adopted. Some of the existing or proposed levee standards are shown in Figure 6–1.

To avoid delays in the annual disbursement of funds from the subventions program, the following provisions of SB 34 are being implemented in three stages:

- increase in funding from $2 million to $6 million;
- increase in State reimbursement ratio from 50 percent to 75 percent;
- provision for advances;

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- provision for reimbursement for disaster-related work denied by the Federal Emergency Management Agency (FEMA);

- specific review authority by DFG to ensure no net long-term loss of fisheries, riparian, or wildlife habitat;

- competitive bidding and increased documentation requirements resulting from passage of SB 1893; and

- funding prioritization plan for years in which "applications for State funding exceed State funds available" to ensure funds are apportioned " . . . among those levees . . . most critical and beneficial, considering the needs of flood control, water quality, recreation, and wildlife." (Quotation taken from SB 34).

The protection act also provides for other flood control measures, such as modification of land management practices, and requires the local public agency to acquire easements of up to 400 feet wide along levees where DWR determines it is necessary. Mitigation of wildlife and fisheries habitat is to be determined by DFG.

In addition to the Flood Protection Fund, the bill authorizes $5 million for appropriation by the Legislature to DWR to mitigate specified adverse impacts in the Delta and San Francisco Bay and some other special areas.

SB 34 has the potential to protect water quality in the Delta from salinity encroachment due to island flooding. It will also increase water supply reliability with no net loss of fish and wildlife habitat.

Eight Western Delta Islands – Special Flood Control Project. A report discussing the future implementation of flood control measures for the eight western Delta islands identified in the Delta Flood Protection Act of 1988 is being prepared for the California Water Commission. Scheduled for release by mid-1990, the report will address such topics as:

- comprehensive levee inspections and studies to identify threatening conditions and levee sections that do not meet minimum FEMA flood hazard mitigation standards;

- assistance programs to participate in pilot programs and document the feasibility of using dredged material for levee improvements;

- programs to assist Bethel Island Municipal Improvement District and Contra Costa County in resolving levee encroachment problems according to local guidelines on Bethel Island and Hotchkiss Tract;

- funding of surveys and monitoring to document land elevations and subsidence;

- discussions with DFG and land owners to identify options for acquisition of easements and wildlife management areas that provide land use options to reduce subsidence. These discussions will include recreational opportunities; and

- Specific recommendations for "fast-track" levee improvements based on a priority of actions applicable to any of the eight islands. These recommendations would be contingent on environmental requirements.

Program priorities will be evaluated in connection with two categories. One category will be priority of actions. These actions would be designed to apply to any of the eight western Delta islands and include fast-track protective measures. Coordination efforts are under way with local representatives to identify threatening levee situations and levees that do not meet short-term FEMA flood hazard mitigation standards.

A second category will investigate island priorities. One promising high-priority program is Sherman Island. Current planning for this island investigates land use options

View of Delta Levee

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to reduce subsidence. Reducing subsidence will be a very important aspect of special flood control projects planning to identify options that will provide the highest levels of future flood protection.

A workshop on the 1988–89 subvention program attended by reclamation district(s) trustees, engineers, and attorneys was held recently. Topics discussed included definition of SB–1893 (Competitive Bidding Act) procedures, DFG criteria for ensuring no net long–term loss of habitat, possible yearly carryover of funds, and easement acquisition as defined in SB 34.

Port of Oakland Dredged Material. DWR is working closely with San Francisco Bay Area Regional Water Quality Control Board (Regional Board) to assist in the evaluation of the proposed use of Port of Oakland dredged material for levee improvements. DWR staff has been made available to help define the interrelationships between the proposal and Delta water quality. Staff plans to assist by providing modeling studies of pollutant dispersion, funding for additional sampling, and a literature search of metal stability in soils. DWR is also exploring the possibility of working with the Regional Board, the Port of Oakland project coordinator, and Delta reclamation districts to implement a pilot program and monitor water quality to test the effects of placement of material on Twitchell Island.

DWR recognizes that proposals to use dredged material must be thoroughly tested to protect Delta water quality. Protecting Delta water quality is essential since the Delta is the source of drinking water for 16 million people, and the estuary is a unique and valuable resource. Protecting water quality also means protecting islands from flooding. As demonstrated in past flood events, water quality impacts can be significant to all Delta beneficial uses. Island floodings can cause short– and long–term impacts that decrease the effectiveness of fresh water outflow and allow salt water to travel farther into the Delta. During past flood events, chloride levels reached 440 ppm at the Contra Costa Canal intake. SWP exports were also interrupted and additional salts were exported to State water users, with undetermined consequences. Future flood protection will be expensive and a program for use of dredged materials for levee rehabilitation can greatly reduce costs.

Coordination With Delta Legislation

Recently enacted water–related bills that could provide mitigation, reduce demands, or otherwise affect the Delta are discussed below:

- The federal Disaster Assistance Act of 1988, which provides assistance for people and businesses affected by drought throughout the U.S. The act authorizes the Secretary of the Interior to: 1) perform water conservation and augmentation studies and assist willing buyers and sellers of water; 2) make water or canal capacity available to water users and others; and 3) make loans to water users for management, conservation, or acquisition and transportation of water.

  The act also authorizes a specific program for Oakdale and South San Joaquin Irrigation districts, as well as construction of a temperature control curtain at Shasta Dam for anadromous fishery protection and enhancement.

- SB 795, PL 100–675: Settles a lawsuit in San Diego County over water rights to the San Luis Rey River. Among many other items, including lining the All–American Canal, the act provides for up to 16,000 AF of supplemental water per year. The water will be derived from: 1) water saved by lining the All American Canal, 2) MWD, or 3) public lands.

- SB 2261, Chapter 1545 of 1988: Permits temporary changes involving the amount of water consumptively used or stored, and permits approval by SWRCB of a petition for a long–term transfer of water or water rights, if SWRCB has approved a temporary change.

- SB 2261, Chapter 1545 of 1988: Enacts the Salmon, Steelhead Trout, And Anadromous Fisheries Program Act, which requires DFG to prepare and maintain a detailed conservation program for protection and increase of salmon, steelhead trout, and anadromous fisheries.

- AB 3654, Chapter 1488 of 1988: Requires the Reclamation Board to offer to lease to DFG, or to a public entity, any lands it acquires as replacement habitat to mitigate environmental impacts of its projects. The board is also required to prepare, in consultation with DFG, a mitigation plan to be implemented prior to construction of a flood control, channel clearing, or bank stabilization project.

- AJR 67, Chapter R-151 of 1988: Advises Congress that the legislature continues to support construction of a multipurpose Auburn Dam at the Auburn site.

- SJR 30, Chapter R-123 of 1988: Memorializes Congress to transfer control and operation of the CVP to the State of California or other public entity.

Delta Recreational Planning

The Delta is a major recreational area with many valuable and unique assets. Recreational development is spread throughout the Delta and can be classified as private (over 20 yacht clubs), commercial (over 100 marinas, valued at about $100 million), and public facilities. To date, there are 22 public recreational areas in the Delta, comprising 5,450 acres of fishing access sites, park and recreational sites, hunting areas, and boat launch areas.

Although the Delta has many recreational opportunities, many areas can be improved. Nearly all recreational facilities in the Delta are provided by private enterprise, which caters almost exclusively to boaters. Poor access and few facilities have so constrained use that demand considerably exceeds current use. For example, in 1980, actual use in the Delta was 12.3 million recreation days and the projected demand, if sufficient facilities could be provided, could exceed 21 million recreation-days annually. This results in a latent (or unsatisfied) demand of nearly 9 million recreation-days, which is expected to grow to over 25 million recreation-days if present trends continue.

Public agencies have allocated over $1 million to major reports on Delta recreational planning. A 1958 DWR report, *Sacramento-San Joaquin Delta, Master Plan for Recreation*, discussed the earliest plan for Delta recreation. In June 1966, the Resources Agency issued a preliminary edition of the *Sacramento-San Joaquin Delta Master Recreation Plan.* This report, which was updated in 1973 and 1976, was prepared by representatives of several State organizations. Specific recreational plans have since been developed by all State and local agencies with interests in recreation in the Delta. These specific plans have incorporated many of the ideas contained in the master plan. Funding is the primary problem in implementing most of these plans. Other plans, such as the extensive DWR plans for recreation and fish and wildlife improvements, are associated with the Davis-Dolwig Act and are tied to water development projects.

The Delta Master Recreation Plan occupies a ten-year span in the history of Delta recreational planning, which was updated or revised three times over this period. A major component of the plan, which was also included in several other plans, is the Delta Waterways Use Program. This program recommends an area use-classification system based on an area's natural or ecological value. It also recognizes multiple-use areas, which are designed to accommodate more intensified use (such as water transfer and recreational facilities). Recreational planning following development of the Delta Master Recreation Plan emphasizes integrating recreational planning into a levee rehabilitation strategy.

Given current economic and political conditions, it seems unlikely that a major comprehensive recreational plan could be implemented on its own merits. However, such a plan could provide an economic advantage to an overall levee rehabilitation program (assuming such a plan itself could be implemented). In addition, more focused recreational planning under Davis-Dolwig could also benefit any specific Delta water transfer plan.

Delta Wetlands Project

A unique wetlands management and water storage project for the Sacramento-San Joaquin Delta has been proposed by Bedford Properties, a land development company.

Land use on four Delta islands—Bouldin, Webb, Holland, and Bacon—will be converted from agricultural use to provide waterfowl habitat and to store water during winter and spring. The water for storage will be pumped from the islands in early summer to provide fishery benefits and for use by DWR. The project will undergo a rigorous approval process starting with applications for water rights permits.

The Bedford Properties proposal is being evaluated by DFG and DWR. Both agencies have set up task forces and are working with the project sponsor to define issues and to identify the types of information needed to make decisions about the project. Some of the issues are: (1) environmental documentation under CEQA and NEPA, (2) required permits, (3) Safety of Dams jurisdiction, (4) operation, structural engineering, and economic feasibility, (5) liability, (6) potential regulatory changes, (7) control of the water in the reservoir, (8) water quality, and (9) public perception.

The project has the potential to increase Delta exports and decrease Delta outflows during the winter. The proj-

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ect's main benefit is to provide operational flexibility, which can benefit fish and wildlife and water quality.

Offstream Storage South of the Delta

In 1984, DWR completed a reconnaissance study of 13 potential offstream storage sites south of the Delta. Reservoirs at these sites could be used to store excess runoff pumped from the Delta during wet periods and delivered via the California Aqueduct. The subsequent report *Alternative Plans for Offstream Storage South of the Delta* recommended that future studies focus on the LBG site, south of the existing San Luis Reservoir.

Any new offstream facility south of the Delta would be of little value without the capability of filling that facility during periods of surplus Delta outflow. The planned SDWMP would provide the capacity to maximize winter banking south of the Delta in a facility such as LBG.

Los Banos Grandes Reservoir. DWR is studying several separate formulations for LBG. The basic formulation would be solely an SWP water supply facility; power generated incidental to the water-supply operation would be incorporated into the SWP power resource plan. Other formulations under study include:

- a joint SWP/CVP facility with incidental power incorporated into the SWP and CVP resource plans; and
- an SWP water supply facility with participation by a private power utility in pumped-storage power generation facilities.

Planning will concentrate on project formulation, analysis of water and power operations, exploration of possible Reclamation and/or utility participation, and development of mitigation plans to offset fish and wildlife impacts. The principal environmental issues appear to be 1) the inundation of significant riparian habitat along Los Banos Creek, and 2) impacts on the San Joaquin kit fox, a species listed as 'threatened' by the State and 'endangered' by the federal government.

The revised schedule calls for completion of the draft EIR/EIS by mid-June 1990 and the final EIR/EIS in June 1991. With this optimistic schedule, the LBG facilities could be completed and in operation by mid-2002.

LBG will provide operational flexibility for the SWP. Operational flexibility will provide improved SWP operations for the fishery and enable shifting more exports to winter and high-flow months, when fish are not as abundant.

Surface and ground water storage south of the Delta will increase exports in wetter years and will cause minimum impact in drier years. Delta outflow will be reduced in wetter years, and water quality will be slightly improved during winter months. The storage projects will provide operational flexibility to reduce incremental fish screening losses.

Kellogg/Los Vaqueros Reservoirs. In fall 1985, Reclamation expanded its Kellogg Reformulation Study to include a preliminary analysis of the Los Vaqueros Reservoir site. The study previously concentrated on Kellogg Reservoir and relocation of the Contra Costa Canal intake. Reclamation's planning report and draft EIS were available for review in early 1988. The report indicated that the Highline Canal and relocation of the Contra Costa Water District (CCWD) intake to Clifton Court are the best alternatives.

CCWD began purchasing the entire Kellogg/Los Vaqueros watershed in early 1987. Environmental and land management plans were addressed by Jones and Stokes, the district's environmental consultant, during 1987 and 1988. A Stage II EIR/EIS will be completed by spring 1991. DWR has paralleled CCWD's studies with operations and cost studies needed to determine whether participation is desirable. However, SWP cannot participate in Los Vaqueros because of the language approved by the electorate in a recent bond authorization initiative

North Of Delta Additional Storage Development

The most economical dam sites in California have already been developed. For environmental, economic, or financial reasons, some reservoir projects once seriously considered for construction have been deferred. Surface storage facilities north of the Delta are discussed in the following paragraphs.

Shasta Lake Enlargement. In recent years, Reclamation and DWR have studied the feasibility of enlarging Shasta Dam. One alternative studied was to increase the height of the existing dam by 200 feet, which would enlarge the reservoir's storage capacity from the present 4.5 MAF to 14 MAF and increase the dependable water supply by about 1.4 MAF per year. Although the unit cost of water would be relatively low, the capital cost would be substantial. Therefore, California's water interests have concluded that other needs take priority over the additional storage of an enlarged Shasta Lake.

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These needs include developing more offstream storage south of the Delta, solving San Joaquin Valley drainage problems, and planning the expansion of the CVP aqueduct system of the San Joaquin Valley (the Mid-Valley Canal). As a result, Reclamation shifted its planning emphasis toward conveying and protecting the quality of existing supplies before developing new supplies. DWR, responding to growing recognition among water contractors of increasing project costs, shifted its planning to smaller, less expensive projects.

Marysville Dam and Reservoir. Marysville Reservoir on the Yuba River, originally authorized as a Corps project in the 1960s, was not developed. The proposal was reanalyzed in 1982 as a possible local project of the Yuba County Water Agency in partnership with KCWA. Neither proposal went beyond the planning stage.

Later, DWR investigated a multipurpose project to provide power, flood control, and additional conservation yield for the SWP, by using the Corps plan for the Parks Bar and Dry Creek Dam sites (about 5 miles upstream of the city of Marysville) and updating the construction cost estimates. Because of the apparent high unit cost of water from the project and the lack of local support, the proposal is currently inactive.

Glenn Reservoir Project. During the 1960s and 1970s, the State studied various possibilities for developing storage reservoirs on Thomes Creek and Stony Creek on the west side of the Sacramento Valley. Three different reservoir sites were considered for various sizes, combinations, and configurations. These were the Paskenta, Newville, and Glenn reservoirs. Under one routing of Eel River imports, the reservoir(s) would have been used to store water from the North Coast. With the slowdown in agricultural demands, and the prospect of more favorable alternatives, planning for these projects has been deferred indefinitely.

Eel River Exports. The 1973 California Wild and Scenic Rivers Act precluded development of many of the North Coast's major streams. The act also provided that DWR, after an initial 12-year period, would report on the need for water supply and flood control projects on the Eel River and its tributaries.

On August 30, 1985, DWR reported by letter to the Legislature:

> "... Based upon the situation today, we see no reason to seek legislation to withdraw the Eel River from the Wild and Scenic River's System . . . it is our view that we would not look to the Eel River as a practical source of additional water supply within the near future, irrespective of its wild and scenic status. It seems appropriate to leave the Eel in the Wild and Scenic River system, subject to future review and reconsideration."

Red Bank Project. Cottonwood Creek, in Shasta and Tehama counties, is the largest uncontrolled tributary of the Sacramento River and is a major contributor to flooding, particularly along the upper river. In the mid-1960s, the Corps selected the Cottonwood Creek Project as the most suitable means of providing flood protection and developing additional water supply.

A 1984 engineering report estimated the total first cost of the Cottonwood Creek Project at $753 million. The annual payments by the SWP contractors would have been prohibitively high. Consequently, in June 1984, DWR asked the Corps to reanalyze the project, looking at methods for cost reduction. The Corps' reanalysis reduced the total first cost to $571 million.

After discussions with the SWP contractors and a briefing before the California Water Commission in 1985, DWR decided not to participate in the project.

In June 1985, DWR's Northern District published a memorandum report, which recommends studying construction of a combination diversion and storage dam at the Dippingvat site on South Fork Cottonwood Creek, a storage dam at the Schoenfield site in the adjacent Red Bank Creek Basin, and a conveyance system connecting the two reservoirs.

Following the June 1985 report's recommendations, DWR began a two-year prefeasibility investigation of the Dippingvat-Schoenfield Project. The cost, including interest during construction and the present worth of operation, maintenance, and replacement, was estimated at $119 million. The project would provide a critical period water supply of 47,000 AF per year to the SWP, assuming Delta transfer facilities are in place. The cost allocated to municipal and industrial water supply would result in a unit economic cost that is competitive with other sources of water supply now under consideration.

The Dippingvat-Schoenfield Project would reduce the 100-year peak flood flow at Cottonwood from 106,000 cfs to 90,000 cfs. The project initially would provide up to 9,000 public recreational days per year, increasing to an

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estimated 113,000 days per year by the end of the 50-year analysis period.

Following the November 1987 report's recommendation, DWR began a feasibility study of the Dippingvat-Schoenfield Project, now called the Red Bank Project, to be completed by mid-1990. The study—being conducted in cooperation with Reclamation, DFG, USF&WS, and the Corps—will include fishery and flood control elements. Communication with Shasta and Tehama counties and cooperative agencies is maintained through an advisory group.

Auburn Dam and Reservoir. In 1967, Reclamation began preliminary construction activities for a 685-foot-high concrete arch dam at the Auburn site. The dam would have impounded a 2.3 MAF multipurpose reservoir to provide CVP water supply, power, recreation, flood control, and fishery enhancement. After foundation preparation was completed in 1976, construction was suspended to permit further study of seismic and design issues.

After intensive studies by eminent engineers, geologists, and seismologists, the Secretary of the Interior concluded in 1980 that a safe dam could be constructed. A concrete gravity dam was recommended in lieu of the original thin arch design, but final design was deferred pending resolution of questions about flows in the lower American River.

Meanwhile, the Corps has continued reconnaissance level studies of flood control options for the lower American River area. Considerable support has come from the Sacramento Area Flood Control Agency in a February 1990 resolution calling for a flood-control only dam at Auburn, which could be expanded when water, power, and recreational interests are able to finance the enlargement.

Folsom Dam and Reservoir-Folsom South Canal. Whereas this is not a new project, there has been a resolution of a long-standing problem involving a storage contract between EBMUD and Reclamation, versus a group of interested users of lower American River flows. EBMUD will be able to exercise its contract with Reclamation for 150,000 AF of Folsom storage annually and to take this water through the Folsom South Canal. A connection will be built by EBMUD between the end of the Folsom South Canal and the Mokelumne Aqueduct. In turn, EBMUD will be restricted by a diversion schedule that would help keep the lower American River in a healthy condition.

Additional storage north of the Delta will potentially increase summer and fall inflow, decrease winter and spring inflow, increase drier year export, reduce winter and spring outflow, and increase summer and fall outflow. Other potential effects include drier year water quality protection, increased river flows, and increased fish screening losses.

Central Coastal Studies

At the request of San Luis Obispo and Santa Barbara County Flood Control and Water Conservation districts, DWR is conducting advanced planning studies, including preparation of an EIR for the proposed Phase II of the Coastal Aqueduct. The Coastal Aqueduct will furnish between 52,973 and 82,000 AF per year, depending on Santa Barbara County's decision to obtain part of its entitlement from the proposed Enlarged Lake Cachuma project, providing it wants to re-purchase the 12,214 AF of SWP water relinquished in 1981. Annual entitlement of SWP water is 25,000 AF for San Luis Obispo County and between 45,486 and 57,700 AF for Santa Barbara County.

Santa Barbara County will have to develop local distribution facilities to convey its SWP water entitlement from the terminus of the Coastal Aqueduct to areas of need. One such local facility, the Mission Hills Extension, will transport water to northern communities of the county and terminate near the city of Lompoc. Another local distribution facility, the Santa Ynez Extension, would extend service to the upper Santa Ynez Valley and South Coast communities.

At the request of Santa Barbara County Flood Control and Water Conservation District, DWR is conducting the environmental assessment and reconnaissance level design for the Extension as part of the advance planning study of the Coastal Aqueduct. Costs of the Santa Ynez Extension have been estimated for economic analysis only.

Phase II, 87 miles long, starts at Devils Den in the northwest corner of Kern County and proceeds southwest of San Luis Obispo, then south to the Santa Maria River. The pipeline varies in diameter from 60 inches at Devils Den to 54 inches at the Santa Maria River. Three pumping plants will lift the water over the Tremblor Mountain range near Polonio Pass. The water will then flow by gravity to the Santa Maria turnout. A power recovery plant near San Luis Obispo will be used to reduce the pressure in the pipeline. There will be four water storage tank sites

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at Polonio Pass, northeast of Santa Margarita, east of San Luis Obispo, and just east of Arroyo Grande.

The Mission Hills Extension, 23 miles long, starts at the Santa Maria River and proceeds south to Mission Hills near Lompoc. The extension pipeline connects with the Phase II pipeline at the Santa Maria River. The extension pipeline varies in diameter from 54 inches at the Santa Maria River to 39 inches at Mission Hills. A pumping plant two miles north of Casmalia will lift the water over the Casmalia Hills. One water storage tank site will be located one mile south of Casmalia, and another will be at Mission Hills.

DWR's environmental study teams (botanists, wildlife biologists, and archaeologists) have been conducting on-site field surveys along the proposed pipeline alignment. The teams have been recommending slight adjustments in the alignment within the study corridor to avoid sensitive habitat. DWR staff members have also conducted meetings and field surveys with the Corps, USF&WS, and DFG representatives to discuss Section 404 permit requirements and to gather recommendations for minimizing project impacts. DWR staff also had five meetings with landowners to discuss alignment of the Aqueduct.

Phase II of the Coastal Aqueduct has the potential to increase SWP deficiencies slightly. Because export, inflow, and outflow are not affected by the project, no cumulative impact will result from the SDWMP.

In addition, Reclamation and DWR are conducting a joint study of the feasibility of enlarging Cachuma Reservoir (Bradbury Dam) in Santa Barbara for additional water supply for the SWP. If constructed, this would be the first local project incorporated as part of the SWP. Also, Reclamation is evaluating ways to bring Bradbury Dam into compliance with its safety of dams criteria.

The reservoir has a storage capacity of 205,000 AF and a firm yield of 24,000 AF for recreation, irrigation, municipal, and industrial uses. Water is released for these demands through: 1) a river outlet for downstream releases; 2) a pipeline for the Santa Ynez River Water Conservation District, Improvement District No. 1; and 3) Tecolote Tunnel for the Santa Barbara area. The preferred enlargement will increase storage some 197,000 AF and would provide the SWP a safe yield of 17,000 AF per year when combined with vegetation management and cloud seeding programs.

Through a contract with Reclamation, an environmental consultant has prepared a preliminary mitigation plan for the potential impacts of the enlarged Cachuma project. As expected, the key mitigation issues will be loss of riparian and wetland habitat, loss of oak/woodland habitat, and impacts to the steelhead fishery.

Potential Conjunctive Use Programs

Conjunctive use is a planned use of both surface and ground water in a complementary manner to increase water yield and/or reliance. Conjunctive use programs will generally reduce pressure on Delta exports, manage resources more efficiently, and increase yield to existing projects.

New Melones Conjunctive Use Plan. Two San Joaquin County Agencies, Stockton East Water District and Central San Joaquin Water Conservation District, made a proposal to DWR that could increase the yield of the SWP. These two districts have contracts with Reclamation for 155,000 AF (106,000 AF surplus and 49,000 AF firm) of New Melones Project water. The districts propose to use their contract entitlements in normal and above-normal years but forego diversions during dry and critical years and release the water down the Stanislaus River into the Sacramento-San Joaquin Delta. The districts would rely on ground water to meet their needs during dry and critical years and then recharge their basins during normal to wet years. In turn, they would want financing for the necessary facilities to divert and convey the New Melones water to their service areas. The proposal has been discussed with Reclamation—which owns and operates New Melones—with San Joaquin County interests, and with the State water contractors. These discussions indicate that the proposal has merit, and DWR plans to use the environmental documentation process to investigate its feasibility.

DWR and Reclamation see the proposal as having the potential to provide many benefits, including water supplies for local use, increased fishery flows in the Stanislaus and San Joaquin rivers, improved water quality in the south Delta, and increased yield to both the SWP and CVP. To attain these benefits, all parties involved must be included in the planning process. Since Reclamation owns and operates New Melones Reservoir, it is a key participant in the program.

In March 1989, DWR and Reclamation signed a Memorandum of Understanding with 15 agencies in Calaveras, Tuolumne, Stanislaus, and San Joaquin counties to pre-

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pare a plan for the long-term use of water supplies from the Stanislaus and Calaveras rivers. DWR and Reclamation have developed and completed a "Scope of Study" for the program and will issue a Notice of Preparation/Intent to prepare a Draft EIR/EIS for the Stanislaus River Basin and the Calaveras River Water Use Program.

Kern Water Bank. The KWB program is a proposed conjunctive use ground water program being developed by DWR, in cooperation with KCWA and local water districts, to augment the dependable water supply of SWP. This program would allow KWB to store and extract water from the Kern County Ground Water Basin, in coordination with the operation of surface water storage and conveyance facilities. In general, water would be banked in the basin during years of above-average water supply and withdrawn during drier years, when surface water supplies are below average.

KWB is being developed as an individual "element," or component, of an overall water recharge, storage, and extraction program of SWP in the Kern County Ground Water Basin. The Kern Fan Element is a program of direct recharge and extraction on 20,000 acres along the Kern River alluvial fan, west of Bakersfield and adjacent to the California Aqueduct. DWR purchased the land in 1988. Additional "local elements" will be developed as cooperative programs with surrounding water districts. These local elements will be combinations of in-lieu and direct recharge programs. In wetter years, in-lieu programs will provide additional water to local farmers in return for reduced surface water deliveries in drier years. Such programs will generally involve expansion of surface water distribution systems to deliver additional water in wetter years and construction of additional wells to increase pumping capacity in dry years.

During 1989, the Kern Fan Element program was restructured for staged development. Initial plans called for development of a program with maximum storage of 1 million AF, with the first stage planned for maximum storage of 300,000 AF. The first stage is planned for development beginning in 1991, and ultimate development following in 3 to 4 years.

Local elements will also be developed in stages. As of December 1989, one local element was being studied at the feasibility level, and four others were being studied at the reconnaissance level.

The Kern Fan Element has the potential of increasing SWP firm dry-period yield as much as 140,000 AF annually. Initial studies indicate that local elements could more than double the contribution of KWB to SWP supplies.

The project will increase exports and decrease outflow during wetter years, but will have no effect on inflow. It will provide operational flexibility to reduce incremental fish screening losses and only slightly degrade water quality.

Glenn-Colusa Irrigation District - DWR Contract. In late 1988, DWR entered into an agreement with Glenn-Colusa Irrigation District to perform a cooperative ground water investigation. Past studies indicate it is possible and may be economically feasible to develop a well field. The investigation evaluates the impact and economic considerations of developing the ground water.

The Glenn-Colusa Irrigation District has drilled a test well to determine the feasibility of supplementing the surface water supply with ground water. DWR is funding 50 percent of this project. The district wishes to develop a conjunctive use operation to ensure its users a reliable supply during water shortages. They would like to develop a ground water capacity of about 100,000 AF per year. The district testing program has been successful, and a production well yielding some 3,000 gpm has been completed. The next phase of the investigation is now being planned.

Water Conservation

The ethic of conserving water has been woven through law and practice in California for decades. It can be traced back to a 1928 Constitutional Amendment, which was adopted to ensure the reasonable and beneficial use and the prevention of waste and unreasonable use of water.

The 1976-77 drought demonstrated, sometimes dramatically, that people can reduce water use when an emergency requires it. This experience, coupled with the growing cost of major water project development, has led to an array of water conservation programs at the State and local government level.

Water management plans for urban areas will benefit both project operations and contractors by reducing demand buildup schedules, thereby stretching available supplies and reducing risks of water shortages. The reduced demand buildup schedule would minimize potential Delta export impacts.

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The two most recent significant pieces of legislation are the Urban Water Management Planning Act of 1983 and the Agricultural Water Management Planning Act of 1986. Both require the larger water suppliers, under certain conditions, to prepare water management plans.

Urban Conservation. Some 300 urban water suppliers have prepared water management plans under the Urban Water Management Planning Act of 1983. These plans identify many current and future water conservation programs. They include low water-use landscaping and improved irrigation efficiency on large turf areas, water audits and leak detection, industrial water conservation, residential retrofit with low-flow and ultra-low-flow toilets and showerheads, waste water reclamation, capital outlay projects to replace old water mains and similar facilities, public education, and in-school education. DWR has provided technical and financial assistance to urban water agencies and local governments in all these areas since 1980.

Agricultural Water Conservation. California's agricultural sector has for decades been developing and implementing ways to reduce on-farm water use. This conservation effort has been broad-based, involving various public institutions, private industries, and individual farmers. Year by year, on a continuing basis, many different irrigation techniques have been developed to reduce and tailor water use for the varied irrigation conditions encountered throughout the State.

DWR has had a multifaceted agricultural water conservation program since 1980. It focuses on assisting water districts and growers with irrigation scheduling based on crop water needs, education to improve the efficiency of various irrigation systems, support of research related to improved irrigation management and reductions in evapotranspiration rates of crops, and financial assistance to agricultural water districts to begin or expand their irrigation management programs.

Since the mid-1970s, DWR has published estimates of weekly crop water use—information that many farmers have used to schedule irrigations. The estimates are based on measured rates of evaporation from standard National Weather Service evaporation pans installed at selected sites within some of the major irrigated areas of California. Now, in response to the need for real-time evapotranspiration information, daily estimates of crop water use are available through the California Irrigation Management Information System, a large, automated weather station network that records solar radiation, wind speed, rainfall, air temperature, humidity, and soil temperature.

These data are transmitted daily by telephone to a central computer that calculates how much water certain plants in a certain area would have used under specified conditions for such factors as soil moisture availability and plant growth. The results are then made available to farmers and other interested parties, who access them through personal computers. The information is also available through irrigation consultants, county farm advisors, U.S. Soil Conservation Service (SCS) field offices, and the media.

While crop water use estimates help farmers decide when to irrigate and how much water to apply, mobile irrigation management laboratories are also available to measure how efficiently an irrigation system is working. These labs are operated by local resource conservation districts, with technical support from SCS.

In 1986, the Legislature passed the Agricultural Water Management Planning Act. It required every agricultural water retailer supplying more than 50,000 AF of water, if not covered by water conservation requirements of State and federal agencies, to report to DWR on how its water is managed. If the supplier finds that water can be conserved, or that the quantity of highly saline or toxic drainage water can be reduced, the supplier must adopt an agricultural water management plan.

Industrial Water Conservation. Under a contract with DWR, MWD completed a literature search to identify industrial water conservation technologies. The best of the abstracts have been reprinted and made available to local water districts for distribution to industrial customers.

DWR is also cosponsoring a project with the City of San Jose. The city's consultant will visit selected industries to assess their potential for improving their water use efficiency. Follow-up pilot projects will be undertaken for those industries showing potential.

Water Transfers

Statewide emphasis on several distinct types of water transfers has intensified during the 1980s. A number of new laws have been passed that express State policy, add to the existing water rights authority of SWRCB, and authorize new programs for DWR.

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These include:

- Voluntary transfer of water and water rights is advocated, where consistent with the public welfare of the place of export and the place of import.

- DWR and SWRCB are directed to encourage voluntary transfers of water and water rights by offering technical assistance, if necessary, to identify and implement water conservation measures that will make additional water available for transfer.

- Local and regional public agencies are authorized to sell, lease, exchange, or transfer surplus agency water for use outside the agency.

- State and local agencies are prohibited from denying a bona fide transferrer of water the use of unused capacity in a water conveyance facility.

DWR is required to:

- establish an ongoing program to facilitate the voluntary exchange or transfer of water;

- implement various State laws pertaining to water transfers;

- create and maintain a list of entities seeking to enter into transfers and a list of the physical facilities that may be available to carry out water transfers; and

- prepare a water transfer guide.

Water transfers can increase Delta inflow and outflow in drier years, increase exports when transfers are north of the Delta, and decrease exports when transfers are south of the Delta. Water quality will be improved, although fish screening losses will be increased.

In March 1986, DWR established an in-house Water Transfers Committee to respond to the interest in water marketing and water transfers. The committee has published two documents to facilitate the voluntary exchange or transfer of water within California. They are titled *A Catalog of Water Transfer Proposals* and *Questions to be Asked in the Case by Case Review of Water Transfer Proposals.* A draft *Water Transfer Guide*, authorized by Section 482 of the Water Code was released in June 1989.

Ideally, a market system involving transfer of water should improve the lot of both the buyer and seller. The buyer should gain by acquiring water needed at a favorable cost; the seller should gain by receiving more in return than he would gain by keeping the water. However, there is concern that such transactions may not adequately compensate those not directly involved in the buying and selling process (farm laborers, food processors, and retailers, for example).

Market water transfers can realize efficiencies; however, equity questions can arise, including instream uses, waster rights questions, third-party impacts, and adverse economic and environmental effects.

Questions are also being raised over whether a market concept would really result in the highest and best use of the water resource. It may be more a sign of comparative purchasing power among sectors than an optimum use pattern. The urban sector, for example, could probably outbid agriculture for a given water supply, but water used to irrigate lawns or wash cars could be regarded as having less economic and social value than water used to produce food.

To date, it appears that a true "market" is unlikely to evolve on a statewide basis in California. However, the fact that water managers and water constituent groups have begun to think in "market" terms has already led to numerous innovate suggestions for water transfers and water sharing.

Transfer of SWP Entitlements. In March 1987, the California Water Commission sponsored a "Briefing and Discussion of Transfer of SWP Entitlements" in Bakersfield. The Commission heard statements from representatives of various SWP contractors. Some of the contractors would like to sell their entitlements, others would like to purchase entitlements, and still others support the concept of the SWP buying back entitlements.

CVP Purchases. DWR has an interest in purchasing existing CVP water supplies that CVP will not need for at least 10 to 20 years. DWR is interested in acquiring such interim supplies to meet near-term SWP needs.

The COA provides that Reclamation and DWR will negotiate a contract for the sale of interim federal water to DWR and for conveyance of federal water through SWP aqueduct facilities. SWRCB, DFG, and USF&WS are also involved in the negotiations, which are open to the public. The negotiations are closely coordinated with peri-

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odic meetings with the State water contractors. (See also "Wheeling-Purchase Negotiations" in Section 10 (h) of the COA, page 192.)

Yuba County Water Agency. DWR entered into an agreement with the Yuba County Water Agency (YCWA) to purchase water released from New Bullards Bar Reservoir during the summer of 1988. The release of this water by YCWA allowed DWR to hold a corresponding amount of water in Lake Oroville and had the effect of transferring the water from New Bullards Bar Reservoir to Lake Oroville.

DWR and YCWA re-negotiated a water transfer for 1989. Yuba County agreed to make 200,000 AF of water available. Santa Clara Valley Water District paid the costs of transferring 90,000 AF, and Tulare Lake Basin Water Storage District paid the costs of transferring the remaining 110,000 AF.

Discussions concerning another transfer in 1990 have been proceeding informally.

City of Napa. The city purchased 7,000 AF of water from YCWA for use in 1989. The water was conveyed through the North Bay Aqueduct (NBA).

East Bay Municipal Utility District. Water rationing was instituted in 1988 and had been planned for 1989, at the 25 percent reduction level. The East Bay Municipal Utility District (EBMUD) purchased 60,000 AF of water from the YCWA to avoid rationing at greater than 25 percent. As a result of additional rains, however, EBMUD did not use this water. In August 1989, EBMUD sold 30,000 AF of the purchased water to DFG for use in the San Joaquin Valley for salmon enhancement and riparian use. The City of Napa and EBMUD negotiated directly with YCWA for their purchases.

Marin Municipal Water District. Marin Municipal Water District (MMWD) is seeking a supplemental water supply of 10,000 AF per year, with the NBA as a possible link in the delivery chain. Water purchased by MMWD somewhere in the Central Valley could be rediverted from the Delta into the NBA and delivered at NBA terminal facilities. MMWD would have to build a conduit from the NBA to its service area in Marin County.

DWR has participated in meetings with MMWD and representatives of the Napa and Solano County agencies that have contracted for deliveries from the NBA. These meetings were primarily to allow MMWD to present its tentative plans to NBA users and assure them that if its use of the NBA should prove feasible, it intends to negotiate mutually beneficial agreements for that use.

Technology For Increasing Water Supply

The following sections describe the present situation regarding augmentation of water supplies by various technological approaches.

Watershed Management. Watershed management can protect developed supplies by reducing sediment accumulation in reservoirs and increasing streamflow by managing vegetative growth. Reducing the amount of shrub and tree cover and substituting grasses both reduces vegetative water use and increases runoff. Water supplies may be augmented where reservoirs regulate the increased runoff.

Water supplies gained by such means, although small in relation to total runoff, can cost less than supplies developed by building new reservoirs. However, extensive areas would have to be managed to significantly increase statewide water supplies. Vegetation management is now being used principally to improve range, reduce wildfires, and enhance wildlife habitat.

Watershed management upstream of the Delta can increase Delta inflow and increase drier year export and outflow. The technique can improve water quality protection in drier years and increase river flows while increasing screening losses.

Weather Modification. Research has established that rain and snow from clouds with the right moisture and temperature characteristics can be increased by weather modification. Many investigators believe that average annual precipitation might be increased by about 10 percent. Weather modification has been conducted along the western slopes of the Sierra Nevada and some of the Coast Ranges for several years. However, precipitation will increase only when storm clouds are present, which means that the technique is more successful in years of near-normal rainfall. Weather modification is most effective when combined with vegetation management to prevent shrubs and trees from using the additional precipitation.

In 1985, DWR awarded a contract to North American Weather Consultants to conduct a feasibility study of cloud seeding in the Feather River watershed. The results led to funding the design of an operational plan and prep-

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aration of environmental documentation for an inflow enhancement program.

The program emphasizes augmenting streamflow by increasing snowpack. It is being developed from a 3- to 5-year prototype project in a remote area of the Middle Fork Feather River near Johnsville. The final operational plan is being designed and implemented by a weather scientist.

DWR is totally funding the prototype project. DWR will also provide environmental documentation for this program and for possible future expansions.

The prototype project will furnish information to guide future design of a larger cloud seeding program in the Feather River watershed. The final operational project will specify the type of storms to be seeded, seeding agents to be used and rates of application, locations for ground-based generators, suspension criteria, and proposed method of evaluation.

The program began in October 1988 with issuance of a Negative Declaration for the prototype runoff-enhancement program. In November 1988, two propane dispensers were installed to permit evaluation of the capabilities of the equipment control system and to provide information on the effectiveness of using propane to enhance precipitation.

If the program proves to be feasible, the eventual average yield might approach 100,000 AF for a 50-dispenser operation program.

Upstream weather modification can increase Delta inflow and increase drier year export and outflow. It can improve water quality protection in drier years and increase river flows while decreasing screening losses.

Desalination. The possibility of finding an economical way to desalt ocean water and brackish water has intrigued engineers, politicians, and the public for many years. Much research has been done and, in some parts of the world, desalting is an important source of water. Worldwide, desalting capacity is about 3 billion gallons per day in 3,500 plants. In the United States, about 750 desalting plants have a combined capacity of 212 million gallons per day. In California, desalting is used to reclaim brackish ground water, desalt sea water, and treat water for such industries as the electronics industry, which require processed water of high purity.

Unfortunately, it is still too expensive for all but a few places and situations in California. Present desalting processes can remove high percentages of organic and inorganic constituents from water, including sea water. Moreover, fresh water obtained from desalting processes can be tailored (by careful selection of process type and design) to meet the water requirements of almost any beneficial use.

The principal limitation of desalting is its high cost, which is directly linked to its high energy requirements. In California, cost has greatly restricted its use. Of the various desalting techniques, the membrane processes (reverse osmosis and electrodialysis) offer the best potential to further reduce costs and thus increase use. Extensive research is being conducted in the private and public sectors to improve the performance of membranes used to remove salt from water. Future improvements in the various distillation methods of desalting are likely to be less significant than those related to membrane desalting.

The Los Banos Demonstration Desalting Facility in the San Joaquin Valley began operation in late 1983 to investigate the present technology and economics of reclaiming drainage water by desalting. In late 1986, following the San Luis Drain shutdown by the federal government, the plant lost its agricultural feedwater, and, except for the solar pond system, the facility closed down. No results have been reported.

The DWR solar pond system at Los Banos is still operating. The Rankine-cycle power generator has operated for two summers, producing about 10W. A 5,000 gallon-per-day vertical-tube foamy evaporator desalter has been integrated into the system to demonstrate steady-state operation of a salt-gradient, power-generation desalting system.

DWR is cooperating with other agencies to establish a multiagency treatment center for investigating selenium-specific removal technologies and evaporation ponds. This treatment center would be located at Westland Water District's Tranquillity site. Additional desalting pretreatment studies by DWR could be conducted at this site.

In California, desalting technology is being studied or used in the following situations:

- Reverse osmosis and electrodialysis membrane desalting of brackish ground water can be used to supply drinking water. This may or may not be related to the

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brackish nature of the water but may instead be a case in which a particular constituent (natural or otherwise) must be removed to meet health or other standards. In the Arlington ground water basin in Southern California, a project is in the planning stage to desalt about 6,000 AF of local ground water a year; and in Orange County, a 1-million-a gallon-per-day reverse osmosis demonstration plant is being constructed. At both sites, the major water quality concern is high nitrate concentrations in the local ground water, a desalting application that is likely to find wider acceptance as new, more efficient membranes are developed.

- Reverse osmosis can be used to reclaim domestic waste water before it is recharged into ground water basins. The best example of this in California is the Orange County Water District's Water Factory 21, which treats 15 million gallons of waste water a day in an advanced waste water treatment and desalting plant and injects it into the local ground water basin.

- As water pollution standards become more stringent, California industries can use desalting to meet discharge requirements. In the San Joaquin Valley, the olive-processing industry, whose discharges are heavily saline, is studying desalting as a method of reducing waste water and supplementing its process water supplies.

- Throughout the State, many industries use desalting to develop process water required for manufacturing paper, pharmaceuticals, certain foods, and electronic components.

- Finally, sea-water desalting is used at locations such as PGandE's Diablo Canyon Power Plant, where a sea-water reverse osmosis plant provides in-plant water. In the San Joaquin Valley, many agencies have been studying the disposal of brackish agricultural drainage water for decades. DWR has investigated reclamation of agricultural drainage water by reverse osmosis since the early 1970s. Discovery of selenium in this water and the ill effects this element has on aquatic wildlife have increased interest in reclaiming drainage water, rather than discharging it to the ocean or estuary. In California, the potential exists to reclaim several hundred thousand acre-feet of drainage water per year through a combination of desalting, salt-harvesting, and power production from salt-gradient solar ponds. Studies of these activities are continuing.

Although the use of desalting to supplement water supplies will continue to be guided by local circumstances, it is likely to increase as the costs of more conventional water supplies rise and the expense of desalting (particularly reverse osmosis and electrodialysis) decreases.

Desalination south of the Delta has the potential to reduce Delta exports, increase water quality protection, and minimize screening losses.

Waste Water Reclamation. Reclaiming and reusing water can lead to important benefits. Reusing water can defer or eliminate the need to develop new fresh water supplies and conveyance facilities. Reclaiming the water in a satellite treatment plant near the place of use can postpone the enlargement of collection systems and treatment plants. Similarly, reclamation may reduce waste water discharge and defer expansion of ocean outfall systems.

Reclaimed water is used for various purposes, including irrigation, industrial cooling, and ground water recharge. Industrial process water may be recycled to recover heat or materials, save water, and reduce sewage discharge fees.

Waste water can be treated to drinking-water quality; however, reuse for drinking water is not permitted, pending studies to determine the long-term effects of reclaimed water on human health.

Because many potential sites for reuse are often located far from the point of supply, the need for separate storage facilities and dual distribution systems increase the costs of many reuse projects. Furthermore, users may be expected to pay the full cost of developing a reuse project.

More treated municipal waste water is now produced in California than is being reclaimed, yet water reclamation is increasing. In 1985, about 250,000 AF was reclaimed. At present, hundreds of thousands of acre-feet of treated water are discharged to the ocean every year. By 2010, under favorable conditions, statewide use of reclaimed water could reach 500,000 AF annually, as urban water managers continue to seek opportunities to use reclaimed water in-lieu of water of drinking quality. The greatest incentives for expanded reuse occur where 1) treated waste discharge is limited by regulation, 2) treatment plant capacity is being exceeded, 3) potable water supplies are being fully used, or 4) potable water is expensive.

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Long-Range Weather Forecasting

Accurate advance weather information—extending weeks, months, and even seasons ahead—would be invaluable in planning water operations in all types of years — wet, dry, and normal. Had it been known, for instance, that 1976 and 1977 were to be extremely dry years or that the drought would end in 1977, water operations could have been planned somewhat differently and the impacts of the drought might have been lessened.

The potential benefits of dependable long-range weather forecasts could probably be calculated in hundreds of millions of dollars, possibly even in billions. The value would be national. For this and other reasons, research programs to investigate and develop such forecasting capability would most appropriately be conducted at the national level. The National Weather Service and the Scripps Institute of Oceanography are engaged in making such forecasts. However, their predictions are not sufficiently reliable for project operation.

Global Warming (Greenhouse Effect). In 1988, the issue of global warming was widely publicized by articles in magazines and newspapers and by a series of Congressional hearings. This widespread interest was undoubtedly abetted by the warm summer and the 1988 drought. There was, and still is, a perception by much of the public that "something is wrong with the weather." The greenhouse effect offers a possible, although controversial, explanation.

Any warming trend, whether the greenhouse effect or just part of a long-term trend, could have some of these effects:

- *Changes in runoff patterns*, with more during the winter and a decrease in snowmelt. Due to snow falling at higher levels during storms, more precipitation would fall in the form of rain-producing direct runoff, and less would be held over until spring as snow. This means less snowmelt runoff and more winter flood runoff.

  This would be of concern since average April-July runoff is about 14 million MAF, or about 40 percent of the estimated total statewide net water use of 34 MAF. Loss of one-third of this natural regulation is 3.5 MAF, which then would have to be replaced by new water storage facilities or a reduction in water supply yield.

- *Sea-level rise.* The current rate of sea-level rise is probably about 0.7 feet per century along the California coast based on San Diego and San Francisco tide gage records. The rise has been fairly constant during the past 50 years and does not show acceleration. A study conducted by EPA investigated the consequences of a 3.3-foot rise, which would be substantial. However, such a rise probably could not occur until some years after 2050.

  In the Delta, a rise to the higher level would be very significant because of the poor levee systems. Any rise could cause some problems. However a minor rise—an extension of current rates—could be tolerated. A major rise, however, would cause significant problems both in the Delta and along the shores of San Francisco Bay.

  The effect of higher sea levels shows up mostly during storms, when the risk of extremely high tides is increased, and formerly uncommon events become frequent. This could cause a shift in the frequency of extreme events. The rare once-in-100-years event could become a 10-year event. The other effect of a higher sea level is increased salinity intrusion due to increased channel depth. Probably enough silt comes down the Sacramento River system to offset a small rise in sea level in the upper estuary (especially in Suisun Bay). It is suspected that the effects on salinity intrusion would be less than that caused by the deep water ship channels, unless the rise exceeds 1 foot.

- *Warmer temperatures* would also affect crop patterns and, thereby, water use. The biggest factor is the potential reduction in frost damage, but warmer temperatures could put added stress on some crops (as well as many of our forests and native plants). These changes would permit expansion of some crops, such as citrus fruits. There may be some additional agricultural problems because of more smog. Higher air temperatures promote smog, producing reactions in the atmosphere.

- *Change in water use.* Higher temperatures would also increase evapotranspiration. This may be offset somewhat by lower plant water use as a result of higher CO_2 concentration. The plants do not have to open their pores as widely to receive the CO_2 needed for photosynthesis. Most observers think the net effect of higher temperatures and increased CO_2 will be higher water consumption, although perhaps not a large increase.

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- *Potential change in rainfall patterns.* Although more precipitation would be expected worldwide because of greater evaporation, it probably will not be evenly distributed. If the winter storm track is shifted farther north, consequences for California would be serious, because we depend on the southern movement of these storms for much of the winter rain and snow. Rainfall predictions from the global circulation models are probably not reliable. There may be some comfort in the fact that known predictions show little change in annual precipitation. Some models do show drier springs, however, which would compound the loss in spring runoff.

  On the other hand, despite drought years, the total water year runoff of the Sacramento River has risen during recent decades.

U.S. Bureau of Reclamation Water Contracting Programs

Since 1979, Reclamation had imposed a moratorium on new long-term contracts for uncommitted water from the CVP because of concerns about environmental and water quality effects in the Delta.

The Coordinated Operation Agreement (COA) enacted in 1986 requires the CVP, in conjunction with the SWP, to operate in conformity with State water quality standards with few exceptions. This action has lifted the moratorium, and Reclamation is now able to resume long-term contracting of available and uncommitted water from the CVP. The law, however, requires an EIS, because entering into new long-term contracts is a major federal action that may have significant effects on the environment in such areas as fisheries and wildlife, energy, land use, population, housing, and related social effects.

Because three distinct areas—the Sacramento River Service area, the American River Service area, and the Delta Export Service area—would be served under the new water contracts, Reclamation has prepared an EIS for each area.

In late 1988, Reclamation distributed three draft EIS's for public review. The draft EIS's disclose probable impacts of selling available and uncommitted water from the Sacramento and Trinity river diversions of CVP.

Because of the overwhelmingly negative comments on the draft EIS's received by Reclamation, it has begun revision of the documents where appropriate. Completion dates for the revised drafts are uncertain at this time. The potential cumulative effects of the water contracts will be very nearly the same as the COA effects in the following section.

Water Supply Reductions in Southern California

Rapidly growing Southern California, with its existing water development facilities and successful legal challenges to sustain or expand its supply, faces increasing dry-year water deficiencies.

Southern California gained an estimated 350,000 new residents during 1988–89, and the area contains five of the nation's ten fastest-growing counties. In addition to the problem of population growth, the area will soon have to adjust to reduced water supplies from both the Colorado River and the eastern Sierra.

Colorado River Supply. Priorities for use of Colorado River water in California are based on the 1931 *Seven-Part Agreement* as modified in 1964 by the U.S. Supreme Court's decree in *Arizona* vs. *California.* With the Central Arizona Project on line, California can no longer depend on receiving more than 4.4 million AF of Colorado River water per year. As the junior appropriator, MWD is limited to 550 TAF per year of fourth-priority water plus half of any surplus flows on the lower Colorado River. After deducting allotments for three Indian reservations, miscellaneous present perfected right holders, delivery system losses, and possible further rights for water to Indian tribes, MWD could be reduced to about 360 TAF per year—down from a recent use averaging 1.1 MAF per year.

Reduction of water supplies will potentially increase Delta export and inflow, decrease outflow, reduce water quality protection, and increase fish screen losses.

Eastern Sierra Supplies. For several years, environmentalists have been attempting to overturn permits and licenses issued to the Los Angeles Department of Water and Power (LADWP) to divert water from Mono Lake. Finally, in August 1989, a Superior Court ruling mandated drastic cuts in the City's diversions, and later, a change in the way that LADWP was preparing to route the increased flow from Mono Lake.

LADWP had been diverting up to 100 TAF per year from the Mono Lake Basin, about 17 percent of its annual needs. The recent ruling will reduce the diversion sub-

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stantially, although a final determination has not been made. LADWP will probably have to rely more on its existing contracts with MWD.

The reduced water supplies from both the Mono Lake Basin and the Colorado River will mean that eventually MWD will have to obtain additional water supplies elsewhere. There are, however, several problems:

- MWD's largest source, SWP, has not been completed, and environmental concerns in the Delta may impede additional deliveries.
- MWD relies on ground water for about one-third of its supply. Expansion of this supply is limited, and current supplies are threatened by contamination and more stringent health standards.
- A third source, large-scale water projects, is either affected by environmental concerns or negative public sentiment.

Environmentalists have suggested that current supplies be used more efficiently, for example, water conservation, waste water reclamation, and re-allocation of water supplies from agriculture to urban use.

In this regard, MWD has agreed with the Imperial Irrigation District to fund conservation measures in exchange for an estimated 100 TAF of water that would be saved. MWD is working on a similar project with Reclamation to line the All-American Canal in exchange for the water saved. The District has offered to buy Colorado River water from Palo Verde Irrigation District in dry years and is exploring a contract with Arvin-Edison Water Storage District to store water underground during wet years for extraction in dry years.

Beyond year 2010, development of new water projects may be the only way to obtain reliable and adequate water supplies. The State-sponsored projects remaining on the books—which are mainly designed to capture excess winter flows for storage south of the Delta (Delta improvements, KWB, LBG)—are estimated to increase the total SWP supply to between 3.5 and 3.7 million AF. The SDWMP can facilitate delivery of additional supplies but, by itself, will add only small incremental amounts to the other related projects.

Finally, two recently signed bills will set aside $390.8 million to help resolve a number of the State's water-related issues. Together, the bills form the Environmental Water Act of 1989. Principally designed to protect the sensitive ecology of Mono Lake, the Act provides as much as $60 million to replace water and power supplies lost by LADWP in preserving the lake.

Local Upstream Increased Use

As growth continues in the northern California region, local water development and use will increase. This could reduce streamflow available for export unless additional storage facilities are added. Increased upstream use can potentially reduce Delta inflow and exports, and reduce instream fish and wildlife benefits.

Upper Sacramento River Fisheries and Riparian Habitat Management Plan

State. Severe declines in salmon and steelhead populations and riparian habitat over the past four decades prompted the California Legislature to enact 1986 legislation calling for preparation of a fisheries and riparian habitat management plan for the Sacramento River, from Keswick Dam to the mouth of the Feather River. The act, SB 1086, created an advisory council composed of 25 members from federal, State, and local agencies and environmental, fishery, and landowner groups.

About 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation spreading 4 to 5 miles. As agriculture and urban areas developed along the river, the riparian vegetation was gradually reduced. Today, less than 5 percent of the original acreage remains.

Riparian lands provide a highly suitable and often critical habitat for a wide array of birds, mammals, and other wildlife. State and/or federal threatened or endangered species include the bald eagle, western yellow-billed cuckoo, Swainson's hawk, and the valley elderberry beetle, which is endemic to the Central Valley. Species of special concern include the bank swallow and the California hibiscus. The area also provides habitat for raptors, migratory birds, wood ducks, and other waterfowl.

Goals and policies identified by the advisory council are:

- The habitat protection plan would reestablish a continuous riparian ecosystem along the river between Chico and Redding and reestablish riparian vegetation along the river from Verona to Chico, consistent with the Sacramento River Flood Control Project.

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- The Advisory Council's intent is to give the highest priority to a fishery restoration plan that will protect, restore, and enhance wild strains of salmon and steelhead.

- Actions that will maximize habitat restoration for naturally spawning salmon and steelhead will be given second priority. Natural production is intended to be limited only by the carrying capacity of the natural ecosystem.

- Artificial production will be limited to actions that will fully compensate for fish populations that existed at the time their historic habitat was permanently lost due to blockage by construction of dams or by other human actions.

- This plan should provide measures necessary to minimize fish losses due to entrainment, predation, and other hazards associated with diversion of water from the upper Sacramento River and its tributaries. Such measures may include installing fish screens, reducing diversions during critical periods, or relocating diversion points to avoid conflicts with fish populations. The owner of the diversion is not responsible for costs. When existing State laws require the owner of a diversion to help pay for these measures, the owner will be expected to participate.

- State and federal legislation should be enacted as soon as possible to provide authority and funding needed to implement the actions contained in this management plan.

- The State of California should commit the necessary funding from a combination of Proposition 70, Proposition 99, and other sources to meet the State's share of the costs.

- The fishery and riparian habitat measures contained herein should be implemented in general conformance with the priorities indicated.

- State and federal legislation should be enacted to authorize an Upper Sacramento River Advisory Council to facilitate implementation of the management plan.

The various potential projects on the upper Sacramento River can decrease Delta outflow, increase Delta exports, reduce water quality protection, and significantly improve Delta fisheries.

Federal. A $185 million measure to restore fish populations in the Sacramento River over the next 10 years has been introduced in Congress. Part of the money would be used to build new fish ladders and more effective fish screens at the Red Bluff Diversion Dam and the Anderson-Cottonwood Irrigation District Dam. Part of the funds would be used to increase the quantity and quality of gravel used for fish spawning and rearing between Keswick and Red Bluff Diversion dams.

Some of the funds would be used to update and expand the Coleman National Fish Hatchery near Redding, to construct new hatcheries, and to build a $50 million device at Shasta Dam to help control downstream water temperatures, which have devastated the salmon run in recent years.

The funds would also be used to reduce the level of toxic zinc and copper leaking from the Iron Mountain Mine complex into the Sacramento River and to improve fish screening at the Glenn-Colusa Irrigation District diversions headworks.

Mitigation Banking

The mitigation banking concept is still in its infancy and is not fully defined. As now applied, the concept involves "wetlands" and "wetlands banking"; in the future, however, this concept could be applied to other ecosystems, such as oak woodlands, native grasslands, forests, etc.

In January 1987, DFG adopted the Wetlands Resources Policy, which states that " . . . it shall seek to provide for the protection, preservation, restoration, enhancement, and expansion of wetlands habitats." Mitigation measures for unavoidable impacts to wetlands must therefore result in no net loss of either wetland acreage or wetland habitat values.

DFG recognizes that in some projects it is not always possible to avoid impacting wetland habitat and that on-site mitigation is at times infeasible or undesirable from a biological perspective. DFG has provided definitions pertinent to wetland mitigation banks in a December 1989 Draft publication, *Guidelines for Establishment and Use of Wetlands Mitigation Banks.* The definitions are as follows:

- **"Qualified Wetland Mitigation Bank.** A single contiguous parcel of land consisting of non-wetland habitat, which has undergone those physical changes necessary to create and optimize the acreage and quality of wetland habitat on the site for the express purpose of

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providing mitigation credits to offset the adverse impacts to wetlands from approved projects elsewhere.

- "**Bank Developer.** A legal entity established to acquire land, to create or restore and maintain wetland habitat upon that land and to operate said land as a qualified wetland mitigation bank pursuant to an operations agreement with DFG. The Bank Developer may employ an agent(s) to actually operate the mitigation bank, provided that said agent(s) has been approved by DFG.

- "**Project Proponents.** Public or private entities acting on their proprietary or management capacity, which have received all of the permits or other clearances necessary to implement a project that would unavoidably and adversely impact wetlands and who seek to compensate for the loss of the wetland acreage and/or wetland habitat values through participation in a mitigation bank.

- "**Mitigation Credit.** A unit of measured area supporting wetland habitat and wetland habitat values not preexisting at the bank site prior to bank development. Each such unit shall have been assigned a habitat value by the DFG in consultation with other appropriate resource agencies."

The impacts of projects on wetlands may be offset by a wetland mitigation bank if DFG determines that the following conditions have been met:

- the project is the least environmentally damaging;

- on-site mitigation is either infeasible or undesirable;

- no suitable mitigation site exists closer to the point of impact;

- the project is located no more than 40 aerial miles from the bank site and DFG has concluded that a lesser distance is not needed to assure effective compensation for affected species;

- the project sponsor obtains all necessary permits and written statements from all permitting agencies that use of the selected site is acceptable; and

- DFG consults with all resource conservation agencies and permitting authorities.

Consideration of the potential wildlife mitigation opportunities available for present and future water development projects under the West Delta Water Management Program may result in the application of the mitigation banking concept.

The mitigation banking concept has the potential, when considered cumulative with other project(s) to reduce the total environmental impacts.

San Joaquin Valley Agricultural Drainage Program

Current agricultural drainage conditions on the west side of the San Joaquin Valley present three basic problems: 1) salt balance, 2) water balance, and 3) toxic or potentially toxic trace elements in subsurface agricultural drainage, which, when discharged to streams, ponds, or wetlands can adversely affect fish and wildlife.

The severity of the toxic problem became known about 1983, with the discovery of deaths and deformities of waterfowl, which were linked to high selenium levels in agricultural drainage water at Kesterson Reservoir.

In mid-1984, Reclamation, USF&WS, USGS, and DFG formed the San Joaquin Valley Drainage Program (SJVDP) to investigate drainage problems and identify possible solutions. The four goals of the SJVDP are to:

- minimize potential health risks associated with subsurface agricultural drainage water;

- protect existing and future reasonable and beneficial uses of surface and ground water from impacts associated with drainage water;

- protect, restore, and, to the extent practicable, improve valley fish and wildlife resources; and

- sustain the productivity of farm land on the west side of the San Joaquin Valley.

In 1987, the SJVDP narrowed its focus on planning alternatives for solving drainage problems to measures that could be taken within the valley itself. In 1989, the SJVDP published a report on preliminary planning alternatives, which would consist of combinations of drainage management strategies falling into seven categories:

- source control to reduce drainage from individual farms;

- management of shallow water tables by pumping;

- treatment of drainage water;

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- reuse of drainage water;
- disposal of drainage water in the valley;
- fish and wildlife measures; and
- institutional changes.

Drainage-water reduction and disposal methods include irrigation improvements, reuse of drainage water for propagation of eucalyptus trees and saltbrush, and limited drainage-water storage in ground water and disposal in evaporation ponds. Discharge to the San Joaquin River is included for selenium-free areas or where drainage containing selenium can be safely assimilated by the river. The alternative also involves actions to protect public health and to protect and restore fish and wildlife, including provision of fresh water supplies conserved from irrigation improvements for use on existing wetlands and wildlife areas.

DWR is collecting data and preparing studies on reuse and disposal of agricultural drainage water in the SWP service area. Analyses emphasize trace elements, such as selenium and arsenic, because of their potential adverse effects on water supplies and the environment. Other water quality parameters, such as nutrients, do not appear to be a problem and are analyzed less frequently.

To determine selenium concentrations in the SWP service area, DWR has increased its selenium data collection and is working with USGS to investigate shallow ground water in the Tulare Lake Basin. Together with information on applied irrigation rates, cropping patterns, soil types, and precipitation, these data are being evaluated to identify possible trends in selenium leaching.

San Joaquin River Basin Planned Development

Development in the form of water transfers, new projects, enlarged projects, re-operated projects, and new studies continue in the San Joaquin River Basin.

Mokelumne River Basin Study. See *New Melones Conjunctive Use Program.*

Friant Dam and Lake Millerton. Friant Dam was constructed by Reclamation in 1948. The enabling legislation said nothing about protecting fish and wildlife resources. In many years, only enough water is released into the San Joaquin River to supply downstream canals and some of the riparian pumps.

Recently, local interests have indicated that the Reclamation should re-operate the project and install some facilities to restore and enhance downstream flow and habitat. Reclamation is committed to work with State and local interests on a San Joaquin River Basin fishery recovery program.

San Joaquin River Comprehensive Program. A program has been started to develop environmentally compatible solutions to water supply and flood control problems of the San Joaquin River. Actions that will enhance fisheries, wildlife habitat, and recreation without adversely affecting water supply and flood control will be identified. In September 1989, several agencies and other interested parties met to discuss program objectives and the formation of work groups.

Suisun Marsh Planning And Implementation

Suisun Marsh in southern Solano County comprises about 116,000 acres. It supports as many as 200 species of wildlife. The brackish water in Suisun Marsh fosters plants and provides habitat for wildfowl.

The marsh's salinity affects the wildlife food chain, and Delta outflow affects the marsh salinity. Decision 1485 required DWR and Reclamation to develop a plan to meet specified water quality standards within the marsh. Initial facilities were completed in 1983, and a coordinated protection plan for Suisun Marsh water quality was developed. The protection plan, published with an EIR in 1984, includes:

- a program to construct (as required) a major tidal pumping station, three conveyance channels, and one additional distribution system; and
- a system to monitor compliance with water quality standards and measure the performance of the facilities constructed. The monitoring plan has been implemented.

In March 1987, DWR, Reclamation, DFG, and the Suisun Resource Conservation District signed the Suisun Marsh Preservation Agreement. The agreement includes definitions of marsh water quality standards and construction

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staging, as well as details for implementing the Plan of Protection.

DWR has been evaluating the effectiveness of the Suisun Marsh salinity control gates facility in maintaining lower salinity levels in the marsh's interior channels since the gates began operating in October 1988. There was an immediate and dramatic reduction in salinity levels in the eastern and middle reaches of Montezuma Slough, and although less dramatic, lower salinities were observed in the western reach just above Grizzly Bay. This western reach did appear to be vulnerable to encroaching salts over extended periods of low outflows and strong tidal currents. Further evaluation will be necessary before DWR can determine the full impact of the operation on the entire western portion of Suisun Marsh.

DWR is conducting this evaluation in cooperation with the other parties of the Suisun Marsh Preservation Agreement (DFG, Reclamation, and the Suisun Resources Conservation District). SWRCB has agreed that DWR and Reclamation can operate under the agreement's Interior Marsh Deficiency Standard through the test operation of the control gates and development of criteria for the most effective operation.

According to the agreement, DWR is to operate the gates for three years and monitor their impact on marsh salinities. The data, along with information gained from running an upgraded Suisun Marsh stage and salinity model, will be used to determine the need and potential effectiveness of additional marsh facilities. If DWR finds that additional facilities are needed to maintain marsh salinity, the next stage is to be in place by October 1, 1993.

View of Suisun March

General Obligation Grant and Loan Programs

Since 1976, DWR has been involved with two loan and grant programs to assist counties in upgrading their water systems: the Safe Drinking Water Bond Law and the Water Conservation Bond Law.

The Safe Drinking Water Bond Law has provided loans and grants to bring domestic water systems up to drinking water standards. Substituting pipelines for open ditches is one method of improving water quality, and has the additional effect of reducing conveyance losses. After Proposition 55 (Safe Drinking Water Bond Law of 1986) passed, 1,976 applications for funds were received; 237 applicants were invited to submit final applications. The bond funds are over-subscribed, however, and new applications are not now being accepted.

Proposition 81 (November 1988 ballot) provided an additional $75 million to continue the Safe Drinking Water loan and grant program. The Department of Health Services, after public notice and hearing and with the advice of DWR, will establish a priority list of projects to be considered for financing under this law. At that time, new applications will be invited.

Table 6-2 summarizes current general obligation bond programs of DWR and Department of Health Services.

The Water Conservation Bond Law (1984) provides funds to DWR to be loaned to irrigation districts, water agencies, and municipalities at low interest rates for use in cost-effective, capital outlay water conservation programs. The maximum loan has been $5 million for a single project, such as lining a distribution canal and replacing distribution mains. The Safe Drinking Water Bond Law of 1986 added ground water recharge projects and feasibility studies as qualifiers for loans. Funds provided under the 1984 law are committed, and DWR has adopted a priority list of applicants for funds provided under the 1986 law.

The first water conservation project completed under the 1984 law was the Sand Trap Siphon Project, dedicated in June 1988. The Georgetown Divide Public Utility District

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Table 6-2
Overview of DWR and Department of Health Services
General Obligation Bond Programs

Program Name	Principal $ Amount[1]	Description	Terms
Safe Drinking Water Bond Law of 1976 (Proposition 3) June 8, 1976. AB 121/Ch.1008/ 1975 (Proposition 9) November 4, 1980. AB 2404/Ch.252/1980	145,000,000L 30,000,000G 175,000,000T	Loans up to $1,500,000 to bring domestic water systems up to drinking water standards. Grants up to $400,000 to public agencies unable to repay a loan.	Loans up to 50 years at State's general obligation bond interest rate.
Safe Drinking Water Bond Law of 1984 (Proposition 28) November 6, 1984. AB 2183/Ch.378/1984.	50,000,000L 25,000,000G 75,000,000T	Loans up to $5,000,000; Grants up to $400,000; Same purposes as Proposition 3.	Same as Proposition 3, except interest rate reduced as per Proposition 55.
Safe Drinking Water Bond Law of 1986 (Proposition 55) November 4, 1986. AB 2668/Ch.410/1986	75,000,000L 25,000,000G 100,000,000T	Same as Proposition 28. Investigation loans and grants up to $25,000 each also available	Same as Proposition 3, except interest rate at half State's rate. Reduced rate retroactively applied to Proposition 28.
Safe Drinking Water Bond Law of 1988 (Proposition 81) November 8, 1988	50,000,000L 25,000,000G 75,000,000T	Same as Proposition 55.	Same as Proposition 55.
Water Conservation Account Clean Water Bond Law of 1984 (Proposition 25) November 6, 1984. AB 1732/Ch.377/1984.	10,000,000 + 500,000 for administration	Loans up to $5,000,000 for cost-effective capital outlay water conservation projects to public agencies	Up to 25 years, at half State's general obligation bond interest rate.
Water Conservation and Water Quality Bond Law of 1986 (Proposition 44) June 3, 1986. AB 1982/Ch.6/1986.	75,000,000	Loans up to $5,000,000 for (A) cost-effective capital outlay water conservation projects, and (B) ground water recharge projects. Feasibility study loans up to $100,000 each also available.	Up to 20 years at half State's general obligation bond interest rate.
Water Conservation Bond Law of 1988 (Proposition 82) November 8, 1988	60,000,000	$40,000,000, same as Proposition 44. $20,000,000 is for loans to develop new basic water supplies.	Same as Proposition 44.

[1] L = Loan; G = grant; T = total.

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received $469,000 for this project. An inverted siphon was constructed to replace a section of unlined ditch. This project is expected to save 1,045 AF of water each year.

A new Water Conservation Bond Law of 1988 (Proposition 82) received voter approval in November 1988. The program provides for a bond issue of $60 million for local water project assistance, water conservation programs, and ground water recharge facilities. Of the $60 million total, $40 million will be a continuation of or similar to Proposition 44 of 1986, and $20 million will be made available for loans to local agencies for purposes that include development of new basic water supplies.

Cumulative Impacts on Bay-Delta Estuary

Analysis of projected water demand and supply balance in the service areas can be a measure of future cumulative impacts of SDWMP when combined with other projects. Table 6-3 shows applied and net water use in different regions of the State for 1985 and 2010, as reported in DWR Bulletin 160-87, *California Water: Looking to the Future*, November 1987.

Net water use is lower than applied water because it takes into consideration the substantial reuse that commonly occurs. It is projected that agricultural net water use will not increase over the next 20 years. However, net urban water use, which generally reflects population growth, is expected to increase. The increase in projected net water use is substantial in all regions, totalling about 1.4 million acre-feet Statewide from 1985 to 2010.

Table 6-4 shows statewide water demands for 1985 and projected 2010 levels as reported in Bulletin 160-87. Except for the Central Valley Project, developed but uncommitted supplies are relatively small. Some of the 1.4 million acre-foot deficit can be met from uncontracted CVP project supplies. The remainder can be satisfied from a variety of other sources.

For the SWP, the present dependable supply is about 2.3 million acre-feet. Projected 2010 water requirements for the SWP service area about 3.6 million acre-feet, assuming: 1) 250,000 acre-feet of water conserved in the Colorado River Basin becomes available, 2) an increase in waste water reuse of 200,000 acre-feet in the SWP service areas, and 3) water conservation measures continuing through 2010. Under those assumptions, existing SWP facilities would have a deficit of dependable supplies in 2010 of about 1.3 million acre-feet. Major facilities to offset this deficit are:

- South Delta facilities,
- North Delta facilities,
- Los Banos Grandes Reservoir,
- Kern Water Bank, and
- Purchase of interim CVP supplies.

Figure 6-2 shows the percentage of years in which dependable supplies will be available with existing and planned facilities. With the additional facilities, dependable water supplies will increase to about 3.2 million acre-feet per year. Projected 2010 requirements of 3.6 million acre-feet could be met 90 percent of the time, with permissible deficiencies 10 percent of the time.

A need for dependable supplies amounting to as much as 0.4 million acre-feet in a given year would remain after the major facilities and actions listed above are implem-

Table 6-3
Regional Use of California's Developed Water Supplies, 1985 and 2010
in 1,000s of acre-feet

	Applied Water			Net Water Use		
Regions	**1985**	**2010**	**Change**	**1985**	**2010**	**Change**
San Francisco Bay and Central Coast	2,780	2,980	200	2,450	2,640	190
South Coast	4,040	4,700	660	3,760	4,360	600
Sacramento River	8,700	10,110	1,410	7,480	7,830	350
San Joaquin River and Tulare Lake	18,690	19,270	580	14,550	15,010	460
Colorado River	3,930	3,710	-220	4,030	3,690	-340
Remaining Regions	2,320	2,460	140	1,950	2,090	140
State Totals	**40,460**	**43,230**	**2,770**	**34,220**	**35,620**	**1,400**

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Table 6-4 Projected Water Demands Over the Next 20 Years (in millions of acre-feet)			
Source of Supply	1985 Net Use	Projected 2010 Net Use	Change from 1985
Local surface water	9.2	9.2	—
Ground water safe yield	6.0	6.1	0.1
Federal Central Valley Project	7.0	7.8	0.8
Other federal sources	1.3	1.3	—
State Water Project	2.4	3.2	0.8
Colorado River	5.0	4.2	-0.8
Local agency imports (excluding the Colorado River)	1.0	1.1	0.1
Reclaimed waste water	0.3	0.5	0.2
Ground water overdraft	2.0	1.8	-0.2
Other sources	--	0.4	0.4
Totals	**34.2**	**35.6**	**1.4**

ented. This would not be a chronic shortage, but a shortage that could occur in dry years. A temporary shortage of this magnitude may well be manageable with extraordinary conservation efforts (measures taken only during times of drought) and such actions as water marketing, water banking, or extra withdrawals from ground water storage. Major facilities listed on the previous page will increase SWP yield by about 900,000 acre-feet per year. However, export rates from the Delta may vary, depending on the type of water year. Figure 6-3 shows the frequency of such exports with the existing and planned facilities.

The analysis of environmental impacts of SDWMP, LBG, and KWB with a 3.3 MAF level of demand is discussed in detail in Chapter 5 and shows that fishery benefits can be achieved from those projects, which provide for operational flexibility and shifting exports to winter periods (winter banking). The general cumulative expected impacts of the SDWMP and other facilities on Delta outflow, export, Delta water quality, and potential fish and wildlife impacts are listed in Table 6-5.

As SWP demands increase with time, beyond the 3.3 MAF level, and without mitigation, the cumulative impacts of the SDWMP—along with LBG, KWB, and other projects—could gradually reduce the fishery benefit that will be gained through implementing the SDWMP.

Not all the water resources activities listed in Table 6-5 will be implemented in the near future, and some will extend into the future—beyond the scope of current statewide water resources planning. Just how all these activities interrelate is difficult to project. However, certain assumptions can be made to combine actions with mitigation and thus produce favorable effects on the cumulative impacts of SDWMP. Other assumptions could combine actions without mitigation, thereby producing adverse impacts.

In addition to SWP and CVP water planning actions, many factors have affected, continue to affect, and in the future will affect the estuary cumulatively. Among these are:

- land reclamation and bay fill;
- sediment load from early gold mining activity;
- toxic chemical, pesticide, and waste water pollution from cities, farms, and boats;
- concentrated salt loadings from irrigation and soil leaching agricultural activities;
- commercial, sport, and illegal fishing;
- construction and maintenance of ship channels;
- use of natural inflows by upstream and Delta agricultural and urban development;
- Delta diversions by the CVP, SWP, local Delta municipal and industrial water users, and Delta agricultural water users;
- levee failures in the Delta;
- wavewash erosion caused by boat traffic; and
- direct diversions and thermal pollution of power plant operations;

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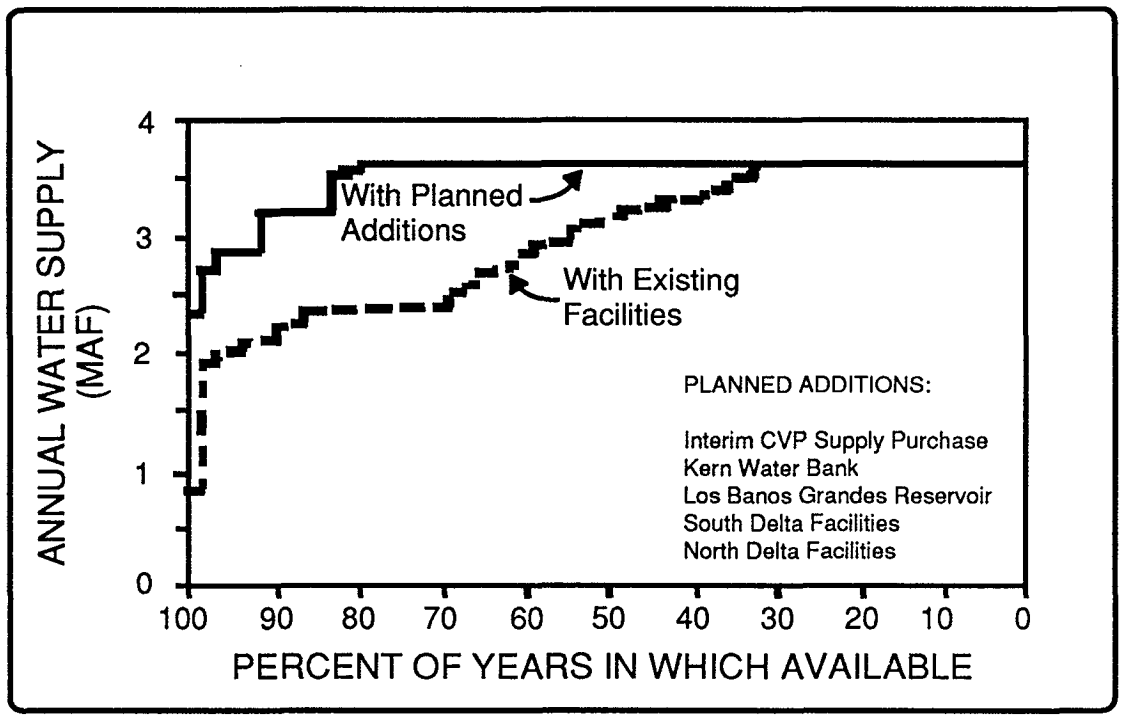

Figure 6-2. SWP Water Capability with Existing Facilities and Planned Additions

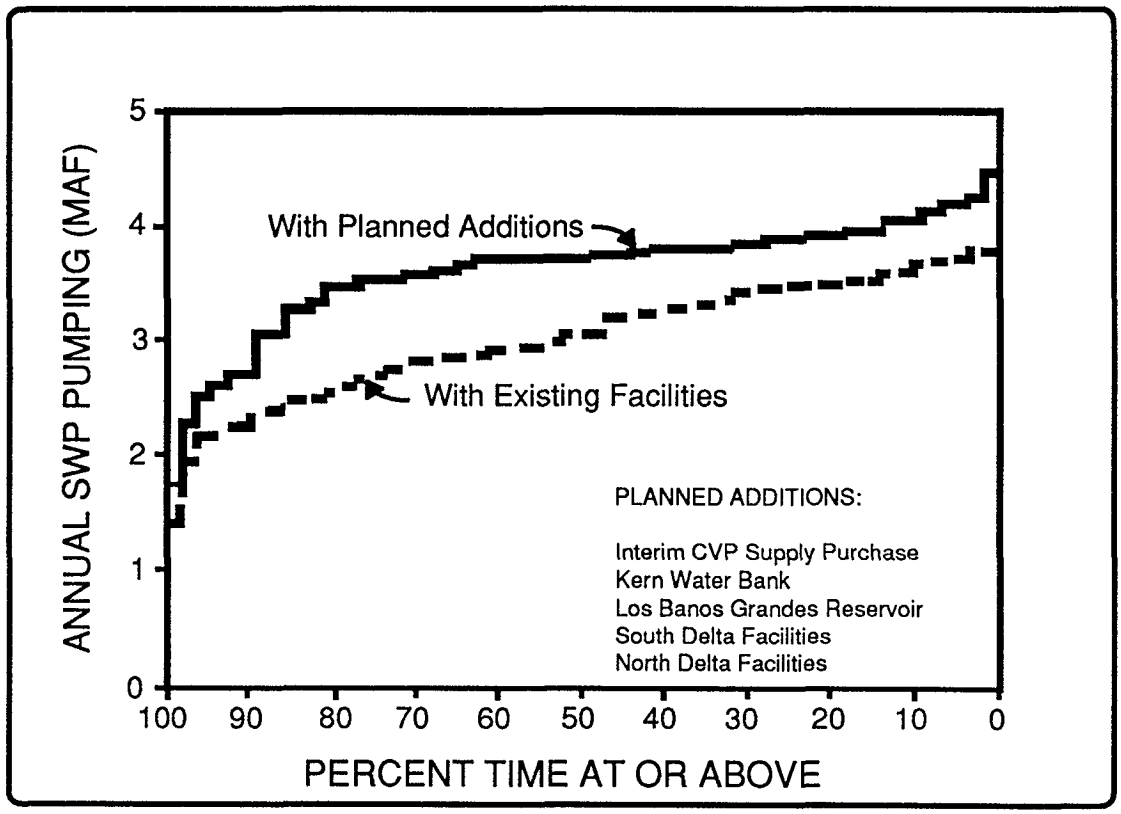

Figure 6-3. SWP Pumping with Existing Facilities and Planned Additions

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Table 6-5
Potential Future Cumulative Effects of South Delta Water Management Facilities and Potential Related Projects or Actions on Delta

Project or Action	Delta Inflow Changes	Delta Export Changes	Delta Outflow Changes	Delta Water Quality Changes	Potential Fish and Wildlife	Comments
South Delta Water Management Program	No change	Winter increases summer decreases	Winter decreases	Improvement in drinking water quality and agricultural water quality	Downstream San Joaquin River salmon migration improved. Water quality, dissolved oxygen, and temperature conditions for resident fish improved in south Delta channels; reduced entrainment losses. Negative minor impacts on Sacramento River Salmon.	Ongoing fishery negotiations concurrently with south Delta water agency negotiations
North Delta Water Management Program	Summer and fall reductions	Drier year increases	Drier year decreases; water right protective outflows will be maintained	Drinking water protections from reduced chlorides, bromides, and THMFP	Net fish migration improved with reduction of reverse flows. Potential reduction of screening losses. Some increase in young salmon in central Delta	Ongoing fishery negotiations concurrently evaluating this program with SDWMP
West Delta water management plan	No change	No change	No change	Protection against salinity intrusion resulting from flooding	Improvement in up to 10,000 acres of diverse wildlife habitat including wetlands	Improve Delta water supply reliability
Coordinated Operation Agreement and Section 10	Potential for increases	Potential for increases	Potential for decreases	Reduced protection without Delta improvements	Increased screening losses	COA requires Delta protection. Mitigation alternatives possible
H. O. Banks Delta Pumping Plant additional units	No change	Slight increase	Slight decrease	Slightly improved due to shifting to winter months	Slight increase in screening losses	Estimated yield increase of 60,000 AF. No further increases without Corps permit.
H.O. Banks Delta Pumping Plant Fish Agreement and Article VII					Significant corrective potential	Article VII negotiations continue

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Table 6-5 (Continued)
Potential Future Cumulative Effects of South Delta Water Management Facilities and Potential Related Projects or Actions on Delta

Project or Action	Delta Inflow Changes	Delta Export Changes	Delta Outflow Changes	Delta Water Quality Changes	Potential Fish and Wildlife	Comments
SB 34 Delta Flood Protection Act	No change	No change	No change	Protection against salinity intrusion from flooding	Act requires the planning for and enhancement of fish and wildlife	Improvement in Delta levees and resulting better reliability of the Delta
Delta wetlands project	No significant change	Potential for some increase	Winter months decreased	Minor winter month changes	Provides operation flexibility	Project planning being conducted by private corporation
Offstream storage south of the Delta	No change	Wetter year increases; minimum change in drier years	Wetter year reductions	Minor changes in winter months	Provides operational flexibility to reduce incremental screening losses	Los Banos and Kern included in Chapter 5 impact analysis
North of Delta additional storage development	Winter and spring reductions; summer and fall increases	Drier year increases	Winter and spring reductions and potential summer and fall increases	Improved drier year protections	Increase in flows and instream benefits/screening losses increased	Current planning on Auburn Dam and Red Bank Project
Central Coastal studies	No change	No change	No change	No change	No change	Slight increase in project deficiencies
Potential Conjunctive use programs upstream of Delta	Drier year increases	Drier year increases	Drier year increases	Improved quality in south Delta in drier years	Increased screening losses improve fishery flows in Stanislaus and San Joaquin rivers in drier years	Active planning for New Melones Reservoir; can provide significant south Delta benefits
Potential water conservation alternatives	No change	Potential reduction	Potential increase	Increased protection	Minimizes screening losses	Additional 200 TAF assumed in place by 2010
Water Transfers north of Delta	Drier year increases	Drier year increase	Drier year increases	Improvement	Screening losses increased	
Water transfers south of Delta	No change	Potential decrease	Potential increase	Improvement	Improvement	Reduced impact on Delta

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Table 6-5 (Continued)
Potential Future Cumulative Effects of South Delta Water Management Facilities and Potential Related Projects or Actions on Delta

Project or Action	Delta Inflow Changes	Delta Export Changes	Delta Outflow Changes	Delta Water Quality Changes	Potential Fish and Wildlife	Comments
Desalination	No change	Potential reduction	Potential increase	Increase protection	Minimizes screening losses	South of the Delta only.
Upstream watershed vegetation management	Winter and spring increases	Drier year increases	Drier year increases	Improved drier year protection	Increase in river flows and instream benefits/screening losses increased	Studies are continuing
Upstream weather modification	Winter and spring increases	Drier year increases	Drier year increases	Improved drier year protection	Increase in river flows and instream benefits/screening losses increased	Pilot program conducted in 1988
Reclamation water contracting programs	Potential for increases	Potential for increases	Potential for decreases	Reduced protection without Delta improvements	Increased screening losses	The environmental effects are similar to those discussed in the COA.
Reduced Colorado River supplies	Potential for increase	Potential for increase	Potential for decrease	Reduces protection without Delta improvements	Increased screening losses	Potential reduction could be 775 TAF
Reduced eastern Sierra supplies	Potential for increase	Potential for increase	Potential for decrease	Reduces protection without Delta improvements	Increased screening losses	Potential reduction 60,000 TAF.
Local upstream increased use	Reduction	No change	Reduction	D-1485	Some reduction in instream benefits	Protected by area of origin and water rights
Upper Sacramento River fisheries and riparian habitat management program	No change	No change	No change	Potential improvement	Improved: temperature, fish rearing, screening, fish ladders, spawning gravels	Federal legislation pending State legislation enacted
Mitigation Banking	No change	No change	No change	No change	Significant improvement in most cases	As now defined, applies to wetlands only
San Joaquin Valley agricultural drainage program	No change	No change	No change	Improved drainage water quality	Will revive and protect wetlands	Drainage management strategies being studied

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- increased urbanization around San Francisco Bay-Delta area, resulting in loss of valuable wildlife habitat.
- agricultural practices and crop patterns that decrease the value of the Delta to wildlife;
- levee maintenance programs in which riprap replaces riparian habitat; and
- upstream storage and regulation of natural inflows by the Hetch Hetchy Aqueduct, Mokelumne Aqueduct project, CVP, SWP, and others.

Cumulative Impacts of SWP Deliveries

The State of California has signed contracts with 30 water agencies throughout the State that require the SWP to deliver a maximum of 4.23 MAF after 2020. Table 6-6 shows projected water deliveries for the SWP at the 2035 level.

Table 6-6
Projected SWP Water Entitlement Requests, Year 2035

Area	1,000 AF
Feather River	40
North Bay	67
South Bay	188
San Joaquin Valley	1,355
Southern California	2,497
Central Coastal*	70
Total	**4,217**

*The Central Coastal service area's entitlement has been reduced from 82,700 AF to 70,000 AF. However, it may be restored to full entitlement in the future.

At present, annual SWP yield is about 2.4 MAF; because of depletions, this could be reduced to about 1.7 MAF by about 2010. Thus, if the SWP is to meet its service area needs, the State must complete additional facilities.

As with the operational impacts of the Delta water management programs, the SWP cumulative impacts will be based on projected water demand and supply balances in the service areas. If the balances identify potential deficits, it will then be necessary to determine how these deficits will be alleviated without additional SWP facilities and at what cost. Thus, the cumulative economic impact of completing the SWP will equal the avoided economic and social costs of the alternatives.

Each year DWR develops short- and long-range operation studies; the most recent is presented in Bulletin 132-89, *Management of the California State Water Project,* November 1989. These studies are the basis for projections of the energy requirements for future SWP operations.

In 1987, the SWP delivered about 2.3 MAF. At this level the cumulative impact of the SDWMP on SWP deliveries will be an increase of about 4 percent of the total deliveries.

Cumulative Impacts of CVP Deliveries

Article 10 (h) of the Coordinated Operation Agreement commits the parties to negotiate a separate contract specifying that excess capacity in the pumping and conveyance facilities of the SWP would be used to increase the amount of water the CVP can deliver from the Delta. This is a separate action, requiring a separate contract or agreement and a separate environmental impact report. With its present Delta export facilities, the CVP lacks the pumping and conveyance capacity to deliver to its existing and potential contractors south of the Delta all the potentially exportable CVP water available in the Delta at certain times.

The SWP has capacity in the California Aqueduct for wheeling CVP supplies at the current level of SWP system development. If proposed storage projects south of the Delta are implemented, wheeling capacity during the winter will be severely restricted. With wheeling through SWP facilities, the effect of the CVP's capacity limitation would be lessened.

Wheeling of the type covered under Article 10 (h) could represent increased exports from the Delta. Such wheeling is distinguishable from other wheeling covered under Article 10 by the fact that the other wheeling, for outages and to make up for the May-June pumping restrictions, is already established and serves only to maintain—not expand—the water supply services of the SWP and CVP.

To the extent that some wheeling arrangements negotiated pursuant to Article 10 (h) could increase project exports from the Delta, the increase could cause environmental impacts incremental to those associated with the existing level of project operations. However, any future wheeling arrangement would have to be carried out within the protective flow and quality provisions of the SWRCB's Delta standards and would require a separate EIR/EIS and contract.

Any incremental impacts of wheeling arrangements negotiated pursuant to Article 10 (h) cannot be quantified or specifically described until the details of these arrangements are known. Early indications from operational studies suggest that the SWP has little remaining pumping capacity and conveyance capacity available for wheeling with existing facilities and restrictions. The potential for wheeling would increase if SWP conveyance facilities were expanded.

Further analysis of the environmental impacts of wheeling may be found in the following future and current documents:

- the water conveyance and purchase contract EIR/EIS now being prepared and tentatively scheduled for release in late 1990.
- the environmental statements being prepared by Reclamation concerning proposed water service contracts;
- any environmental document prepared in connection with new Delta standards that succeed those of Decision 1485; and
- this environmental impact study for the SDWMP, the results of which indicate that the impact of wheeling would increase only slightly with implementation of the SDWMP because of other restrictions and limitations.

Other Cumulative Impacts

Other cumulative effects associated with potential water development above the Delta probably would be similar to, and would increase the impacts of, past surface water development. Past projects on the Sacramento, San Joaquin, and Trinity river systems have had a variety of beneficial and adverse effects, including:

- development of water supplies for local and statewide needs;
- development of hydroelectric power;
- increased power requirements;
- improved navigation on the Sacramento River;
- creation of reservoir recreation areas and fisheries;
- increased flood control;
- creation of jobs;
- displacement of people and wildlife;
- inundation of lands, archeological sites, and live streams;
- Blockage of anadromous fish runs; and
- changed flow regimes, sediment regimes, water quality, and seepage conditions along affected streams.

Cumulative effects of offstream storage south of the Delta would include:

- new recreation opportunities and reservoir fisheries;
- creation of jobs;
- displacement of people and wildlife;
- inundation of lands and archeological sites;
- improvement in quality of water delivered to service areas;
- a net increase in power requirements; and
- ground water programs south of the Delta, which would involve construction of wells and distribution systems, as well as local water quality and hydrologic impacts and increased power requirements.

Growth Inducement.

CEQA requires a discussion of the ways in which a proposed project could " . . . foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects which would remove obstacles to population growth."

The location, timing, and magnitude of economic and population growth within a region are determined by a multitude of interrelated economic, social, and political factors, including:

- employment opportunities;
- availability and cost of natural resources, including land, water, and energy;
- the availability and cost of housing;
- the adequacy of community infrastructure (transportation facilities, fire and police protection, schools, recreational facilities, etc.); and

- local government policy concerning growth issues (zoning ordinances, general plans, etc.).

Whereas each of these variables influences growth, it is very difficult to ascertain whether a change in one of them is sufficient to cause a significant change in community growth rates. Economic growth is discussed in Chapter 5. Following is a discussion of population growth.

Because minimal amounts of water are necessary to sustain life, water must be available if growth is to occur. However, rarely will the provision of water alone stimulate growth if all the other factors listed above are not conducive to growth. But, if all the other variables are conducive to growth, and no water supplies are available, then the provision of water may be growth inducing since it could "remove a barrier to growth."

Several factors must be examined in order to determine if the proposed project is growth inducing. First, are there alternatives (both demand management and supply augmentation) that could be implemented in the absence of the proposed project? If the proposed project is the only source of water available to a region, it may in fact remove a barrier to growth, and, therefore, be growth inducing. However, if feasible alternatives are available (even if more expensive than the proposed project), it can then be assumed that they would be implemented in the absence of the project.

Hence, with or without the project, growth will occur; the only effect of the project is to use a less expensive source of water. Another factor that needs to be considered is local government policy regarding growth. Most communities in the State have implemented land use policies through their general plans and zoning ordinances that attempt to manage growth in conjunction with their available resources. These plans address population growth, land use, circulation, public services, and environmental resources. Typically, the strength of these plans in managing growth varies from community to community.

Finally, the determination of whether a particular water supply is growth inducing depends upon how it is used. For example, if the project's yield is used in addition to current surface and ground water supplies, then the resulting growth-inducing impacts could be considerably larger than if the yield were used to replace existing supplies (such as overdrafted ground water basins).

Since it has been determined that population growth will occur with or without the project and that the project's yield can be a replacement for some existing water supplies, the project is not expected to be growth inducing. (See also Chapter 5.)

Mitigation Measures for Cumulative Impacts

Various actions such as Decision 1485, the Suisun Marsh facilities, and DFG stocking programs have benefited fish and wildlife in the Delta. Studies by State, federal, and local agencies and private groups have provided much information, from which laws protecting fish and wildlife have been enacted. Today, at least 30 State and federal policies, as well as agency regulations, help protect the Delta's environment. Physical facilities such as fish screens at CVP and SWP pumping plants have been relatively effective in salvaging fish from export water. Funds from State, federal, and local sources for protection of fish and wildlife resources are in the many millions for ecological studies and physical facilities.

Mitigation measures for cumulative impacts due to future State, federal, and local water development generally consist of:

- safeguards by-laws, regulations, and water rights standards;
- contracts;
- physical measures and;
- studies and water management programs.

Safeguards

State and federal laws that provide safeguards include:

- Area of Origin Law,
- County of Origin Law,
- Davis-Dolwig Act,
- Delta Protection Act,
- Burns-Porter Act,
- California Environmental Quality Act,
- National Environmental Policy Act,
- National Fish and Wildlife Coordination Act,
- National Clean Water Act, and
- Provisions in Congressional Authorization of Federal Water Projects.

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State and federal regulatory agencies administering the laws include the SWRCB, Regional Water Quality Control Boards, EPA, and the Corps.

Contracts

Binding contracts are negotiated between project operators and various interests. DWR has executed contracts with several Delta water agencies that commit DWR to provide reliable water supplies and qualities under the Delta Protection Act. These contracts provide a further safeguard for Delta protection. DWR is continuing negotiations with other Delta interests.

Contracts for management of fish and wildlife resources in San Francisco Bay-Delta estuary can be broadened as to scope and the participating agencies. Such contracts would specify mitigation measures identified by studies and negotiations.

The agreement for coordinated operation of the SWP and the CVP allocates available supplies and shortages between both projects after meeting in-basin obligations, including Delta water quality objectives.

Physical Measures

Potential physical mitigation measures for identified significant impacts are listed below. Specific measures could be incorporated in contracts.

- Fish—hatchery construction, adjustment of reservoir releases, habitat modification, establishment of reservoir fishery, fish screens and return systems, export curtailments, and fish stocking programs.
- Wildlife—Purchase of replacement lands, capture and removal of species, control fencing, escape devices; mitigation in Suisun Marsh as specified in the Environmental Impact Report and Plan of Protection.
- Socioeconomic—payment of increased public services caused by project workforce.
- Cultural—avoidance or removal of identified cultural resources where possible, purchase of private property where necessary.
- Recreation—construction of recreational facilities.
- Soils and Vegetation—re-establishment of native vegetation, erosion control techniques, replacement of soil and topography where possible.
- Transportation—Relocation of roads and railroads.
- Utilities—Relocation of utilities.

Studies and Water Management Programs

State legislation passed in 1986 created "The Upper Sacramento River Fisheries and Riparian-Habitat Advisory Council." In 1989, the Advisory Council prepared the "Upper Sacramento Fisheries and Riparian Management Plan," which proposes 20 action items for restoration of fisheries and riparian habitat in the upper Sacramento River and its tributaries.

Federal legislation appears to be progressing through Congress to provide funding to restore fish populations in the upper Sacramento River. Fish screens and ladders, gravel restoration, hatchery expansion, and toxic reduction are proposed action items listed in the Advisory Council plan and would be eligible programs.

Many of the specific needs for mitigation are uncertain. Potential impacts requiring mitigation can be identified during studies. Objectives of the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, funded in part by the SWP, are to:

- improve understanding of the requirements of fish and wildlife in the estuary;
- develop design and operating criteria for the SWP and CVP for protection and enhancement of fish and wildlife; and
- monitor and evaluate project operations.

These studies provide a sound basis for mitigation measures. For example, the predation control studies in Clifton Court Forebay may reduce losses of Chinook salmon.

The court decision requiring monitoring of Delta channels with the additional pumps also provides mitigation. Mitigation for Delta agricultural needs are identified through studies of leaching practices and the salt tolerance of corn. Continuation of programs to improve water management would provide mitigation by reducing the buildup rate of future upstream diversions and Delta exports.

A primary objective of the SDWMP is to reduce fishery impacts by reducing reverse flows in the lower San Joaquin River and by shifting pumping. The program should add cumulatively to the Upper Sacramento River Fisheries and Riparian Habitat Management Plan, and could be considered one link in the restoration of salmon and steelhead.

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CHAPTER 7. CONSULTATION AND COORDINATION

Environmental Documentation And Public Involvement

The California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (Reclamation) prepared this Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for the South Delta Water Management Program (SDWMP) in compliance with the California Environmental Quality Act and the National Environmental Policy Act (NEPA). This EIR/EIS conforms with both State and federal legal requirements.

The process of environmental review began in March 1987. A Notice of Intent to prepare an EIR/EIS was published in the Federal Register Vol. 52, No. 54. In June 1987, Notices of Preparation were sent to the California State Clearinghouse and many other interested parties.

DWR and Reclamation implemented a public involvement process for the SDWMP. Public involvement activities include project scoping and public information meetings, and opportunities to comment on both the draft and final EIR/EIS's.

Purpose of Scoping

The Council on Environmental Quality regulations (40 CFR 1500–1508) for implementation of NEPA requires "... an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. This process shall be termed scoping. . . ." The purposes of the EIR/EIS scoping process were to identify the significant issues for study in the EIR/EIS and to determine the scope of the research of each issues.

Scoping is designed to explore issues for environmental assessment, to ensure that important considerations are not overlooked, and to discover concerns that might otherwise go unrecognized. Through scoping DWR and Reclamation endeavored to make the EIR/EIS more meaningful and useful to decision-makers and to those affected by the proposals or alternatives.

Scoping Meetings

DWR and Reclamation held two public scoping meetings in April 1987, during which the public and interested agencies identified significant issues related to the SDWMP. Table A-1 in Appendix A lists the scoping issues ranked by the meeting attendees in order of importance.

Additional public workshops for landowners in the south Delta planning area were held in August and September of 1988. A public meeting on recreational planning in conjunction with the SDWMP was held in Tracy in October 1988.

Written Comments

Agencies and organizations also submitted written comments identifying significant issues. These are summarized in Table A-2 of Appendix A.

Scoping Report

In December 1987 DWR and Reclamation published a scoping report for the SDWMP. The report describes the planning and environmental documentation process and contains a synthesis of comments received at the scoping meetings and the written comments, copies of written comments, and an analysis of issues.

Ongoing Coordination

Throughout the study period and during preparation of the EIR/EIS, DWR and Reclamation coordinated and consulted with the federal, State, and local agencies. These agencies included:

Federal Agencies

U. S. Army Corps of Engineers
U. S. Environmental Protection Agency
U. S. Fish and Wildlife Service
U. S. Geological Survey
National Marine Fisheries Service

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State Agencies

Department of Fish and Game
Department of Parks and Recreation
Department of Boating and Waterways
State Lands Commission
State Water Resources Control Board

Local Agencies

South Delta Water Agency
San Joaquin County Parks and Recreation
East Bay Regional Park District
East Bay Municipal Utility District
Planning and Conservation League
Metropolitan Water District of Southern California
State Water Contractors
California Striped Bass Association
United Anglers
Golden Gate Fishermen Association
California Farm Bureau

Opportunities to Comment on the Draft and Final EIR/EIS's

Agencies, interest groups, and the public will have opportunities to submit written comments on the draft and final EIR/EIS's and to make oral presentations at hearings to be held on the draft EIR/EIS.

Environmental Review and Consultation Requirements

This draft EIR/EIS has been prepared concurrently with environmental review and consultation required by federal environmental law other than NEPA, as required by 40 CFR 1502.25. Compliance with specific environmental review and consultation requirements is described below.

Clean Water Act (33 USC 1251 et seq.)

The Clean Water Act of 1977 aims to ". . . restore and maintain the chemical, physical, and biological integrity of the Nation's waters. " Section 404 of the act establishes a permit program, administered by the U. S. Army Corps of Engineers (Corps), to regulate the discharge of dredged or fill materials into the waters of the United States. Section 401 of the act requires that the project not violate State water quality standards.

Construction of the enlarged Clifton Court Forebay, channel dredging, and installation of barrier-type facilities would require placing fill material into United States waters. This will require a Corps Section 404 permit. DWR will also be requesting project certification from the State Water Resources Control Board to fulfill Section 401. See discussion in Chapter 1 under "Regulatory Permits"

Rivers and Harbors Act of 1899 (USC 401–413)

Section 10 of the Rivers and Harbors Act prohibits the unauthorized obstruction or alteration of any navigable waters of the United States. Increasing the pumping rate at Banks Pumping Plant would require a Corps Section 10 permit. DWR will apply for this permit.

Fish and Wildlife Coordination Act (16 USC 661 et. seq.)

The Fish and Wildlife Coordination Act (FWCA) requires federal agencies to consult with the U. S. Fish and Wildlife Service (USF&WS) and the California Department of Fish and Game (DFG) before undertaking projects that control or modify surface water. This consultation is intended both to promote the conservation of wildlife resources by preventing loss of or damage to wildlife resources and to provide for the development and improvement of wildlife resources in connection with water projects. Federal agencies undertaking water projects are required to include in project reports recommendations made by the USF&WS and DFG, to give full consideration to these recommendations, and to include in project plans justifiable means and measures for wildlife purposes.

The USF&WS and DFG have been extensively involved in this project from the start. USF&WS prepared planning aid memoranda on November 13, 1987 and August 30, 1988. USF&WS lead the Habitat Evaluation Procedures (HEP) team consisting of representatives from USF&WS, DFG, Reclamation, and DWR. USF&WS prepared a draft report on impacts and compensation needs analysis using HEP in December 1989. Negotiations are continuing on the HEP, and an agreement will be reached by all agencies before the final EIR/EIS. A preliminary draft FWCA report on impacts from the project and recommended compensation measures to mitigate for the impacts is currently under review. The FWCA report will be included in the final EIR/EIS.

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Endangered Species Act (16 USC 1531 et. seq.)

Section 7 of the Endangered Species Act (ESA) of 1973 requires federal agencies, in consultation with the Secretary of the Interior, to ensure that their actions do not jeopardize the continued existence of endangered or threatened species, or result in the destruction or adverse modification of the critical habitat of these species.

USF&WS prepared a list of threatened, endangered, and candidate species which may occur in the project area. As discussed in Chapter 3, DWR and Reclamation had field surveys conducted for these species in 1987 and 1988. As negotiations for definition of the proposed action near completion, a biological assessment will be prepared to determine whether any listed species or species proposed for listing are likely to be affected by the proposed action. This assessment will be submitted to USF&WS, the National Marine Fisheries Service (NMFS) and DFG with a request for formal consultation if the proposed action would affect listed species. Subsequently, USF&WS, NMFS, and DFG would prepare a Biological Opinion to determine whether the action would jeopardize the continued existence of listed species or adversely modify their critical habitat. If a finding of jeopardy or adverse modification is made in the Biological Opinion, DWR and Reclamation would have to modify the project to ensure listed species are not affected.

National Historic Preservation Act (16 USC 470 et. seq.)

Section 106 of the National Historical Preservation Act (NHPA) requires federal agencies to evaluate the effects of federal undertakings on historical, archeological, and cultural resources. Agencies are required, within the vicinity of proposed projects, to identify historical or archeological properties, including properties on the National Register of Historic Places, and those that the agency and the State Historic Preservation Office (SHPO) agree are eligible for listing in the National Register. If the federal project is determined to have an adverse effect on National register properties or those eligible for listing, the agency is required to consult with the SHPO and the Advisory Council on Historic Preservation to develop alternatives or mitigation measures to allow the project to proceed.

A Class II cultural resource survey was completed in April 1990. When the results are analyzed, it will be determined whether a more extensive Class III survey is necessary. A cultural resources report will be prepared and sent to the SHPO. If it is determined that adverse effects will occur, the procedure described in the previous paragraph will be followed.

Farmland Protection Act (16 USC 590 a–f,q)

Council on Environmental Quality memoranda to Heads of Agencies, dated August 30,1976, and August 11, 1980 and the Farmland Protection Act of 1981 require agencies in their EIS's to include farmlands assessments designed to minimize adverse impacts on prime and unique farmlands. The regulations published in the Federal Register (Vol. 49, No. 130, July 5, 1984) contain the criteria to be used to identify these lands and determine impacts. As negotiations for definition of the proposed action near completion, the Soil Conservation Service will be contacted to identify whether the proposed action will affect any lands classified as prime and unique farmlands. If any lands are identified, alternatives would be considered which could lessen impacts to such lands.

Executive Order 11988: Floodplain Management

Executive Order 11988 requires federal agencies to prepare floodplain assessments for proposals located within or affecting floodplains. If an agency proposes to conduct an action within a floodplain, it must consider alternatives to avoid adverse impacts and incompatible development in the floodplain. If the only practicable alternative involves siting in a flood plain, the agency must minimize potential harm to or within the floodplain.

The south Delta lies within the floodplain. Therefore, the SDWMP facilities are located in the floodplain. Modification to existing levees would enlarge south Delta channel cross-sections and hence increase channel capacity. With increased capacity, the channels would be able to contain greater floodflows and provide greater protection from flooding. New levees would also be designed to meet 100-year flood standards.

Executive Order 11990: Protection of Wetlands

Executive Order 11990 requires federal agencies to prepare wetlands assessments for proposals located within or affecting wetlands. Agencies must avoid undertaking new construction located in wetlands unless no practical alternative is available and the proposed action includes all practicable measures to minimize harm to wetlands. The SDWMP will not impact any natural occurring wetlands.

See discussion in Chapter 5, under "Impacts on Wetlands."

Clean Air Act (42 USC 7501)

Section 176 (c) of the Clean Water Act requires that no federal agency, "... (1) engage in, (2) support in any way or provide financial assistance for, (3) license or permit, or (4) approve, any activity which does not conform to a plan after it has been approved or promulgated under Section 110." A "plan" refers to a State Implementation Plan (SIP) to meet the National Ambient Air Quality Standards (NAAQS) that is approved by the Administrator of the Environmental Protection Agency (EPA). Each approved SIP must contain a clear definition of the circumstances in which a federally funded or approved project will or not conform to the SIP. If there is no approved SIP, EPA is responsible for determining compliance with the Clean Air Act and whether or not a project will affect future abilities to meet the NAAQS. In either case, providing the information necessary for a determination of conformity is an agency responsibility. SIP's are required for any area whose present ambient air quality does not meet the NAAQS.

To show conformity with the NAAQS, a federal agency proposing an action must show that the proposal will not cause violations of the NAAQS or in any way hinder future attainment of the NAAQS. This can be done by demonstrating that the proposed action does not induce growth which would prevent or hinder compliance with the NAAQS, showing that growth projections used in the air-quality analysis are in accordance with projections in an approved SIP, or mitigate increased pollutants which would result form a proposed action.

The SDWMP will not have any growth-inducing impacts and, hence, will comply with the Clean Water Act. Growth-inducing impacts are discussed in Chapter 5.

Distribution List

1. Statements distributed by the Commissioner of the Bureau of Reclamation for review and comment.

a) **U. S. Department of the Interior:**
Bureau of Land Management
Fish and Wildlife Service
Geological Survey

b) **Other Federal Agencies:**
Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army
Department of Energy
Department of Transportation
Environmental Protection Agency

2. Statements distributed by the Commissioner of the Bureau of Reclamation for information only.

a) **United States Senate, Washington D.C.**
Honorable Alan Cranston
Honorable Pete Wilson

b) **United States House of Representatives, Washington D.C.**
Honorable Tom Campbell
Honorable Ronald V. Dallums
Honorable Don Edwards
Honorable Vic Fazio
Honorable Tom Lantos
Honorable George Miller
Honorable Norman Y. Mineta
Honorable Nancy Pelosi
Honorable Fortney H. (Pete) Stark

3. Statements distributed by the Regional Director, Mid-Pacific Region, for review and comment.

a) **U. S. Department of the Interior:**
Bureau of Land Management, Sacramento
Fish and Wildlife Service, Portland; Sacramento (2)
Geological Survey, Sacramento; Menlo Park
National Park Service, San Francisco (2)
Regional Environmental Officer, DOI, San Francisco

b) **Other Federal Agencies:**
Army Corps of Engineers, Sacramento; San Francisco
Environmental Protection Agency, San Francisco (3)
Federal Emergency Management Agency, San Francisco
Forest Service, San Francisco
Federal Highway Administration, San Francisco
National Marine Fisheries Service, Terminal Island,
Soil Conservation Service, Davis
Western Area Power Administration, Sacramento

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c) **State Agencies (State of California)**

Air Resources Board, Sacramento
Assembly Committee on Agriculture, Sacramento
Assembly Committee on Water, Parks, and Wildlife, Sacramento
Assembly Natural Resources Committee, Sacramento
Board of Aeronautics, Sacramento
California Highway Patrol, Napa
California Water Commission, Sacramento
Chamber of Commerce, Sacramento
Department of Boating and Waterways, Sacramento
Department of Conservation, Sacramento
Department of Fish and Game, Sacramento (4)
Department of Food and Agriculture, Sacramento
Department of Forestry, Sacramento, Spanish Flat Station (2)
Department of General Services, Sacramento
Department of Health Services
Department of Parks and Recreation, Sacramento
Department of Transportation, Sacramento
Department of Water Resources, Sacramento
Native American Heritage Commission, Sacramento
Office of Governor Deukmejian, Sacramento
Office of Historic Preservation Sacramento
Regional Water Quality Control Board, Central Valley Region, Sacramento
State Clearing House, Sacramento (20)
State Lands Commission, Sacramento
State Reclamation Board, Sacramento
State Water Resources Control Board, Sacramento
Wildlife Conservation Board, Sacramento

d) **Local Agencies:**

Alameda County Flood Control
Byron-Bethany Irrigation District
Byron Tract Reclamation District 800
Central Delta Water Agency
City of Antioch
City of Brentwood
City of Oakley
City of Pittsburgh
City of Stockton
City of Tracy
Coney Island Reclamation District 2117
Contra Costa County
Contra Costa County Water Agency
Contra Costa Water District
East Bay Municipal Utility District
East Contra Costa Irrigation District
Fabian Tract Reclamation District 773
Middle Roberts Island Reclamation District 524
North Delta Water Agency
Pacific Gas and Electric Company
Paradise Junction Reclamation District 2095
Pescadero Tract Reclamation District 2058
Pico-Naglee Reclamation District 1007
South Delta Water Agency
Stark Tract Reclamation District 2089
Union Island Reclamation District 1, 2
Upper Jones Tract Reclamation District 2039
Upper Roberts Island Reclamation District 544
Victoria Island Reclamation District 2040
Woodward Island Reclamation District 2072

e) **Organizations:**

Association of California Water Agencies, Bay Institute of San Francisco,Brown and Caldwell, California Trout, California Striped Bass Association,California Wildlife Federation, California Waterfowl Association, CH2M Hill, Defenders of Wildlife, Environmental Council, Environmental Defense Fund, Friends of the River, Izaak Walton League of America, League of Women Voters of California, Natural Defense Council, Pacific Interclub Yacht Association, Planning and Conservation League, Recreational Boaters of California, San Francisco Bay Conservation and Development Commission, Sacramento Audubon Society, Salmon Unlimited, Sierra Club, Save San Francisco Bay Association, Association of State Water Contractors, Stockton Audubon Society, The Nature Conservancy, United Anglers of California, Murray Burns & Kienlen, Woodward-Clyde Consultants, San Joaquin River Water Users Association

f) **Individuals:**

Harvey O. Banks, Brian Bell, Dante J. Nomellini, William E. Warne, John L.Winther, Ken Woodward, Frederick Bold Jr., Max Bookman, D.W. Kelley, Ann Schneider, George Basye, Gerald Orlob, John W. Pulver, Robert Krieger, Robert Mygrant, Richard Dornhelm, Gwen Buchholz, Joseph I. Burns, RichardL. Schafer, Thomas M. Stetson, Dorothy Green, Victor Viets, B.J. Miller, Tom Mongan, John Gregg, Bert Parkinson, Sally Freedman.

g) **Media:**

Angler Magazine, Antioch Daily Ledger, Bakersfield Californian, Brentwood News, Los Angeles Times, Record Searchlight, San Francisco Chronicle, Tracy Press, San Diego Union, San Bernardino Sun,

Fresno Bee, Times-Standard, Sacramento Bee, Sacramento Union.

4. Statements distributed by the Regional Director of the Mid-Pacific Region, for information only.

a) **State Senate**
Honorable John Doolittle
Honorable John Garamendi
Honorable Leroy Greene
Honorable Barry Keene
Honorable James Nielsen

b) **State Assembly**
Honorable Chris Chandler
Honorable Lloyd Connelly
Honorable Thomas Hannigan
Honorable Bev Hansen
Honorable Dan Hauser
Honorable Phillip Isenberg
Honorable Patrick Johnston
Honorable Tim Leslie
Honorable Stan Statham
Honorable Norm Waters

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APPENDIXES

Note: Some of the appendixes to the South Delta Water Management Program Environmental Impact Report/ Statement are too long to be included in this document. The information in these appendices has been abbreviated in the EIR/EIS and summarized here. Readers wishing to consult the full appendixes for more detailed information should contact the Department of Water Resources, Division of Planning, Sacramento, California for locations where the appendixes are available for public review.

A. Scoping Process

B. South Delta Negotiation Agreements

C. Modeling Assumptions and Results

D. Negative Declaration for Land Purchase for SDWMP

E. Economic Analysis Summary

F. SDWMP Biological Assessment Summary

G. Direct Fish Impact Analysis Summary

H. U.S. Fish and Wildlife Service's Coordination Act Report Summary

I. Construction Report Summary

J. Seismic Report Summary

K. Archeological Report Summary

L. Recreation Report Summary

M. Narrowing of Alternatives

N. Documents Incorporated by Reference

O. List of Preparers

APPENDIX A
SCOPING PROCESS

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APPENDIX A
SCOPING PROCESS

Scoping sessions were conducted on April 13 and 21, 1987 to solicit public input in determining the scope of trhe EIR/EIS and significant issues related to the alternatives identified. A December 1987 report—*South Delta Water Management Project, A Report on Public Involvement and Identification of Issues,* prepared by the Department of Water Resources and the U.S. Bureau of Reclamation—discussed the planning and environmental documentation process and findings of the scoping meetings. The report also contains documents pertinent to the scoping process, including the federal Notice of Intent, the State Notice of Preparation, and the U.S. Army Corps of Engineers pre-application meeting notice.

Issues and questions identified at the public scoping sessions were scored on the basis of frequency and relative ranking of each issue raised. Table A-1 shows the scoping issues by rank. Various federal and State agencies and private citizens sent letters identifying a number of issues. Written comments are summarized in Table A-2.

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Table A–1
Scoping Issues, By Rank

Rank	Issue	Score
1	High quality water must be guaranteed to the south Delta.	27
2	Blockage or interference of fish migration, including barriers, must be avoided.	23
3	North Delta and South Delta planning should be concurrent.	22
4	Communications should be maintained with landowners whose property would be affected.	15
5	The EIR/EIS should address conjunctive use from the Stanislaus and American rivers.	14
6	Availability of water for wetlands should be discussed.	12
7	Federal participation in Delta fish protection agreement should be addressed.	11
8	Diversion of fish too small to be screened should be considered.	11
9	Sandbars and silt should be removed from the Delta.	10
10	Water should be managed and conserved to reduce Delta exports.	10
11	Effects of a project on reverse flows should be addressed.	10
12	Feasibility studies are needed on storage south of the Delta (no North Delta improvements).	8
13	Effectiveness of the proposed facilities should be evaluated.	8
14	Additional reservoirs are needed south of the Delta on the west side of the valley to capture winter floodflows.	7
15	Effects on rare and endangered species should be considered.	7
16	San Joaquin Valley agricultural discharges should be improved to improve river water quality.	6
17	Boat fees should be used to finance dredging to improve navigation.	6
18	Project financing must be addressed.	6
19	Additional pumping during winter for flood control should be discussed.	6
20	The source of silt in the Delta–Mendota Canal should be determined.	5
21	New levees should be set back from existing embankments.	5
22	Channel and levee improvements should be combined with 100–year–flood protection.	5
23	Effects of Decision 1485 rehearing on the project should be discussed.	5
24	Pumps in the San Joaquin River at Old River would increase flow.	4
25	Adequate fish screens are needed at Clifton Court Forebay.	4
26	Additional recreation opportunities should be provided in the Delta.	4
27	Increased fish predation due to enlarging Clifton Court Forebay should be discussed.	3
28	One–for–one mitigation should be provided for fish in the Delta.	3
29	The type of fish screens at SWP and CVP facilities needs to be studied.	3
30	Effects on the integrity of flood control levees should be covered.	2
31	Riparian vegetation must be protected.	2
32	Methods other than New Melones to bring high–quality water to the Delta should be found.	1
33	The EIR/EIS should discuss the relationship between project alternatives and Delta facilities legislation.	1
34	Water quality degradation and siltation near the Port of Stockton and San Joaquin River should be evaluated.	0
35	Tidal gates at Carquinez Strait should be considered.	0
36	Enlarging Clifton Court Forebay would inundate upland game and waterfowl habitat.	0
37	Export supplies could be reintroduced to the San Joaquin River to improve water quality.	0
38	Impacts of siltation on Clifton Court Forebay should be covered.	0
39	Drafting of fish from the central Delta and Sacramento River into the southern Delta should be discussed.	0
40	Waterfowl rafting due to enlarging Clifton Court Forebay should be discussed.	0
41	Exports to the south from the Delta should be discontinued.	0
42	Responsibility for levee maintenance on improved channels should be determined.	0

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Table A-2
Summary of Written Comments

Contra Costa Water District

1. The following impacts should be addressed: water quality, water levels, fish and wildlife in other parts of the Delta.
2. Identify whether exports are to be increased; if so, identify the impacts of this increase on the estuary.

South Delta Water Agency

1. Effect on south Delta water levels.
2. Effect on water circulation and depth.
3. Effect of barriers on fish migrations: "Project" vs. "No-project."

East Bay Municipal Utility District (EBMUD)

1. Mokelumne Aqueduct, which crosses the project area, should be protected during any construction and service should remain uninterrupted.
2. Use of any EBMUD right-of-way should be approved before construction.

U.S. Army Corps of Engineers

1. Depletion of suspended sediments from pumping plant operations.
2. Effects on "Null Zone" from export pumping.
3. Effects of changes in outflow on San Francisco Bay.
4. Effects of salinity changes on wildlife in Suisun Marsh.
5. Contribution of SWP pumping to dissolved oxygen depletion near Stockton.
6. Economic effects on central and west Delta.

Planning and Conservation League

1. Water conservation programs should accompany new increase in project exports.
2. Study only those facilities that would improve fisheries.
3. Alternatives should maximize fish and water quality benefits, including the Peripheral Canal and a smaller peripheral canal for SWP only.
4. Consider relocating fish screens outside of Clifton Court.
5. Depending on cost, consider use of General Funds if statewide benefits are provided.
6. CVP, Contra Costa Water District, and EBMUD should be tied to any rebuilt export facilities.
7. SWP should refuse to wheel CVP water if CVP does not comply with State water quality standards.
8. Consider overall Delta facilities and operation under future water demand and conditions.

California Department of Fish and Game

Fisheries Considerations

1. Fish migration interference (mainly salmon).
2. Drafting of fish from central Delta and Sacramento River to the south Delta.
3. Diversion of fish too small to be screened effectively.
4. Barrier configuration (for fish passage).
5. Physical/operational measures to offset existing fish impacts and avoid greater future impacts.
6. Existing CVP screens promote higher than desirable fish losses.
7. Increased exports will decrease screening efficiency at SWP screens
8. Consider measures to improve screening efficiency.
9. Negotiate with CVP for a new fish agreement similar to the Banks Pumping Plant Fish Agreement between DWR and DFG.

Table A–2 (Continued)
Summary of Written Comments

California Department of Fish and Game (Continued)

Wildlife (Potential Impacts)

1. Riparian habitat.
2. Rare/threatened/endangered species.
3. Species of special concern.
4. Waterfowl/upland game species.

Institutional Considerations

1. Project proposals differ substantially in scope and complexity.
2. Target completion date does not seem reasonable considering overall scope of project.
3. Project time table would have the final document completed before the results of ongoing monitoring studies on interim facilities is complete.
4. Before diversions are increased, existing fish agreement (Article 7) must be renegotiated to offset adverse fish impacts of SWP that are not covered in the existing agreement.

U.S. Environmental Protection Agency

General

1. Actions that serve the same purpose should be analyzed as a group; not as separate actions.
2. Discuss other alternatives, particularly those related to water conservation.
3. Relate unquantified impacts to any cost/benefit analysis.
4. Analyze impact to prime agricultural land.

Water Quality

1. Document water export needs.
2. Assess impacts of building new or using existing winter storage facilities.
3. Address the Banks Pumping Plant Fish Agreement between DWR and DFG, including a revised agreement as a mitigation measure.
4. Discuss relationship with other proposed SWP and CVP projects.
5. Show compliance with water quality standards.
6. Discuss relationship with possible new Bay–Delta water standards and effects of standards on signed contracts.
7. Maintain and protect beneficial uses of south Delta waterways.
8. Coordinate planning with State Water Resources Control Board and DFG.
9. Discuss flow releases to the Delta necessary to meet water quality standards.
10. Upstream and downstream changes to floodplains.
11. Increased toxicity in south Delta from discharge or runoff.
12. Changes in salinity or temperature of surface or ground water.
13. Impacts to riparian habitat on aquatic conditions.

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The scoping report noted that impacts in 12 environmental categories will be analyzed. The emphasis within each area is discussed below.

Water Quantity and Quality

Key issues to be addressed include:

- effects of the proposed project on water quality, circulation patterns, and water levels in south Delta channels;
- effects of the proposed project on water supply reliability through improved capability for banking winter supplies (Los Banos Grandes and Kern Water Bank); and
- how the project can maximize efficiency of the SWP and CVP operations.

Additional specific issues to be addressed include:

- relationship of the proposed project to related projects, such as interim south Delta facilities, any North Delta water management program, wheeling and purchase agreements with Reclamation, Los Banos Grandes, potential conjunctive use programs, installation of additional pumping units at the Bank Delta Pumping Plant, and Reclamation's additional Delta export water contracting;
- effects of the proposed project on reverse flows in the west Delta;
- potential for increased toxicity from discharge or runoff, and changes in water temperature;
- relationship of the proposed project to dissolved oxygen depletion near Stockton;
- relationship to existing water quality standards;
- potential water conservation measures;
- relationship of CVP, EBMUD, and CCWD facilities to any new SWP export facilities; and
- relationship of the project to siltation in south Delta channels, Clifton Court Forebay, and the Delta-Mendota Canal.

DWR, Reclamation, and SDWA will make extensive use of hydrodynamic and water quality models to evaluate water quality/quantity impacts and to determine the most viable alternative for mitigating adverse impacts. Hydrodynamic simulation of flow requirements of south Delta channels under various conditions of SWP and CVP operations, boundary condition tides, and San Joaquin River flows should provide the basis for determining project impacts on water levels.

Fisheries

Key issues to be included:

- how the proposed project, including barriers, will affect fish (primarily salmon) migration in the San Joaquin River system;
- how the proposed project will affect the drafting of fish from the central Delta and Sacramento River and the diversion of fish too small to be screened effectively;
- how the proposed project will affect predation losses in Clifton Court Forebay; and
- if increased exports result from the project, how the increase will have on screening efficiency in Clifton Court Forebay and/or CVP screens.

Additional specific issues to be addressed include:

- potential physical and operational measures that may offset existing fishery impacts and avoid or reduce future impacts;
- effects of increased exports on the fish agreement between DWR and DFG;
- potential for developing a similar agreement between DFG and Reclamation to compensate for fish losses;
- relationship of the proposed project to fish and fish food resources in other parts of the Delta, Suisun Bay, and San Francisco Bay; and
- relative effectiveness of new intakes to Clifton Court Forebay and relocation of fish screens to outside Clifton Court Forebay.

Fishery impacts will be analyzed using existing information where possible. Much of this information has been compiled through various State, federal, and interagency programs designed to monitor and assess project impacts on Bay-Delta biological resources. The fishery impact

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analysis will be coordinated with the following programs or activities:

- Interagency Ecological Studies Program;
- Bay–Delta water rights hearings and exhibits;
- Interim South Delta facilities monitoring;
- Suisun Marsh monitoring;
- Project operation studies;
- Banks Pumping Plant Fish Agreement; and
- Skinner Fish Facility monitoring.

Where appropriate, hydrodynamic and project operation models will be used to represent simulated base and projected conditions to assess effects of proposed alternatives relative to some base set of conditions.

Wildlife and Native Vegetation

Key issues to be addressed include:

- effects of the proposed project on Delta riparian habitat and such species as raptors; and
- effect of the proposed project on waterfowl and upland game species.

Additional specific issues to be addressed include:

- potential for waterfowl rafting on an enlarged Clifton Court Forebay;
- effects on food production for wintering waterfowl;
- effects on amphibians and reptiles;
- effect on species of special concern;
- potential to design levees (setbacks) for long–term improvement of riparian habitat;
- effects on wildlife in Suisun Marsh due to salinity changes; and
- effect on availability of water for wetlands.

Impacts on wildlife and native vegetation will be assessed on the basis of field studies designed and conducted specifically for this project. Field studies include: vegetation/habitat analysis, including wetlands, using a Habitat Evaluation Program (HEP) or modified HEP approach designed by USFWS; and an analysis of waterfowl habitat use.

Land Use and Agriculture

The key issue to be addressed is:

- Effectiveness of the proposed project to provide water quality and quantity to meet agricultural needs in the south Delta.

Additional specific issues to be addressed include:

- effects on existing rights–of–way, such as that held by EBMUD;
- effects on floodplains and wetlands;
- compatibility of ancillary project features, such as recreation, mitigation easements, etc., with existing land use plans; and
- effects such as inundation on prime agricultural land.

Geology, Soils, and Flood Control

The key issue to be addressed is:

- Effect of the proposed project on flood control benefits and levee maintenance in the south Delta.

Recreation

Key issues to be addressed include:

- effects of the project on recreational boating; and
- the need for additional or enlarged recreational facilities.

Effects of the project on hunting and fishing will be discussed under the sections, "Fisheries" and "Wildlife and Native Vegetation."

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Cultural Resources

A Class I archaeological survey to be conducted for the study area will include a literature and records search to identify significant historical and archaeological resources. A Class II survey consists of a detailed records and literature search supplemented with partial field examination. When the final alternative is selected, a Class III survey, which consists of an intensive total field examination will be conducted.

Rare, Threatened, and Endangered Species

The key issue to be addressed is:

- Effect of the proposed project on rare/threatened/endangered plant and animal species.

Field inventories will be conducted to determine the presence and distribution of listed and candidate species, including plants, mammals, birds, reptiles/amphibians, and insects.

Social and Economic Effects

Social and economic impacts will be given an overall general treatment.

Specific issues to be addressed include:

- Economic effects of the proposed project on the central and south Delta;
- Financing of the proposed project, including mitigation; and
- Cost of the proposed project.

Related Programs

Impacts on related programs will be given an overall general treatment. Related programs to be considered include:

- North Delta water management facilities;
- West Delta water management facilities;
- Los Banos Grandes offstream storage facilities;
- Potential conjunctive use programs;
- Potential water conservation alternatives;
- Banks Pumping Plant Fish Agreement;
- Bay-Delta water rights hearings;
- Interagency Delta Management Committee;
- Coordinated Operation Agreement wheeling and purchase agreements;
- Kellogg and Los Vaqueros project planning;
- Contra Costa Canal relocation planning;
- Coordination with Delta legislation;
- Kern Water Bank;
- Coastal Aqueduct; and
- Delta recreation planning.

Cumulative Impacts

Cumulative impacts will be analyzed for various elements of the proposed project in the Bay-Delta estuary and in SWP and CVP service areas. Mitigation measures for cumulative impacts will also be discussed. Cumulative impacts will be discussed in relation to the Delta, SWP, and CVP planning and related projects.

Growth Inducement

This section will describe how the project could foster economic and population growth and the construction of additional housing, either directly or indirectly.

APPENDIX B
SOUTH DELTA NEGOTIATION AGREEMENTS

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APPENDIX B
SOUTH DELTA NEGOTIATION AGREEMENTS

The Department of Water Resources (DWR) has signed three agreements with the South Delta Water Agency (SDWA) to settle the litigation between DWR, the U.S. Bureau of Reclamation (Reclamation) and SDWA. They are the:

- *Joint Powers Agreement Regarding Mitigation for the South Delta*, June 1986.
- *Joint Powers Agreement for Tom Paine Slough*, June 1986
- *Agreement on Framework for Settling Litigation Brought by the South Delta Water Agency Against the United States and the California Department of Water Resources*, October 1986.

Negotiators for the three agencies are working actively on a permanent agreement delineating mutually acceptable long-term solution to the water-level and circulation problems in the south Delta. This fourth agreement is expected to be included in the final EIR/EIS.

Summary of Agreements

The *Joint Powers Agreement Regarding Mitigation for the South Delta* was signed in June 1986. Under this agreement, four interim measures were accomplished in the south Delta:

1. dredging a pilot channel in Tom Paine Slough to increase conveyance and improve water levels;
2. modifying Clifton Court Forebay operations;
3. installing four 36-inch siphons at Tom Paine Slough; and
4. installing a weir in Middle River near Victoria Canal.

This agreement will terminate when mitigation for State Water Project (SWP) impacts on the southern Delta are eliminated or when the parties reach a permanent solution.

The *Joint Powers Agreement for Tom Paine Slough* among DWR, SDWA, and Pescadero Reclamation District permitted Pescadero to undertake the dredging and siphon work in Tom Paine Slough described above. DWR reimbursed Pescadero for all costs. DWR, Pescadero, and SDWA are monitoring water levels and circulation in Tom Paine Slough.

The *Agreement for Settling Litigation Brought by the South Delta Water Agency against the United States and the California Department of Water Resources* was signed October 10, 1986. This agreement, among DWR, SDWA, and Reclamation committed the parties to work out a negotiated permanent solution to the water supply problems in the southern Delta. The agreement includes releases from New Melones Reservoir by Reclamation on an interim basis. All parties involved will work to solve all problems in the south Delta through physical and/or operational means.

Long-term possible solutions include tide-gate barriers in Middle River near Victoria Canal and Old River, dredging of shallow channel reaches, and releases from New Melones Reservoir. In addition, all three agencies will cooperate in developing a method of forecasting low tides in the south Delta.

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AGREEMENT ON FRAMEWORK FOR SETTLING LITIGATION BROUGHT BY THE SOUTH DELTA WATER AGENCY AGAINST THE UNITED STATES AND THE CALIFORNIA DEPARTMENT OF WATER RESOURCES

STATEMENT OF OBJECTIVES

The South Delta Water Agency (SDWA), the United States and the California Department of Water Resources (DWR) are engaged in litigation concerning the impacts of the operations of the Central Valley Project by the Bureau of Reclamation (Bureau) and the State Water Project by the DWR on the water rights asserted by the SDWA in the southern Sacramento/San Joaquin Delta. The parties agree to attempt to settle this litigation, and, to that end, they will work together to develop mutually acceptable, long-term solutions to the water supply problems of the water users within the SDWA. To facilitate settlement negotiations, the parties will stipulate to a stay of all action in the litigation. During the negotiation process, the Bureau will provide water releases from the New Melones Reservoir for an interim period and cooperate with the SDWA in addressing the particular interim problems of water diverters from Old River between the Delta Mendota Canal intake and Salmon Slough, as described below.

DEVELOPMENT OF A BASIS FOR SETTLEMENT

The parties will cooperate in developing a plan that specifies long-term physical and/or operational solutions to the water supply problems of the South Delta region. The particular

problems this plan will address are the loss of efficient pump operations, reductions in the San Joaquin River inflows and accumulations of salts above historical levels in the San Joaquin River and southern delta channels. The long-term actions to be considered for inclusion in the plan will be, among others, the construction and operation of tide-gated barriers in the Middle River near, but upstream of, Victoria Canal and in the Old River west of the Westside Irrigation District intake channel; dredging of shallow channel reaches; and specified releases from the New Melones Reservoir.

The plan will contain provisions for appropriate cost sharing among the parties, and a division of other responsibilities for the implementation of solutions specified in the plan. The allocation of costs also will be determined by agreement among the parties, taking into account available information about the sources of the problems addressed and the benefits each will receive as the result of the implementation of the plan.

The parties will attempt to develop a preliminary statement of the plan, focusing on physical and operational actions, no later than April 1, 1987, and a final statement of the plan, including provisions for cost allocations, no later than April 1, 1988. It is understood that the Bureau's participation in implementing the plan may depend on new Congressional authorization and/or appropriations, and that its

ability to agree to any provision of the plan requring an act of Congress is severely constrained.

INTERIM ACTIONS

To facilitate the settlement negotiations, the Bureau will provide sufficient water releases from the New Melones Reservoir to meet the following criteria, applied at the U.S. Geological Survey stream gage near Vernalis, during the period of the negotiations: (a) flows of the San Joaquin River will be maintained at not less than 500 cfs on a seven day running average basis; (b) flows of the San Joaquin River will be maintained at a 14-day running average water quality of 450 ppm TDS or better during the irrigation season of April through October and at a mean monthly water quality of 500 ppm TDS or better during the remainder of the year; (c) flows of the San Joaquin River will not be less than the monthly volumes presented in the table below; (d) the releases from New Melones required under the preceding criteria will be limited to a maximum of 150,000 acre-feet per water year in addition to the releases made by the Bureau from New Melones to maintain fish and water quality in accordance with the California Water Resources Control Board's Decision D-1422; and (e) the Bureau will not reduce the interim flows specified in these criteria without first providing SWDA with six months notice, unless a lesser notice period is compelled by emergency circumstances.

Month	Vernalis Flow in KAF
Oct	37
Nov	31
Dec	30
Jan	30
Feb	30
Mar	30
Apr	35
May	44
June	49
July	69
Aug	64
Sep	45

Additionally, the Bureau, the DWR and the SDWA will cooperate in developing a reasonable method of forecasting low tide conditions in the southern delta under which the diversions of water from Old River between the Delta Mendota Canal intake and Salmon Slough may be restricted, and the Bureau will consider timely requests by the SDWA to modify its export pumping operations to reduce such restrictions.

CONDITIONS

1. The court must approve a stipulation by the parties that provides at a minimum that the April 1987 trial date now scheduled in the litigation be cancelled and that no party will seek to schedule a new trial to begin sooner than six months after written notice to the other parties, except as provided in condition 5, below.

2. This Agreement may be terminated by any party on or after 6 months from the date of notice provided in accordance with condition 1.

3. The parties agree that none of the actions taken by the parties as bases for settlement of the litigation, nor any writings proposing or describing such action, will be relied upon: (a) to establish that the Central Valley Project and/or the State Water Project operations have damaged or unlawfully interfered with the water rights of the SDWA or any of its water users; (b) to define, limit or establish the nature or extent of any water rights asserted by the water users within the SDWA; or (c) to establish any new cause of action by the SDWA against either the United States or the DWR.

4. The parties agree that it is not their intention to create any third party interest by any action taken or agreement reached in the settlement negotiation process.

5. The stipulation to stay the litigation will not preclude the SDWA from seeking emergency injunctive relief, but upon any such action by the SDWA, the Bureau and/or the DWR may withdraw from this Agreement.

6. This Agreement is not intended to modify any outstanding agreement between the SDWA and the DWR.

10/2-86
(Date)

Robert E. Ferguson, Chairman
South Delta Water Agency

9/29/86
(Date)

David G. Houston,
Regional Director,
U.S. Bureau of Reclamation

OCT 10 1986
(Date)

David N. Kennedy, ~~Director~~
California Department Of Water Resources

Approved as to legal form and sufficiency:

Chief Counsel, Department of Water Resources

JOINT POWERS AGREEMENT REGARDING MITIGATION FOR THE SOUTH DELTA

The parties to this agreement are the Department of Water Resources of the State of California (DWR) and the South Delta Water Agency (SDWA).

RECITALS

1. DWR is the state agency which operates the State Water Resources Development System which includes the State Water Project.

2. SDWA is a public agency formed for the purposes of entering into contracts with the United States and the State of California to protect the water supply of lands within the agency from salinity intrusion and to assure a dependable supply of water to meet needs of lands within the SDWA.

3. On July 9, 1982, SDWA filed a lawsuit in which it alleged, among other things,that operations of DWR's State Water Project (SWP) and the United States Bureau of Reclamation's Central Valley Project (CVP) adversely affected water levels and circulation in the SDWA and that DWR and the United States Bureau of Reclamation had a legal responsibility to mitigate for such impacts.

4. On September 4, 1985, DWR and SDWA agreed to a letter of intent which is the basis of negotiations between the two parties for a permanent agreement to eliminate adverse water level and circulation impacts resulting from the construction and operation of the SWP, a copy of which is attached as Exhibit A.

5. This agreement is intended by the parties to carry out the obligation of DWR under the letter of intent to take interim steps needed to prevent losses of adequate agricultural pump draft within SDWA caused by the SWP and CVP and does not affect other provisions of the letter of intent, including ultimate allocation of costs.

THEREFORE, the parties agree:

1. DWR acknowledges that it has some responsibility for causing or contributing to the low water level in the SDWA. The exact level of responsibility is not known at this time. Both parties agree that, until final agreement is reached, interim measures are needed to prevent low water levels which could adversely affect beneficial uses within SDWA.

2. Nothing in this agreement shall be construed to indicate that the SWP has damaged or unlawfully interfered with the water rights of the SDWA or its water users nor shall be interpreted in any way to limit, define, or establish the full extent of any water rights of water users within the SDWA.

3. DWR will use its best efforts to dredge a pilot channel in the existing Tom Paine Slough to increase water conveyance and improve water levels before August 1986. The channel will extend from approximately 3,100 feet upstream of Laurel Avenue to approxiamtely 1,500 feet upstream of California Avenue. Dredging will consist of approximately 100,000 cubic yards of material.

4. Modeling studies by DWR and SDWA described in Appendix A show that the dredging described in Paragraph 3, together with the operation of Clifton Court as described in Appendix B, may eliminate adverse impacts on water levels in Tom Paine Slough caused by the CVP and SWP. Upon completion of dredging, an engineering study which includes field measurements will be implemented to verify the modeling results. If the pilot channel described in Paragraph 3 does not provide Tom Paine Slough with the maximum diversion rates that would exist without the SWP and CVP as set forth in Appendix A, DWR will conduct more dredging or install up to four 36" siphons with flap gates at the existing barrier near Sugar Cut, until such maximum diversion rates can be reached. If permitting agencies determine that screens are necessary to protect the fishery, fish screens will be installed at the inlets to the siphons.

5. Each year, beginning in 1986, DWR will use its best efforts to install a weir in Middle River near Victoria Canal including at least six 48 inch diameter culverts with flap gates during the irrigation season except when San Joaquin River flows will clearly continue to be sufficient to provide low tide conditions which would prevent low water level problems to diverters in Middle River. Once installed, the weir would remain until the end of the irrigation season. The weir is intended to increase water levels in Middle River between Old River and Victoria Canal so that agricultural pumps can divert water for at least as long a period of time during each tidal cycle as would be possible in the absence of the CVP and SWP. After the irrigation season, the part of the weir which does not contain the culverts will be removed by DWR.

6. Modeling studies by DWR and SDWA described in Appendix A, show that installation of the weir described in paragraph 5, together with the operation of Clifton Court as described in Appendix B, may eliminate adverse impacts on water levels in Middle River caused by the SWP and CVP. Upon installation of the weir, a field testing program will be implemented to verify the modeling results. If the weir does not provide Middle River with the maximum diversion rates that would exist without the CVP and SWP as set forth in Appendix A, DWR and SDWA will work together to determine if there are other interim measures which can eliminate or reduce such adverse impacts. If other measures are found which both parties find acceptable, this agreement may be renegotiated to include such measures. In the event a situation should arise in which the weir is damaging rather than benefitting the Middle River water supply, the weir will promptly be removed by DWR upon request of SDWA.

7. With cooperation from SDWA, DWR shall be responsible for obtaining necessary permits, licenses and approvals and will be the lead agency for appropriate environmental documentation for the

work to be done under this agreement. The parties agree that each of the projects described in paragraphs 3-6 are subject to the California Environmental Quality Act (CEQA). All environmental determinations have not been made as of the date of execution of this agreement because there is not sufficient information to provide detailed meaningful information about likely environmental effects of all the projects and appropriate mitigation measures or alternatives. A decision to approve each of the projects will be made only after the environmental process has been completed for that project and the required findings and determinations have been made and neither party shall be obligated under this agreement to carry out a specific project until the process has been completed and a Notice of Determination filed.

8. DWR may contract with public entities in the SDWA to carry out the work described in paragraphs 3-6.

9. DWR shall not be obligated to carry out the work described in paragraphs 3-6 if necessary access and right of way are not provided by the landowners, including for placement of dredge spoil and stock piling of the weir material during the non-irrigation season; if despite DWR's best efforts, required permits and licenses are not granted; or if any circumstances beyond DWR's control prevent carrying out such work.

10. After the work described in paragraph 3 is completed, DWR shall not be responsible for dredging required to maintain the hydraulic capacity of Tom Paine Slough at the level attained through constructing the pilot channel. However, DWR shall be responsible for any dredging made necessary by a failure or defect in the pilot channel itself, such as sloughing of material into the trench in a manner which reduces hydraulic capacity. If a dispute arises regarding responsibilities, DWR shall complete an engineering study which includes field measurements to determine whether hydraulic capacity has been reduced and if so what are the causes.

If the siphons described in paragraph 4 are installed, then DWR shall thereafter maintain them together with any appurtenant fish screens. Such maintenance shall include all repairs and replacement made necessary by corrosion or any other damage save that caused by the negligence of the local reclamation district. DWR shall not be responsible for day to day operations of the siphons including priming the siphons, and keeping the siphons clear of debris.

11. DWR agrees to operate Clifton Court Forebay as set forth in Appendix B.

12. SDWA agrees that if the Department completes the work agreed to in paragraphs 3-6, operates as required by paragraph 11, and continues to negotiate in good faith toward a permanent solution of SWP caused problems in the SDWA, it will release DWR from any claims it may have based upon the impact of the SWP operations on water levels in the SDWA during the term of this agreement, unless it is determined that the measures described in

paragraphs 3-6 are not working as predicted and are substantially unable to eliminate adverse impacts on water levels in Tom Paine Slough and Middle River caused by the SWP and the CVP.

If SWP impacts reduce water levels in other areas of the SDWA so that pump draft of other water users within SDWA is substantially inadequate, DWR will undertake every effort to operate Clifton Court in a way which will eliminate problems caused by the SWP. If DWR does not undertake such an effort, SDWA shall not be required to continue the release agreed to above.

13. This agreement shall be effective as of January 1, 1986, and shall terminate when a permanent agreement is reached regarding mitigation for SWP impacts on the SDWA or when termination is agreed to by both parties.

14. DWR and SDWA shall seek the cooperation of the Bureau of Reclamation to eliminate the adverse impacts of the CVP's export facilities, including meeting its share of the costs of the measures in this agreement.

15. The maximum amount to be spent by DWR under this agreement shall not exceed $231,000 for the dredging described in paragraph 3; $230,000 for the siphons described in paragraph 4; $250,000 for initial installation of the weir described in paragraph 5; and $81,000, adjusted annually in accordance with the Bureau of Reclamation construction cost composite trends indicator for annual removal (including permanent removal if required by permitting agencies or if the contract is terminated) and reinstallation of the weir described in paragraph 5. DWR administrative costs and personnel time other than for construction engineering and inspection shall not be charged to the above costs. If it is determined that the work described in paragraphs 3-6 will cost more than the amounts set forth in this paragraph, the parties will consult with respect to the problem and may agree to renegotiate this agreement and the maximum amounts set forth in this paragraph.

16. A copy of the Resolution of the Board of Directors of SDWA authorizing execution of this agreement is attached.

17. Subject to applicable State laws and regulations, DWR shall have full and free access at all reasonable times to SDWA's account books and records insofar as they pertain to the subject matter of this agreement, with the right at any time during office hours to make copies thereof. SDWA shall have the same rights with respect to the books and records of DWR.

18. Those matters pertaining to the performance of this agreement including the cost of administering this contract shall be subject to the examination and audit of the California Auditor General for a period of three years after final payment under this contract.

19. Any claim that SDWA may have regarding the performance of this agreement shall be submitted to DWR within

thirty days of its accrual or discovery. DWR and SDWA shall then attempt to negotiate a resolution of such claim and process an amendment to this agreement to implement the terms of any such resolution.

20. SDWA affirms that it is aware of the provisions of Section 3700 of the California Labor Code which requires every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that Code, and SDWA affirms that it will comply with such provisions if it performs work under this agreement which is subject to that Code.

21. The provisions of the attached Nondiscrimination Clause are made a part of this agreement by this reference.

22. Any notices required or desired to be served by either party upon the other shall be addressed to the respective parties as set forth below:

DATED JUN 05 1986

DWR

State of California
Department of Water Resources
1416 Ninth Street
Sacramento, CA 95814

SDWA

South Delta Water Agency
311 East Main Street, Room 504
Stockton, CA 95202

APPROVED AS TO LEGAL
FORM AND SUFFICIENCY:

Chief Counsel

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

By
Director

By
ROBERT E. FERGUSON
Chairman

I hereby certify that all conditions for exemption set forth in State Administrative Manual Section 1099 have been complied with and this document is exempt from review by the Department of Finance.

Signature

FORM | POLICY | BUDGET

Department of General Services
APPROVED
JUN 13 1986
By ELIZABETH YOST
Chief Deputy Director

JOINT POWERS AGREEMENT FOR TOM PAINE SLOUGH

The parties to this agreement are the Department of Water Resources of the State of California (DWR), Pescadero Reclamation District # 2058 (Pescadero), and the South Delta Water Agency (SDWA).

RECITALS

1. DWR is the state agency which operates the State Water Resources Development System which includes the State Water Project.

2. SDWA is a public agency formed for the purposes of entering into contracts with the United States and the State of California to protect the water supply of lands within the agency from salinity intrusion and to assure a dependable supply of water to meet needs of lands within the SDWA.

3. Pescadero is a public agency with authority to maintain the Tom Paine Slough and the inlet gates near Sugar Cut for purposes of supplying water to lands within Pescadero.

4. On July 9, 1982, SDWA filed a lawsuit in which it alleged, among other things, that operations of DWR's State Water Project (SWP) and the United States Bureau of Reclamation's Central Valley Project (CVP) adversely affected water levels and circulation in Tom Paine Slough and elsewhere in the SDWA and that DWR and the United States Bureau of Reclamation had a legal responsibility to mitigate for such impacts.

5. In an effort to resolve the dispute DWR and SDWA recently agreed, among other things, to interim steps aimed at improving water levels in Tom Paine Slough through dredging and possibly the installation of siphons. The agreement provides a local agency may be selected for the task and DWR has asked Pescadero to undertake the work. Pescadero has agreed so long as it is reimbursed for its costs. Therefore, in order to set out their respective responsibilities in carrying out these improvements the parties have entered into the following:

AGREEMENT

1. The works of improvement shall consist firstly of Pescadero dredging a pilot channel in Tom Paine Slough to increase water conveyance and improve water levels. The channel shall extend from a point approximately 3,100 feet east of Laurel Avenue to a point approximately 1,500 feet east of California Avenue. The

dredging will remove approximately 100,000 cubic yards of material from the slough.

2. Upon completion of dredging DWR and SDWA shall conduct appropriate tests and studies to determine the degree of improvement in water conveyance and levels brought about by the dredging. Thereafter DWR may request Pescadero to install up to four 36" siphons with flap gates in the levee between Tom Paine Slough and Sugar Cut. Pescadero shall have no responsibility to install or contract for fish screens if required by regulatory agencies.

3. With cooperation from Pescadero and SDWA, DWR shall obtain necessary permits, licenses and approvals and will be the lead agency for appropriate environmental documentation for the work to be done under this agreement. DWR will provide preliminary designs and specifications for the proposed work which will include restrictions on dredging and placement of spoil designed to protect sensitive plants and wildlife.

4. Pescadero shall prepare final design, specification, contract procedures, cost estimates, and schedules. Such work must receive approval from DWR before any work to be paid for under this agreement is started. DWR will use its best efforts to approve all items within 15 days of submission by Pescadero.

5. Pescadero may contract with others to do the work specified in this agreement; however, DWR's approval of such contracts must be obtained before any work to be paid for under this agreement is started. DWR shall use its best efforts to approve all items within 15 days of submission by Pescadero.

If Pescadero decides to contract with others, it shall provide plans and specifications to at least three qualified contractors who shall be given the opportunity to bid. Where three bids cannot be secured, an explanation shall be provided in writing to the Department of Water Resources (DWR). The award shall be made to the lowest responsible bidder, unless DWR agrees that it is in the best interests of the State to have the work performed by another bidder.

6. DWR shall inspect the work carried out by Pescadero to assure itself that the work is being done in compliance with the design, costs and schedules and contracts approved by DWR pursuant to Articles 4 and 5. Primary inspection shall be the responsibility of Pescadero.

7. If at any time DWR does not approve the work to be done, Pescadero and DWR shall exercise good faith efforts to resolve any differences and to have the work conform to DWR's needs. If a resolution of differences does not occur within a reasonable time,

this Agreement shall be terminable by either party upon written notice to the other. In case of termination, all documents prepared pursuant to Articles 4 and 5 shall be delivered to DWR and Pescadero shall be compensated for any costs incurred which have been approved by the Department for work it has carried out pursuant to this contract, which approval shall not be unreasonably withheld.

The phrase "costs incurred which have been approved by the Department" includes but is not limited to all legal and engineering fees and administrative expenses incurred by Pescadero in negotiating and preparing this agreement and conducting the preliminary meetings, site inspections and engineering work.

8. Except for those costs described in Article 9, and the costs of Pescadero's responsibilities described in Article 10, DWR shall pay Pescadero for the actual costs incurred in preparing this agreement and carrying out its terms, including reasonable costs attributable to legal and engineering services and administrative expenses. Payment shall be as follows:

a. DWR shall pay Pescadero $7,300 within 30 days after the execution of this agreement to cover preliminary planning costs.

b. Other costs incurred shall be paid as follows: By the first day of each month in which work under Articles 1 and 2 is to be carried out, Pescadero shall give DWR an estimate of the amounts required for that month's work, including related engineering, legal and administrative expenses. Pescadero may also submit estimates on a basis not mentioned herein provided the basis is first approved by DWR. Upon approval by DWR it shall pay Pescadero 75 percent of the estimate. Such payment shall be made within 30 days after approval.

At the end of the month or when Pescadero has ascertained the true costs of the work for which the estimate was given, it shall submit to DWR a billing showing those costs, together with itemized invoices and other appropriate documentation sufficient to permit DWR to satisfy itself as to the accuracy of the billing. When DWR has approved the billing it shall forthwith pay to Pescadero the difference between the true cost of the work and the partial payment previously made. DWR shall use its best efforts to make payment within 15 days after receipt of billing by Pescadero. Bills or portions of bills which are not paid by the date due shall thereafter accrue an interest charge at the rate of one and one-quarter percent (1 1/4%) per month or the maximum rate permitted by law, whichever is less, from the date the billing payment is due until such payment is made; provided, however, that payments sent by mail shall not be subject to such interest charges if the postmark indicates the payment was mailed on or before the due date.

As soon as practicable after the execution of this agreement DWR shall meet with Pescadero to explain the degree of itemization, accounting and documentation DWR needs in order to satisfy itself as to the accuracy of claims submitted by Pescadero.

1). Costs for the work described in Article 1 shall not exceed the following:

Costs of dredging -- $171,600.

Costs for engineering and inspection services of Pescadero -- $40,000.

Costs for legal services of Pescadero -- $5,000.

Costs for administrative expenses of Pescadero -- $3,100.

2) Costs for further dredging and/or the purchase and installation of the siphons described in Article 2 shall not exceed $230,000.

c. In the event that:

(1) before the contracts are let it appears the maximum costs will exceed those listed in Article 8(b);

(2) during the work, unforeseen conditions are discovered which make it clear that the costs of completing the project will exceed those listed in Article 8(b);

(3) unforeseen requirements imposed by the courts or governmental agencies increase or threaten to increase costs to more than those listed in Article 8(b);

Then the parties will consult with respect to the problem and may agree to renegotiate this contract and the maximum amounts listed in Article 8(b) sufficiently to cover the additional costs including additional engineering, legal and administration costs. If the parties fail to agree on such an increase then Pescadero shall not be required to perform any services the cost of which exceeds the maximum set forth in Article 8(b).

9. Pescadero shall provide all access and right of way necessary to perform the work described in this agreement. Pescadero shall also be responsible for disposing of the material dredged from Tom Paine Slough after it has been deposited on the land adjacent to Tom Paine Slough.

10. After Pescadero completes the work described in Article 1, it shall be responsible for dredging required to maintain

the hydraulic capacity of Tom Paine Slough at the level attained through constructing the pilot channel. However, DWR shall be responsible for any dredging made necessary by a failure or defect in the pilot channel itself, such as sloughing of material into the trench in a manner which reduces hydraulic capacity.

If the siphons described in Article 2 are installed, then DWR shall thereafter maintain them together with any appurtenant fish screens. Such maintenance shall include all repairs and replacement made necessary by corrosion or any other damage save that caused by the negligence of Pescadero. Pescadero shall be responsible for day to day operations of the siphons including priming the siphons and keeping them clear of debris.

DWR and Pescadero agree that even though this agreement may terminate for other purposes, the maintenance obligations of DWR set forth in this Article shall continue for so long as DWR continues to draw water for the State Water project from the channels of the south delta or until the facilities installed under this agreement are removed.

11. The parties have in mind the crisis which exists in the insurance industry at the time this agreement is to be performed and the grave problems faced by all public agencies in purchasing adequate liability coverage. They therefore agree that Pescadero shall make reasonable efforts to obtain property damage and personal liability insurance policies to cover damages which may possibly result from the activities carried out by Pescadero under this agreement if such activities are not covered under existing insurance policies. Pescadero's insurance policies shall include DWR, its officers and employees as additional insureds for the activities described in this agreement. If the coverage described in this Article will result in increased premium charges to Pescadero, Pescadero shall not be obligated to purchase such coverage. Pescadero shall, however, inform DWR of the cost of such incremental coverage and shall obtain such coverage if DWR agrees to pay the incremental costs.

12. To the extent a liability damage or injury claim is not covered by insurance obtained in accordance with this Agreement, each Party agrees to accept to the extent provided by law, legal liability and financial responsibility, including any duty to indemnify the other party, for its own activities and conduct under this Agreement which cause damage or injury to the other Party or to any person or property.

13. Pescadero agrees to be bound by any release which SDWA gives to DWR with respect to claims based upon the impact of

SWP operations; for example, if SDWA releases DWR from any claims it may have based upon SWP operations, then such release shall also constitute an identical release from Pescadero.

14. Performance by the parties of their respective obligations under this agreement, except for the payment of money for costs incurred which have been approved by DWR shall be excused during such time as such performance is prevented by acts of God, strikes, riots, acts of war, governmental agencies having jurisdiction or other causes beyond the control of any party.

15. This agreement shall be effective as of January 1, 1986, and shall terminate when a permanent agreement is reached between SDWA and DWR on mitigation for SWP impacts on the SDWA or when termination is agreed to by all the parties.

16. Subject to applicable State laws and regulations, DWR shall have full and free access at all reasonable times to Pescadero's account books and records insofar as they pertain to the subject matter of this agreement, with the right at any time during office hours to make copies thereof. Pescadero shall have the same rights with respect to the books and records of DWR.

17. Those matters pertaining to the performance of this agreement including the cost of administering this contract shall be subject to the examination and audit of the California Auditor General for a period of three years after final payment under this contract. If Pescadero contracts with others to perform work for Pescadero, it shall require the cost records of such contractors to be subject to the same condition.

18. Except for claims made under Article 8b above, any claim that SDWA and/or Pescadero may have regarding the performance of this agreement including, but not limited to, claims for additional compensation or extension of time, shall be submitted to DWR within thirty days of its accrual or discovery. DWR, and SDWA, or Pescadero shall then attempt to negotiate a resolution of such claim and process an amendment to this agreement to implement the terms of any such resolution.

19. Pescadero affirms that it is aware of the provisions of Section 3700 of the California Labor Code which requires every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that Code, and Pescadero affirms that it will comply with such provisions before commencing the performance of the work under this agreement.

20. The provisions of the attached Nondiscrimination Clause are made a part of this agreement by this reference.

21. A copy of the Resolution of the Board of Directors of Pescadero authorizing execution of this agreement is attached.

22. Any notices required or desired to be served by either party upon the other shall be addressed to the respective parties as set forth below:

DATED _____

DWR

State of California
Department of Water Resources
1416 Ninth Street
Sacramento, CA 95814

PESCADERO

Pescadero Reclamation District #2058
3650 West Canal Boulevard
Tracy, CA 95376

APPROVED AS TO LEGAL FORM AND SUFFICIENCY:

Chief Counsel

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

PESCADERO RECLAMATION DISTRICT #2058

BY

SDWA

South Delta Water Agency
311 East Main Street, Room 504
Stockton, CA 95202

BY

BY

I hereby certify that all conditions for exemption set forth in State Administrative Manual Section 1209 have been complied with and this document is exempt from review by the Department of Finance.

Signature

FORM | POLICY | BUDGET

Department of Personnel Services

APPROVED

JUN 18 1986

ORIGINAL SIGNED BY
ELIZABETH YOST

By ELIZABETH YOST
Chief Deputy Director

APPENDIX C
MODELING ASSUMPTIONS AND RESULTS

C—041518

C-041518

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INTRODUCTION

This appendix presents details of engineering studies made in support of the South Delta Water Management Program (SDWMP). It includes the following technical discussions and data:

- assumptions and criteria in operation studies;
- boundary conditions and hydrology data for Delta studies;
- process of selecting which configurations of alternative components to evaluate for environmental impacts;
- south Delta configurations for Delta studies;
- examples of the presentation of Delta modeling results;
- tables of monthly average Delta salinity at D-1485 standards stations; and
- tables of changes in Delta salinity and water levels with respect to the no-action alternative.

OPERATION STUDIES

Monthly water supply studies of the State Water Project (SWP) and the Central Valley Project (CVP) systems were performed with the Department of Water Resources' (DWR's) statewide water simulation model (DWRSIM) to evaluate the impacts of the South Delta Water Management Program (SDWMP) on SWP operation. These water supply studies account for the total availability, storage, release, and use of water in the Sacramento and San Joaquin River systems, the Delta, the aqueduct systems south of the Delta, and any proposed additions to the SWP system such as Los Banos Grandes Reservoir (LBG) and Kern Water Bank (KWB). They represent a superimposition of future water demands and development on the historical water supply for the 57-year period from water year 1922 through 1978. Such studies provide monthly data on reservoir storage and releases, and Delta inflows, exports, and outflows.

To evaluate the impact of the SDWMP on Delta inflows, exports, and outflows, two water supply operation studies were simulated assuming SWP demands of 3.3 million acre-feet (MAF): a base study to be used for the no-action alternative, and a second study to be used for both the preferred alternative and the other SDWMP alternatives. The base study (study 340B) assumed that four additional pumps at Banks Pumping Plant were operational but without other south Delta improvements, thus limiting SWP allowable diversion capacity to 6,680 cfs (7,300 cfs in some winter months if there is sufficient San Joaquin River flow at Vernalis). The second study (study 327B) assumed south Delta facilities to allow SWP diversion at Banks Pumping Plant to 10,300 cfs, as well as the operation of LBG and KWB.

The two studies operated SWP facilities in accordance with Decision 1485, the Coordinated Operation Agreement, and agreements and contracts with local Delta interests. The operation studies used delivery-carryover storage relationships that were designed to simulate the concept and philosophy of criteria adopted by the DWR's Division of Operations and Maintenance in 1987. Table C-1 lists in more detail the assumptions in the two operation studies.

The monthly Delta inflows, exports, and outflows produced from these operation studies over the 57-year study period aided in analyses of possible impacts of the SDWMP on: SWP monthly operational changes, SWP reliability, Delta outflows and outflow pulses, striped bass, Chinook Salmon, and other fish species, fish food supply, Suisun Marsh, and San Francisco Bay aquatic resources.

The monthly Delta inflows, exports, and outflows simulated with these operation studies also provided the hydrologic conditions for the subsequent Delta studies conducted in support of the SDWMP.

Table C-1
Basic Assumptions And Operation Criteria In Statewide Operation Studies
In Support Of South Delta Water Management Program

1. **No-Action Study (Study 340B)**

- SWP demands of 3.3 MAF.
- 57-year study period from October 1922 through September 1978.
- No Delta facilities.
- Carriage water requirements based on allowable export/salinity repulsion curves developed by the DWR Central District, updated as of January 14, 1988, to maintain 100 ppm chloride at Clifton Court.
- Minimum Delta outflow requirements based on SWRCB Decision 1485, assuming the new Emmaton flow/salinity relationship and interim Suisun Marsh criteria.
- SWP H.O. Banks Pumping Plant capacity limited by the Corps permit to 6,680 cfs (7,300 cfs in some winter months), and further limited by the SWRCB Decision 1485 to 3,000 cfs in May and June, and 4,600 cfs in July.
- CVP Tracy Pumping Plant capacity at 4,600 cfs. Pumping capacity limited to 3,000 cfs in May and June in compliance with the SWRCB Decision 1485.
- Wheeling of CVP water by SWP facilities, only when unused pumping capacity becomes available at the H.O. Banks Pumping Plant, and up to 194 TAF for repayment of CVP Tracy Pumping Plant curtailment in May and June.
- CVP/SWP sharing ratio used for meeting requirements at the Delta were as follows: storage withdrawals for in-basin use split 70% CVP / 30% SWP, and unstored flow for storage and export split 55% CVP / 45% SWP.
- East Branch of the California Aqueduct enlarged by 1,400 cfs from the Alamo Power Plant, with total capacity at 3,037 cfs. West Branch of the California Aqueduct at the existing capacity of 2,414 cfs. Joint reach below O'Neill Forebay at existing capacity of 7,100 cfs.
- American River minimum fish and recreation flows used were as follows:

Reduced D-1400 years[1]	D-893 years	Reduced D-893 years
1926	1929	1924
1935	1930	1931
1936		1932
1939		1933
1947		1934
1959		1976
1960		1977
1966		
1968		

[1]D-1400 flow requirements apply above City of Sacramento intake. Modified D-1400 flows were met in all other years from 1922 through 1978

Table C-1 (Continued)
Basic Assumptions And Operation Criteria In Statewide Operation Studies
In Support Of South Delta Water Management Program

1. **No-Action Study (Continued)**

- New Melones storage at 2.4 MAF, operated to meet local demands and the SWRCB Decision 1422 requirements only.

- CVP demands as follows:

Contra Costa Canal	=	160	TAF/Yr
DMC and Exchange	=	1,637	TAF/Yr
CVP San Luis Unit	=	1,320	TAF/Yr
San Luis Interim Delivery	=	60	TAF/Yr
San Felipe Unit	=	173	TAF/Yr
Total CVP Delta Export	=	3,350	TAF/Yr
Folsom South Canal	=	312	TAF/Yr

- 3.3 MAF SWP demands (including losses and recreation water), based on DWR Bulletin 132-87 (WHL87) as follows:

	Entitlement Request (TAF/Yr)	Scheduled Surplus (TAF/Yr)
North Bay Aqueduct	52	0
South Bay Aqueduct	213	0
SWP Dos Amigos	3,095	0
Total	3,360	0
Agricultural Portion	1,242	0
M&I Portion	2,049	0
Losses & Recreation	69	0

SWP actual deliveries and shortages in any given year are computed by the model, based on hydrology in that year. A set of carryover storage targets for study 340B are as follows:

Delivery Class	Delivery Target (TAF/Yr)	Carryover Storage Range (TAF)	
		Max	Min
1	3,360	2,770	2,730
2	3,360	2,770	2,730
3	3,360	2,770	2,400
4	2,646	2,400	2,200
5	2,290	2,200	1,750
6	2,062	1,750	900
7	1,607	900	900
8	838	900	900
9	222	900	900

Table C-1 (Continued)
Basic Assumptions And Operation Criteria In Statewide Operation Studies
In Support Of South Delta Water Management Program

2. Preferred Alternative and Other Alternatives (Study 327B)

All basic assumptions and operation criteria for this study are similar to those described for study 340B, except for the following:

- Improved south Delta channels allowed full use of the Harvey O. Banks Pumping Plant capacity to 10,300 cfs.

- A Los Banos Grandes Offstream Storage Facility and a Kern Water Bank were with a combined capacity of from 2 to 3 MAF were incorporated into the SWP system. The Kern Water Bank was assumed to have the following characteristics:

  Ground Water Recharge

  - Maximum recharge rate of 30 TAF/mo.
  - After nine consecutive months of recharging at 30 TAF/mo., the recharge rate was reduced to 25 TAF/mo.
  - Ground water basin recharge in wet, above normal, and below normal years with normal snowmelt.
  - Recharge activity halted, regardless of year type, if Oroville storage fell below 1,450 TAF.
  - SWP recharge activity in months of high local and natural recharge was adjusted according to the data provided by the San Joaquin District.
  - Losses during recharge operation set at 5% of the diversions made for ground water storage.

  Ground Water Extraction

  - Maximum extraction rate of 30 TAF/mo.
  - Extraction from the ground water basin in below normal years with subnormal snowmelt, dry, and critical years.
  - Extraction from the ground water basin started, regardless of the year type, if Oroville storage fell below 1,300 TAF.

- SWP actual deliveries and shortages in any given year are computed by the model, based on hydrology in that year. A set of carryover storage targets for study 327B are as follows:

Delivery Class	Delivery Target (TAF/Yr)	Carryover Storage Range (TAF)	
		Max	Min
1	3,360	4,000	3,980
2	3,360	4,000	3,980
3	3,360	4,000	3,100
4	2,920	3,100	2,950
5	2,700	2,950	2,450
6	2,429	2,450	1,180
7	1,887	1,180	1,000
8	978	1,000	1,000
9	251	1,000	1,000

DELTA MODELING STUDIES

Mathematical model studies of flows and salinity in the Sacramento–San Joaquin Delta were conducted in support of the SDWMP EIR/EIS. These studies were completed in several steps:

- selection and preparation of computer models capable of simulating hydrodynamic and salinity conditions for the Sacramento–San Joaquin Delta based on physical principles and an accurate representation of Delta channel configuration;
- selection of tidal and hydrologic conditions in magnitude and duration appropriate for planning studies;
- preparation of model representation of each proposed facility, channel modification, and export operation;
- Phase I Delta hydrodynamic modeling conducted to evaluate the feasibility of proposed SDWMP alternative configurations;
- selection of several alternative configurations of facilities, channel modifications, and export operations for more detailed hydrodynamic modeling and salinity modeling in order to assess the environmental impacts of alternative configurations; and
- Phase II hydrodynamic and salinity modeling conducted to assess the relative improvements and impact of the alternatives selected after Phase I modeling, as compared to projected no-action conditions, over a wide range of hydrologic conditions.

Delta Mathematical Models Used

Two computer simulation models of the Sacramento–San Joaquin Delta were used for evaluating the hydrodynamic and salinity responses of various alternative configurations. These models and important attributes are now described.

DWR/RMA Delta Hydrodynamics Model (1988 Version). The DWR/RMA Delta Hydrodynamics Model was selected to simulate water surface elevations and flow/velocity patterns in the Delta. The Delta as characterized by the model is bounded by the communities of Sacramento on the north, Vernalis on the south, and Martinez on the west. A schematic representation of the Delta used for this model is shown in Figure C–1. The following attributes of this model are of particular importance:

- it uses the most current descriptions of Delta channel bathymetry;
- it simulates timed operations of forebay intake gates such as the SWP Clifton Court Forebay;
- it simulates existing and proposed hydraulic structures such as the Delta Cross Channel and intake culverts to Tom Paine Slough; and
- it uses the most up-to-date descriptions of diversion and drainage return flows in the Delta both in magnitude and spatial distribution.

In 1987, the DWR Delta Modeling Section calibrated the DWR/RMA Delta Hydrodynamics Model using recorded 15-minute stage data from thirty-nine monitoring stations for July 1 through 4, 1979. The model was verified using data for July 5 through 30, 1979. The model was verified in 1989 for high flows using recorded 15-minute stage data from twenty-three monitoring stations for February 1 through 28, 1986. Most recently, this model was verified for May 1 through 31, 1988, using recorded 15-minute stage data from twenty-seven monitoring stations, as well as, stage, flow and velocity data from eighteen monitoring sites for selected days in May 1988.

Fischer Delta Model (Version 7). The Fischer Delta Model (version 7) was selected to simulate dissolved salt transport for the Delta. A schematic representation of the Delta used for this model is shown in Figure C–2. The following attributes of this model are noteworthy:

- it uses a Lagrangian solution method for dissolved salt transport which substantially reduces numerical dispersion common to Eulerian solution methods;
- it incorporates timed exports at any specified location as determined by the hydrodynamic model;
- it simulates existing and proposed hydraulic structures such as the Delta Cross Channel and intake culverts to Tom Paine Slough; and
- it simulates dissolved salt transport (total dissolved solids, TDS) in the Delta up to an entire year on a 15-minute time interval.

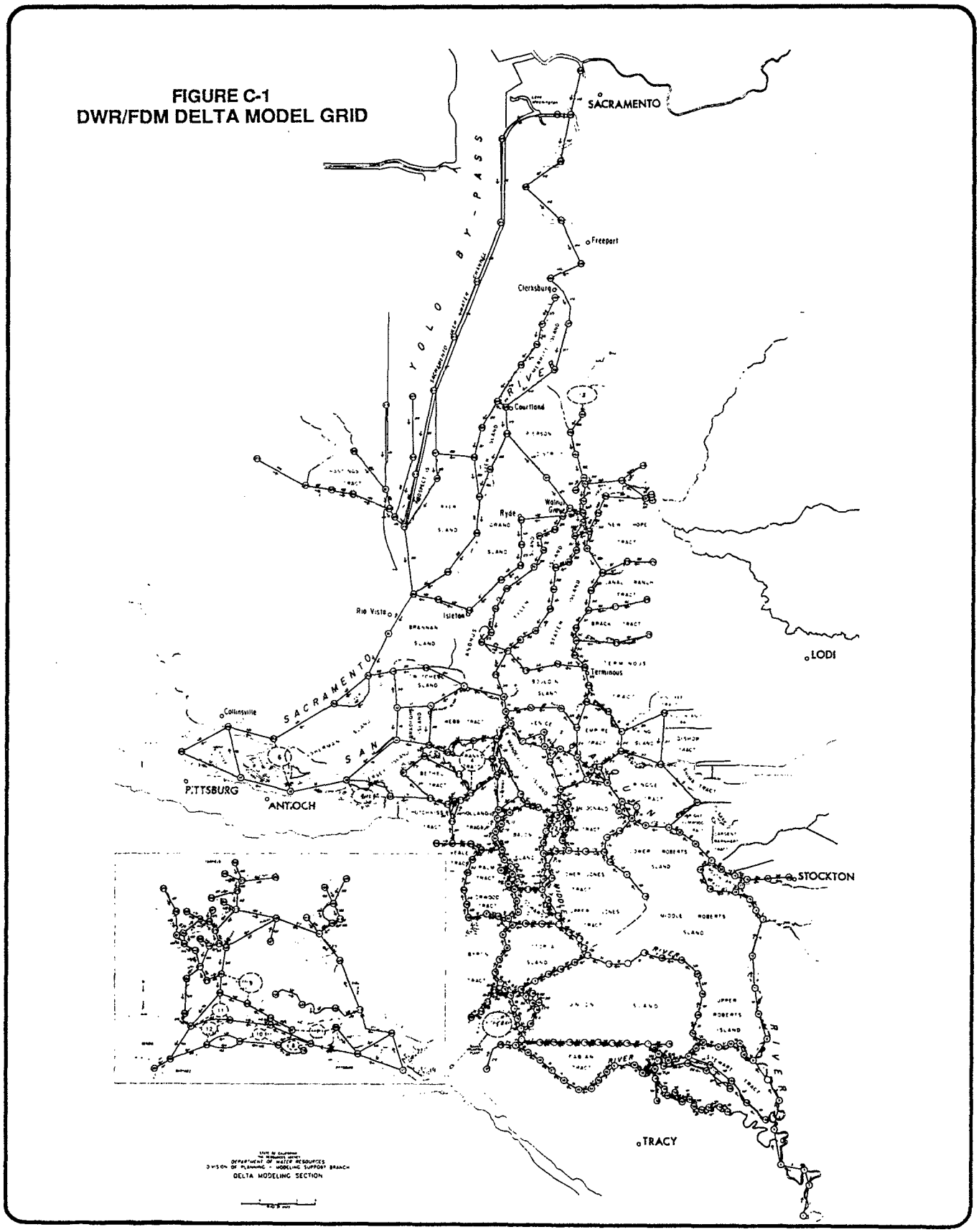
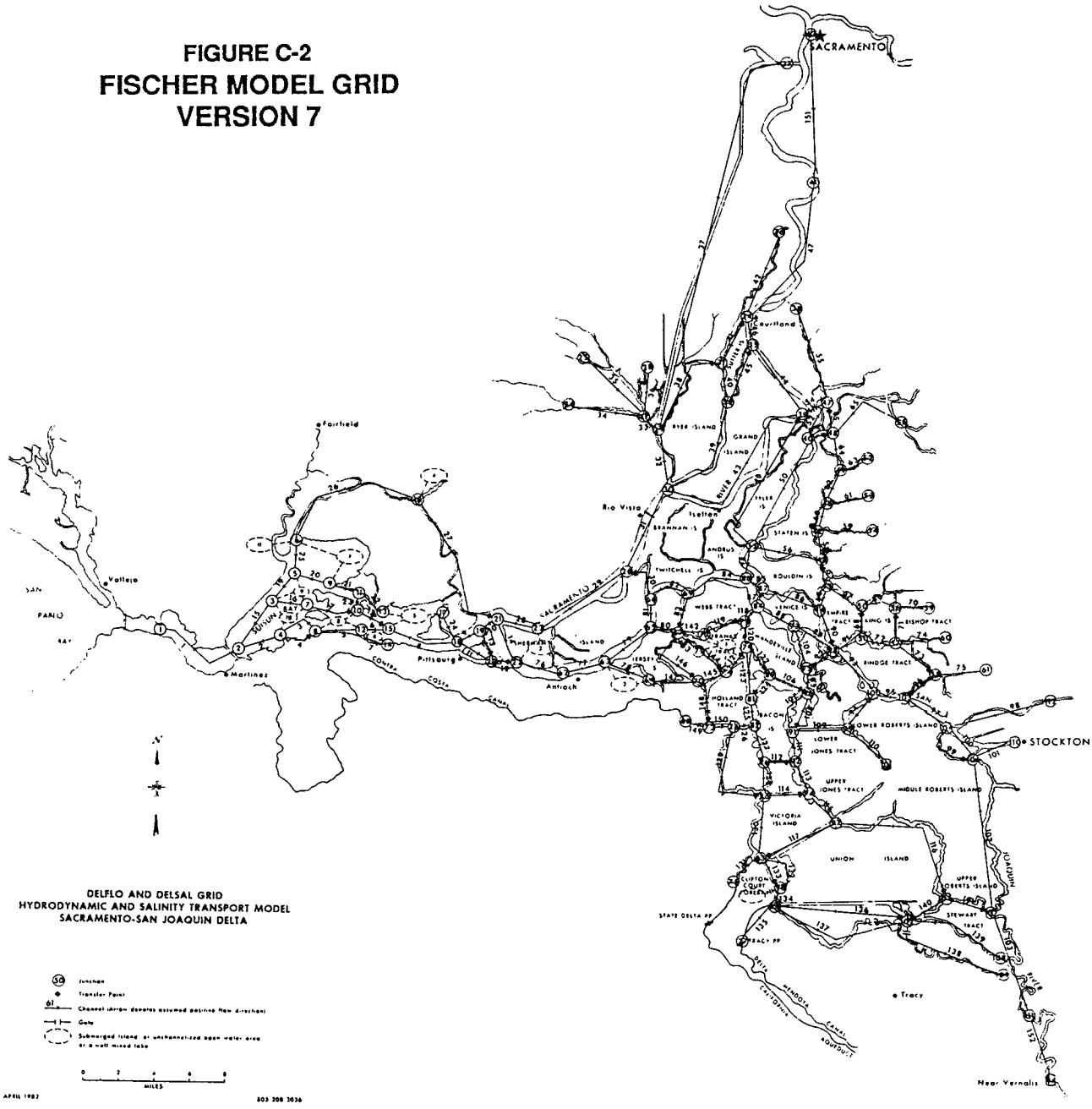


FIGURE C-1
DWR/FDM DELTA MODEL GRID

FIGURE C-2
FISCHER MODEL GRID
VERSION 7



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The hydrodynamic module of the Fischer Delta Model (Version 7), DELFLO, was calibrated and verified by Flow Science, Incorporated. In 1987, DWR verified DELFLO using recorded stage data from April 1 through 4, 1972, November 5 through 6, 1976, April 3 through 4, 1980, and April 8 through 9, 1981. In 1987, DWR re-calibrated and re-verified the salinity transport module, DELSAL. With the 19-year mean, 25-hour tide at Eckley, DELSAL was re-calibrated using mean tidal day salinity data (electrical conductivity converted to total dissolved solids) from sixteen monitoring sites for 1968 in conjunction with the Parameter Estimation Program. DELSAL was then verified using mean tidal day salinity data for 1972, 1976, 1977 and 1978, and 4-day grab sample salinity data for 1931.

Phase I Delta Modeling

Phase I modeling evaluated the feasibility of various combinations of south Delta facilities under a representative worst-case water condition. This was accomplished by simulating Delta flows, velocities, and water levels under extreme summer hydrologic conditions. This process consisted of: 1) selecting and preparing an appropriate tide, Delta channel diversion and drainage return data, and hydrologic conditions, 2) defining a large number of alternative south Delta configurations and operations, and 3) evaluating the alternatives with the DWR/RMA Delta Hydrodynamics Model. The DWR/RMA Delta Hydrodynamics Model was run for one tidal cycle (25 hours) with a low-energy tide. This was considered reasonable for the evaluation and comparison of various alternative configurations based on average water level, net flow and net velocity patterns in the Delta. It was also considered reasonable for the evaluation of general trends in instantaneous 15-minute water levels, flows and velocities.

Assumptions. The boundary tide at Martinez/Benicia in Carquinez Strait, Delta consumptive use patterns, and boundary Delta hydrologic conditions were selected to collectively provide a representative worst-case water condition, making it difficult for any combination of south Delta facilities to improve Delta water conditions. It is anticipated that performance of alternative configurations of south Delta facilities would frequently be better than those studied in the Phase I modeling. Improvements to Delta water conditions were assessed by examining improvements to water levels and flow patterns in the south Delta and direction of flow in the upper and lower San Joaquin River.

a. Boundary Tide. Fifteen minute tide data from the Martinez/Benicia monitoring site for July 3, 1979, were used to simulate a low-energy tide. This tide is presented in Figure C-3.

b. Delta Consumptive Use. For Delta modeling, Delta channel diversions and drainage return flows were estimated by DWR with a consumptive use analysis of 142 areas in the Delta and a survey of current diversion siphons and drainage pipes. Constant rates for channel diversions and

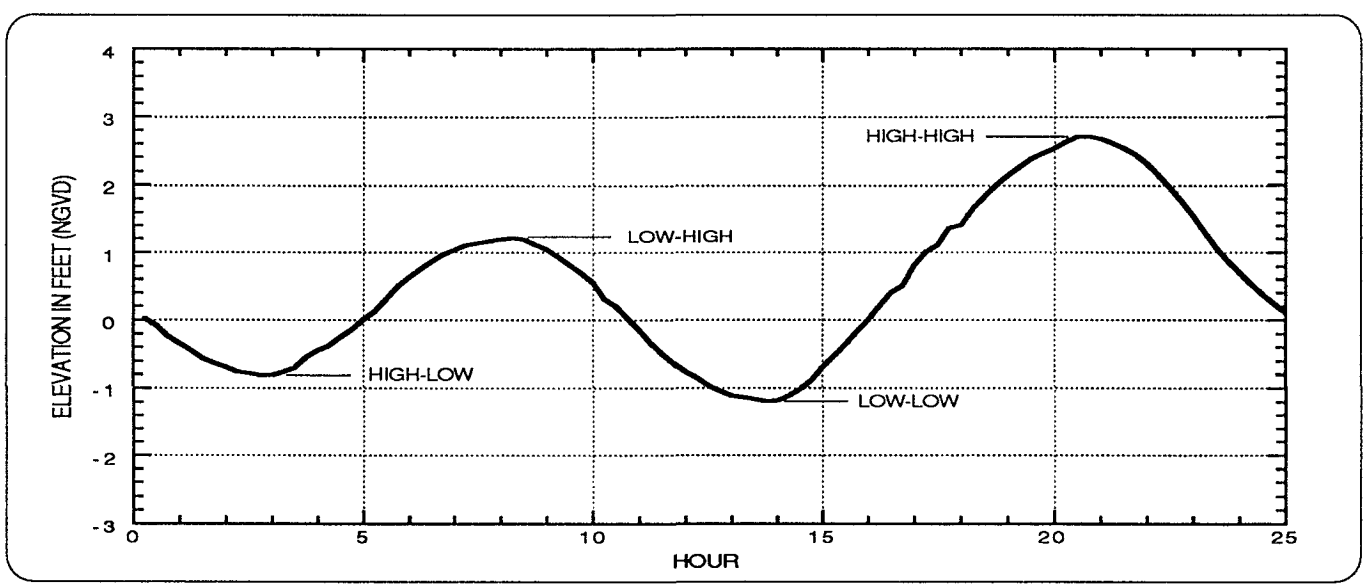


Figure C-3. Phase I Modeling
Martinez/Benecia Low-Energy 25-Hour Tide, July 3, 1979 (Smoothed)

drainage returns over one tidal cycle (25 hours) were used for the DWR\RMA Delta Hydrodynamics Model. Delta-wide channel diversions, drainage returns and net channel depletion are presented in Table C-2.

c. Boundary Hydrologic Conditions. Two different Delta hydrologic conditions were used in Phase I modeling to characterize two SWP export levels and two CVP export strategies. These two hydrologies are reported in Table C-2 as hydrology set 1 and set 2. All configurations were examined at both SWP export levels, 6400 and 10,300 cfs, except for the base-case configuration which was only examined at the 6400 cfs export rate. The Sacramento River inflow rate was varied accordingly for each export level to maintain a Net Delta Outflow Index of approximately 5000 cfs.

d. Clifton Court Forebay Gate Operation. The operation of SWP forebay intake gates for Phase I is shown at the top of Table C-3. This operation was designed to 1) take water into the SWP forebay after the peak of the high-high tide and through the low-high tide and 2) discontinue forebay inflow during the low-low tide and high-low tide. To simulate the tide at each intake gate location, the DWR/RMA Delta Hydrodynamics Model was run without SWP exports. The resulting tide stages at the different forebay intake gate locations are presented in the center panel of Table C-3. The gate operations were then determined by using the Phase I gate operation in conjunction with the simulated tide at each location. The resulting gate operations are presented at the bottom of Table C-3.

e. South Delta Configurations of Facilities. Alternative south Delta configurations evaluated in Phase I modeling were comprised of different combinations of existing and proposed facilities, channel modifications and export operations. These alternative configurations were generated with different combinations of the following six components:

- SWP forebay size,
- SWP forebay intake gate location,
- SWP forebay intake capacity,
- CVP export location,
- Channel modifications (dredging and/or enlargement),
- Hydraulic structures and barrier facilities.

All components that were considered are shown in Table C-4. Each component is defined and given an identification number in Table C-4.

A large number of alternative configurations were then defined by combining various components listed in Table C-4. Every combination of SWP forebay and intake gate location was used to define a distinct group (or series) of alternatives. Each series, in turn, was evaluated with different combinations of channel modifications, barrier facilities and hydrologies. In addition, certain series include the relocation of the CVP export intake (CVP tie-in) from its current location to the SWP forebay (or Italian Slough for Series S08, S18 and S28). In all, 163 different configurations were simulated. These configurations are defined in Table C-5 using the six component categories and component identification numbers presented in Table C-4, and the two hydrology sets defined in Table C-2. Configuration S01-A, as defined in Table C-5, was used to characterize existing conditions in the Delta. This configuration is designated as the base-case configuration. Model results of all other configurations were evaluated in relation to the model results of the base-case configuration.

Phase I Modeling Results. DWR/RMA Delta Hydrodynamics Model simulations were conducted with the tide and hydrology data mentioned above, for each South Delta configuration displayed in Table C-5. Model results include minimum, mean and maximum tidal cycle water surface elevations; minimum, maximum and net tidal cycle velocities and flows; and 15-minute stages, velocities and flows over the 25-hour simulation period.

Model results for each of the 163 configurations were presented graphically to expedite the comparative evaluation of many simulations. For each configuration, the following graphical displays were generated and analyzed:

1. Net Tidal Cycle Flows in the North Delta,
2. Net Tidal Cycle Flows in the South Delta,
3. Net Tidal Cycle Velocities in the South Delta,
4. Net Change in South Delta Net Tidal Cycle Flows With Respect to the base-case condition,
5. Net Change in South Delta Net Tidal Cycle Velocities With Respect to the base-case condition,
6. Water Surface Elevation Profiles at 18 locations

TABLE C-2
PHASE I MODELING
TIDE, DEPLETION AND HYDROLOGY DATA

TIDE BOUNDARY CONDITION

25-hour low energy tide at Martinez/Benicia consisting of 15-minute tide data observed during July 3 and the first hour of July 4, 1979. The observed tide data were smoothed to remove minor, short-duration oscillations.

DELTA NET CHANNEL DEPLETIONS

Estimates of historic July 1979 diversion and drainage return data were modified to include additional net channel depletions from the crescent of Middle River (between its head and Victoria Cut) and Tom Paine Slough. Estimates of historic July 1979 were determined using a consumptive use analysis of 142 areas (islands) in the Delta (DWR Delta island consumptive use study, 1987, unpublished), and the 1987 DWR field survey of current diversion siphons and drainage pipes. These values are:

	Diversion	Drainage	Net CD
(cfs)	6159	1626	4533

Net Channel Depletion (CD) is defined as Diversion minus Drainage. For model simulations, diversions and drainage returns were allocated to appropriate model nodes.

DELTA HYDROLOGY BOUNDARY CONDITIONS

RIM INFLOWS (cubic feet per second)	SET 1	SET 2
Sacramento River at Sacramento	19252	23152
San Joaquin River at Vernalis	1100	1100
Calaveras River	10	10
Cosumnes + Mokelumne Rivers + Dry Creek	388	388
RIM EXPORTS (cubic feet per second)		
SWP Banks Pumping Plant	6400	10300
CVP Tracy Pumping Plant	4600	4600
Contra Costa Canal	217	217

For CVP export tie-in, the Tracy Pumping Plant export is taken from the SWP forebay.

NET DELTA OUTFLOW INDEX

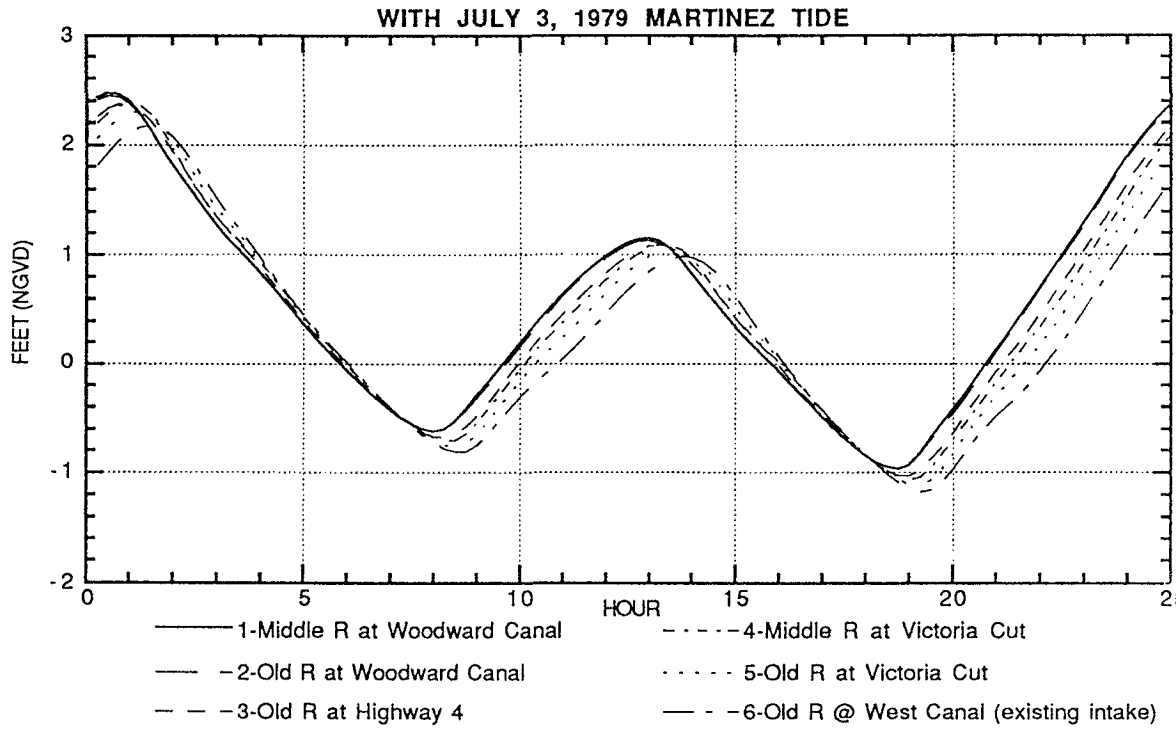
The net Delta outflow index is determined by subtracting the sum of all exports and net channel depletions from the sum of all rim inflows. The net Delta outflow index for the selected hydrologies is 5000 cfs.

TABLE C-3
PHASE I MODELING
SWP FOREBAY GATE OPERATION SCHEDULE

PHASE I GATE OPERATION

GATE OPERATION	TIMING
OPEN	1 HOUR AFTER HIGH-HIGH TIDE
CLOSE	1 HOUR BEFORE HIGH-LOW TIDE
OPEN	1 HOUR AFTER HIGH-LOW TIDE
CLOSE	2 HOURS BEFORE LOW-LOW TIDE

TIDES AT FOREBAY INTAKE LOCATIONS WITHOUT SWP EXPORTS WITH JULY 3, 1979 MARTINEZ TIDE



GATE OPERATION SCHEDULE

LOCATION	MODEL NODE	TIME IN HOURS			
		OPEN	CLOSE	OPEN	CLOSE
1	117	1.25	6.75	8.75	16.50
2	82	1.25	6.75	8.75	16.50
3	79	1.50	7.00	9.00	16.75
4	113	1.75	7.00	9.00	16.75
5	75	2.00	7.25	9.25	17.00
6	72	2.25	7.25	9.25	17.00

TABLE C-4
PHASE I MODELING
CONFIGURATION COMPONENTS

ID NUMBER	DESCRIPTION
SWP FOREBAY	
1	Existing Clifton Court Forebay (2100 acres); export pumping from Clifton Court.
2	Modified forebay consisting of a portion of Byron Tract along Old River to Highway 4 (1400 acres), Coney Island (900 acres), and enlarged Clifton Court Forebay (2700 acres); siphons with flap gates connecting Byron Tract and Coney Island Forebays to Clifton Court; export pumping from Clifton Court.
3	Modified forebay consisting of a portion of Byron Tract along Old River to North Victoria-Woodward Canals (2900 acres) and the existing Clifton Court Forebay (2100 acres); siphons with flap gates connecting Byron Tract Forebay to Clifton Court Forebay; export pumping from Clifton Court Forebay.
4	Modified forebay consisting of the northern portion of Victoria Island (2400 acres), a portion of Byron Tract along Old River (500 acres), and the existing Clifton Court Forebay (2100 acres); siphons with flap gates connecting Victoria Island Forebay to Byron Tract Forebay and Byron Tract Forebay to Clifton Court Forebay; export pumping for Clifton Court Forebay.
5	Modified forebay consisting of the northwestern portion of Union Island (1400 acres), Coney Island (900 acres), and enlarged Clifton Court Forebay (2700 acres); siphons with flap gates connecting Union Island Forebay to Coney Island Forebay and Coney Island Forebay to Clifton Court Forebay; export pumping from Clifton Court Forebay.
SWP FOREBAY INTAKE LOCATION	
1	Existing intake gates to Clifton Court Forebay located on West Canal at the southern confluence with Old River.
2	Intake gates to Clifton Court Forebay located on Old River at Victoria-North Canals.
3	Intake gates to Byron Tract Forebay located on Old River at Highway 4.
4	Intake gates to Byron Tract Forebay located on Old River at North Victoria-Woodward Canals.
5	Intake gates to Victoria Island Forebay located on Old River at North Victoria-Woodward Canals.
6	Intake gates to Victoria Island Forebay located on Middle River at North Victoria-Woodward Canals.
7	Intake gates to Union Island Forebay located on Middle River at Victoria-North Canals.
SWP FOREBAY INTAKE CAPACITY	
1	Existing maximum forebay intake rate of 15,000 cfs.
2	Increased maximum forebay intake rate to 30,000 cfs.
3	No restriction on forebay intake rate.

TABLE C-4 (Continued)

ID NUMBER	DESCRIPTION

CVP EXPORT LOCATION

1 Existing CVP export operation; Tracy Pumping Plant exports from the Delta-Mendota Canal.

2 Modified CVP export operation; Tracy Pumping Plant export taken directly from Clifton Court Forebay.

CHANNEL MODIFICATIONS

1 None.

2 Increase combined cross-sectional area of Victoria-North Canals to 7200 sq ft.

3 Increase combined cross-sectional area of North Victoria-Woodward Canals to 7200 sq ft.

4 Increase Middle River cross-sectional area to 7200 sq ft between Victoria-North Canals and the Topeka-Santa Fe Railroad.

5 Increase Middle River cross-sectional area to 7200 sq ft between North Victoria-Woodward Canals and the Topeka-Santa Fe Railroad.

6 Increase Middle River cross-sectional area to 7200 sq ft between Victoria-North Canals and North Victoria-Woodward Canals.

7 Increase Middle River cross-sectional area to 1500 sq ft from the Head of Middle River to approximately 3 miles upstream of Victoria-North Canals.

8 Dredge Old River to minus 10 feet NGVD between Sugar Cut and approximately 1.75 miles upstream of the Delta-Mendota Canal.

9 Increase Old River cross-sectional area to 1500 sq ft where needed between Sugar Cut and 1.75 miles upstream of the Delta-Mendota Canal.

10 Increase Italian Slough cross-sectional area to 7200 sq ft.

HYDRAULIC STRUCTURES AND BARRIER FACILITIES

1 Existing hydraulic structures and barrier facilities used for all configurations:

A) Full tide barrier on Sandmound Slough near Rock Slough - only downstream flow.
B) 2 box culverts with flap gates at Tom Paine Slough intake - only flow into Tom Paine Sl.
C) 4 pipe siphons with flap gates at Tom Paine Slough intake - only flow into Tom Paine Sl.

2 Partial tide barrier on Old River approximately 1/2 mile upstream of the Delta-Mendota Canal intake - constricted downstream flow.

3 Partial tide barrier on Grantline Canal approximately 1/2 mile east of Old River - restricted westward flow.

4 Full tide barrier on Middle River approximately 1/2 mile upstream of Victoria-North Canals - only upstream flow.

5 Full tide barrier on Old River approximately 1/2 mile upstream of the Delta-Mendota Canal intake - only upstream flow.

6 Full tide barrier on Old River approximately 1/2 mile downstream of Head - only flow into the San Joaquin River.

TABLE C-5
PHASE I MODELING
SOUTH DELTA ALTERNATIVE CONFIGURATIONS

ID NUMBER	SERIES ID	SWP FOREBAY	INTAKE LOCATION	INTAKE CAPACITY	CVP EXPORT LOCATION	CHANNEL MODIFICATION	STRUCTURES & BARRIERS	HYDROLOGY SET NO.
1	S01-A	1	1	1	1	1	1	1
2	S01-B	1	1	1	1	1	1,2,3,4	1
3	S01-C	1	1	1	1	2,4	1	1
4	S01-D	1	1	1	1	2,4	1,2,3,4	1
5	S01-E	1	1	1	1	2,4	1,3,4	1
6	S01-F	1	1	1	1	1	1,5,6	1
7	S01-G	1	1	1	1	2,4	1,4,5	1
8	S01-H	1	1	1	1	2,4	1,3,4,5	1
9	S01-I	1	1	1	1	2,4	1,4,5,6	1
10	S02-B	1	2	1	1	1	1	1
11	S02-C	1	2	1	1	2,4	1	1
12	S02-D	1	2	1	1	2,4	1,4,5	1
13	S02-E	1	2	1	1	2,4	1,3,4,5	1
14	S02-F	1	2	1	1	2,4	1,4,5,6	1
15	S12-B	1	2	2	1	2,4	1	2
16	S12-C	1	2	2	1	2,4	1,4,5	2
17	S12-D	1	2	2	1	2,4	1,3,4,5	2
18	S12-E	1	2	2	1	2,4	1,4,5,6	2
19	S22-B	1	2	3	2	2,4	1	2
20	S22-C	1	2	3	2	2,4	1,4,5	2
21	S22-D	1	2	3	2	2,4	1,3,4,5	2
22	S22-E	1	2	3	2	2,4	1,4,5,6	2
23	S22-F	1	2	3	2	2,4	1,4	2
24	S22-G	1	2	3	2	2,4	1,4,6	2
25	S03-B	2	3	2	1	3,5	1	1
26	S03-C	2	3	2	1	3,5	1,4,5	1
27	S03-D	2	3	2	1	3,5	1,3,4,5	1
28	S03-E	2	3	2	1	3,5	1,4,5,6	1
29	S03-F	2	3	2	1	3,8	1	1
30	S03-G	2	3	2	1	3,8	1,4,5	1
31	S03-H	2	3	2	1	3,8	1,3,4,5	1
32	S03-I	2	3	2	1	3,8	1,4,5,6	1
33	S03-J	2	3	2	1	3,8	1,3,4,5,6	1
34	S13-B	2	3	2	1	3,5	1	2
35	S13-C	2	3	2	1	3,5	1,4,5	2
36	S13-D	2	3	2	1	3,5	1,3,4,5	2
37	S13-E	2	3	2	1	3,5	1,4,5,6	2
38	S13-F	2	3	2	1	3,8	1	2
39	S13-G	2	3	2	1	3,8	1,4,5	2
40	S13-H	2	3	2	1	3,8	1,3,4,5	2
41	S13-I	2	3	2	1	3,8	1,4,5,6	2
42	S13-J	2	3	2	1	3,8	1,3,4,5,6	2
43	S23-B	2	3	3	2	3,5	1	2
44	S23-C	2	3	3	2	3,5	1,4,5	2
45	S23-D	2	3	3	2	3,5	1,3,4,5	2
46	S23-E	2	3	3	2	3,5	1,4,5,6	2
47	S23-F	2	3	3	2	3,5	1,4	2
48	S23-G	2	3	3	2	3,5	1,4,6	2
49	S23-H	2	3	3	2	3,8	1	2
50	S23-I	2	3	3	2	3,8	1,4,5	2
51	S23-J	2	3	3	2	3,8	1,3,4,5	2
52	S23-K	2	3	3	2	3,8	1,4,5,6	2
53	S23-L	2	3	3	2	3,8	1,4	2

TABLE C-5 (con't)

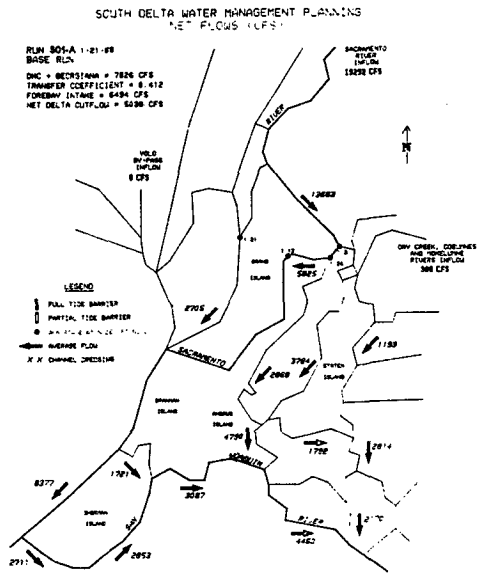
ID NUMBER	SERIES ID	SWP FOREBAY	INTAKE LOCATION	INTAKE CAPACITY	CVP EXPORT LOCATION	CHANNEL MODIFICATION	STRUCTURES & BARRIERS	HYDROLOGY SET NO.
56	S04-B	3	4	2	1	3,5	1	1
57	S04-C	3	4	2	1	3,5	1,4,5	1
58	S04-D	3	4	2	1	3,5	1,3,4,5	1
59	S04-E	3	4	2	1	3,5	1,4,5,6	1
60	S04-F	3	4	2	1	3,8	1	1
61	S04-G	3	4	2	1	3,8	1,4,5	1
62	S04-H	3	4	2	1	3,8	1,3,4,5	1
63	S04-I	3	4	2	1	3,8	1,4,5,6	1
64	S04-J	3	4	2	1	3,8	1,3,4,5,6	1
65	S04-K	3	4	2	1	3,7,9	1,3,4,5	1
66	S14-B	3	4	2	1	3,5	1	2
67	S14-C	3	4	2	1	3,5	1,4,5	2
68	S14-D	3	4	2	1	3,5	1,3,4,5	2
69	S14-E	3	4	2	1	3,5	1,4,5,6	2
70	S14-F	3	4	2	1	3,8	1	2
71	S14-G	3	4	2	1	3,8	1,4,5	2
72	S14-H	3	4	2	1	3,8	1,3,4,5	2
73	S14-I	3	4	2	1	3,8	1,4,5,6	2
74	S14-J	3	4	2	1	3,8	1,3,4,5,6	2
75	S14-K	3	4	2	1	3,7,9	1,3,4,5	2
76	S24-B	3	4	3	2	3,5	1	2
77	S24-C	3	4	3	2	3,5	1,4,5	2
78	S24-D	3	4	3	2	3,5	1,3,4,5	2
79	S24-E	3	4	3	2	3,5	1,4,5,6	2
80	S24-F	3	4	3	2	3,5	1,4	2
81	S24-G	3	4	3	2	3,5	1,4,6	2
82	S24-H	3	4	3	2	3,8	1	2
83	S24-I	3	4	3	2	3,8	1,4,5	2
84	S24-J	3	4	3	2	3,8	1,3,4,5	2
85	S24-K	3	4	3	2	3,8	1,4,5,6	2
86	S24-L	3	4	3	2	3,8	1,4	2
87	S24-M	3	4	3	2	3,8	1,4,6	2
88	S24-N	3	4	3	2	3,8	1,3,4,5,6	2
89	S24-O	3	4	3	2	3,7,9	1,3,4,5	2
90	S05-B	4	5,6	2	1	5	1	1
91	S05-C	4	5,6	2	1	5	1,4,5	1
92	S05-D	4	5,6	2	1	5	1,3,4,5	1
93	S05-E	4	5,6	2	1	5	1,4,5,6	1
94	S05-F	4	5,6	2	1	5,7,8	1	1
95	S05-G	4	5,6	2	1	5,7,8	1,4,5	1
96	S05-H	4	5,6	2	1	5,7,8	1,3,4,5	1
97	S05-I	4	5,6	2	1	5,7,8	1,4,5,6	1
98	S15-B	4	5,6	2	1	5	1	2
99	S15-C	4	5,6	2	1	5	1,4,5	2
100	S15-D	4	5,6	2	1	5	1,3,4,5	2
101	S15-E	4	5,6	2	1	5	1,4,5,6	2
102	S15-F	4	5,6	2	1	5,7,8	1	2
103	S15-G	4	5,6	2	1	5,7,8	1,4,5	2
104	S15-H	4	5,6	2	1	5,7,8	1,3,4,5	2
105	S15-I	4	5,6	2	1	5,7,8	1,4,5,6	2
106	S25-B	4	5,6	3	2	5	1	2
107	S25-C	4	5,6	3	2	5	1,4,5	2
108	S25-D	4	5,6	3	2	5	1,3,4,5	2
109	S25-E	4	5,6	3	2	5	1,4,5,6	2
110	S25-F	4	5,6	3	2	5	1,4	2
111	S25-G	4	5,6	3	2	5	1,4,6	2

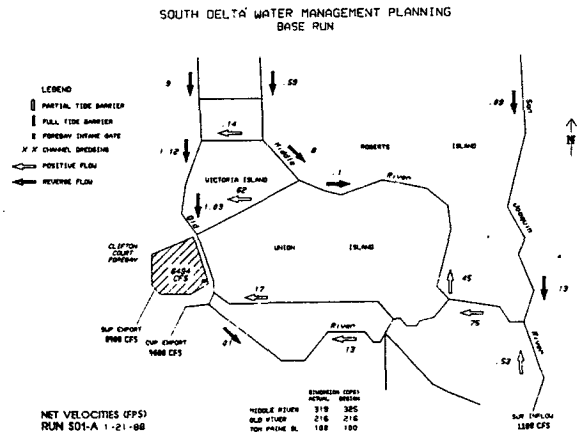
TABLE C-5 (con't)

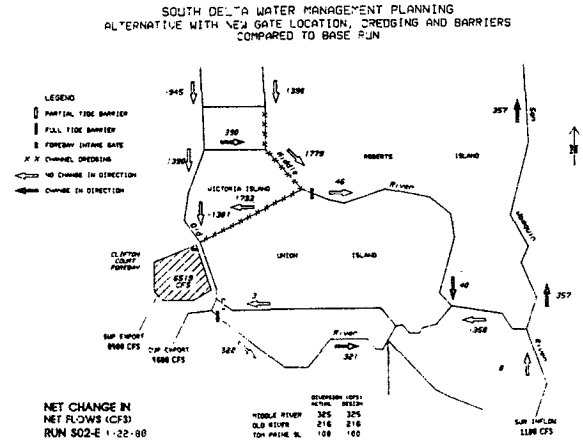
ID NUMBER	SERIES ID	SWP FOREBAY	INTAKE LOCATION	INTAKE CAPACITY	CVP EXPORT LOCATION	CHANNEL MODIFICATION	STRUCTURES & BARRIERS	HYDROLOGY SET NO.
112	S25-H	4	5,6	3	2	5,7,8	1	2
113	S25-I	4	5,6	3	2	5,7,8	1,4,5	2
114	S25-J	4	5,6	3	2	5,7,8	1,3,4,5	2
115	S25-K	4	5,6	3	2	5,7,8	1,4,5,6	2
116	S25-L	4	5,6	3	2	5,7,8	1,4	2
117	S25-M	4	5,6	3	2	5,7,8	1,4,6	2
118	S06-B	5	7	2	1	4	1	1
119	S06-C	5	7	2	1	4	1,4,5	1
120	S06-D	5	7	2	1	4	1,3,4,5	1
121	S06-E	5	7	2	1	4	1,4,5,6	1
122	S16-B	5	7	2	1	4	1	2
123	S16-C	5	7	2	1	4	1,4,5	2
124	S16-D	5	7	2	1	4	1,3,4,5	2
125	S16-E	5	7	2	1	4	1,4,5,6	2
126	S26-B	5	7	3	2	4	1	2
127	S26-C	5	7	3	2	4	1,4,5	2
128	S26-D	5	7	3	2	4	1,3,4,5	2
129	S26-E	5	7	3	2	4	1,4,5,6	2
130	S26-F	5	7	3	2	4	1,4	2
131	S26-G	5	7	3	2	4	1,4,6	2
132	S07-B	4	6	2	1	5	1	1
133	S07-C	4	6	2	1	5	1,4,5	1
134	S07-D	4	6	2	1	5	1,3,4,5	1
135	S07-E	4	6	2	1	5	1,4,5,6	1
136	S17-B	4	6	2	1	5	1	2
137	S17-C	4	6	2	1	5	1,4,5	2
138	S17-D	4	6	2	1	5	1,3,4,5	2
139	S17-E	4	6	2	1	5	1,4,5,6	2
140	S27-B	4	6	3	2	5	1	2
141	S27-C	4	6	3	2	5	1,4,5	2
142	S27-D	4	6	3	2	5	1,3,4,5	2
143	S27-E	4	6	3	2	5	1,4,5,6	2
144	S27-F	4	6	3	2	5	1,4	2
145	S27-G	4	6	3	2	5	1,4,6	2
146	S08-B	NONE	-	-	1	2,6,10	1	1
147	S08-C	NONE	-	-	1	2,6,10	1,4,5	1
148	S08-D	NONE	-	-	1	2,6,10	1,3,4,5	1
149	S08-E	NONE	-	-	1	2,6,10	1,4,5,6	1
150	S08-F	NONE	-	-	1	2,6,10	1,2,3,4	1
151	S08-G	NONE	-	-	1	2,6,10	1,3,4	1
152	S08-H	NONE	-	-	1	2,6,10	1,5,6	1
153	S18-B	NONE	-	-	1	2,6,10	1	2
154	S18-C	NONE	-	-	1	2,6,10	1,4,5	2
155	S18-D	NONE	-	-	1	2,6,10	1,3,4,5	2
156	S18-E	NONE	-	-	1	2,6,10	1,4,5,6	2
157	S28-B	NONE	-	-	2*	2,6,10	1	2
158	S28-C	NONE	-	-	2*	2,6,10	1,4,5	2
159	S28-D	NONE	-	-	2*	2,6,10	1,3,4,5	2
160	S28-E	NONE	-	-	2*	2,6,10	1,4,5,6	2
161	S28-F	NONE	-	-	2*	2,6,10	1,4	2
162	S28-G	NONE	-	-	2*	2,6,10	1,4,6	2
163	S28-H	NONE	-	-	2*	2,6,10	1,3,4,5,6	2

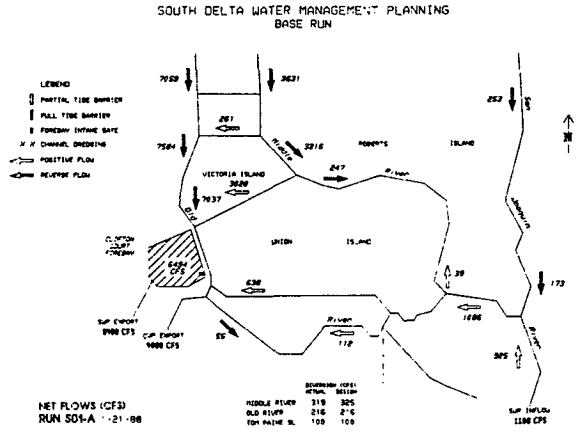
* CVP export from Italian Slough

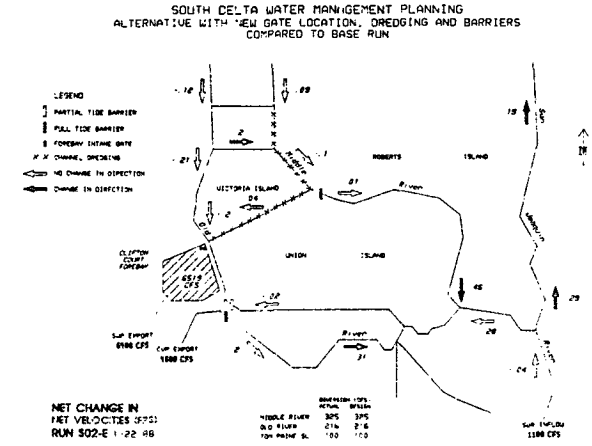
FIGURE C-4
PHASE I MODELING
SAMPLE FLOW AND VELOCITY SCHEMATICS











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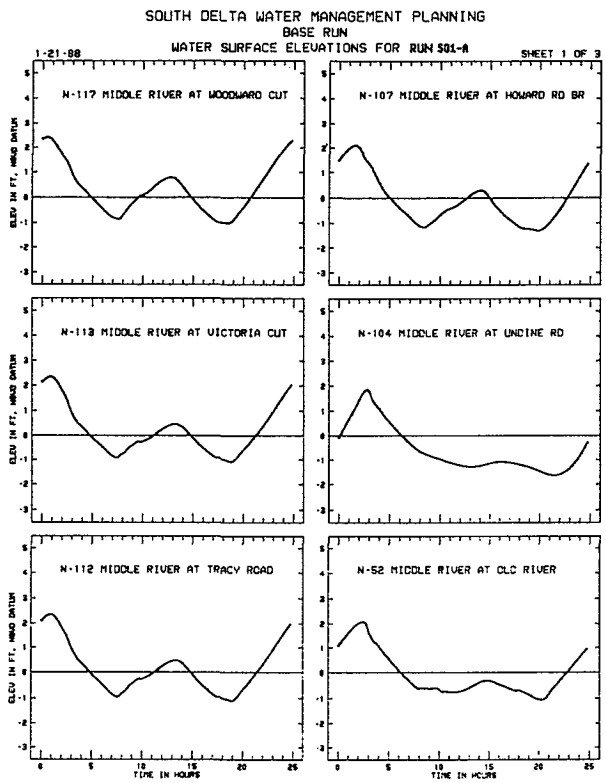
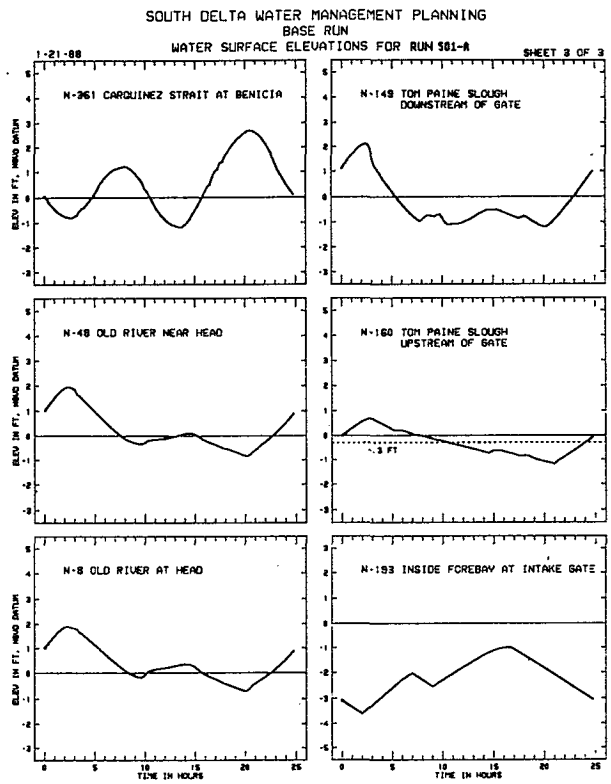




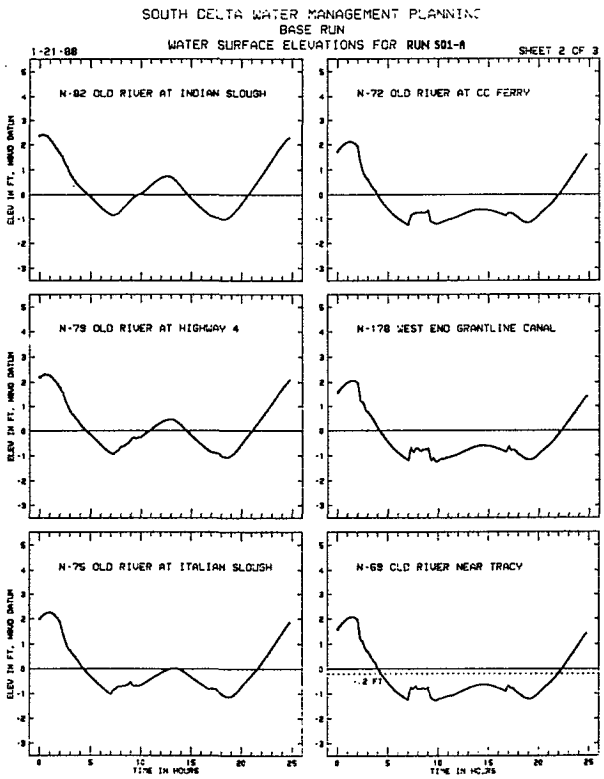
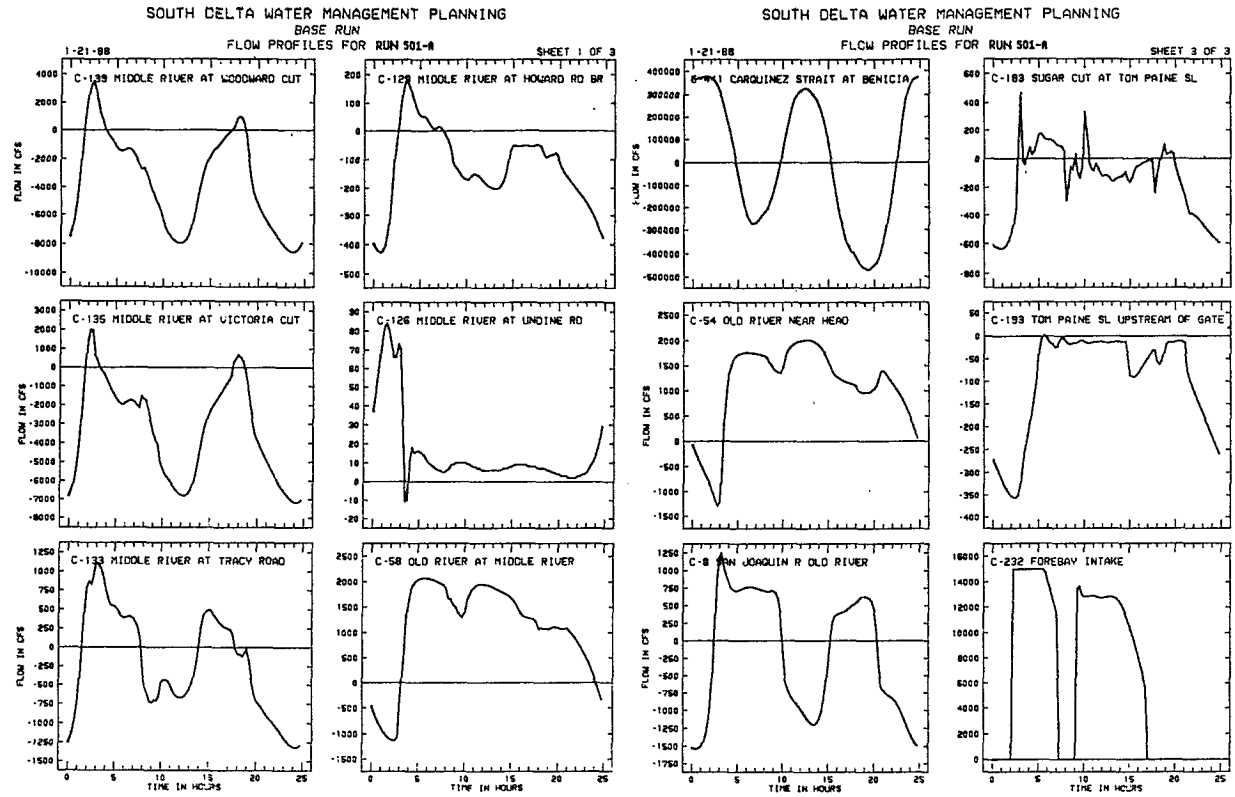


FIGURE C-5
PHASE I MODELING
SAMPLE WATER SURFACE ELEVATION PROFILES



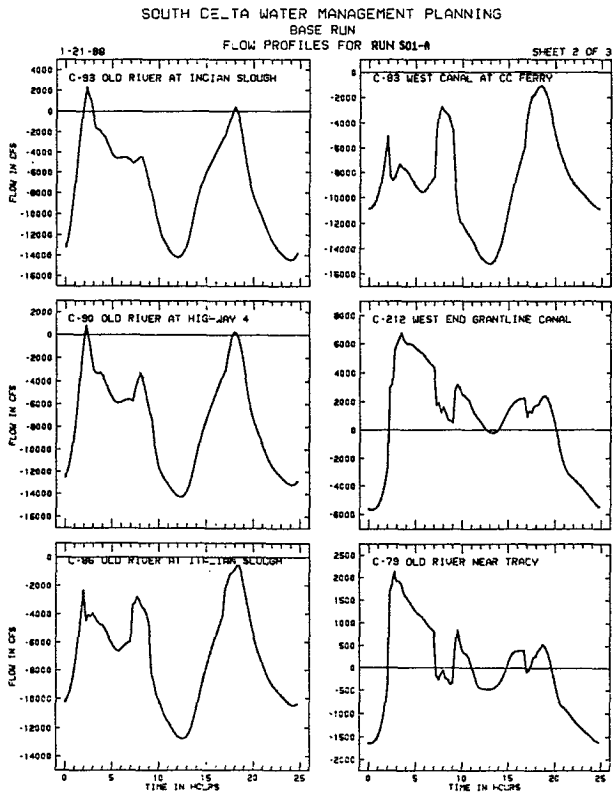
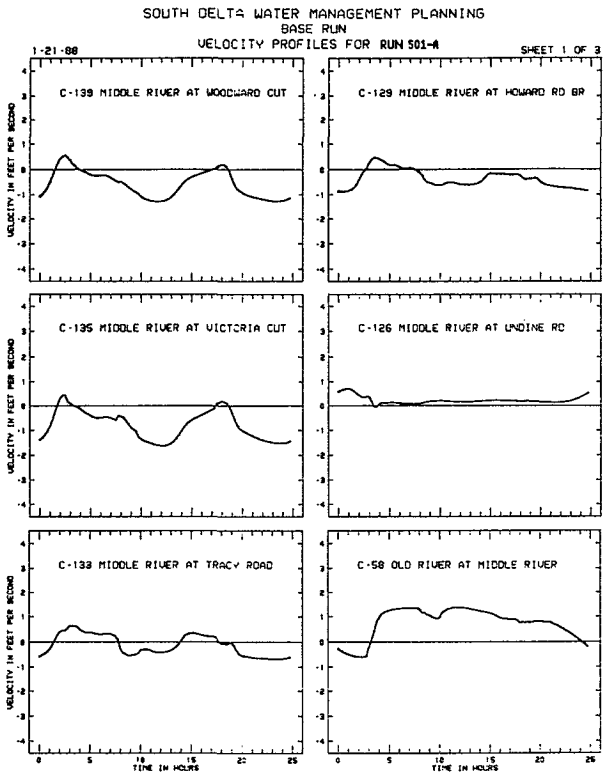
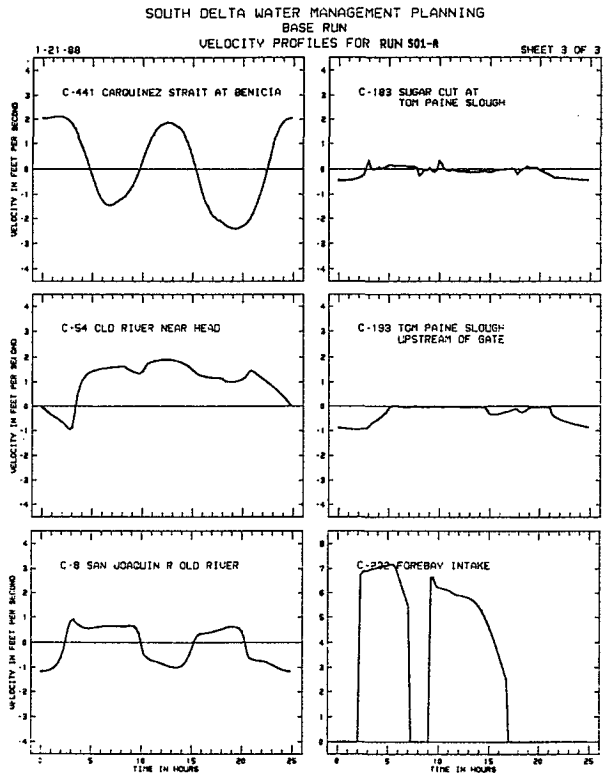


FIGURE C-6
PHASE I MODELING
SAMPLE FLOW PROFILES





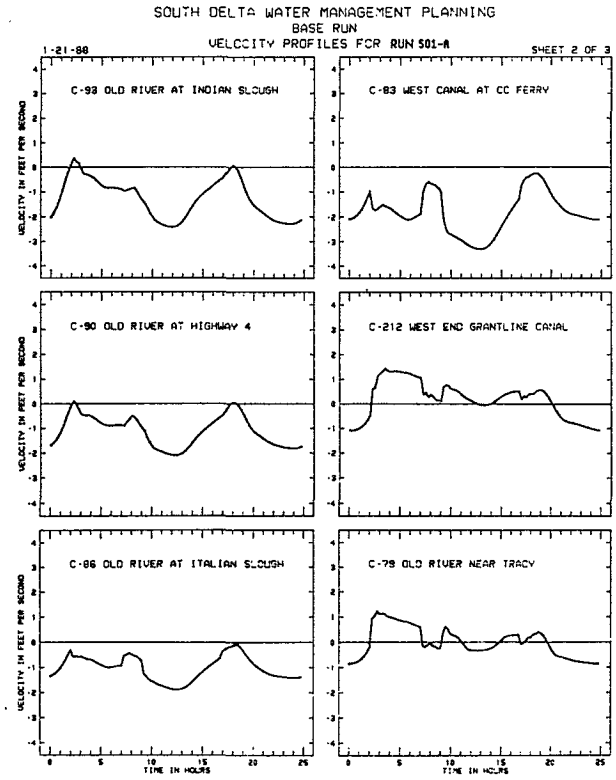


FIGURE C-7
PHASE I MODELING
SAMPLE VELOCITY PROFILES

C-041541

7. Flow Profiles at 18 locations, and

8. Velocity Profiles at 18 locations.

As examples, Figure C–4 displays items 1 through 5 and Figures C–5, C–6 and C–7 display items 6, 7, and 8 respectively for the base–case configuration. The eighteen locations presented in items 6 through 8 are important locations with respect to alternative forebays and barrier facilities. The DWR/RMA Delta Hydrodynamics Model node numbers are listed in Figure C–5 (e.g., N–117) for the stage elevation reporting locations, and the model channel numbers are listed in Figures C–6 and C–7 (e.g., C–139) for the flow and velocity reporting locations (see Figure C–1 for model map).

Selection Of Phase II Alternative Configurations

For Phase I modeling, many configurations significantly improved water surface elevations, flow patterns for fish protection, and scour velocities, when compared to the base–case condition. However, Phase I modeling configurations with different forebay intake gate locations and the CVP export tie–in produced significantly different flow patterns in the south and interior Delta. Since net flow patterns help determine salinity patterns, it was anticipated that alternative configurations might significantly vary in the degree of improvement to Delta water quality. Changes in water levels, scouring potential, water circulation and related possible water quality patterns were examined with respect to forebay intake location, CVP export tie–in, and barrier–type facilities. This process was used in selecting configurations for study in Phase II modeling for the range of variations of these factors.

For Phase II Delta modeling, four alternative configurations were selected with significantly different forebay intake locations. In addition, each of these four alternatives were evaluated with and without the CVP export tie–in, resulting in eight different configurations. These eight alternatives, and the configuration representing existing Delta conditions (designated as the no–action alternative) are summarized in Table C–6 and Figure C–8.

Phase II Delta Modeling

Phase II modeling generated the information to assist the evaluation of environmental impacts of alternative combinations of south Delta facilities. This was accomplished by 1) selecting and preparing an appropriate tide and a wide range of Delta net channel depletions and hydrologic conditions, 2) evaluating the mean monthly hydrodynamic responses of the no–action and eight alternative configurations reported in Table C–6 with the DWR/RMA Delta Hydrodynamics Model, and 3) evaluating the mean tidal daily salinity responses of the alternatives with the Fischer Delta Model (Version 7).

Assumptions. A boundary tide at Martinez/Benicia in Carquinez Strait, Delta consumptive use patterns, and boundary Delta hydrologic conditions were prepared so that a wide range of representative hydrodynamic and salinity conditions in the Delta could be simulated for each alternative configuration of south Delta facilities. Operation of Clifton Court Forebay and proposed barriers in the Delta were also established.

Monthly average Delta hydrodynamic conditions were simulated by running the DWR/RMA Delta Hydrodynamics Model for one tidal cycle (25 hours) for each month. This was considered reasonable for the evaluation and comparison of various alternative configurations based on monthly average and minimum water levels, monthly net flow and net velocity patterns in the Delta.

a. Boundary Tide. The 19–year mean, 25–hour tide at Martinez/Benicia was used to simulate mean monthly conditions. This tide is shown in Figure C–9.

b. Boundary Salinity. Daily average salinity at Eckley in Carquinez Strait was generated by DWR's model, SALDIF (version 2). This model predicts the salinity at Benicia given the Net Delta Outflow Index. A regression between the salinity at Benicia and Eckley was then used to establish the salinity at Eckley. Monthly average Net Delta Outflow Indexes were derived from the same operation studies (340B and 327B) that yielded the corresponding Delta hydrologies.

c. Delta Consumptive Use. Estimates of monthly internal Delta channel diversions and drainage returns are based on the DWR Delta island consumptive use study (1987) and the DWR field survey of diversion and drainage return locations (1987). For Delta modeling, these flows were allocated to appropriate model nodes and then varied monthly. The quality (TDS) of Delta agricultural drainage return flows is input for the Fischer Delta Model. These values, taken from DWR Bulletin 123 (*Delta and Suisun Bay Water Quality Investigation,* August 1967), vary by month and by Delta region (i.e., west, north, and southeast Delta). For any given month and Delta location, the

FIGURE C-8
PHASE II MODELING
SOUTH DELTA WATER MANAGEMENT PROGRAM ALTERNATIVES

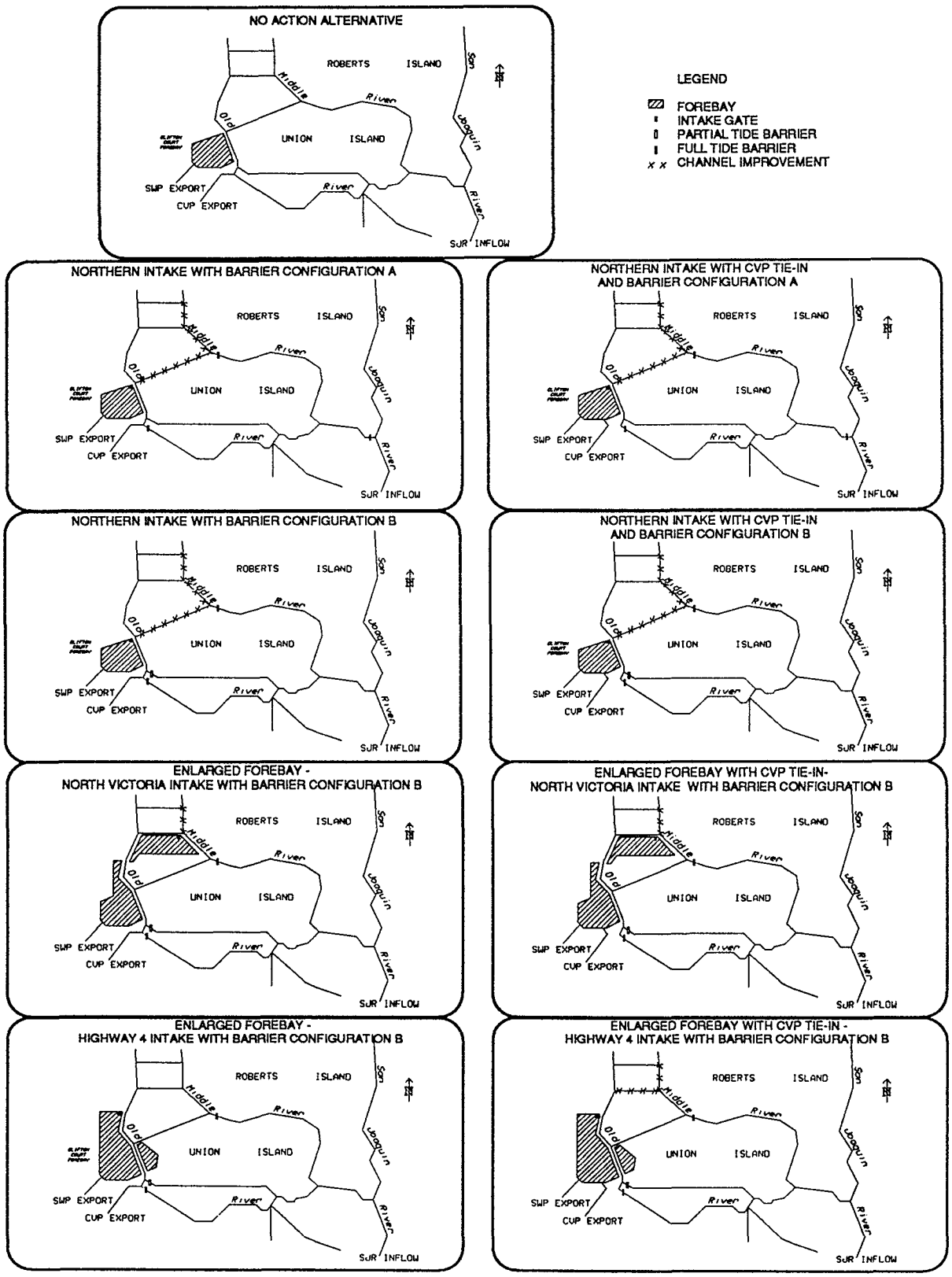


TABLE C-6
PHASE II MODELING
ALTERNATIVE SOUTH DELTA CONFIGURATIONS

ALTERNATIVE	FOREBAY	FOREBAY INTAKE LOCATION	DREDGING	CVP EXPORT OPERATION	FACILITY CONFIG*
NO ACTION (BASE CASE)	EXISTING	EXISTING	NO	EXISTING	NO ACTION
1	EXISTING	MIDDLE RIVER AT VICTORIA CUT	YES	EXISTING	A
2	EXISTING	MIDDLE RIVER AT VICTORIA CUT	YES	EXISTING	B
3	VICTORIA ISLAND + BYRON TRACT + CLIFTON COURT	MIDDLE RIVER AT WOODWARD CUT/ N. VICTORIA CUT	YES	EXISTING	B
4	BYRON TRACT + CONEY ISLAND + CLIFTON COURT	OLD RIVER AT HWY 4	YES	EXISTING	B
5	EXISTING	MIDDLE RIVER AT VICTORIA CUT	YES	CVP TIE-IN**	A
6	EXISTING	MIDDLE RIVER AT VICTORIA CUT	YES	CVP TIE-IN**	B
7	VICTORIA ISLAND + BYRON TRACT + CLIFTON COURT	MIDDLE RIVER AT WOODWARD CUT/ N. VICTORIA CUT	YES	CVP TIE-IN**	B
8	BYRON TRACT + CONEY ISLAND + CLIFTON COURT	OLD RIVER AT HWY 4	YES	CVP TIE-IN**	B

* See Tables C-9, C-10 & C-11 for Facilities description.
** With the CVP export tie-in, Tracy Pumping Plant exports are taken from the SWP forebay.

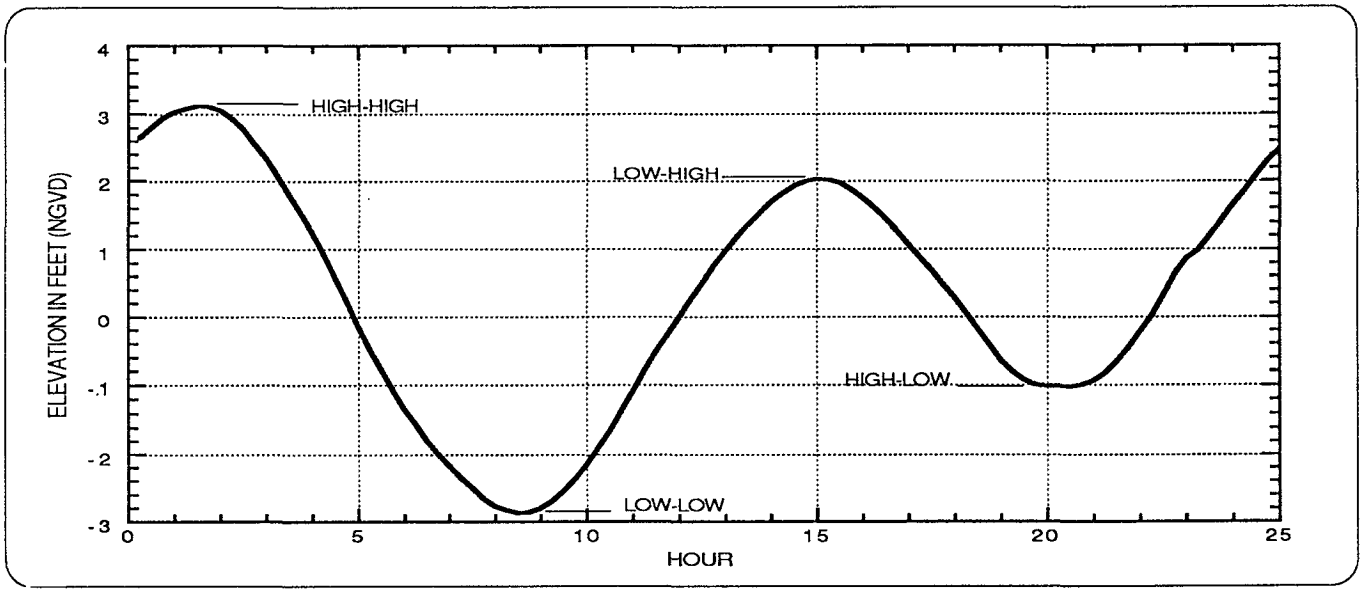


Figure C–9. Phase II Modeling
Martinez/Benecia 19–Year Mean 25–Hour Tide

quality (TDS) of agricultural return flows is assumed to be the same for each year in Delta salinity simulations.

d. Boundary Hydrologic Conditions. Delta hydrology data were derived from the two statewide operation model (DWRSIM) studies, 340B and 327B, discussed in the section, "Operation Studies." These studies provided monthly Delta inflows, exports, and net Delta outflows over a 57-year study period reflecting the components in the SDWMP (i.e. South Delta Facilities, Los Banos Grandes Reservoir, and Kern Water Bank). In Phase II modeling, Delta hydrology was changed once per month to evaluate and compare various alternative configurations based on seasonal Delta channel salinity patterns.

Five different water years were selected from each operation study to represent each of the five water year types defined in Decision 1485. The selected water years were determined with consultation with DFG and are: 1964 as the representative dry water year, 1972 as the representative below normal water year, 1975 as the representative above normal water year, 1976 as the representative critical water year, and 1978 as the representative wet water year. The monthly hydrologies for these water years are reported in Table C–7. For alternatives with the CVP export tie-in, CVP Tracy Pumping Plant exports reported in Table C–7 were taken from the SWP forebay. The Delta hydrologies defined for these water years represent the historic hydrology adjusted to a future level of water demand and development.

e. Clifton Court Forebay Gate Operation. The operation of SWP forebay intake gates was determined using the Phase II modeling forebay intake gate operation strategy presented at the top of Table C–8. This gate operation was designed to 1) take water into the SWP forebay through the peak of the high-high tide and through the low-high tide and 2) discontinue forebay inflow during the low-low tide and high-low tide. As in Phase I modeling, the tide at each intake gate location was simulated with the DWR/RMA Delta Hydrodynamics Model run without SWP exports. The resulting tides at the different intake gate locations are presented in the center panel of Table C–8. The gate operations were then determined by using the Phase II modeling gate operation pattern in conjunction with the simulated tide at each location. The resulting gate operations are presented at the bottom of Table C–8.

f. Channel Modifications. Channel geometry in the Fischer Delta Model was modified, when necessary, based on the relative change in flow patterns observed in the DWR/RMA Delta Hydrodynamics Model simulation for the alternative of interest with respect to the no-action alternative.

g. South Delta Alternatives Configurations. The no-action and eight alternative configurations selected for Phase II modeling are depicted in Figure C–8. The forebay configuration, forebay intake location, channel modifications and CVP export operation remain the same for each alternative. The operation of existing and proposed hydrau-

lic structures and barrier facilities were varied from month to month and for different water year types in optimum consideration of agricultural, fisheries, and flood control needs. Three sets of monthly barrier operations were defined. The first set, presented in Table C-9, is designated as the No-Action Facility Configuration and was used only with the no-action alternative. The second set, designated as Facility Configuration A, includes a barrier facility on Old River at Head, but no barrier on Grant Line Canal, as described in Table C-10. The third set, designated as Facility Configuration B, includes a barrier facility on Grant Line Canal, but no barrier on Old River at Head, as reported in Table C-11.

For each of the nine configurations presented in Table C-6, 60 hydrodynamic model simulations were made with both the DWR/RMA Delta Hydrodynamics Model and the Fischer Delta Model (Version 7). These simulations were made with the tide, channel depletion and hydrology data described above to represent mean monthly hydrodynamic conditions for the five selected water years. Initial hydrodynamic and salinity conditions in the Delta for each water year were based on model simulation results for the preceding month (i.e., September).

The evaluation of changes in hydrodynamic conditions were based on results from the DWR/RMA Delta Hydrodynamics Model, while the Fischer Delta Model hydrodynamic runs were used as input for subsequent water quality simulations.

Five-year-long salinity model simulations were made with the Fischer Delta Model for each alternative.

Phase II Modeling Results. Phase II modeling provided 15-minute water levels, velocities, and flows, as well as tidal daily average, minimum, and maximum surface salinity as total dissolved solids, throughout the Delta. The analysis for environmental impacts of south Delta facilities were based on the monthly averages for daily maximum, minimum, and average water levels, net flows, and velocities, as well as monthly average total dissolved solids throughout the Delta.

a. Sample Graphical Presentations. Model results were presented graphically on Delta schematic maps to show representative net monthly flows and mean monthly salinity conditions for each alternative for comparative evaluations. For each alternative, the following graphical displays were generated and analyzed:

- Monthly net flows in the south Delta,
- Monthly net flows in the north Delta,
- Monthly average total dissolved solids and net flows for the Delta.

Examples of modeling results of monthly net flows in the south and north Delta are displayed in Figures C-10 and C-11. An example of the modeling results of monthly average total dissolved solids and net flows in the Delta is shown in Figure C-12.

b. Summary Tables and Figures. Tables C-12, C-13, and C-14 show the simulated monthly average salinity at Decision 1485 standards locations. Model results for each of the five representative water years and for each of the eight alternative configurations of south Delta facilities and the no-action alternative are presented. The monthly average salinities at Jersey Point in June and July of the representative critical year have been adjusted for the alternatives: No-Action, Northern Intake-Barrier Configuration A, and Northern Intake-Barrier Configuration A with CVP tie-in, in order to comply with Decision 1485 agricultural standards. To accomplish this, additional Sacramento River flows of about 39 TAF in both June and July of the representative critical year would be required for these three alternatives.

Tables C-15, C-16, C-17, and C-18 show the impact of the eight alternative configurations of south Delta facilities upon average and minimum water levels in the south Delta, when compared to the no-action alternative. Model results for all five representative water years are included.

Table C-19 summarizes the impact of the eight alternative south Delta configurations on the monthly average salinity in the south Delta, when compared to the no-action al-

TABLE C-7
PHASE II MODELING
DWRSIM HYDROLOGY
MEAN MONTHLY FLOWS IN CFS

DRY WATER YEAR WITH EXISTING FOREBAY
STUDY 340B: WATER YEAR 1964

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	1707	33	260	179	13301	4374	4276	228	98	870	5634
NOV	2068	286	756	286	23601	4270	6674	202	101	488	15279
DEC	2179	49	228	49	13252	4260	5122	163	65	746	5400
JAN	1854	569	732	943	21268	4228	7301	163	65	-1383	14992
FEB	1530	72	234	54	15876	4320	6858	162	72	621	5733
MAR	1561	98	98	65	16179	4423	6569	179	65	1208	5540
APR	1799	269	420	168	15852	4589	4186	202	67	2222	7225
MAY	1285	195	520	114	13626	2992	2211	244	81	3056	7171
JUN	1093	202	353	101	13734	3009	2152	269	67	2820	7165
JUL	1057	244	195	49	13447	4602	813	293	49	4239	4996
AUG	943	211	228	98	10488	4455	341	293	49	2899	3947
SEP	1244	202	219	101	10456	4656	1311	252	84	1802	4098

DRY WATER YEAR WITH MODIFIED FOREBAY
STUDY 327B: WATER YEAR 1964

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	1707	33	260	179	13301	4374	4260	228	98	870	5650
NOV	2068	286	756	286	23601	4270	10220	202	101	488	11733
DEC	2179	49	228	49	13252	4260	5122	163	65	746	5400
JAN	1854	569	732	943	22439	4228	10163	163	65	-1383	13301
FEB	1530	72	234	54	14256	4320	5688	162	72	621	5283
MAR	1561	98	98	65	19967	4423	9496	179	81	1208	8385
APR	1799	269	420	168	18121	4589	5766	202	101	2222	7864
MAY	1301	195	520	114	14211	2992	2748	244	114	3056	7171
JUN	1093	202	353	101	14423	3009	2807	269	101	2820	7165
JUL	1057	244	195	49	13821	4602	1154	293	98	4239	4996
AUG	943	211	228	98	11691	4455	1008	293	81	2899	4435
SEP	1244	202	219	101	10439	4656	1278	252	118	1802	4098

BELOW NORMAL WATER YEAR WITH EXISTING FOREBAY
STUDY 340B: WATER YEAR 1972

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	1902	81	1415	114	16927	4374	6650	228	98	1259	7831
NOV	1832	34	353	34	16070	4270	6674	202	101	914	6163
DEC	2244	455	992	260	20553	4260	6992	163	65	650	12374
JAN	2911	114	293	98	18975	4228	6130	163	65	-98	11903
FEB	2898	216	610	72	21474	4320	7290	162	72	253	13355
MAR	1447	195	114	65	27691	4472	3154	179	81	1459	20187
APR	2202	202	807	118	15179	4589	4421	202	101	1829	7366
MAY	1919	211	358	114	14049	2992	2992	244	98	2814	7511
JUN	1328	219	185	101	15616	3009	3009	269	84	3371	7707
JUL	1252	244	195	49	17805	4602	3642	293	81	4293	6650
AUG	1171	211	163	98	12179	4455	1350	293	81	2931	4728
SEP	2286	185	185	67	11195	4656	2841	252	101	1365	4703

BELOW NORMAL WATER YEAR WITH MODIFIED FOREBAY
STUDY 327B: WATER YEAR 1972

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	1902	81	1415	114	17951	4374	8618	228	98	1259	6887
NOV	1832	34	353	34	17365	4270	7850	202	101	914	6298
DEC	2244	455	992	260	21886	4260	9187	163	65	650	11496
JAN	2911	114	293	98	18975	4228	5398	163	65	-98	12651
FEB	2898	216	610	72	21474	4320	4698	162	72	253	15947
MAR	1447	195	114	65	27691	4472	5317	179	81	1459	18004
APR	2202	202	807	118	16289	4589	5480	202	101	1829	7400
MAY	1935	211	358	114	13658	2992	2602	244	114	2814	7511
JUN	1328	219	185	101	15263	3009	2622	269	101	3371	7707
JUL	1252	244	195	49	16667	4602	2927	293	98	4293	6211
AUG	1171	211	163	98	12408	4455	1496	293	81	2931	4793
SEP	2286	185	185	67	11195	4656	2824	252	118	1365	4703

ABOVE NORMAL WATER YEAR WITH EXISTING FOREBAY
STUDY 340B: WATER YEAR 1975

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	2618	49	1577	33	16309	4374	6650	228	98	1333	7903
NOV	3127	319	353	17	17348	4270	6674	202	101	846	9089
DEC	2959	390	585	260	18520	4260	6992	163	65	801	10435
JAN	2000	81	293	81	18211	4228	4374	163	65	-29	11866
FEB	6930	1134	4140	3690	55818	4320	6174	162	72	-1263	62229
MAR	3073	2016	6081	9447	70959	4439	3463	179	81	-1103	84500
APR	2303	370	1933	689	22290	4606	4976	202	101	1031	16636
MAY	764	179	1593	98	31707	2992	2992	244	114	2977	25039
JUN	824	219	1597	101	22677	3009	3009	269	101	3762	15251
JUL	1333	244	407	49	20390	4602	4602	293	98	3727	9102
AUG	1106	211	163	98	16000	4732	3203	293	81	2464	6804
SEP	2068	219	1109	101	15095	4656	5951	252	118	1666	5949

ABOVE NORMAL WATER YEAR WITH MODIFIED FOREBAY
STUDY 327B: WATER YEAR 1975

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	2618	49	1577	33	18959	4374	10293	228	98	1333	6927
NOV	3127	319	353	17	18928	4270	9615	202	101	846	7728
DEC	2959	390	585	260	18601	4260	6406	163	65	801	11102
JAN	2000	81	293	81	18211	4228	4374	163	65	-29	11866
FEB	6930	1134	4140	3690	55818	4320	4752	162	72	-1263	63669
MAR	3073	2016	6081	9447	70959	4439	3805	179	81	-1103	84159
APR	2303	370	1933	689	22290	4606	5177	202	101	1031	16451
MAY	780	179	1593	98	31707	2992	2992	244	114	2977	25039
JUN	824	219	1597	101	22677	3009	3009	269	101	3762	15251
JUL	1333	244	407	49	17496	4602	2358	293	98	3727	8452
AUG	1106	211	163	98	13512	4732	1691	293	81	2464	5828
SEP	2068	219	1109	101	15936	4656	6287	252	118	1666	6453

CRITICAL WATER YEAR WITH EXISTING FOREBAY
STUDY 340B: WATER YEAR 1976

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	2715	33	1789	244	20309	4374	6650	228	98	849	12907
NOV	3110	656	34	0	18054	4270	6674	202	101	1019	9605
DEC	2911	309	488	16	16585	4260	6992	163	65	1011	7802
JAN	1789	114	114	0	12325	4228	4894	163	65	380	4612
FEB	972	144	90	0	13644	4320	4644	162	72	965	4687
MAR	1886	179	98	260	11772	4423	3756	179	65	2233	3539
APR	2084	219	252	134	14305	4589	3782	202	84	2017	6304
MAY	1837	228	195	114	11561	2992	2667	244	81	4238	3713
JUN	1328	235	185	101	12120	3009	2488	269	67	5723	2396
JUL	1154	244	195	49	13837	4602	1285	293	65	5061	4174
AUG	1008	195	130	81	11805	4455	1268	293	65	2176	4976
SEP	1446	202	151	84	10792	4656	1782	252	84	1437	4446

CRITICAL WATER YEAR WITH MODIFIED FOREBAY
STUDY 327B: WATER YEAR 1976

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	2715	33	1789	244	23577	4374	10293	228	98	849	12517
NOV	3110	656	34	0	19382	4270	9195	202	101	1019	8411
DEC	2911	309	488	16	16569	4260	6406	163	65	1011	8387
JAN	1789	114	114	0	12325	4228	4439	163	65	380	5067
FEB	972	144	90	0	13644	4320	4662	162	72	965	4669
MAR	1886	179	98	260	11772	4423	3333	179	81	2233	3946
APR	2084	219	252	134	12994	4589	2454	202	101	2017	6304
MAY	1854	228	195	114	11561	2992	2634	244	114	4238	3713
JUN	1328	235	185	101	11767	3009	2118	269	101	5723	2396
JUL	1154	244	195	49	12325	4602	423	293	98	5061	3508
AUG	1008	195	130	81	11805	4455	1252	293	81	2176	4946
SEP	1446	202	151	84	10792	4656	1748	252	118	1437	4446

WET WATER YEAR WITH EXISTING FOREBAY
STUDY 340B: WATER YEAR 1978

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	1480	81	81	81	5301	959	1041	163	49	1267	3530
NOV	925	34	84	151	8086	3530	1378	151	50	816	3369
DEC	553	276	293	585	13870	4260	4878	114	33	540	5769
JAN	3171	780	2341	14358	32894	4228	7301	114	33	-4501	46370
FEB	4842	486	1638	5544	40284	4320	7290	126	36	-2204	43226
MAR	9447	683	2049	13984	48374	2537	5203	179	81	-2471	68991
APR	11397	740	2152	14255	38966	3345	4320	202	101	43	59464
MAY	3707	179	878	81	18764	2992	2992	244	114	2208	15060
JUN	3043	235	353	101	18441	1109	2370	269	101	3405	14901
JUL	3333	244	195	49	16862	2504	3203	293	98	4204	10381
AUG	1301	211	163	98	14195	4455	2195	293	81	3068	5875
SEP	2404	168	134	101	12759	4656	3715	252	118	1692	5116

WET WATER YEAR WITH MODIFIED FOREBAY
STUDY 340B: WATER YEAR 1978

MONTH	QSJR	QCAL	QEAST	QYOLO	QSAC	TRYPP	DELPP	CCCAN	DEMNB	NCD	NDO
OCT	1480	81	81	81	5967	959	1691	163	81	1267	3530
NOV	925	34	84	151	13515	3530	4488	151	67	816	5656
DEC	553	276	293	585	13886	4260	5073	114	49	540	5541
JAN	3171	780	2341	14358	32894	4228	10114	114	49	-4501	43541
FEB	4842	486	1638	5544	40284	4320	10116	126	54	-2204	40382
MAR	9447	683	2049	13984	42813	2553	10211	179	81	-2471	58422
APR	11397	740	2152	14255	35402	3345	6926	202	101	43	53295
MAY	3724	179	878	81	18764	2992	2992	244	114	2208	15060
JUN	3043	235	353	101	16491	1109	420	269	101	3405	14901
JUL	3333	244	195	49	15106	2504	1463	293	98	4204	10381
AUG	1301	211	163	98	13284	4455	1610	293	81	3068	5566
SEP	2404	168	134	101	12759	4656	3715	252	118	1692	5133

LEGEND:

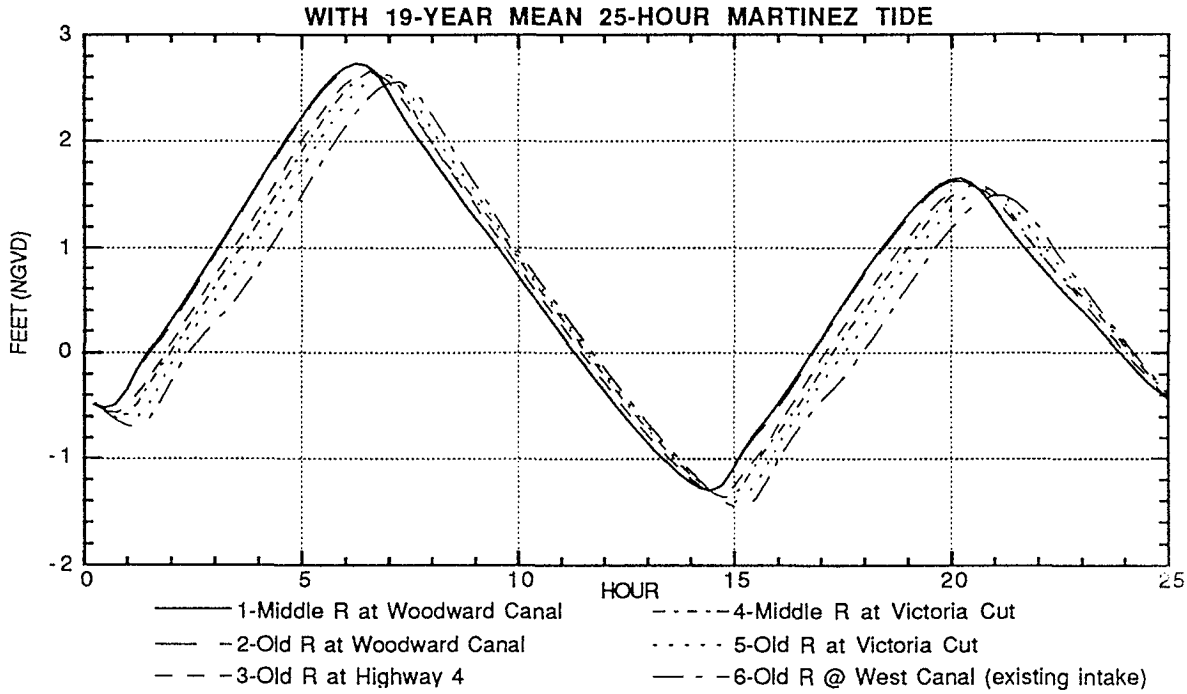
QSJR = SAN JOAQUIN RIVER INFLOW NEAR VERNALIS
QCAL = CALAVARAS RIVER INFLOW
QEAST = COSUMNES R., MOKELUMNE R. AND DRY CREEK INFLOWS
QYOLO = YOLO BYPASS INFLOW NEAR RIO VISTA
QSAC = SACRAMENTO RIVER INFLOW NEAR SACRAMENTO
TRYPP = CVP EXPORT AT TRACY PUMPING PLANT
DELPP = SWP EXPORT AT BANKS PUMPING PLANT
CCCAN = CONTRA COSTA CANAL EXPORT
DEMNB = NORTH BAY AQUEDUCT EXPORT FROM BARKER SLOUGH
NCD = DELTA NET CHANNEL DEPLETIONS FROM THE DWR DELTA ISLAND CONSUMPTIVE USE STUDY
NDO = NET DELTA OUTFLOW USING NCD ABOVE

TABLE C-8
PHASE II MODELING
SWP FOREBAY GATE OPERATION SCHEDULE

PHASE II GATE OPERATION

GATE OPERATION	TIMING
OPEN	1 HOUR BEFORE HIGH-HIGH TIDE
CLOSE	2 HOURS BEFORE LOW-LOW TIDE
OPEN	1 HOUR AFTER LOW-LOW TIDE
CLOSE	1 HOUR BEFORE HIGH-LOW TIDE

TIDES AT FOREBAY INTAKE LOCATIONS WITHOUT SWP EXPORTS WITH 19-YEAR MEAN 25-HOUR MARTINEZ TIDE



GATE OPERATION SCHEDULE

LOCATION	MODEL NODE	TIME IN HOURS OPEN	CLOSE	OPEN	CLOSE
1	117	5.00	12.25	15.25	24.25
2	82	5.00	12.25	15.25	24.25
3	79	5.25	12.50	15.50	24.50
4	113	5.50	12.50	15.50	24.50
5	75	5.75	12.75	15.75	24.75
6	72	6.00	13.00	16.00	25.00

TABLE C-9
PHASE II MODELING
FACILITIES OPERATION FOR NO-ACTION CONFIGURATION

MONTH	BASE FACILITY*		NEW FACILITY				
	DXC	MSCS	TPS	MRF	ORDF	ORHF	GLCP
DRY WATER YEAR (1964)							
OCT	OPEN	OPERATING	-	-	-	-	-
NOV	OPEN	OPERATING	-	-	-	-	-
DEC	OPEN	OPERATING	-	-	-	-	-
JAN	CLOSED	OPERATING	-	-	-	-	-
FEB	OPEN	OPERATING	-	-	-	-	-
MAR	OPEN	OPERATING	-	-	-	-	-
APR	OPEN	OPERATING	-	-	-	-	-
MAY	OPEN	OPERATING	-	-	-	-	-
JUN	OPEN	NOT OPERATING	-	-	-	-	-
JUL	OPEN	NOT OPERATING	-	-	-	-	-
AUG	OPEN	NOT OPERATING	-	-	-	-	-
SEP	OPEN	NOT OPERATING	-	-	-	-	-
BELOW NORMAL WATER YEAR (1972)							
OCT	OPEN	OPERATING	-	-	-	-	-
NOV	OPEN	OPERATING	-	-	-	-	-
DEC	OPEN	OPERATING	-	-	-	-	-
JAN	CLOSED	OPERATING	-	-	-	-	-
FEB	CLOSED	OPERATING	-	-	-	-	-
MAR	CLOSED	NOT OPERATING	-	-	-	-	-
APR	OPEN	OPERATING	-	-	-	-	-
MAY	OPEN	OPERATING	-	-	-	-	-
JUN	OPEN	NOT OPERATING	-	-	-	-	-
JUL	OPEN	NOT OPERATING	-	-	-	-	-
AUG	OPEN	NOT OPERATING	-	-	-	-	-
SEP	OPEN	NOT OPERATING	-	-	-	-	-
ABOVE NORMAL WATER YEAR (1975)							
OCT	OPEN	OPERATING	-	-	-	-	-
NOV	OPEN	OPERATING	-	-	-	-	-
DEC	OPEN	OPERATING	-	-	-	-	-
JAN	OPEN	OPERATING	-	-	-	-	-
FEB	CLOSED	NOT OPERATING	-	-	-	-	-
MAR	CLOSED	NOT OPERATING	-	-	-	-	-
APR	CLOSED	NOT OPERATING	-	-	-	-	-
MAY	CLOSED	NOT OPERATING	-	-	-	-	-
JUN	OPEN	NOT OPERATING	-	-	-	-	-
JUL	OPEN	NOT OPERATING	-	-	-	-	-
AUG	OPEN	NOT OPERATING	-	-	-	-	-
SEP	OPEN	NOT OPERATING	-	-	-	-	-
CRITICAL WATER YEAR (1976)							
OCT	OPEN	OPERATING	-	-	-	-	-
NOV	OPEN	OPERATING	-	-	-	-	-
DEC	OPEN	OPERATING	-	-	-	-	-
JAN	OPEN	OPERATING	-	-	-	-	-
FEB	OPEN	OPERATING	-	-	-	-	-
MAR	OPEN	OPERATING	-	-	-	-	-
APR	OPEN	OPERATING	-	-	-	-	-
MAY	OPEN	OPERATING	-	-	-	-	-
JUN	OPEN	NOT OPERATING	-	-	-	-	-
JUL	OPEN	NOT OPERATING	-	-	-	-	-
AUG	OPEN	NOT OPERATING	-	-	-	-	-
SEP	OPEN	NOT OPERATING	-	-	-	-	-
WET WATER YEAR (1978)							
OCT	OPEN	OPERATING	-	-	-	-	-
NOV	OPEN	OPERATING	-	-	-	-	-
DEC	OPEN	OPERATING	-	-	-	-	-
JAN	CLOSED	NOT OPERATING	-	-	-	-	-
FEB	CLOSED	NOT OPERATING	-	-	-	-	-
MAR	CLOSED	NOT OPERATING	-	-	-	-	-
APR	CLOSED	NOT OPERATING	-	-	-	-	-
MAY	CLOSED	NOT OPERATING	-	-	-	-	-
JUN	OPEN	NOT OPERATING	-	-	-	-	-
JUL	OPEN	NOT OPERATING	-	-	-	-	-
AUG	OPEN	NOT OPERATING	-	-	-	-	-
SEP	OPEN	NOT OPERATING	-	-	-	-	-

* SAND MOUND SLOUGH TIDE GATE AND 2 BOX CULVERTS AT TOM PAINE SLOUGH OPERATING ALL MONTHS

DXC = DELTA CROSS CHANNEL
MSCS = MONTEZUMA CONTROL STRUCTURE
TPS = 4 PIPES SIPHONS AT TOM PAINE SLOUGH INTAKE
MRF = FULL TIDE BARRIER ON MIDDLE RIVER NEAR VICTORIA CUT
ORDF = FULL TIDE BARRIER ON OLD RIVER NEAR DELTA-MENDOTA CANAL
ORHF = FULL TIDE BARRIER ON OLD RIVER AT HEAD
GLCP = PARTIAL TIDE BARRIER ON GRANTLINE CANAL NEAR CLIFTON COURT FOREBAY

TABLE C-10
PHASE II MODELING
FACILITIES OPERATION FOR BARRIER CONFIGURATION A

MONTH	BASE FACILITY* DXC	BASE FACILITY* MSCS	NEW FACILITY TPS	NEW FACILITY MRF	NEW FACILITY ORDF	NEW FACILITY ORHF	NEW FACILITY GLCP
DRY WATER YEAR (1964)							
OCT	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
JAN	CLOSED	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
FEB	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
MAR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
APR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
MAY	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
AUG	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
SEP	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
BELOW NORMAL WATER YEAR (1972)							
OCT	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
JAN	CLOSED	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
FEB	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
MAR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
APR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
MAY	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
AUG	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
SEP	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
ABOVE NORMAL WATER YEAR (1975)							
OCT	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
JAN	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
FEB	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
MAR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
APR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
MAY	CLOSED	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
AUG	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
SEP	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
CRITICAL WATER YEAR (1976)							
OCT	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
JAN	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
FEB	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
MAR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
APR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
MAY	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
AUG	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
SEP	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	NOT OPERATING	-
WET WATER YEAR (1978)							
OCT	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
JAN	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
FEB	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
MAR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
APR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
MAY	CLOSED	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	OPERATING	-
AUG	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-
SEP	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	NOT OPERATING	-

* SAND MOUND SLOUGH TIDE GATE AND 2 BOX CULVERTS AT TOM PAINE SLOUGH OPERATING ALL MONTHS

DXC = DELTA CROSS CHANNEL
MSCS = MONTEZUMA CONTROL STRUCTURE
TPS = 4 PIPES SIPHONS AT TOM PAINE SLOUGH INTAKE
MRF = FULL TIDE BARRIER ON MIDDLE RIVER NEAR VICTORIA CUT
ORDF = FULL TIDE BARRIER ON OLD RIVER NEAR DELTA-MENDOTA CANAL
ORHF = FULL TIDE BARRIER ON OLD RIVER AT HEAD
GLCP = PARTIAL TIDE BARRIER ON GRANTLINE CANAL NEAR CLIFTON COURT FOREBAY

TABLE C-11
PHASE II MODELING
FACILITIES OPERATION FOR BARRIER CONFIGURATION B

MONTH	BASE FACILITY* DXC	BASE FACILITY* MSCS	NEW FACILITY TPS	NEW FACILITY MRF	NEW FACILITY ORDF	NEW FACILITY ORHF	NEW FACILITY GLCP
DRY WATER YEAR (1964)							
OCT	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
JAN	CLOSED	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
FEB	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
MAR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
APR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
MAY	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
AUG	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
SEP	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
BELOW NORMAL WATER YEAR (1972)							
OCT	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
JAN	CLOSED	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
FEB	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
MAR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
APR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
MAY	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
AUG	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
SEP	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
ABOVE NORMAL WATER YEAR (1975)							
OCT	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
JAN	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
FEB	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
MAR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
APR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
MAY	CLOSED	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
AUG	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
SEP	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
CRITICAL WATER YEAR (1976)							
OCT	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
JAN	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
FEB	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
MAR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
APR	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
MAY	OPEN	OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
AUG	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
SEP	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
WET WATER YEAR (1978)							
OCT	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
NOV	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
DEC	OPEN	OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
JAN	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
FEB	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
MAR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
APR	CLOSED	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
MAY	CLOSED	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUN	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
JUL	OPEN	NOT OPERATING	OPERATING	OPERATING	OPERATING	-	OPERATING
AUG	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING
SEP	OPEN	NOT OPERATING	OPERATING	NOT OPERATING	NOT OPERATING	-	NOT OPERATING

* SAND MOUND SLOUGH TIDE GATE AND 2 BOX CULVERTS AT TOM PAINE SLOUGH OPERATING ALL MONTHS

DXC = DELTA CROSS CHANNEL
MSCS = MONTEZUMA CONTROL STRUCTURE
TPS = 4 PIPES SIPHONS AT TOM PAINE SLOUGH INTAKE
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GLCP = PARTIAL TIDE BARRIER ON GRANTLINE CANAL NEAR CLIFTON COURT FOREBAY

ternative. Model results for all five representative water years are included. The information shown in Table C-19 should only be used to compare the various alternatives in the SDWMP based on the relative changes in TDS from the no-action alternative. Reported salinity values are provided to indicate the general range of changes in Delta TDS for the alternatives under a wide range of hydrologic conditions. Absolute TDS values for the interior Delta are not reported because Fischer Delta Model salinity results for this region can be significantly affected by the drainage return qualities specified as inputs to the model and are not dynamically simulated. Furthermore, the Fischer Delta Model allows for relatively few agricultural diversions and drainage returns in the south Delta.

Figures C-14, C-15, C-16, and C-18 display modeling results of the Enlarged Forebay-North Victoria Intake with Barrier Configuration B alternative's impact on water levels and salinity in the south Delta. The information for these figures is contained in the tables presented in this section.

Figure C-14 shows how average and minimum water levels improve at the 16 Delta locations shown in Figure C-13 during the representative dry year under the Enlarged Forebay-North Victoria Intake with Barrier Configuration B alternative.

Figure C-15 shows how improvements in average and minimum water levels under this alternative vary along reaches of Old River, the Upper San Joaquin River, Middle River, and Grant Line Canal when the barrier-type facilities were in operation.

Figure C-16 shows how improvements in average and minimum water levels under this alternative, due only to forebay improvements, vary as the change from the no-action alternative SWP export rate varies.

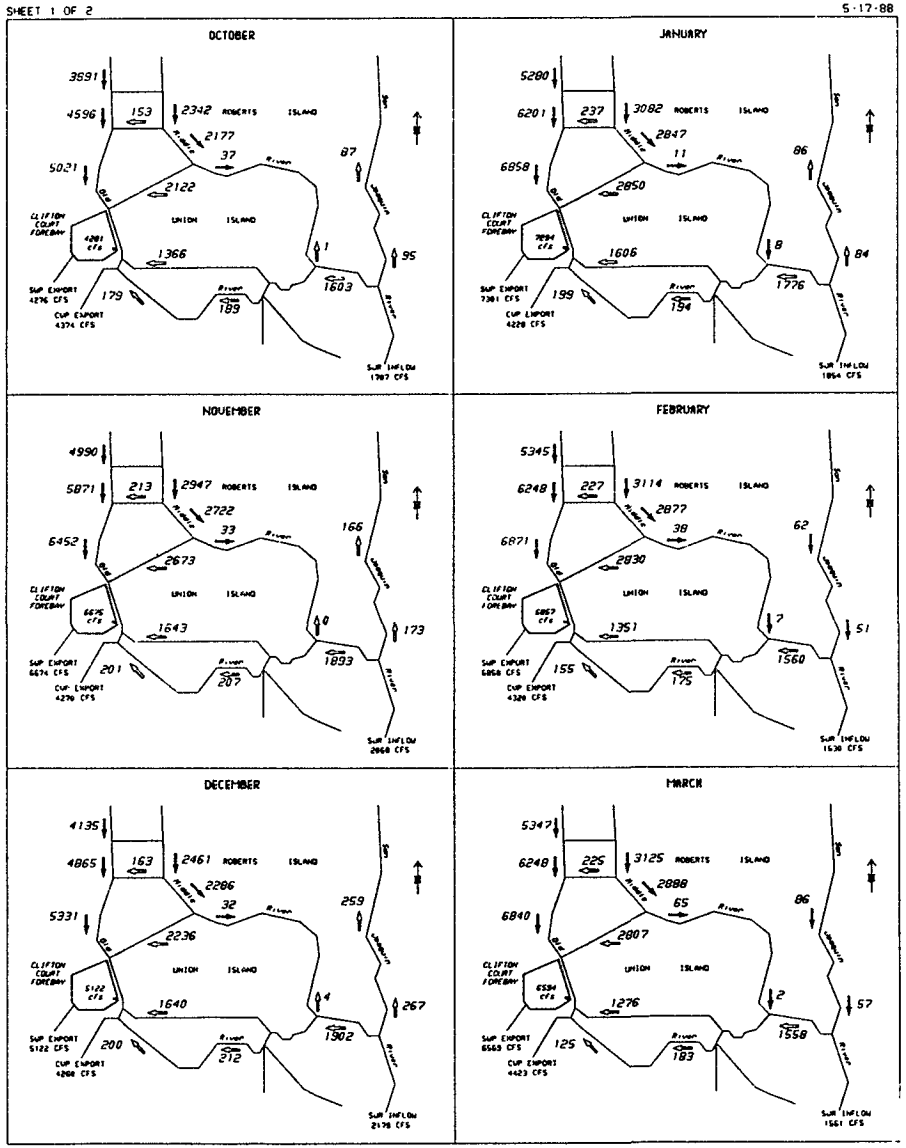
Figure C-18 shows how the improvements in monthly average salinity under this alternative improve at the 16 locations in the Delta shown in Figure C-17 during the representative dry year.

Tables C-20 and C-21 shows maximum upstream and downstream velocities for areas where channel velocities may be affected by the SDWMP. These values are provided to indicate the possible magnitude of changes in maximum velocities in the Delta with respect to the no-action alternative under a wide range of hydrologic conditions. Caution must be taken when using the absolute velocities shown since the DWR/RMA Delta Hydrodynamics Model, which provided the information, was calibrated for stage and later verified for flow and velocity at 18 Delta locations for May 1988.

FIGURE C-10
PHASE II MODELING
SAMPLE SOUTH DELTA FLOW SCHEMATIC

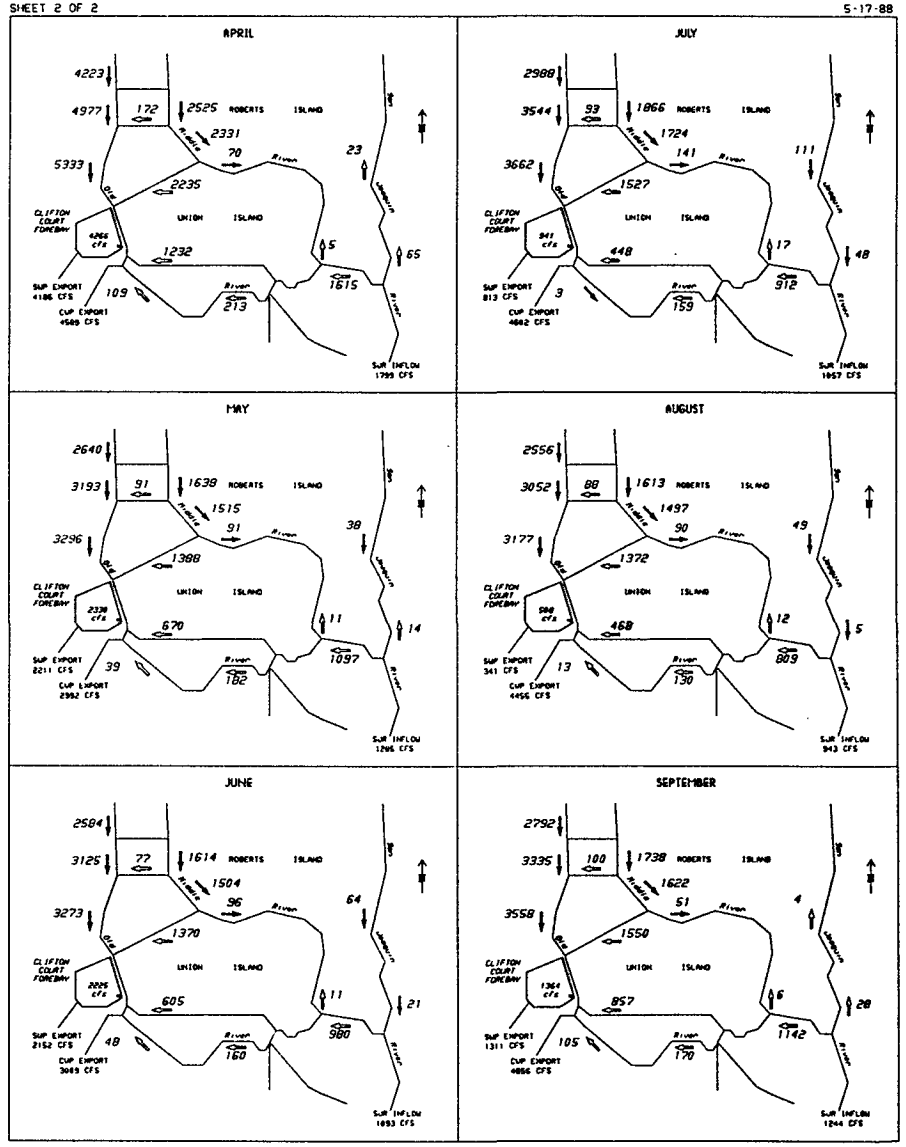
SOUTH DELTA WATER MANAGEMENT PLANNING
MONTHLY NET FLOWS IN CFS
DRY YEAR, RUN 340B - BASE CONDITION

SHEET 1 OF 2 — 5-17-88



SOUTH DELTA WATER MANAGEMENT PLANNING
MONTHLY NET FLOWS IN CFS
DRY YEAR, RUN 340B - BASE CONDITION

SHEET 2 OF 2 — 5-17-88



PARTIAL TIDE BARRIER | FULL TIDE BARRIER | INTAKE GATE | CHANNEL DREDGING | POSITIVE FLOW | REVERSE FLOW

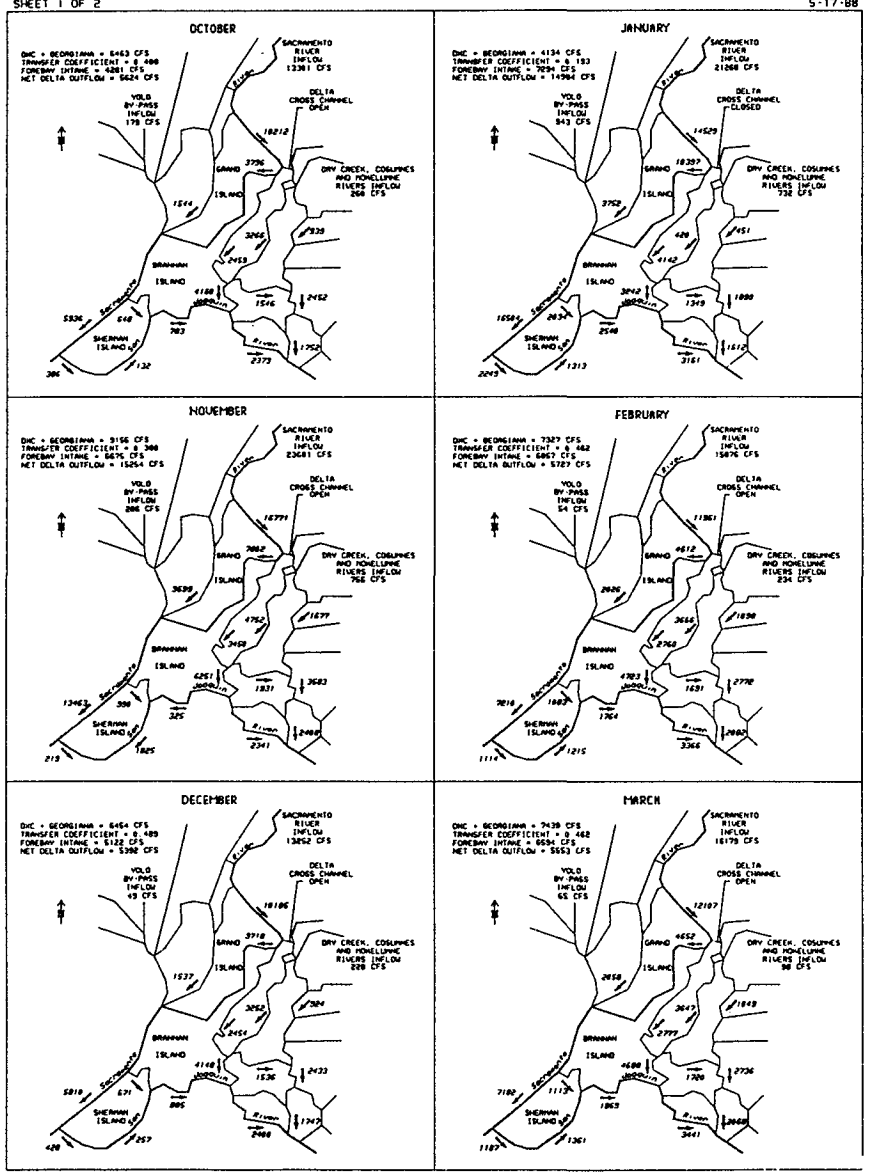
C-041553

C-041553

FIGURE C-11
PHASE II MODELING
SAMPLE NORTH DELTA FLOW SCHEMATIC

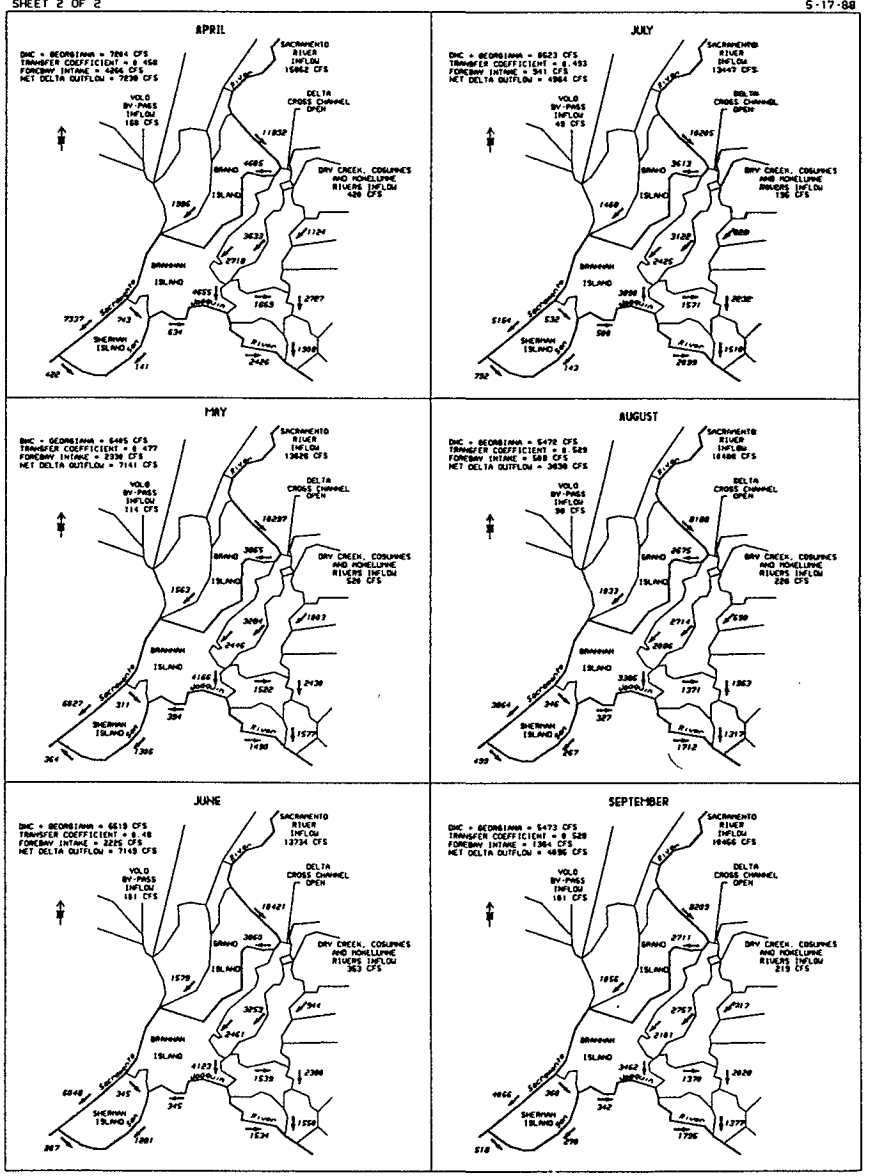
SOUTH DELTA WATER MANAGEMENT PLANNING
NORTH DELTA MONTHLY NET FLOWS IN CFS
DRY YEAR, RUN 340B - BASE CONDITION

SHEET 1 OF 2 — 5-17-88



SOUTH DELTA WATER MANAGEMENT PLANNING
NORTH DELTA MONTHLY NET FLOWS IN CFS
DRY YEAR, RUN 340B - BASE CONDITION

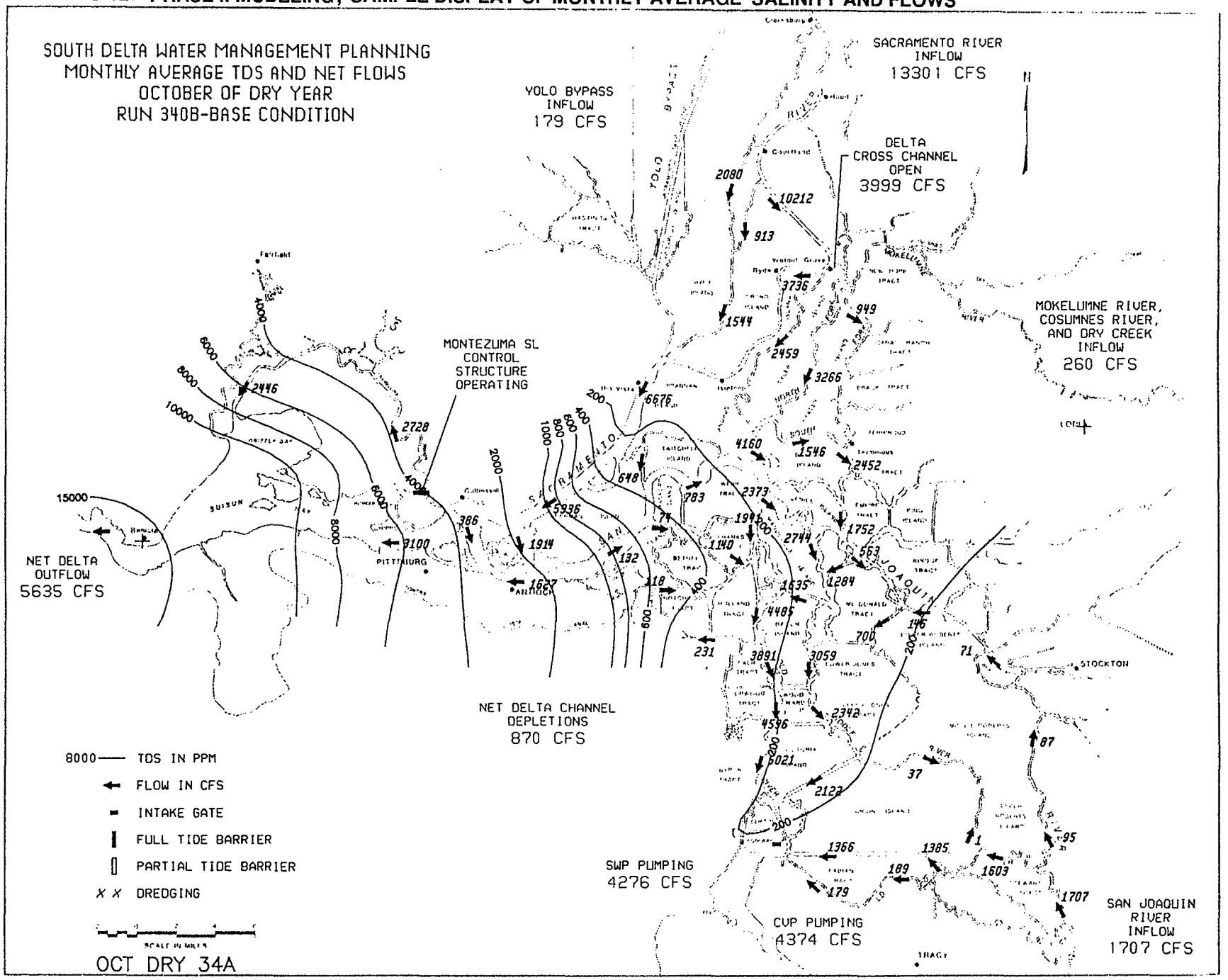
SHEET 2 OF 2 — 5-17-88



C-041554

C-041554

FIGURE C-12. PHASE II MODELING, SAMPLE DISPLAY OF MONTHLY AVERAGE SALINITY AND FLOWS



C-041555

C—041555

TABLE C-12
PHASE II MODELING
MONTHLY AVERAGE TOTAL DISSOLVED SOLIDS IN PPM
AT DECISION 1485 MUNICIPAL AND INDUSTRIAL STANDARDS LOCATIONS
CLIFTON COURT FOREBAY INTAKE

Decision 1485 salinity standards at Banks Pumping Plant are 250 mg/L maximum mean daily chlorides (approximately 630 PPM TDS). State Water Project objectives are 100 mg/L monthly average chlorides (approximately 315 PPM TDS).

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	129	127	123	150	186	238	262	228	269	344	263	192
1	125	121	121	137	168	214	243	225	273	349	298	210
2	125	120	120	137	164	194	203	183	202	238	215	177
3	123	121	117	131	148	172	176	169	182	195	175	158
4	126	118	119	136	166	202	216	188	214	267	237	187
5	241	225	223	270	291	338	285	256	289	363	384	333
6	249	227	223	270	335	376	360	336	292	314	346	350
7	232	207	212	256	281	342	331	272	209	233	308	350
8	128	130	144	172	183	224	236	237	247	272	260	228

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	194	143	131	157	152	150	176	170	151	138	155	174
1	191	161	131	187	177	174	205	184	170	168	171	172
2	186	153	129	186	178	161	172	155	146	148	152	160
3	157	138	122	173	168	147	151	145	142	142	144	150
4	191	157	128	191	179	170	183	157	144	146	154	163
5	301	276	247	307	298	295	234	218	202	191	288	324
6	326	273	247	307	324	300	329	310	297	260	303	345
7	307	242	244	266	292	275	300	252	254	186	230	343
8	206	162	162	196	192	169	192	210	203	191	217	222

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	176	142	136	149	140	134	135	166	151	133	144	160
1	191	177	156	145	149	125	145	176	174	162	159	158
2	191	177	156	145	149	125	127	148	151	142	142	153
3	154	149	138	139	145	125	127	145	146	137	134	137
4	201	188	159	144	147	124	125	147	149	138	145	154
5	297	281	259	251	248	267	186	210	204	179	282	300
6	297	281	259	251	248	267	319	321	294	280	291	300
7	272	253	236	244	244	236	286	275	227	219	248	295
8	212	201	168	170	183	147	146	219	204	167	194	208

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	169	144	126	143	172	167	132	128	126	118	120	128
1	190	173	139	131	176	156	122	128	144	153	143	128
2	190	173	139	131	176	156	122	125	132	137	130	127
3	159	154	131	128	180	145	118	121	130	135	128	120
4	199	177	139	130	172	153	119	125	130	132	130	127
5	279	251	230	261	208	246	245	172	170	175	278	270
6	279	251	230	261	208	246	245	236	233	296	290	270
7	256	225	219	251	211	232	238	170	163	243	260	255
8	201	184	162	170	186	189	150	170	176	171	183	155

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	381	329	335	259	230	226	172	208	270	221	143	145
1	331	303	230	231	211	205	160	172	221	225	168	139
2	283	268	220	230	211	205	160	158	291	231	155	139
3	234	217	172	224	221	204	161	155	202	203	147	130
4	248	276	236	232	214	211	166	152	287	225	154	136
5	416	383	350	311	250	207	157	196	253	252	298	280
6	404	363	343	311	250	207	157	263	333	315	290	280
7	423	349	320	306	252	206	159	234	308	300	243	279
8	362	285	241	242	212	212	166	204	325	275	199	185

DESCRIPTION OF ALTERNATIVES:

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria, Barr. Config. B
4 Enlarged Forebay with Highway 4 Intake, Barr. Config. B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with N. Victoria Intake, Barr. Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barr. Config. B, CVP tie-in

TABLE C-12 (cont.)
PHASE II MODELING
MONTHLY AVERAGE TOTAL DISSOLVED SOLIDS
AT DECISION 1485 MUNICIPAL AND INDUSTRIAL STANDARDS LOCATIONS
DELTA MENDOTA CANAL INTAKE

Decision 1485 salinity standards at this station 250 mg/L maximum daily chlorides (approximately 630 PPM TDS).

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	201	196	191	220	247	297	305	288	304	365	303	251
1	215	202	199	216	239	282	265	262	297	362	337	263
2	208	201	199	216	224	260	260	273	261	267	251	226
3	213	200	203	218	228	268	271	282	269	271	260	232
4	206	203	202	216	214	248	252	268	256	266	249	224
5	241	225	223	270	291	338	285	256	289	363	384	333
6	249	227	223	270	335	376	360	336	292	314	346	350
7	232	207	212	256	281	342	331	272	209	233	308	350
8	128	130	144	172	183	224	236	237	247	272	260	228

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	251	220	200	236	230	229	244	234	212	181	202	236
1	257	235	208	263	251	245	226	219	195	187	226	233
2	247	230	207	263	243	228	238	235	213	187	196	211
3	263	243	214	273	257	241	259	245	215	188	197	212
4	227	217	206	249	238	217	225	232	213	187	195	210
5	301	276	247	307	298	295	234	218	202	191	288	324
6	326	273	247	307	324	300	329	310	297	260	303	345
7	307	242	244	266	292	275	300	252	254	186	230	343
8	206	162	162	196	192	169	192	210	203	191	217	222

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	247	217	212	215	211	204	217	243	215	187	203	227
1	259	243	231	223	220	202	175	209	202	182	208	230
2	259	243	231	223	220	202	215	245	224	190	195	226
3	294	272	251	229	223	200	215	248	226	190	197	232
4	235	224	218	224	225	204	216	245	224	189	195	224
5	297	281	259	251	248	267	186	210	204	179	282	300
6	297	281	259	251	248	267	319	321	294	280	291	300
7	272	253	236	244	244	236	286	275	227	219	248	295
8	212	201	168	170	183	147	146	219	204	167	194	208

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	235	202	194	212	198	216	201	177	175	182	186	209
1	255	231	211	213	205	217	201	173	175	171	193	214
2	255	231	211	213	205	217	201	192	185	187	184	213
3	291	257	224	214	205	225	203	195	188	187	185	218
4	233	218	209	216	207	219	203	192	185	186	185	213
5	279	251	230	261	208	246	245	172	170	175	278	270
6	279	251	230	261	208	246	245	236	233	296	290	270
7	256	225	219	251	211	232	238	170	163	243	260	255
8	201	184	162	170	186	189	150	170	176	171	183	155

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	419	358	366	297	254	213	157	245	309	270	202	219
1	402	352	282	294	252	211	157	194	262	257	220	220
2	381	325	273	293	252	211	157	246	325	303	210	219
3	386	368	318	322	260	212	157	251	327	319	214	222
4	387	286	242	285	256	211	157	239	326	304	212	219
5	416	383	350	311	250	207	157	196	253	252	298	280
6	404	363	343	311	250	207	157	263	333	315	290	280
7	423	349	320	306	252	206	159	234	308	300	243	279
8	362	285	241	242	212	212	166	204	325	275	199	185

DESCRIPTION OF ALTERNATIVES:

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria, Barr. Config. B
4 Enlarged Forebay with Highway 4 Intake, Barr. Config. B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with N. Victoria Intake, Barr. Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barr. Config. B, CVP tie-in

TABLE C-12 (cont.)
PHASE II MODELING
MONTHLY AVERAGE TOTAL DISSOLVED SOLIDS
AT DECISION 1485 MUNICIPAL AND INDUSTRIAL STANDARDS LOCATIONS
OLD RIVER AT ROCK SLOUGH
(2.5 Miles East of Contra Costa Canal Intake)

Decision 1485 salinity standards for municipal and industrial uses at this station are 250 mg/L maximum mean daily chlorides (approximately 600 PPM TDS), and 150 mg/L (approximately 400 PPM TDS) at least 66% of the calendar year in wet years, 48% in below normal years, and 42% in critical years. Salinities at Rock Slough and at Contra Costa Canal Intake may be different due to local degradation.

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	123	104	108	150	260	369	371	272	444	583	397	272
1	136	115	118	139	229	333	316	254	430	600	467	307
2	133	113	117	139	211	268	254	195	282	382	308	214
3	139	115	119	139	207	261	251	194	278	380	308	215
4	133	113	117	138	209	264	252	193	281	384	310	216
5	137	116	119	140	234	341	322	256	433	598	474	313
6	134	113	118	140	214	272	263	199	294	395	322	223
7	145	116	121	143	220	279	274	201	281	388	328	231
8	133	113	118	139	211	267	256	195	284	381	312	218

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	262	161	111	166	152	195	212	154	130	138	186	250
1	283	213	146	240	190	255	257	167	142	148	191	235
2	266	195	142	239	189	219	223	146	125	127	149	175
3	268	205	145	250	194	225	226	147	126	127	149	174
4	264	195	141	239	189	221	225	146	125	127	150	176
5	289	216	149	243	192	256	260	169	142	147	192	238
6	271	195	144	242	191	216	222	146	126	127	151	178
7	299	217	152	261	206	233	243	154	129	129	151	177
8	269	195	142	239	190	217	223	145	125	127	149	175

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	249	186	152	122	126	116	111	119	122	130	156	185
1	295	273	199	136	125	112	118	137	135	137	163	191
2	295	273	199	136	125	112	112	121	123	122	145	183
3	311	288	211	138	126	113	112	122	124	122	145	184
4	293	270	198	135	125	112	112	120	122	122	146	183
5	297	276	200	136	125	113	118	137	135	137	163	192
6	297	276	200	136	125	113	112	121	123	123	146	187
7	342	313	230	143	127	113	113	123	126	124	147	195
8	293	270	197	135	125	113	112	121	122	123	145	184

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	217	135	113	112	139	132	109	105	105	109	115	132
1	285	238	153	115	144	134	109	106	109	114	120	140
2	285	238	153	115	144	134	109	107	107	109	115	139
3	309	257	159	116	144	135	110	108	108	110	116	141
4	285	237	152	114	144	134	109	107	107	109	116	139
5	286	240	154	115	144	135	109	107	109	114	120	141
6	286	240	154	115	144	135	109	107	107	110	116	141
7	333	281	172	117	140	139	110	110	110	111	117	147
8	284	237	152	115	145	135	109	108	108	110	116	140

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	535	598	586	268	186	217	222	133	131	126	119	138
1	534	534	397	244	173	178	162	140	174	176	135	143
2	381	464	377	241	173	178	162	131	170	167	126	142
3	378	477	390	251	169	174	170	134	181	175	127	143
4	379	462	374	241	174	178	163	127	169	167	126	141
5	526	539	401	247	175	178	163	140	175	177	135	144
6	384	468	382	244	174	178	163	131	173	167	127	143
7	376	514	426	267	167	173	180	140	235	217	130	147
8	371	460	373	242	176	179	163	132	169	169	127	142

DESCRIPTION OF ALTERNATIVES:

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria, Barr. Config. B
4 Enlarged Forebay with Highway 4 Intake, Barr. Config. B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with N. Victoria Intake, Barr. Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barr. Config. B, CVP tie-in

TABLE C-12 (cont.)
PHASE II MODELING
MONTHLY AVERAGE TOTAL DISSOLVED SOLIDS IN PPM
AT DECISION 1485 MUNICIPAL AND INDUSTRIAL STANDARDS LOCATIONS
SAN JOAQUIN RIVER AT ANTIOCH

Decision 1485 salinity standards at this station for municipal and industrial are the same as, and are a substitute for, those at Old River at Rock Slough. When the CVP and SWP impose deficiencies, a relaxation provision for striped bass spawning from April 1 through May 5 of all year types is:

Definiency (in MAF)	EC	Chlorides	TDS in PPM (approx.)
0	1.5	408	845
0.5	1.9	533	1,070
1.0	2.5	720	1,415
1.5	3.4	1,000	1,925
2.0	4.4	1,313	2,500

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	525	365	702	1774	2778	3700	3041	3158	4490	4320	3094	2670
1	595	552	735	1488	2513	3318	2705	3025	4446	4774	3538	2838
2	562	533	730	1485	2301	2865	2282	2460	3537	3693	2695	2177
3	563	534	730	1478	2264	2806	2246	2439	3515	3694	2702	2178
4	565	537	733	1490	2299	2855	2280	2466	3555	3727	2731	2206
5	594	554	739	1495	2522	3340	2737	3066	4467	4720	3551	2861
6	553	531	736	1496	2312	2888	2295	2491	3607	3758	2757	2248
7	559	534	730	1493	2271	2807	2210	2412	3511	3642	2634	2148
8	559	533	737	1500	2313	2887	2296	2492	3599	3751	2752	2230

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2556	698	848	513	798	1813	1680	1250	935	1375	2310	2899
1	2634	1155	1161	694	933	1828	1457	1156	938	1390	2130	2672
2	2440	1054	1147	692	855	1617	1238	907	717	1049	1631	2084
3	2398	1036	1143	685	839	1588	1211	885	701	1045	1638	2092
4	2431	1049	1144	688	851	1624	1250	910	716	1058	1652	2111
5	2652	1166	1169	699	941	1841	1464	1166	944	1382	2148	2705
6	2429	1050	1153	697	851	1601	1214	888	721	1071	1670	2143
7	2386	1032	1150	688	839	1580	1193	865	693	1029	1606	2055
8	2443	1056	1151	695	856	1611	1232	893	718	1069	1657	2130

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1933	1706	708	303	245	135	399	823	758	926	1555	2102
1	2116	1966	900	323	162	119	426	837	749	1001	1612	2094
2	2116	1966	900	323	162	119	385	695	594	799	1470	2052
3	2118	1963	897	319	162	119	377	679	580	785	1461	2047
4	2118	1973	897	319	162	119	384	693	592	798	1475	2059
5	2140	1978	904	322	163	119	426	839	752	998	1632	2116
6	2140	1978	904	322	163	119	378	695	599	797	1492	2081
7	2127	1980	905	324	163	119	374	672	575	757	1461	2071
8	2143	1986	903	322	162	119	385	695	595	800	1490	2077

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1499	870	493	282	115	110	110	107	113	255	642	1121
1	1814	1487	657	271	116	111	111	107	113	272	804	1183
2	1814	1487	657	271	116	111	111	107	111	235	761	1171
3	1796	1477	655	271	116	111	110	107	111	234	763	1170
4	1811	1475	655	272	116	111	111	107	111	237	765	1174
5	1813	1486	661	275	116	111	111	107	113	273	811	1188
6	1813	1486	661	275	116	111	111	107	111	239	779	1182
7	1806	1481	656	273	116	111	111	107	111	233	768	1178
8	1812	1486	661	275	116	111	111	107	111	237	777	1177

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	5255	5740	4404	449	141	138	124	119	120	183	664	1385
1	5251	4373	3121	428	141	130	117	117	124	185	701	1437
2	4588	4149	3061	423	141	130	117	116	120	169	683	1433
3	4590	4139	3050	427	141	130	117	116	120	169	684	1430
4	4623	4160	3060	424	141	130	117	112	120	169	685	1435
5	5285	4355	3122	427	141	130	117	117	123	185	707	1453
6	4643	4143	3066	423	141	130	117	116	120	172	694	1445
7	4576	4126	3059	429	142	130	117	116	120	171	691	1440
8	4616	4128	3060	422	141	130	117	116	119	171	693	1446

DESCRIPTION OF ALTERNATIVES:

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria, Barr. Config. B
4 Enlarged Forebay with Highway 4 Intake, Barr. Config. B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with N. Victoria Intake, Barr. Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barr. Config. B, CVP tie-in

TABLE C-13
PHASE II MODELING
MONTHLY AVERAGE TOTAL DISSOLVED SOLIDS IN PPM
AT DECISION 1485 AGRICULTURAL STANDARDS LOCATIONS
SAN JOAQUIN RIVER AT JERSY POINT

Decision 1485 salinity standards for agriculture at this station are a maximum 14-day running average mean daily EC (millimhos) of: Wet years = 0.45 (approximately 75 mg/L chlorides or 250 PPM TDS) 4/1 - 8/15; Below normal years = 0.45 (approximately 75 mg/L chlorides or 250 PPM TDS) 4/1 - 6/20 and 0.74 (approximately 165 mg/L chlorides or 400 PPM TDS) 6/20 -8/15; Critical years = 2.20 (approximately 600 mg/L chlorides or 1,170 PPM TDS) 4/1 - 8/15.

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	168	116	158	356	729	1045	842	709	1150	1150	867	629
1	226	169	179	286	629	896	654	649	1150	1150	1015	698
2	211	162	177	285	540	695	503	455	872	981	659	463
3	214	163	176	282	523	675	491	454	864	988	662	461
4	213	162	178	285	539	691	504	455	875	996	674	469
5	227	171	180	290	629	893	671	644	1150	1150	1009	707
6	211	162	179	290	534	693	515	469	893	1006	682	483
7	214	163	177	289	514	651	490	446	849	956	652	456
8	211	163	179	288	527	679	507	466	884	1007	681	475

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	613	234	173	269	226	511	441	246	192	273	470	658
1	644	446	265	434	270	674	498	254	203	287	451	593
2	578	394	258	432	250	547	401	200	159	201	305	405
3	572	390	258	428	246	540	394	195	155	200	306	406
4	577	390	257	430	249	556	407	199	158	202	311	413
5	659	456	272	437	273	683	503	258	204	281	453	599
6	572	396	263	435	250	538	392	196	159	204	312	419
7	567	391	262	429	248	526	386	193	156	196	298	399
8	576	395	260	431	248	546	394	197	159	203	310	415

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	539	452	234	150	150	119	123	159	169	237	329	441
1	711	662	357	171	126	111	129	162	166	237	345	443
2	711	662	357	171	126	111	124	143	140	182	296	426
3	717	652	358	172	126	111	123	141	138	180	293	427
4	714	656	355	170	125	111	123	142	139	183	298	430
5	725	657	357	172	125	111	129	162	166	234	339	445
6	725	657	357	172	125	111	123	143	140	180	296	436
7	731	669	366	172	126	111	122	140	137	172	291	432
8	710	660	357	169	125	111	123	142	140	179	298	431

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	424	216	145	119	113	109	106	105	104	116	163	266
1	674	525	221	119	115	109	106	105	104	113	170	287
2	674	525	221	119	115	109	106	105	104	110	162	282
3	671	527	219	120	115	109	106	105	104	110	161	287
4	665	520	218	119	115	109	106	105	104	110	163	236
5	682	528	220	120	115	109	106	105	104	113	170	295
6	682	528	220	120	115	109	106	105	104	110	164	293
7	678	535	221	120	115	109	106	105	104	110	163	292
8	675	526	219	120	115	109	106	105	104	110	164	292

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1393	1561	1440	248	138	140	125	111	107	110	154	280
1	1394	1221	969	243	139	130	117	109	114	120	158	297
2	1075	1104	935	241	139	130	117	109	111	116	154	293
3	1067	1097	936	242	139	130	117	109	111	116	154	296
4	1086	1101	933	240	139	130	117	105	111	115	154	289
5	1405	1221	968	243	139	130	117	109	114	119	158	300
6	1088	1112	936	240	139	130	117	109	111	116	154	297
7	1065	1112	947	243	139	130	117	109	111	117	155	298
8	1087	1101	931	240	138	130	117	109	110	116	155	295

DESCRIPTION OF ALTERNATIVES:

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria, Barr. Config. B
4 Enlarged Forebay with Highway 4 Intake, Barr. Config. B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with N. Victoria Intake, Barr. Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barr. Config. B, CVP tie-in

TABLE C-13 (cont.)
PHASE II MODELING
MONTHLY AVERAGE TOTAL DISSOLVED SOLIDS IN PPM
AT DECISION 1485 AGRICULTURAL STANDARDS LOCATIONS
SAN JOAQUIN RIVER AT SAN ANDREAS LANDING

Decision 1485 salinity standards for agriculture at this station (from April 1 through August 15) are a maximum 14-day running average of mean daily electrical conductivity (in millimhos) of: wet years and below normal years, 0.45 (approximately 70 mg/L chlorides or 250 PPM TDS); critical years, 0.87 (approximately 150 mg/L chlorides or 475 PPM TDS).

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	105	100	102	131	191	263	228	197	325	368	245	188
1	111	105	105	123	172	233	194	180	312	386	276	202
2	109	104	105	123	159	193	164	151	225	258	197	156
3	109	104	104	122	155	187	161	150	219	256	196	155
4	109	104	105	122	159	192	164	151	222	258	199	157
5	111	105	105	123	173	235	195	181	314	385	279	206
6	109	104	105	123	159	192	165	152	228	264	200	159
7	109	104	105	122	156	186	160	149	219	252	193	153
8	109	104	105	123	159	193	165	151	224	262	199	157

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	179	117	104	142	129	151	149	121	111	118	148	184
1	186	144	121	187	146	181	168	123	112	120	145	173
2	176	136	119	186	144	160	148	116	107	111	124	141
3	172	135	118	186	144	158	147	115	107	110	124	141
4	175	136	118	186	144	161	150	116	107	111	125	142
5	188	146	121	188	147	184	170	123	112	120	146	175
6	174	136	119	187	144	158	146	115	107	111	124	141
7	174	135	119	186	144	156	146	115	107	110	122	138
8	177	137	119	186	144	159	148	115	107	111	124	141

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	164	142	118	113	113	107	104	107	107	113	127	144
1	188	183	137	119	110	105	104	108	107	113	129	144
2	188	183	137	119	110	105	104	106	105	108	121	140
3	187	181	136	118	110	105	104	106	105	108	121	140
4	187	182	136	118	109	105	104	106	105	108	121	141
5	190	184	138	119	110	105	104	108	107	113	129	144
6	190	184	138	119	110	105	104	106	105	108	121	143
7	190	183	138	119	110	105	104	106	105	107	120	141
8	189	183	137	118	109	105	104	106	105	107	121	142

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	146	111	103	106	110	104	101	100	100	102	106	114
1	186	163	116	106	111	104	101	100	100	102	107	117
2	186	163	116	106	111	104	101	100	100	102	106	116
3	186	162	116	106	111	104	101	100	100	102	106	116
4	186	162	116	106	111	104	101	100	100	102	106	116
5	187	164	116	106	111	104	101	100	100	102	107	117
6	187	164	116	106	111	104	101	100	100	102	106	117
7	188	164	117	106	111	104	101	100	100	102	106	117
8	186	162	116	106	111	104	101	100	100	102	106	117

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	402	428	359	168	130	141	122	106	104	105	106	119
1	396	317	245	166	128	129	117	106	116	115	109	120
2	302	283	236	165	128	129	117	105	109	110	108	120
3	302	282	235	165	128	129	116	105	109	109	108	120
4	306	281	235	165	128	129	117	102	109	109	108	120
5	399	318	245	166	128	129	117	106	116	114	109	120
6	304	284	236	165	128	129	117	105	109	109	108	120
7	301	282	235	165	128	128	116	105	109	109	108	120
8	306	282	235	165	128	129	117	105	109	109	108	120

DESCRIPTION OF ALTERNATIVES:

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria, Barr. Config. B
4 Enlarged Forebay with Highway 4 Intake, Barr. Config. B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with N. Victoria Intake, Barr. Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barr. Config. B, CVP tie-in

TABLE C-13 (cont.)
PHASE II MODELING
MONTHLY AVERAGE TOTAL DISSOLVED SOLIDS IN PPM
AT DECISION 1485 AGRICULTURAL STANDARDS LOCATIONS
SACRAMENTO RIVER AT EMMATON

Decision 1485 salinity standards for agriculture at this station are a maximum 14-day running average of mean daily electrical conductivity (in millimhos) of: Wet years = 0.45 (approximately 90 mg/L chlorides or 250 PPM TDS) 4/1 - 8/15; Below normal years = 0.45 (approximately 90 mg/L chlorides or 250 PPM TDS) 4/1 - 6/20 and 1.14 (approximately 300 mg/L chlorides or 635 PPM TDS) 6/20 - 8/15; Critical years = 2.78 (approximately 785 mg/L chlorides or 1,560 PPM TDS) 4/1 - 8/15.

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
NA	130	116	148	372	579	889	649	849	1350	1125	810	726
1	135	131	156	322	511	822	617	767	1358	1461	969	773
2	132	128	156	321	472	705	522	619	1081	1111	728	587
3	130	128	152	311	462	689	515	612	1076	1111	729	586
4	132	128	154	321	472	706	523	621	1086	1118	736	593
5	134	131	155	322	519	828	613	767	1370	1448	974	782
6	130	128	154	322	478	712	522	616	1085	1121	727	595
7	130	128	152	318	469	658	504	626	1057	1070	709	573
8	129	129	155	320	475	690	527	606	1084	1114	732	593
REPRESENTATIVE DRY YEAR												
ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	532	147	192	144	187	327	310	278	225	304	611	789
1	549	194	254	168	228	299	273	253	217	302	521	720
2	517	181	250	168	218	264	236	215	186	245	421	566
3	516	179	249	167	214	262	231	212	187	246	422	568
4	517	181	250	167	218	266	238	216	187	245	425	572
5	557	196	256	169	229	300	275	256	218	305	516	715
6	517	181	252	169	218	258	230	214	188	252	408	565
7	513	178	249	167	217	260	230	209	184	240	411	577
8	525	182	248	168	217	260	236	215	186	250	408	571
REPRESENTATIVE BELOW NORMAL YEAR												
ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	340	301	152	115	111	105	130	192	177	185	382	541
1	351	341	175	120	107	104	128	197	179	202	374	519
2	351	341	175	120	107	104	124	182	160	175	339	506
3	349	330	175	119	107	104	125	178	159	175	340	507
4	354	339	175	120	107	104	125	180	160	177	341	510
5	358	344	176	120	107	104	128	198	180	205	367	520
6	358	344	176	120	107	104	124	180	161	178	337	502
7	352	333	175	120	107	104	125	179	159	173	328	492
8	357	339	174	120	107	104	125	181	161	177	343	508
REPRESENTATIVE ABOVE NORMAL YEAR												
ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	281	172	128	117	109	104	103	103	102	111	158	227
1	309	257	152	116	109	104	103	103	102	115	197	228
2	309	257	152	116	109	104	103	103	102	112	190	226
3	309	258	151	116	109	104	103	103	102	112	189	223
4	306	254	151	116	109	104	103	103	102	112	191	227
5	307	258	153	117	109	104	103	103	102	114	198	229
6	307	258	153	117	109	104	103	103	102	112	194	229
7	310	260	152	116	109	104	103	103	102	112	190	228
8	307	257	153	116	109	104	103	103	102	112	194	227
REPRESENTATIVE WET YEAR												
ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2297	2038	921	140	117	112	104	106	105	111	173	312
1	2218	1000	603	138	117	113	103	105	109	117	189	328
2	1858	923	586	138	117	113	103	105	107	114	185	323
3	1837	915	577	138	117	113	103	105	107	114	186	323
4	1871	923	587	138	117	113	103	101	107	113	184	321
5	2227	998	602	138	117	113	103	105	108	116	190	326
6	1876	923	586	138	117	113	103	105	107	114	185	324
7	1830	901	587	138	117	113	103	105	107	114	184	322
8	1869	921	587	138	117	113	103	105	107	114	185	328

DESCRIPTION OF ALTERNATIVES:

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria, Barr. Config. B
4 Enlarged Forebay with Highway 4 Intake, Barr. Config. B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with N. Victoria Intake, Barr. Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barr. Config. B, CVP tie-in

TABLE C-14
PHASE II MODELING
MONTHLY AVERAGE TOTAL DISSOLVED SOLIDS IN PPM
AT DECISION 1485 FISH AND WILDLIFE STANDARDS LOCATIONS
SACRAMENTO RIVER AT COLLINSVILLE

Decision 1485 salinity standards for this station and other stations west of Collinsville for Suisun Marsh at high tide and in all year types are:

	Oct	Nov/Dec	Jan	Feb/Mar	Apr/May
EC (millimhos) (monthly average of both daily high tides):	19.0	15.5	12.5	8.0	11.0
Chlorides (mg/L)	6,300	5,100	4,100	2,550	3,600
Total Dissolved Solids (PPM) (approximately)	11,150	9,100	7,350	4,700	6,450

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	663	562	1032	2486	3468	4599	3697	4273	5430	5080	3940	3589
1	662	754	1045	2150	3193	4166	3521	4139	5431	5708	4402	3772
2	635	734	1039	2146	3009	3764	3107	3535	4636	4776	3606	3106
3	631	733	1035	2116	2965	3708	3063	3490	4614	4779	3613	3088
4	638	741	1040	2136	3008	3760	3105	3541	4647	4806	3642	3120
5	664	757	1052	2163	3222	4234	3540	4172	5448	5658	4396	3795
6	630	733	1049	2164	3035	3829	3146	3593	4665	4780	3672	3196
7	632	740	1039	2155	2988	3755	3084	3475	4567	4670	3562	3071
8	632	740	1056	2166	3049	3829	3159	3596	4659	4768	3653	3185

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	3333	725	1280	475	1106	2237	2134	1868	1393	1985	3255	3883
1	3406	1165	1662	635	1320	2063	1710	1684	1351	1969	2933	3633
2	3224	1089	1649	634	1234	1884	1502	1410	1109	1603	2400	3041
3	3188	1073	1629	628	1213	1858	1474	1384	1099	1591	2405	3032
4	3233	1082	1644	628	1236	1884	1508	1412	1116	1609	2421	3053
5	3436	1177	1681	639	1340	2083	1733	1699	1366	1958	2934	3669
6	3228	1090	1666	637	1244	1874	1485	1397	1136	1637	2448	3109
7	3197	1071	1656	632	1231	1854	1476	1369	1091	1591	2384	2984
8	3248	1091	1675	634	1246	1885	1509	1415	1126	1619	2442	3106

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2309	2148	811	361	269	127	639	1323	1099	1230	2212	2905
1	2445	2306	944	363	165	120	646	1337	1113	1370	2271	2900
2	2445	2306	944	363	165	120	596	1164	936	1155	2118	2856
3	2433	2316	949	359	165	119	593	1155	913	1139	2105	2859
4	2436	2301	938	361	165	120	596	1169	929	1157	2116	2872
5	2451	2348	950	366	166	120	662	1349	1118	1373	2282	2918
6	2451	2348	950	366	166	120	594	1180	945	1156	2137	2879
7	2447	2332	947	370	167	120	595	1163	912	1122	2109	2861
8	2453	2344	946	366	166	120	610	1195	946	1170	2136	2904

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1896	1176	688	422	111	105	113	106	127	356	931	1514
1	2061	1722	820	402	111	105	113	106	126	415	1230	1548
2	2061	1722	820	402	111	105	113	106	122	364	1176	1536
3	2054	1714	811	397	111	105	113	106	121	362	1164	1530
4	2055	1709	811	402	111	105	113	106	122	365	1180	1535
5	2062	1712	830	406	111	105	115	106	126	412	1253	1563
6	2062	1712	830	406	111	105	115	106	122	372	1219	1558
7	2066	1726	820	406	111	105	115	106	121	364	1197	1543
8	2056	1719	831	405	111	105	115	106	122	368	1219	1559

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	7431	7483	4975	238	122	116	107	126	144	279	1032	1967
1	7341	5294	3656	221	121	115	106	125	147	283	1103	2051
2	6635	5079	3602	220	121	115	106	123	141	258	1075	2036
3	6615	5044	3579	220	121	115	106	123	141	259	1069	2016
4	6648	5083	3600	220	121	115	106	119	141	258	1071	2015
5	7365	5309	3659	222	121	115	106	125	147	285	1119	2053
6	6692	5103	3607	221	121	115	106	124	141	266	1093	2045
7	6611	5061	3609	221	121	115	106	123	141	263	1093	2024
8	6672	5092	3624	221	121	115	106	124	141	264	1093	2053

DESCRIPTION OF ALTERNATIVES:

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria, Barr. Config. B
4 Enlarged Forebay with Highway 4 Intake, Barr. Config. B
5 Northern Intake, Barrier Configuration A, CVP tie-in
6 Northern Intake, Barrier Configuration B, CVP tie-in
7 Enlarged Forebay with N. Victoria Intake, Barr. Config. B, CVP tie-in
8 Enlarged Forebay with Highway 4 Intake, Barr. Config. B, CVP tie-in

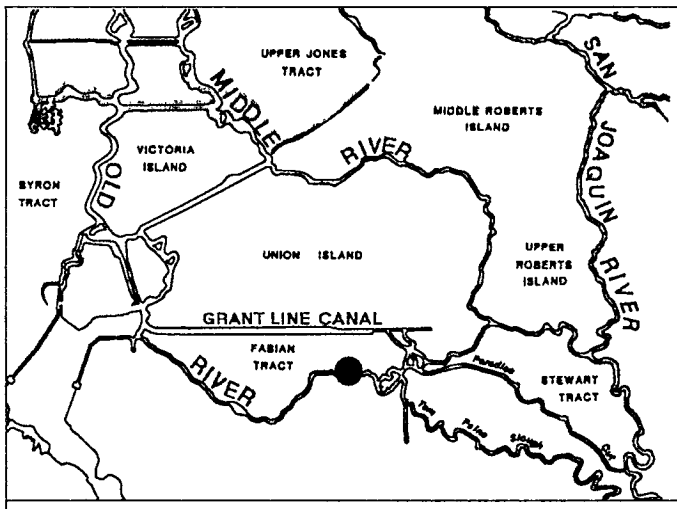


TABLE C-15
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

OLD RIVER AT TRACY ROAD

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET) | IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.34	0.06	0.29	0.24	0.54	0.55	0.35	0.23	0.31	0.37	0.49	0.53	0.52	-0.02	0.05	0.03	0.80	0.76	0.51	0.44	0.48	0.58	0.81	0.84
2	0.89	0.06	0.29	0.24	0.85	0.91	1.01	0.80	0.78	0.86	0.82	0.88	1.54	-0.02	0.05	0.03	1.53	1.60	1.69	1.52	1.41	1.53	1.55	1.64
3	1.06	0.28	0.42	0.31	0.96	0.98	1.06	0.87	0.83	0.82	0.83	0.91	1.76	0.02	0.08	0.05	1.55	1.61	1.69	1.54	1.44	1.51	1.55	1.65
4	0.86	0.10	0.29	0.23	0.83	0.88	0.99	0.79	0.76	0.79	0.79	0.86	1.61	-0.02	0.04	0.02	1.47	1.55	1.65	1.50	1.39	1.47	1.51	1.61
5	0.40	0.11	0.34	0.29	0.55	0.56	0.36	0.23	0.31	0.38	0.49	0.52	0.56	0.09	0.29	0.28	0.84	0.87	0.58	0.50	0.54	0.65	0.89	0.94
6	0.98	0.11	0.34	0.29	0.89	0.93	1.02	0.79	0.75	0.78	0.77	0.86	1.59	0.09	0.29	0.28	1.48	1.60	1.72	1.55	1.47	1.56	1.56	1.67
7	1.27	0.50	0.63	0.52	1.08	1.08	1.15	0.92	0.88	0.92	0.91	0.99	1.90	0.31	0.38	0.36	1.72	1.79	1.87	1.66	1.54	1.63	1.68	1.81
8	0.99	0.23	0.42	0.35	0.87	0.91	1.00	0.78	0.75	0.79	0.77	0.84	1.67	0.23	0.32	0.30	1.55	1.68	1.80	1.58	1.45	1.54	1.60	1.74

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.55	-0.03	0.21	0.03	0.67	0.37	0.13	0.25	0.26	0.30	0.43	0.51	0.82	-0.06	0.02	-0.04	0.82	0.55	0.42	0.49	0.52	0.57	0.78	0.84
2	0.92	-0.03	0.21	0.03	1.04	0.78	0.79	0.73	0.72	0.77	0.75	0.85	1.68	-0.06	0.02	-0.04	1.59	1.32	1.50	1.46	1.46	1.48	1.50	1.61
3	1.01	0.22	0.30	0.29	1.15	0.97	0.91	0.80	0.78	0.76	0.75	0.86	1.68	-0.01	0.04	0.01	1.67	1.55	1.58	1.49	1.49	1.48	1.50	1.61
4	0.90	0.02	0.20	0.08	1.01	0.74	0.76	0.72	0.71	0.73	0.71	0.82	1.63	-0.06	0.01	-0.04	1.60	1.38	1.51	1.44	1.44	1.44	1.47	1.57
5	0.56	0.03	0.26	0.09	0.68	0.42	0.17	0.25	0.27	0.30	0.42	0.50	0.89	0.03	0.26	0.05	0.81	0.56	0.40	0.54	0.58	0.65	0.86	0.92
6	0.96	0.03	0.26	0.09	1.09	0.84	0.84	0.72	0.70	0.71	0.69	0.81	1.64	0.03	0.26	0.05	1.58	1.36	1.49	1.47	1.47	1.50	1.53	1.63
7	1.12	0.45	0.51	0.51	1.29	1.18	1.07	0.85	0.84	0.86	0.83	0.94	1.86	0.28	0.35	0.30	1.82	1.69	1.74	1.59	1.59	1.62	1.63	1.76
8	0.94	0.15	0.32	0.21	1.08	0.87	0.84	0.71	0.69	0.71	0.69	0.80	1.71	0.19	0.29	0.20	1.66	1.45	1.58	1.51	1.50	1.53	1.54	1.68

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.10	0.17	0.09	0.28	0.45	0.01	0.13	0.25	0.32	0.37	0.10	0.15	-0.01	0.02	-0.02	0.04	0.09	-0.03	0.38	0.45	0.50	0.54	0.00	0.00
2	0.10	0.17	0.09	0.28	0.45	0.01	0.87	0.86	0.81	0.86	0.10	0.15	-0.01	0.02	-0.02	0.04	0.09	-0.03	1.59	1.58	1.48	1.46	0.00	0.00
3	0.30	0.35	0.31	0.38	0.53	0.10	0.97	0.92	0.88	0.93	0.09	0.18	0.03	0.05	0.02	0.07	0.11	-0.02	1.66	1.60	1.51	1.49	0.01	0.02
4	0.13	0.19	0.13	0.28	0.44	0.00	0.83	0.84	0.80	0.85	0.07	0.13	-0.02	0.01	-0.02	0.04	0.08	-0.05	1.59	1.55	1.46	1.43	0.00	0.00
5	0.15	0.21	0.14	0.33	0.50	0.06	0.16	0.26	0.32	0.39	0.19	0.23	0.12	0.18	0.10	0.29	0.34	0.21	0.38	0.50	0.56	0.62	0.25	0.27
6	0.15	0.21	0.14	0.33	0.50	0.06	0.92	0.85	0.79	0.86	0.19	0.23	0.12	0.18	0.10	0.29	0.34	0.21	1.58	1.60	1.50	1.46	0.25	0.27
7	0.53	0.56	0.53	0.59	0.74	0.33	1.13	0.97	0.93	1.04	0.33	0.41	0.33	0.35	0.31	0.38	0.42	0.30	1.82	1.71	1.62	1.67	0.32	0.35
8	0.26	0.32	0.25	0.40	0.56	0.13	0.91	0.83	0.79	0.85	0.21	0.26	0.24	0.27	0.23	0.32	0.37	0.24	1.66	1.64	1.53	1.56	0.28	0.30

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.02	0.02	0.29	0.19	0.29	0.12	0.19	0.34	0.34	0.50	0.25	0.23	-0.04	-0.03	0.04	0.01	0.04	-0.01	0.02	0.53	0.52	0.58	0.04	0.03
2	-0.02	0.02	0.29	0.19	0.29	0.12	0.19	0.73	0.74	1.01	0.25	0.23	-0.04	-0.03	0.04	0.01	0.04	-0.01	0.02	1.39	1.38	1.54	0.04	0.03
3	0.24	0.26	0.42	0.26	0.38	0.17	0.28	0.80	0.81	1.07	0.25	0.35	0.01	0.02	0.07	0.03	0.07	0.00	0.03	1.42	1.42	1.56	0.05	0.05
4	0.03	0.07	0.29	0.18	0.29	0.10	0.18	0.73	0.73	0.99	0.22	0.22	-0.04	-0.03	0.04	0.01	0.05	-0.01	0.01	1.37	1.37	1.51	0.03	[illegible]
5	0.05	0.08	0.33	0.24	0.35	0.19	0.25	0.36	0.35	0.51	0.35	0.27	0.05	0.07	0.28	0.26	0.31	0.25	0.27	0.59	0.59	0.66	0.30	0.28
6	0.05	0.08	0.33	0.24	0.35	0.19	0.25	0.72	0.72	1.00	0.35	0.27	0.05	0.07	0.28	0.26	0.31	0.25	0.27	1.40	1.39	1.55	0.30	0.28
7	0.48	0.48	0.62	0.47	0.57	0.37	0.51	0.86	0.87	1.16	0.50	0.59	0.30	0.31	0.37	0.34	0.40	0.32	0.36	1.53	1.52	1.73	0.37	0.38
8	0.17	0.19	0.41	0.30	0.41	0.23	0.32	0.72	0.72	0.99	0.37	0.37	0.21	0.22	0.31	0.29	0.35	0.28	0.30	1.43	1.43	1.63	0.33	0.31

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	-0.07	0.21	0.03	0.02	-0.22	-0.08	0.05	0.24	0.22	0.17	0.18	-0.06	-0.04	0.02	-0.04	-0.03	-0.21	-0.09	0.23	0.31	0.31	0.03	0.01
2	0.00	-0.07	0.21	0.03	0.02	-0.22	-0.08	0.96	1.01	1.03	0.17	0.18	-0.06	-0.04	0.02	-0.04	-0.03	-0.21	-0.09	1.91	1.79	1.80	0.03	0.01
3	0.03	0.01	0.29	0.26	0.26	0.01	0.08	1.02	1.01	1.07	0.17	0.23	-0.01	-0.01	0.05	0.01	0.02	-0.07	-0.03	1.90	1.80	1.82	0.03	0.02
4	0.00	-0.07	0.20	0.08	0.07	-0.17	-0.04	0.95	0.97	1.02	0.14	0.16	-0.03	-0.04	0.01	-0.03	-0.02	-0.12	-0.06	1.87	1.76	1.78	0.02	0.00
5	0.02	-0.02	0.25	0.08	0.08	-0.19	-0.02	0.06	0.23	0.21	0.26	0.25	0.00	0.17	0.25	0.05	0.05	-0.12	0.06	0.30	0.31	0.34	0.28	0.27
6	0.02	-0.02	0.25	0.08	0.08	-0.19	-0.02	0.98	0.95	1.00	0.26	0.25	0.00	0.17	0.25	0.05	0.05	-0.12	0.06	1.92	1.75	1.87	0.28	0.27
7	0.08	0.18	0.50	0.48	0.49	0.14	0.22	1.06	1.00	1.08	0.40	0.46	0.07	0.25	0.34	0.30	0.32	0.13	0.23	2.02	1.78	1.89	0.35	0.35
8	0.03	0.03	0.32	0.20	0.20	-0.09	0.05	0.94	0.95	0.98	0.28	0.30	0.04	0.19	0.28	0.21	0.23	0.04	0.18	1.94	1.74	1.84	0.30	0.30

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

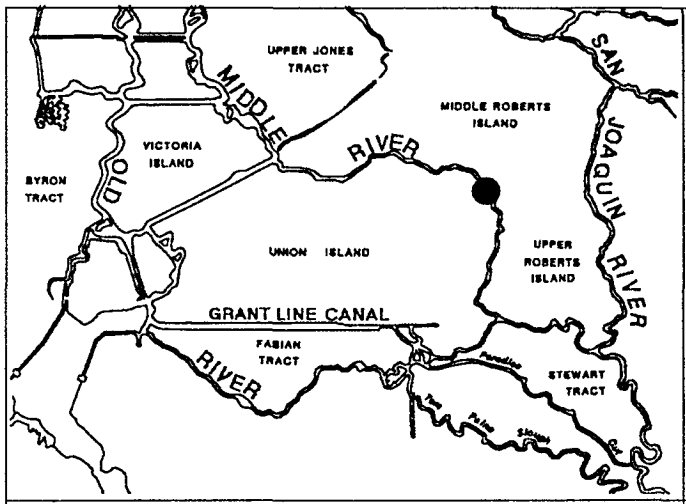


TABLE C-15 (cont.)
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

MIDDLE RIVER AT HOWARD ROAD

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
1	1.58	-0.08	0.08	0.08	1.46	1.32	1.36	1.14	1.11	1.27	1.38	1.44
2	1.68	-0.08	0.08	0.08	1.52	1.40	1.57	1.32	1.26	1.39	1.44	1.51
3	1.43	-0.06	0.09	0.09	1.23	1.26	1.36	1.23	1.21	1.37	1.35	1.36
4	1.50	-0.06	0.08	0.07	1.37	1.31	1.45	1.25	1.20	1.32	1.35	1.40
5	1.74	-0.07	0.09	0.10	1.62	1.47	1.54	1.16	1.11	1.21	1.47	1.59
6	1.83	-0.07	0.09	0.10	1.67	1.55	1.71	1.34	1.26	1.34	1.52	1.65
7	1.62	-0.06	0.11	0.13	1.39	1.30	1.47	1.17	1.09	1.16	1.26	1.40
8	1.68	-0.01	0.12	0.12	1.52	1.40	1.57	1.24	1.17	1.25	1.38	1.51
REPRESENTATIVE DRY YEAR												
1	1.51	-0.15	0.07	-0.12	1.63	1.51	1.29	1.18	1.19	1.22	1.33	1.39
2	1.59	-0.15	0.07	-0.12	1.70	1.57	1.47	1.32	1.31	1.35	1.39	1.46
3	1.33	-0.14	0.08	-0.10	1.41	1.27	1.18	1.20	1.19	1.29	1.32	1.37
4	1.44	-0.13	0.06	-0.09	1.54	1.39	1.30	1.25	1.24	1.26	1.30	1.37
5	1.67	-0.14	0.07	-0.10	1.79	1.67	1.48	1.28	1.28	1.19	1.35	1.52
6	1.74	-0.14	0.07	-0.10	1.85	1.73	1.63	1.40	1.39	1.32	1.41	1.57
7	1.49	-0.14	0.10	-0.11	1.59	1.47	1.38	1.17	1.16	1.13	1.18	1.32
8	1.59	-0.07	0.10	-0.04	1.70	1.57	1.48	1.26	1.25	1.22	1.27	1.43
REPRESENTATIVE BELOW NORMAL YEAR												
1	-0.06	-0.01	-0.07	0.10	0.20	-0.06	1.34	1.21	1.19	1.18	0.04	0.05
2	-0.06	-0.01	-0.07	0.10	0.20	-0.06	1.55	1.41	1.33	1.33	0.04	0.05
3	-0.04	0.01	-0.05	0.11	0.21	-0.05	1.28	1.28	1.24	1.22	0.03	0.06
4	-0.05	0.00	-0.05	0.09	0.19	-0.07	1.39	1.32	1.26	1.24	0.02	0.03
5	-0.05	0.00	-0.06	0.11	0.21	-0.04	1.53	1.31	1.22	1.26	0.08	0.08
6	-0.05	0.00	-0.06	0.11	0.21	-0.04	1.71	1.49	1.36	1.39	0.08	0.08
7	-0.04	0.02	-0.05	0.13	0.24	-0.01	1.47	1.26	1.18	1.18	0.11	0.10
8	0.01	0.04	0.00	0.13	0.23	-0.02	1.56	1.35	1.26	1.27	0.09	0.09
REPRESENTATIVE ABOVE NORMAL YEAR												
1	-0.14	-0.10	0.08	0.06	0.13	0.04	0.06	1.22	1.18	1.28	0.11	0.05
2	-0.14	-0.10	0.08	0.06	0.13	0.04	0.06	1.32	1.29	1.44	0.11	0.05
3	-0.13	-0.09	0.09	0.07	0.14	0.04	0.06	1.18	1.16	1.34	0.10	0.06
4	-0.11	-0.08	0.08	0.04	0.12	0.02	0.05	1.24	1.21	1.36	0.09	0.04
5	-0.12	-0.09	0.09	0.07	0.14	0.06	0.06	1.32	1.21	1.37	0.15	0.06
6	-0.12	-0.09	0.09	0.07	0.14	0.06	0.06	1.40	1.31	1.50	0.15	0.06
7	-0.13	-0.09	0.12	0.10	0.16	0.08	0.09	1.16	1.12	1.28	0.17	0.08
8	-0.06	-0.03	0.12	0.09	0.16	0.07	0.09	1.25	1.21	1.37	0.15	0.09
REPRESENTATIVE WET YEAR												
1	-0.02	-0.07	0.05	-0.11	-0.11	-0.27	-0.13	1.16	1.28	1.21	0.07	0.06
2	-0.02	-0.07	0.05	-0.11	-0.11	-0.27	-0.13	1.52	1.53	1.51	0.07	0.06
3	0.00	-0.06	0.06	-0.09	-0.09	-0.24	-0.11	1.34	1.50	1.45	0.06	0.07
4	-0.02	-0.08	0.04	-0.09	-0.08	-0.24	-0.11	1.44	1.48	1.46	0.05	0.04
5	0.00	-0.06	0.06	-0.10	-0.10	-0.26	-0.12	1.26	1.25	1.17	0.11	0.08
6	0.00	-0.06	0.06	-0.10	-0.10	-0.26	-0.12	1.59	1.48	1.46	0.11	0.08
7	0.01	-0.03	0.08	-0.10	-0.09	-0.25	-0.11	1.43	1.42	1.34	0.13	0.11
8	-0.01	-0.04	0.08	-0.04	-0.04	-0.21	-0.08	1.48	1.45	1.40	0.12	0.09

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
1	2.72	-0.02	0.05	0.03	2.61	2.36	2.56	2.20	2.16	2.42	2.64	2.73
2	2.83	-0.02	0.05	0.03	2.68	2.48	2.79	2.40	2.32	2.56	2.71	2.82
3	2.69	0.02	0.08	0.04	2.51	2.56	2.70	2.48	2.39	2.53	2.74	2.75
4	2.71	-0.01	0.05	0.03	2.57	2.48	2.72	2.41	2.36	2.52	2.71	2.75
5	2.84	0.10	0.20	0.19	2.73	2.45	2.68	2.07	2.04	2.18	2.64	2.82
6	2.94	0.10	0.20	0.19	2.79	2.55	2.88	2.29	2.22	2.33	2.71	2.90
7	2.86	0.20	0.27	0.24	2.63	2.45	2.76	2.38	2.28	2.41	2.57	2.76
8	2.84	0.14	0.23	0.21	2.68	2.45	2.77	2.31	2.23	2.35	2.61	2.80
REPRESENTATIVE DRY YEAR												
1	2.72	-0.06	0.02	-0.02	2.81	2.59	2.40	2.29	2.29	2.45	2.62	2.69
2	2.81	-0.06	0.02	-0.02	2.89	2.66	2.59	2.45	2.43	2.58	2.69	2.77
3	2.67	-0.01	0.04	0.03	2.71	2.47	2.44	2.55	2.53	2.57	2.67	2.78
4	2.71	-0.05	0.02	-0.02	2.77	2.53	2.47	2.49	2.48	2.55	2.66	2.75
5	2.83	0.06	0.17	0.08	2.93	2.72	2.55	2.35	2.33	2.15	2.46	2.74
6	2.91	0.06	0.17	0.08	3.00	2.78	2.71	2.49	2.45	2.30	2.53	2.81
7	2.78	0.16	0.23	0.18	2.85	2.65	2.58	2.42	2.41	2.39	2.48	2.68
8	2.81	0.10	0.20	0.12	2.89	2.67	2.60	2.39	2.36	2.33	2.43	2.71
REPRESENTATIVE BELOW NORMAL YEAR												
1	0.00	0.02	-0.01	0.05	0.11	-0.04	2.50	2.32	2.27	2.19	0.00	0.00
2	0.00	0.02	-0.01	0.05	0.11	-0.04	2.72	2.55	2.42	2.36	0.00	0.00
3	0.03	0.05	0.03	0.07	0.12	-0.03	2.58	2.62	2.50	2.44	0.00	0.02
4	0.00	0.02	-0.01	0.05	0.11	-0.05	2.61	2.54	2.44	2.37	0.00	0.01
5	0.13	0.16	0.11	0.20	0.26	0.13	2.65	2.37	2.14	2.06	0.18	0.18
6	0.13	0.16	0.11	0.20	0.26	0.13	2.84	2.58	2.31	2.22	0.18	0.18
7	0.22	0.23	0.20	0.26	0.32	0.18	2.72	2.48	2.40	2.29	0.22	0.23
8	0.16	0.17	0.15	0.22	0.29	0.15	2.73	2.49	2.33	2.23	0.20	0.21
REPRESENTATIVE ABOVE NORMAL YEAR												
1	-0.03	-0.02	0.05	0.02	0.05	-0.01	0.02	2.29	2.21	2.32	0.02	0.03
2	-0.03	-0.02	0.05	0.02	0.05	-0.01	0.02	2.39	2.33	2.49	0.02	0.03
3	0.02	0.02	0.07	0.03	0.08	0.00	0.03	2.50	2.41	2.56	0.03	0.05
4	-0.03	-0.02	0.05	0.01	0.06	-0.01	0.01	2.43	2.34	2.50	0.02	0.03
5	0.08	0.10	0.20	0.17	0.21	0.16	0.17	2.33	2.08	2.23	0.21	0.19
6	0.08	0.10	0.20	0.17	0.21	0.16	0.17	2.42	2.22	2.39	0.21	0.19
7	0.19	0.20	0.27	0.22	0.28	0.20	0.23	2.38	2.31	2.39	0.25	0.26
8	0.13	0.14	0.23	0.19	0.24	0.18	0.19	2.33	2.25	2.33	0.23	0.21
REPRESENTATIVE WET YEAR												
1	-0.05	-0.03	0.02	-0.03	-0.03	-0.16	-0.10	2.32	2.45	2.35	0.01	0.01
2	-0.05	-0.03	0.02	-0.03	-0.03	-0.16	-0.10	2.77	2.72	2.68	0.01	0.01
3	-0.02	-0.02	0.03	0.01	0.02	-0.08	-0.05	2.73	2.71	2.72	0.01	0.02
4	-0.03	-0.03	0.01	-0.02	-0.02	-0.13	-0.07	2.74	2.70	2.71	0.01	0.01
5	-0.01	0.09	0.16	0.08	0.08	-0.08	0.02	2.39	2.42	2.17	0.19	0.19
6	-0.01	0.09	0.16	0.08	0.08	-0.08	0.02	2.79	2.69	2.53	0.19	0.19
7	0.02	0.14	0.22	0.18	0.19	0.01	0.10	2.77	2.73	2.61	0.23	0 24
8	0.02	0.11	0.18	0.12	0.13	-0.04	0.06	2.72	2.74	2.54	0.21	0.21

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

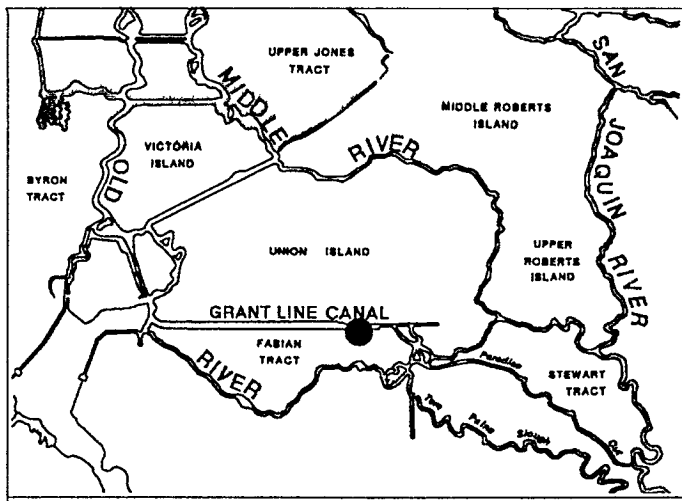


TABLE C-15 (cont.)

PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

GRANTLINE CANAL AT TRACY ROAD

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
1	0.09	0.06	0.29	0.24	0.29	0.29	0.07	-0.03	0.05	0.06	0.19	0.21
2	0.83	0.06	0.29	0.24	0.76	0.82	0.93	0.71	0.69	0.76	0.72	0.77
3	1.00	0.28	0.42	0.31	0.87	0.89	0.97	0.78	0.73	0.73	0.72	0.80
4	0.81	0.10	0.30	0.23	0.75	0.80	0.91	0.71	0.67	0.70	0.68	0.76
5	0.14	0.11	0.34	0.29	0.32	0.34	0.14	0.02	0.10	0.17	0.25	0.27
6	0.91	0.11	0.34	0.29	0.80	0.85	0.94	0.71	0.66	0.70	0.68	0.77
7	1.21	0.50	0.64	0.53	1.00	1.01	1.08	0.84	0.80	0.84	0.82	0.90
8	0.94	0.23	0.42	0.36	0.80	0.84	0.93	0.70	0.67	0.71	0.68	0.76
REPRESENTATIVE DRY YEAR												
1	0.28	-0.03	0.21	0.04	0.41	0.14	-0.08	-0.02	-0.01	-0.01	0.14	0.20
2	0.84	-0.03	0.21	0.04	0.96	0.70	0.72	0.64	0.62	0.67	0.66	0.76
3	0.92	0.22	0.30	0.29	1.06	0.90	0.83	0.71	0.69	0.66	0.65	0.77
4	0.82	0.02	0.21	0.09	0.93	0.68	0.69	0.64	0.62	0.62	0.62	0.73
5	0.32	0.02	0.26	0.09	0.44	0.19	-0.03	0.03	0.04	0.08	0.21	0.27
6	0.88	0.02	0.26	0.09	1.00	0.76	0.77	0.63	0.61	0.62	0.61	0.73
7	1.05	0.45	0.52	0.52	1.21	1.10	1.00	0.77	0.75	0.77	0.75	0.86
8	0.87	0.15	0.33	0.22	1.00	0.80	0.77	0.64	0.61	0.63	0.62	0.73
REPRESENTATIVE BELOW NORMAL YEAR												
1	0.10	0.17	0.09	0.29	0.45	0.00	-0.08	-0.01	0.05	0.11	0.10	0.15
2	0.10	0.17	0.09	0.29	0.45	0.00	0.80	0.77	0.72	0.77	0.10	0.15
3	0.31	0.35	0.31	0.39	0.53	0.10	0.90	0.83	0.78	0.84	0.09	0.18
4	0.14	0.19	0.13	0.29	0.44	0.00	0.77	0.76	0.72	0.76	0.07	0.13
5	0.15	0.21	0.14	0.33	0.50	0.05	-0.03	0.04	0.10	0.19	0.19	0.22
6	0.15	0.21	0.14	0.33	0.50	0.05	0.85	0.76	0.71	0.78	0.19	0.22
7	0.53	0.56	0.54	0.60	0.74	0.32	1.06	0.88	0.85	0.96	0.34	0.42
8	0.27	0.32	0.26	0.41	0.57	0.13	0.85	0.76	0.71	0.78	0.22	0.27
REPRESENTATIVE ABOVE NORMAL YEAR												
1	-0.01	0.03	0.28	0.18	0.28	0.12	0.19	0.08	0.08	0.23	0.24	0.22
2	-0.01	0.03	0.28	0.18	0.28	0.12	0.19	0.64	0.65	0.92	0.24	0.22
3	0.24	0.26	0.41	0.26	0.37	0.17	0.28	0.71	0.72	0.97	0.24	0.35
4	0.04	0.08	0.29	0.18	0.29	0.11	0.19	0.63	0.64	0.91	0.21	0.23
5	0.05	0.09	0.33	0.24	0.34	0.18	0.25	0.13	0.13	0.31	0.33	0.27
6	0.05	0.09	0.33	0.24	0.34	0.18	0.25	0.63	0.63	0.92	0.33	0.27
7	0.48	0.49	0.63	0.47	0.57	0.38	0.52	0.78	0.78	1.08	0.49	0.59
8	0.17	0.21	0.42	0.30	0.40	0.24	0.32	0.63	0.64	0.92	0.37	0.37
REPRESENTATIVE WET YEAR												
1	0.01	-0.06	0.20	0.03	0.02	-0.23	-0.08	-0.20	-0.05	-0.06	0.16	0.17
2	0.01	-0.06	0.20	0.03	0.02	-0.23	-0.08	0.90	0.94	0.96	0.16	0.17
3	0.04	0.02	0.28	0.26	0.26	0.01	0.07	0.96	0.93	0.99	0.16	0.23
4	0.01	-0.06	0.19	0.08	0.07	-0.17	-0.05	0.89	0.90	0.94	0.13	0.16
5	0.03	-0.01	0.24	0.08	0.08	-0.19	-0.02	-0.15	-0.03	-0.01	0.25	0.24
6	0.03	-0.01	0.24	0.08	0.08	-0.19	-0.02	0.92	0.89	0.93	0.25	0.24
7	0.09	0.20	0.50	0.48	0.49	0.14	0.23	1.01	0.93	1.01	0.40	0.46
8	0.04	0.04	0.32	0.20	0.20	-0.08	0.06	0.89	0.89	0.92	0.28	0.30

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
1	0.09	-0.03	0.04	0.02	0.14	0.15	-0.23	-0.24	-0.19	-0.14	0.13	0.14
2	1.51	-0.03	0.04	0.02	1.44	1.55	1.65	1.48	1.36	1.49	1.48	1.57
3	1.72	0.01	0.07	0.04	1.46	1.56	1.65	1.50	1.38	1.45	1.47	1.58
4	1.58	-0.03	0.04	0.02	1.38	1.50	1.61	1.45	1.34	1.42	1.44	1.54
5	0.19	0.08	0.30	0.29	0.35	0.38	0.01	-0.07	-0.02	0.09	0.35	0.38
6	1.55	0.08	0.30	0.29	1.42	1.57	1.69	1.54	1.40	1.48	1.52	1.64
7	1.88	0.33	0.41	0.38	1.64	1.73	1.82	1.60	1.47	1.55	1.59	1.74
8	1.66	0.25	0.34	0.32	1.52	1.63	1.74	1.51	1.37	1.46	1.50	1.65
REPRESENTATIVE DRY YEAR												
1	0.14	-0.07	0.02	-0.06	0.16	0.08	-0.23	-0.22	-0.21	-0.17	0.11	0.15
2	1.61	-0.07	0.02	-0.06	1.55	1.26	1.48	1.39	1.37	1.42	1.44	1.55
3	1.61	-0.02	0.04	0.00	1.59	1.52	1.53	1.42	1.41	1.42	1.43	1.55
4	1.56	-0.07	0.01	-0.06	1.52	1.35	1.45	1.37	1.35	1.38	1.39	1.51
5	0.37	0.01	0.29	0.03	0.38	0.20	0.00	-0.04	-0.03	0.07	0.32	0.38
6	1.61	0.01	0.29	0.03	1.52	1.29	1.45	1.45	1.43	1.46	1.47	1.61
7	1.80	0.29	0.38	0.31	1.78	1.63	1.72	1.52	1.50	1.54	1.54	1.68
8	1.70	0.20	0.32	0.21	1.62	1.41	1.56	1.42	1.40	1.44	1.44	1.59
REPRESENTATIVE BELOW NORMAL YEAR												
1	-0.02	0.01	-0.02	0.03	0.08	-0.04	-0.27	-0.25	-0.20	-0.16	0.00	0.00
2	-0.02	0.01	-0.02	0.03	0.08	-0.04	1.58	1.53	1.42	1.40	0.00	0.00
3	0.02	0.04	0.02	0.06	0.10	-0.02	1.61	1.55	1.45	1.42	0.01	0.02
4	-0.02	0.00	-0.03	0.03	0.08	-0.05	1.55	1.50	1.40	1.37	-0.01	0.00
5	0.12	0.17	0.09	0.30	0.36	0.22	-0.04	-0.08	-0.02	0.07	0.27	0.30
6	0.12	0.17	0.09	0.30	0.36	0.22	1.55	1.60	1.48	1.41	0.27	0.30
7	0.35	0.37	0.33	0.40	0.45	0.31	1.81	1.65	1.54	1.59	0.34	0.38
8	0.26	0.28	0.25	0.34	0.39	0.25	1.65	1.57	1.45	1.48	0.30	0.33
REPRESENTATIVE ABOVE NORMAL YEAR												
1	-0.05	-0.04	0.04	0.01	0.03	-0.02	0.01	-0.16	-0.16	-0.13	0.03	0.03
2	-0.05	-0.04	0.04	0.01	0.03	-0.02	0.01	1.31	1.30	1.49	[illegible]	0.03
3	0.01	0.01	0.07	0.03	0.06	-0.01	0.03	1.34	1.34	1.50	0.04	0.05
4	-0.05	-0.04	0.04	0.01	0.04	-0.02	0.00	1.29	1.28	1.45	0.02	0.01
5	0.04	0.06	0.30	0.28	0.32	0.26	0.29	0.01	0.02	0.10	0.31	0.28
6	0.04	0.06	0.30	0.28	0.32	0.26	0.29	1.35	1.35	1.51	0.31	0.28
7	0.32	0.33	0.41	0.36	0.42	0.33	0.38	1.43	1.43	1.66	0.39	0.40
8	0.23	0.24	0.34	0.31	0.37	0.29	0.32	1.33	1.32	1.55	0.34	0.33
REPRESENTATIVE WET YEAR												
1	-0.06	-0.04	0.02	-0.05	-0.05	-0.20	-0.11	-0.45	-0.36	-0.38	0.02	0.01
2	-0.06	-0.04	0.02	-0.05	-0.05	-0.20	-0.11	1.89	1.78	1.78	0.02	0.01
3	-0.01	-0.01	0.04	0.00	0.01	-0.07	-0.04	1.88	1.78	1.80	0.03	0.02
4	-0.04	-0.04	0.01	-0.04	-0.04	-0.13	-0.07	1.84	1.74	1.75	0.01	0.00
5	0.01	0.18	0.26	0.04	0.04	-0.12	0.09	-0.28	-0.30	-0.23	0.29	0.30
6	0.01	0.18	0.26	0.04	0.04	-0.12	0.09	1.92	1.72	1.84	0.29	0.30
7	0.07	0.27	0.36	0.31	0.33	0.15	0.26	1.99	1.75	1.85	0.36	0.38
8	0.05	0.21	0.29	0.23	0.25	0.07	0.20	1.90	1.70	1.80	0.32	0.33

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

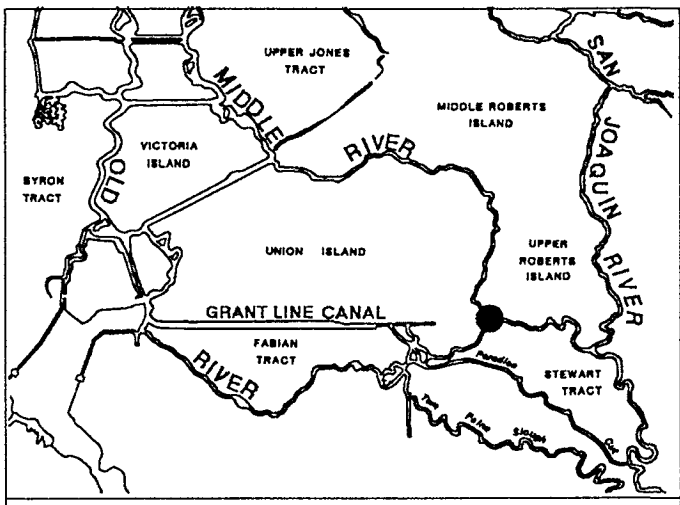


TABLE C-15 (cont.)
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

OLD RIVER AT MIDDLE RIVER

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.13	0.04	0.24	0.22	0.30	0.31	-0.16	-0.22	-0.08	-0.07	0.23	0.25
2	0.68	0.04	0.24	0.22	0.66	0.71	0.80	0.61	0.61	0.67	0.63	0.67
3	0.81	0.22	0.35	0.29	0.76	0.77	0.83	0.67	0.65	0.64	0.63	0.69
4	0.65	0.06	0.24	0.21	0.65	0.69	0.77	0.60	0.59	0.61	0.59	0.65
5	0.19	0.09	0.27	0.25	0.32	0.35	-0.09	-0.17	-0.04	0.02	0.25	0.28
6	0.76	0.09	0.27	0.25	0.70	0.74	0.82	0.60	0.58	0.60	0.58	0.66
7	0.99	0.40	0.52	0.46	0.88	0.87	0.93	0.72	0.71	0.73	0.71	0.78
8	0.77	0.17	0.33	0.30	0.69	0.72	0.79	0.60	0.58	0.61	0.58	0.64

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.30	-0.03	0.19	0.03	0.41	0.16	-0.30	-0.16	-0.13	-0.12	0.17	0.24
2	0.72	-0.03	0.19	0.03	0.82	0.59	0.61	0.55	0.54	0.58	0.57	0.66
3	0.79	0.19	0.27	0.25	0.91	0.76	0.70	0.61	0.60	0.58	0.56	0.66
4	0.70	0.01	0.18	0.07	0.79	0.57	0.57	0.55	0.54	0.54	0.52	0.63
5	0.33	0.03	0.22	0.08	0.43	0.21	-0.25	-0.11	-0.08	-0.05	0.20	0.27
6	0.76	0.03	0.22	0.08	0.87	0.66	0.66	0.54	0.53	0.53	0.51	0.62
7	0.91	0.38	0.44	0.44	1.05	0.95	0.85	0.67	0.66	0.67	0.64	0.75
8	0.75	0.12	0.28	0.17	0.86	0.68	0.66	0.54	0.53	0.53	0.51	0.62

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.09	0.14	0.08	0.24	0.38	0.01	-0.35	-0.20	-0.09	-0.03	0.11	0.14
2	0.09	0.14	0.08	0.24	0.38	0.01	0.67	0.66	0.63	0.68	0.11	0.14
3	0.27	0.30	0.26	0.32	0.45	0.10	0.75	0.72	0.69	0.74	0.11	0.17
4	0.11	0.15	0.10	0.23	0.37	0.00	0.63	0.65	0.62	0.67	0.08	0.12
5	0.14	0.18	0.12	0.27	0.41	0.04	-0.30	-0.16	-0.04	0.03	0.16	0.19
6	0.14	0.18	0.12	0.27	0.41	0.04	0.72	0.66	0.62	0.68	0.16	0.19
7	0.46	0.48	0.45	0.49	0.61	0.29	0.90	0.76	0.74	0.85	0.30	0.35
8	0.22	0.26	0.21	0.32	0.46	0.10	0.71	0.65	0.62	0.68	0.18	0.22

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.01	0.02	0.23	0.17	0.20	0.11	0.18	0.00	-0.01	0.07	0.25	0.20
2	-0.01	0.02	0.23	0.17	0.20	0.11	0.18	0.58	0.58	0.82	0.25	0.20
3	0.20	0.21	0.35	0.23	0.27	0.15	0.26	0.64	0.64	0.87	0.25	0.31
4	0.02	0.05	0.23	0.15	0.20	0.09	0.17	0.57	0.57	0.80	0.22	0.19
5	0.05	0.07	0.27	0.20	0.25	0.15	0.22	0.05	0.03	0.14	0.30	0.24
6	0.05	0.07	0.27	0.20	0.25	0.15	0.22	0.56	0.56	0.81	0.30	0.24
7	0.40	0.39	0.51	0.40	0.40	0.31	0.45	0.70	0.70	0.96	0.46	0.51
8	0.14	0.15	0.33	0.25	0.28	0.18	0.27	0.57	0.56	0.81	0.33	0.31

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.01	-0.07	0.20	0.02	0.01	-0.14	-0.05	-0.59	-0.33	-0.40	0.17	0.16
2	0.01	-0.07	0.20	0.02	0.01	-0.14	-0.05	0.72	0.79	0.78	0.17	0.16
3	0.04	0.01	0.29	0.21	0.19	0.00	0.04	0.76	0.78	0.81	0.17	0.21
4	0.01	-0.07	0.19	0.05	0.04	-0.12	-0.04	0.71	0.75	0.77	0.14	0.15
5	0.02	-0.04	0.22	0.07	0.06	-0.12	-0.01	-0.54	-0.31	-0.36	0.22	0.21
6	0.02	-0.04	0.22	0.07	0.06	-0.12	-0.01	0.74	0.74	0.76	0.22	0.21
7	0.08	0.16	0.47	0.38	0.37	0.08	0.13	0.81	0.78	0.82	0.36	0.40
8	0.03	0.00	0.29	0.15	0.14	-0.06	0.02	0.71	0.74	0.74	0.24	0.25

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.19	-0.01	0.06	0.05	0.22	0.24	-0.72	-0.67	-0.54	-0.49	0.23	0.24
2	1.16	-0.01	0.06	0.05	1.20	1.26	1.33	1.20	1.13	1.25	1.23	1.29
3	1.31	0.03	0.08	0.06	1.22	1.27	1.34	1.23	1.16	1.22	1.24	1.30
4	1.18	-0.02	0.04	0.03	1.15	1.21	1.30	1.18	1.11	1.19	1.20	1.25
5	0.26	0.07	0.20	0.23	0.37	0.39	-0.50	-0.51	-0.38	-0.28	0.36	0.39
6	1.19	0.07	0.20	0.23	1.26	1.33	1.41	1.27	1.17	1.23	1.27	1.38
7	1.45	0.25	0.31	0.31	1.39	1.43	1.49	1.31	1.23	1.30	1.33	1.43
8	1.25	0.15	0.24	0.24	1.27	1.34	1.41	1.24	1.14	1.21	1.24	1.35

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.24	-0.04	0.04	-0.01	0.26	0.18	-0.70	-0.57	-0.54	-0.52	0.18	0.24
2	1.32	-0.04	0.04	-0.01	1.32	1.11	1.22	1.15	1.14	1.17	1.18	1.27
3	1.32	0.01	0.05	0.04	1.32	1.26	1.23	1.18	1.18	1.17	1.18	1.28
4	1.26	-0.05	0.02	-0.03	1.25	1.13	1.16	1.13	1.12	1.13	1.14	1.24
5	0.40	0.09	0.21	0.13	0.42	0.32	-0.48	-0.41	-0.37	-0.30	0.31	0.38
6	1.36	0.09	0.21	0.13	1.33	1.14	1.24	1.21	1.19	1.20	1.20	1.34
7	1.49	0.23	0.29	0.26	1.50	1.41	1.42	1.27	1.26	1.28	1.26	1.39
8	1.39	0.13	0.23	0.16	1.37	1.21	1.30	1.18	1.17	1.18	1.17	1.31

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.01	0.03	0.00	0.06	0.11	-0.02	-0.79	-0.70	-0.56	-0.52	0.03	0.02
2	0.01	0.03	0.00	0.06	0.11	-0.02	1.29	1.25	1.18	1.16	0.03	0.02
3	0.05	0.06	0.05	0.08	0.13	0.00	1.29	1.27	1.21	1.19	0.04	0.03
4	-0.01	0.01	-0.01	0.04	0.10	-0.04	1.23	1.22	1.15	1.13	0.02	0.01
5	0.17	0.20	0.14	0.22	0.28	0.17	-0.57	-0.53	-0.40	-0.30	0.22	0.21
6	0.17	0.20	0.14	0.22	0.28	0.17	1.30	1.32	1.23	1.25	0.22	0.21
7	0.29	0.30	0.27	0.30	0.36	0.26	1.48	1.36	1.29	1.34	0.28	0.28
8	0.19	0.21	0.17	0.24	0.30	0.18	1.34	1.29	1.20	1.23	0.23	0.23

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.02	-0.02	0.05	0.03	0.05	0.00	0.04	-0.43	-0.45	-0.51	0.07	0.05
2	-0.02	-0.02	0.05	0.03	0.05	0.00	0.04	1.11	1.10	1.23	0.07	0.05
3	0.03	0.03	0.08	0.04	0.06	0.01	0.05	1.15	1.14	1.26	0.08	0.07
4	-0.03	-0.03	0.04	0.01	0.05	-0.01	0.02	1.09	1.08	1.21	0.05	0.03
5	0.07	0.05	0.20	0.21	0.18	0.19	0.22	-0.27	-0.28	-0.29	0.26	0.23
6	0.07	0.05	0.20	0.21	0.18	0.19	0.22	1.15	1.14	1.32	0.26	0.23
7	0.25	0.24	0.30	0.28	0.26	0.24	0.30	1.23	1.22	1.39	0.33	0.33
8	0.14	0.14	0.24	0.22	0.22	0.20	0.24	1.13	1.12	1.29	0.27	0.25

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.04	-0.03	0.04	-0.02	-0.03	-0.14	-0.05	-1.22	-0.94	-1.06	0.05	0.03
2	-0.04	-0.03	0.04	-0.02	-0.03	-0.14	-0.05	1.44	1.43	1.38	0.05	0.03
3	0.01	0.00	0.07	0.02	0.05	-0.04	-0.02	1.43	1.43	1.39	0.06	0.04
4	-0.02	-0.05	0.02	-0.03	0.00	-0.07	-0.04	1.40	1.39	1.35	0.03	0.01
5	0.01	0.12	0.21	0.05	0.04	-0.09	0.00	-1.05	-0.89	-0.92	0.23	0.22
6	0.01	0.12	0.21	0.05	0.04	-0.09	0.00	1.46	1.38	1.43	0.23	0.22
7	0.06	0.20	0.31	0.23	0.24	0.06	0.11	1.50	1.40	1.45	0.30	0.29
8	0.03	0.14	0.23	0.13	0.14	0.00	0.07	1.42	1.36	1.40	0.25	0.24

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

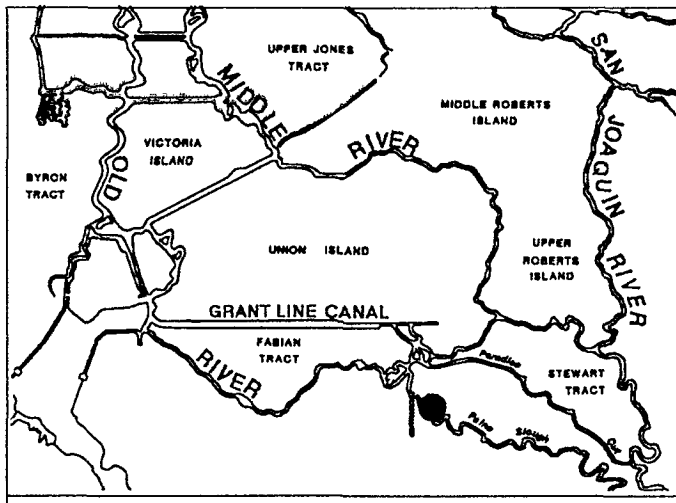


TABLE C-15 (cont.)
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

INSIDE TOM PAINE SLOUGH

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.19	0.09	0.13	0.12	0.28	0.68	0.50	0.37	0.51	0.54	0.46	0.48
2	0.43	0.09	0.13	0.12	0.51	0.87	0.85	0.77	0.90	0.93	0.56	0.57
3	0.52	0.28	0.31	0.37	0.64	0.96	0.98	0.86	0.95	0.88	0.58	0.64
4	0.26	-0.09	-0.02	0.13	0.44	0.84	0.88	0.77	0.88	0.85	0.53	0.52
5	0.30	0.21	0.25	0.25	0.35	0.60	0.33	0.30	0.48	0.52	0.29	0.28
6	0.56	0.21	0.25	0.25	0.58	0.89	0.92	0.76	0.85	0.83	0.45	0.51
7	0.77	0.52	0.57	0.58	0.86	1.05	1.06	0.89	1.00	0.98	0.60	0.76
8	0.47	0.11	0.18	0.19	0.58	0.84	0.87	0.73	0.86	0.84	0.40	0.54

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.21	0.05	0.12	0.04	0.21	0.27	0.15	0.35	0.32	0.43	0.44	0.40
2	0.40	0.05	0.12	0.04	0.40	0.54	0.75	0.64	0.56	0.74	0.58	0.50
3	0.53	0.25	0.32	0.23	0.53	0.71	0.83	0.73	0.65	0.73	0.57	0.54
4	0.28	-0.12	0.04	-0.15	0.32	0.43	0.65	0.64	0.56	0.70	0.52	0.46
5	0.35	0.17	0.25	0.19	0.32	0.33	0.16	0.27	0.23	0.36	0.33	0.20
6	0.52	0.17	0.25	0.19	0.52	0.66	0.84	0.62	0.54	0.66	0.48	0.46
7	0.69	0.48	0.56	0.45	0.76	0.95	1.08	0.76	0.69	0.82	0.62	0.64
8	0.46	0.06	0.19	0.08	0.45	0.63	0.83	0.59	0.51	0.66	0.45	0.43

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.11	0.08	0.08	0.11	0.19	0.17	0.12	0.39	0.47	0.56	0.44	0.40
2	0.11	0.08	0.08	0.11	0.19	0.17	0.82	0.79	0.78	0.92	0.44	0.40
3	0.34	0.29	0.28	0.27	0.40	0.37	0.88	0.87	0.86	1.01	0.43	0.52
4	-0.04	-0.08	-0.09	-0.02	0.15	0.16	0.71	0.78	0.78	0.91	0.38	0.36
5	0.19	0.21	0.19	0.26	0.32	0.09	0.13	0.31	0.40	0.50	0.32	0.32
6	0.19	0.21	0.19	0.26	0.32	0.09	0.92	0.78	0.75	0.92	0.32	0.32
7	0.59	0.53	0.51	0.54	0.64	0.60	1.13	0.90	0.89	1.10	0.54	0.71
8	0.14	0.12	0.10	0.19	0.26	0.25	0.90	0.74	0.73	0.89	0.34	0.39

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.13	0.07	0.13	0.11	0.21	0.17	0.20	0.50	0.51	0.74	0.69	0.22
2	0.13	0.07	0.13	0.11	0.21	0.17	0.20	0.69	0.74	1.09	0.69	0.22
3	0.35	0.25	0.31	0.32	0.31	0.32	0.44	0.78	0.83	1.15	0.72	0.49
4	-0.02	-0.11	-0.02	0.04	0.07	0.12	0.20	0.69	0.74	1.07	0.66	0.20
5	0.22	0.20	0.25	0.25	0.34	0.30	0.31	0.43	0.45	0.66	0.52	0.31
6	0.22	0.20	0.25	0.25	0.34	0.30	0.31	0.67	0.71	1.07	0.52	0.31
7	0.61	0.49	0.57	0.54	0.55	0.54	0.71	0.82	0.87	1.23	0.77	0.77
8	0.15	0.10	0.18	0.19	0.26	0.22	0.32	0.65	0.70	1.03	0.53	0.37

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.22	-0.10	0.12	0.07	0.07	0.00	0.06	0.12	0.44	0.43	0.55	0.39
2	0.22	-0.10	0.12	0.07	0.07	0.00	0.06	0.74	0.95	1.04	0.55	0.39
3	0.28	0.18	0.38	0.22	0.21	0.10	0.18	0.77	0.94	1.08	0.54	0.54
4	0.17	-0.12	0.06	-0.12	-0.12	-0.17	-0.06	0.67	0.90	1.02	0.49	0.36
5	0.05	0.00	0.25	0.19	0.21	0.00	0.08	-0.03	0.41	0.36	0.43	0.35
6	0.05	0.00	0.25	0.19	0.21	0.00	0.08	0.80	0.88	0.99	0.43	0.35
7	0.28	0.34	0.62	0.44	0.44	0.18	0.31	0.88	0.93	1.07	0.66	0.78
8	0.15	-0.06	0.19	0.08	0.10	-0.11	0.03	0.74	0.88	0.96	0.46	0.45

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.21	0.10	0.15	0.15	0.32	0.67	0.50	0.31	0.43	0.42	0.42	0.49
2	0.48	0.10	0.15	0.15	0.56	0.83	0.79	0.73	0.86	0.84	0.51	0.59
3	0.59	0.32	0.36	0.42	0.68	0.95	0.98	0.81	0.89	0.79	0.51	0.64
4	0.34	-0.03	0.04	0.18	0.48	0.84	0.87	0.73	0.84	0.77	0.47	0.52
5	0.29	0.19	0.23	0.23	0.35	0.60	0.36	0.27	0.42	0.45	0.25	0.27
6	0.62	0.19	0.23	0.23	0.62	0.81	0.84	0.69	0.81	0.77	0.32	0.58
7	0.84	0.56	0.62	0.63	0.90	0.98	0.98	0.81	0.94	0.91	0.46	0.77
8	0.55	0.15	0.22	0.23	0.62	0.76	0.79	0.66	0.81	0.78	0.27	0.56

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.26	0.06	0.13	0.04	0.22	0.27	0.22	0.28	0.29	0.36	0.40	0.35
2	0.50	0.06	0.13	0.04	0.45	0.56	0.74	0.57	0.52	0.69	0.53	0.45
3	0.59	0.29	0.36	0.27	0.57	0.75	0.82	0.66	0.59	0.67	0.49	0.47
4	0.39	-0.08	0.10	-0.10	0.37	0.47	0.63	0.58	0.52	0.65	0.46	0.39
5	0.34	0.13	0.22	0.14	0.29	0.31	0.12	0.22	0.20	0.33	0.29	0.14
6	0.55	0.13	0.22	0.14	0.54	0.68	0.82	0.53	0.47	0.61	0.41	0.41
7	0.80	0.51	0.60	0.49	0.80	1.00	1.08	0.66	0.60	0.75	0.54	0.58
8	0.55	0.08	0.22	0.08	0.54	0.67	0.82	0.50	0.43	0.61	0.38	0.37

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.11	0.10	0.10	0.13	0.23	0.15	0.20	0.35	0.42	0.51	0.38	0.43
2	0.11	0.10	0.10	0.13	0.23	0.15	0.83	0.74	0.74	0.89	0.38	0.43
3	0.37	0.34	0.33	0.32	0.45	0.31	0.89	0.83	0.81	0.96	0.36	0.53
4	0.00	-0.02	-0.03	0.04	0.21	0.09	0.72	0.75	0.73	0.89	0.33	0.37
5	0.18	0.18	0.17	0.22	0.32	0.02	0.09	0.28	0.37	0.46	0.27	0.32
6	0.18	0.18	0.17	0.22	0.32	0.02	0.92	0.70	0.68	0.84	0.27	0.32
7	0.63	0.57	0.56	0.57	0.69	0.52	1.14	0.81	0.82	1.03	0.46	0.74
8	0.18	0.15	0.13	0.21	0.31	0.17	0.91	0.65	0.66	0.82	0.28	0.42

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.13	0.09	0.15	0.14	0.27	0.22	0.23	0.46	0.45	0.71	0.68	0.24
2	0.13	0.09	0.15	0.14	0.27	0.22	0.23	0.63	0.68	1.07	0.68	0.24
3	0.38	0.30	0.36	0.38	0.40	0.38	0.48	0.73	0.76	1.12	0.70	0.51
4	0.01	-0.05	0.04	0.15	0.17	0.19	0.24	0.64	0.68	1.05	0.65	0.22
5	0.21	0.18	0.23	0.23	0.36	0.29	0.32	0.40	0.43	0.65	0.53	0.31
6	0.21	0.18	0.23	0.23	0.36	0.29	0.32	0.60	0.65	1.02	0.53	0.31
7	0.65	0.54	0.62	0.59	0.63	0.59	0.76	0.74	0.78	1.17	0.70	0.80
8	0.18	0.13	0.22	0.22	0.32	0.27	0.37	0.57	0.63	0.99	0.46	0.40

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.24	-0.08	0.14	0.09	0.09	0.04	0.10	0.13	0.34	0.38	0.50	0.41
2	0.24	-0.08	0.14	0.09	0.09	0.04	0.10	0.67	0.86	1.01	0.50	0.41
3	0.26	0.21	0.41	0.28	0.27	0.19	0.24	0.69	0.84	1.04	0.48	0.55
4	0.16	-0.03	0.15	-0.06	-0.06	-0.09	0.01	0.59	0.83	1.01	0.44	0.36
5	0.09	-0.03	0.21	0.16	0.18	-0.02	0.10	0.02	0.36	0.34	0.39	0.34
6	0.09	-0.03	0.21	0.16	0.18	-0.02	0.10	0.74	0.84	0.92	0.39	0.34
7	0.28	0.37	0.64	0.48	0.48	0.26	0.38	0.82	0.89	0.99	0.59	0.79
8	0.15	-0.03	0.22	0.10	0.11	-0.07	0.09	0.67	0.86	0.89	0.39	0.46

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

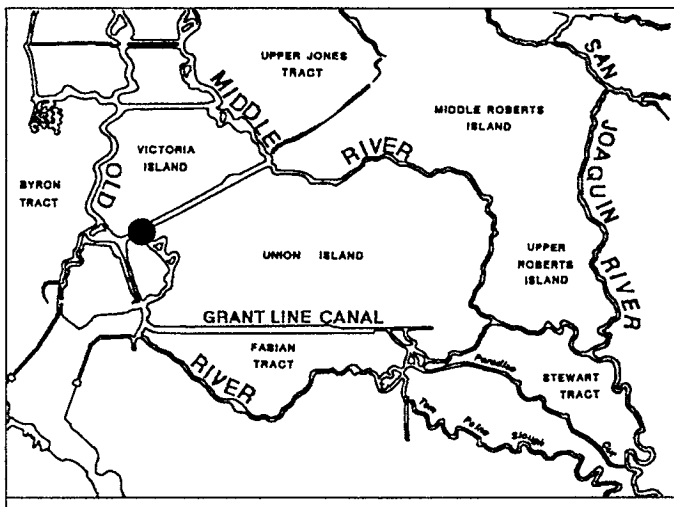


TABLE C-15 (cont.)
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

OLD RIVER AT VICTORIA CANAL

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.17	-0.11	0.10	0.09	0.07	0.10	0.06	-0.01	0.02	0.06	0.06	0.07
2	-0.17	-0.11	0.10	0.09	0.08	0.11	0.15	0.06	0.08	0.12	0.07	0.07
3	0.05	0.08	0.22	0.15	0.15	0.14	0.16	0.08	0.09	0.08	0.05	0.07
4	-0.10	-0.06	0.12	0.09	0.08	0.09	0.13	0.05	0.06	0.07	0.03	0.05
5	-0.19	-0.13	0.08	0.08	0.06	0.09	0.05	-0.02	0.02	0.08	0.07	0.07
6	-0.20	-0.13	0.08	0.08	0.05	0.09	0.14	0.06	0.07	0.12	0.07	0.07
7	0.19	0.22	0.35	0.29	0.26	0.25	0.29	0.17	0.17	0.22	0.18	0.20
8	-0.05	0.00	0.18	0.15	0.12	0.14	0.19	0.09	0.10	0.15	0.10	0.11

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.07	-0.20	0.06	-0.15	0.14	-0.11	-0.11	-0.03	-0.03	0.01	0.04	0.07
2	0.08	-0.20	0.06	-0.15	0.15	-0.11	-0.01	0.02	0.02	0.07	0.05	0.08
3	0.13	0.01	0.15	0.06	0.24	0.09	0.08	0.05	0.05	0.05	0.03	0.06
4	0.07	-0.15	0.07	-0.10	0.16	-0.06	0.00	0.01	0.01	0.03	0.01	0.04
5	0.06	-0.22	0.05	-0.16	0.12	-0.13	-0.13	-0.04	-0.03	0.02	0.06	0.08
6	0.05	-0.22	0.05	-0.16	0.11	-0.14	-0.05	0.02	0.02	0.07	0.05	0.08
7	0.25	0.16	0.28	0.21	0.35	0.22	0.20	0.13	0.13	0.18	0.16	0.19
8	0.12	-0.09	0.13	-0.03	0.20	-0.01	0.05	0.05	0.05	0.10	0.08	0.11

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.08	-0.02	-0.09	0.12	0.24	-0.09	-0.09	0.00	0.03	0.06	0.05	0.06
2	-0.08	-0.02	-0.09	0.12	0.24	-0.09	0.02	0.08	0.08	0.13	0.05	0.06
3	0.10	0.14	0.10	0.21	0.31	-0.01	0.10	0.10	0.11	0.14	0.04	0.08
4	-0.04	0.01	-0.05	0.13	0.24	-0.09	0.02	0.07	0.07	0.11	0.02	0.04
5	-0.10	-0.04	-0.11	0.10	0.23	-0.11	-0.12	0.00	0.02	0.04	0.06	0.06
6	-0.10	-0.04	-0.11	0.10	0.23	-0.11	-0.02	0.08	0.08	0.10	0.06	0.06
7	0.24	0.27	0.24	0.34	0.45	0.13	0.22	0.18	0.19	0.26	0.20	0.24
8	0.02	0.07	0.02	0.19	0.31	-0.02	0.07	0.11	0.11	0.15	0.11	0.12

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.18	-0.14	0.10	0.06	0.15	0.03	0.04	0.03	0.02	0.14	0.13	0.04
2	-0.18	-0.14	0.10	0.06	0.15	0.03	0.04	0.07	0.06	0.21	0.13	0.04
3	0.03	0.06	0.21	0.12	0.23	0.07	0.12	0.09	0.09	0.22	0.12	0.15
4	-0.13	-0.09	0.11	0.06	0.16	0.03	0.04	0.06	0.05	0.19	0.10	0.05
5	-0.20	-0.16	0.08	0.05	0.14	0.02	0.03	0.02	0.01	0.13	0.14	0.03
6	-0.20	-0.16	0.08	0.05	0.14	0.02	0.03	0.06	0.05	0.19	0.14	0.03
7	0.19	0.21	0.35	0.26	0.36	0.21	0.27	0.17	0.16	0.34	0.29	0.30
8	-0.07	-0.03	0.18	0.13	0.23	0.09	0.11	0.09	0.08	0.24	0.19	0.12

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.02	-0.11	0.05	-0.14	-0.14	-0.34	-0.16	-0.09	0.02	0.02	0.09	0.06
2	-0.02	-0.11	0.05	-0.14	-0.14	-0.34	-0.16	0.03	0.09	0.12	0.09	0.06
3	0.01	-0.04	0.12	0.06	0.07	-0.10	-0.01	0.07	0.09	0.12	0.08	0.10
4	-0.02	-0.11	0.05	-0.09	-0.08	-0.25	-0.10	0.03	0.08	0.10	0.05	0.05
5	-0.01	-0.12	0.03	-0.16	-0.16	-0.36	-0.17	-0.09	0.03	0.03	0.10	0.05
6	-0.01	-0.12	0.03	-0.16	-0.16	-0.36	-0.17	0.03	0.10	0.13	0.10	0.05
7	0.04	0.07	0.26	0.20	0.22	-0.02	0.10	0.15	0.13	0.20	0.23	0.25
8	0.01	-0.05	0.11	-0.03	-0.02	-0.21	-0.05	0.07	0.11	0.15	0.14	0.12

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.13	-0.06	0.00	0.01	-0.04	-0.04	-0.10	-0.14	-0.11	-0.08	-0.06	-0.06
2	-0.23	-0.06	0.00	0.01	-0.10	-0.10	-0.11	-0.16	-0.13	-0.10	-0.13	-0.13
3	-0.18	-0.01	0.03	0.02	-0.12	-0.12	-0.13	-0.17	-0.14	-0.13	-0.15	-0.15
4	-0.22	-0.05	0.00	0.00	-0.13	-0.13	-0.14	-0.18	-0.15	-0.13	-0.15	-0.15
5	0.10	0.16	0.23	0.24	0.17	0.19	0.12	0.01	0.04	0.13	0.17	0.18
6	-0.01	0.16	0.23	0.24	0.06	0.08	0.09	-0.02	0.01	0.09	0.07	0.08
7	0.07	0.28	0.34	0.33	0.12	0.13	0.13	0.01	0.04	0.12	0.10	0.12
8	0.07	0.22	0.28	0.29	0.08	0.10	0.11	-0.01	0.02	0.10	0.08	0.09

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.05	-0.09	0.00	-0.09	-0.05	-0.11	-0.11	-0.13	-0.14	-0.09	-0.07	-0.05
2	-0.12	-0.09	0.00	-0.09	-0.11	-0.20	-0.11	-0.15	-0.16	-0.11	-0.14	-0.13
3	-0.14	-0.05	0.01	-0.05	-0.13	-0.14	-0.12	-0.17	-0.18	-0.13	-0.16	-0.15
4	-0.15	-0.09	-0.01	-0.09	-0.14	-0.19	-0.14	-0.17	-0.18	-0.13	-0.16	-0.15
5	0.17	0.09	0.23	0.09	0.16	0.11	0.09	0.02	0.01	0.13	0.16	0.18
6	0.06	0.09	0.23	0.09	0.05	0.02	0.05	-0.02	-0.03	0.08	0.06	0.08
7	0.11	0.23	0.33	0.24	0.11	0.09	0.12	0.01	0.01	0.12	0.09	0.11
8	0.08	0.18	0.28	0.18	0.08	0.08	0.08	-0.01	-0.02	0.09	0.07	0.09

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.04	-0.02	-0.06	0.01	0.04	-0.05	-0.12	-0.14	-0.12	-0.08	-0.01	-0.01
2	-0.04	-0.02	-0.06	0.01	0.04	-0.05	-0.11	-0.16	-0.14	-0.08	-0.01	-0.01
3	-0.01	0.00	-0.02	0.03	0.06	-0.04	-0.13	-0.17	-0.16	-0.11	-0.01	-0.01
4	-0.05	-0.02	-0.05	0.01	0.04	-0.06	-0.14	-0.18	-0.16	-0.11	-0.02	-0.02
5	0.17	0.20	0.15	0.25	0.28	0.18	0.09	0.01	0.03	0.14	0.23	0.25
6	0.17	0.20	0.15	0.25	0.28	0.18	0.06	-0.02	-0.01	0.10	0.23	0.25
7	0.28	0.30	0.27	0.35	0.38	0.27	0.12	0.01	0.03	0.14	0.31	0.33
8	0.22	0.24	0.21	0.30	0.33	0.22	0.09	-0.01	0.01	0.11	0.27	0.30

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.08	-0.07	0.00	-0.01	0.01	-0.01	0.00	-0.11	-0.11	-0.06	0.01	0.01
2	-0.08	-0.07	0.00	-0.01	0.01	-0.01	0.00	-0.13	-0.13	-0.07	0.01	0.01
3	-0.03	-0.02	0.02	0.01	0.05	-0.01	0.01	-0.15	-0.14	-0.10	0.01	0.02
4	-0.07	-0.06	0.00	-0.01	0.03	-0.02	0.00	-0.15	-0.15	-0.10	0.00	0.00
5	0.11	0.13	0.23	0.23	0.26	0.21	0.25	0.04	0.04	0.15	0.27	0.25
6	0.11	0.13	0.23	0.23	0.26	0.21	0.25	0.00	0.00	0.12	0.27	0.25
7	0.26	0.27	0.33	0.31	0.38	0.29	0.34	0.03	0.03	0.15	0.34	0.35
8	0.21	0.21	0.28	0.27	0.34	0.26	0.30	0.01	0.01	0.13	0.31	0.30

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.08	-0.03	0.01	-0.09	-0.09	-0.24	-0.17	-0.21	-0.19	-0.17	0.00	0.00
2	-0.08	-0.03	0.01	-0.09	-0.09	-0.24	-0.17	-0.21	-0.22	-0.19	0.00	0.00
3	-0.03	-0.01	0.02	-0.04	-0.03	-0.12	-0.08	-0.22	-0.21	-0.19	0.00	0.01
4	-0.05	-0.03	0.00	-0.07	-0.07	-0.17	-0.10	-0.22	-0.22	-0.20	-0.01	-0.01
5	-0.02	0.16	0.23	0.07	0.06	-0.18	0.05	-0.06	-0.14	-0.05	0.24	0.26
6	-0.02	0.16	0.23	0.07	0.06	-0.18	0.05	-0.06	-0.17	-0.06	0.24	0.26
7	0.05	0.24	0.32	0.25	0.27	0.08	0.21	-0.02	-0.14	-0.03	0.31	0.35
8	0.03	0.20	0.27	0.19	0.21	0.02	0.16	-0.04	-0.16	-0.04	0.28	0.31

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

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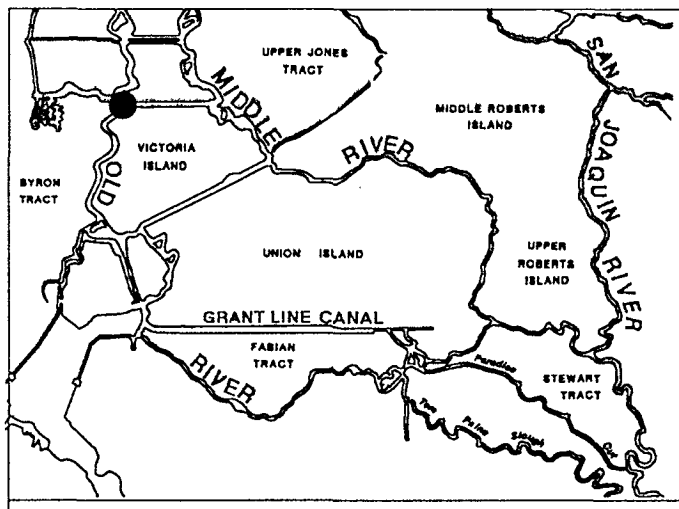

TABLE C-15 (cont.)

PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

OLD RIVER AT WOODWARD CANAL

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.09	-0.07	0.05	0.04	0.02	0.05	0.02	-0.02	0.00	0.00	0.02	0.02
2	-0.10	-0.07	0.05	0.04	0.02	0.04	0.06	0.02	0.03	0.03	0.01	0.01
3	-0.05	-0.03	0.07	0.05	0.03	0.04	0.06	0.02	0.02	0.02	0.00	0.01
4	-0.10	-0.08	0.04	0.03	0.01	0.04	0.06	0.01	0.02	0.02	0.01	0.01
5	-0.09	-0.06	0.05	0.05	0.03	0.06	0.04	0.00	0.01	0.03	0.04	0.04
6	-0.10	-0.06	0.05	0.05	0.02	0.05	0.07	0.03	0.04	0.05	0.03	0.03
7	0.01	0.03	0.12	0.10	0.07	0.09	0.11	0.05	0.06	0.07	0.06	0.06
8	-0.10	-0.08	0.04	0.04	0.02	0.04	0.07	0.02	0.03	0.05	0.03	0.02

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.02	-0.13	0.03	-0.09	0.05	-0.06	-0.06	-0.03	-0.02	-0.01	0.01	0.01
2	0.02	-0.13	0.03	-0.09	0.05	-0.07	-0.02	-0.01	0.00	0.01	0.01	0.01
3	0.02	-0.08	0.04	-0.05	0.07	-0.03	-0.01	0.00	0.00	0.00	0.00	0.00
4	0.01	-0.13	0.02	-0.10	0.04	-0.07	-0.03	-0.01	-0.01	0.00	0.00	0.00
5	0.03	-0.12	0.03	-0.09	0.06	-0.06	-0.06	-0.02	-0.01	0.01	0.03	0.04
6	0.02	-0.12	0.03	-0.09	0.05	-0.06	-0.02	0.00	0.01	0.03	0.03	0.03
7	0.07	-0.02	0.09	0.01	0.11	0.03	0.04	0.03	0.03	0.05	0.05	0.06
8	0.02	-0.13	0.02	-0.10	0.05	-0.07	-0.02	0.00	0.00	0.02	0.02	0.02

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.06	-0.02	-0.06	0.05	0.13	-0.07	-0.06	-0.01	0.00	0.01	0.01	0.02
2	-0.06	-0.02	-0.06	0.05	0.13	-0.07	-0.01	0.03	0.02	0.04	0.01	0.02
3	-0.02	0.02	-0.02	0.07	0.14	-0.05	0.00	0.03	0.03	0.04	0.01	0.02
4	-0.06	-0.02	-0.06	0.04	0.12	-0.07	-0.02	0.02	0.02	0.03	0.01	0.01
5	-0.05	-0.01	-0.05	0.06	0.14	-0.06	-0.05	0.01	0.01	0.02	0.03	0.03
6	-0.05	-0.01	-0.05	0.06	0.14	-0.06	-0.01	0.04	0.04	0.05	0.03	0.03
7	0.03	0.06	0.04	0.12	0.19	0.00	0.05	0.06	0.06	0.09	0.06	0.07
8	-0.07	-0.02	-0.07	0.05	0.13	-0.07	-0.02	0.03	0.03	0.04	0.03	0.02

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.11	-0.09	0.05	0.02	0.08	0.01	0.01	0.00	0.00	0.06	0.05	0.01
2	-0.11	-0.09	0.05	0.02	0.08	0.01	0.01	0.01	0.02	0.09	0.05	0.01
3	-0.06	-0.04	0.07	0.03	0.09	0.02	0.03	0.01	0.02	0.08	0.05	0.03
4	-0.11	-0.10	0.04	0.02	0.07	0.01	0.01	0.01	0.01	0.08	0.05	0.00
5	-0.10	-0.08	0.05	0.03	0.09	0.02	0.02	0.01	0.01	0.07	0.07	0.02
6	-0.10	-0.08	0.05	0.03	0.09	0.02	0.02	0.02	0.03	0.10	0.07	0.02
7	0.00	0.01	0.12	0.08	0.14	0.06	0.08	0.04	0.05	0.13	0.11	0.08
8	-0.12	-0.10	0.04	0.02	0.08	0.01	0.01	0.01	0.02	0.09	0.07	0.01

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.01	-0.05	0.01	-0.10	-0.10	-0.22	-0.11	-0.05	0.01	0.01	0.03	0.02
2	-0.01	-0.05	0.01	-0.10	-0.10	-0.22	-0.11	0.00	0.04	0.06	0.03	0.02
3	-0.01	-0.04	0.02	-0.05	-0.05	-0.15	-0.07	0.01	0.04	0.06	0.03	0.03
4	-0.02	-0.05	0.00	-0.10	-0.10	-0.23	-0.11	0.00	0.03	0.05	0.02	0.02
5	-0.01	-0.04	0.01	-0.09	-0.09	-0.22	-0.10	-0.04	0.02	0.03	0.05	0.03
6	-0.01	-0.04	0.01	-0.09	-0.09	-0.22	-0.10	0.01	0.05	0.08	0.05	0.03
7	0.00	0.00	0.07	0.00	0.01	-0.12	-0.03	0.04	0.05	0.09	0.08	0.08
8	-0.01	-0.05	0.01	-0.11	-0.11	-0.23	-0.12	0.01	0.04	0.07	0.04	0.03

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.12	-0.05	0.00	0.01	-0.04	-0.05	-0.08	-0.09	-0.08	-0.07	-0.06	-0.06
2	-0.21	-0.05	0.00	0.01	-0.10	-0.11	-0.10	-0.12	-0.11	-0.10	-0.13	-0.13
3	-0.16	-0.02	0.01	0.02	-0.10	-0.11	-0.11	-0.13	-0.12	-0.12	-0.14	-0.13
4	-0.18	-0.06	-0.02	0.00	-0.12	-0.12	-0.12	-0.14	-0.13	-0.12	-0.14	-0.14
5	0.01	0.06	0.13	0.14	0.08	0.09	0.06	0.00	0.02	0.06	0.07	0.08
6	-0.06	0.06	0.13	0.14	0.01	0.01	0.02	-0.04	-0.03	0.02	0.00	0.00
7	-0.02	0.12	0.17	0.18	0.04	0.03	0.04	-0.02	-0.01	0.03	0.01	0.02
8	-0.02	0.07	0.11	0.13	0.00	0.00	0.01	-0.05	-0.04	0.00	-0.02	-0.01

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.05	-0.10	0.01	-0.08	-0.06	-0.10	-0.09	-0.09	-0.09	-0.08	-0.07	-0.06
2	-0.11	-0.10	0.01	-0.08	-0.12	-0.18	-0.12	-0.13	-0.13	-0.11	-0.13	-0.12
3	-0.11	-0.06	0.02	-0.04	-0.11	-0.13	-0.11	-0.14	-0.13	-0.12	-0.14	-0.13
4	-0.13	-0.10	-0.01	-0.08	-0.13	-0.16	-0.13	-0.15	-0.15	-0.13	-0.15	-0.14
5	0.08	0.01	0.14	0.03	0.07	0.03	0.04	0.00	0.00	0.05	0.06	0.09
6	0.00	0.01	0.14	0.03	-0.01	-0.04	-0.01	-0.05	-0.05	0.01	-0.01	0.01
7	0.03	0.07	0.18	0.09	0.03	0.01	0.03	-0.03	-0.03	0.03	0.00	0.03
8	0.00	0.03	0.12	0.05	-0.01	0.00	0.00	-0.06	-0.06	0.00	-0.03	-0.01

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.05	-0.02	-0.05	0.01	0.05	-0.05	-0.11	-0.09	-0.08	-0.07	-0.01	0.00
2	-0.05	-0.02	-0.05	0.01	0.05	-0.05	-0.13	-0.13	-0.12	-0.09	-0.01	0.00
3	-0.02	0.00	-0.03	0.03	0.05	-0.04	-0.12	-0.13	-0.12	-0.10	-0.01	0.00
4	-0.06	-0.03	-0.06	0.00	0.03	-0.06	-0.14	-0.14	-0.13	-0.11	-0.03	-0.02
5	0.07	0.10	0.06	0.15	0.18	0.09	0.03	0.00	0.01	0.06	0.13	0.15
6	0.07	0.10	0.06	0.15	0.18	0.09	-0.01	-0.04	-0.03	0.02	0.13	0.15
7	0.13	0.15	0.12	0.18	0.21	0.12	0.02	-0.03	-0.02	0.05	0.15	0.18
8	0.07	0.09	0.06	0.13	0.16	0.07	-0.01	-0.06	-0.05	0.01	0.11	0.13

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.07	-0.06	0.00	0.00	0.03	-0.01	0.00	-0.08	-0.08	-0.04	0.01	0.00
2	-0.07	-0.06	0.00	0.00	0.03	-0.01	0.00	-0.12	-0.11	-0.07	0.01	0.00
3	-0.03	-0.03	0.02	0.01	0.04	-0.01	0.01	-0.12	-0.12	-0.08	0.01	0.02
4	-0.07	-0.07	-0.01	-0.01	0.01	-0.03	-0.02	-0.14	-0.13	-0.09	-0.01	-0.01
5	0.04	0.05	0.13	0.13	0.16	0.12	0.14	0.01	0.01	0.09	0.16	0.14
6	0.04	0.05	0.13	0.13	0.16	0.12	0.14	-0.04	-0.04	0.05	0.16	0.14
7	0.11	0.11	0.18	0.17	0.20	0.14	0.18	-0.02	-0.02	0.07	0.18	0.18
8	0.06	0.06	0.12	0.12	0.15	0.11	0.12	-0.05	-0.05	0.04	0.14	0.12

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.03	-0.03	0.00	-0.08	-0.08	-0.17	-0.10	-0.13	-0.10	-0.11	0.00	-0.01
2	-0.03	-0.03	0.00	-0.08	-0.08	-0.17	-0.10	-0.16	-0.14	-0.14	0.00	-0.01
3	-0.02	-0.02	0.01	-0.04	-0.04	-0.12	-0.07	-0.16	-0.14	-0.14	0.00	0.00
4	-0.05	-0.04	-0.01	-0.08	-0.08	-0.17	-0.11	-0.17	-0.15	-0.16	-0.01	-0.03
5	0.00	0.08	0.13	0.03	0.04	-0.09	0.01	-0.04	-0.07	-0.03	0.15	0.14
6	0.00	0.08	0.13	0.03	0.04	-0.09	0.01	-0.07	-0.11	-0.06	0.15	0.14
7	0.01	0.11	0.16	0.09	0.10	-0.03	0.06	-0.05	-0.11	-0.05	0.17	0.17
8	-0.02	0.06	0.11	0.04	0.05	-0.10	0.00	-0.08	-0.13	-0.08	0.13	0.12

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

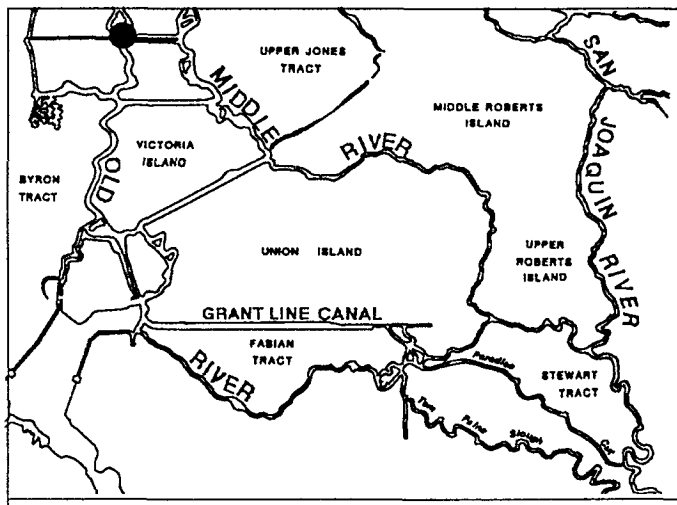

TABLE C-15 (cont.)
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

OLD RIVER AT SANTA FE RAILROAD

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.07	-0.06	0.02	0.03	0.01	0.02	0.01	-0.02	0.00	0.00	0.00	0.00
2	-0.08	-0.06	0.02	0.03	0.00	0.01	0.03	0.00	0.01	0.01	0.00	0.00
3	-0.07	-0.05	0.02	0.03	0.00	0.01	0.03	0.00	0.01	0.00	-0.01	-0.01
4	-0.07	-0.06	0.02	0.02	0.00	0.01	0.03	0.00	0.01	0.00	0.00	0.00
5	-0.06	-0.05	0.03	0.03	0.01	0.03	0.03	-0.01	0.01	0.02	0.02	0.02
6	-0.07	-0.05	0.03	0.03	0.01	0.02	0.04	0.01	0.02	0.03	0.02	0.01
7	-0.04	-0.03	0.04	0.04	0.02	0.03	0.05	0.01	0.02	0.03	0.02	0.02
8	-0.07	-0.05	0.02	0.03	0.01	0.02	0.04	0.00	0.02	0.02	0.01	0.01

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.01	-0.10	0.01	-0.08	0.02	-0.05	-0.04	-0.02	-0.03	-0.02	0.00	0.00
2	0.00	-0.10	0.01	-0.08	0.02	-0.05	-0.02	-0.01	-0.02	-0.01	-0.01	0.00
3	0.00	-0.10	0.01	-0.07	0.02	-0.05	-0.03	-0.01	-0.02	-0.01	-0.01	-0.01
4	0.00	-0.10	0.01	-0.08	0.02	-0.05	-0.03	-0.01	-0.02	-0.01	-0.01	-0.01
5	0.01	-0.10	0.01	-0.07	0.03	-0.04	-0.04	-0.01	-0.02	0.00	0.01	0.02
6	0.01	-0.10	0.01	-0.07	0.02	-0.04	-0.02	0.00	-0.01	0.01	0.01	0.01
7	0.02	-0.07	0.03	-0.05	0.04	-0.02	-0.01	0.00	-0.01	0.01	0.01	0.02
8	0.01	-0.10	0.01	-0.07	0.02	-0.04	-0.02	-0.01	-0.01	0.01	0.01	0.01

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.04	-0.02	-0.05	0.03	0.09	-0.06	-0.04	-0.01	0.00	0.00	0.01	0.01
2	-0.04	-0.02	-0.05	0.03	0.09	-0.06	-0.02	0.01	0.01	0.02	0.01	0.01
3	-0.04	-0.02	-0.04	0.03	0.09	-0.06	-0.02	0.00	0.01	0.01	0.00	0.01
4	-0.04	-0.02	-0.05	0.03	0.09	-0.06	-0.02	0.00	0.01	0.01	0.00	0.01
5	-0.03	-0.01	-0.04	0.03	0.10	-0.05	-0.04	0.00	0.01	0.01	0.02	0.02
6	-0.03	-0.01	-0.04	0.03	0.10	-0.05	-0.02	0.02	0.02	0.03	0.02	0.02
7	-0.02	0.00	-0.02	0.05	0.11	-0.04	0.00	0.02	0.02	0.03	0.03	0.03
8	-0.04	-0.02	-0.05	0.03	0.10	-0.06	-0.02	0.01	0.01	0.02	0.02	0.02

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.08	-0.07	0.03	0.00	0.05	0.00	0.00	0.00	-0.01	0.03	0.03	0.00
2	-0.08	-0.07	0.03	0.00	0.05	0.00	0.00	0.00	0.00	0.04	0.03	0.00
3	-0.08	-0.06	0.03	0.00	0.06	0.00	0.00	0.00	0.00	0.04	0.03	0.01
4	-0.08	-0.07	0.03	0.00	0.05	0.00	0.00	0.00	0.00	0.04	0.03	0.00
5	-0.08	-0.06	0.03	0.01	0.06	0.01	0.01	0.01	0.00	0.04	0.05	0.01
6	-0.08	-0.06	0.03	0.01	0.06	0.01	0.01	0.01	0.01	0.06	0.05	0.01
7	-0.05	-0.04	0.05	0.02	0.07	0.01	0.02	0.01	0.01	0.06	0.05	0.03
8	-0.08	-0.07	0.03	0.01	0.06	0.01	0.01	0.01	0.01	0.05	0.04	0.01

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.01	-0.03	0.00	-0.08	-0.08	-0.18	-0.09	-0.03	0.01	0.01	0.01	0.01
2	-0.01	-0.03	0.00	-0.08	-0.08	-0.18	-0.09	-0.01	0.03	0.03	0.01	0.01
3	-0.01	-0.03	0.00	-0.08	-0.07	-0.16	-0.08	-0.01	0.03	0.03	0.01	0.01
4	-0.01	-0.03	0.00	-0.08	-0.08	-0.17	-0.09	-0.01	0.02	0.03	0.01	0.01
5	0.00	-0.03	0.01	-0.08	-0.07	-0.17	-0.08	-0.03	0.02	0.02	0.03	0.02
6	0.00	-0.03	0.01	-0.08	-0.07	-0.17	-0.08	0.00	0.04	0.04	0.03	0.02
7	0.00	-0.02	0.02	-0.05	-0.05	-0.14	-0.06	0.01	0.04	0.04	0.03	0.03
8	-0.01	-0.03	0.01	-0.08	-0.08	-0.17	-0.09	0.00	0.03	0.04	0.02	0.01

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.09	-0.04	0.02	0.03	-0.01	-0.02	-0.04	-0.05	-0.04	-0.03	-0.03	-0.03
2	-0.16	-0.04	0.02	0.03	-0.06	-0.07	-0.07	-0.08	-0.08	-0.07	-0.08	-0.08
3	-0.12	-0.02	0.02	0.03	-0.06	-0.07	-0.08	-0.09	-0.09	-0.08	-0.09	-0.09
4	-0.14	-0.05	0.00	0.02	-0.08	-0.09	-0.09	-0.10	-0.09	-0.08	-0.10	-0.10
5	-0.02	0.02	0.09	0.11	0.06	0.06	0.04	0.00	0.01	0.05	0.05	0.06
6	-0.07	0.02	0.09	0.11	0.01	0.01	0.01	-0.03	-0.02	0.01	0.00	0.00
7	-0.04	0.06	0.11	0.12	0.02	0.02	0.02	-0.02	-0.02	0.01	0.00	0.01
8	-0.05	0.01	0.07	0.09	0.00	0.00	0.00	-0.04	-0.04	0.00	-0.01	-0.01

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.02	-0.09	0.02	-0.05	-0.03	-0.08	-0.06	-0.06	-0.06	-0.05	-0.04	-0.04
2	-0.07	-0.09	0.02	-0.05	-0.08	-0.14	-0.08	-0.09	-0.09	-0.08	-0.09	-0.09
3	-0.08	-0.05	0.02	-0.02	-0.07	-0.10	-0.08	-0.10	-0.10	-0.09	-0.10	-0.10
4	-0.09	-0.09	0.00	-0.05	-0.09	-0.13	-0.09	-0.10	-0.10	-0.09	-0.11	-0.10
5	0.06	-0.03	0.10	0.01	0.05	0.00	0.02	0.00	0.00	0.04	0.04	0.05
6	0.00	-0.03	0.10	0.01	-0.01	-0.05	-0.01	-0.04	-0.03	0.00	-0.01	0.00
7	0.01	0.01	0.11	0.05	0.01	-0.02	0.01	-0.03	-0.03	0.01	-0.01	0.00
8	-0.01	-0.02	0.08	0.01	-0.01	-0.03	-0.01	-0.05	-0.05	-0.01	-0.02	-0.02

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.03	-0.01	-0.03	0.03	0.07	-0.04	-0.06	-0.05	-0.04	-0.03	0.01	0.00
2	-0.03	-0.01	-0.03	0.03	0.07	-0.04	-0.09	-0.08	-0.08	-0.06	0.01	0.00
3	-0.01	0.00	-0.01	0.03	0.07	-0.04	-0.08	-0.09	-0.09	-0.07	0.00	0.00
4	-0.04	-0.02	-0.04	0.01	0.06	-0.05	-0.10	-0.09	-0.09	-0.08	-0.01	-0.01
5	0.03	0.05	0.03	0.11	0.15	0.04	0.02	0.01	0.01	0.05	0.10	0.09
6	0.03	0.05	0.03	0.11	0.15	0.04	-0.01	-0.02	-0.02	0.02	0.10	0.09
7	0.07	0.08	0.06	0.12	0.16	0.05	0.01	-0.02	-0.02	0.03	0.10	0.10
8	0.02	0.04	0.02	0.09	0.13	0.02	-0.01	-0.04	-0.03	0.01	0.07	0.07

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.06	-0.05	0.02	0.01	0.05	0.00	0.01	-0.04	-0.04	-0.01	0.01	0.02
2	-0.06	-0.05	0.02	0.01	0.05	0.00	0.01	-0.08	-0.07	-0.04	0.01	0.02
3	-0.03	-0.03	0.03	0.01	0.04	-0.01	0.01	-0.09	-0.08	-0.05	0.00	0.02
4	-0.06	-0.06	0.01	-0.01	0.03	-0.02	0.00	-0.09	-0.09	-0.05	0.00	0.01
5	0.00	0.00	0.10	0.09	0.13	0.08	0.10	0.01	0.01	0.07	0.10	0.10
6	0.00	0.00	0.10	0.09	0.13	0.08	0.10	-0.03	-0.02	0.04	0.10	0.10
7	0.04	0.04	0.12	0.10	0.14	0.08	0.11	-0.02	-0.02	0.05	0.11	0.12
8	0.01	0.00	0.08	0.07	0.11	0.06	0.08	-0.04	-0.03	0.03	0.08	0.08

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	0.00	0.02	-0.06	-0.06	-0.14	-0.07	-0.08	-0.04	-0.04	0.02	0.01
2	0.00	0.00	0.02	-0.06	-0.06	-0.14	-0.07	-0.10	-0.08	-0.08	0.02	0.01
3	-0.01	0.00	0.02	-0.04	-0.03	-0.11	-0.07	-0.11	-0.09	-0.09	0.01	0.00
4	-0.02	-0.02	0.00	-0.07	-0.06	-0.14	-0.09	-0.12	-0.10	-0.09	0.00	-0.01
5	0.02	0.06	0.09	-0.01	0.00	-0.09	-0.01	-0.02	-0.03	0.00	0.10	0.09
6	0.02	0.06	0.09	-0.01	0.00	-0.09	-0.01	-0.05	-0.06	-0.02	0.10	0.09
7	0.01	0.07	0.11	0.03	0.04	-0.06	0.00	-0.04	-0.07	-0.03	0.10	0.10
8	0.00	0.05	0.07	-0.01	0.00	-0.10	-0.03	-0.06	-0.08	-0.04	0.08	0.08

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

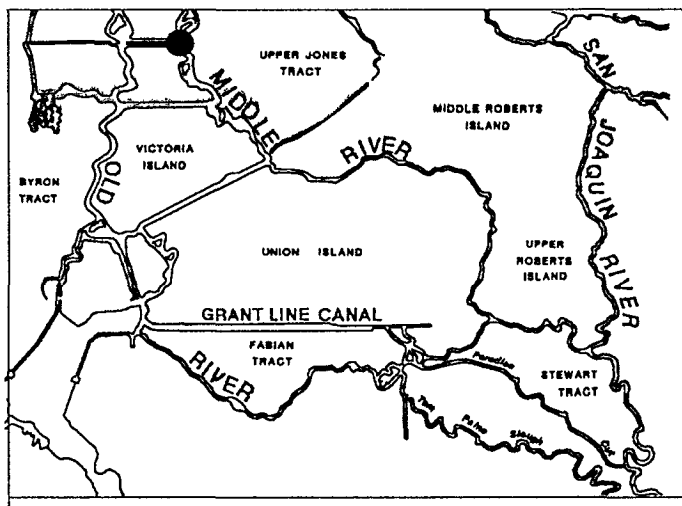

TABLE C-15 (cont.)
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

MIDDLE RIVER AT SANTA FE RAILROAD

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET) | IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.09	-0.08	0.00	0.01	-0.01	0.01	-0.01	-0.02	-0.02	-0.01	0.00	0.00	-0.06	-0.01	0.04	0.05	-0.01	0.00	-0.03	-0.03	-0.02	-0.03	-0.02	-0.02
2	-0.09	-0.08	0.00	0.01	-0.02	0.00	0.01	-0.01	-0.01	0.00	-0.01	-0.01	-0.13	-0.01	0.04	0.05	-0.06	-0.05	-0.06	-0.06	-0.05	-0.06	-0.07	-0.07
3	-0.14	-0.12	-0.02	-0.01	-0.03	-0.01	0.01	-0.02	-0.01	-0.01	-0.02	-0.02	-0.09	0.00	0.04	0.04	-0.06	-0.07	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08
4	-0.09	-0.07	0.00	0.01	-0.02	0.00	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.12	-0.02	0.03	0.03	-0.07	-0.07	-0.07	-0.07	-0.07	-0.08	-0.08	-0.08
5	-0.08	-0.07	0.01	0.01	-0.01	0.02	0.01	-0.02	-0.01	0.01	0.01	0.01	0.01	0.05	0.12	0.13	0.07	0.08	0.06	0.03	0.04	0.05	0.07	0.07
6	-0.09	-0.07	0.01	0.01	-0.01	0.01	0.03	0.00	0.00	0.02	0.01	0.01	-0.04	0.05	0.12	0.13	0.01	0.02	0.03	0.00	0.00	0.02	0.01	0.02
7	-0.18	-0.15	-0.05	-0.03	-0.05	-0.02	0.00	-0.02	-0.02	0.00	-0.01	-0.02	-0.03	0.07	0.12	0.13	0.02	0.02	0.02	-0.01	-0.01	0.01	0.01	0.01
8	-0.08	-0.07	0.01	0.01	-0.01	0.01	0.02	0.00	0.00	0.02	0.01	0.00	-0.03	0.05	0.10	0.11	0.01	0.02	0.02	-0.01	-0.01	0.00	0.00	0.01

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	-0.12	-0.01	-0.10	0.00	-0.07	-0.06	-0.03	-0.03	-0.02	-0.01	-0.01	-0.01	-0.06	0.04	-0.03	0.00	-0.05	-0.04	-0.03	-0.03	-0.04	-0.03	-0.02
2	-0.01	-0.12	-0.01	-0.10	0.00	-0.07	-0.04	-0.02	-0.02	-0.01	-0.02	-0.01	-0.06	-0.06	0.04	-0.03	-0.05	-0.11	-0.07	-0.07	-0.06	-0.08	-0.08	-0.08
3	-0.02	-0.17	-0.03	-0.14	-0.02	-0.11	-0.06	-0.03	-0.03	-0.02	-0.02	-0.02	-0.07	-0.03	0.03	-0.01	-0.05	-0.07	-0.06	-0.08	-0.08	-0.09	-0.09	-0.09
4	-0.01	-0.12	-0.01	-0.09	0.00	-0.06	-0.04	-0.02	-0.03	-0.02	-0.02	-0.02	-0.07	-0.06	0.02	-0.04	-0.07	-0.10	-0.08	-0.08	-0.08	-0.09	-0.09	-0.09
5	0.00	-0.12	0.00	-0.09	0.01	-0.06	-0.05	-0.02	-0.03	-0.01	0.01	0.01	0.07	0.01	0.11	0.03	0.07	0.03	0.04	0.03	0.03	0.04	0.06	0.07
6	0.00	-0.12	0.00	-0.09	0.01	-0.06	-0.04	-0.01	-0.02	0.00	0.00	0.00	0.02	0.01	0.11	0.03	0.02	-0.02	0.01	-0.01	-0.01	0.01	0.01	0.01
7	-0.04	-0.21	-0.05	-0.18	-0.04	-0.15	-0.09	-0.03	-0.04	-0.02	-0.02	-0.02	0.02	0.03	0.11	0.05	0.03	0.00	0.02	-0.02	-0.02	0.00	0.00	0.00
8	0.00	-0.12	0.00	-0.09	0.01	-0.06	-0.04	-0.01	-0.02	0.00	0.00	0.00	0.01	0.01	0.10	0.03	0.02	-0.01	0.01	-0.02	-0.02	0.00	-0.01	0.00

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.06	-0.04	-0.07	0.02	0.07	-0.07	-0.05	-0.02	-0.01	-0.02	-0.01	-0.01	0.00	0.02	0.00	0.06	0.10	-0.02	-0.05	-0.03	-0.03	-0.03	0.03	0.03
2	-0.06	-0.04	-0.07	0.02	0.07	-0.07	-0.03	0.00	0.00	0.00	-0.01	-0.01	0.00	0.02	0.00	0.06	0.10	-0.02	-0.07	-0.06	-0.06	-0.06	0.03	0.03
3	-0.10	-0.07	-0.11	0.00	0.06	-0.09	-0.05	-0.01	-0.01	-0.01	-0.02	-0.01	0.01	0.02	0.01	0.05	0.09	-0.03	-0.07	-0.08	-0.08	-0.07	0.01	0.02
4	-0.06	-0.04	-0.07	0.02	0.07	-0.07	-0.03	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.01	0.04	0.08	-0.04	-0.08	-0.08	-0.08	-0.07	0.01	0.01
5	-0.05	-0.03	-0.06	0.03	0.08	-0.06	-0.04	-0.01	0.00	0.00	0.00	0.00	0.06	0.08	0.06	0.13	0.18	0.06	0.04	0.03	0.03	0.06	0.11	0.12
6	-0.05	-0.03	-0.06	0.03	0.08	-0.06	-0.03	0.01	0.01	0.01	0.00	0.00	0.06	0.08	0.06	0.13	0.18	0.06	0.00	-0.01	-0.01	0.02	0.11	0.12
7	-0.13	-0.10	-0.14	-0.02	0.04	-0.11	-0.07	-0.01	-0.01	-0.02	-0.02	-0.03	0.08	0.10	0.08	0.13	0.18	0.06	0.01	-0.02	-0.01	0.02	0.10	0.11
8	-0.05	-0.03	-0.06	0.03	0.08	-0.06	-0.02	0.00	0.01	0.01	0.00	0.00	0.05	0.07	0.05	0.12	0.16	0.04	0.00	-0.02	-0.02	0.01	0.09	0.10

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.10	-0.09	0.01	0.00	0.04	-0.02	-0.02	-0.01	-0.01	0.01	0.01	-0.01	-0.03	-0.03	0.05	0.03	0.07	0.01	0.03	-0.03	-0.02	0.00	0.03	0.04
2	-0.10	-0.09	0.01	0.00	0.04	-0.02	-0.02	-0.01	-0.01	0.03	0.01	-0.01	-0.03	-0.03	0.05	0.03	0.07	0.01	0.03	-0.06	-0.06	-0.04	0.03	0.04
3	-0.15	-0.13	-0.01	-0.02	0.02	-0.03	-0.04	-0.02	-0.02	0.02	0.01	-0.04	-0.01	-0.01	0.05	0.02	0.06	0.00	0.03	-0.08	-0.07	-0.05	0.02	0.04
4	-0.10	-0.09	0.01	0.00	0.04	-0.02	-0.02	-0.01	-0.01	0.02	0.01	-0.01	-0.03	-0.03	0.04	0.01	0.05	-0.01	0.01	-0.08	-0.07	-0.05	0.01	0.02
5	-0.10	-0.08	0.01	0.00	0.05	-0.01	-0.01	0.00	-0.01	0.03	0.03	-0.01	0.03	0.04	0.13	0.11	0.15	0.09	0.11	0.03	0.03	0.08	0.12	0.12
6	-0.10	-0.08	0.01	0.00	0.05	-0.01	-0.01	0.00	0.00	0.04	0.03	-0.01	0.03	0.04	0.13	0.11	0.15	0.09	0.11	-0.01	-0.01	0.05	0.12	0.12
7	-0.19	-0.17	-0.04	-0.03	0.01	-0.04	-0.06	-0.02	-0.02	0.01	0.00	-0.07	0.05	0.06	0.13	0.11	0.15	0.09	0.12	-0.01	-0.01	0.04	0.11	0.13
8	-0.10	-0.08	0.01	0.00	0.04	-0.01	-0.01	0.00	0.00	0.04	0.03	-0.01	0.03	0.03	0.11	0.09	0.13	0.07	0.10	-0.02	-0.02	0.04	0.10	0.10

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.01	-0.04	-0.02	-0.09	-0.09	-0.18	-0.09	-0.03	0.01	0.00	0.00	0.00	0.02	0.02	0.04	-0.04	-0.03	-0.11	-0.04	-0.05	-0.01	-0.03	0.03	0.02
2	-0.01	-0.04	-0.02	-0.09	-0.09	-0.18	-0.09	0.00	0.03	0.02	0.00	0.00	0.02	0.02	0.04	-0.04	-0.03	-0.11	-0.04	-0.08	-0.05	-0.06	0.03	0.02
3	-0.01	-0.06	-0.03	-0.14	-0.13	-0.22	-0.11	-0.01	0.02	0.02	0.00	-0.01	0.00	0.01	0.03	-0.01	-0.01	-0.10	-0.05	-0.09	-0.07	-0.08	0.02	0.01
4	-0.01	-0.04	-0.02	-0.09	-0.09	-0.18	-0.09	-0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.02	-0.04	-0.03	-0.12	-0.06	-0.09	-0.07	-0.08	0.01	0.01
5	0.00	-0.04	-0.01	-0.08	-0.08	-0.18	-0.08	-0.02	0.01	0.01	0.02	0.01	0.04	0.08	0.11	0.03	0.03	-0.07	0.02	0.01	0.00	0.02	0.12	0.11
6	0.00	-0.04	-0.01	-0.08	-0.08	-0.18	-0.08	0.01	0.03	0.04	0.02	0.01	0.04	0.08	0.11	0.03	0.03	-0.07	0.02	-0.02	-0.04	-0.01	0.12	0.11
7	-0.01	-0.07	-0.05	-0.17	-0.17	-0.24	-0.13	-0.02	0.02	0.02	0.00	-0.03	0.02	0.08	0.11	0.05	0.05	-0.06	0.02	-0.03	-0.06	-0.03	0.11	0.11
8	0.00	-0.04	-0.01	-0.08	-0.08	-0.18	-0.08	0.00	0.03	0.03	0.02	0.01	0.02	0.06	0.09	0.03	0.04	-0.08	0.00	-0.03	-0.05	-0.02	0.10	0.09

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

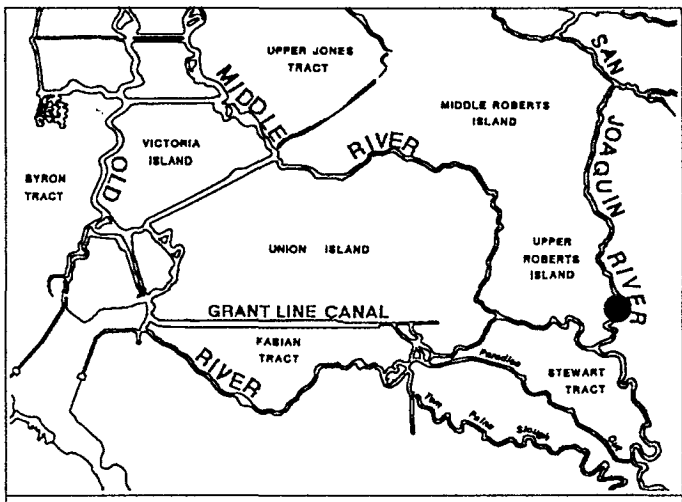

TABLE C-15 (cont.)
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

SAN JOAQUIN RIVER NEAR LATHROP

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET) | IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.04	0.00	0.10	0.12	0.18	0.17	1.43	1.21	0.97	0.90	0.16	0.16	0.07	0.00	0.06	0.06	0.12	0.12	2.04	1.79	1.48	1.43	0.13	0.13
2	0.26	0.00	0.10	0.12	0.38	0.36	0.39	0.33	0.35	0.42	0.37	0.37	0.44	0.00	0.06	0.06	0.60	0.59	0.63	0.57	0.56	0.66	0.62	0.63
3	0.32	0.07	0.15	0.16	0.44	0.39	0.42	0.37	0.39	0.39	0.38	0.39	0.56	0.05	0.09	0.08	0.64	0.61	0.65	0.60	0.59	0.65	0.64	0.66
4	0.24	0.00	0.09	0.10	0.36	0.34	0.38	0.32	0.35	0.37	0.35	0.36	0.45	-0.01	0.05	0.04	0.56	0.56	0.61	0.55	0.54	0.61	0.60	0.61
5	0.07	0.02	0.12	0.15	0.20	0.19	1.44	1.22	0.98	0.91	0.15	0.17	0.12	0.04	0.12	0.14	0.19	0.20	2.04	1.79	1.48	1.43	0.17	0.20
6	0.31	0.02	0.12	0.15	0.42	0.39	0.42	0.34	0.34	0.35	0.34	0.38	0.44	0.04	0.12	0.14	0.67	0.66	0.70	0.61	0.57	0.61	0.63	0.69
7	0.42	0.15	0.23	0.26	0.53	0.46	0.47	0.40	0.42	0.44	0.43	0.45	0.64	0.15	0.20	0.22	0.76	0.72	0.75	0.66	0.64	0.68	0.70	0.75
8	0.31	0.05	0.14	0.16	0.40	0.37	0.40	0.32	0.33	0.35	0.33	0.36	0.47	0.06	0.13	0.14	0.65	0.64	0.68	0.58	0.55	0.59	0.61	0.67

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.16	-0.03	0.09	0.00	0.20	0.08	1.34	0.94	0.86	0.82	0.10	0.15	0.12	-0.04	0.04	0.00	0.16	0.09	1.86	1.47	1.38	1.37	0.07	0.12
2	0.37	-0.03	0.09	0.00	0.42	0.30	0.31	0.31	0.31	0.33	0.31	0.37	0.63	-0.04	0.04	0.00	0.66	0.52	0.57	0.56	0.55	0.58	0.56	0.63
3	0.41	0.06	0.13	0.10	0.46	0.38	0.36	0.36	0.36	0.33	0.31	0.38	0.64	0.03	0.06	0.07	0.68	0.63	0.58	0.60	0.60	0.59	0.57	0.65
4	0.35	-0.03	0.08	0.00	0.39	0.27	0.28	0.31	0.31	0.30	0.28	0.35	0.59	-0.05	0.02	-0.02	0.61	0.52	0.51	0.55	0.54	0.55	0.53	0.61
5	0.19	0.01	0.11	0.04	0.23	0.12	1.35	0.95	0.87	0.83	0.08	0.15	0.20	0.01	0.12	0.05	0.24	0.15	1.86	1.46	1.38	1.37	0.10	0.18
6	0.41	0.01	0.11	0.04	0.46	0.35	0.36	0.31	0.31	0.28	0.26	0.35	0.70	0.01	0.12	0.05	0.71	0.49	0.62	0.60	0.59	0.57	0.55	0.66
7	0.49	0.17	0.22	0.21	0.56	0.51	0.46	0.39	0.39	0.38	0.35	0.42	0.77	0.14	0.19	0.19	0.82	0.74	0.73	0.66	0.66	0.65	0.62	0.72
8	0.39	0.03	0.13	0.07	0.45	0.35	0.34	0.30	0.30	0.28	0.26	0.33	0.68	0.03	0.12	0.07	0.70	0.53	0.61	0.57	0.57	0.56	0.53	0.63

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.03	0.07	0.02	0.10	0.17	0.00	1.51	1.27	1.01	1.09	0.09	0.07	0.01	0.04	0.01	0.06	0.11	-0.01	2.12	1.85	1.51	1.55	0.05	0.04
2	0.03	0.07	0.02	0.10	0.17	0.00	0.31	0.35	0.37	0.39	0.09	0.07	0.01	0.04	0.01	0.06	0.11	-0.01	0.59	0.59	0.58	0.58	0.05	0.04
3	0.12	0.14	0.10	0.14	0.20	0.05	0.35	0.38	0.41	0.44	0.10	0.09	0.06	0.08	0.06	0.08	0.13	0.01	0.60	0.61	0.62	0.61	0.07	0.05
4	0.03	0.06	0.01	0.09	0.16	-0.02	0.29	0.34	0.36	0.38	0.06	0.06	-0.01	0.01	0.00	0.04	0.10	-0.04	0.54	0.57	0.57	0.56	0.04	0.02
5	0.07	0.10	0.05	0.12	0.19	0.03	1.52	1.27	1.02	1.10	0.09	0.10	0.08	0.11	0.07	0.12	0.18	0.07	2.12	1.85	1.50	1.54	0.12	0.12
6	0.07	0.10	0.05	0.12	0.19	0.03	0.36	0.36	0.36	0.41	0.09	0.10	0.08	0.11	0.07	0.12	0.18	0.07	0.62	0.63	0.61	0.63	0.12	0.12
7	0.23	0.25	0.20	0.22	0.28	0.17	0.45	0.42	0.44	0.51	0.19	0.18	0.20	0.22	0.18	0.19	0.24	0.16	0.74	0.68	0.68	0.72	0.18	0.18
8	0.10	0.13	0.08	0.14	0.20	0.05	0.34	0.34	0.35	0.39	0.10	0.10	0.08	0.11	0.08	0.12	0.18	0.07	0.61	0.61	0.59	0.61	0.11	0.12

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.02	0.00	0.09	0.09	0.08	0.05	0.08	0.75	0.78	1.16	0.19	0.09	-0.01	-0.01	0.06	0.04	0.04	0.02	0.04	1.23	1.26	1.61	0.10	0.05
2	-0.02	0.00	0.09	0.09	0.08	0.05	0.08	0.36	0.36	0.47	0.19	0.09	-0.01	-0.01	0.06	0.04	0.04	0.02	0.04	0.57	0.56	0.64	0.10	0.05
3	0.07	0.07	0.14	0.12	0.10	0.08	0.12	0.42	0.42	0.50	0.20	0.14	0.05	0.04	0.09	0.06	0.05	0.03	0.06	0.62	0.61	0.67	0.13	0.08
4	-0.01	0.00	0.09	0.08	0.08	0.04	0.07	0.36	0.36	0.45	0.17	0.08	-0.03	-0.02	0.04	0.02	0.03	0.00	0.02	0.56	0.55	0.62	0.09	0.02
5	0.02	0.02	0.11	0.11	0.10	0.08	0.11	0.77	0.79	1.17	0.20	0.12	0.02	0.03	0.12	0.12	0.08	0.09	0.12	1.25	1.27	1.61	0.18	0.13
6	0.02	0.02	0.11	0.11	0.10	0.08	0.11	0.35	0.35	0.48	0.20	0.12	0.02	0.03	0.12	0.12	0.08	0.09	0.12	0.59	0.58	0.69	0.18	0.13
7	0.17	0.15	0.22	0.22	0.16	0.15	0.22	0.46	0.45	0.56	0.30	0.25	0.15	0.14	0.20	0.19	0.12	0.14	0.19	0.68	0.67	0.76	0.25	0.22
8	0.04	0.05	0.13	0.12	0.10	0.08	0.13	0.35	0.34	0.46	0.20	0.14	0.05	0.04	0.12	0.12	0.09	0.09	0.12	0.58	0.57	0.67	0.17	0.13

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.02	-0.06	0.13	-0.02	-0.02	-0.07	-0.02	2.42	1.79	2.08	0.13	0.08	-0.01	-0.03	0.06	-0.01	-0.02	-0.05	-0.02	3.07	2.51	2.78	0.07	0.04
2	0.02	-0.06	0.13	-0.02	-0.02	-0.07	-0.02	0.30	0.38	0.34	0.13	0.08	-0.01	-0.03	0.06	-0.01	-0.02	-0.05	-0.02	0.59	0.67	0.60	0.07	0.04
3	0.04	0.01	0.21	0.06	0.05	-0.02	0.00	0.32	0.38	0.36	0.14	0.11	0.03	0.01	0.11	0.04	0.03	-0.01	-0.01	0.59	0.67	0.61	0.09	0.05
4	0.01	-0.07	0.12	-0.02	-0.01	-0.06	-0.02	0.29	0.36	0.33	0.11	0.07	-0.01	-0.05	0.04	-0.02	-0.02	-0.04	-0.02	0.56	0.64	0.58	0.06	0.02
5	0.01	-0.04	0.15	0.01	0.00	-0.06	-0.01	2.42	1.79	2.08	0.14	0.11	0.01	0.03	0.13	0.02	0.01	-0.03	0.00	3.07	2.51	2.78	0.15	0.12
6	0.01	-0.04	0.15	0.01	0.00	-0.06	-0.01	0.31	0.35	0.33	0.14	0.11	0.01	0.03	0.13	0.02	0.01	-0.03	0.00	0.59	0.62	0.62	0.15	0.12
7	0.05	0.09	0.32	0.14	0.12	0.01	0.03	0.35	0.37	0.36	0.24	0.20	0.05	0.12	0.24	0.13	0.11	0.02	0.03	0.62	0.65	0.64	0.21	0.18
8	0.01	-0.03	0.17	0.03	0.03	-0.04	0.00	0.30	0.35	0.32	0.14	0.12	0.01	0.03	0.13	0.04	0.03	-0.02	0.01	0.56	0.61	0.60	0.14	0.11

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

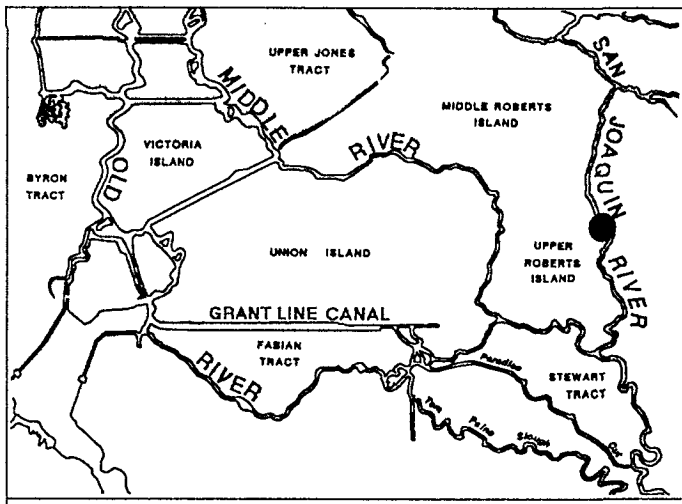

TABLE C-15 (cont.)
PHASE II MODELING

IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS IN THE SOUTH DELTA

SAN JOAQUIN RIVER AT BRANDT BRIDGE

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.01	-0.01	0.06	0.07	0.10	0.10	0.86	0.72	0.57	0.52	0.09	0.09	0.04	0.00	0.07	0.07	0.09	0.10	1.37	1.21	0.96	0.90	0.09	0.09
2	0.14	-0.01	0.06	0.07	0.22	0.21	0.24	0.19	0.20	0.25	0.21	0.22	0.37	0.00	0.07	0.07	0.37	0.37	0.40	0.35	0.34	0.41	0.37	0.38
3	0.17	0.04	0.09	0.09	0.26	0.23	0.25	0.22	0.23	0.23	0.22	0.23	0.41	0.05	0.09	0.09	0.39	0.38	0.41	0.37	0.37	0.40	0.39	0.40
4	0.13	-0.01	0.06	0.06	0.21	0.20	0.23	0.19	0.20	0.21	0.20	0.21	0.33	-0.01	0.05	0.05	0.33	0.34	0.38	0.33	0.33	0.37	0.35	0.36
5	0.03	0.01	0.08	0.09	0.11	0.11	0.87	0.73	0.58	0.53	0.08	0.10	0.06	0.02	0.10	0.12	0.14	0.15	1.38	1.21	0.97	0.91	0.11	0.14
6	0.17	0.01	0.08	0.09	0.24	0.23	0.25	0.20	0.19	0.20	0.19	0.22	0.40	0.02	0.10	0.12	0.41	0.42	0.45	0.38	0.35	0.36	0.37	0.43
7	0.24	0.09	0.14	0.15	0.31	0.27	0.29	0.24	0.24	0.25	0.24	0.26	0.49	0.12	0.17	0.18	0.49	0.47	0.49	0.42	0.40	0.42	0.43	0.47
8	0.17	0.02	0.09	0.09	0.23	0.22	0.24	0.19	0.19	0.20	0.18	0.21	0.39	0.03	0.10	0.11	0.40	0.40	0.43	0.36	0.33	0.35	0.36	0.41

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.09	-0.05	0.05	-0.02	0.11	0.03	0.79	0.56	0.50	0.47	0.05	0.09	0.09	-0.03	0.06	0.01	0.14	0.07	1.28	0.96	0.88	0.85	0.04	0.09
2	0.21	-0.05	0.05	-0.02	0.24	0.16	0.17	0.18	0.18	0.18	0.17	0.21	0.39	-0.03	0.06	0.01	0.44	0.35	0.35	0.33	0.33	0.34	0.32	0.38
3	0.23	0.01	0.07	0.04	0.26	0.20	0.20	0.21	0.21	0.18	0.17	0.22	0.40	0.04	0.07	0.07	0.45	0.40	0.36	0.36	0.36	0.35	0.33	0.39
4	0.20	-0.05	0.04	-0.02	0.22	0.14	0.16	0.18	0.17	0.17	0.15	0.20	0.36	-0.04	0.03	-0.01	0.40	0.31	0.30	0.32	0.32	0.32	0.30	0.36
5	0.11	-0.02	0.06	0.01	0.13	0.06	0.80	0.56	0.51	0.48	0.03	0.08	0.15	-0.01	0.10	0.03	0.19	0.09	1.29	0.97	0.89	0.86	0.05	0.12
6	0.24	-0.02	0.06	0.01	0.26	0.19	0.20	0.18	0.17	0.15	0.14	0.20	0.45	-0.01	0.10	0.03	0.49	0.39	0.40	0.35	0.35	0.33	0.31	0.40
7	0.28	0.08	0.13	0.11	0.33	0.28	0.27	0.23	0.23	0.21	0.19	0.24	0.50	0.12	0.16	0.15	0.56	0.50	0.47	0.41	0.40	0.40	0.37	0.45
8	0.22	-0.01	0.07	0.02	0.26	0.19	0.20	0.17	0.17	0.15	0.13	0.19	0.43	0.00	0.09	0.04	0.47	0.37	0.38	0.34	0.33	0.32	0.29	0.38

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	0.03	0.00	0.06	0.12	-0.02	0.91	0.75	0.59	0.64	0.06	0.05	0.03	0.05	0.02	0.07	0.13	0.00	1.43	1.25	1.00	1.02	0.05	0.04
2	0.00	0.03	0.00	0.06	0.12	-0.02	0.18	0.20	0.21	0.22	0.06	0.05	0.03	0.05	0.02	0.07	0.13	0.00	0.36	0.37	0.35	0.35	0.05	0.04
3	0.06	0.07	0.05	0.09	0.14	0.01	0.20	0.22	0.24	0.25	0.06	0.06	0.07	0.09	0.07	0.09	0.14	0.01	0.37	0.39	0.38	0.38	0.06	0.05
4	0.00	0.02	0.00	0.06	0.12	-0.03	0.16	0.20	0.20	0.22	0.04	0.04	0.01	0.03	0.00	0.06	0.11	-0.03	0.32	0.35	0.34	0.34	0.03	0.02
5	0.03	0.05	0.02	0.08	0.14	0.00	0.92	0.76	0.60	0.65	0.05	0.06	0.06	0.09	0.04	0.11	0.16	0.04	1.44	1.26	1.01	1.03	0.09	0.09
6	0.03	0.05	0.02	0.08	0.14	0.00	0.21	0.21	0.21	0.23	0.05	0.06	0.06	0.09	0.04	0.11	0.16	0.04	0.41	0.40	0.38	0.39	0.09	0.09
7	0.12	0.14	0.12	0.14	0.19	0.08	0.26	0.24	0.25	0.29	0.11	0.12	0.17	0.19	0.15	0.17	0.22	0.12	0.48	0.44	0.43	0.46	0.14	0.14
8	0.04	0.06	0.04	0.08	0.14	0.01	0.20	0.20	0.20	0.23	0.05	0.07	0.06	0.09	0.05	0.11	0.16	0.03	0.39	0.38	0.36	0.38	0.07	0.08

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.03	-0.02	0.06	0.05	0.05	0.03	0.05	0.43	0.44	0.69	0.12	0.05	-0.01	0.00	0.07	0.05	0.05	0.02	0.04	0.74	0.76	1.08	0.09	0.06
2	-0.03	-0.02	0.06	0.05	0.05	0.03	0.05	0.20	0.20	0.27	0.12	0.05	-0.01	0.00	0.07	0.05	0.05	0.02	0.04	0.34	0.33	0.40	0.09	0.06
3	0.03	0.02	0.09	0.08	0.07	0.04	0.07	0.24	0.24	0.29	0.13	0.09	0.05	0.05	0.09	0.06	0.06	0.03	0.06	0.37	0.36	0.42	0.11	0.09
4	-0.03	-0.02	0.05	0.05	0.05	0.02	0.04	0.20	0.20	0.26	0.10	0.05	-0.02	-0.01	0.05	0.02	0.04	0.00	0.02	0.33	0.32	0.38	0.08	0.04
5	0.00	0.00	0.07	0.07	0.07	0.04	0.06	0.44	0.45	0.70	0.11	0.08	0.00	0.01	0.10	0.09	0.08	0.07	0.09	0.76	0.77	1.09	0.14	0.11
6	0.00	0.00	0.07	0.07	0.07	0.04	0.06	0.20	0.19	0.28	0.11	0.08	0.00	0.01	0.10	0.09	0.08	0.07	0.09	0.35	0.34	0.44	0.14	0.11
7	0.09	0.08	0.14	0.14	0.11	0.09	0.13	0.26	0.25	0.33	0.18	0.16	0.12	0.12	0.17	0.15	0.12	0.11	0.15	0.42	0.41	0.50	0.19	0.19
8	0.01	0.01	0.08	0.08	0.07	0.05	0.07	0.19	0.19	0.27	0.12	0.09	0.02	0.03	0.10	0.08	0.08	0.06	0.08	0.34	0.33	0.42	0.12	0.10

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.01	-0.04	0.07	-0.02	-0.03	-0.08	-0.04	1.54	1.09	1.30	0.09	0.05	0.00	-0.01	0.06	-0.01	-0.02	-0.07	-0.02	2.22	1.73	1.95	0.06	0.04
2	0.01	-0.04	0.07	-0.02	-0.03	-0.08	-0.04	0.17	0.23	0.21	0.09	0.05	0.00	-0.01	0.06	-0.01	-0.02	-0.07	-0.02	0.38	0.44	0.38	0.06	0.04
3	0.02	0.00	0.12	0.02	0.01	-0.05	-0.02	0.18	0.22	0.22	0.09	0.07	0.02	0.01	0.10	0.04	0.03	-0.03	-0.01	0.38	0.44	0.40	0.08	0.05
4	0.00	-0.04	0.07	-0.02	-0.03	-0.08	-0.04	0.16	0.21	0.21	0.08	0.04	-0.01	-0.04	0.04	-0.02	-0.02	-0.06	-0.02	0.35	0.42	0.37	0.05	0.02
5	0.00	-0.03	0.08	-0.01	-0.01	-0.07	-0.03	1.55	1.09	1.30	0.09	0.06	0.01	0.02	0.10	0.00	-0.01	-0.06	-0.01	2.22	1.72	1.95	0.11	0.09
6	0.00	-0.03	0.08	-0.01	-0.01	-0.07	-0.03	0.17	0.21	0.20	0.09	0.06	0.01	0.02	0.10	0.00	-0.01	-0.06	-0.01	0.41	0.40	0.40	0.11	0.09
7	0.03	0.05	0.18	0.07	0.06	-0.03	0.00	0.19	0.22	0.22	0.14	0.12	0.04	0.09	0.19	0.11	0.09	-0.01	0.02	0.43	0.42	0.42	0.16	0.14
8	0.00	-0.02	0.09	0.01	0.00	-0.06	-0.02	0.16	0.21	0.20	0.09	0.07	0.00	0.01	0.09	0.02	0.01	-0.05	0.00	0.39	0.38	0.38	0.09	0.08

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

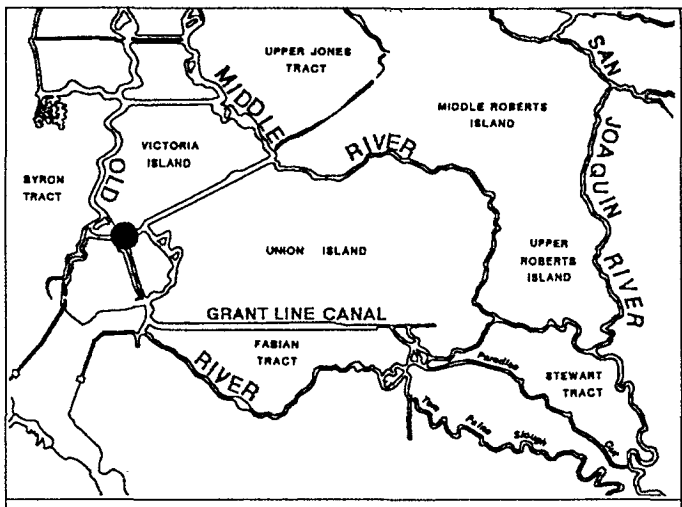

TABLE C-16
PHASE II MODELING

CHANGE IN MINIMUM AND AVERAGE WATER LEVELS IN VICINITY OF PROPOSED FOREBAY INTAKE GATES

OLD RIVER AT NORTH END OF WEST CANAL

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.19	-0.14	0.08	0.09	0.06	0.09	0.05	-0.02	0.02	0.06	0.07	0.06
2	-0.19	-0.14	0.08	0.09	0.07	0.10	0.15	0.06	0.08	0.11	0.07	0.07
3	0.08	0.09	0.22	0.17	0.15	0.14	0.16	0.09	0.10	0.08	0.06	0.07
4	-0.12	-0.09	0.10	0.09	0.07	0.09	0.13	0.05	0.06	0.06	0.04	0.04
5	-0.22	-0.17	0.05	0.07	0.03	0.07	0.03	-0.03	0.02	0.07	0.07	0.06
6	-0.23	-0.17	0.05	0.07	0.03	0.07	0.12	0.04	0.07	0.11	0.07	0.06
7	0.23	0.25	0.37	0.32	0.27	0.27	0.30	0.17	0.19	0.23	0.19	0.21
8	-0.07	-0.03	0.16	0.15	0.11	0.13	0.17	0.08	0.10	0.14	0.10	0.10

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.07	-0.22	0.05	-0.18	0.13	-0.13	-0.11	-0.03	-0.04	0.01	0.04	0.07
2	0.08	-0.22	0.05	-0.18	0.14	-0.13	-0.01	0.03	0.02	0.06	0.05	0.07
3	0.14	0.03	0.15	0.08	0.24	0.11	0.10	0.06	0.05	0.04	0.03	0.06
4	0.07	-0.16	0.06	-0.12	0.14	-0.07	0.00	0.02	0.01	0.03	0.01	0.04
5	0.05	-0.25	0.03	-0.21	0.09	-0.17	-0.15	-0.04	-0.05	0.00	0.04	0.07
6	0.04	-0.25	0.03	-0.21	0.09	-0.17	-0.06	0.01	0.01	0.05	0.04	0.06
7	0.27	0.20	0.30	0.24	0.37	0.26	0.23	0.15	0.14	0.18	0.16	0.20
8	0.11	-0.11	0.12	-0.06	0.18	-0.03	0.04	0.05	0.04	0.09	0.07	0.10

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.10	-0.03	-0.12	0.10	0.24	-0.11	-0.10	0.00	0.02	0.05	0.05	0.05
2	-0.10	-0.03	-0.12	0.10	0.24	-0.11	0.01	0.07	0.08	0.12	0.05	0.05
3	0.11	0.15	0.11	0.21	0.33	0.00	0.12	0.10	0.11	0.15	0.04	0.08
4	-0.06	0.00	-0.07	0.11	0.24	-0.10	0.02	0.06	0.07	0.10	0.01	0.03
5	-0.13	-0.06	-0.15	0.08	0.22	-0.13	-0.14	-0.01	0.01	0.02	0.05	0.04
6	-0.13	-0.06	-0.15	0.08	0.22	-0.13	-0.04	0.06	0.07	0.09	0.05	0.04
7	0.26	0.30	0.26	0.36	0.48	0.15	0.25	0.19	0.19	0.28	0.21	0.25
8	0.00	0.06	-0.01	0.17	0.31	-0.04	0.06	0.10	0.10	0.14	0.10	0.11

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.20	-0.17	0.09	0.05	0.14	0.02	0.04	0.02	0.02	0.14	0.13	0.04
2	-0.20	-0.17	0.09	0.05	0.14	0.02	0.04	0.06	0.06	0.21	0.13	0.04
3	0.05	0.07	0.23	0.13	0.23	0.08	0.14	0.10	0.10	0.23	0.12	0.17
4	-0.14	-0.11	0.11	0.05	0.16	0.02	0.04	0.05	0.05	0.19	0.10	0.05
5	-0.23	-0.20	0.06	0.03	0.13	0.01	0.01	0.01	0.00	0.12	0.13	0.00
6	-0.23	-0.20	0.06	0.03	0.13	0.01	0.01	0.05	0.05	0.19	0.13	0.00
7	0.23	0.23	0.38	0.27	0.38	0.22	0.30	0.18	0.18	0.36	0.30	0.33
8	-0.09	-0.05	0.17	0.11	0.22	0.08	0.11	0.08	0.08	0.24	0.18	0.11

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.03	-0.11	0.03	-0.17	-0.17	-0.35	-0.18	-0.09	0.01	0.02	0.08	0.05
2	-0.03	-0.11	0.03	-0.17	-0.17	-0.35	-0.18	0.04	0.09	0.12	0.08	0.05
3	0.01	-0.03	0.13	0.07	0.08	-0.08	0.00	0.08	0.09	0.14	0.08	0.11
4	-0.02	-0.11	0.03	-0.11	-0.10	-0.25	-0.11	0.04	0.08	0.11	0.05	0.04
5	-0.02	-0.13	0.01	-0.20	-0.20	-0.38	-0.19	-0.10	0.03	0.03	0.08	0.03
6	-0.02	-0.13	0.01	-0.20	-0.20	-0.38	-0.19	0.03	0.10	0.13	0.08	0.03
7	0.05	0.10	0.27	0.23	0.25	0.02	0.12	0.17	0.13	0.22	0.24	0.27
8	0.00	-0.06	0.09	-0.05	-0.04	-0.22	-0.06	0.07	0.11	0.16	0.13	0.11

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.15	-0.07	-0.01	0.00	-0.05	-0.05	-0.11	-0.15	-0.12	-0.08	-0.07	-0.07
2	-0.25	-0.07	-0.01	0.00	-0.10	-0.12	-0.12	-0.16	-0.15	-0.11	-0.14	-0.14
3	-0.19	-0.02	0.02	0.03	-0.12	-0.13	-0.13	-0.17	-0.15	-0.13	-0.16	-0.16
4	-0.23	-0.05	0.00	0.01	-0.13	-0.14	-0.14	-0.17	-0.16	-0.13	-0.16	-0.16
5	-0.17	-0.12	0.20	0.24	0.16	0.17	0.11	0.01	0.03	0.13	0.15	0.17
6	-0.19	-0.12	0.20	0.24	0.06	0.07	0.08	-0.02	-0.01	0.09	0.05	0.06
7	0.06	0.28	0.33	0.34	0.12	0.12	0.13	0.02	0.03	0.13	0.09	0.11
8	0.05	0.22	0.28	0.29	0.09	0.09	0.11	0.00	0.01	0.10	0.07	0.09

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.06	-0.11	-0.01	-0.10	-0.07	-0.13	-0.12	-0.15	-0.14	-0.11	-0.08	-0.07
2	-0.12	-0.11	-0.01	-0.10	-0.13	-0.22	-0.11	-0.17	-0.17	-0.12	-0.15	-0.14
3	-0.14	-0.05	0.02	-0.04	-0.13	-0.15	-0.12	-0.17	-0.17	-0.14	-0.17	-0.16
4	-0.15	-0.09	0.00	-0.08	-0.15	-0.20	-0.14	-0.18	-0.18	-0.14	-0.17	-0.16
5	0.16	-0.21	0.23	-0.19	0.15	-0.10	0.09	0.01	0.01	0.11	0.14	0.17
6	0.05	-0.21	0.23	-0.19	0.03	-0.11	0.04	-0.03	-0.03	0.07	0.04	0.06
7	0.11	0.23	0.33	0.24	0.11	0.08	0.12	0.01	0.01	0.11	0.08	0.11
8	0.08	0.17	0.29	0.18	0.07	0.06	0.08	-0.01	-0.01	0.09	0.06	0.09

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.06	-0.04	-0.06	0.00	0.02	-0.06	-0.13	-0.16	-0.14	-0.09	-0.01	-0.02
2	-0.06	-0.04	-0.06	0.00	0.02	-0.06	-0.12	-0.18	-0.16	-0.10	-0.01	-0.02
3	-0.02	0.00	-0.01	0.03	0.05	-0.04	-0.14	-0.18	-0.16	-0.11	0.00	0.00
4	-0.05	-0.03	-0.05	0.01	0.03	-0.06	-0.15	-0.19	-0.17	-0.12	-0.01	-0.01
5	-0.07	0.00	-0.11	0.24	0.27	0.18	0.07	0.00	0.02	0.12	0.23	0.25
6	-0.07	0.00	-0.11	0.24	0.27	0.18	0.04	-0.03	-0.02	0.08	0.23	0.25
7	0.28	0.30	0.27	0.35	0.37	0.28	0.12	0.01	0.02	0.13	0.31	0.34
8	0.22	0.24	0.21	0.30	0.33	0.23	0.08	-0.01	0.00	0.10	0.28	0.30

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.09	-0.09	-0.02	-0.01	0.00	-0.03	-0.01	-0.12	-0.12	-0.07	0.00	-0.01
2	-0.09	-0.09	-0.02	-0.01	0.00	-0.03	-0.01	-0.15	-0.15	-0.08	0.00	-0.01
3	-0.03	-0.03	0.02	0.01	0.04	-0.02	0.01	-0.15	-0.15	-0.10	0.01	0.02
4	-0.07	-0.07	-0.01	-0.01	0.02	-0.03	-0.01	-0.16	-0.16	-0.10	0.00	0.00
5	-0.19	-0.15	0.19	0.22	0.25	0.20	0.24	0.03	0.03	0.15	0.26	0.18
6	-0.19	-0.15	0.19	0.22	0.25	0.20	0.24	-0.02	-0.01	0.11	0.26	0.18
7	0.26	0.27	0.33	0.32	0.37	0.28	0.34	0.02	0.03	0.16	0.35	0.35
8	0.20	0.20	0.28	0.28	0.33	0.25	0.29	0.00	0.00	0.13	0.31	0.29

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.10	-0.05	-0.01	-0.10	-0.11	-0.32	-0.18	-0.21	-0.21	-0.18	-0.01	-0.01
2	-0.10	-0.05	-0.01	-0.10	-0.11	-0.32	-0.18	-0.22	-0.24	-0.20	-0.01	-0.01
3	-0.03	-0.02	0.02	-0.04	-0.04	-0.12	-0.08	-0.21	-0.22	-0.19	0.00	0.00
4	-0.05	-0.04	-0.01	-0.08	-0.08	-0.16	-0.11	-0.22	-0.23	-0.20	-0.01	-0.01
5	-0.04	0.15	0.22	-0.23	-0.24	-0.43	-0.03	-0.06	-0.16	-0.05	0.24	0.25
6	-0.04	0.15	0.22	-0.23	-0.24	-0.43	-0.03	-0.07	-0.19	-0.06	0.24	0.25
7	0.04	0.24	0.31	0.24	0.26	0.09	0.21	-0.02	-0.15	-0.02	0.32	0.34
8	0.02	0.20	0.27	0.18	0.20	0.02	0.16	-0.04	-0.16	-0.04	0.29	0.30

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

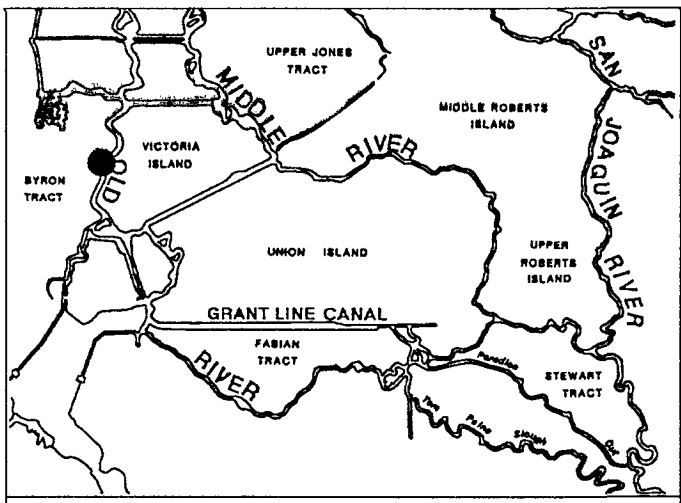

TABLE C-16 (cont.)
PHASE II MODELING

CHANGE IN MINIMUM AND AVERAGE WATER LEVELS IN VICINITY OF PROPOSED FOREBAY INTAKE GATES

OLD RIVER AT HIGHWAY 4

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.13	-0.09	0.06	0.06	0.04	0.06	0.03	-0.01	0.01	0.03	0.04	0.04
2	-0.14	-0.09	0.06	0.06	0.04	0.06	0.09	0.04	0.05	0.07	0.04	0.04
3	-0.01	0.02	0.13	0.09	0.08	0.08	0.10	0.05	0.06	0.04	0.03	0.03
4	-0.27	-0.23	-0.04	-0.02	-0.03	0.01	0.05	-0.01	0.01	0.02	0.00	0.00
5	-0.14	-0.10	0.05	0.06	0.04	0.06	0.04	-0.01	0.02	0.06	0.06	0.05
6	-0.15	-0.10	0.05	0.06	0.03	0.06	0.10	0.04	0.06	0.09	0.05	0.05
7	0.09	0.12	0.22	0.18	0.16	0.16	0.18	0.10	0.12	0.14	0.12	0.12
8	-0.32	-0.27	-0.07	-0.04	-0.07	-0.02	0.02	-0.02	0.00	0.03	-0.01	-0.02

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.04	-0.16	0.04	-0.13	0.09	-0.08	-0.08	-0.03	-0.03	-0.01	0.02	0.04
2	0.04	-0.16	0.04	-0.13	0.09	-0.09	-0.02	0.01	0.00	0.03	0.02	0.04
3	0.07	-0.04	0.09	0.00	0.14	0.03	0.03	0.02	0.02	0.01	0.01	0.03
4	-0.03	-0.32	-0.04	-0.28	0.00	-0.22	-0.11	-0.04	-0.04	-0.02	-0.02	0.00
5	0.04	-0.16	0.04	-0.13	0.08	-0.09	-0.09	-0.02	-0.03	0.01	0.04	0.06
6	0.03	-0.16	0.04	-0.13	0.07	-0.09	-0.04	0.01	0.01	0.04	0.04	0.05
7	0.15	0.07	0.18	0.10	0.22	0.13	0.12	0.08	0.07	0.10	0.10	0.12
8	-0.06	-0.36	-0.07	-0.32	-0.03	-0.26	-0.15	-0.05	-0.06	-0.03	-0.02	-0.01

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.07	-0.02	-0.08	0.08	0.18	-0.08	-0.07	0.00	0.01	0.03	0.03	0.03
2	-0.07	-0.02	-0.08	0.08	0.18	-0.08	0.00	0.05	0.05	0.08	0.03	0.03
3	0.04	0.07	0.03	0.13	0.22	-0.03	0.04	0.06	0.06	0.09	0.02	0.05
4	-0.20	-0.15	-0.22	0.00	0.11	-0.17	-0.09	0.01	0.01	0.02	-0.01	-0.02
5	-0.07	-0.03	-0.08	0.07	0.18	-0.08	-0.08	0.00	0.02	0.03	0.05	0.04
6	-0.07	-0.03	-0.08	0.07	0.18	-0.08	-0.02	0.05	0.06	0.07	0.05	0.04
7	0.13	0.16	0.13	0.22	0.32	0.06	0.13	0.12	0.12	0.17	0.13	0.15
8	-0.24	-0.18	-0.25	-0.03	0.08	-0.20	-0.13	-0.01	-0.01	-0.01	-0.02	-0.04

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.14	-0.12	0.07	0.03	0.10	0.01	0.02	0.01	0.01	0.09	0.09	0.02
2	-0.14	-0.12	0.07	0.03	0.10	0.01	0.02	0.03	0.04	0.13	0.09	0.02
3	-0.01	0.00	0.14	0.07	0.15	0.04	0.07	0.05	0.05	0.13	0.08	0.08
4	-0.30	-0.26	-0.03	-0.04	0.05	-0.04	-0.06	-0.02	-0.02	0.08	0.04	-0.08
5	-0.14	-0.12	0.06	0.03	0.11	0.02	0.02	0.01	0.01	0.09	0.10	0.01
6	-0.14	-0.12	0.06	0.03	0.11	0.02	0.02	0.03	0.04	0.13	0.10	0.01
7	0.09	0.10	0.22	0.16	0.24	0.12	0.16	0.10	0.11	0.22	0.19	0.18
8	-0.34	-0.30	-0.06	-0.06	0.03	-0.07	-0.09	-0.04	-0.03	0.05	0.03	-0.12

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.02	-0.07	0.03	-0.12	-0.12	-0.28	-0.14	-0.06	0.01	0.01	0.05	0.04
2	-0.02	-0.07	0.03	-0.12	-0.12	-0.28	-0.14	0.02	0.06	0.08	0.05	0.04
3	0.00	-0.03	0.07	0.00	0.01	-0.13	-0.04	0.04	0.06	0.08	0.05	0.06
4	-0.04	-0.14	-0.06	-0.26	-0.25	-0.37	-0.19	-0.02	0.04	0.05	0.01	-0.03
5	-0.01	-0.07	0.03	-0.13	-0.12	-0.28	-0.14	-0.06	0.02	0.03	0.07	0.04
6	-0.01	-0.07	0.03	-0.13	-0.12	-0.28	-0.14	0.03	0.07	0.10	0.07	0.04
7	0.02	0.04	0.16	0.10	0.11	-0.07	0.03	0.10	0.09	0.14	0.15	0.16
8	-0.03	-0.17	-0.09	-0.30	-0.29	-0.40	-0.22	-0.03	0.05	0.06	0.00	-0.06

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.14	-0.07	-0.01	0.00	-0.06	-0.05	-0.10	-0.12	-0.11	-0.08	-0.07	-0.07
2	-0.24	-0.07	-0.01	0.00	-0.12	-0.12	-0.12	-0.15	-0.14	-0.11	-0.14	-0.14
3	-0.18	-0.02	0.02	0.02	-0.13	-0.13	-0.13	-0.15	-0.14	-0.13	-0.15	-0.15
4	-0.21	-0.06	-0.01	0.00	-0.14	-0.14	-0.13	-0.16	-0.15	-0.13	-0.16	-0.16
5	0.04	0.09	0.17	0.18	0.10	0.12	0.08	0.00	0.01	0.09	0.11	0.12
6	-0.05	0.09	0.17	0.18	0.01	0.03	0.04	-0.04	-0.03	0.04	0.02	0.02
7	0.01	0.19	0.24	0.25	0.06	0.07	0.08	-0.01	0.00	0.07	0.05	0.06
8	-0.27	-0.01	0.19	0.20	0.03	0.04	0.05	-0.03	-0.03	0.05	0.02	0.03

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.06	-0.11	-0.01	-0.10	-0.06	-0.12	-0.12	-0.12	-0.13	-0.10	-0.08	-0.07
2	-0.13	-0.11	-0.01	-0.10	-0.13	-0.21	-0.14	-0.16	-0.17	-0.13	-0.15	-0.14
3	-0.14	-0.06	0.01	-0.05	-0.12	-0.15	-0.13	-0.16	-0.17	-0.14	-0.16	-0.15
4	-0.15	-0.10	-0.01	-0.09	-0.14	-0.20	-0.15	-0.17	-0.18	-0.15	-0.17	-0.15
5	0.11	0.05	0.17	0.06	0.11	0.05	0.05	0.00	-0.01	0.07	0.10	0.12
6	0.01	0.05	0.17	0.06	0.01	-0.03	0.00	-0.05	-0.06	0.03	0.01	0.03
7	0.06	0.14	0.24	0.15	0.06	0.03	0.06	-0.02	-0.03	0.06	0.04	0.06
8	0.03	-0.24	0.19	-0.22	0.03	-0.14	0.02	-0.04	-0.05	0.03	0.01	0.03

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.05	-0.03	-0.07	0.00	0.03	-0.05	-0.12	-0.12	-0.11	-0.09	-0.02	-0.02
2	-0.05	-0.03	-0.07	0.00	0.03	-0.05	-0.13	-0.15	-0.15	-0.11	-0.02	-0.02
3	-0.01	0.00	-0.02	0.02	0.05	-0.04	-0.13	-0.15	-0.15	-0.12	-0.01	0.00
4	-0.05	-0.03	-0.06	0.00	0.03	-0.06	-0.15	-0.17	-0.16	-0.13	-0.02	-0.02
5	0.11	0.14	0.09	0.18	0.21	0.13	0.04	0.00	0.01	0.08	0.17	0.18
6	0.11	0.14	0.09	0.18	0.21	0.13	0.00	-0.04	-0.04	0.04	0.17	0.18
7	0.20	0.22	0.18	0.25	0.28	0.19	0.06	-0.01	-0.01	0.08	0.22	0.25
8	0.08	0.15	-0.01	0.20	0.23	0.14	0.02	-0.04	-0.03	0.05	0.18	0.20

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.08	-0.08	0.00	-0.02	0.01	-0.02	-0.01	-0.11	-0.10	-0.07	0.00	0.00
2	-0.08	-0.08	0.00	-0.02	0.01	-0.02	-0.01	-0.15	-0.13	-0.09	0.00	0.00
3	-0.03	-0.03	0.03	0.00	0.03	-0.01	0.00	-0.15	-0.14	-0.10	0.01	0.02
4	-0.07	-0.07	0.00	-0.02	0.01	-0.02	-0.02	-0.16	-0.15	-0.11	0.00	-0.01
5	0.08	0.08	0.17	0.16	0.19	0.15	0.18	0.01	0.02	0.11	0.20	0.18
6	0.08	0.08	0.17	0.16	0.19	0.15	0.18	-0.04	-0.03	0.06	0.20	0.18
7	0.17	0.18	0.25	0.23	0.27	0.21	0.25	-0.01	0.00	0.10	0.25	0.26
8	-0.24	-0.09	0.19	0.18	0.23	0.18	0.19	-0.04	-0.03	0.07	0.22	0.20

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.07	-0.04	0.00	-0.09	-0.10	-0.21	-0.14	-0.17	-0.16	-0.14	-0.01	-0.01
2	-0.07	-0.04	0.00	-0.09	-0.10	-0.21	-0.14	-0.19	-0.20	-0.17	-0.01	-0.01
3	-0.03	-0.02	0.02	-0.04	-0.04	-0.12	-0.07	-0.19	-0.18	-0.17	-0.01	0.00
4	-0.05	-0.05	-0.01	-0.08	-0.08	-0.17	-0.11	-0.20	-0.20	-0.18	-0.02	-0.02
5	-0.02	0.10	0.17	0.06	0.07	-0.09	0.02	-0.05	-0.12	-0.04	0.18	0.18
6	-0.02	0.10	0.17	0.06	0.07	-0.09	0.02	-0.07	-0.16	-0.07	0.18	0.18
7	0.02	0.17	0.23	0.16	0.17	0.02	0.13	-0.04	-0.14	-0.04	0.23	0.25
8	0.00	0.12	0.18	-0.17	-0.18	-0.06	0.07	-0.06	-0.15	-0.06	0.19	0.20

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

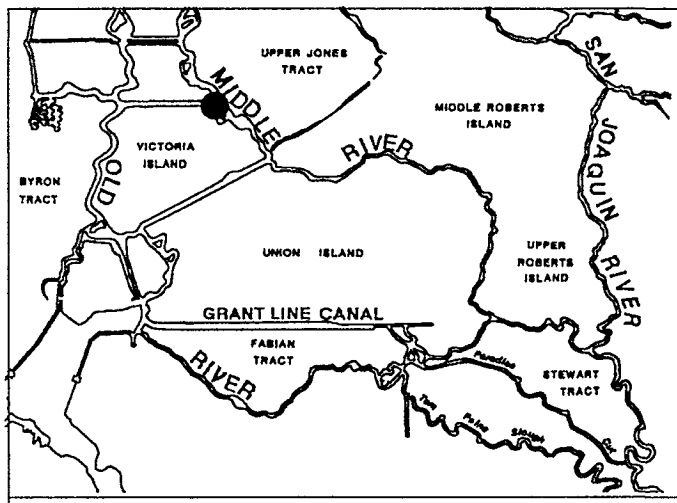

TABLE C-16 (cont.)

PHASE II MODELING

CHANGE IN MINIMUM AND AVERAGE WATER LEVELS IN VICINITY OF PROPOSED FOREBAY INTAKE GATES

MIDDLE RIVER AT WOODWARD CANAL

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.11	-0.08	0.04	0.04	0.02	0.03	0.01	-0.02	0.00	0.00	0.01	0.01
2	-0.11	-0.08	0.04	0.04	0.02	0.03	0.05	0.02	0.02	0.02	0.01	0.01
3	-0.30	-0.26	-0.07	-0.03	-0.06	-0.02	0.02	-0.02	-0.01	0.02	-0.01	-0.01
4	-0.09	-0.07	0.04	0.04	0.02	0.03	0.05	0.02	0.02	0.02	0.01	0.01
5	-0.10	-0.07	0.04	0.05	0.03	0.05	0.03	-0.01	0.01	0.03	0.04	0.04
6	-0.11	-0.07	0.04	0.05	0.02	0.04	0.06	0.03	0.04	0.05	0.03	0.03
7	-0.47	-0.40	-0.19	-0.13	-0.16	-0.11	-0.06	-0.07	-0.05	-0.03	-0.06	-0.08
8	-0.08	-0.06	0.05	0.05	0.03	0.05	0.07	0.03	0.04	0.05	0.03	0.03

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.02	-0.14	0.01	-0.11	0.04	-0.08	-0.07	-0.03	-0.03	-0.02	0.00	0.01
2	0.02	-0.14	0.01	-0.11	0.04	-0.08	-0.03	-0.01	-0.01	0.00	-0.01	0.01
3	-0.05	-0.34	-0.07	-0.31	-0.05	-0.25	-0.13	-0.05	-0.05	-0.02	-0.02	-0.01
4	0.02	-0.12	0.02	-0.09	0.05	-0.06	-0.03	-0.01	-0.01	0.00	-0.01	0.01
5	0.03	-0.13	0.02	-0.10	0.05	-0.07	-0.07	-0.02	-0.02	0.00	0.02	0.04
6	0.02	-0.13	0.02	-0.10	0.04	-0.07	-0.03	0.00	0.00	0.02	0.02	0.03
7	-0.15	-0.49	-0.17	-0.46	-0.16	-0.41	-0.25	-0.09	-0.10	-0.08	-0.08	-0.07
8	0.03	-0.12	0.03	-0.08	0.05	-0.05	-0.02	0.00	0.00	0.02	0.02	0.03

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.07	-0.03	-0.07	0.05	0.12	-0.08	-0.07	-0.02	0.00	0.00	0.01	0.02
2	-0.07	-0.03	-0.07	0.05	0.12	-0.08	-0.02	0.02	0.02	0.03	0.01	0.02
3	-0.24	-0.17	-0.25	-0.04	0.04	-0.17	-0.11	-0.02	-0.01	-0.01	-0.01	-0.02
4	-0.06	-0.02	-0.06	0.05	0.12	-0.07	-0.02	0.02	0.02	0.03	0.01	0.02
5	-0.06	-0.02	-0.06	0.06	0.13	-0.07	-0.06	-0.01	0.01	0.01	0.03	0.03
6	-0.06	-0.02	-0.06	0.06	0.13	-0.07	-0.02	0.03	0.03	0.04	0.03	0.03
7	-0.37	-0.30	-0.38	-0.14	-0.05	-0.28	-0.23	-0.07	-0.06	-0.10	-0.07	-0.11
8	-0.05	-0.01	-0.05	0.06	0.13	-0.06	-0.01	0.03	0.04	0.04	0.04	0.04

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.12	-0.10	0.03	0.01	0.08	0.00	0.00	0.00	-0.01	0.04	0.04	0.01
2	-0.12	-0.10	0.03	0.01	0.08	0.00	0.00	0.01	0.01	0.07	0.04	0.01
3	-0.33	-0.29	-0.08	-0.06	0.01	-0.06	-0.08	-0.03	-0.04	0.04	0.02	-0.10
4	-0.10	-0.09	0.04	0.01	0.08	0.00	0.01	0.01	0.01	0.08	0.04	0.02
5	-0.11	-0.09	0.04	0.02	0.09	0.01	0.01	0.01	0.00	0.06	0.06	0.02
6	-0.11	-0.09	0.04	0.02	0.09	0.01	0.01	0.02	0.02	0.09	0.06	0.02
7	-0.48	-0.43	-0.19	-0.15	-0.08	-0.14	-0.19	-0.08	-0.09	-0.04	-0.06	-0.23
8	-0.10	-0.08	0.05	0.02	0.09	0.01	0.02	0.02	0.02	0.09	0.07	0.02

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.01	-0.06	0.01	-0.11	-0.11	-0.22	-0.11	-0.05	0.00	0.00	0.02	0.01
2	-0.01	-0.06	0.01	-0.11	-0.11	-0.22	-0.11	0.00	0.04	0.05	0.02	0.01
3	-0.04	-0.13	-0.08	-0.30	-0.30	-0.39	-0.22	-0.04	0.02	0.03	0.00	-0.04
4	-0.02	-0.06	0.01	-0.09	-0.09	-0.21	-0.11	0.00	0.03	0.05	0.03	0.02
5	-0.01	-0.05	0.01	-0.10	-0.10	-0.21	-0.10	-0.04	0.02	0.02	0.05	0.02
6	-0.01	-0.05	0.01	-0.10	-0.10	-0.21	-0.10	0.02	0.05	0.07	0.05	0.02
7	-0.05	-0.21	-0.18	-0.44	-0.44	-0.49	-0.31	-0.09	0.02	0.00	-0.06	-0.14
8	-0.01	-0.05	0.02	-0.09	-0.09	-0.21	-0.10	0.01	0.05	0.06	0.05	0.03

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.11	-0.03	0.01	0.03	-0.03	-0.03	-0.06	-0.08	-0.06	-0.06	-0.05	-0.05
2	-0.19	-0.03	0.01	0.03	-0.09	-0.10	-0.09	-0.11	-0.10	-0.10	-0.12	-0.12
3	-0.14	-0.02	0.01	0.02	-0.09	-0.11	-0.10	-0.12	-0.11	-0.10	-0.12	-0.12
4	-0.17	-0.04	0.00	0.02	-0.10	-0.10	-0.10	-0.12	-0.11	-0.10	-0.12	-0.12
5	0.02	0.08	0.14	0.16	0.09	0.10	0.07	0.01	0.03	0.08	0.09	0.10
6	-0.05	0.08	0.14	0.16	0.02	0.02	0.03	-0.03	-0.01	0.03	0.01	0.01
7	-0.24	-0.01	0.13	0.14	0.02	0.02	0.03	-0.04	-0.03	0.02	0.00	0.00
8	-0.03	0.07	0.13	0.14	0.02	0.02	0.03	-0.03	-0.02	0.02	0.00	0.01

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.04	-0.07	0.01	-0.09	-0.04	-0.09	-0.09	-0.08	-0.08	-0.08	-0.06	-0.05
2	-0.11	-0.07	0.01	-0.09	-0.11	-0.17	-0.11	-0.12	-0.12	-0.12	-0.13	-0.11
3	-0.11	-0.05	0.01	-0.06	-0.10	-0.12	-0.10	-0.13	-0.13	-0.12	-0.13	-0.12
4	-0.12	-0.07	0.00	-0.08	-0.11	-0.15	-0.12	-0.13	-0.13	-0.12	-0.13	-0.12
5	0.08	0.04	0.15	0.02	0.08	0.04	0.04	0.01	0.01	0.06	0.08	0.10
6	0.00	0.04	0.15	0.02	0.00	-0.02	0.00	-0.04	-0.03	0.01	0.00	0.02
7	0.00	-0.18	0.13	-0.18	0.01	-0.12	0.01	-0.05	-0.05	0.00	-0.01	0.01
8	0.00	0.03	0.13	0.02	0.01	-0.01	0.00	-0.04	-0.04	0.00	-0.01	0.01

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.03	0.00	-0.04	0.03	0.05	-0.03	-0.09	-0.08	-0.07	-0.05	0.00	0.00
2	-0.03	0.00	-0.04	0.03	0.05	-0.03	-0.12	-0.12	-0.11	-0.08	0.00	0.00
3	-0.02	0.00	-0.02	0.02	0.04	-0.04	-0.10	-0.13	-0.12	-0.09	-0.01	-0.01
4	-0.03	-0.01	-0.04	0.02	0.04	-0.04	-0.12	-0.12	-0.11	-0.09	-0.01	-0.01
5	0.09	0.12	0.07	0.16	0.19	0.10	0.04	0.01	0.02	0.08	0.15	0.16
6	0.09	0.12	0.07	0.16	0.19	0.10	0.00	-0.03	-0.02	0.03	0.15	0.16
7	0.05	0.12	-0.01	0.15	0.17	0.09	0.01	-0.04	-0.03	0.03	0.12	0.13
8	0.08	0.11	0.07	0.14	0.17	0.08	0.00	-0.04	-0.03	0.03	0.13	0.14

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.06	-0.05	0.02	0.01	0.05	-0.01	0.01	-0.07	-0.06	-0.04	0.01	0.02
2	-0.06	-0.05	0.02	0.01	0.05	-0.01	0.01	-0.11	-0.10	-0.07	0.01	0.02
3	-0.03	-0.03	0.02	0.00	0.03	-0.01	0.01	-0.12	-0.11	-0.08	0.00	0.02
4	-0.05	-0.05	0.01	0.00	0.03	-0.02	0.00	-0.12	-0.11	-0.08	0.01	0.01
5	0.05	0.07	0.15	0.14	0.18	0.13	0.16	0.02	0.02	0.09	0.17	0.16
6	0.05	0.07	0.15	0.14	0.18	0.13	0.16	-0.03	-0.02	0.05	0.17	0.16
7	-0.18	-0.08	0.14	0.12	0.17	0.12	0.14	-0.03	-0.03	0.05	0.14	0.15
8	0.05	0.06	0.13	0.12	0.17	0.11	0.14	-0.03	-0.03	0.04	0.15	0.14

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.02	-0.01	0.01	-0.07	-0.07	-0.15	-0.08	-0.12	-0.08	-0.08	0.01	0.01
2	-0.02	-0.01	0.01	-0.07	-0.07	-0.15	-0.08	-0.14	-0.13	-0.12	0.01	0.01
3	-0.05	-0.02	0.01	-0.05	-0.05	-0.15	-0.10	-0.16	-0.15	-0.13	0.00	0.00
4	-0.03	-0.02	0.01	-0.07	-0.07	-0.16	-0.09	-0.16	-0.14	-0.13	0.00	-0.01
5	0.02	0.10	0.14	0.04	0.04	-0.07	0.03	-0.03	-0.06	-0.01	0.15	0.16
6	0.02	0.10	0.14	0.04	0.04	-0.07	0.03	-0.06	-0.10	-0.04	0.15	0.16
7	-0.02	0.08	0.13	-0.16	-0.17	-0.10	0.00	-0.07	-0.12	-0.06	0.13	0.14
8	0.00	0.08	0.13	0.04	0.05	-0.08	0.01	-0.06	-0.11	-0.05	0.13	0.14

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

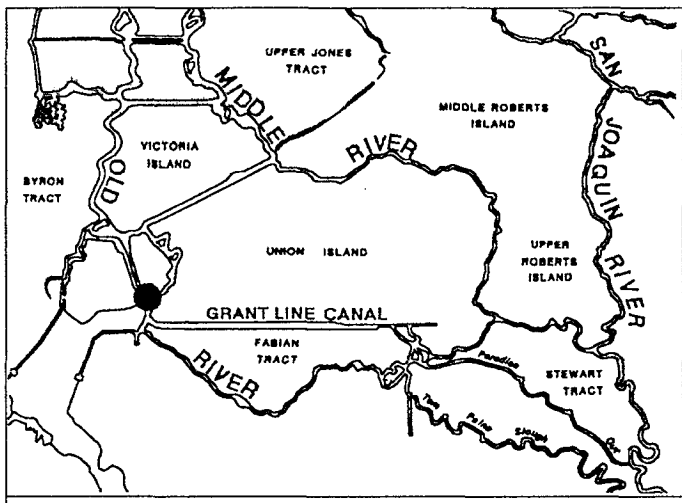

TABLE C-17
PHASE II MODELING

CHANGE IN MINIMUM AND AVERAGE WATER LEVELS DOWNSTREAM OF PROPOSED BARRIER-TYPE FACILITIES

OLD RIVER AT SOUTH END OF WEST CANAL

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET) | IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.01	0.05	0.28	0.23	0.22	0.21	0.14	0.03	0.07	0.08	0.11	0.12	-0.14	-0.07	-0.01	0.00	-0.04	-0.04	-0.11	-0.16	-0.13	-0.09	-0.05	-0.06
2	0.01	0.05	0.28	0.23	0.24	0.24	0.28	0.14	0.16	0.18	0.14	0.14	-0.24	-0.07	-0.01	0.00	-0.08	-0.10	-0.09	-0.16	-0.13	-0.09	-0.11	-0.12
3	0.28	0.27	0.41	0.30	0.31	0.28	0.30	0.17	0.18	0.14	0.12	0.14	-0.17	-0.01	0.02	0.02	-0.10	-0.11	-0.11	-0.16	-0.14	-0.11	-0.13	-0.14
4	0.09	0.10	0.29	0.23	0.24	0.23	0.27	0.13	0.15	0.13	0.11	0.11	-0.22	-0.05	0.00	0.00	-0.11	-0.12	-0.12	-0.17	-0.15	-0.11	-0.13	-0.14
5	0.05	0.10	0.32	0.29	0.26	0.27	0.21	0.07	0.13	0.19	0.20	0.20	0.16	0.23	0.31	0.32	0.24	0.26	0.16	0.04	0.07	0.18	0.25	0.26
6	0.03	0.10	0.32	0.29	0.25	0.26	0.32	0.16	0.20	0.25	0.19	0.19	0.04	0.23	0.31	0.32	0.12	0.14	0.15	0.02	0.04	0.15	0.13	0.13
7	0.47	0.50	0.63	0.53	0.49	0.45	0.49	0.29	0.31	0.35	0.32	0.33	0.13	0.37	0.42	0.41	0.18	0.19	0.20	0.06	0.08	0.19	0.17	0.18
8	0.18	0.23	0.43	0.36	0.32	0.32	0.37	0.20	0.22	0.27	0.22	0.23	0.11	0.30	0.37	0.37	0.15	0.16	0.18	0.04	0.06	0.16	0.14	0.15

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.19	-0.03	0.19	0.04	0.34	0.08	-0.01	0.01	0.01	0.02	0.06	0.11	-0.06	-0.11	-0.01	-0.10	-0.06	-0.12	-0.12	-0.16	-0.16	-0.11	-0.07	-0.06
2	0.21	-0.03	0.19	0.04	0.36	0.09	0.14	0.10	0.09	0.12	0.09	0.14	-0.11	-0.11	-0.01	-0.10	-0.10	-0.20	-0.09	-0.17	-0.17	-0.10	-0.12	-0.12
3	0.27	0.21	0.29	0.29	0.46	0.33	0.24	0.13	0.12	0.10	0.07	0.12	-0.13	-0.05	0.02	-0.04	-0.11	-0.13	-0.10	-0.17	-0.17	-0.13	-0.14	-0.14
4	0.21	0.03	0.20	0.10	0.37	0.16	0.15	0.09	0.08	0.08	0.05	0.11	-0.14	-0.10	0.00	-0.08	-0.13	-0.18	-0.12	-0.18	-0.18	-0.13	-0.14	-0.14
5	0.24	0.01	0.25	0.09	0.38	0.12	0.04	0.06	0.06	0.12	0.16	0.21	0.24	0.13	0.31	0.14	0.23	0.18	0.14	0.04	0.04	0.16	0.23	0.25
6	0.23	0.01	0.25	0.09	0.36	0.11	0.14	0.13	0.12	0.18	0.15	0.19	0.11	0.13	0.31	0.14	0.10	0.07	0.11	0.01	0.01	0.13	0.11	0.13
7	0.45	0.45	0.51	0.52	0.64	0.53	0.43	0.26	0.25	0.30	0.26	0.32	0.17	0.31	0.41	0.32	0.18	0.15	0.19	0.05	0.05	0.17	0.15	0.17
8	0.30	0.15	0.33	0.22	0.45	0.25	0.24	0.16	0.15	0.21	0.18	0.23	0.14	0.24	0.36	0.25	0.14	0.13	0.15	0.03	0.03	0.15	0.13	0.15

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.10	0.16	0.08	0.27	0.44	-0.01	0.00	0.05	0.09	0.15	0.09	0.13	-0.05	-0.03	-0.06	0.00	0.03	-0.05	-0.13	-0.17	-0.14	-0.08	-0.01	-0.02
2	0.10	0.16	0.08	0.27	0.44	-0.01	0.16	0.17	0.18	0.26	0.09	0.13	-0.05	-0.03	-0.06	0.00	0.03	-0.05	-0.10	-0.17	-0.14	-0.07	-0.01	-0.02
3	0.30	0.34	0.30	0.37	0.52	0.09	0.26	0.20	0.20	0.29	0.08	0.16	-0.01	0.01	-0.02	0.03	0.05	-0.04	-0.11	-0.17	-0.15	-0.09	-0.01	-0.01
4	0.14	0.19	0.13	0.28	0.44	0.00	0.17	0.16	0.16	0.24	0.06	0.11	-0.05	-0.02	-0.05	0.01	0.03	-0.06	-0.13	-0.18	-0.16	-0.09	-0.02	-0.02
5	0.15	0.21	0.13	0.32	0.50	0.05	0.04	0.10	0.14	0.22	0.18	0.21	0.24	0.27	0.22	0.33	0.36	0.26	0.13	0.03	0.06	0.18	0.31	0.33
6	0.15	0.21	0.13	0.32	0.50	0.05	0.16	0.19	0.20	0.29	0.18	0.21	0.24	0.27	0.22	0.33	0.36	0.26	0.11	0.02	0.03	0.16	0.31	0.33
7	0.53	0.56	0.53	0.59	0.75	0.32	0.44	0.32	0.33	0.47	0.34	0.41	0.37	0.39	0.35	0.44	0.46	0.36	0.19	0.06	0.08	0.20	0.39	0.42
8	0.27	0.32	0.26	0.41	0.58	0.14	0.25	0.23	0.24	0.34	0.23	0.27	0.30	0.32	0.29	0.39	0.42	0.31	0.15	0.03	0.05	0.17	0.35	0.38

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.01	0.02	0.29	0.17	0.29	0.10	0.18	0.10	0.09	0.27	0.23	0.21	-0.09	-0.08	-0.01	-0.01	0.00	-0.03	-0.01	-0.13	-0.13	-0.07	0.00	0.00
2	-0.01	0.02	0.29	0.17	0.29	0.10	0.18	0.16	0.16	0.38	0.23	0.21	-0.09	-0.08	-0.01	-0.01	0.00	-0.03	-0.01	-0.13	-0.13	-0.06	0.00	0.00
3	0.23	0.25	0.42	0.24	0.38	0.15	0.27	0.19	0.20	0.39	0.22	0.34	-0.03	-0.02	0.02	0.01	0.04	-0.01	0.01	-0.14	-0.14	-0.08	0.01	0.02
4	0.05	0.08	0.30	0.17	0.30	0.09	0.18	0.15	0.15	0.36	0.19	0.22	-0.08	-0.06	0.00	-0.01	0.02	-0.02	-0.01	-0.15	-0.15	-0.08	0.00	0.00
5	0.04	0.07	0.33	0.23	0.35	0.17	0.23	0.14	0.14	0.34	0.32	0.26	0.15	0.20	0.31	0.31	0.36	0.29	0.33	0.07	0.07	0.20	0.34	0.33
6	0.04	0.07	0.33	0.23	0.35	0.17	0.23	0.19	0.19	0.41	0.32	0.26	0.15	0.20	0.31	0.31	0.36	0.29	0.33	0.03	0.04	0.18	0.34	0.33
7	0.48	0.48	0.64	0.47	0.60	0.37	0.51	0.32	0.32	0.58	0.49	0.58	0.34	0.36	0.42	0.40	0.48	0.37	0.43	0.07	0.08	0.22	0.42	0.44
8	0.18	0.20	0.44	0.31	0.44	0.23	0.32	0.22	0.22	0.46	0.37	0.37	0.27	0.29	0.36	0.36	0.44	0.34	0.38	0.05	0.05	0.19	0.39	0.37

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	-0.07	0.19	0.02	0.01	-0.26	-0.10	-0.06	0.02	0.06	0.14	0.16	-0.09	-0.05	0.00	-0.11	-0.10	-0.24	-0.17	-0.25	-0.24	-0.21	-0.01	-0.01
2	0.00	-0.07	0.19	0.02	0.01	-0.26	-0.10	0.11	0.13	0.20	0.14	0.16	-0.09	-0.05	0.00	-0.11	-0.10	-0.24	-0.17	-0.22	-0.24	-0.20	-0.01	-0.01
3	0.03	0.01	0.28	0.26	0.26	0.01	0.07	0.15	0.13	0.21	0.14	0.21	-0.03	-0.02	0.02	-0.05	-0.03	-0.11	-0.08	-0.22	-0.22	-0.20	0.00	0.01
4	0.00	-0.07	0.19	0.08	0.08	-0.16	-0.04	0.11	0.12	0.19	0.11	0.15	-0.05	-0.04	0.00	-0.08	-0.07	-0.16	-0.10	-0.23	-0.23	-0.21	-0.01	-0.01
5	0.02	-0.02	0.24	0.06	0.06	-0.22	-0.04	-0.02	0.06	0.11	0.24	0.23	-0.01	0.22	0.29	0.13	0.15	-0.11	0.16	-0.05	-0.16	-0.04	0.32	0.34
6	0.02	-0.02	0.24	0.06	0.06	-0.22	-0.04	0.13	0.15	0.24	0.24	0.23	-0.01	0.22	0.29	0.13	0.15	-0.11	0.16	-0.03	-0.17	-0.03	0.32	0.34
7	0.09	0.20	0.50	0.48	0.49	0.16	0.25	0.27	0.18	0.32	0.39	0.46	0.07	0.31	0.39	0.32	0.37	0.18	0.32	0.02	-0.13	0.01	0.40	0.43
8	0.04	0.05	0.32	0.21	0.21	-0.08	0.07	0.17	0.16	0.26	0.28	0.31	0.05	0.26	0.34	0.26	0.30	0.11	0.27	0.00	-0.15	-0.01	0.36	0.39

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

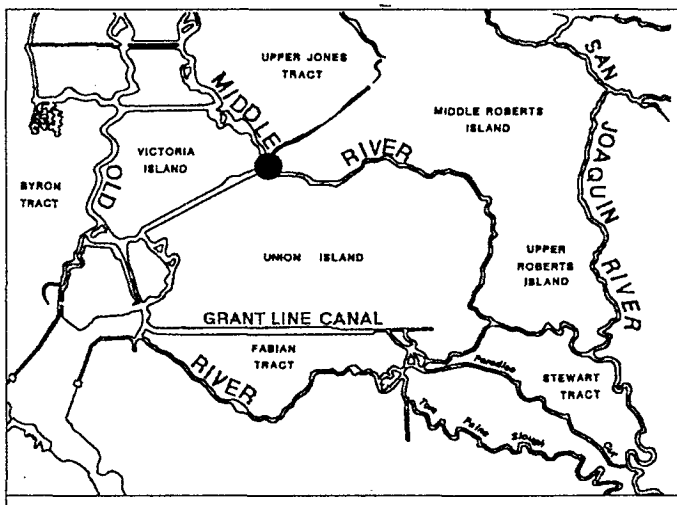

TABLE C-17 (cont.)

PHASE II MODELING

CHANGE IN MINIMUM AND AVERAGE WATER LEVELS DOWNSTREAM OF PROPOSED BARRIER-TYPE FACILITIES

MIDDLE RIVER AT VICTORIA CANAL

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET)

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
1	-0.12	-0.08	0.07	0.07	0.05	0.07	0.04	-0.01	0.02	0.04	0.04	0.04
2	-0.12	-0.08	0.07	0.07	0.06	0.08	0.11	0.04	0.06	0.07	0.04	0.04
3	-0.14	-0.09	0.06	0.06	0.04	0.06	0.09	0.02	0.05	0.05	0.02	0.03
4	-0.08	-0.06	0.08	0.07	0.06	0.07	0.10	0.03	0.05	0.04	0.02	0.03
5	-0.11	-0.08	0.08	0.08	0.06	0.08	0.06	0.00	0.04	0.07	0.07	0.06
6	-0.12	-0.08	0.08	0.08	0.05	0.08	0.11	0.05	0.07	0.10	0.06	0.06
7	-0.17	-0.11	0.07	0.08	0.03	0.06	0.10	0.04	0.06	0.09	0.05	0.05
8	-0.05	-0.02	0.12	0.11	0.09	0.10	0.14	0.06	0.08	0.11	0.08	0.08
REPRESENTATIVE DRY YEAR												
1	0.06	-0.16	0.05	-0.11	0.10	-0.08	-0.07	-0.03	-0.02	0.01	0.03	0.05
2	0.06	-0.16	0.05	-0.11	0.10	-0.08	-0.01	0.01	0.02	0.04	0.03	0.05
3	0.04	-0.18	0.04	-0.13	0.09	-0.10	-0.03	0.00	0.00	0.02	0.01	0.03
4	0.05	-0.13	0.05	-0.08	0.11	-0.04	0.00	0.01	0.01	0.02	0.01	0.03
5	0.06	-0.15	0.06	-0.10	0.10	-0.08	-0.07	-0.02	-0.01	0.03	0.06	0.08
6	0.05	-0.15	0.06	-0.10	0.09	-0.08	-0.02	0.02	0.02	0.06	0.06	0.07
7	0.04	-0.19	0.05	-0.14	0.08	-0.13	-0.04	0.01	0.01	0.05	0.05	0.06
8	0.09	-0.09	0.09	-0.04	0.14	-0.01	0.03	0.03	0.04	0.08	0.07	0.09
REPRESENTATIVE BELOW NORMAL YEAR												
1	-0.05	-0.01	-0.07	0.09	0.19	-0.07	-0.06	0.00	0.02	0.04	0.04	0.04
2	-0.05	-0.01	-0.07	0.09	0.19	-0.07	0.01	0.05	0.06	0.09	0.04	0.04
3	-0.07	-0.03	-0.08	0.08	0.17	-0.09	-0.01	0.04	0.05	0.07	0.02	0.03
4	-0.03	0.00	-0.04	0.09	0.19	-0.07	0.01	0.05	0.05	0.08	0.02	0.03
5	-0.05	-0.01	-0.06	0.10	0.19	-0.06	-0.06	0.01	0.03	0.05	0.07	0.06
6	-0.05	-0.01	-0.06	0.10	0.19	-0.06	0.00	0.06	0.07	0.09	0.07	0.06
7	-0.08	-0.03	-0.09	0.10	0.20	-0.07	-0.02	0.05	0.06	0.07	0.07	0.06
8	0.00	0.04	0.00	0.14	0.23	-0.02	0.05	0.08	0.08	0.11	0.08	0.09
REPRESENTATIVE ABOVE NORMAL YEAR												
1	-0.14	-0.11	0.08	0.05	0.12	0.02	0.03	0.02	0.02	0.10	0.09	0.03
2	-0.14	-0.11	0.08	0.05	0.12	0.02	0.03	0.05	0.05	0.15	0.09	0.03
3	-0.16	-0.12	0.07	0.03	0.12	0.00	0.02	0.03	0.03	0.13	0.07	0.01
4	-0.11	-0.08	0.09	0.04	0.13	0.01	0.04	0.04	0.04	0.14	0.08	0.04
5	-0.13	-0.10	0.08	0.06	0.14	0.03	0.04	0.03	0.03	0.12	0.12	0.04
6	-0.13	-0.10	0.08	0.06	0.14	0.03	0.04	0.05	0.06	0.16	0.12	0.04
7	-0.17	-0.13	0.08	0.06	0.14	0.03	0.04	0.04	0.04	0.14	0.12	0.02
8	-0.07	-0.04	0.13	0.09	0.18	0.06	0.08	0.07	0.07	0.18	0.14	0.08
REPRESENTATIVE WET YEAR												
1	-0.02	-0.07	0.03	-0.11	-0.11	-0.28	-0.13	-0.06	0.01	0.02	0.06	0.05
2	-0.02	-0.07	0.03	-0.11	-0.11	-0.28	-0.13	0.03	0.07	0.10	0.06	0.05
3	-0.02	-0.08	0.01	-0.12	-0.11	-0.25	-0.11	0.02	0.06	0.08	0.04	0.03
4	-0.02	-0.07	0.03	-0.08	-0.08	-0.23	-0.10	0.03	0.05	0.09	0.04	0.04
5	-0.01	-0.06	0.03	-0.10	-0.10	-0.27	-0.12	-0.05	0.02	0.04	0.09	0.06
6	-0.01	-0.06	0.03	-0.10	-0.10	-0.27	-0.12	0.04	0.08	0.12	0.09	0.06
7	0.00	-0.06	0.03	-0.13	-0.13	-0.27	-0.11	0.03	0.08	0.11	0.09	0.06
8	0.00	-0.03	0.07	-0.04	-0.04	-0.20	-0.07	0.06	0.08	0.12	0.11	0.09

IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
1	-0.12	-0.05	0.01	0.01	-0.04	-0.03	-0.09	-0.11	-0.09	-0.06	-0.05	-0.06
2	-0.22	-0.05	0.01	0.01	-0.10	-0.10	-0.11	-0.14	-0.12	-0.10	-0.12	-0.13
3	-0.16	-0.01	0.03	0.02	-0.11	-0.12	-0.12	-0.15	-0.13	-0.11	-0.14	-0.15
4	-0.20	-0.03	0.02	0.01	-0.12	-0.12	-0.12	-0.15	-0.13	-0.11	-0.14	-0.15
5	0.05	0.12	0.19	0.20	0.12	0.14	0.09	0.01	0.03	0.11	0.13	0.13
6	-0.03	0.12	0.19	0.20	0.03	0.05	0.05	-0.03	-0.01	0.07	0.04	0.04
7	0.01	0.20	0.25	0.25	0.06	0.07	0.07	-0.02	0.00	0.07	0.05	0.05
8	0.01	0.16	0.22	0.22	0.05	0.06	0.06	-0.02	-0.01	0.07	0.04	0.04
REPRESENTATIVE DRY YEAR												
1	-0.05	-0.08	0.01	-0.09	-0.04	-0.09	-0.10	-0.11	-0.11	-0.08	-0.06	-0.06
2	-0.12	-0.08	0.01	-0.09	-0.11	-0.19	-0.11	-0.15	-0.15	-0.11	-0.13	-0.13
3	-0.14	-0.03	0.03	-0.04	-0.11	-0.13	-0.11	-0.16	-0.16	-0.13	-0.14	-0.14
4	-0.14	-0.07	0.01	-0.08	-0.12	-0.16	-0.13	-0.16	-0.16	-0.13	-0.15	-0.14
5	0.12	0.07	0.20	0.06	0.13	0.08	0.07	0.01	0.01	0.09	0.12	0.13
6	0.02	0.07	0.20	0.06	0.03	0.00	0.02	-0.04	-0.04	0.05	0.03	0.04
7	0.05	0.09	0.25	0.09	0.06	0.05	0.06	-0.03	-0.03	0.06	0.04	0.05
8	0.03	0.13	0.22	0.12	0.05	0.04	0.04	-0.03	-0.03	0.05	0.03	0.04
REPRESENTATIVE BELOW NORMAL YEAR												
1	-0.03	-0.01	-0.05	0.02	0.04	-0.05	-0.11	-0.11	-0.10	-0.07	0.00	-0.01
2	-0.03	-0.01	-0.05	0.02	0.04	-0.05	-0.12	-0.14	-0.14	-0.09	0.00	-0.01
3	0.00	0.02	-0.01	0.04	0.05	-0.03	-0.13	-0.15	-0.15	-0.11	0.00	0.00
4	-0.02	-0.01	-0.04	0.03	0.04	-0.05	-0.14	-0.15	-0.14	-0.10	0.00	-0.01
5	0.14	0.16	0.11	0.21	0.23	0.14	0.06	0.01	0.02	0.10	0.19	0.20
6	0.14	0.16	0.11	0.21	0.23	0.14	0.02	-0.03	-0.02	0.06	0.19	0.20
7	0.21	0.23	0.19	0.26	0.28	0.19	0.05	-0.02	-0.02	0.08	0.23	0.25
8	0.17	0.19	0.16	0.24	0.26	0.17	0.04	-0.03	-0.02	0.06	0.22	0.23
REPRESENTATIVE ABOVE NORMAL YEAR												
1	-0.07	-0.06	0.01	0.00	0.02	-0.02	0.01	-0.09	-0.09	-0.05	0.02	0.00
2	-0.07	-0.06	0.01	0.00	0.02	-0.02	0.01	-0.12	-0.12	-0.07	0.02	0.00
3	-0.02	-0.02	0.03	0.02	0.04	-0.01	0.02	-0.13	-0.13	-0.08	0.02	0.02
4	-0.05	-0.04	0.01	0.01	0.03	-0.02	0.01	-0.14	-0.13	-0.08	0.02	0.01
5	0.09	0.10	0.19	0.19	0.21	0.17	0.20	0.03	0.03	0.13	0.23	0.20
6	0.09	0.10	0.19	0.19	0.21	0.17	0.20	-0.02	-0.02	0.09	0.23	0.20
7	0.10	0.16	0.25	0.24	0.27	0.21	0.26	-0.01	-0.01	0.10	0.26	0.26
8	0.15	0.15	0.22	0.22	0.25	0.19	0.23	-0.02	-0.01	0.09	0.25	0.22
REPRESENTATIVE WET YEAR												
1	-0.05	-0.04	0.00	-0.08	-0.08	-0.21	-0.13	-0.17	-0.15	-0.13	0.00	0.00
2	-0.05	-0.04	0.00	-0.08	-0.08	-0.21	-0.13	-0.19	-0.19	-0.16	0.00	0.00
3	-0.03	-0.02	0.02	-0.03	-0.03	-0.13	-0.08	-0.20	-0.19	-0.17	0.01	0.01
4	-0.03	-0.03	0.00	-0.06	-0.06	-0.15	-0.09	-0.20	-0.19	-0.17	0.00	0.00
5	-0.01	0.12	0.18	0.08	0.08	-0.09	0.03	-0.05	-0.11	-0.03	0.20	0.20
6	-0.01	0.12	0.18	0.08	0.08	-0.09	0.03	-0.07	-0.15	-0.05	0.20	0.20
7	0.02	0.17	0.24	0.09	0.10	0.01	0.11	-0.06	-0.15	-0.05	0.24	0.25
8	0.02	0.15	0.21	0.14	0.15	-0.03	0.09	-0.06	-0.14	-0.05	0.22	0.23

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

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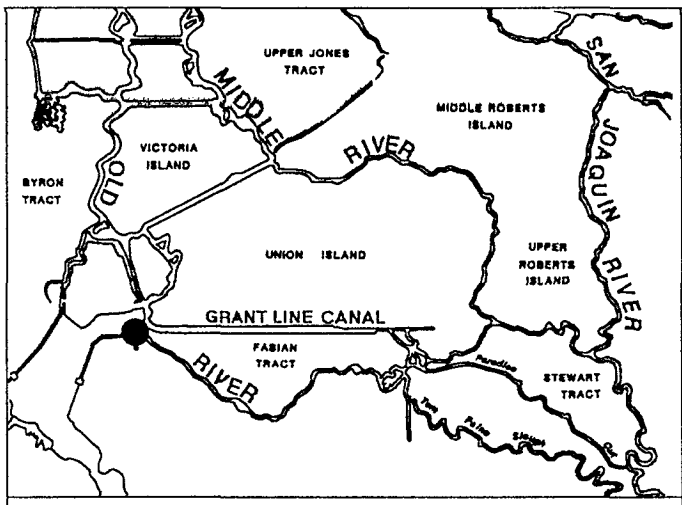

TABLE C-18
PHASE II MODELING

CHANGE IN MINIMUM AND AVERAGE WATER LEVELS NEAR TRACY PUMPING PLANT

OLD RIVER AT DMC INTAKE

IMPROVEMENT TO AVERAGE WATER LEVEL (FEET) | IMPROVEMENT TO MINIMUM WATER LEVEL (FEET)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.01	0.05	0.28	0.23	0.22	0.21	0.12	0.01	0.07	0.07	0.11	0.12	-0.15	-0.07	-0.01	0.00	-0.04	-0.05	-0.12	-0.16	-0.13	-0.08	-0.06	-0.06
2	0.02	0.05	0.28	0.23	0.25	0.24	0.28	0.14	0.17	0.19	0.14	0.15	-0.24	-0.07	-0.01	0.00	-0.08	-0.09	-0.09	-0.15	-0.12	-0.08	-0.11	-0.11
3	0.28	0.27	0.41	0.30	0.32	0.27	0.30	0.17	0.18	0.15	0.13	0.14	-0.16	-0.02	0.03	0.02	-0.09	-0.11	-0.11	-0.16	-0.13	-0.10	-0.13	-0.13
4	0.09	0.10	0.30	0.22	0.25	0.22	0.26	0.13	0.15	0.14	0.11	0.12	-0.21	-0.06	0.00	0.00	-0.10	-0.12	-0.12	-0.17	-0.14	-0.10	-0.13	-0.14
5	0.09	0.14	0.36	0.32	0.30	0.31	0.24	0.09	0.16	0.23	0.24	0.25	0.20	0.24	0.35	0.36	0.28	0.30	0.19	0.06	0.09	0.22	0.29	0.31
6	0.06	0.14	0.36	0.32	0.29	0.29	0.35	0.18	0.22	0.29	0.23	0.23	0.04	0.24	0.35	0.36	0.16	0.18	0.20	0.05	0.07	0.20	0.16	0.18
7	0.51	0.54	0.67	0.56	0.53	0.49	0.52	0.31	0.34	0.40	0.36	0.37	0.17	0.40	0.46	0.45	0.22	0.23	0.24	0.09	0.11	0.23	0.21	0.23
8	0.21	0.27	0.47	0.40	0.36	0.35	0.40	0.22	0.25	0.32	0.27	0.27	0.15	0.33	0.41	0.41	0.19	0.20	0.22	0.07	0.09	0.21	0.18	0.20

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.20	-0.03	0.19	0.04	0.33	0.07	-0.03	0.00	0.00	0.01	0.06	0.11	-0.06	-0.11	-0.01	-0.10	-0.06	-0.13	-0.13	-0.16	-0.16	-0.10	-0.07	-0.06
2	0.22	-0.03	0.19	0.04	0.36	0.09	0.13	0.10	0.09	0.12	0.09	0.14	-0.11	-0.11	-0.01	-0.10	-0.09	-0.19	-0.08	-0.16	-0.16	-0.09	-0.12	-0.11
3	0.29	0.21	0.29	0.29	0.46	0.33	0.24	0.13	0.12	0.10	0.07	0.13	-0.12	-0.05	0.02	-0.04	-0.11	-0.12	-0.10	-0.17	-0.17	-0.12	-0.14	-0.13
4	0.22	0.03	0.20	0.10	0.37	0.16	0.15	0.09	0.08	0.09	0.06	0.11	-0.13	-0.09	0.00	-0.08	-0.12	-0.18	-0.12	-0.18	-0.18	-0.12	-0.14	-0.13
5	0.29	0.05	0.29	0.12	0.41	0.15	0.06	0.08	0.08	0.16	0.20	0.25	0.29	0.14	0.35	0.15	0.28	0.22	0.17	0.06	0.06	0.20	0.27	0.31
6	0.27	0.05	0.29	0.12	0.39	0.14	0.17	0.15	0.14	0.21	0.19	0.23	0.16	0.14	0.35	0.15	0.14	0.10	0.15	0.04	0.04	0.18	0.15	0.18
7	0.49	0.49	0.55	0.56	0.67	0.56	0.46	0.28	0.27	0.34	0.30	0.37	0.21	0.35	0.45	0.36	0.22	0.19	0.23	0.08	0.08	0.22	0.19	0.22
8	0.34	0.19	0.37	0.26	0.48	0.28	0.27	0.18	0.17	0.25	0.22	0.27	0.18	0.28	0.40	0.29	0.17	0.16	0.19	0.06	0.06	0.19	0.17	0.20

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.10	0.16	0.08	0.27	0.44	0.00	-0.01	0.04	0.07	0.14	0.09	0.13	-0.05	-0.03	-0.06	0.00	0.03	-0.06	-0.14	-0.17	-0.14	-0.09	-0.02	-0.02
2	0.10	0.16	0.08	0.27	0.44	0.00	0.17	0.17	0.18	0.26	0.09	0.13	-0.05	-0.03	-0.06	0.00	0.03	-0.06	-0.09	-0.16	-0.14	-0.07	-0.02	-0.02
3	0.30	0.34	0.30	0.37	0.52	0.09	0.27	0.20	0.20	0.29	0.08	0.16	-0.01	0.01	-0.01	0.04	0.06	-0.04	-0.11	-0.17	-0.14	-0.09	-0.01	0.00
4	0.14	0.19	0.13	0.28	0.44	0.00	0.18	0.16	0.16	0.25	0.05	0.12	-0.05	-0.02	-0.05	0.01	0.04	-0.06	-0.13	-0.18	-0.15	-0.09	-0.02	-0.02
5	0.18	0.24	0.17	0.36	0.54	0.09	0.08	0.12	0.15	0.25	0.23	0.26	0.27	0.31	0.24	0.37	0.40	0.30	0.16	0.05	0.08	0.21	0.34	0.38
6	0.18	0.24	0.17	0.36	0.54	0.09	0.20	0.22	0.22	0.33	0.23	0.26	0.27	0.31	0.24	0.37	0.40	0.30	0.16	0.05	0.06	0.20	0.34	0.38
7	0.57	0.60	0.56	0.63	0.79	0.37	0.48	0.34	0.35	0.51	0.38	0.46	0.40	0.42	0.39	0.48	0.50	0.39	0.23	0.09	0.10	0.24	0.42	0.47
8	0.31	0.36	0.30	0.45	0.62	0.18	0.30	0.25	0.26	0.38	0.27	0.32	0.33	0.35	0.32	0.43	0.46	0.34	0.19	0.06	0.08	0.21	0.39	0.43

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-0.01	0.02	0.28	0.17	0.28	0.10	0.18	0.09	0.08	0.25	0.23	0.21	-0.09	-0.08	-0.01	-0.01	0.01	-0.02	-0.01	-0.13	-0.13	-0.07	0.01	-0.01
2	-0.01	0.02	0.28	0.17	0.28	0.10	0.18	0.16	0.16	0.38	0.23	0.21	-0.09	-0.08	-0.01	-0.01	0.01	-0.02	-0.01	-0.13	-0.12	-0.05	0.01	-0.01
3	0.23	0.25	0.41	0.24	0.37	0.15	0.27	0.19	0.19	0.39	0.22	0.34	-0.03	-0.02	0.02	0.01	0.05	-0.01	0.01	-0.14	-0.13	-0.07	0.01	0.02
4	0.05	0.08	0.30	0.17	0.30	0.09	0.18	0.15	0.15	0.36	0.20	0.23	-0.08	-0.06	0.00	-0.01	0.03	-0.02	-0.01	-0.14	-0.14	-0.07	0.00	-0.01
5	0.08	0.11	0.36	0.27	0.38	0.21	0.28	0.16	0.16	0.38	0.38	0.31	0.16	0.22	0.35	0.34	0.41	0.33	0.37	0.09	0.09	0.24	0.39	0.37
6	0.08	0.11	0.36	0.27	0.38	0.21	0.28	0.21	0.21	0.45	0.38	0.31	0.16	0.22	0.35	0.34	0.41	0.33	0.37	0.06	0.06	0.22	0.39	0.37
7	0.52	0.53	0.67	0.51	0.63	0.41	0.56	0.34	0.34	0.62	0.54	0.63	0.38	0.40	0.46	0.44	0.53	0.41	0.47	0.10	0.10	0.27	0.47	0.47
8	0.22	0.24	0.47	0.34	0.47	0.27	0.37	0.24	0.24	0.50	0.42	0.42	0.31	0.33	0.40	0.40	0.49	0.38	0.42	0.07	0.08	0.24	0.43	0.41

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.00	-0.06	0.19	0.03	0.01	-0.26	-0.10	-0.07	0.01	0.04	0.14	0.16	-0.08	-0.05	-0.01	-0.10	-0.10	-0.24	-0.17	-0.25	-0.24	-0.22	-0.01	-0.01
2	0.00	-0.06	0.19	0.03	0.01	-0.26	-0.10	0.11	0.13	0.20	0.14	0.16	-0.08	-0.05	-0.01	-0.10	-0.10	-0.24	-0.17	-0.21	-0.24	-0.20	-0.01	-0.01
3	0.03	0.01	0.28	0.26	0.26	0.00	0.07	0.16	0.13	0.21	0.14	0.21	-0.02	-0.02	0.02	-0.04	-0.03	-0.12	-0.07	-0.22	-0.22	-0.20	0.00	0.00
4	0.00	-0.06	0.19	0.09	0.08	-0.17	-0.04	0.11	0.12	0.19	0.11	0.15	-0.04	-0.04	-0.01	-0.08	-0.07	-0.16	-0.10	-0.23	-0.23	-0.20	-0.01	-0.01
5	0.03	0.02	0.28	0.11	0.10	-0.21	-0.01	0.00	0.06	0.12	0.28	0.27	0.01	0.24	0.33	0.15	0.17	-0.04	0.20	-0.03	-0.16	-0.03	0.35	0.38
6	0.03	0.02	0.28	0.11	0.10	-0.21	-0.01	0.16	0.16	0.25	0.28	0.27	0.01	0.24	0.33	0.15	0.17	-0.04	0.20	0.01	-0.16	-0.01	0.35	0.38
7	0.09	0.23	0.54	0.53	0.53	0.17	0.28	0.29	0.19	0.34	0.44	0.50	0.09	0.33	0.42	0.37	0.41	0.20	0.37	0.06	-0.12	0.03	0.43	0.47
8	0.05	0.08	0.36	0.25	0.25	-0.07	0.10	0.20	0.16	0.28	0.33	0.34	0.06	0.29	0.37	0.30	0.34	0.13	0.31	0.04	-0.14	0.02	0.40	0.43

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that water level decreases over the No-Action Alternative

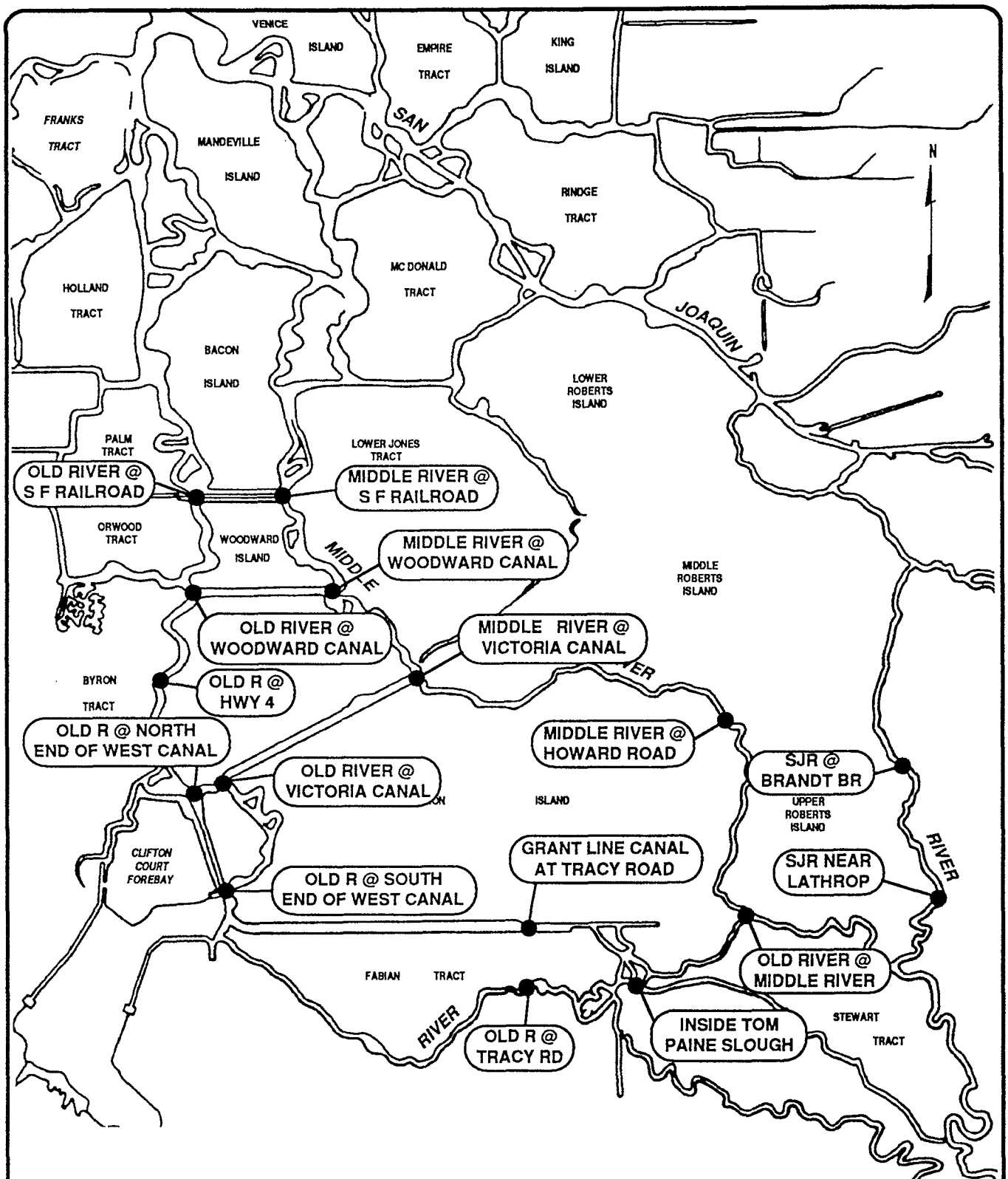

FIGURE C-13
PHASE II MODELING
LOCATIONS WHERE WATER LEVEL IMPROVEMENTS PRESENTED

FIGURE C-14
PHASE II MODELING
IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE DRY YEAR

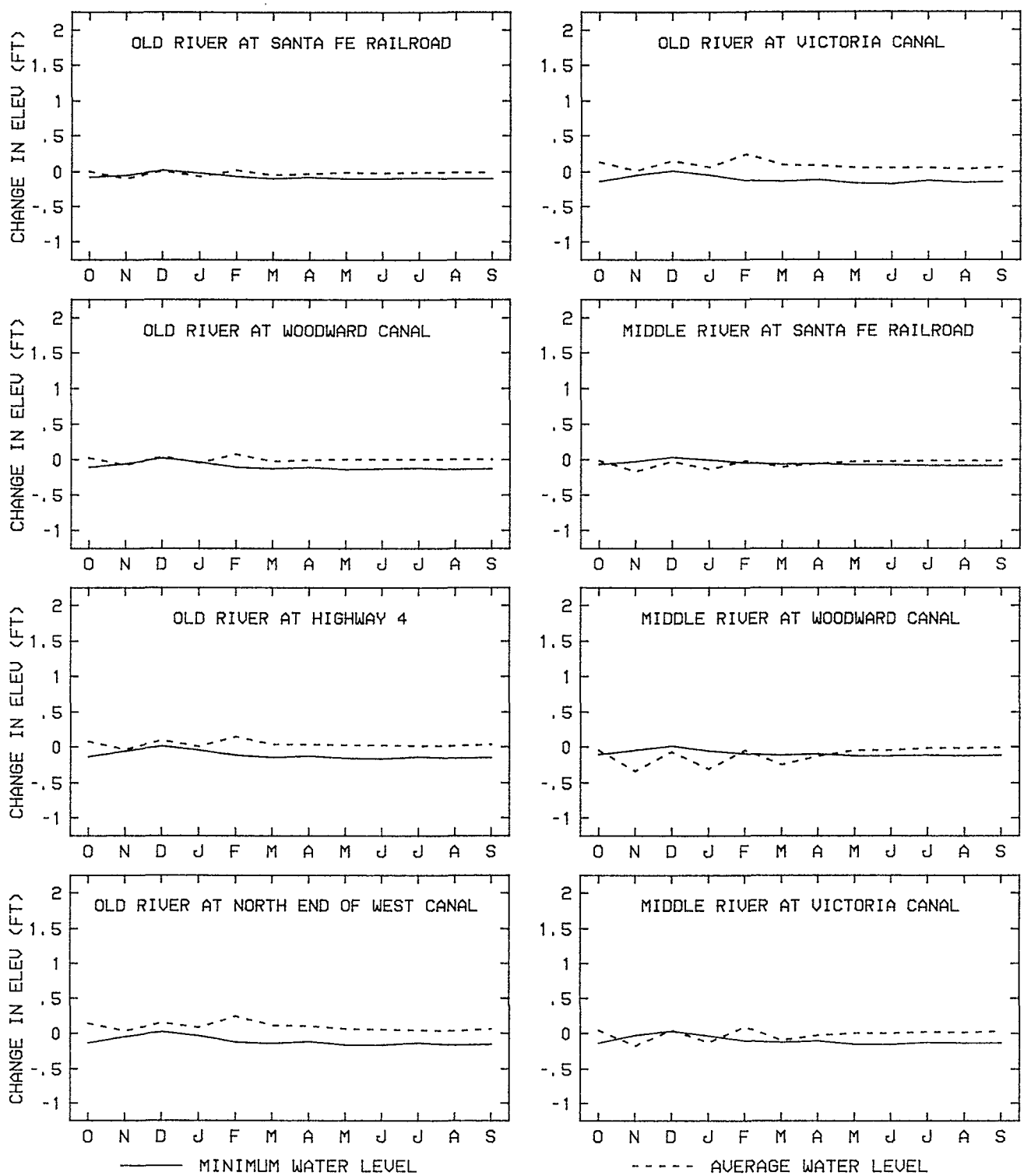

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FIGURE C-14 (cont.)
PHASE II MODELING
IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE DRY YEAR

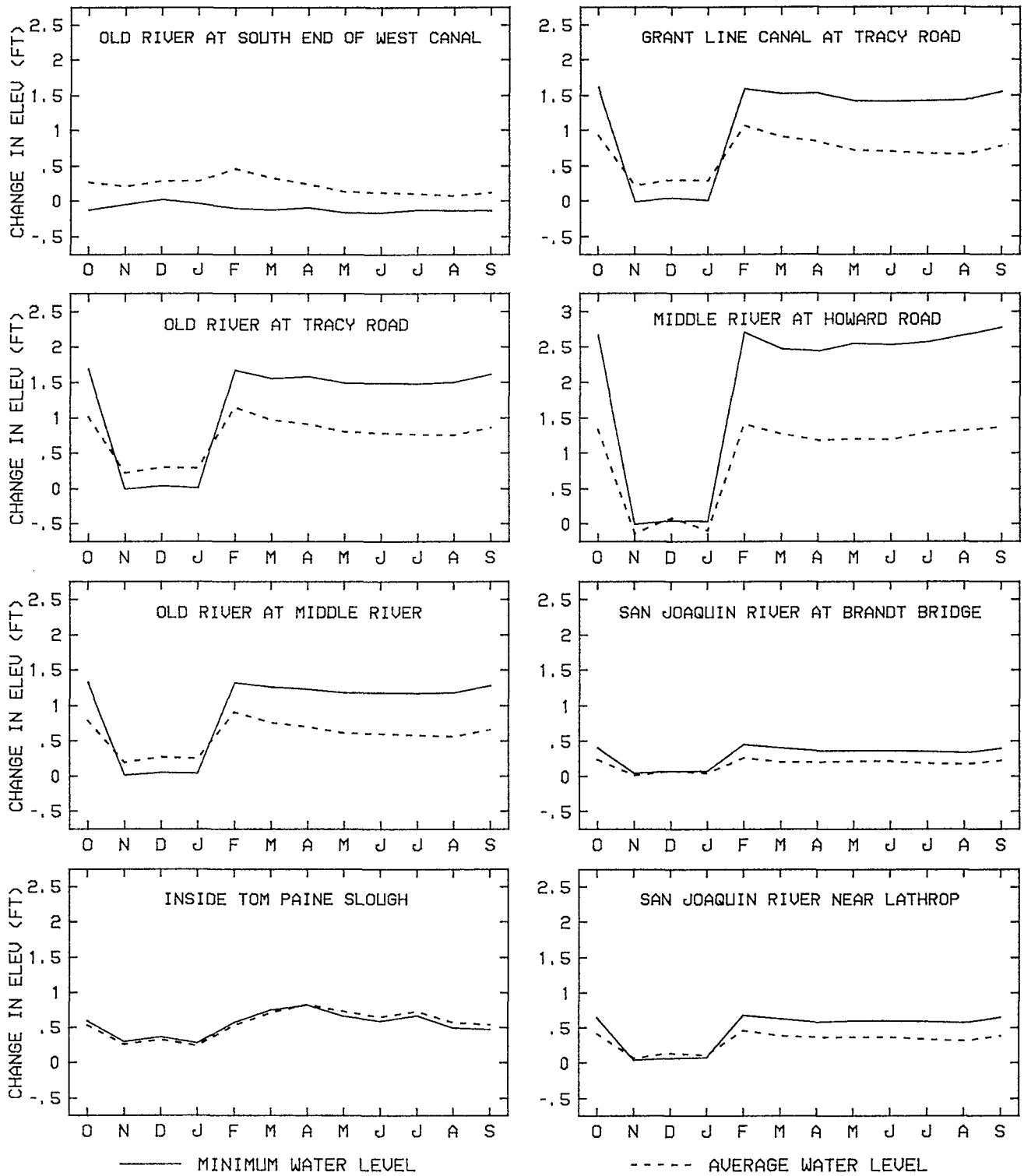

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FIGURE C-15
PHASE II MODELING
PROFILES OF IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS WHEN BARRIERS OPERATING
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE CRITICAL YEAR

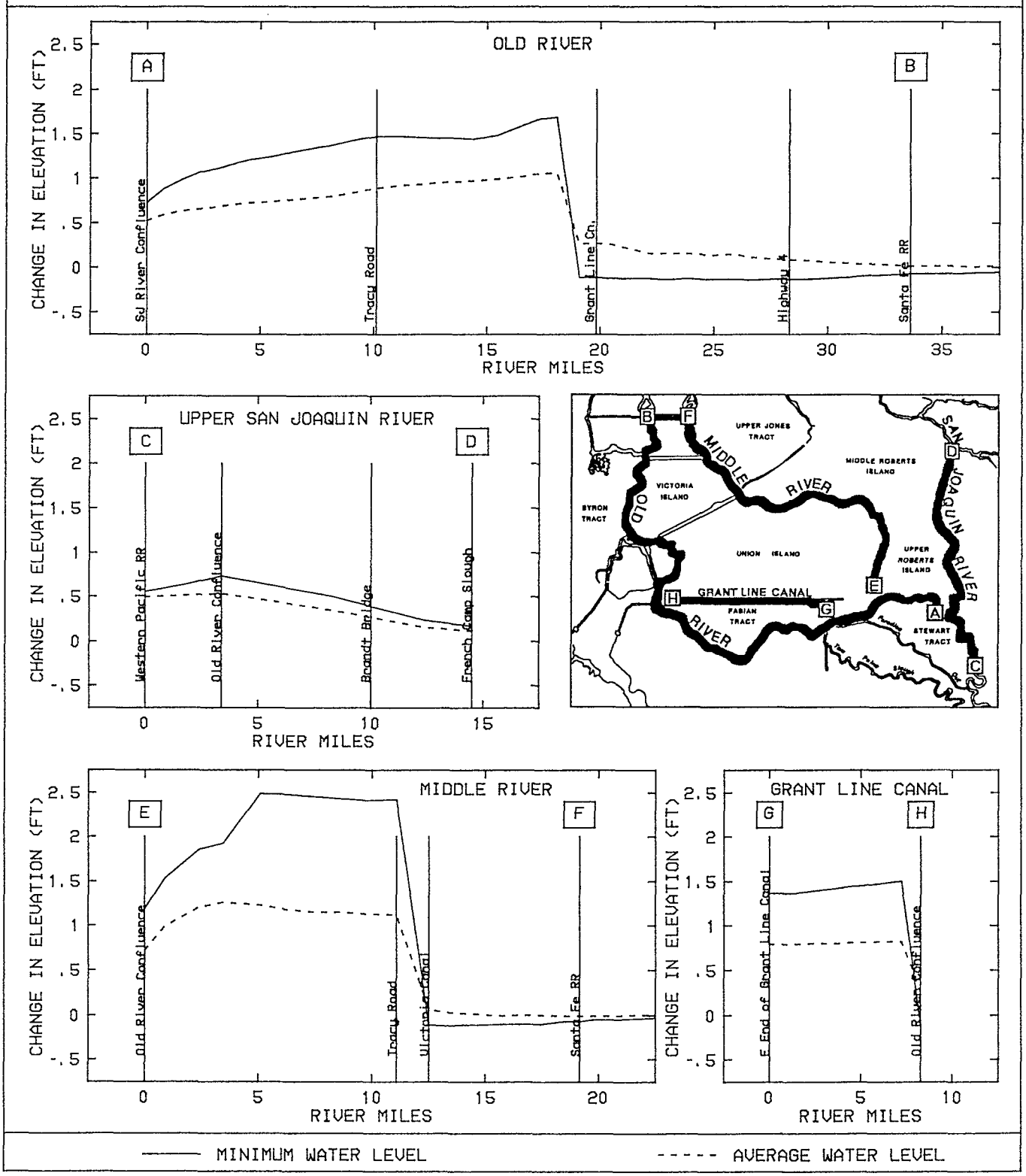

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FIGURE C-15 (cont.)
PHASE II MODELING
PROFILES OF IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS WHEN BARRIERS OPERATING
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE DRY YEAR

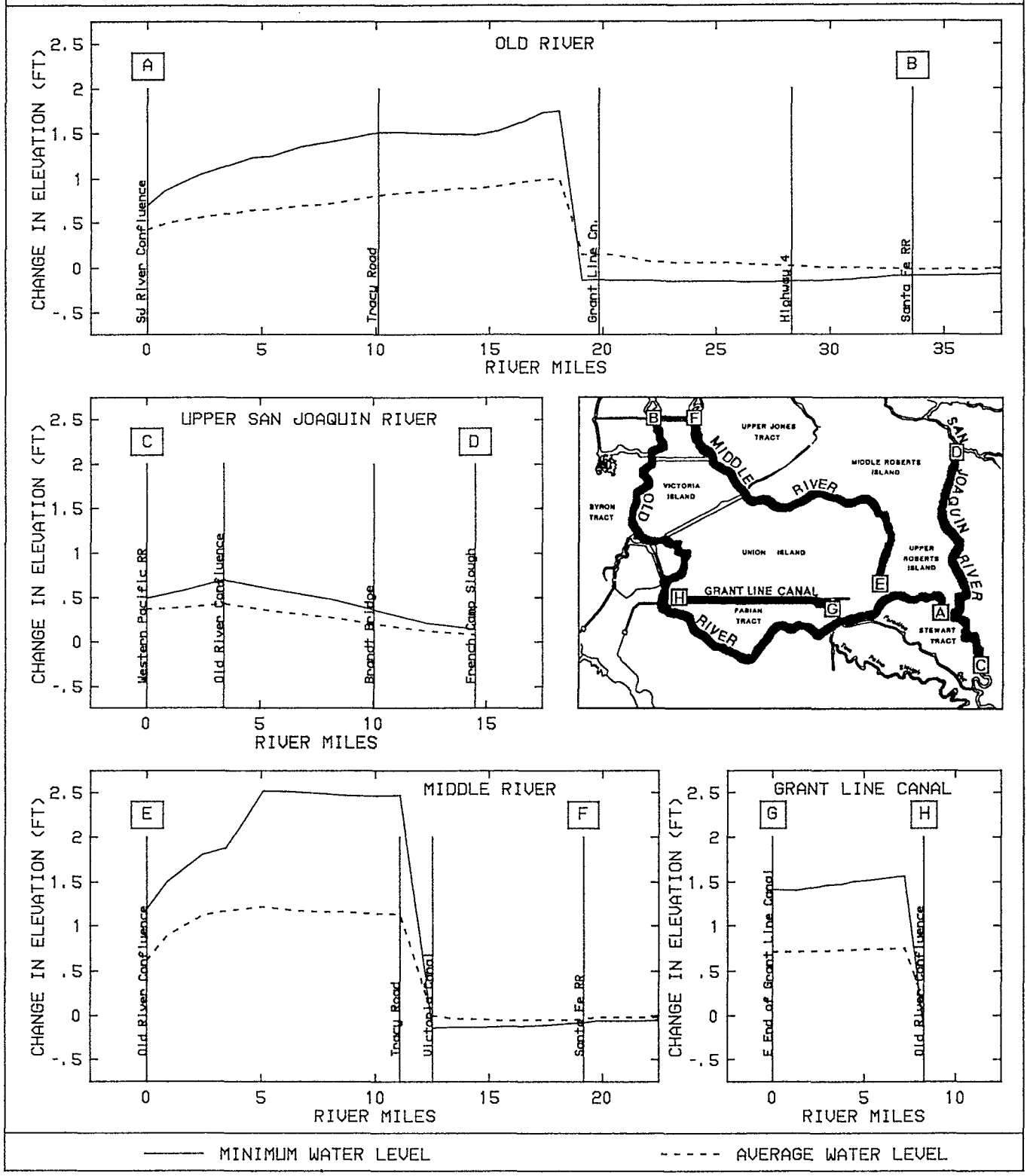

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FIGURE C-15 (cont.)
PHASE II MODELING
PROFILES OF IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS WHEN BARRIERS OPERATING
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE BELOW NORMAL YEAR

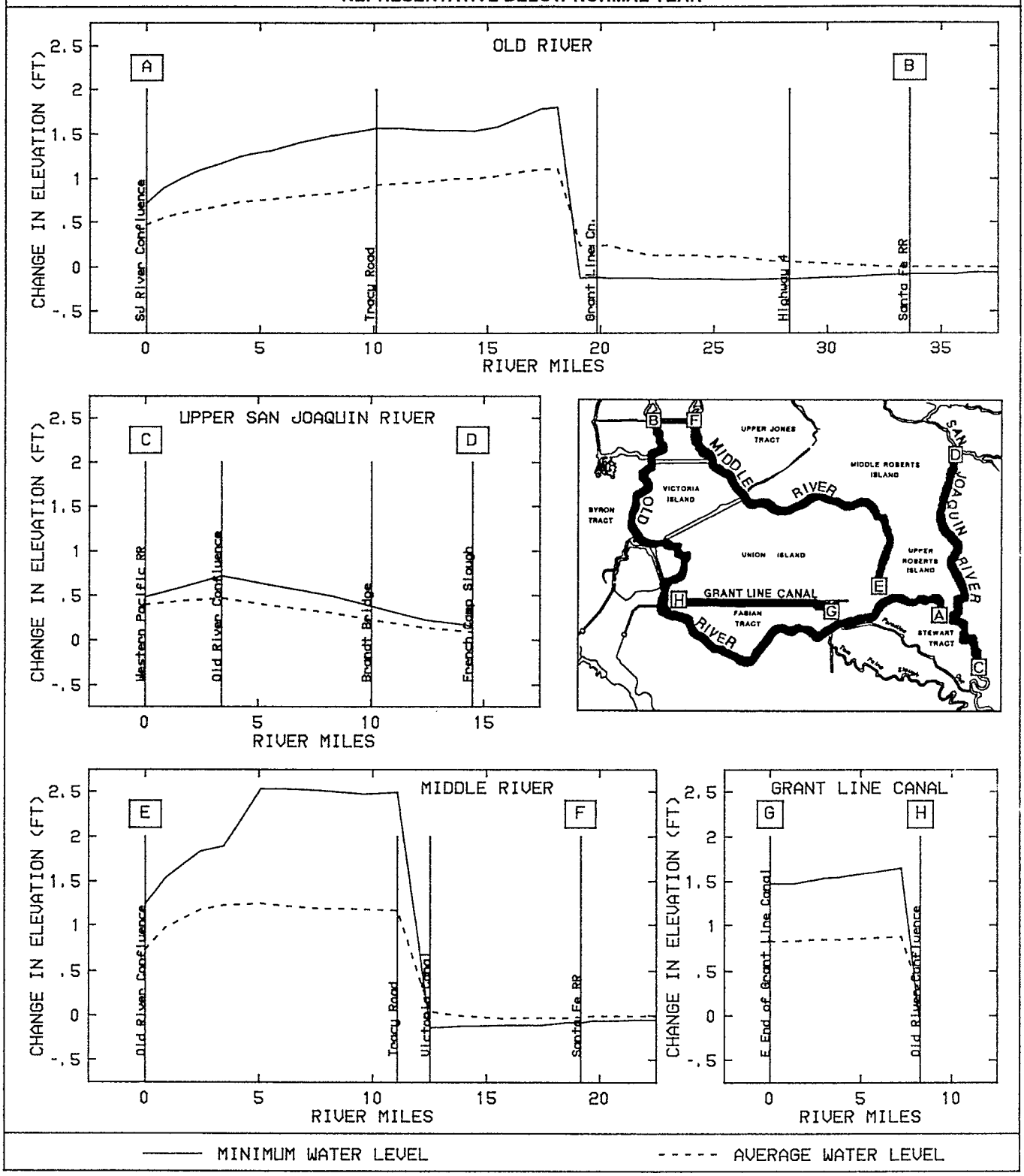

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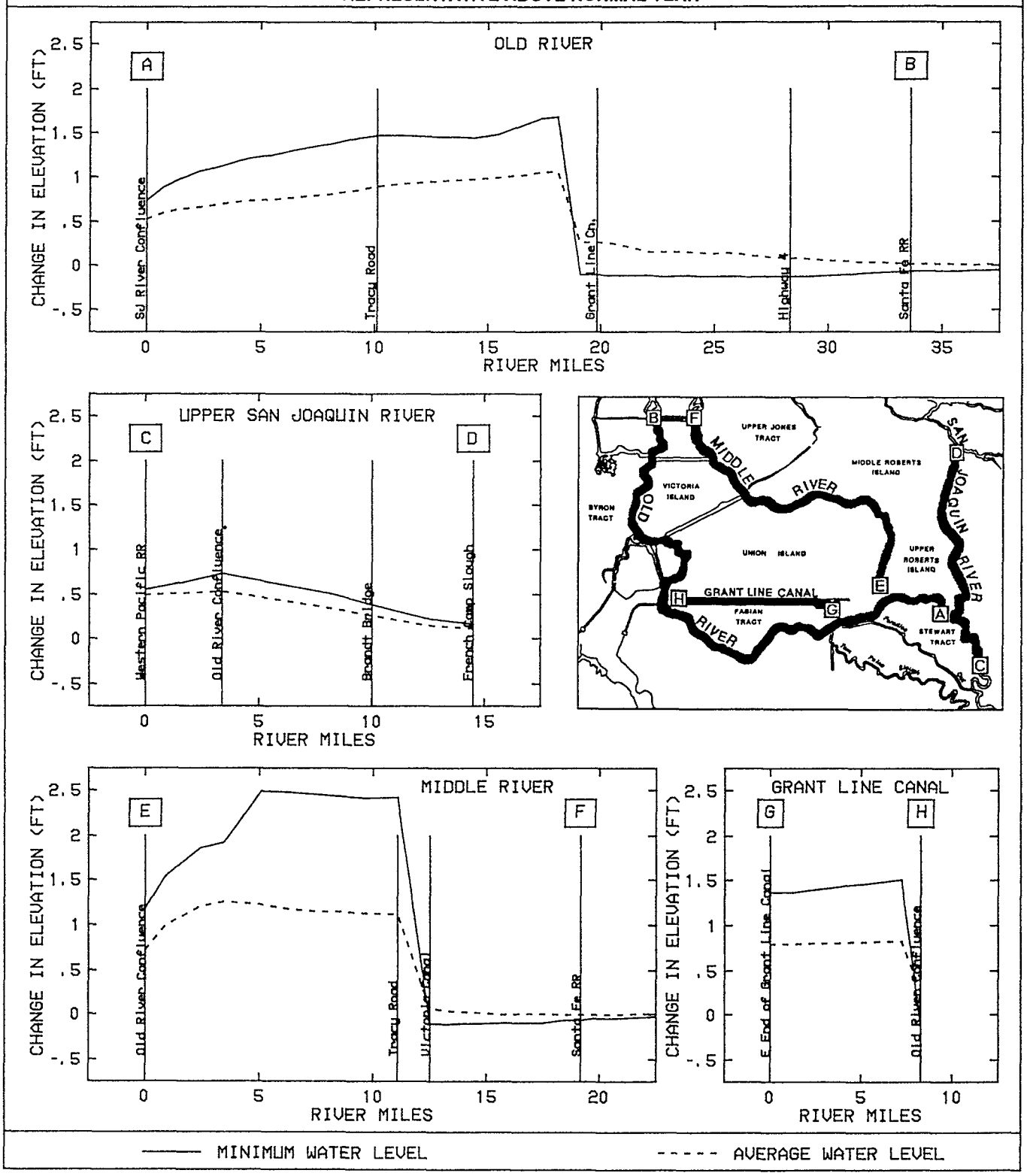
FIGURE C-15 (cont.)
PHASE II MODELING
PROFILES OF IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS WHEN BARRIERS OPERATING
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE ABOVE NORMAL YEAR



C-041587

FIGURE C-15 (cont.)
PHASE II MODELING
PROFILES OF IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS WHEN BARRIERS OPERATING
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE WET YEAR

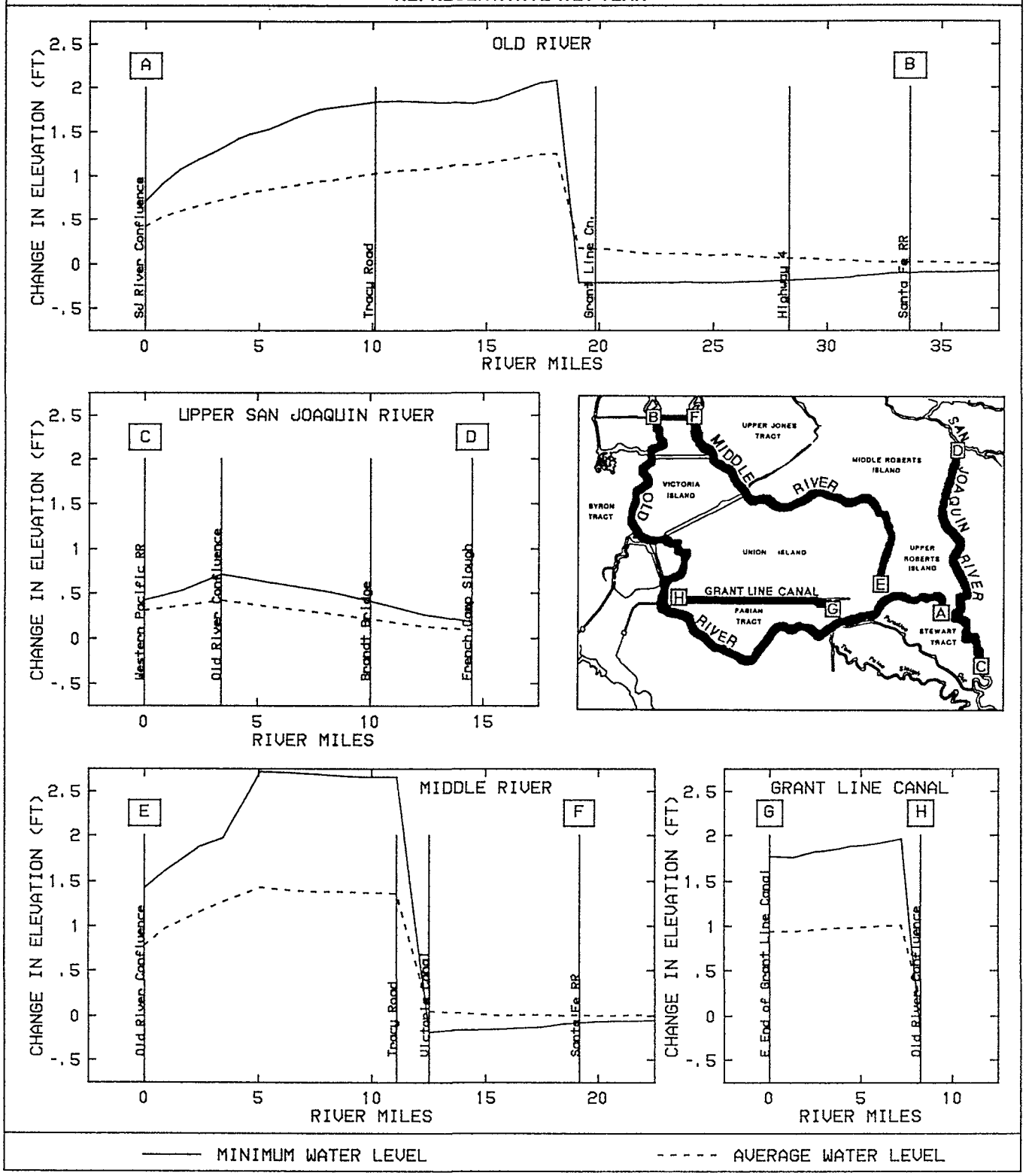


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FIGURE C-16
PHASE II MODELING
IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS
DUE TO FOREBAY IMPROVEMENTS ALONE
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE

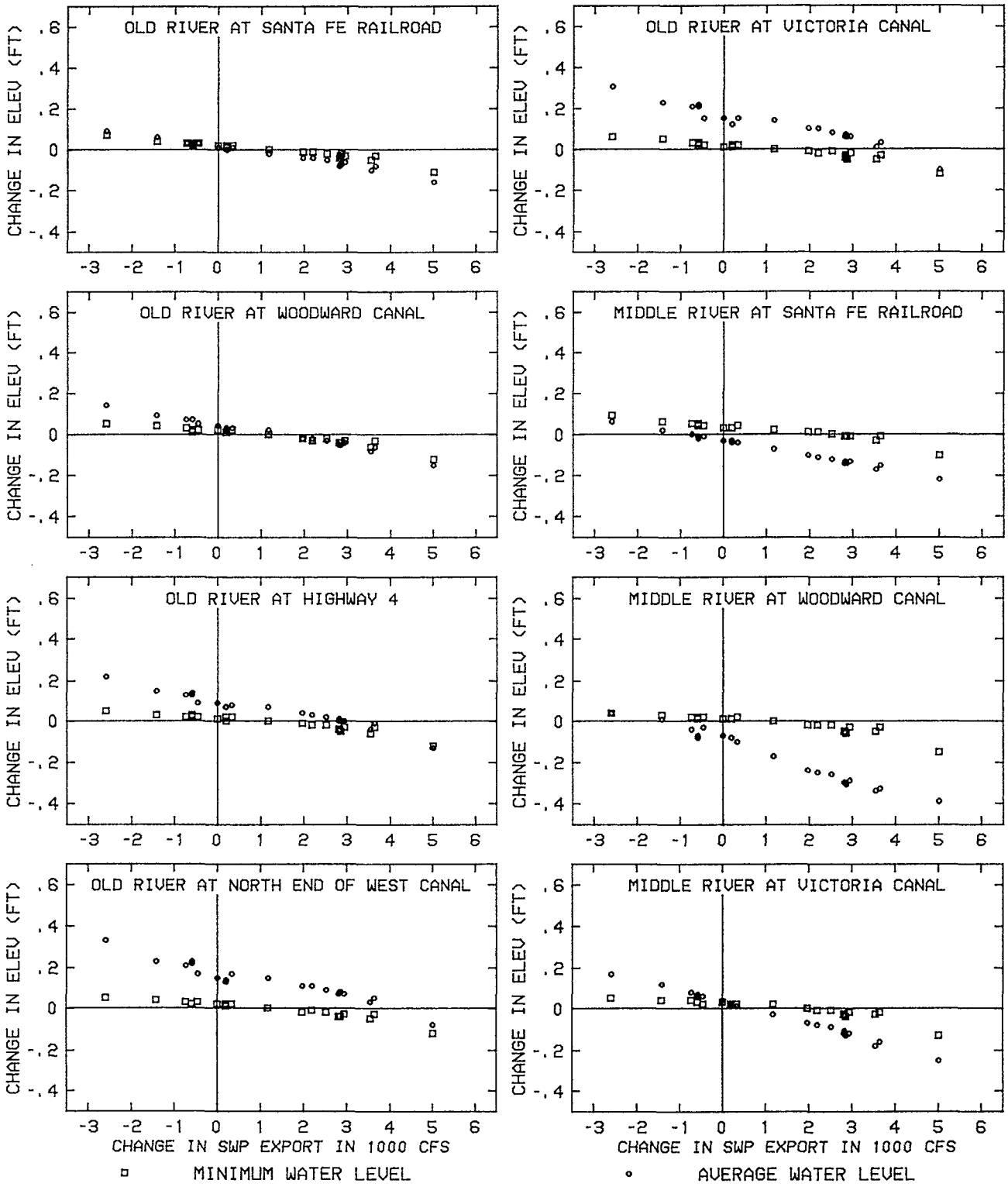
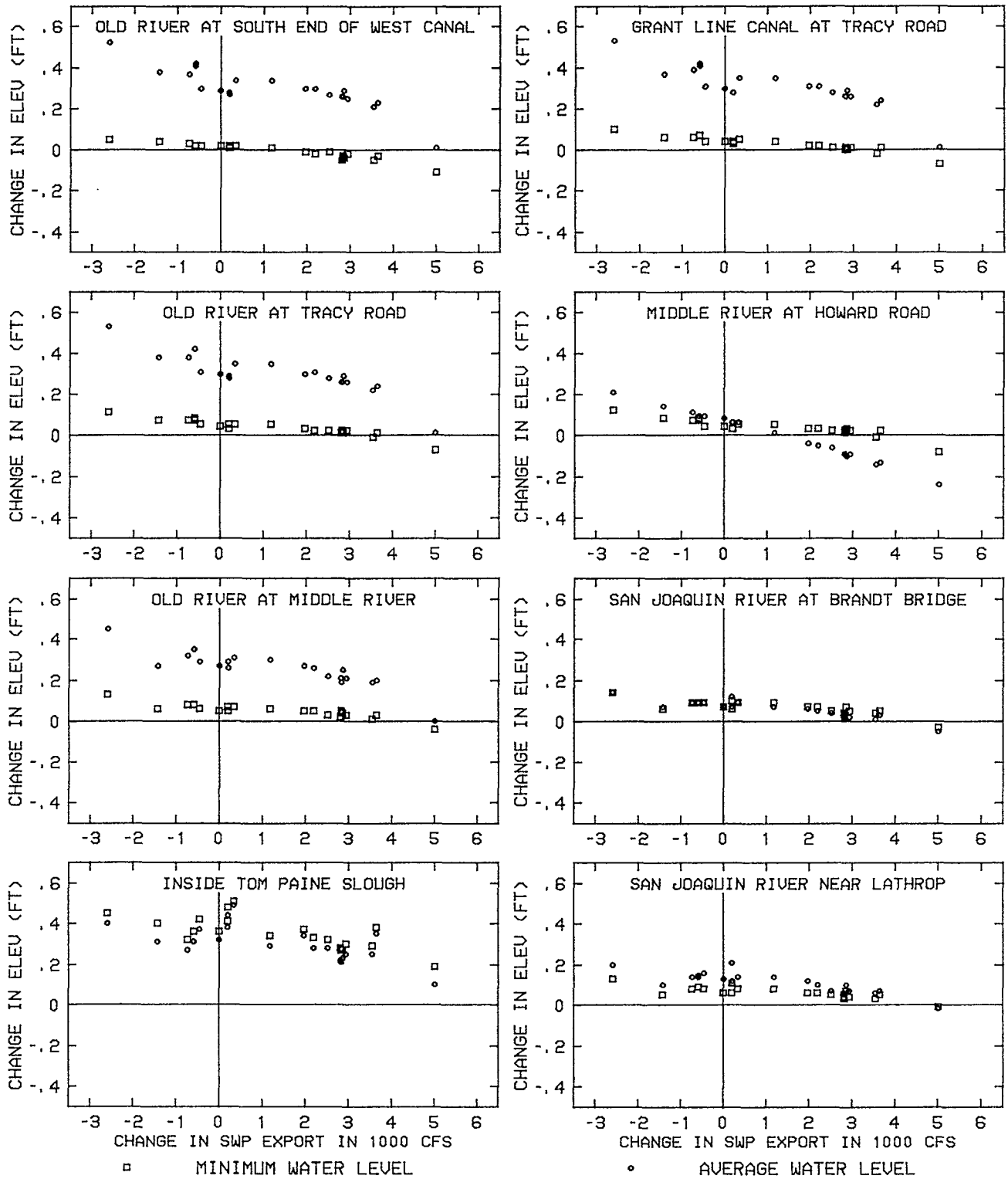


FIGURE C-16 (cont.)
PHASE II MODELING
IMPROVEMENT IN MINIMUM AND AVERAGE WATER LEVELS
DUE TO FOREBAY IMPROVEMENTS ALONE
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE



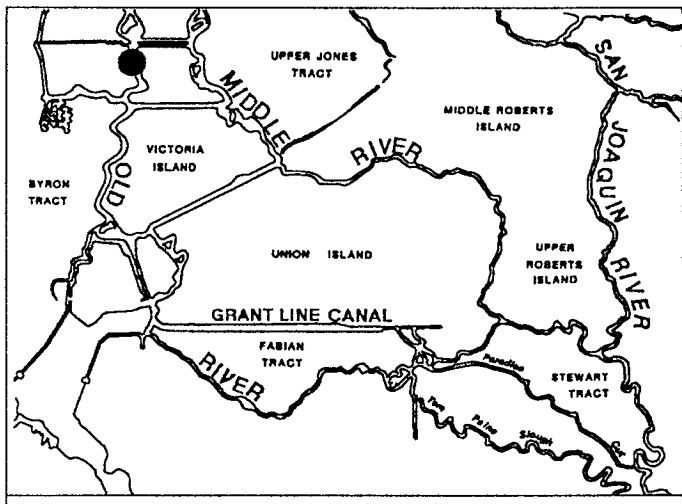


TABLE C-19
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

OLD RIVER NEAR SANTA FE RAILROAD

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-7	-2	-5	3	9	7	6	-20	-19	-27	-55	-32	-7	-3	-4	3	5	3	3	-10	-7	-8	-21	-17
2	-6	-1	-4	3	25	46	66	31	86	135	60	18	-6	-1	-4	3	13	19	25	16	31	38	23	10
3	-9	-2	-5	1	25	46	62	27	82	132	56	17	-8	-2	-4	2	13	19	24	14	30	36	21	9
4	-6	-1	-4	4	25	48	64	31	85	133	57	17	-6	-2	-4	3	13	20	24	16	31	37	21	9
5	-7	-3	-5	2	7	-6	-4	-24	-27	-43	-72	-43	-7	-3	-5	2	4	-2	-2	-12	-10	-12	-27	-22
6	-6	-2	-5	2	22	40	55	28	76	118	43	10	-6	-2	-4	2	11	17	21	14	27	33	16	6
7	-12	-3	-7	0	18	35	47	22	83	138	51	5	-11	-3	-6	-1	10	14	18	11	30	38	19	3
8	-7	-2	-5	2	20	40	56	29	79	122	46	11	-7	-2	-4	2	11	17	22	14	28	34	17	6

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-25	-35	-21	-50	-31	-42	-53	-32	-31	-28	-19	-4	-13	-25	-19	-33	-21	-27	-32	-23	-25	-22	-14	-2
2	-5	-23	-18	-49	-29	-18	-13	-3	-9	-6	4	20	-3	-16	-16	-32	-20	-12	-8	-2	-8	-5	3	12
3	-8	-31	-21	-56	-35	-24	-17	-7	-12	-10	2	20	-5	-21	-19	-37	-24	-16	-11	-5	-10	-8	1	12
4	-7	-21	-17	-46	-30	-20	-18	-3	-8	-5	5	21	-4	-15	-16	-30	-21	-13	-11	-2	-7	-4	4	13
5	-32	-34	-23	-49	-33	-41	-56	-33	-30	-27	-21	-9	-17	-24	-20	-32	-22	-26	-33	-24	-24	-21	-15	-5
6	-12	-21	-20	-48	-31	-15	-13	-3	-8	-5	4	19	-6	-15	-18	-31	-22	-10	-8	-3	-7	-4	3	11
7	-31	-42	-27	-65	-44	-23	-29	-12	-16	-14	-1	17	-16	-30	-25	-42	-30	-15	-17	-9	-13	-11	-1	10
8	-16	-20	-19	-46	-32	-18	-16	-4	-9	-6	4	19	-8	-14	-17	-30	-22	-12	-10	-3	-7	-5	3	11

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-44	-65	-36	-8	-3	5	-14	-37	-33	-24	-16	-7	-23	-43	-26	-7	-3	4	-12	-30	-27	-19	-13	-5
2	-44	-65	-36	-8	-3	5	-1	-12	-13	-5	0	-1	-23	-43	-26	-7	-3	4	-2	-10	-11	-4	0	-1
3	-52	-70	-43	-12	-4	3	-3	-15	-16	-8	-2	-4	-28	-47	-32	-9	-4	2	-3	-13	-14	-6	-2	-3
4	-37	-61	-32	-8	-3	5	-1	-11	-12	-5	0	-2	-20	-41	-23	-7	-3	4	-1	-10	-10	-4	0	-1
5	-40	-66	-35	-9	-3	5	-14	-35	-31	-23	-18	-11	-21	-44	-25	-8	-2	4	-12	-28	-25	-18	-14	-8
6	-40	-66	-35	-9	-3	5	-2	-10	-11	-5	-1	-7	-21	-44	-25	-8	-2	4	-2	-9	-10	-4	-2	-5
7	-76	-95	-61	-17	-5	2	-4	-17	-19	-11	-5	-13	-40	-63	-44	-13	-5	2	-3	-14	-16	-9	-4	-9
8	-33	-59	-31	-9	-3	4	-2	-11	-11	-4	-1	-5	-18	-40	-22	-8	-3	4	-2	-10	-10	-3	-1	-4

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-48	-70	-26	-1	-3	0	0	-7	-20	-29	-18	-9	-27	-54	-22	-2	-2	-1	1	-6	-18	-27	-17	-7
2	-48	-70	-26	-1	-3	0	0	-5	-12	-16	-8	-7	-27	-54	-22	-2	-2	-1	1	-5	-11	-15	-8	-7
3	-66	-79	-31	-2	-4	-3	0	-8	-16	-19	-9	-9	-37	-61	-27	-3	-3	-3	0	-7	-15	-17	-9	-7
4	-44	-64	-25	-1	-3	0	0	-4	-11	-15	-8	-6	-25	-50	-21	-2	-2	-1	1	-5	-10	-14	-7	-6
5	-44	-66	-28	-1	-2	0	0	-6	-19	-27	-17	-10	-25	-51	-24	-2	-2	-1	1	-6	-17	-25	-16	-9
6	-44	-66	-28	-1	-2	0	0	-4	-10	-13	-8	-9	-25	-51	-24	-2	-2	-1	1	-4	-9	-12	-8	-8
7	-86	-98	-43	-5	-12	-7	-1	-10	-21	-22	-11	-13	-48	-76	-37	-5	-9	-6	-1	-9	-19	-20	-11	-12
8	-41	-62	-26	-1	-3	0	0	-4	-10	-14	-8	-9	-23	-48	-23	-2	-3	-1	0	-4	-9	-13	-8	-8

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-38	-18	94	17	22	56	68	-11	-47	-57	-22	-4	-14	-5	25	7	11	22	28	-8	-30	-39	-17	-3
2	32	26	108	20	22	55	68	3	-54	-45	-11	-3	12	8	28	8	11	22	28	3	-34	-31	-9	-2
3	39	10	98	8	19	53	66	0	-82	-56	-13	-4	15	3	26	3	9	21	28	-1	-52	-38	-11	-4
4	32	33	113	21	21	55	68	3	-48	-44	-10	-2	12	10	30	9	10	22	28	5	-30	-30	-9	-2
5	-39	-25	91	19	21	56	67	-9	-47	-58	-21	-5	-14	-7	24	8	10	23	28	-7	-30	-40	-17	-5
6	27	21	104	21	21	56	67	3	-62	-47	-10	-4	10	6	27	9	10	23	28	3	-39	-32	-8	-4
7	19	-16	63	-7	21	44	75	-5	-147	-100	-18	-8	7	-5	17	-3	10	18	31	-3	-93	-68	-15	-7
8	31	28	106	22	19	55	67	3	-43	-45	-10	-4	12	8	28	9	10	22	28	2	-27	-31	-9	-4

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

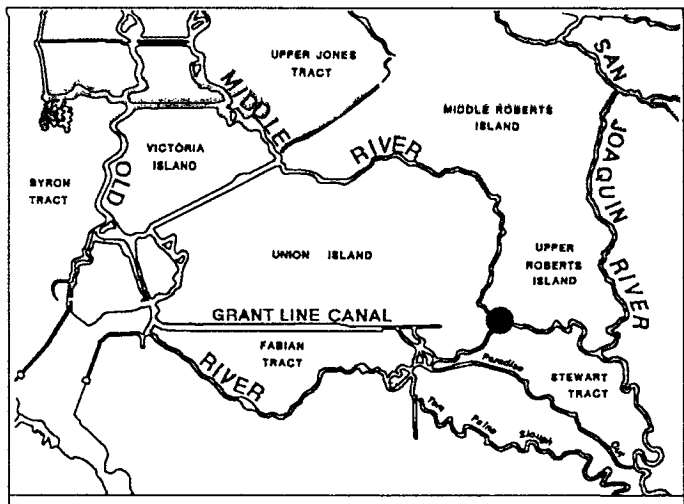


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

OLD RIVER AT MIDDLE RIVER

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	5	-4	-71	-130	-36	3	0	0
2	0	0	0	0	6	-4	0	2	0	-3	1	-3
3	0	0	0	0	6	-4	0	2	0	-3	2	-3
4	0	0	0	0	7	-4	0	2	5	-3	0	-3
5	0	0	0	0	10	-4	-93	-145	-39	-3	5	-1
6	0	0	0	0	11	-4	0	1	-4	-1	10	-3
7	0	0	0	0	0	-5	0	2	-5	-7	-9	-6
8	0	0	0	0	13	-4	0	2	1	2	9	-3

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	1	0	-80	9	129	91	4	0
2	0	0	0	0	1	0	0	2	4	0	5	-3
3	0	0	0	0	1	0	0	7	4	0	6	-2
4	0	0	0	0	1	0	0	8	4	0	3	-2
5	0	0	0	0	0	-1	-40	-13	114	80	14	-1
6	0	0	0	0	0	-2	-1	3	11	10	17	0
7	0	0	0	0	0	-1	0	-3	-6	-8	-10	-12
8	0	0	0	0	0	-1	0	6	9	9	14	-2

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	-97	-66	49	41	-1	-1
2	0	0	0	0	0	0	-1	2	1	-1	-2	-1
3	0	0	0	0	0	0	-1	2	2	1	0	-1
4	0	0	0	0	0	0	-1	2	3	2	2	-1
5	0	0	0	0	0	-6	-65	-82	38	30	-8	-1
6	0	0	0	0	0	-6	-1	2	0	-2	-9	-1
7	0	0	0	0	0	-3	-1	2	-3	-8	-6	-1
8	0	0	0	0	0	-3	-1	2	2	1	-4	-1

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	134	160	56	0	0
2	0	0	0	0	0	0	0	22	11	-2	-4	0
3	0	0	0	0	0	0	0	10	3	0	0	0
4	0	0	0	0	0	0	0	11	0	0	2	0
5	0	0	0	0	0	0	0	101	138	43	-3	0
6	0	0	0	0	0	0	0	29	25	-2	-4	0
7	0	0	0	0	0	0	0	-7	-19	-10	-3	-1
8	0	0	0	0	0	0	0	24	15	-2	-2	0

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	-7	0	0	0	0	-95	-97	-141	0	0
2	0	0	-7	0	0	0	0	2	0	0	0	0
3	0	0	-30	0	0	0	0	2	0	0	1	0
4	0	1	-5	0	0	0	0	2	0	0	1	0
5	0	0	-13	0	0	0	0	-106	-99	-141	-11	0
6	0	0	-12	0	0	0	0	2	0	0	-10	0
7	0	0	-42	0	0	0	0	2	0	0	-5	-1
8	0	0	-25	0	0	0	0	2	0	0	-3	0

IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	1	-1	-20	-34	-8	1	0	0
2	0	0	0	0	1	-1	0	1	0	-1	0	-1
3	0	0	0	0	1	-1	0	1	0	-1	0	-1
4	0	0	0	0	1	-1	0	1	1	-1	0	-1
5	0	0	0	0	2	-1	-26	-38	-9	-1	1	0
6	0	0	0	0	2	-1	0	1	-1	0	2	-1
7	0	0	0	0	0	-1	0	1	-1	-2	-2	-2
8	0	0	0	0	3	-1	0	1	0	1	2	-1

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	-21	2	27	19	1	0
2	0	0	0	0	0	0	0	0	1	0	1	-1
3	0	0	0	0	0	0	0	2	1	0	1	0
4	0	0	0	0	0	0	0	2	1	0	1	0
5	0	0	0	0	0	0	-10	-3	24	16	3	0
6	0	0	0	0	0	-1	0	1	2	2	3	0
7	0	0	0	0	0	0	0	-1	-1	-2	-2	-3
8	0	0	0	0	0	0	0	1	2	2	3	0

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	-28	-18	11	9	0	0
2	0	0	0	0	0	0	0	1	1	0	0	0
3	0	0	0	0	0	0	-1	1	1	0	0	0
4	0	0	0	0	0	0	0	1	1	0	1	0
5	0	0	0	0	0	-2	-19	-22	9	7	-2	0
6	0	0	0	0	0	-2	0	1	0	-1	-2	0
7	0	0	0	0	0	-1	-1	1	-1	-2	-1	0
8	0	0	0	0	0	-1	0	1	1	0	-1	0

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	24	29	13	0	0
2	0	0	0	0	0	0	0	4	2	0	-1	0
3	0	0	0	0	0	0	0	2	1	0	0	0
4	0	0	0	0	0	0	0	2	0	0	1	0
5	0	0	0	0	0	0	0	18	25	10	-1	0
6	0	0	0	0	0	0	0	5	5	0	-1	0
7	0	0	0	0	0	0	0	-1	-4	-3	-1	0
8	0	0	0	0	0	0	0	4	3	0	0	0

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	-1	0	0	0	0	-36	-33	-50	0	0
2	0	0	-1	0	0	0	0	1	0	0	0	0
3	0	0	-5	0	0	0	0	1	0	0	1	0
4	0	0	-1	0	0	0	0	4	0	0	1	0
5	0	0	-2	0	0	0	0	-40	-34	-50	-3	0
6	0	0	-2	0	0	0	0	1	0	0	-3	0
7	0	0	-7	0	0	0	0	1	0	0	-1	0
8	0	0	-4	0	0	0	0	1	0	0	-1	0

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

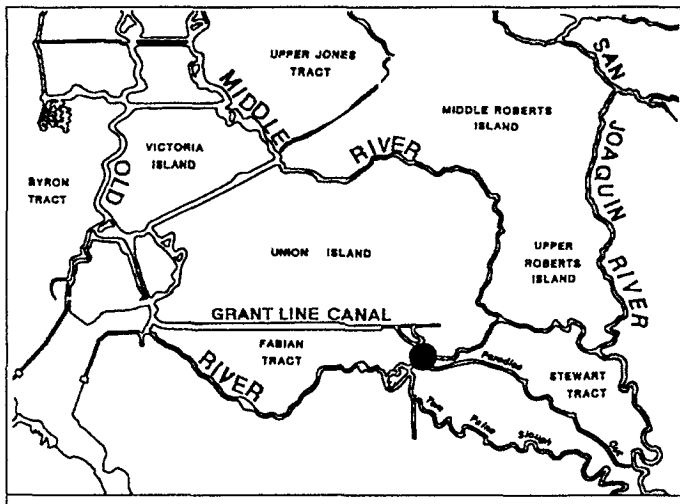


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

OLD RIVER AT PARADISE CUT

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	15	0	0	0	92	32	56	55	108	104	96	58
2	8	0	0	0	84	21	14	29	66	80	108	49
3	4	0	0	0	76	13	8	23	59	76	101	46
4	6	0	0	0	80	17	12	28	62	75	103	46
5	15	0	0	0	81	31	10	14	80	87	79	48
6	8	0	0	0	74	19	13	24	47	59	82	42
7	-3	0	0	0	3	-38	-25	-23	-8	1	-20	-35
8	6	0	0	0	68	15	10	21	43	53	74	39

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	32	0	0	0	39	49	102	170	229	226	146	88
2	27	0	0	0	33	41	31	79	109	115	140	76
3	19	0	0	0	24	29	20	70	102	107	138	71
4	25	0	0	0	29	38	29	76	104	106	138	71
5	30	0	0	0	36	49	62	125	189	187	117	71
6	23	0	0	0	28	37	28	62	83	88	104	60
7	-9	0	0	0	-5	-13	-21	-25	-29	-16	-20	-46
8	21	0	0	0	25	34	25	56	77	81	94	56

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	81	92	168	183	3	-2
2	0	0	0	0	0	0	14	28	71	73	1	-2
3	0	0	0	0	0	0	4	25	68	66	0	-2
4	0	0	0	0	0	0	11	29	69	67	1	-2
5	0	0	0	0	0	0	27	49	131	149	0	-1
6	0	0	0	0	0	0	11	25	55	61	-1	-1
7	-1	0	0	0	0	0	-19	-18	-16	-25	-5	-2
8	0	0	0	0	0	0	8	22	51	55	-2	-2

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	281	276	191	-1	-2
2	0	0	0	0	0	0	0	168	159	65	-4	-2
3	0	0	0	0	0	0	0	164	161	57	-5	-2
4	0	0	0	0	0	0	0	160	155	59	-3	-2
5	0	0	0	0	0	0	0	231	236	155	-4	-1
6	0	0	0	0	0	0	0	125	119	53	-6	-1
7	0	0	0	0	0	0	0	43	-14	-37	-11	-3
8	0	0	0	0	0	0	0	114	106	47	-8	-2

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2	1	-9	0	0	0	0	14	-6	-31	-3	-1
2	2	1	-8	0	0	0	0	3	2	-1	0	-1
3	2	0	-49	-2	0	0	0	2	2	-2	-1	-2
4	2	0	-13	0	0	0	0	3	2	0	0	-1
5	2	0	-18	0	0	0	0	-10	-35	-66	-4	-1
6	1	0	-17	0	0	0	0	3	2	0	-1	-1
7	-1	0	-58	-2	0	0	0	1	-5	-7	-1	-2
8	1	0	-41	0	0	0	0	3	1	-2	-2	-1

IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5	0	0	0	18	7	15	13	22	21	18	14
2	3	0	0	0	17	5	4	7	14	16	20	11
3	2	0	0	0	15	3	2	5	12	15	19	11
4	2	0	0	0	16	4	3	6	13	15	20	11
5	5	0	0	0	16	7	3	3	17	17	15	11
6	3	0	0	0	15	5	4	6	10	12	15	10
7	-1	0	0	0	1	-9	-6	-5	-2	0	-4	-8
8	2	0	0	0	14	4	3	5	9	10	14	9

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	9	0	0	0	10	12	24	34	46	43	26	18
2	7	0	0	0	8	10	8	16	22	22	25	16
3	5	0	0	0	6	7	5	14	21	21	25	15
4	7	0	0	0	7	9	7	15	21	20	25	15
5	8	0	0	0	9	12	15	25	38	36	21	15
6	6	0	0	0	7	9	7	12	17	17	19	13
7	-2	0	0	0	-1	-3	-5	-5	-6	-3	-4	-10
8	6	0	0	0	6	8	6	11	16	16	17	12

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	21	22	36	38	1	-1
2	0	0	0	0	0	0	4	7	15	15	0	-1
3	0	0	0	0	0	0	1	6	15	14	0	-1
4	0	0	0	0	0	0	3	7	15	14	0	-1
5	0	0	0	0	0	0	7	12	28	31	0	-1
6	0	0	0	0	0	0	3	6	12	13	0	-1
7	0	0	0	0	0	0	-5	-5	-4	-5	-1	-1
8	0	0	0	0	0	0	2	5	11	11	0	-1

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	48	50	41	0	-1
2	0	0	0	0	0	0	0	29	28	14	-1	-1
3	0	0	0	0	0	0	0	28	29	12	-1	-1
4	0	0	0	0	0	0	0	27	28	13	-1	-1
5	0	0	0	0	0	0	0	39	42	33	-1	-1
6	0	0	0	0	0	0	0	21	22	11	-1	-1
7	0	0	0	0	0	0	0	7	-3	-8	-2	-1
8	0	0	0	0	0	0	0	20	19	10	-2	-1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1	0	-2	0	0	0	0	5	-2	-10	-1	0
2	1	0	-1	0	0	0	0	1	1	0	0	0
3	1	0	-9	-1	0	0	0	1	1	-1	0	-1
4	1	0	-2	0	0	0	0	5	1	0	0	-1
5	1	0	-3	0	0	0	0	-4	-11	-21	-1	-1
6	1	0	-3	0	0	0	0	1	1	0	0	-1
7	0	0	-10	-1	0	0	0	0	-2	-2	0	-1
8	1	0	-7	0	0	0	0	1	0	-1	0	-1

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

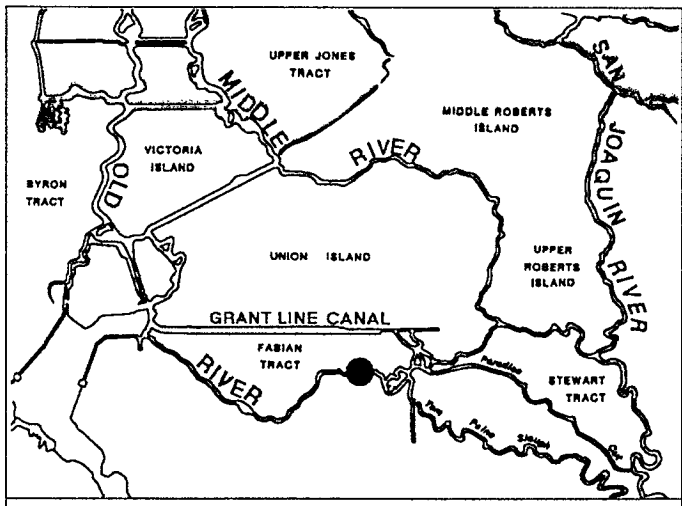


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

OLD RIVER AT TRACY ROAD

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	151	4	0	0	311	225	141	202	204	153	219	223
2	138	4	0	0	305	248	180	237	271	267	308	260
3	119	3	0	0	301	238	165	223	259	262	298	253
4	135	3	0	0	317	265	192	246	277	271	313	264
5	36	1	0	0	105	18	14	79	125	104	74	33
6	-6	0	0	0	85	-9	-33	-26	15	38	48	6
7	-21	0	0	1	30	-82	-76	-54	-47	-27	-31	-76
8	-12	0	0	0	56	-35	-51	-27	-5	11	33	-2

IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	49	1	0	0	62	50	36	46	42	30	41	50
2	44	1	0	0	61	55	46	54	56	53	58	59
3	38	1	0	0	60	53	42	51	54	52	56	57
4	43	1	0	0	63	59	49	56	58	53	59	60
5	12	1	0	0	21	4	4	18	26	21	14	7
6	-2	0	0	0	17	-2	-8	-6	3	8	9	2
7	-7	0	0	0	6	-19	-19	-13	-10	-6	-6	-17
8	-4	0	0	0	11	-8	-13	-6	-1	2	6	-1

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	165	6	0	0	203	252	215	299	323	344	375	313
2	154	6	0	0	192	269	242	326	345	363	396	327
3	141	6	0	0	178	246	210	312	339	361	395	326
4	184	6	0	0	199	283	262	331	346	364	398	329
5	21	2	0	0	47	104	103	175	215	242	145	58
6	-3	1	0	0	22	51	12	28	47	66	71	10
7	-27	-1	0	0	-3	-28	-58	-44	-48	-37	-36	-87
8	-8	1	0	0	15	21	-9	12	34	44	53	7

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	42	2	0	0	49	58	50	60	64	67	68	64
2	39	2	0	0	46	62	57	66	69	70	71	67
3	36	2	0	0	43	57	49	63	68	70	71	66
4	47	2	0	0	48	66	62	67	69	71	72	67
5	5	1	0	0	12	24	24	35	43	47	26	12
6	-1	0	0	0	6	12	3	6	10	13	13	2
7	-7	-1	0	0	-1	-7	-14	-9	-10	-7	-7	-18
8	-2	0	0	0	4	5	-2	3	7	9	10	1

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	218	228	277	316	33	-2
2	0	0	0	0	0	0	194	248	296	332	32	-2
3	-1	0	0	0	0	1	200	243	291	330	31	-2
4	0	0	0	0	0	0	193	250	297	334	34	-2
5	0	0	0	0	0	1	66	106	167	218	24	-1
6	0	0	0	0	0	1	-32	-17	24	48	3	-2
7	-1	0	0	0	0	4	-65	-47	-29	-41	-10	-4
8	0	0	0	0	0	0	-46	-17	17	21	0	-3

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	56	55	60	66	7	-1
2	0	0	0	0	0	0	50	60	64	69	7	-1
3	0	0	0	0	0	0	52	59	63	68	6	-1
4	0	0	0	0	0	0	50	60	64	69	7	-1
5	0	0	0	0	0	0	17	26	36	45	5	0
6	0	0	0	0	0	0	-9	-4	5	10	1	-1
7	-1	0	0	0	0	1	-17	-11	-6	-9	-2	-1
8	0	0	0	0	0	0	-12	-4	4	5	0	-1

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	372	404	318	25	-1
2	0	0	0	0	0	0	0	371	419	332	23	-1
3	0	0	0	0	0	0	0	365	412	330	23	-3
4	0	0	0	0	0	0	0	372	420	332	23	-2
5	0	0	0	0	0	0	0	227	294	218	16	-2
6	0	0	0	0	0	0	0	87	105	34	-2	-2
7	-1	0	0	0	0	0	0	29	-39	-68	-13	-4
8	0	0	0	0	0	0	0	63	63	11	-4	-3

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	71	72	67	5	-1
2	0	0	0	0	0	0	0	71	75	70	5	-1
3	0	0	0	0	0	0	0	69	74	70	5	-1
4	0	0	0	0	0	0	0	71	75	70	5	-1
5	0	0	0	0	0	0	0	43	53	46	3	-1
6	0	0	0	0	0	0	0	17	19	7	-1	-1
7	0	0	0	0	0	0	0	6	-7	-14	-3	-1
8	0	0	0	0	0	0	0	12	11	2	-1	-1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	14	0	-6	0	0	0	0	102	73	70	5	-1
2	18	0	-6	0	0	0	0	109	12	21	5	-1
3	19	0	-39	-4	0	0	0	88	7	-5	4	-2
4	19	0	-11	0	0	0	0	98	9	19	5	-1
5	5	0	-13	-1	0	0	0	34	1	-21	-4	-1
6	4	0	-13	-1	0	0	0	16	-20	-31	-3	-1
7	-5	2	-37	-7	0	0	0	15	-28	-44	2	-4
8	4	0	-34	-3	0	0	0	16	-21	-41	-1	-2

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	3	0	-1	0	0	0	0	37	23	23	1	-1
2	4	0	-1	0	0	0	0	39	4	7	1	-1
3	5	0	-7	-2	0	0	0	32	3	-2	1	-1
4	5	0	-2	0	0	0	0	37	3	6	1	-1
5	1	0	-2	-1	0	0	0	13	1	-7	-1	-1
6	1	0	-3	-1	0	0	0	6	-7	-10	-1	-1
7	-1	1	-7	-3	0	0	0	6	-9	-14	1	-1
8	1	0	-6	-1	0	0	0	6	-7	-14	0	-1

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

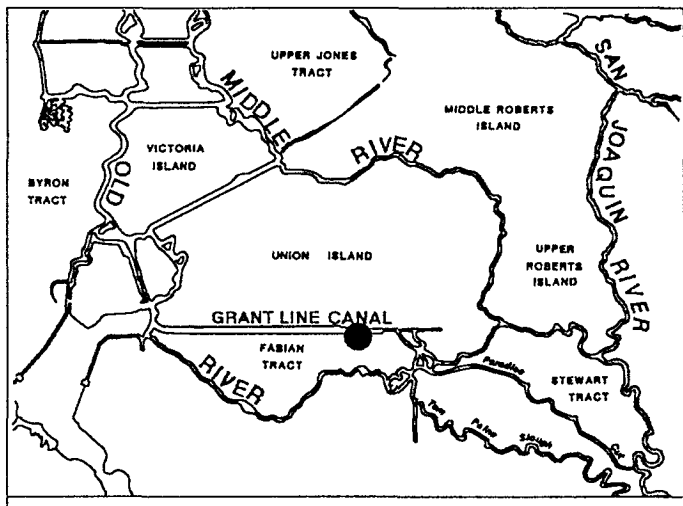


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

GRANT LINE CANAL AT TRACY ROAD

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	37	1	0	0	152	94	101	137	160	132	132	108	12	0	0	0	30	21	26	31	33	26	25	25
2	26	1	0	0	143	81	53	87	133	149	178	112	8	0	0	0	29	18	13	20	28	29	34	25
3	19	0	0	1	147	77	48	82	127	144	172	108	6	0	0	0	29	17	12	19	26	28	33	24
4	22	1	0	0	143	83	54	86	131	147	174	110	7	0	0	0	28	19	14	20	27	29	33	25
5	18	0	0	1	76	27	12	54	106	99	69	41	6	0	0	0	15	6	3	12	22	20	13	9
6	4	0	0	1	70	13	0	10	30	46	63	29	2	0	0	0	14	3	0	2	6	9	12	7
7	-6	0	0	2	17	-45	-36	-29	-25	-9	-23	-48	-2	0	0	1	3	-10	-9	-7	-5	-2	-4	-11
8	2	0	0	1	58	5	-4	8	21	33	55	24	1	0	0	0	12	1	-1	2	5	7	11	5

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	67	3	0	0	80	99	162	237	277	288	224	161	17	1	0	0	19	23	38	48	55	56	41	33
2	52	3	0	0	65	95	80	158	188	205	236	160	13	1	0	0	16	22	19	32	38	40	43	33
3	46	2	0	0	59	83	69	151	188	202	234	158	12	1	0	0	14	19	16	31	38	39	42	32
4	57	3	0	0	64	91	81	155	185	198	230	156	15	1	0	0	15	21	19	32	37	38	42	32
5	25	2	0	1	35	58	88	152	200	219	120	61	6	1	0	0	8	13	21	31	40	43	22	12
6	13	1	0	1	23	37	21	45	61	72	83	41	4	1	0	0	6	9	5	9	12	14	15	8
7	-13	-1	0	1	-2	-15	-28	-30	-38	-25	-27	-60	-4	0	0	0	-1	-4	-7	-6	-8	-5	-5	-12
8	11	1	0	1	21	29	16	37	55	62	74	37	3	1	0	0	5	7	4	8	11	12	14	8

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	146	168	224	254	22	-1	0	0	0	0	0	0	38	41	49	53	5	0
2	0	0	0	0	0	0	45	87	140	155	13	-1	0	0	0	0	0	0	12	21	31	32	3	0
3	0	0	0	0	0	0	45	85	140	156	12	-1	0	0	0	0	0	0	12	21	30	32	3	0
4	0	0	0	0	0	0	44	85	136	151	12	-1	0	0	0	0	0	0	12	21	30	31	2	0
5	0	0	0	0	0	0	46	84	148	190	18	-1	0	0	0	0	0	0	12	20	32	40	4	0
6	0	0	0	0	0	0	-1	13	38	51	5	-1	0	0	0	0	0	0	0	3	8	11	1	0
7	-1	0	0	-1	0	2	-28	-24	-20	-29	-5	-2	0	0	0	0	0	1	-7	-6	-5	-6	-1	-1
8	0	0	0	0	0	0	-4	11	35	40	3	-1	0	0	0	0	0	0	-1	3	8	8	1	0

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	312	341	260	14	-1	0	0	0	0	0	0	0	58	61	55	3	-1
2	0	0	0	0	0	0	0	235	267	152	6	-1	0	0	0	0	0	0	0	44	48	32	1	-1
3	0	0	0	0	0	0	0	234	268	151	5	-2	0	0	0	0	-1	0	0	43	48	32	1	-1
4	0	0	0	0	0	0	0	227	260	147	5	-1	0	0	0	0	-1	0	0	42	47	31	1	-1
5	0	0	0	0	0	0	0	215	265	193	11	-1	0	0	0	0	0	0	0	40	48	41	2	-1
6	0	0	0	0	0	0	0	95	103	44	-1	-1	0	0	0	0	0	0	0	18	19	9	0	-1
7	-1	0	0	0	-1	0	0	34	-31	-47	-10	-4	0	0	0	0	-1	0	0	6	-6	-10	-2	-1
8	0	0	0	0	0	0	0	82	81	32	-2	-2	0	0	0	0	0	0	0	15	15	7	-1	-1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	9	0	-6	0	0	0	0	64	40	24	0	-1	2	0	-1	0	0	1	0	23	13	8	0	0
2	11	0	-5	0	0	0	0	15	5	2	0	-1	3	0	-1	0	0	1	0	6	2	1	0	0
3	10	0	-38	-3	0	0	0	13	3	-2	0	-1	3	0	-7	-1	0	0	0	5	1	-1	0	0
4	11	0	-9	0	0	0	0	14	4	2	0	0	3	0	-2	0	0	0	0	8	1	1	0	0
5	5	0	-13	-1	0	0	0	20	-13	-39	-3	-1	1	0	-2	0	0	1	0	7	-4	-13	-1	0
6	4	0	-13	0	0	0	0	5	-2	-5	1	-1	1	0	-2	0	0	1	0	2	-1	-2	0	0
7	-3	2	-38	-5	0	0	0	3	-10	-13	4	-2	-1	0	-7	-2	0	0	0	1	-3	-4	1	-1
8	4	0	-31	-2	0	0	0	5	-3	-8	1	-1	1	0	-6	-1	0	0	0	2	-1	-3	0	0

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

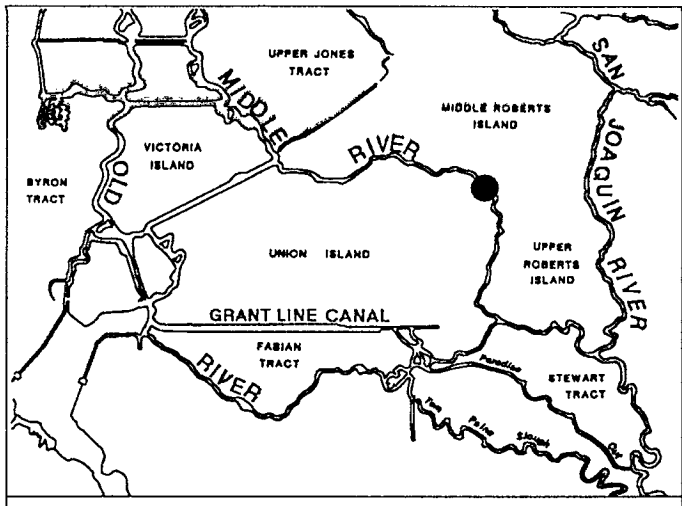


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

MIDDLE RIVER AT HOWARD ROAD

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	186	23	0	-14	123	225	199	225	182	101	133	249	59	8	0	-4	44	58	50	52	45	29	38	60
2	172	22	0	-14	117	225	223	262	220	155	173	254	54	8	0	-4	42	58	56	61	55	44	49	62
3	143	11	0	-27	105	217	217	260	221	157	173	254	45	4	0	-8	38	56	54	60	55	45	49	62
4	168	19	0	-18	115	225	224	262	220	156	174	256	53	7	0	-5	41	58	56	61	55	44	49	62
5	184	21	0	-26	120	223	198	225	182	101	134	249	58	7	0	-8	43	57	50	52	45	29	38	60
6	168	20	0	-27	113	224	223	263	219	153	173	255	53	7	0	-8	40	57	56	61	55	44	49	62
7	-23	0	0	-39	-161	-136	-75	-38	27	-22	-170	-124	-8	0	0	-11	-57	-35	-19	-9	7	-6	-49	-30
8	161	16	0	-31	111	223	222	261	218	152	171	253	51	6	0	-9	39	57	56	61	54	43	49	61

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	226	94	0	14	136	144	194	267	262	186	208	278	58	27	0	4	44	51	53	60	60	52	57	66
2	217	92	0	14	129	145	219	301	293	213	222	273	56	26	0	4	41	51	60	68	67	60	60	65
3	189	10	-2	-30	106	134	208	297	294	215	224	275	49	3	-1	-9	34	47	57	67	67	60	61	65
4	216	56	-2	-9	124	145	218	301	294	214	223	275	55	16	-1	-3	40	51	60	68	67	60	61	65
5	223	56	-2	-11	132	143	193	267	262	186	208	278	57	16	-1	-3	43	51	52	60	60	52	57	65
6	212	54	-2	-12	122	146	218	301	294	214	223	274	55	15	-1	-3	39	52	60	68	67	60	61	65
7	-38	-12	-2	-37	-97	-137	-92	-59	-106	-117	-158	-161	-10	-3	-1	-11	-31	-48	-25	-14	-24	-33	-43	-38
8	208	26	-3	-32	118	144	216	299	292	212	221	273	53	8	-1	-9	38	51	59	67	67	59	60	64

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	3	-4	-1	0	0	32	230	232	239	132	25	-5	1	-1	0	0	0	9	59	56	57	44	7	-2
2	3	-4	-1	0	0	32	242	271	270	159	34	-5	1	-1	0	0	0	9	62	65	64	54	10	-1
3	-31	-39	-8	0	0	-73	218	274	272	161	-8	-6	-9	-12	-3	0	0	-20	56	66	65	54	-3	-2
4	-20	-24	-8	0	0	5	240	271	270	160	38	-3	-6	-7	-3	0	0	2	62	65	64	54	11	-1
5	-29	-26	-8	-1	-1	-6	228	232	239	131	-13	-10	-8	-8	-3	0	-1	-2	58	56	57	44	-4	-3
6	-29	-26	-8	-1	-1	-6	234	271	271	159	-7	-9	-8	-8	-3	0	-1	-2	60	65	65	54	-2	-3
7	-31	-39	-8	0	-2	-105	-61	-33	-43	-188	-201	-6	-9	-12	-3	0	-1	-28	-16	-8	-10	-63	-59	-2
8	-37	-39	-10	-1	-1	-60	223	270	269	158	-73	-10	-11	-12	-3	0	-1	-16	57	65	64	53	-22	-3

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-7	0	0	-2	0	0	-1	94	48	30	-81	-49	-2	0	0	-1	0	0	0	41	25	16	-37	-15
2	-7	0	0	-2	0	0	-1	96	69	58	-64	-48	-2	0	0	-1	0	0	0	41	35	30	-29	-15
3	-11	1	0	-8	0	-2	-5	94	69	59	-116	-55	-3	1	0	-2	0	-1	-2	40	35	31	-53	-17
4	-12	0	0	-4	0	0	-2	95	69	59	-62	-49	-4	0	0	-1	0	0	-1	41	35	31	-28	-15
5	-17	0	0	-7	0	-1	-5	93	48	31	-122	-64	-5	0	0	-2	-1	-1	-2	40	24	17	-55	-19
6	-17	0	0	-7	0	-1	-5	96	69	59	-102	-66	-5	0	0	-2	-1	-1	-2	41	35	31	-46	-20
7	-11	2	0	-14	0	-4	-9	-154	-262	-328	-311	-61	-3	1	0	-4	0	-1	-3	-67	-132	-169	-140	-18
8	-18	0	0	-11	0	-2	-7	93	67	57	-172	-68	-6	0	0	-3	0	-1	-2	40	34	29	-78	-20

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	43	56	39	0	0	0	0	99	99	84	-8	-7	10	13	15	0	0	0	0	36	31	27	-2	-2
2	46	61	44	0	0	0	0	125	133	106	2	-7	10	14	17	0	0	0	0	45	41	34	1	-2
3	40	-34	-214	-21	0	0	0	122	137	92	-31	-8	9	-8	-81	-7	0	0	0	44	42	29	-9	-2
4	45	31	19	-3	0	0	0	124	132	104	18	-4	10	7	7	-1	0	0	0	47	41	33	5	-1
5	40	53	32	-4	0	0	0	99	98	83	-41	-14	9	12	12	-2	0	0	0	36	30	27	-12	-4
6	43	63	38	-4	0	0	0	125	132	105	-32	-14	10	14	14	-1	0	0	0	45	41	33	-9	-4
7	-6	-51	-349	-25	1	0	0	44	-3	-29	-146	-7	-2	-12	-132	-8	0	0	0	16	-1	-10	-41	-2
8	41	-1	-77	-14	0	0	0	124	108	93	-75	-11	9	0	-29	-5	0	0	0	45	34	30	-21	-3

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

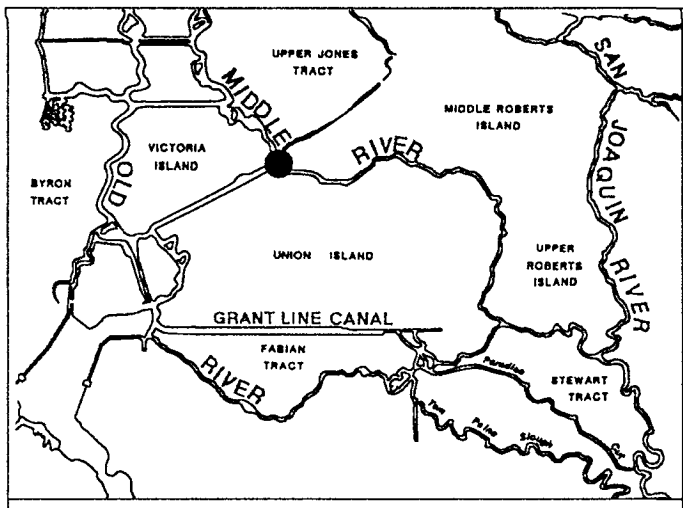


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

MIDDLE RIVER AT VICTORIA CANAL

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	4	-7	0	4	5	-14	-30	-21	-18	-28	-14
2	-1	3	-7	0	3	5	13	7	18	37	10	-9
3	-16	-47	-32	-7	-1	-1	8	5	18	39	10	-9
4	-3	0	-10	-2	3	5	13	7	18	37	10	-8
5	0	2	-7	-2	3	4	-14	-29	-20	-17	-26	-14
6	-2	1	-7	-2	2	4	13	8	17	35	10	-8
7	-211	-168	-175	-227	-309	-352	-276	-304	-214	-194	-361	-375
8	-5	-1	-15	-8	1	4	11	6	16	34	8	-10

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-1	-5	-3	-15	-16	-10	-29	-37	-41	-37	-21	-4
2	-3	-4	-3	-14	-18	-10	-2	-2	-9	-10	-8	-9
3	-24	-48	-21	-52	-28	-18	-13	-6	-9	-8	-5	-8
4	-3	-7	-5	-16	-19	-11	-3	-2	-9	-9	-6	-8
5	-3	-8	-5	-18	-17	-12	-31	-37	-41	-37	-20	-4
6	-5	-7	-4	-17	-20	-10	-3	-2	-8	-9	-7	-8
7	-272	-228	-217	-216	-269	-291	-323	-377	-413	-365	-416	-441
8	-6	-12	-11	-22	-20	-13	-4	-4	-10	-11	-9	-10

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-5	-16	-9	-2	-16	6	-19	-41	-42	-38	-20	-5
2	-5	-16	-9	-2	-16	6	6	-2	-9	-10	-4	-2
3	-53	-59	-57	-24	-27	0	7	0	-8	-8	-4	-11
4	-8	-19	-12	-6	-20	4	7	-2	-9	-10	-4	-2
5	-9	-19	-11	-4	-18	4	-19	-41	-41	-38	-22	-8
6	-9	-19	-11	-4	-18	4	5	-2	-8	-10	-6	-6
7	-260	-243	-218	-168	-170	-230	-306	-310	-336	-365	-285	-258
8	-15	-24	-17	-11	-26	-1	4	-4	-11	-11	-11	-15

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-7	-10	-12	0	0	2	1	-10	-32	-48	-28	-8
2	-7	-10	-12	0	0	2	1	-2	-11	-20	-14	-7
3	-71	-92	-51	-7	-26	-14	-9	-2	-10	-18	-15	-20
4	-12	-14	-16	-3	-7	-2	-1	-2	-10	-19	-13	-9
5	-9	-12	-13	-2	-1	1	0	-11	-32	-47	-30	-10
6	-9	-12	-13	-2	-1	1	0	-2	-10	-18	-15	-9
7	-216	-163	-172	-212	-42	-124	-212	-299	-382	-417	-314	-288
8	-17	-17	-20	-9	-24	-10	-7	-4	-12	-20	-20	-18

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2	24	46	18	24	2	-13	-9	-31	-47	-23	-1
2	24	39	51	19	24	2	-13	15	-4	-22	-9	-1
3	-43	-36	7	-74	-23	14	0	14	-11	-31	-10	-10
4	17	38	51	15	20	9	1	14	-7	-22	-10	-3
5	-1	24	46	16	23	2	-13	-10	-32	-47	-25	-5
6	21	39	50	17	23	2	-13	15	-7	-22	-11	-4
7	-256	-231	-259	-150	-43	10	0	-105	-142	-160	-233	-257
8	0	34	49	12	19	19	0	14	-50	-26	-17	-13

IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	3	-7	0	3	3	-7	-17	-10	-8	-15	-9
2	-2	3	-7	0	3	3	7	5	9	16	6	-7
3	-14	-38	-28	-5	-1	-1	5	3	9	17	5	-7
4	-3	-1	-9	-1	3	3	7	5	9	16	6	-5
5	0	2	-7	-1	2	2	-7	-16	-10	-7	-14	-9
6	-2	1	-7	-1	2	3	7	5	9	15	5	-6
7	-180	-132	-148	-163	-206	-201	-146	-171	-106	-83	-194	-252
8	-4	-2	-13	-6	1	2	6	4	8	15	4	-7

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-1	-5	-2	-11	-12	-8	-20	-26	-31	-29	-15	-4
2	-3	-4	-2	-10	-13	-8	-1	-1	-8	-8	-6	-7
3	-17	-39	-17	-35	-19	-15	-9	-4	-7	-7	-4	-6
4	-3	-6	-4	-11	-13	-9	-2	-1	-7	-8	-4	-6
5	-2	-7	-4	-13	-12	-10	-21	-26	-31	-29	-15	-4
6	-3	-6	-3	-12	-14	-8	-2	-1	-7	-8	-5	-6
7	-188	-181	-175	-144	-183	-223	-223	-266	-308	-275	-302	-311
8	-4	-10	-9	-15	-14	-11	-3	-3	-8	-9	-7	-7

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-4	-13	-8	-1	-11	4	-14	-29	-30	-31	-16	-4
2	-4	-13	-8	-1	-11	4	5	-1	-7	-9	-3	-2
3	-40	-49	-48	-17	-20	-1	6	0	-6	-7	-4	-9
4	-7	-16	-10	-5	-14	4	5	-1	-7	-9	-4	-2
5	-7	-16	-10	-3	-14	3	-15	-29	-30	-30	-17	-6
6	-7	-16	-10	-3	-14	3	4	-1	-7	-9	-5	-5
7	-193	-201	-179	-115	-121	-171	-229	-216	-242	-286	-216	-182
8	-12	-20	-14	-8	-18	-2	4	-3	-8	-9	-9	-11

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-5	-8	-11	-1	-1	1	2	-9	-27	-41	-25	-7
2	-5	-8	-11	-1	-1	1	2	-3	-9	-17	-12	-6
3	-51	-70	-42	-6	-15	-10	-7	-3	-9	-15	-13	-18
4	-9	-11	-13	-3	-4	-2	-1	-3	-9	-16	-12	-8
5	-7	-9	-11	-2	-1	1	0	-9	-28	-40	-26	-9
6	-7	-9	-11	-2	-1	1	0	-3	-8	-15	-14	-8
7	-157	-124	-142	-156	-24	-80	-166	-252	-322	-356	-271	-244
8	-12	-13	-17	-7	-14	-7	-6	-4	-11	-17	-18	-16

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1	11	23	8	10	1	-9	-6	-16	-26	-17	-1
2	10	17	25	8	10	1	-9	9	-3	-12	-7	-1
3	-17	-16	4	-33	-10	7	-1	8	-6	-17	-7	-7
4	7	17	26	7	9	4	1	12	-4	-13	-7	-2
5	0	11	23	8	10	1	-9	-6	-17	-26	-18	-4
6	9	18	25	8	10	1	-9	9	-4	-12	-8	-4
7	-103	-102	-127	-66	-19	5	0	-61	-74	-87	-163	-186
8	0	15	24	6	8	9	0	8	-26	-14	-12	-9

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

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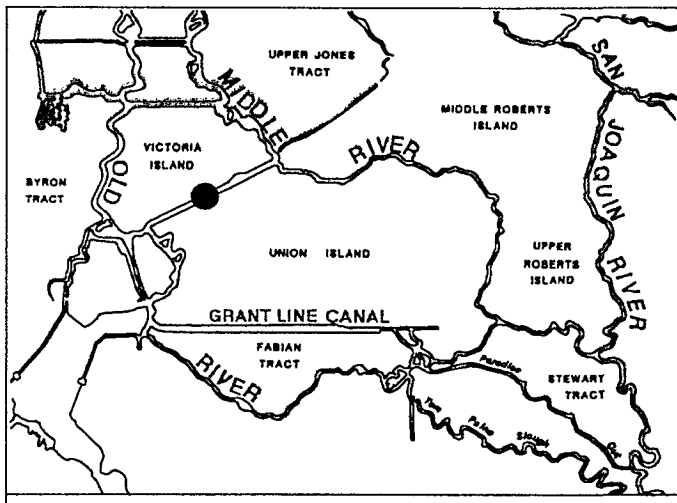


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

VICTORIA CANAL

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	3	5	0	0	3	2	-17	-30	-22	-19	-28	-13	3	5	-1	-1	2	2	-9	-18	-12	-8	-16	-9
2	0	4	0	0	2	2	8	7	16	36	10	-9	1	4	-1	-1	1	2	5	4	8	16	5	-7
3	-20	-72	-65	-31	-4	-5	3	5	17	38	9	-9	-17	-57	-55	-23	-3	-3	2	3	9	16	5	-7
4	1	2	-4	-5	2	1	9	7	16	35	10	-7	2	2	-4	-4	1	1	5	4	9	16	5	-5
5	2	4	-1	-2	2	1	-17	-29	-21	-18	-27	-14	2	4	-2	-2	1	1	-9	-17	-11	-8	-15	-10
6	0	4	-1	-2	1	1	9	8	15	33	10	-8	-1	3	-1	-2	1	1	5	5	8	15	5	-6
7	-207	-172	-174	-230	-316	-355	-278	-313	-319	-294	-372	-370	-172	-137	-146	-172	-214	-208	-150	-177	-160	-126	-201	-249
8	0	0	-14	-15	0	0	7	6	15	33	7	-10	0	0	-13	-12	0	1	4	3	8	14	4	-7

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-4	-2	-4	-11	-15	-9	-32	-36	-40	-37	-21	-4	-3	-2	-4	-7	-10	-7	-23	-26	-30	-28	-15	-3
2	-6	0	-3	-10	-17	-9	-6	-2	-9	-10	-8	-9	-5	0	-3	-7	-11	-7	-5	-2	-7	-8	-6	-7
3	-28	-74	-52	-80	-31	-17	-16	-5	-8	-8	-5	-7	-20	-57	-45	-52	-21	-13	-12	-4	-6	-6	-4	-6
4	-6	-1	-7	-11	-18	-8	-6	-2	-8	-9	-6	-8	-5	-1	-7	-7	-12	-7	-5	-1	-6	-7	-5	-6
5	-5	-3	-5	-13	-16	-11	-33	-36	-40	-37	-21	-5	-4	-3	-5	-8	-11	-8	-24	-26	-30	-28	-15	-4
6	-7	-2	-4	-12	-18	-10	-7	-2	-8	-9	-7	-8	-6	-2	-4	-8	-12	-8	-6	-1	-6	-7	-5	-6
7	-273	-224	-221	-212	-269	-293	-327	-389	-419	-412	-445	-438	-193	-174	-188	-138	-181	-220	-233	-275	-310	-308	-323	-309
8	-9	-4	-18	-13	-20	-9	-8	-4	-10	-11	-8	-10	-7	-4	-16	-9	-13	-7	-6	-3	-7	-8	-7	-7

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-2	-13	-3	-3	-8	6	-24	-41	-43	-39	-21	-5	-2	-11	-2	-2	-6	5	-19	-29	-31	-32	-16	-4
2	-2	-13	-3	-3	-8	6	1	-3	-11	-12	-4	-3	-2	-11	-2	-2	-6	5	2	-2	-8	-10	-4	-2
3	-79	-79	-89	-62	-50	-15	2	0	-8	-10	-5	-28	-58	-66	-71	-45	-35	-11	2	0	-6	-9	-5	-20
4	-3	-14	-5	-10	-15	5	1	-2	-10	-12	-4	-7	-3	-12	-4	-7	-10	5	2	-2	-7	-10	-4	-5
5	-4	-14	-5	-4	-9	5	-25	-41	-42	-39	-22	-7	-4	-12	-4	-4	-7	5	-19	-29	-30	-32	-17	-5
6	-4	-14	-5	-4	-9	5	0	-3	-10	-11	-6	-4	-4	-12	-4	-4	-7	5	0	-2	-7	-9	-5	-4
7	-255	-239	-215	-176	-166	-213	-313	-314	-350	-374	-254	-262	-187	-197	-172	-126	-115	-159	-243	-220	-252	-297	-192	-188
8	-8	-18	-9	-22	-28	-1	-1	-4	-11	-13	-14	-27	-6	-16	-7	-16	-19	-1	-1	-4	-9	-11	-11	-19

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-3	-8	-5	0	-5	2	0	-10	-31	-47	-30	-6	-3	-6	-4	-1	-4	2	0	-9	-27	-41	-26	-5
2	-3	-8	-5	0	-5	2	0	-3	-11	-20	-15	-5	-3	-6	-4	-1	-4	2	0	-3	-10	-17	-14	-4
3	-105	-119	-80	-34	-10	-36	-37	-3	-10	-18	-16	-43	-76	-92	-66	-26	-6	-24	-30	-3	-8	-16	-15	-37
4	-5	-10	-9	-6	-14	-4	-2	-3	-10	-19	-15	-6	-4	-9	-7	-5	-9	-3	-3	-3	-9	-17	-13	-5
5	-6	-10	-6	-2	-6	1	0	-10	-31	-46	-31	-7	-4	-8	-5	-2	-4	1	-1	-9	-27	-41	-27	-6
6	-6	-10	-6	-2	-6	1	0	-2	-10	-18	-16	-7	-4	-8	-5	-2	-4	1	-1	-3	-8	-16	-14	-6
7	-216	-165	-170	-216	-45	-126	-218	-340	-453	-421	-288	-287	-155	-128	-138	-163	-27	-81	-180	-287	-382	-364	-250	-247
8	-9	-14	-19	-18	-29	-19	-14	-4	-12	-20	-24	-15	-7	-11	-15	-14	-17	-13	-12	-4	-10	-18	-21	-13

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	15	27	46	18	20	-6	-9	-5	-18	-43	-25	-2	6	12	23	8	9	-3	-6	-3	-9	-24	-18	-2
2	37	43	51	18	20	-6	-9	20	3	-19	-10	-2	14	19	25	8	9	-3	-6	11	2	-10	-8	-2
3	-11	-48	1	-77	-12	1	-1	18	-52	-36	-12	-31	-5	-21	1	-34	-6	1	-1	11	-25	-20	-9	-24
4	22	40	52	18	21	4	0	19	-22	-21	-11	-6	8	18	26	8	9	2	1	14	-11	-11	-8	-5
5	8	27	46	17	20	-5	-9	-5	-20	-43	-26	-4	3	12	23	8	9	-3	-6	-3	-10	-24	-18	-3
6	30	43	51	17	20	-5	-9	19	-11	-19	-11	-4	11	19	25	8	9	-3	-6	11	-6	-10	-8	-3
7	-235	-224	-238	-155	-49	-2	0	-105	-134	-155	-214	-263	-88	-97	-117	-69	-22	-1	0	-60	-66	-83	-150	-199
8	-11	34	49	15	16	11	-2	18	-107	-33	-22	-25	-5	15	24	7	7	6	-1	11	-53	-18	-15	-20

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

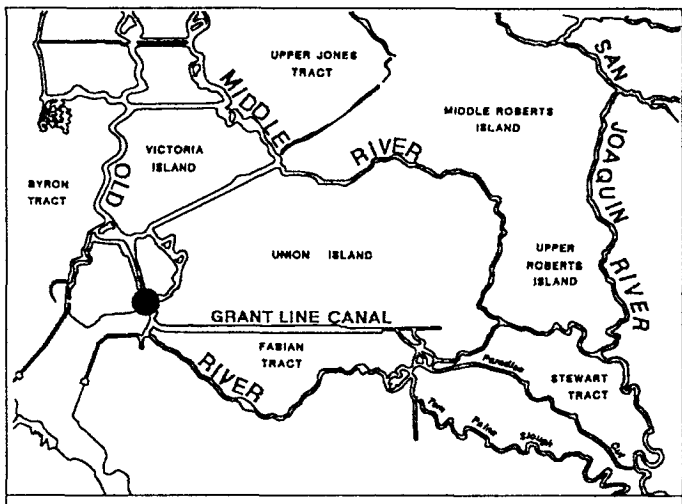


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

OLD RIVER AT SOUTH END OF WEST CANAL

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-18	-13	-15	1	19	20	17	-3	-6	-8	-40	-21	-14	-10	-12	1	11	9	7	-1	-3	-2	-15	-11
2	3	-13	-14	1	23	44	58	45	68	110	53	17	2	-10	-11	1	13	19	23	20	26	32	21	9
3	-10	-26	-32	-10	13	33	44	29	57	103	42	10	-8	-21	-26	-7	8	14	17	13	21	30	16	6
4	6	-18	-23	0	34	59	69	51	74	107	52	19	5	-14	-19	-1	19	25	26	23	28	31	20	10
5	-141	-137	-149	-203	-204	-173	-109	-116	-72	-52	-183	-200	-110	-108	-121	-136	-110	-73	-42	-51	-27	-15	-70	-104
6	-158	-138	-149	-203	-217	-192	-136	-204	-162	-96	-193	-213	-123	-109	-121	-136	-117	-81	-52	-90	-60	-28	-73	-111
7	-195	-168	-171	-229	-299	-282	-190	-267	-261	-192	-301	-314	-151	-133	-140	-153	-161	-119	-73	-117	-97	-56	-114	-164
8	-174	-158	-167	-224	-244	-216	-149	-222	-201	-135	-218	-231	-135	-124	-136	-150	-131	-91	-57	-97	-75	-39	-83	-120

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-3	-29	-13	-40	-28	-27	-30	-19	-23	-29	-17	1	-2	-20	-11	-26	-18	-19	-17	-11	-15	-22	-11	1
2	7	-22	-11	-40	-26	-11	6	16	5	-7	4	16	4	-15	-9	-26	-17	-7	4	9	4	-6	3	9
3	-17	-57	-31	-71	-47	-33	-23	2	0	-9	2	14	-9	-40	-24	-46	-32	-22	-14	2	0	-7	2	8
4	33	-6	-13	-23	-18	4	19	20	6	-6	5	17	17	-4	-10	-15	-12	3	11	12	4	-5	4	10
5	-156	-177	-185	-191	-204	-193	-148	-138	-125	-123	-246	-237	-80	-124	-142	-122	-134	-129	-84	-81	-83	-90	-159	-136
6	-173	-176	-185	-191	-219	-210	-212	-270	-271	-276	-295	-267	-89	-124	-142	-122	-144	-140	-121	-159	-180	-201	-190	-154
7	-216	-221	-210	-226	-269	-303	-298	-372	-398	-415	-439	-395	-112	-155	-161	-144	-177	-202	-170	-219	-264	-301	-284	-227
8	-183	-199	-204	-210	-234	-232	-234	-297	-298	-313	-331	-287	-94	-139	-157	-134	-154	-155	-133	-175	-197	-228	-214	-166

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-22	-40	-32	-15	-27	6	-7	-14	-27	-28	-19	-9	-13	-29	-24	-11	-19	5	-6	-8	-18	-21	-13	-6
2	-22	-40	-32	-15	-27	6	9	18	0	-7	-1	-4	-13	-29	-24	-11	-19	5	7	11	0	-5	-1	-3
3	-80	-94	-76	-34	-37	-4	6	12	-5	-9	-5	-16	-46	-66	-56	-24	-27	-3	4	7	-3	-7	-4	-11
4	10	-19	-17	-21	-36	2	9	20	0	-5	0	-1	6	-13	-13	-14	-26	2	7	12	1	-4	-1	-1
5	-180	-196	-173	-146	-155	-263	-182	-129	-128	-126	-273	-202	-103	-139	-127	-99	-111	-196	-136	-78	-85	-95	-190	-127
6	-180	-196	-173	-146	-155	-263	-242	-233	-258	-270	-302	-202	-103	-139	-127	-99	-111	-196	-180	-141	-171	-203	-210	-127
7	-222	-231	-208	-163	-170	-297	-300	-291	-341	-389	-382	-229	-127	-163	-153	-110	-121	-222	-223	-176	-226	-293	-266	-144
8	-200	-216	-193	-159	-167	-282	-262	-249	-280	-303	-342	-219	-114	-153	-143	-107	-119	-211	-195	-151	-185	-228	-238	-138

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-35	-44	-29	-5	-22	-5	1	-6	-21	-34	-25	-3	-21	-31	-24	-4	-13	-4	1	-5	-18	-30	-21	-3
2	-35	-44	-29	-5	-22	-5	1	2	-5	-16	-13	-1	-21	-31	-24	-4	-13	-4	1	2	-5	-14	-11	-2
3	-95	-93	-61	-16	-22	-21	-12	-4	-10	-18	-15	-22	-57	-65	-48	-11	-13	-13	-10	-3	-9	-15	-13	-18
4	-1	-24	-30	-10	-27	-9	-5	4	-3	-15	-13	-3	-1	-17	-25	-7	-16	-6	-5	4	-3	-14	-11	-3
5	-147	-128	-147	-191	-38	-111	-187	-154	-126	-133	-296	-232	-87	-89	-118	-134	-22	-67	-142	-121	-100	-113	-247	-181
6	-147	-128	-147	-191	-38	-111	-187	-280	-283	-289	-326	-231	-87	-89	-118	-134	-22	-67	-142	-219	-225	-246	-272	-181
7	-179	-148	-166	-214	-39	-119	-213	-381	-469	-417	-400	-286	-106	-103	-133	-150	-23	-72	-162	-298	-373	-354	-333	-224
8	-161	-140	-162	-211	-38	-119	-206	-321	-337	-321	-357	-266	-95	-97	-129	-148	-23	-72	-156	-252	-268	-272	-298	-209

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5	15	106	9	0	20	15	32	31	-10	-29	-6	1	5	32	4	0	9	9	15	12	-5	-21	-5
2	36	49	116	10	0	20	15	36	-47	-28	-17	-5	9	15	35	4	0	9	9	18	-18	-13	-13	-4
3	26	-11	55	-39	-14	23	15	21	-52	-68	-23	-16	7	-3	17	-15	-7	10	9	11	-20	-31	-16	-11
4	27	95	146	25	-4	22	15	36	-52	-30	-18	-6	7	29	44	10	-2	10	9	20	-19	-14	-13	-4
5	-60	-134	-175	-73	-31	20	16	-39	-32	-91	-280	-208	-16	-41	-52	-28	-14	9	9	-19	-12	-42	-197	-144
6	-60	-129	-172	-73	-31	20	16	-75	-63	-108	-275	-208	-16	-39	-51	-28	-14	9	9	-36	-23	-49	-192	-144
7	-97	-153	-217	-103	-40	19	15	-78	-70	-117	-310	-241	-26	-47	-65	-40	-18	9	9	-38	-26	-53	-218	-167
8	-69	-138	-194	-88	-38	19	15	-76	-63	-112	-301	-231	-18	-42	-58	-34	-17	8	9	-37	-24	-51	-211	-160

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

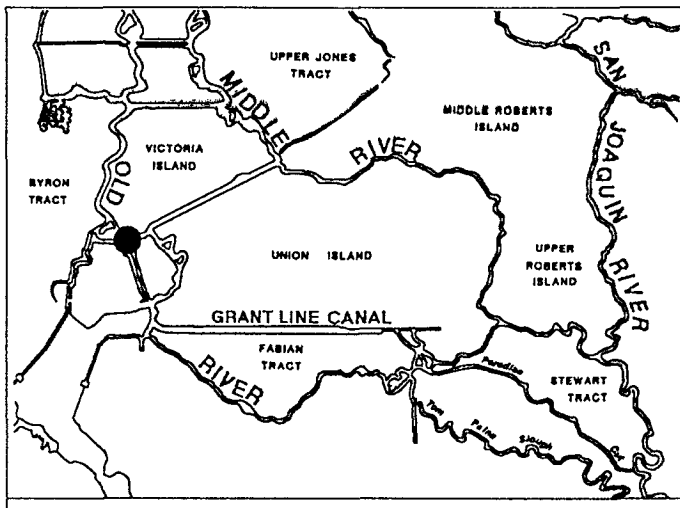


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

OLD RIVER AT NORTH END OF WEST CANAL

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-1	0	-4	1	14	18	12	-18	-10	-9	-41	-24
2	0	0	-3	2	18	39	52	23	59	101	41	8
3	-14	-9	-16	-7	6	24	33	8	49	100	29	0
4	1	-3	-8	0	33	59	68	31	69	110	53	16
5	-116	-105	-106	-131	-109	-105	-29	-49	-26	-23	-127	-147
6	-124	-106	-105	-131	-152	-143	-104	-129	-29	25	-89	-164
7	-201	-176	-177	-235	-293	-293	-204	-292	-266	-196	-308	-327
8	-151	-120	-132	-174	-186	-173	-121	-192	-118	-47	-150	-196

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-5	-17	-14	-30	-24	-23	-34	-31	-33	-30	-19	-1
2	0	-10	-12	-29	-26	-10	-1	-2	-9	-10	0	10
3	-34	-44	-29	-62	-51	-35	-36	-16	-14	-10	-1	8
4	29	3	-12	-15	-17	7	18	3	-8	-7	2	14
5	-115	-133	-131	-150	-146	-144	-64	-66	-65	-53	-136	-154
6	-141	-130	-130	-150	-171	-149	-159	-157	-160	-122	-151	-174
7	-228	-215	-225	-218	-267	-282	-303	-390	-417	-414	-440	-407
8	-160	-125	-169	-140	-200	-185	-198	-235	-235	-211	-239	-235

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-13	-34	-19	-7	-9	5	-16	-37	-36	-29	-18	-6
2	-13	-34	-19	-7	-9	5	1	-9	-13	-10	-1	-1
3	-71	-84	-61	-23	-17	0	-1	-15	-19	-11	-4	-12
4	16	-11	-4	-12	-18	3	0	-7	-12	-8	0	0
5	-119	-137	-122	-114	-109	-135	-57	-71	-66	-47	-140	-148
6	-119	-137	-122	-114	-109	-135	-190	-182	-156	-147	-149	-147
7	-219	-224	-205	-177	-172	-266	-312	-323	-356	-380	-325	-246
8	-114	-142	-126	-142	-143	-181	-230	-242	-228	-206	-235	-191

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-22	-39	-19	-2	-14	-2	0	-6	-23	-36	-23	-5
2	-22	-39	-19	-2	-14	-2	0	-4	-12	-20	-11	-4
3	-87	-92	-47	-11	-13	-19	-8	-11	-17	-20	-12	-19
4	7	-18	-16	-7	-28	-6	-2	-2	-10	-18	-11	-3
5	-111	-117	-110	-132	-45	-93	-123	-50	-49	-58	-159	-147
6	-111	-117	-110	-132	-45	-93	-123	-115	-112	-179	-171	-147
7	-184	-160	-173	-225	-52	-133	-222	-362	-463	-422	-354	-291
8	-108	-114	-131	-174	-51	-118	-162	-204	-215	-235	-252	-184

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-9	17	98	24	19	39	29	0	-14	-50	-27	-2
2	37	52	108	25	20	39	29	13	-84	-56	-14	-2
3	19	-15	47	-29	0	40	31	-1	-105	-104	-19	-11
4	23	99	148	42	17	40	31	13	-101	-56	-15	-3
5	-94	-62	-21	-56	-18	36	32	-25	-45	-77	-157	-143
6	-82	-42	-15	-55	-18	36	32	-92	-126	-141	-149	-143
7	-169	-150	-168	-118	-44	37	32	-113	-136	-167	-272	-257
8	-122	-59	-38	-67	-33	37	32	-105	-129	-159	-218	-194

IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-1	-1	-3	1	8	8	5	-9	-4	-3	-16	-13
2	-1	0	-3	1	10	17	20	12	23	30	16	5
3	-11	-8	-14	-5	3	10	13	4	19	30	12	1
4	2	-3	-7	1	19	25	27	16	26	33	21	9
5	-94	-88	-91	-94	-60	-45	-12	-24	-10	-7	-50	-79
6	-101	-89	-91	-94	-84	-61	-41	-62	-12	7	-35	-88
7	-162	-148	-152	-169	-162	-126	-80	-141	-102	-58	-121	-176
8	-122	-100	-113	-125	-102	-75	-48	-93	-45	-14	-59	-105

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-3	-13	-13	-19	-16	-15	-21	-21	-25	-23	-13	-1
2	-1	-7	-11	-19	-17	-7	-1	-2	-7	-8	-1	6
3	-18	-31	-26	-40	-34	-23	-22	-11	-11	-8	-1	5
4	16	3	-10	-10	-12	5	11	3	-7	-5	1	8
5	-63	-93	-113	-96	-96	-95	-38	-43	-49	-39	-91	-91
6	-76	-91	-113	-96	-113	-99	-94	-104	-118	-90	-101	-103
7	-124	-151	-195	-139	-176	-187	-179	-257	-307	-303	-292	-239
8	-87	-87	-147	-89	-132	-123	-117	-155	-174	-155	-159	-138

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-7	-24	-14	-6	-7	5	-13	-27	-27	-23	-13	-4
2	-7	-24	-14	-6	-7	5	1	-7	-10	-8	-1	-1
3	-40	-59	-45	-18	-13	0	-2	-11	-15	-9	-3	-9
4	9	-8	-3	-9	-14	2	0	-5	-10	-6	0	1
5	-67	-97	-89	-83	-78	-104	-45	-51	-49	-36	-100	-97
6	-67	-97	-89	-83	-78	-104	-149	-131	-115	-112	-106	-97
7	-123	-157	-150	-130	-124	-204	-245	-232	-260	-288	-231	-163
8	-64	-99	-93	-104	-104	-139	-181	-174	-167	-156	-167	-126

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-13	-30	-16	-2	-9	-2	0	-6	-20	-31	-20	-5
2	-13	-30	-16	-2	-9	-2	0	-3	-10	-17	-3	-4
3	-52	-70	-40	-9	-9	-12	-7	-9	-15	-17	-11	-16
4	4	-14	-14	-5	-17	-4	-3	-2	-8	-15	-9	-3
5	-66	-89	-92	-102	-28	-61	-101	-42	-42	-50	-134	-121
6	-66	-89	-92	-102	-28	-61	-101	-95	-94	-153	-144	-121
7	-110	-121	-145	-174	-32	-87	-183	-300	-386	-361	-298	-239
8	-64	-87	-110	-135	-32	-77	-134	-169	-179	-201	-213	-151

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-3	6	30	9	9	16	15	-1	-7	-29	-19	-2
2	12	17	33	10	9	16	15	8	-41	-33	-10	-2
3	6	-5	14	-12	0	16	17	-1	-51	-60	-14	-9
4	8	31	45	17	7	16	17	11	-49	-32	-11	-3
5	-30	-19	-7	-22	-8	15	17	-15	-22	-45	-111	-106
6	-26	-13	-5	-22	-8	15	17	-54	-61	-81	-106	-106
7	-53	-47	-52	-47	-20	15	17	-66	-66	-97	-193	-190
8	-38	-18	-12	-27	-15	15	18	-62	-62	-91	-155	-143

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

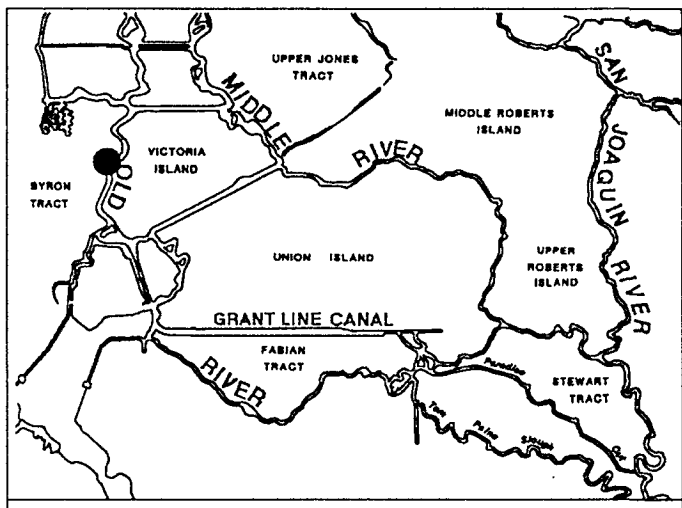


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

OLD RIVER AT HIGHWAY 4

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-7	-3	-6	2	17	9	8	-12	-15	-29	-61	-36	-6	-3	-5	2	9	4	3	-5	-5	-8	-21	-18
2	-6	-2	-5	3	26	45	54	28	74	124	55	18	-6	-2	-5	2	13	18	19	13	25	31	19	9
3	-13	-4	-6	-1	18	36	43	13	66	126	48	13	-11	-4	-6	-1	9	14	15	6	23	32	16	6
4	-3	-4	-6	3	36	57	64	36	82	131	61	21	-2	-4	-6	2	18	22	23	16	28	33	21	10
5	-7	-4	-6	2	13	6	6	-13	-15	-23	-61	-39	-7	-4	-6	1	7	3	2	-6	-5	-6	-21	-19
6	-7	-2	-6	2	25	44	52	26	70	121	50	15	-7	-3	-5	2	13	17	19	12	24	30	17	7
7	-171	-140	-159	-168	-165	-246	-182	-255	-152	-63	-241	-313	-140	-123	-143	-121	-82	-95	-65	-113	-51	-16	-81	-151
8	-5	-16	-32	-33	18	34	44	-12	50	126	37	-20	-4	-14	-29	-24	9	14	16	-5	17	32	13	-10

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-18	-31	-21	-45	-32	-37	-49	-27	-27	-24	-19	-3	-9	-21	-19	-29	-21	-23	-27	-17	-20	-18	-13	-2
2	-8	-19	-18	-44	-32	-17	-11	-5	-8	-8	4	23	-4	-13	-16	-28	-21	-11	-7	-3	-7	-7	3	12
3	-24	-33	-23	-60	-46	-30	-32	-18	-16	-12	1	21	-12	-22	-20	-38	-31	-19	-18	-11	-12	-9	1	11
4	10	-6	-15	-31	-26	-6	-1	0	-7	-7	6	25	5	-5	-13	-20	-17	-4	-1	1	-5	-5	4	13
5	-21	-32	-23	-46	-34	-37	-52	-28	-28	-25	-19	-4	-10	-21	-20	-29	-22	-23	-29	-18	-20	-19	-12	-2
6	-9	-18	-19	-45	-33	-16	-12	-4	-8	-8	3	22	-5	-13	-17	-28	-22	-10	-7	-3	-6	-6	3	12
7	-213	-115	-181	-128	-228	-71	-174	-336	-391	-313	-374	-388	-105	-77	-161	-81	-149	-44	-97	-213	-285	-226	-234	-206
8	-4	-11	-48	-37	-39	-6	-11	-52	-65	-51	-57	-34	-2	-8	-43	-23	-26	-4	-6	-33	-48	-37	-36	-18

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-29	-58	-33	-10	-5	4	-13	-33	-31	-24	-17	-7	-15	-37	-23	-9	-5	4	-11	-25	-24	-19	-12	-5
2	-29	-58	-33	-10	-5	4	-2	-15	-16	-7	0	-1	-15	-37	-23	-9	-5	4	-2	-11	-13	-6	0	-1
3	-53	-77	-50	-17	-8	1	-6	-25	-25	-13	-2	-6	-27	-49	-36	-14	-7	2	-6	-19	-19	-11	-2	-5
4	2	-31	-17	-13	-12	3	-2	-12	-14	-6	1	2	1	-21	-12	-11	-10	2	-2	-9	-11	-5	1	1
5	-28	-60	-33	-11	-6	4	-13	-34	-32	-25	-17	-9	-14	-39	-23	-9	-5	3	-11	-25	-25	-20	-12	-6
6	-28	-60	-33	-11	-6	4	-3	-15	-15	-7	0	-4	-14	-39	-23	-9	-5	3	-2	-11	-12	-6	0	-3
7	-126	-148	-139	-175	-169	-86	-266	-318	-333	-209	-97	-215	-63	-95	-98	-135	-127	-68	-216	-236	-249	-160	-67	-138
8	-8	-45	-25	-39	-48	-19	-23	-84	-69	-35	-48	-51	-4	-29	-18	-31	-37	-16	-19	-62	-52	-28	-33	-33

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-38	-65	-27	-2	-3	-2	0	-6	-19	-29	-21	-7	-20	-49	-23	-2	-3	-1	0	-6	-17	-26	-18	-7
2	-38	-65	-27	-2	-3	-2	0	-8	-14	-17	-11	-6	-20	-49	-23	-2	-3	-1	0	-8	-12	-16	-9	-5
3	-71	-88	-38	-6	-7	-13	-2	-17	-23	-22	-13	-11	-38	-66	-33	-6	-5	-9	-2	-15	-21	-20	-12	-10
4	-12	-44	-22	-6	-18	-4	-1	-6	-12	-17	-11	-2	-6	-33	-19	-6	-12	-3	-2	-5	-11	-16	-10	-2
5	-37	-65	-28	-3	-5	-3	0	-7	-20	-30	-21	-8	-20	-49	-24	-2	-4	-2	-1	-7	-18	-27	-19	-7
6	-37	-65	-28	-3	-5	-3	0	-9	-14	-17	-11	-7	-20	-49	-24	-2	-4	-2	-1	-8	-12	-16	-10	-7
7	-136	-153	-163	-194	-66	-132	-172	-233	-276	-318	-131	-151	-73	-115	-139	-158	-44	-89	-148	-197	-237	-280	-112	-123
8	-14	-51	-45	-47	-32	-40	-32	-50	-59	-56	-64	-30	-6	-38	-39	-38	-22	-27	-28	-43	-50	-50	-55	-25

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-22	7	124	23	20	92	68	-1	-43	-57	-27	-4	-8	2	31	9	9	30	28	-1	-25	-35	-21	-4
2	62	54	138	25	20	92	68	5	-84	-79	-16	-3	20	14	34	10	9	30	28	3	-48	-49	-13	-3
3	53	26	106	-8	0	95	87	-10	-117	-121	-22	-7	18	7	26	-3	-1	32	36	-7	-67	-75	-17	-6
4	59	102	174	38	17	91	80	6	-112	-63	-17	-3	19	27	42	14	8	30	33	7	-64	-39	-13	-2
5	-23	7	121	23	21	91	68	-2	-44	-58	-28	-5	-8	2	30	9	10	30	28	-1	-25	-36	-21	-5
6	52	53	135	26	21	91	68	4	-131	-81	-17	-4	17	14	33	10	10	30	28	2	-75	-51	-13	-4
7	-191	-38	44	-106	-63	92	88	-112	-165	-181	-127	-217	-62	-10	11	-40	-29	30	36	-68	-94	-112	-93	-164
8	-54	93	168	28	9	90	81	-39	-150	-113	-62	-51	-18	25	41	10	4	30	33	-24	-86	-70	-46	-39

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

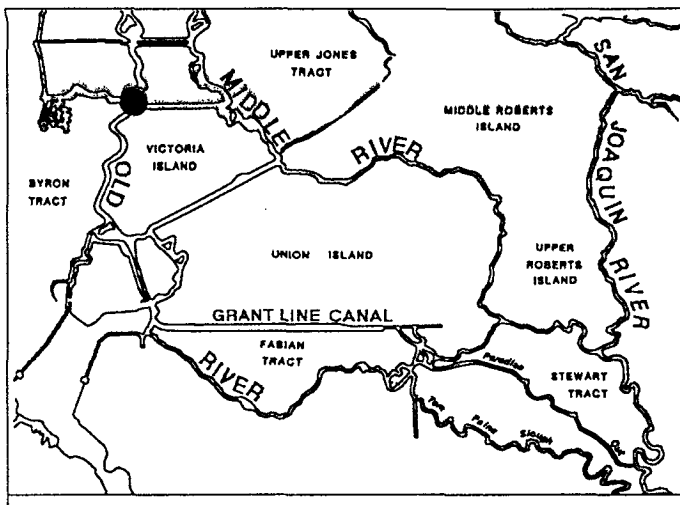


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

OLD RIVER AT WOODWARD CANAL

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-5	-4	-6	4	22	27	33	-7	-2	-5	-49	-31
2	-4	-3	-5	4	34	67	85	36	94	164	69	28
3	-11	-4	-6	5	34	71	88	33	97	171	76	30
4	-2	-4	-5	6	43	80	101	43	103	175	83	36
5	-6	-5	-6	6	22	25	30	-8	0	-2	-53	-33
6	-5	-4	-6	6	34	68	84	37	92	152	63	24
7	-45	-39	-66	-50	-11	-49	-56	-125	17	98	-74	-177
8	-2	-5	-6	6	44	84	106	46	108	181	90	37

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-11	-25	-24	-42	-34	-32	-38	-27	-26	-23	-20	1
2	1	-13	-21	-41	-34	-11	-7	-4	-7	-4	5	30
3	-1	-30	-24	-59	-41	-26	-12	-9	-11	-6	5	32
4	18	-4	-17	-32	-29	-4	4	0	-6	-3	7	34
5	-13	-26	-26	-43	-34	-32	-36	-28	-26	-22	-19	1
6	0	-14	-22	-42	-34	-9	-2	-1	-5	-3	5	30
7	-101	-52	-80	-74	-101	-33	-52	-154	-175	-104	-151	-205
8	23	-2	-17	-30	-27	0	12	2	-6	-3	8	34

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-20	-53	-28	-10	-4	6	-13	-31	-28	-17	-13	-3
2	-20	-53	-28	-10	-4	6	0	-13	-12	-2	4	2
3	-48	-74	-47	-13	-5	5	-1	-19	-17	-2	3	3
4	4	-30	-15	-9	-6	4	-1	-12	-12	-1	4	9
5	-17	-52	-28	-10	-4	6	-12	-31	-27	-16	-13	-2
6	-17	-52	-28	-10	-4	6	0	-11	-10	0	3	1
7	-82	-104	-78	-99	-94	-8	-71	-207	-164	-49	-16	-98
8	10	-25	-13	-11	-8	2	-2	-12	-11	-1	7	11

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-27	-60	-30	-2	-2	0	0	-4	-17	-22	-16	-7
2	-27	-60	-30	-2	-2	0	0	-6	-10	-12	-7	-5
3	-65	-86	-37	-2	-5	-3	0	-10	-16	-14	-6	-7
4	-7	-44	-23	-2	-7	1	0	-5	-11	-13	-7	-3
5	-27	-60	-30	-1	-4	0	0	-4	-15	-21	-16	-6
6	-27	-60	-30	-1	-4	0	0	-5	-8	-11	-6	-5
7	-96	-123	-97	-83	-67	-93	-59	-77	-79	-101	-31	-33
8	-2	-40	-21	-4	-10	0	-1	-4	-10	-13	-7	-2

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-25	-5	140	40	27	79	66	-2	-44	-57	-24	-1
2	60	48	155	42	27	79	66	4	-96	-74	-13	0
3	62	44	142	22	28	71	81	-5	-126	-103	-17	-1
4	69	97	193	53	26	75	68	5	-91	-62	-15	0
5	-24	0	139	40	27	80	65	-1	-45	-57	-23	-2
6	55	53	153	43	27	80	65	5	-124	-76	-13	-1
7	-146	8	107	-36	-22	70	84	-99	-177	-193	-53	-88
8	56	111	212	53	24	76	71	5	-86	-57	-13	0

IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-4	-4	-5	3	11	9	10	-3	-1	-1	-16	-14
2	-4	-4	-5	3	16	23	27	16	30	38	22	13
3	-9	-4	-6	4	16	25	28	15	30	40	24	14
4	-2	-4	-5	5	20	28	32	19	32	41	27	16
5	-5	-4	-6	4	11	9	10	-3	0	-1	-17	-15
6	-4	-4	-5	4	16	23	27	16	29	35	20	11
7	-37	-35	-59	-36	-6	-17	-18	-53	5	23	-23	-81
8	-2	-5	-5	4	21	29	33	20	34	42	28	17

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-5	-16	-22	-27	-22	-19	-20	-17	-20	-16	-13	1
2	1	-9	-20	-26	-22	-7	-4	-3	-6	-3	3	16
3	-1	-20	-21	-37	-27	-16	-7	-6	-9	-4	3	16
4	8	-3	-15	-21	-19	-2	2	0	-5	-2	4	17
5	-6	-17	-23	-27	-22	-19	-19	-18	-20	-16	-12	1
6	-1	-9	-21	-27	-23	-5	-1	-1	-4	-2	3	16
7	-46	-34	-71	-47	-65	-20	-27	-97	-129	-73	-95	-105
8	10	-2	-15	-19	-17	-1	6	2	-5	-2	5	18

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-10	-33	-19	-8	-4	5	-11	-23	-21	-13	-9	-2
2	-10	-33	-19	-8	-4	5	0	-10	-10	-1	3	2
3	-23	-47	-33	-11	-4	4	-2	-14	-13	-2	3	2
4	2	-19	-10	-8	-5	3	-2	-10	-10	-1	3	6
5	-8	-33	-19	-8	-4	5	-10	-23	-20	-12	-9	-1
6	-8	-33	-19	-8	-4	5	-1	-9	-8	-1	3	1
7	-39	-66	-54	-76	-70	-6	-58	-153	-120	-36	-11	-59
8	5	-16	-9	-9	-7	2	-2	-9	-9	-1	5	7

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-15	-45	-26	-2	-1	0	1	-4	-14	-19	-13	-6
2	-15	-45	-26	-2	-1	0	1	-5	-9	-11	-6	-5
3	-34	-64	-32	-2	-4	-3	0	-9	-14	-13	-6	-6
4	-4	-33	-20	-2	-5	1	0	-5	-10	-12	-6	-2
5	-14	-45	-26	-2	-3	-1	0	-4	-13	-19	-13	-6
6	-14	-45	-26	-2	-3	-1	0	-5	-8	-10	-5	-5
7	-50	-92	-83	-68	-44	-62	-50	-65	-67	-86	-25	-27
8	-2	-30	-18	-4	-7	1	-1	-4	-8	-12	-6	-2

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-8	-2	31	14	12	27	27	-2	-26	-36	-17	-2
2	20	12	35	15	12	27	27	3	-57	-46	-10	-1
3	20	11	32	8	12	25	34	-4	-74	-64	-12	-2
4	23	24	43	18	11	26	28	6	-54	-39	-11	-1
5	-8	0	31	14	12	28	27	-1	-27	-36	-17	-2
6	18	13	34	15	12	28	27	3	-73	-48	-9	-2
7	-48	2	24	-13	-9	24	34	-61	-105	-121	-39	-64
8	18	28	47	19	11	26	29	3	-51	-35	-9	-1

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

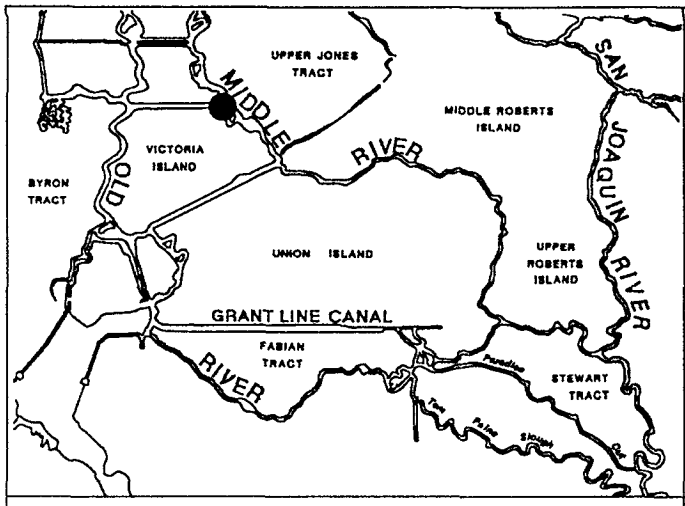


TABLE C-19 (cont.)

PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

MIDDLE RIVER AT WOODWARD CANAL

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	3	-1	2	3	1	-21	-37	-25	-19	-30	-19	1	3	-1	2	2	1	-12	-22	-13	-9	-17	-13
2	-2	2	0	2	2	0	7	0	15	36	7	-15	-2	3	-1	2	1	0	4	1	8	16	4	-11
3	-5	0	0	3	1	-1	5	1	16	36	6	-15	-4	1	0	3	1	-1	3	1	9	16	3	-11
4	-1	2	0	2	3	1	8	2	16	36	8	-14	-2	3	-1	2	2	1	4	2	9	16	4	-10
5	0	2	-1	1	3	0	-21	-36	-28	-21	-28	-19	0	3	-1	1	2	0	-12	-22	-14	-9	-16	-14
6	-3	1	-1	1	1	0	6	0	12	31	6	-15	-3	2	-1	2	1	0	4	0	7	14	3	-11
7	-114	-85	-94	-121	-131	-170	-149	-100	-10	0	-126	-207	-97	-70	-81	-90	-87	-100	-82	-59	-5	0	-70	-145
8	-3	1	-1	2	0	0	5	0	14	33	5	-16	-3	2	-1	2	1	-1	3	1	8	14	3	-11

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-6	-4	-4	-12	-16	-10	-34	-43	-46	-39	-23	-9	-5	-3	-4	-8	-11	-8	-25	-32	-37	-30	-18	-7
2	-9	-2	-3	-11	-18	-9	-6	-9	-15	-13	-11	-15	-7	-2	-4	-7	-12	-7	-5	-7	-13	-10	-9	-11
3	-17	-12	-7	-18	-20	-14	-9	-10	-14	-11	-9	-13	-13	-10	-6	-12	-14	-11	-6	-7	-11	-8	-8	-10
4	-8	-2	-3	-10	-18	-8	-7	-8	-14	-11	-8	-12	-7	-2	-4	-7	-12	-7	-6	-7	-11	-8	-7	-10
5	-7	-5	-5	-12	-17	-11	-34	-43	-46	-40	-22	-9	-6	-4	-5	-8	-12	-8	-25	-32	-36	-31	-17	-7
6	-10	-3	-4	-12	-20	-10	-7	-9	-15	-13	-11	-13	-8	-3	-4	-8	-14	-8	-5	-7	-12	-10	-9	-10
7	-167	-115	-129	-111	-144	-142	-157	-117	-125	-55	-95	-205	-121	-92	-112	-72	-97	-107	-111	-87	-98	-42	-72	-150
8	-11	-4	-5	-11	-20	-10	-8	-11	-15	-13	-11	-15	-8	-3	-5	-7	-14	-8	-6	-9	-13	-11	-9	-12

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-3	-13	-4	2	-6	3	-28	-51	-45	-37	-21	-5	-3	-12	-4	2	-4	2	-22	-38	-33	-29	-16	-4
2	-3	-13	-4	2	-6	3	-1	-12	-13	-11	-5	-3	-3	-12	-4	2	-4	2	-1	-10	-10	-9	-4	-2
3	-18	-28	-15	3	-2	6	0	-11	-10	-6	-5	-4	-14	-23	-13	3	-2	5	0	-8	-7	-5	-4	-3
4	-3	-13	-4	3	-5	4	-2	-11	-11	-8	-4	-1	-3	-12	-4	2	-4	3	-2	-9	-8	-6	-3	-1
5	-5	-15	-6	1	-6	3	-28	-51	-44	-37	-21	-6	-4	-12	-5	1	-5	3	-22	-38	-32	-29	-16	-5
6	-5	-15	-6	1	-6	3	-3	-14	-12	-10	-5	-4	-4	-12	-5	1	-5	3	-2	-10	-9	-8	-5	-3
7	-136	-131	-113	-101	-102	-104	-159	-141	-90	-89	-118	-162	-102	-109	-93	-71	-72	-80	-125	-105	-67	-69	-92	-122
8	-5	-15	-6	2	-7	4	-4	-15	-13	-9	-5	-4	-4	-12	-6	2	-5	3	-3	-11	-10	-8	-5	-3

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-5	-11	-5	0	-3	0	0	-10	-31	-45	-26	-5	-4	-9	-5	0	-2	0	1	-8	-27	-39	-22	-5
2	-5	-11	-5	0	-3	0	0	-2	-11	-17	-13	-4	-4	-9	-5	0	-2	0	1	-3	-10	-15	-11	-4
3	-22	-28	-11	1	-15	0	1	-1	-10	-15	-12	-5	-17	-22	-10	2	-9	-1	1	-1	-9	-13	-10	-4
4	-5	-11	-5	0	-3	1	0	-1	-10	-16	-12	-3	-4	-9	-5	0	-2	1	1	-2	-8	-13	-10	-4
5	-7	-11	-6	-1	-4	0	0	-10	-31	-44	-27	-6	-5	-10	-6	-1	-3	0	0	-9	-27	-38	-23	-6
6	-7	-11	-6	-1	-4	0	0	-2	-10	-16	-13	-6	-5	-10	-6	-1	-3	0	0	-3	-8	-14	-11	-5
7	-120	-99	-100	-121	-46	-87	-119	-50	-43	-123	-144	-139	-88	-79	-84	-93	-28	-61	-100	-42	-37	-104	-124	-122
8	-7	-12	-6	-1	-7	0	0	-2	-12	-18	-13	-5	-5	-10	-5	-1	-5	0	0	-2	-11	-16	-11	-5

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-11	22	46	16	24	64	45	-25	-50	-63	-22	-2	-5	10	23	7	11	23	21	-17	-30	-38	-16	-2
2	13	37	51	16	24	64	45	0	-26	-35	-8	-1	6	17	25	7	11	23	21	1	-16	-21	-6	-1
3	-8	5	31	4	12	81	60	1	-28	-37	-7	-1	-4	2	16	2	5	29	28	1	-17	-22	-5	-1
4	14	38	51	21	26	68	51	0	-26	-34	-7	0	6	17	26	10	12	24	23	4	-16	-21	-6	-1
5	-14	23	46	18	25	66	45	-25	-52	-62	-21	-3	-7	10	23	8	11	23	21	-17	-31	-37	-15	-2
6	10	38	50	19	24	66	45	0	-28	-34	-8	-2	4	17	25	9	11	23	21	1	-17	-21	-6	-2
7	-198	-126	-116	-76	-19	79	62	-77	-134	-133	-102	-149	-88	-57	-57	-34	-8	28	28	-50	-78	-81	-74	-116
8	11	38	50	21	28	69	57	1	-28	-34	-8	-3	5	17	25	10	12	25	26	1	-17	-21	-6	-2

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 *Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay*
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

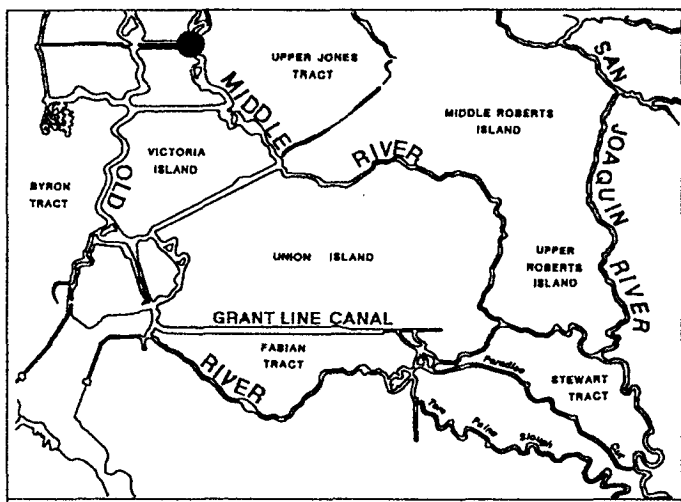


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

MIDDLE RIVER AT SANTA FE RAILROAD

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1	3	0	0	3	0	-21	-38	-26	-21	-32	-21
2	0	2	0	0	2	2	7	0	18	43	9	-14
3	-5	3	0	-3	-3	-5	3	-2	14	39	6	-15
4	0	3	0	0	2	3	8	1	19	43	10	-12
5	1	2	-1	-1	2	0	-21	-38	-23	-17	-28	-19
6	-1	1	-1	-1	1	1	8	1	18	40	10	-12
7	-9	2	-1	-5	-10	-14	-4	-5	11	30	-3	-22
8	-1	1	-1	-2	0	0	7	0	18	40	9	-14

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-5	-3	-4	-13	-15	-10	-36	-43	-46	-40	-22	-9
2	-7	-1	-3	-13	-18	-9	-7	-9	-15	-13	-10	-12
3	-16	-13	-6	-26	-23	-17	-14	-12	-16	-15	-12	-12
4	-7	-1	-3	-12	-18	-8	-8	-9	-14	-12	-8	-11
5	-6	-4	-5	-14	-17	-11	-37	-44	-47	-41	-22	-9
6	-9	-2	-4	-14	-19	-9	-9	-9	-14	-13	-10	-11
7	-33	-23	-11	-36	-29	-28	-25	-15	-19	-18	-15	-17
8	-10	-2	-5	-15	-20	-10	-9	-10	-15	-14	-11	-13

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-3	-13	-4	-3	-6	3	-30	-52	-47	-40	-21	-6
2	-3	-13	-4	-3	-6	3	-2	-13	-15	-12	-5	-3
3	-24	-33	-16	-4	-5	1	-4	-15	-16	-14	-9	-5
4	-3	-13	-3	-3	-6	3	-2	-13	-14	-11	-5	-2
5	-5	-15	-5	-4	-7	1	-32	-53	-47	-40	-22	-6
6	-5	-15	-5	-4	-7	1	-4	-14	-14	-12	-6	-4
7	-46	-48	-27	-6	-4	0	-5	-16	-18	-16	-13	-15
8	-5	-15	-5	-5	-8	1	-5	-15	-15	-13	-6	-5

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-5	-10	-5	0	-2	0	0	-13	-33	-48	-26	-6
2	-5	-10	-5	0	-2	0	0	-5	-13	-20	-13	-5
3	-29	-27	-10	-1	-1	-2	1	-7	-16	-21	-14	-8
4	-5	-9	-5	0	-3	0	0	-4	-12	-19	-12	-4
5	-6	-11	-6	-2	-3	0	0	-14	-35	-48	-27	-7
6	-6	-11	-6	-2	-3	0	0	-5	-12	-19	-13	-7
7	-49	-40	-17	-1	-1	-2	0	-9	-20	-24	-16	-13
8	-6	-10	-6	-3	-4	0	-1	-5	-14	-21	-15	-8

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-17	27	46	13	17	45	59	-28	-53	-62	-22	-2
2	9	43	51	13	17	46	59	0	-22	-32	-9	-2
3	6	14	29	2	21	47	58	0	-35	-36	-11	-2
4	10	44	51	14	17	42	59	0	-21	-31	-9	-1
5	-20	30	46	11	17	45	59	-28	-55	-62	-22	-4
6	7	45	51	12	17	45	59	0	-25	-32	-10	-3
7	1	-12	-1	-4	25	47	62	-1	-53	-41	-12	-7
8	9	46	50	12	17	41	58	-1	-23	-32	-11	-4

IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2	3	-1	0	3	0	-12	-24	-13	-9	-18	-15
2	-1	2	-1	0	2	2	4	1	10	19	5	-10
3	-4	3	-1	-2	-2	-3	2	-1	8	17	3	-10
4	0	3	-1	0	2	2	5	1	10	19	6	-8
5	1	2	-2	-1	2	1	-12	-23	-12	-7	-16	-13
6	-1	1	-2	-1	1	1	4	1	10	17	6	-8
7	-8	2	-2	-4	-7	-8	-3	-4	6	13	-2	-15
8	-1	1	-2	-2	1	1	4	0	10	17	5	-10

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-4	-3	-4	-9	-11	-9	-26	-34	-38	-32	-18	-7
2	-5	-2	-3	-9	-12	-7	-6	-8	-12	-10	-8	-9
3	-11	-11	-6	-18	-16	-14	-10	-10	-14	-12	-9	-9
4	-5	-2	-3	-9	-12	-7	-6	-8	-12	-10	-7	-8
5	-4	-3	-5	-10	-12	-9	-28	-34	-39	-33	-18	-7
6	-6	-2	-4	-10	-14	-7	-7	-8	-12	-10	-8	-8
7	-23	-19	-10	-25	-20	-22	-18	-12	-15	-14	-12	-12
8	-7	-2	-4	-11	-14	-8	-7	-8	-13	-11	-8	-9

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-3	-12	-3	-2	-4	2	-25	-41	-37	-34	-17	-5
2	-3	-12	-3	-2	-4	2	-2	-11	-12	-10	-5	-2
3	-19	-27	-14	-3	-4	2	-3	-12	-13	-12	-7	-4
4	-3	-12	-3	-2	-4	2	-2	-10	-11	-10	-4	-2
5	-5	-12	-4	-3	-6	2	-27	-41	-38	-34	-18	-5
6	-5	-12	-4	-3	-6	2	-4	-11	-12	-10	-6	-3
7	-34	-41	-22	-5	-3	1	-5	-12	-14	-13	-10	-12
8	-5	-13	-4	-4	-6	1	-5	-12	-13	-11	-6	-4

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-4	-8	-4	-1	-1	1	0	-12	-30	-44	-23	-5
2	-4	-8	-4	-1	-1	1	0	-4	-12	-18	-12	-5
3	-22	-21	-8	-2	-1	-1	1	-6	-14	-19	-13	-8
4	-4	-7	-4	-1	-2	1	1	-4	-11	-17	-12	-4
5	-5	-9	-5	-2	-3	0	-1	-12	-31	-44	-25	-7
6	-5	-9	-5	-2	-3	0	-1	-4	-11	-17	-13	-6
7	-36	-32	-14	-2	-1	-1	0	-8	-18	-21	-15	-12
8	-4	-8	-5	-2	-3	0	-1	-5	-13	-19	-13	-7

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	-8	12	23	6	8	18	26	-18	-33	-39	-17	-2
2	5	19	25	7	8	18	26	0	-13	-20	-8	-2
3	3	6	14	1	10	19	25	0	-22	-23	-8	-2
4	5	19	25	7	8	17	26	3	-13	-20	-7	-1
5	-9	13	23	6	8	18	26	-18	-34	-40	-17	-3
6	3	20	25	6	8	18	26	0	-15	-21	-8	-3
7	1	-6	-1	-2	12	19	27	-1	-32	-26	-9	-6
8	4	20	25	6	8	16	25	-1	-15	-20	-8	-4

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

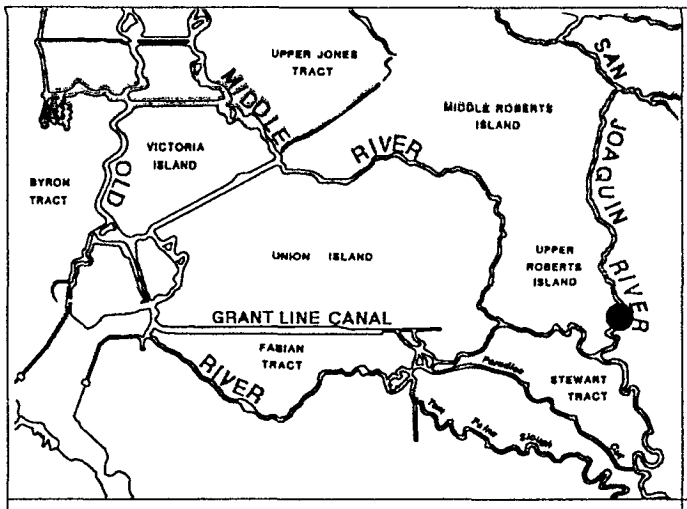


TABLE C-19 (cont.)
PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

SAN JOAQUIN RIVER NEAR LATHROP

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	-49	-3	0	1	-9	-21	-26	1	0	0	0	0	-11	-1	0	0	-2	-5	-6	0
2	0	0	0	0	-53	-2	0	2	-8	-21	-26	0	0	0	0	0	-12	-1	0	1	-2	-5	-6	0
3	0	0	0	0	-54	-2	0	2	-8	-21	-26	-1	0	0	0	0	-12	-1	0	1	-2	-5	-6	0
4	0	0	0	0	-53	-2	0	2	-8	-21	-26	-1	0	0	0	0	-12	-1	0	1	-2	-5	-6	0
5	0	0	0	0	-49	-3	0	1	-9	-21	-26	0	0	0	0	0	-11	-1	0	0	-2	-5	-6	0
6	0	0	0	0	-53	-2	0	2	-8	-21	-26	-1	0	0	0	0	-12	-1	0	1	-2	-5	-6	0
7	0	0	0	0	-54	-2	0	2	-8	-21	-26	-1	0	0	0	0	-12	-1	0	1	-2	-5	-6	0
8	0	0	0	0	-53	-2	0	2	-8	-21	-26	-1	0	0	0	0	-12	-1	0	1	-2	-5	-6	0

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	-2	-3	-13	-27	1	0	0	0	0	0	0	0	-1	-1	-3	-6	0
2	0	0	0	0	0	0	0	0	-3	-13	-27	0	0	0	0	0	0	0	0	0	-1	-3	-6	0
3	0	0	0	0	0	0	0	-1	-3	-13	-27	0	0	0	0	0	0	0	0	0	-1	-3	-6	0
4	0	0	0	0	0	0	0	-1	-3	-13	-27	0	0	0	0	0	0	0	0	0	-1	-3	-6	0
5	0	0	0	0	0	0	0	-2	-3	-13	-27	1	0	0	0	0	0	0	0	-1	-1	-3	-6	0
6	0	0	0	0	0	0	0	0	-3	-13	-27	0	0	0	0	0	0	0	0	0	-1	-3	-6	0
7	0	0	0	0	0	0	0	-1	-3	-13	-27	0	0	0	0	0	0	0	0	0	-1	-3	-6	0
8	0	0	0	0	0	0	0	-1	-3	-13	-27	0	0	0	0	0	0	0	0	0	-1	-3	-6	0

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	1	0	1	-5	-11	-6	0	0	0	0	0	0	1	0	0	-1	-3	-2	0
2	0	0	0	0	0	1	0	1	-4	-11	-6	0	0	0	0	0	0	1	0	0	-1	-3	-1	0
3	0	0	0	0	0	0	0	1	-4	-11	-6	0	0	0	0	0	0	0	0	0	-1	-3	-2	0
4	0	0	0	0	0	1	0	1	-4	-11	-6	0	0	0	0	0	0	1	0	0	-1	-3	-1	0
5	0	0	0	0	0	0	0	1	-5	-11	-6	0	0	0	0	0	0	0	0	0	-1	-3	-2	0
6	0	0	0	0	0	0	0	1	-4	-11	-6	0	0	0	0	0	0	0	0	1	-1	-3	-2	0
7	0	0	0	0	0	-3	0	1	-4	-11	-7	0	0	0	0	0	0	-1	0	0	-1	-3	-2	0
8	0	0	0	0	0	0	0	1	-4	-11	-7	0	0	0	0	0	0	0	0	0	-1	-3	-2	0

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	-183	-209	-16	-34	-1	0	0	0	0	0	0	0	-50	-61	-4	-8	0
2	0	0	0	0	0	0	0	-181	-209	-17	-33	-1	0	0	0	0	0	0	0	-49	-61	-4	-8	0
3	0	0	0	0	0	0	0	-181	-209	-17	-34	0	0	0	0	0	0	0	0	-49	-61	-4	-8	0
4	0	0	0	0	0	0	0	-181	-209	-17	-32	-1	0	0	0	0	0	0	0	-49	-61	-4	-7	0
5	0	0	0	0	0	0	0	-182	-209	-15	-34	-1	0	0	0	0	0	0	0	-49	-61	-4	-8	0
6	0	0	0	0	0	0	0	-180	-209	-17	-34	-1	0	0	0	0	0	0	0	-49	-61	-4	-8	0
7	0	0	0	0	0	0	0	-182	-209	-17	-36	0	0	0	0	0	0	0	0	-49	-61	-4	-8	0
8	0	0	0	0	0	0	0	-181	-209	-17	-35	0	0	0	0	0	0	0	0	-49	-61	-4	-8	0

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	12	-16	0	0	0	0	2	0	0	-6	0	0	3	-4	0	0	0	0	1	0	0	-2	0
2	0	12	-16	0	0	0	0	1	0	0	-7	0	0	3	-4	0	0	0	0	1	0	0	-2	0
3	0	0	-104	0	0	0	0	1	0	0	-8	0	0	0	-25	0	0	0	0	1	0	0	-2	0
4	0	11	-10	0	0	0	0	1	0	0	-5	0	0	2	-2	0	0	0	0	4	0	0	-1	0
5	0	6	-39	0	0	0	0	2	0	0	-8	0	0	1	-9	0	0	0	0	1	0	0	-2	0
6	0	6	-41	0	0	0	0	1	0	0	-9	0	0	1	-10	0	0	0	0	1	0	0	-2	0
7	0	-7	-182	0	0	0	0	1	0	0	-13	0	0	-1	-43	0	0	0	0	1	0	0	-3	0
8	0	0	-90	0	0	0	0	1	0	0	-10	0	0	0	-21	0	0	0	0	1	0	0	-3	0

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

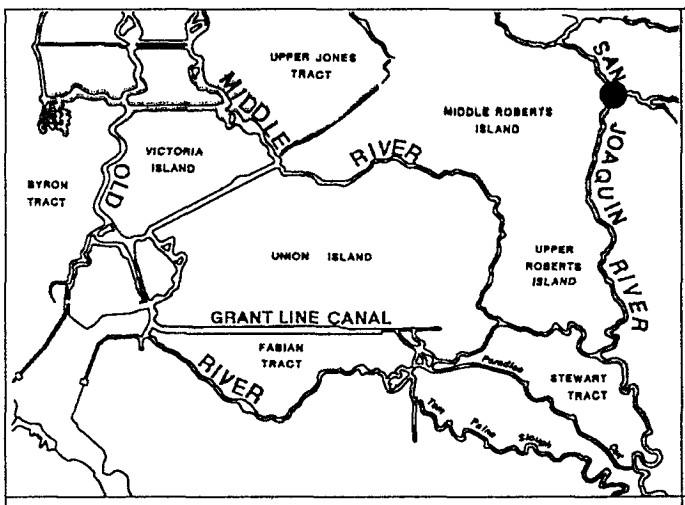


TABLE C-19 (cont.)

PHASE II MODELING

IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN THE SOUTH DELTA

SAN JOAQUIN RIVER AT FRENCH CAMP SLOUGH

IMPROVEMENT IN TOTAL DISSOLVED SOLIDS (PPM) | IMPROVEMENT IN PERCENT

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	-52	-6	2	1	-15	-69	-103	-2	0	0	0	0	-13	-2	1	0	-4	-17	-26	-1
2	1	0	0	0	-77	-3	0	2	-10	-67	-105	0	0	0	0	0	-20	-1	0	1	-2	-17	-27	0
3	1	0	0	0	-82	-2	0	2	-10	-67	-105	0	0	0	0	0	-21	-1	0	1	-2	-17	-27	0
4	1	0	0	0	-78	-3	0	2	-9	-67	-105	-1	0	0	0	0	-20	-1	0	1	-2	-17	-27	0
5	0	0	0	0	-57	-6	2	1	-15	-69	-103	-2	0	0	0	0	-14	-2	1	0	-4	-17	-26	-1
6	1	0	0	0	-79	-3	0	2	-10	-67	-105	-1	0	0	0	0	-20	-1	0	1	-2	-17	-27	0
7	1	0	0	-2	-85	-1	1	2	-11	-67	-105	0	0	0	0	-1	-21	-1	0	1	-3	-17	-27	0
8	1	0	0	-1	-80	-3	0	2	-10	-66	-105	0	0	0	0	0	-20	-1	0	1	-2	-17	-27	0

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	3	0	0	0	-1	4	5	-15	-23	-73	-114	-11	1	0	0	0	-1	1	2	-4	-5	-18	-29	-2
2	5	0	0	0	-2	6	3	-10	-20	-72	-116	-7	2	0	0	0	-1	2	1	-2	-5	-17	-29	-2
3	5	0	0	0	-3	6	4	-10	-21	-72	-116	-8	2	0	0	0	-1	2	1	-2	-5	-17	-29	-2
4	5	0	0	0	-2	5	3	-10	-20	-72	-116	-8	2	0	0	0	-1	2	1	-2	-5	-17	-29	-2
5	3	0	0	0	-1	5	5	-15	-23	-73	-114	-10	1	0	0	0	-1	1	2	-4	-5	-18	-29	-2
6	5	0	0	0	-2	6	4	-10	-20	-72	-116	-8	2	0	0	0	-1	2	1	-2	-5	-17	-29	-2
7	6	1	0	0	-3	6	4	-11	-21	-72	-117	-6	2	0	0	0	-1	2	1	-3	-5	-18	-29	-2
8	5	0	0	0	-3	6	4	-10	-20	-72	-116	-7	2	0	0	0	-1	2	1	-2	-5	-17	-29	-2

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	2	5	0	-20	-48	-52	0	0	0	0	0	0	1	1	0	-5	-12	-13	0
2	0	0	0	0	0	2	3	1	-17	-47	-53	0	0	0	0	0	0	1	1	0	-4	-12	-13	0
3	1	0	0	0	0	-5	3	1	-17	-47	-53	0	1	0	0	0	0	-1	1	0	-4	-12	-13	0
4	0	0	0	0	0	4	3	1	-16	-47	-51	0	0	0	0	0	0	1	1	0	-4	-12	-13	0
5	0	0	0	0	0	-3	5	0	-20	-48	-53	0	0	0	0	0	0	-1	1	0	-5	-12	-13	0
6	0	0	0	0	0	-3	3	1	-17	-47	-54	0	0	0	0	0	0	-1	1	0	-4	-12	-13	0
7	3	0	0	0	0	-15	3	1	-18	-47	-55	0	1	0	0	0	0	-4	1	0	-4	-12	-14	0
8	1	0	0	0	0	-7	3	1	-17	-47	-54	0	1	0	0	0	0	-2	1	0	-4	-12	-13	0

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	0	0	0	0	0	0	-233	-305	-128	-124	-6	0	0	0	0	0	0	0	-76	-122	-40	-37	-2
2	0	0	0	0	0	0	0	-213	-308	-136	-126	-6	0	0	0	0	0	0	0	-70	-123	-43	-38	-2
3	0	0	0	0	0	0	0	-216	-307	-136	-126	-4	0	0	0	0	0	0	0	-71	-122	-43	-38	-1
4	0	0	0	0	0	0	0	-211	-308	-137	-122	-5	0	0	0	0	0	0	0	-70	-123	-43	-36	-1
5	0	0	0	0	0	0	0	-233	-305	-128	-129	-5	0	0	0	0	0	0	0	-77	-122	-40	-39	-1
6	0	0	0	0	0	0	0	-210	-308	-137	-130	-5	0	0	0	0	0	0	0	-69	-123	-43	-39	-1
7	1	0	0	-1	0	0	0	-223	-306	-134	-136	-1	0	0	0	0	0	0	0	-73	-122	-42	-41	-1
8	0	0	0	-1	0	0	0	-213	-308	-136	-132	-4	0	0	0	0	0	0	0	-70	-123	-43	-39	-1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0	12	-12	0	0	0	0	0	0	0	-18	0	0	3	-4	0	0	0	0	0	0	0	-5	0
2	0	13	-12	0	0	0	0	1	0	0	-18	0	0	3	-4	0	0	0	0	0	0	0	-5	0
3	0	-1	-83	0	0	0	0	1	0	0	-20	0	0	0	-24	0	0	0	0	0	0	0	-6	0
4	0	15	-8	0	0	0	0	1	0	0	-12	0	0	3	-3	0	0	0	0	4	0	0	-4	0
5	0	7	-31	0	0	0	0	0	0	0	-27	0	0	2	-9	0	0	0	0	0	0	0	-8	0
6	0	7	-31	0	0	0	0	1	0	0	-27	0	0	2	-9	0	0	0	0	0	0	0	-8	0
7	0	-21	-183	1	0	0	0	1	0	0	-44	1	0	-5	-53	0	0	0	0	0	0	0	-12	0
8	0	0	-62	0	0	0	0	1	0	0	-32	0	0	0	-18	0	0	0	0	0	0	0	-9	0

DESCRIPTION OF ALTERNATIVES:

1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B

5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: Outlined values indicate that barriers are operating

Note: Negative values indicate that salinity increases over the No-Action Alternative

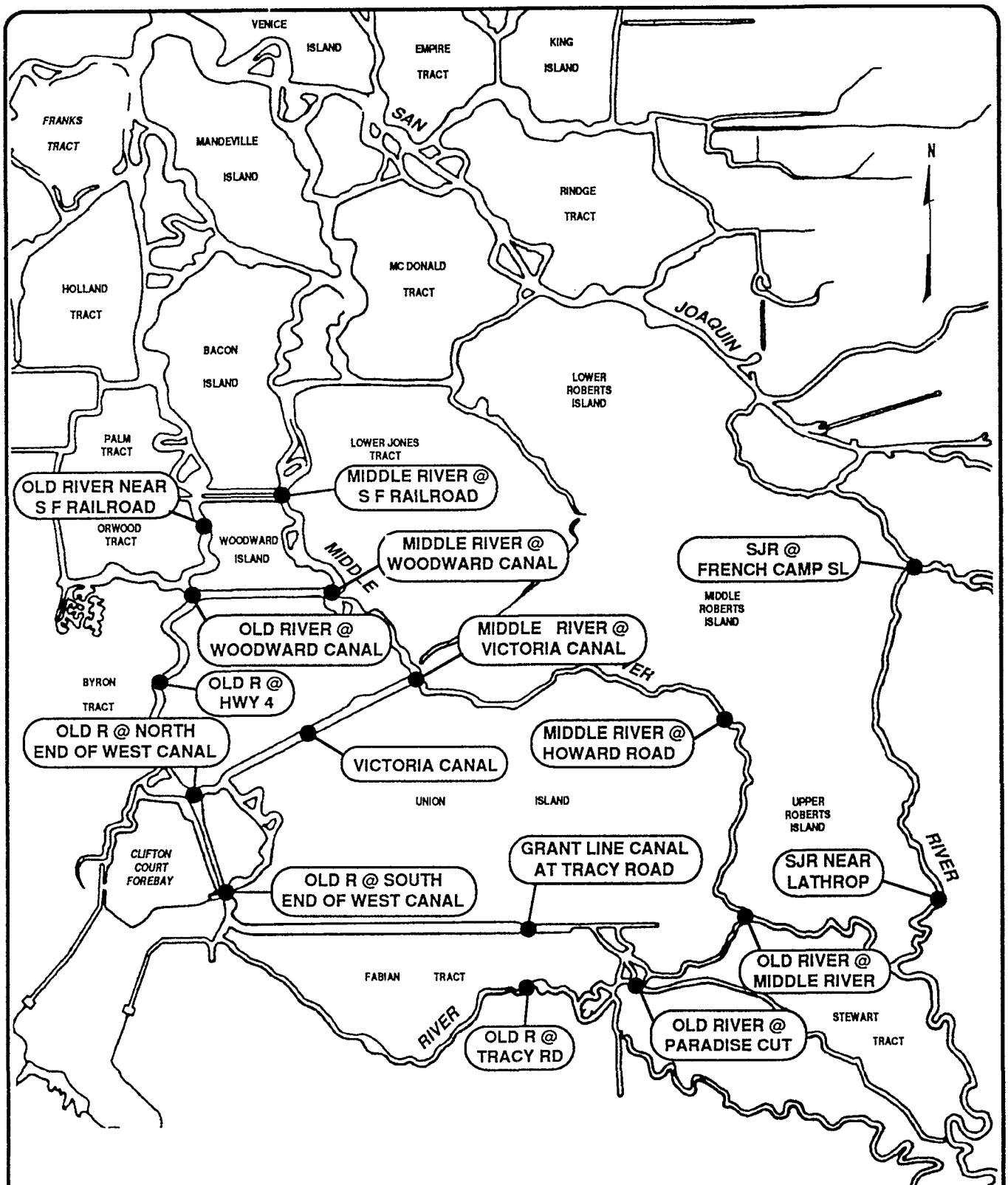
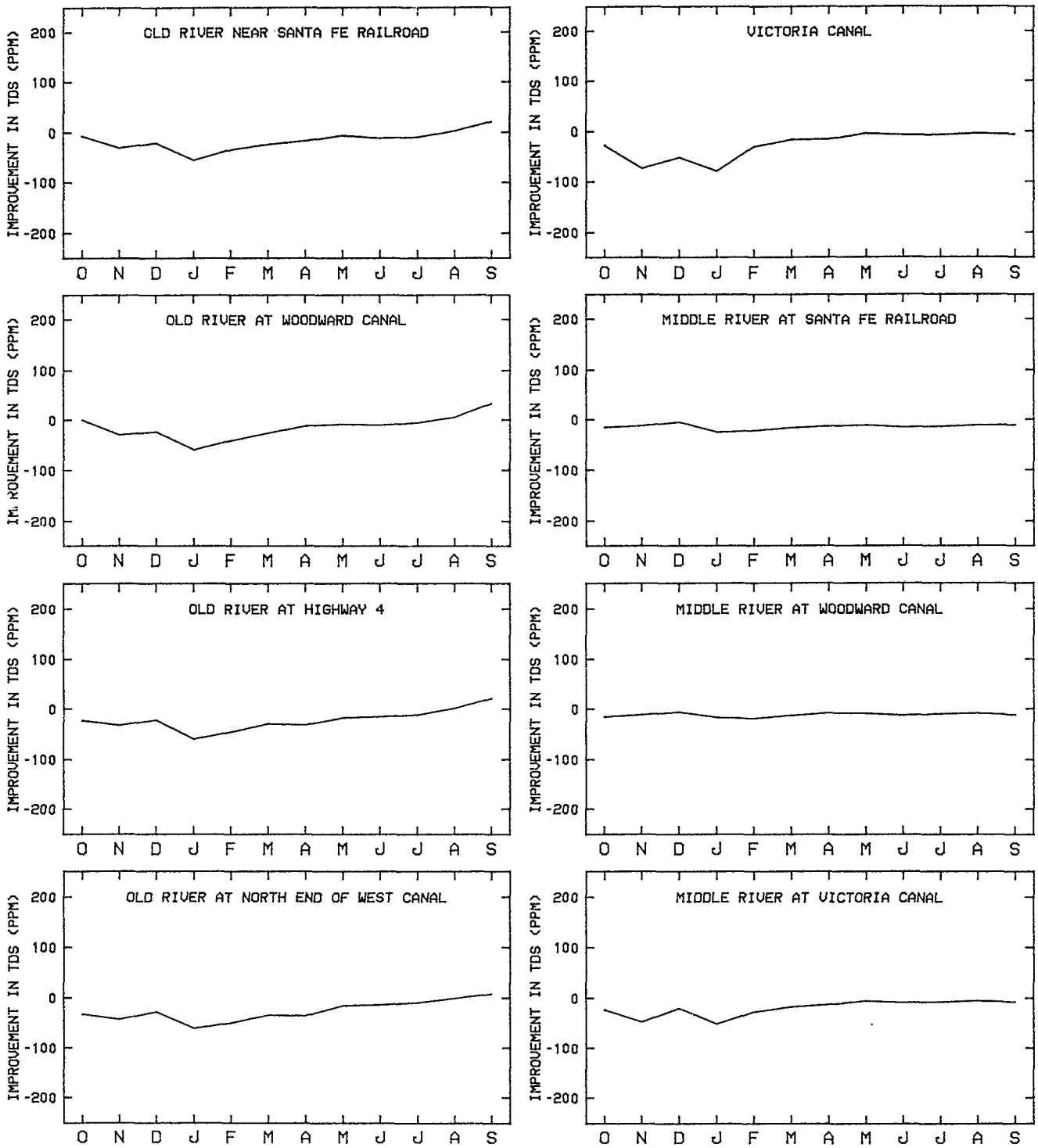


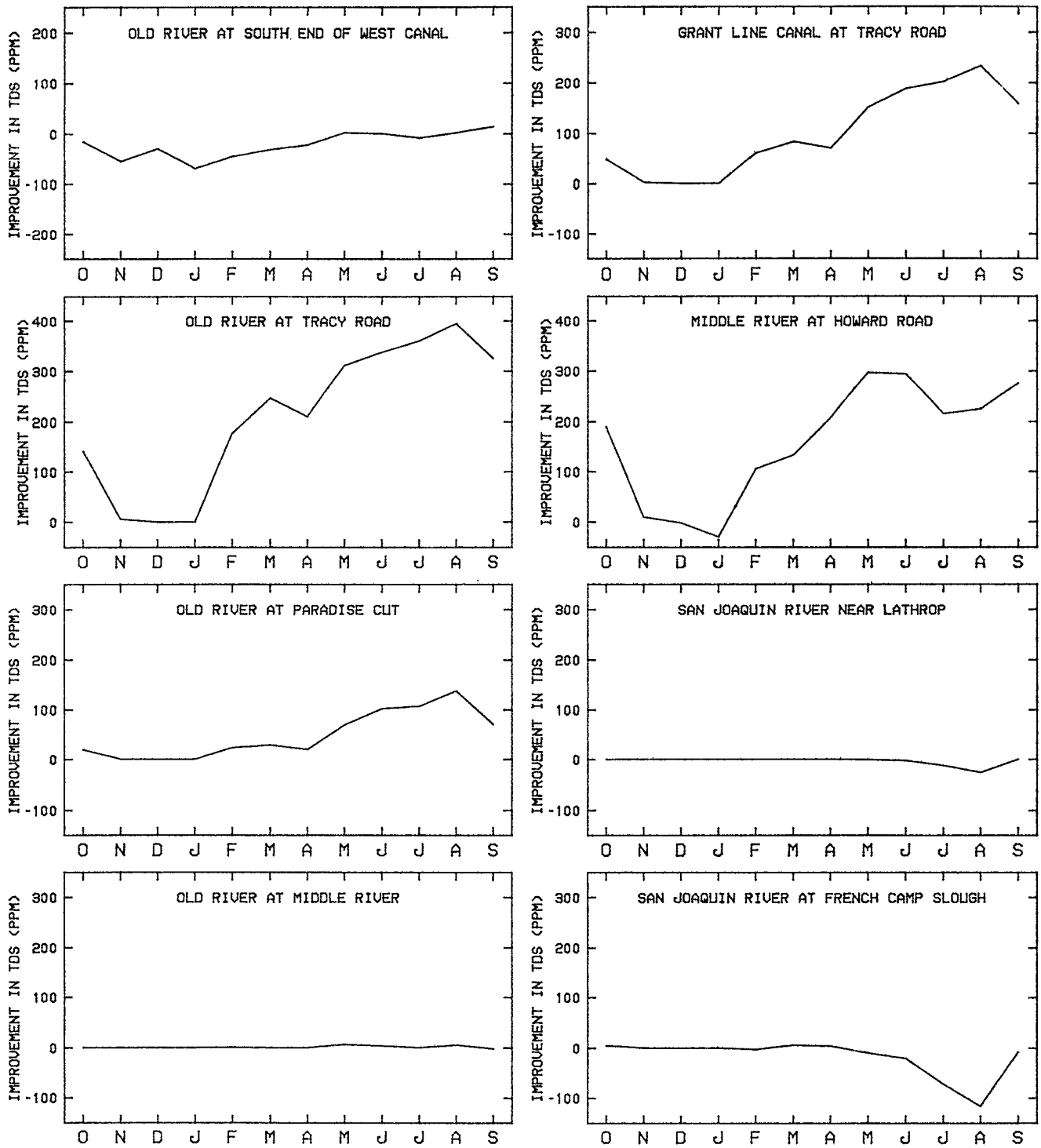
FIGURE C-17
PHASE II MODELING
LOCATIONS WHERE SALINITY IMPROVEMENTS PRESENTED

FIGURE C-18
IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN TDS
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE DRY YEAR



Note: During some months, salinity improvement does not occur at isolated loctions. It is anticipated that the new facilities will allow for the operational flexibility to provide for improvement in salintiy in these months and locations.

FIGURE C-18 (cont.)
IMPROVEMENT IN MONTHLY AVERAGE SALINITY IN TDS
ENLARGED FOREBAY-NORTH VICTORIA INTAKE ALTERNATIVE
REPRESENTATIVE DRY YEAR



Note: During some months, salinity improvement does not occur at isolated loctions. It is anticipated that the new facilities will allow for the operational flexibility to provide for improvement in salintiy in these months and locations.

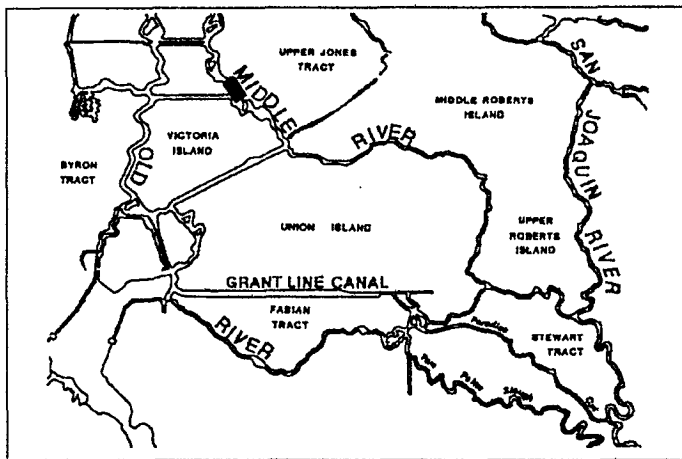


TABLE C-20
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

MIDDLE RIVER JUST DOWNSTREAM OF WOODWARD CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
1	0.8	0.9	0.9	1.0	0.9	0.9	0.8	0.8	0.9	0.8	0.8	0.9	1.9	1.9	1.7	1.6	1.5	1.4	1.5	1.4	1.4	1.4	1.3	1.4
2	0.7	0.9	0.9	1.0	0.8	0.9	0.8	0.9	0.9	0.7	0.8	0.8	1.9	1.9	1.7	1.6	1.4	1.4	1.4	1.3	1.4	1.3	1.3	1.4
3	0.5	0.8	0.9	0.9	0.7	0.7	0.7	0.8	0.8	0.7	0.8	0.8	3.2	3.3	3.3	3.1	3.1	2.8	2.5	2.6	2.5	1.8	2.2	2.3
4	0.6	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1.7	1.8	1.7	1.6	1.6	1.5	1.4	1.4	1.4	1.3	1.4	1.4
5	0.8	0.9	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.1	2.0	2.0	1.8	1.7	1.7	1.6	1.7	1.5	1.5	1.5	1.5	1.5
6	0.8	0.9	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.9	2.0	1.8	1.7	1.6	1.5	1.5	1.4	1.5	1.4	1.4	1.4
7	0.6	0.9	0.9	1.0	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	3.8	3.9	3.7	3.6	3.5	3.4	3.3	3.1	3.1	3.0	3.1	3.2
8	0.6	0.8	0.9	1.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.8	1.8	1.7	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.8	0.6	0.7	0.5	0.6	0.6	0.7	0.8	0.8	0.8	0.8	0.8	1.3	1.4	1.3	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
1	0.9	0.8	0.9	0.8	0.9	0.8	0.7	0.9	0.9	0.8	0.8	0.8	1.5	2.0	1.6	2.0	1.6	1.9	1.7	1.4	1.4	1.4	1.4	1.3
2	0.9	0.8	0.9	0.8	0.8	0.7	0.8	0.9	0.9	0.8	0.8	0.8	1.4	2.0	1.6	2.0	1.5	1.9	1.6	1.4	1.4	1.4	1.3	1.3
3	0.7	0.7	0.9	0.8	0.7	0.5	0.7	0.8	0.8	0.7	0.7	0.8	2.9	3.3	3.2	3.3	3.2	3.2	3.2	2.6	2.6	2.2	2.0	2.2
4	0.7	0.7	0.8	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	1.6	1.8	1.7	1.8	1.6	1.7	1.7	1.4	1.5	1.4	1.4	1.4
5	1.0	0.9	1.1	0.9	1.0	0.8	0.9	0.9	1.0	0.9	1.0	1.1	1.6	2.0	1.8	2.0	1.7	1.9	1.9	1.6	1.6	1.6	1.5	1.5
6	1.0	0.9	1.1	0.9	0.9	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.6	2.0	1.8	2.0	1.7	1.9	1.7	1.4	1.4	1.5	1.4	1.4
7	0.7	0.8	0.9	0.8	0.7	0.6	0.7	0.8	0.8	0.8	0.8	0.8	3.5	3.9	3.6	3.9	3.6	3.8	3.7	3.1	3.2	3.2	3.1	3.1
8	0.8	0.8	0.9	0.8	0.8	0.6	0.7	0.8	0.8	0.8	0.8	0.8	1.6	1.9	1.6	1.8	1.7	1.8	1.7	1.5	1.5	1.5	1.5	1.5

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.7	0.5	0.8	0.7	0.8	0.8	0.7	0.8	0.8	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.3	1.3	1.3	1.3
1	0.9	0.9	0.9	1.0	1.0	0.9	0.7	0.9	0.9	0.8	1.0	1.0	1.9	1.8	1.9	1.6	1.6	1.7	1.7	1.4	1.4	1.5	1.4	1.4
2	0.9	0.9	0.9	1.0	1.0	0.9	0.8	0.9	0.9	0.8	1.0	1.0	1.9	1.8	1.9	1.6	1.6	1.7	1.5	1.3	1.4	1.4	1.4	1.4
3	0.8	0.8	0.8	0.9	0.9	0.8	0.7	0.8	0.8	0.7	0.9	0.9	3.3	3.3	3.3	3.2	3.1	3.3	3.2	2.5	2.6	2.7	2.4	2.8
4	0.7	0.8	0.7	0.9	0.9	0.8	0.6	0.7	0.7	0.7	0.9	0.9	1.8	1.8	1.8	1.6	1.6	1.7	1.6	1.4	1.4	1.5	1.5	1.5
5	0.9	1.0	0.9	1.1	1.1	1.0	0.9	1.0	0.9	0.9	1.1	1.1	2.0	1.9	2.0	1.7	1.7	1.8	1.9	1.5	1.5	1.7	1.6	1.7
6	0.9	1.0	0.9	1.1	1.1	1.0	0.9	1.0	1.0	1.0	1.1	1.1	2.0	1.9	2.0	1.7	1.7	1.8	1.7	1.4	1.4	1.6	1.6	1.7
7	0.9	0.9	0.9	1.0	1.0	0.9	0.7	0.8	0.8	0.7	1.0	1.0	3.9	3.8	3.9	3.6	3.6	3.7	3.6	3.1	3.1	3.4	3.3	3.4
8	0.8	0.8	0.8	1.0	1.0	0.9	0.8	0.8	0.8	0.8	1.0	1.0	1.8	1.8	1.8	1.6	1.6	1.7	1.7	1.5	1.5	1.6	1.6	1.6

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.8	0.8	0.8	0.7	0.8	0.8	0.7	0.7	0.7	1.4	1.4	1.4	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.3	1.4
1	0.8	0.9	0.9	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.9	0.9	2.0	1.9	1.7	1.5	1.5	1.5	1.6	1.4	1.4	1.5	1.4	1.8
2	0.8	0.9	0.9	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.9	0.9	2.0	1.9	1.7	1.5	1.5	1.5	1.6	1.4	1.4	1.4	1.4	1.8
3	0.7	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.7	0.9	0.8	3.3	3.3	3.3	3.1	3.1	3.0	3.2	2.7	2.7	2.6	2.5	3.3
4	0.7	0.8	0.8	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.8	0.8	1.8	1.8	1.7	1.6	1.6	1.6	1.7	1.5	1.5	1.5	1.5	1.7
5	0.9	0.9	1.1	1.1	1.2	1.1	1.1	0.9	0.9	0.9	1.1	1.0	2.0	2.0	1.8	1.7	1.7	1.7	1.8	1.6	1.6	1.7	1.6	1.9
6	0.9	0.9	1.1	1.1	1.2	1.1	1.1	1.0	1.0	1.0	1.1	1.0	2.0	2.0	1.8	1.7	1.7	1.7	1.8	1.5	1.5	1.5	1.6	1.9
7	0.8	0.9	0.9	1.0	1.0	1.0	0.9	0.8	0.8	0.8	1.0	0.9	3.9	3.9	3.7	3.6	3.6	3.6	3.7	3.2	3.2	3.3	3.4	3.8
8	0.8	0.8	0.9	1.0	1.0	1.0	0.9	0.8	0.8	0.8	1.0	0.9	1.9	1.8	1.7	1.6	1.5	1.6	1.7	1.6	1.6	1.6	1.6	1.7

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.0	0.8	0.7	0.6	0.6	0.9	1.0	0.9	0.9	0.9	0.8	0.8	1.1	1.2	1.4	1.4	1.4	1.2	1.1	1.2	1.2	1.2	1.3	1.3
1	1.1	1.0	0.9	0.9	0.9	1.1	1.1	0.9	1.0	0.9	1.0	1.0	1.3	1.6	1.7	1.9	1.9	1.8	1.5	1.4	1.3	1.4	1.4	1.5
2	1.1	1.0	0.9	0.9	0.9	1.1	1.1	0.9	1.0	0.9	1.0	1.0	1.3	1.6	1.7	1.9	1.9	1.8	1.5	1.3	1.0	1.2	1.4	1.5
3	1.0	0.9	0.8	0.8	0.8	1.0	1.0	0.8	0.9	0.8	0.9	0.9	2.3	3.1	3.2	3.2	3.2	3.0	2.9	2.5	1.5	2.2	2.4	3.0
4	1.0	0.9	0.8	0.7	0.8	1.0	1.0	0.8	0.9	0.8	0.9	0.8	1.3	1.6	1.7	1.8	1.8	1.6	1.4	1.3	1.0	1.3	1.5	1.6
5	1.1	1.1	1.0	0.9	1.0	1.1	1.2	1.0	1.0	1.0	1.1	1.1	1.2	1.7	1.8	2.0	2.0	1.8	1.6	1.6	1.3	1.4	1.6	1.7
6	1.1	1.1	1.0	0.9	1.0	1.1	1.2	1.1	1.0	1.1	1.1	1.1	1.2	1.7	1.8	2.0	2.0	1.8	1.6	1.4	1.1	1.3	1.6	1.7
7	1.0	0.9	0.9	0.9	0.9	1.0	1.1	0.8	0.9	0.9	1.0	1.0	2.5	3.5	3.7	3.9	3.9	3.8	3.6	3.1	2.1	2.7	3.3	3.6
8	1.0	0.9	0.9	0.8	0.8	1.0	1.1	0.8	0.9	0.9	1.0	1.0	1.3	1.6	1.7	1.8	1.8	1.6	1.5	1.4	1.2	1.4	1.6	1.6

DESCRIPTION OF ALTERNATIVES

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

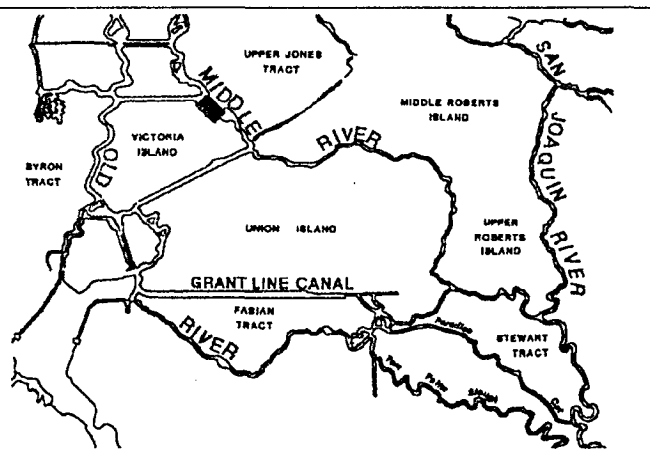


TABLE C-20 (cont.)

PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

MIDDLE RIVER JUST UPSTREAM OF WOODWARD CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1.4	1.3	1.4	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.3
1	0.7	0.8	0.9	0.9	0.7	0.8	0.7	0.8	0.8	0.7	0.7	0.8	1.9	1.9	1.8	1.6	1.6	1.5	1.6	1.6	1.6	1.5	1.5	1.5
2	0.6	0.8	0.9	0.9	0.7	0.7	0.7	0.8	0.7	0.6	0.6	0.7	1.9	1.9	1.8	1.6	1.5	1.5	1.5	1.5	1.5	1.3	1.4	1.5
3	1.4	1.3	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	1.1	1.3	1.3	1.3	1.2	1.1	1.1	1.1	1.2	1.2	1.2	1.1
4	0.5	0.7	0.8	0.8	0.6	0.6	0.6	0.7	0.7	0.6	0.7	0.7	1.1	1.3	1.3	1.3	1.2	1.1	1.1	1.1	1.1	1.2	1.1	1.1
5	0.8	0.9	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.9	2.0	2.0	1.9	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6
6	0.7	0.9	1.0	1.0	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.9	2.0	1.9	1.8	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6
7	1.8	1.6	1.5	1.3	1.4	1.3	1.2	1.0	0.9	0.8	1.0	1.1	1.0	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0
8	0.6	0.8	0.9	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1.2	1.3	1.2	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.6	0.7	0.5	0.5	0.5	0.7	0.8	0.8	0.7	0.8	0.7	1.3	1.4	1.3	1.4	1.4	1.4	1.3	1.2	1.2	1.3	1.3	1.3
1	0.8	0.7	0.9	0.8	0.7	0.7	0.6	0.8	0.8	0.7	0.7	0.7	1.5	2.0	1.6	2.0	1.6	1.9	1.7	1.5	1.5	1.5	1.4	1.5
2	0.7	0.7	0.9	0.8	0.7	0.6	0.7	0.8	0.7	0.6	0.6	0.6	1.5	2.0	1.6	2.0	1.5	1.8	1.6	1.5	1.5	1.5	1.4	1.4
3	0.8	1.4	0.9	1.3	0.8	1.2	0.8	0.8	0.8	0.7	0.7	0.7	1.1	1.3	1.3	1.3	1.1	1.2	1.2	1.1	1.1	1.2	1.2	1.1
4	0.6	0.7	0.8	0.7	0.6	0.5	0.6	0.7	0.7	0.7	0.7	0.7	1.1	1.3	1.3	1.3	1.1	1.2	1.2	1.1	1.1	1.2	1.2	1.1
5	0.9	0.8	1.0	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.9	0.9	1.7	2.1	1.8	2.0	1.8	2.0	1.9	1.6	1.6	1.6	1.8	1.6
6	0.9	0.8	1.0	0.8	0.8	0.7	0.8	0.9	0.9	0.9	0.9	0.9	1.6	2.1	1.8	2.0	1.7	1.9	1.7	1.6	1.6	1.6	1.6	1.6
7	1.4	1.6	1.4	1.6	1.5	1.7	1.5	1.0	1.0	1.0	0.9	1.0	1.0	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0
8	0.7	0.8	0.9	0.8	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	1.1	1.3	1.2	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.5	0.5	0.5	0.6	0.5	0.7	0.7	0.8	0.7	0.7	0.7	0.7	1.4	1.4	1.4	1.3	1.4	1.3	1.3	1.2	1.2	1.3	1.3	1.3
1	0.8	0.8	0.8	0.9	0.9	0.8	0.6	0.8	0.8	0.7	0.9	0.9	1.9	1.9	2.0	1.6	1.6	1.7	1.7	1.5	1.6	1.6	1.5	1.5
2	0.8	0.8	0.8	0.9	0.9	0.8	0.7	0.8	0.7	0.7	0.9	0.9	1.9	1.9	2.0	1.6	1.6	1.7	1.5	1.4	1.5	1.6	1.5	1.5
3	1.1	1.0	1.2	0.9	0.9	0.9	0.8	0.9	0.8	0.7	0.9	0.9	1.3	1.3	1.3	1.2	1.3	1.3	1.1	1.1	1.1	1.2	1.3	1.3
4	0.7	0.7	0.7	0.8	0.8	0.8	0.6	0.7	0.7	0.6	0.8	0.8	1.3	1.3	1.3	1.2	1.2	1.3	1.1	1.1	1.1	1.2	1.3	1.3
5	0.9	0.9	0.9	1.0	1.0	1.0	0.8	0.8	0.8	0.8	1.0	1.0	2.0	2.0	2.0	1.8	1.8	1.9	1.9	1.6	1.6	1.7	1.6	1.7
6	0.9	0.9	0.9	1.0	1.0	1.0	0.8	0.9	0.9	0.9	1.0	1.0	2.0	2.0	2.0	1.8	1.8	1.9	1.7	1.6	1.6	1.7	1.6	1.7
7	1.5	1.5	1.6	1.4	1.3	1.4	1.5	1.0	0.9	1.2	1.0	1.2	1.2	1.2	1.2	1.1	1.1	1.2	1.0	1.0	1.0	1.1	1.2	1.1
8	0.8	0.8	0.8	0.9	0.9	0.8	0.7	0.7	0.7	0.7	0.9	0.9	1.3	1.3	1.3	1.2	1.1	1.2	1.1	1.1	1.1	1.2	1.2	1.1

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	1.4	1.3	1.4	1.2	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.3
1	0.7	0.8	0.9	0.9	1.0	0.9	0.9	0.7	0.7	0.7	0.9	0.8	2.0	2.0	1.8	1.6	1.5	1.5	1.7	1.5	1.6	1.6	1.5	1.8
2	0.7	0.8	0.9	0.9	1.0	0.9	0.9	0.7	0.7	0.7	0.9	0.8	2.0	2.0	1.8	1.6	1.5	1.5	1.7	1.5	1.5	1.5	1.5	1.8
3	1.4	1.3	0.9	0.9	1.0	1.0	0.9	0.8	0.8	0.7	0.9	0.9	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.1	1.2	1.2	1.3	1.3
4	0.7	0.7	0.8	0.8	0.9	0.8	0.8	0.7	0.7	0.6	0.8	0.7	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.1	1.2	1.2	1.3	1.3
5	0.8	0.9	1.0	1.0	1.1	1.0	1.0	0.8	0.8	0.8	1.0	1.0	2.1	2.0	1.9	1.8	1.7	1.8	1.8	1.7	1.7	1.7	1.6	1.9
6	0.8	0.9	1.0	1.0	1.1	1.0	1.0	0.9	0.9	0.9	1.0	1.0	2.1	2.0	1.9	1.8	1.7	1.8	1.8	1.6	1.6	1.6	1.6	1.9
7	1.6	1.6	1.5	1.3	1.5	1.3	1.4	1.0	1.0	1.1	1.0	1.5	1.2	1.1	1.1	1.1	1.0	1.2	1.1	1.1	1.1	1.1	1.2	1.2
8	0.8	0.8	0.9	0.9	1.0	0.9	0.9	0.7	0.7	0.7	0.9	0.8	1.3	1.3	1.2	1.1	1.1	1.2	1.2	1.1	1.1	1.1	1.1	1.2

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.9	0.8	0.6	0.5	0.6	0.9	0.9	0.8	0.9	0.8	0.7	0.7	1.1	1.2	1.3	1.4	1.3	1.1	1.1	1.2	1.2	1.2	1.3	1.3
1	1.1	0.9	0.8	0.8	0.8	1.0	1.1	0.8	0.9	0.8	0.9	0.9	1.3	1.6	1.7	2.0	2.0	1.8	1.6	1.5	1.3	1.5	1.5	1.5
2	1.1	0.9	0.8	0.8	0.8	1.0	1.1	0.8	0.9	0.8	0.9	0.9	1.3	1.6	1.7	2.0	2.0	1.8	1.6	1.4	1.0	1.5	1.5	1.5
3	1.0	0.9	0.9	1.5	1.5	1.7	1.3	0.9	0.9	0.9	0.9	0.9	1.2	1.3	1.3	1.3	1.2	1.0	1.0	1.0	1.0	1.0	1.3	1.3
4	1.0	0.8	0.8	0.7	0.7	0.9	1.0	0.7	0.8	0.7	0.8	0.8	1.1	1.3	1.3	1.3	1.3	1.2	1.0	1.0	0.9	1.0	1.3	1.3
5	1.1	1.0	1.0	0.9	0.9	1.1	1.2	0.9	0.9	0.9	1.0	1.0	1.3	1.7	1.8	2.0	2.0	1.9	1.7	1.6	1.4	1.6	1.6	1.7
6	1.1	1.0	1.0	0.9	0.9	1.1	1.2	1.0	0.9	0.9	1.0	1.0	1.3	1.7	1.8	2.0	2.0	1.9	1.7	1.5	1.3	1.5	1.6	1.7
7	1.1	1.2	1.3	1.7	1.7	1.8	1.8	1.1	1.0	0.9	1.0	1.3	1.1	1.2	1.2	1.1	1.1	0.9	0.8	0.9	0.9	0.9	1.2	1.1
8	1.0	0.9	0.8	0.8	0.9	1.0	1.0	0.8	0.8	0.8	0.9	0.9	1.1	1.1	1.2	1.3	1.3	1.2	1.0	1.1	0.9	1.0	1.2	1.1

DESCRIPTION OF ALTERNATIVES

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

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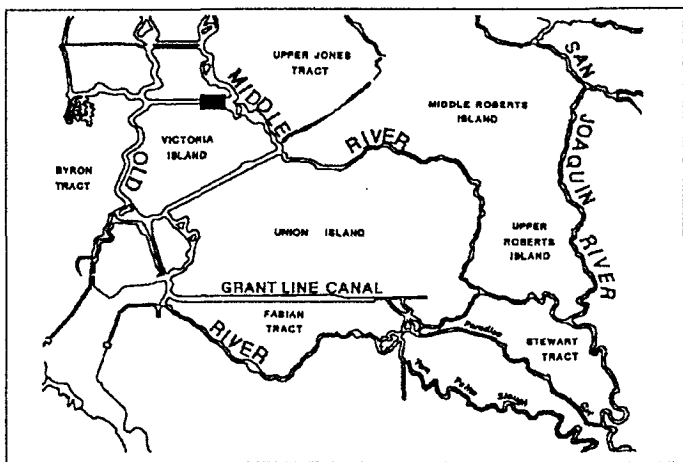

TABLE C-20 (cont.)

PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

EAST END OF WOODWARD CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.5	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.9	1.9	1.9	1.7	1.8	1.5	1.3	1.4	1.3	0.7	1.1	1.2
4	1.3	1.3	1.2	1.1	1.1	1.0	0.8	0.8	0.8	0.6	0.7	0.8	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2
5	0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.3	0.3	0.3	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	2.7	2.6	2.5	2.4	2.4	2.3	2.2	2.0	1.9	1.9	2.0	2.1
8	1.5	1.5	1.4	1.3	1.3	1.3	1.2	1.1	1.1	1.1	1.2	1.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.5	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.7	1.9	1.9	1.9	1.9	1.9	1.9	1.4	1.4	1.1	1.0	1.1
4	1.0	1.3	1.1	1.3	1.2	1.3	1.2	0.9	0.9	0.7	0.7	0.7	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1
5	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	2.4	2.7	2.4	2.6	2.5	2.6	2.5	2.0	2.0	2.0	2.0	2.0
8	1.3	1.5	1.3	1.5	1.4	1.5	1.4	1.2	1.2	1.2	1.1	1.2	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.2	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.4	1.9	1.9	1.9	1.9	1.8	1.9	1.9	1.4	1.4	1.4	1.2	1.4
4	1.3	1.3	1.3	1.1	1.1	1.1	1.1	0.8	0.8	0.9	0.8	0.9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2
5	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	2.6	2.6	2.6	2.4	2.4	2.4	2.5	2.0	2.0	2.2	2.0	2.2
8	1.4	1.4	1.5	1.3	1.3	1.4	1.4	1.1	1.2	1.3	1.2	1.3	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	1.9	1.9	1.9	1.7	1.8	1.7	1.9	1.4	1.5	1.3	1.2	1.9
4	1.3	1.3	1.2	1.1	1.1	1.0	1.1	0.9	0.9	0.8	0.8	1.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	2.7	2.6	2.5	2.4	2.5	2.4	2.4	2.0	2.1	2.2	2.1	2.5
8	1.5	1.5	1.4	1.3	1.4	1.3	1.4	1.2	1.2	1.2	1.2	1.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
1	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.5	0.5	0.5	0.5	0.5	1.2	1.8	1.9	1.9	1.9	1.9	1.9	1.5	0.7	1.2	1.2	1.6
4	0.7	1.1	1.1	1.3	1.3	1.3	1.2	0.9	0.5	0.7	0.8	1.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.4	0.4	0.4	0.4	0.4	1.4	2.3	2.4	2.7	2.7	2.7	2.6	2.1	1.2	1.7	2.1	2.3
8	0.8	1.3	1.3	1.5	1.5	1.5	1.4	1.2	0.7	1.0	1.2	1.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

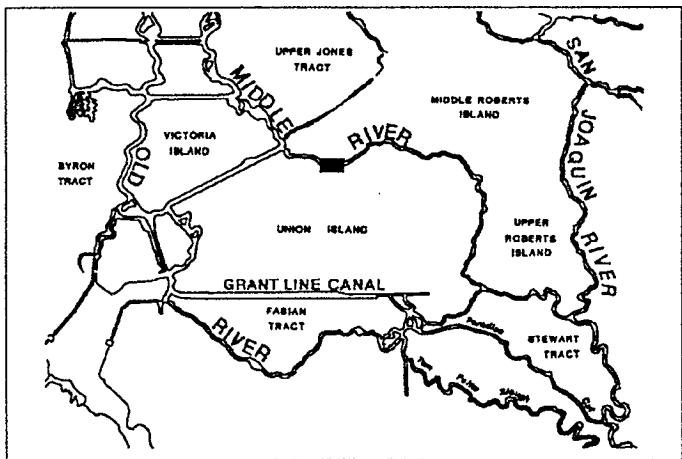

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

MIDDLE RIVER UPSTREAM OF VICTORIA CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7
1	0.1	0.6	0.6	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6
2	0.1	0.6	0.6	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5
3	0.1	0.9	0.9	0.8	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.6	0.7	0.7	0.7	0.6	0.6	0.5	0.6	0.6	0.6	0.5	0.5
4	0.1	0.6	0.5	0.5	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.6	0.7	0.7	0.7	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.5
5	0.1	0.8	0.9	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.6
6	0.1	0.8	0.9	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
7	0.1	1.1	1.1	1.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
8	0.1	0.8	0.7	0.7	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.7	0.6	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7
1	0.1	0.6	0.6	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
2	0.1	0.6	0.6	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3	0.1	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.7	0.7	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.5
4	0.1	0.5	0.5	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.6	0.7	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.5
5	0.1	0.8	0.9	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6
6	0.1	0.8	0.9	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
7	0.1	1.1	1.1	1.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
8	0.1	0.8	0.7	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
1	0.6	0.6	0.6	0.6	0.6	0.6	0.1	0.1	0.1	0.1	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7
2	0.6	0.6	0.6	0.6	0.6	0.6	0.1	0.1	0.1	0.1	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7
3	0.9	0.9	0.9	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7
4	0.5	0.5	0.5	0.6	0.6	0.5	0.1	0.1	0.1	0.1	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7
5	0.8	0.8	0.8	0.9	0.9	0.8	0.1	0.1	0.1	0.1	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.7
6	0.8	0.8	0.8	0.9	0.9	0.8	0.1	0.1	0.1	0.1	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7
7	1.1	1.1	1.1	1.1	1.1	1.1	0.1	0.1	0.1	0.1	0.9	1.0	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7
8	0.7	0.7	0.7	0.7	0.7	0.7	0.1	0.1	0.1	0.1	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
1	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.1	0.1	0.1	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
2	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.1	0.1	0.1	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
3	0.9	0.9	0.9	0.8	0.9	0.8	0.9	0.1	0.1	0.1	0.6	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
4	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.1	0.1	0.1	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
5	0.8	0.8	0.9	0.9	1.0	1.0	0.9	0.1	0.1	0.1	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
6	0.8	0.8	0.9	0.9	1.0	1.0	0.9	0.1	0.1	0.1	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.1	0.1	0.1	1.0	1.1	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
8	0.8	0.8	0.7	0.7	0.8	0.7	0.7	0.1	0.1	0.1	0.6	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7
1	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.1	0.1	0.1	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
2	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.1	0.1	0.1	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.6	0.6	0.7	0.7
3	0.6	0.8	0.9	0.9	0.9	0.9	1.0	0.1	0.0	0.1	0.6	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.5	0.6	0.6	0.7	0.7
4	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.1	0.1	0.1	0.5	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.7	0.7
5	0.7	0.8	0.8	0.9	0.9	1.1	1.1	0.1	0.1	0.1	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7
6	0.7	0.8	0.8	0.9	0.9	1.1	1.1	0.1	0.1	0.1	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
7	0.6	1.0	1.1	1.2	1.2	1.2	1.2	0.1	0.1	0.1	0.9	1.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.6	0.6	0.7	0.7
8	0.5	0.6	0.7	0.8	0.8	0.9	0.9	0.1	0.1	0.1	0.5	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

C-041613

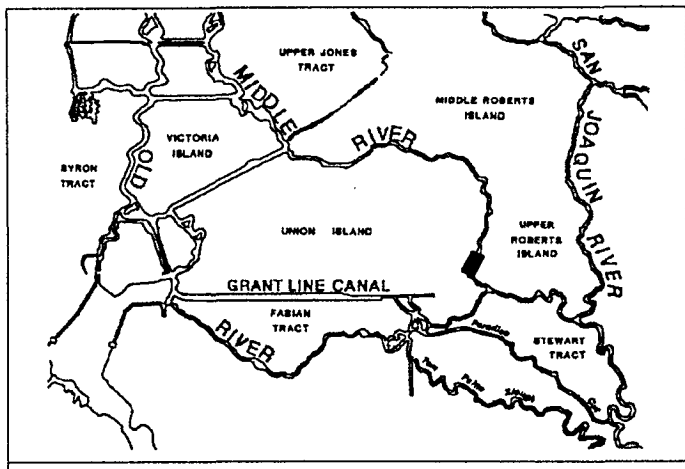

TABLE C-20 (cont.)

PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

MIDDLE RIVER NEAR UNDINE ROAD

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND)

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
NA	0.3	0.3	0.3	0.3	0.2	0.4	0.3	0.5	0.6	0.6	0.3	0.3
1	0.2	0.3	0.3	0.3	0.0	0.2	*	0.2	0.3	0.3	0.1	0.1
2	0.2	0.3	0.3	0.3	0.1	0.2	0.1	0.3	0.3	0.2	0.1	0.1
3	0.4	0.6	0.6	0.5	0.2	0.4	0.4	0.4	0.4	0.2	0.2	0.3
4	0.2	0.3	0.3	0.3	0.1	0.2	0.1	0.3	0.3	0.2	0.1	0.2
5	0.2	0.4	0.4	0.3	0.1	0.2	0.1	0.3	0.3	0.3	0.1	0.1
6	0.2	0.4	0.4	0.3	0.1	0.2	0.2	0.3	0.3	0.3	0.1	0.2
7	0.5	0.7	0.6	0.6	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.4
8	0.2	0.4	0.4	0.3	0.1	0.2	0.2	0.3	0.3	0.2	0.1	0.1
REPRESENTATIVE DRY YEAR												
NA	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.4	0.3
1	0.1	0.3	0.3	0.2	0.1	0.1	*	0.2	0.2	0.2	0.1	0.1
2	0.1	0.3	0.3	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1
3	0.3	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3
4	0.1	0.3	0.3	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.2
5	0.2	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1
6	0.2	0.3	0.3	0.3	0.1	0.2	0.2	0.2	0.2	0.3	0.1	0.1
7	0.4	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
8	0.2	0.3	0.3	0.3	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1
REPRESENTATIVE BELOW NORMAL YEAR												
NA	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.3
1	0.3	0.3	0.3	0.3	0.3	0.3	*	0.2	0.2	0.2	0.4	0.3
2	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.2	0.2	0.2	0.4	0.3
3	0.5	0.5	0.6	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.4	0.5
4	0.3	0.3	0.3	0.3	0.3	0.4	0.1	0.3	0.2	0.2	0.4	0.3
5	0.3	0.3	0.4	0.3	0.3	0.3	0.1	0.1	0.3	0.2	0.3	0.3
6	0.3	0.3	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3
7	0.6	0.6	0.6	0.6	0.6	0.6	0.4	0.4	0.4	0.4	0.6	0.6
8	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.4	0.3
REPRESENTATIVE ABOVE NORMAL YEAR												
NA	0.3	0.3	0.3	0.2	0.5	0.3	0.2	0.3	0.4	0.4	0.3	0.3
1	0.3	0.3	0.3	0.3	0.6	0.4	0.3	0.2	0.2	0.2	0.4	0.3
2	0.3	0.3	0.3	0.3	0.6	0.4	0.3	0.2	0.2	0.2	0.4	0.3
3	0.6	0.6	0.6	0.5	0.7	0.6	0.5	0.3	0.3	0.3	0.3	0.5
4	0.3	0.3	0.3	0.3	0.6	0.3	0.3	0.1	0.2	0.2	0.3	0.3
5	0.4	0.4	0.4	0.3	0.6	0.4	0.3	0.1	0.3	0.2	0.3	0.3
6	0.4	0.4	0.4	0.3	0.6	0.4	0.3	0.1	0.2	0.2	0.3	0.3
7	0.6	0.7	0.6	0.6	0.8	0.7	0.6	0.3	0.3	0.4	0.5	0.6
8	0.4	0.4	0.4	0.3	0.6	0.3	0.3	0.1	0.2	0.2	0.3	0.3
REPRESENTATIVE WET YEAR												
NA	0.4	0.3	0.2	0.2	0.3	0.7	0.8	0.4	0.5	0.5	0.4	0.3
1	0.4	0.2	0.2	0.3	0.4	0.7	0.8	0.1	0.4	0.2	0.4	0.3
2	0.4	0.2	0.2	0.3	0.4	0.7	0.8	0.2	0.4	0.4	0.4	0.3
3	0.5	0.5	0.4	0.6	0.6	0.8	0.9	0.5	0.4	0.5	0.4	0.5
4	0.4	0.3	0.2	0.3	0.4	0.7	0.8	0.3	0.4	0.4	0.4	0.4
5	0.4	0.3	0.2	0.3	0.4	0.7	0.8	0.1	0.3	0.3	0.4	0.4
6	0.4	0.3	0.2	0.3	0.4	0.7	0.8	0.2	0.4	0.4	0.4	0.4
7	0.5	0.5	0.5	0.6	0.7	0.8	0.9	0.5	0.5	0.5	0.6	0.6
8	0.4	0.3	0.2	0.3	0.4	0.7	0.8	0.2	0.4	0.3	0.4	0.3

MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
REPRESENTATIVE CRITICAL YEAR												
NA	0.4	0.4	0.4	0.5	0.5	0.4	0.5	0.4	0.3	0.4	0.5	0.5
1	0.7	0.1	0.1	0.3	0.7	0.6	0.7	0.6	0.6	0.6	0.7	0.7
2	0.6	0.1	0.1	0.3	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.6
3	0.6	0.0	0.0	0.1	0.6	0.5	0.6	0.5	0.4	0.5	0.6	0.6
4	0.6	0.1	0.1	0.2	0.6	0.5	0.6	0.5	0.4	0.5	0.6	0.6
5	0.7	0.2	0.3	0.4	0.7	0.7	0.7	0.6	0.6	0.6	0.7	0.7
6	0.7	0.2	0.3	0.4	0.7	0.6	0.7	0.5	0.5	0.5	0.7	0.7
7	0.6	*	*	0.1	0.6	0.5	0.6	0.4	0.4	0.4	0.6	0.6
8	0.6	0.1	0.1	0.2	0.6	0.6	0.6	0.5	0.4	0.5	0.6	0.6
REPRESENTATIVE DRY YEAR												
NA	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.5
1	0.7	0.3	0.3	0.3	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.7
2	0.6	0.3	0.3	0.3	0.7	0.6	0.6	0.6	0.6	0.5	0.6	0.6
3	0.6	0.1	0.1	0.1	0.6	0.5	0.5	0.5	0.5	0.5	0.6	0.6
4	0.6	0.2	0.2	0.3	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6
5	0.7	0.4	0.3	0.4	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7
6	0.7	0.4	0.3	0.4	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.7
7	0.6	0.0	0.0	0.1	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.6
8	0.6	0.3	0.2	0.3	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6
REPRESENTATIVE BELOW NORMAL YEAR												
NA	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.5	0.5
1	0.3	0.3	0.2	0.2	0.2	0.3	0.7	0.7	0.6	0.6	0.3	0.2
2	0.3	0.3	0.2	0.2	0.2	0.3	0.6	0.6	0.6	0.5	0.3	0.2
3	0.1	0.1	0.1	0.1	0.0	0.1	0.5	0.5	0.5	0.5	0.1	0.1
4	0.2	0.2	0.2	0.1	0.1	0.2	0.6	0.6	0.5	0.5	0.1	0.1
5	0.4	0.4	0.3	0.3	0.3	0.4	0.7	0.7	0.7	0.6	0.4	0.3
6	0.4	0.4	0.3	0.3	0.3	0.4	0.7	0.6	0.6	0.6	0.4	0.3
7	0.0	0.1	0.0	*	*	0.0	0.6	0.5	0.5	0.5	0.1	0.0
8	0.3	0.3	0.2	0.1	0.1	0.2	0.6	0.6	0.5	0.5	0.2	0.2
REPRESENTATIVE ABOVE NORMAL YEAR												
NA	0.4	0.4	0.4	0.5	0.2	0.5	0.5	0.5	0.4	0.4	0.5	0.5
1	0.2	0.1	0.1	0.3	*	0.3	0.3	0.7	0.6	0.6	0.3	0.3
2	0.2	0.1	0.1	0.3	*	0.3	0.3	0.6	0.6	0.6	0.3	0.3
3	0.1	0.0	0.0	0.1	*	*	0.1	0.6	0.5	0.5	0.1	0.1
4	0.1	0.1	0.1	0.2	*	0.2	0.2	0.6	0.5	0.5	0.2	0.2
5	0.3	0.2	0.2	0.4	*	0.3	0.4	0.7	0.7	0.7	0.4	0.4
6	0.3	0.2	0.2	0.4	*	0.3	0.4	0.6	0.6	0.6	0.4	0.4
7	0.0	*	*	0.1	*	*	0.0	0.6	0.5	0.5	0.1	0.0
8	0.2	0.1	0.1	0.3	*	0.2	0.2	0.6	0.6	0.5	0.2	0.2
REPRESENTATIVE WET YEAR												
NA	0.4	0.5	0.5	0.4	0.4	*	*	0.3	0.3	0.3	0.5	0.4
1	0.3	0.4	0.4	0.2	0.0	*	*	0.7	0.7	0.6	0.2	0.2
2	0.3	0.4	0.4	0.2	0.0	*	*	0.5	0.5	0.5	0.2	0.2
3	0.1	0.1	0.1	0.0	*	*	*	0.5	0.5	0.4	0.1	0.1
4	0.1	0.3	0.3	0.2	0.0	*	*	0.5	0.5	0.5	0.1	0.1
5	0.3	0.4	0.4	0.3	0.1	*	*	0.7	0.7	0.6	0.3	0.3
6	0.3	0.4	0.4	0.3	0.1	*	*	0.6	0.5	0.5	0.3	0.3
7	0.1	0.1	0.1	*	*	*	*	0.5	0.5	0.4	0.0	0.0
8	0.1	0.3	0.3	0.2	0.0	*	*	0.5	0.5	0.5	0.2	0.1

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

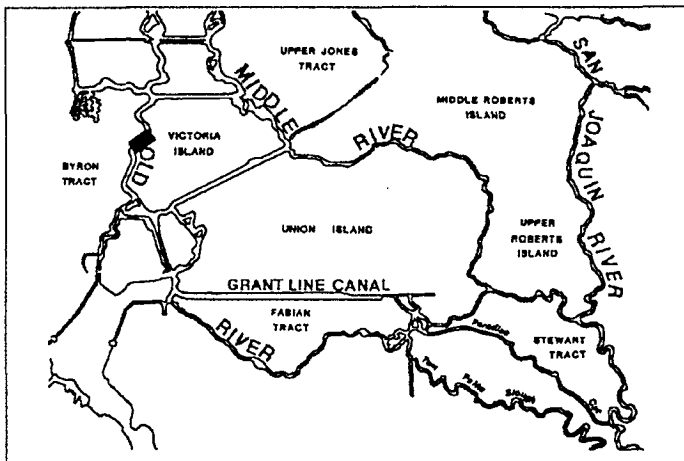

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

OLD RIVER JUST DOWNSTREAM OF HIGHWAY 4

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	0.9	0.9	0.9
1	0.7	0.8	0.9	0.9	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.8
2	0.6	0.8	0.9	0.9	0.7	0.7	0.7	0.8	0.8	0.6	0.6	0.7
3	0.6	1.0	1.0	1.1	0.6	0.7	0.7	0.8	0.8	0.7	0.7	0.7
4	0.6	0.9	1.0	1.0	0.6	0.7	0.7	0.8	0.8	0.7	0.7	0.7
5	0.9	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
6	0.8	1.0	1.1	1.1	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	0.9	1.3	1.3	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8	0.8	1.1	1.2	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.9	0.7	0.8	0.6	0.6	0.7	0.8	1.0	1.0	0.9	1.0	0.9
1	0.8	0.8	0.9	0.8	0.8	0.7	0.6	0.9	0.9	0.8	0.8	0.8
2	0.8	0.8	0.9	0.8	0.7	0.6	0.7	0.8	0.8	0.6	0.6	0.6
3	0.7	0.9	1.1	0.9	0.6	0.6	0.6	0.8	0.8	0.7	0.7	0.7
4	0.7	0.8	1.0	0.8	0.6	0.6	0.6	0.8	0.8	0.7	0.7	0.7
5	1.0	0.9	1.1	0.9	1.0	0.9	0.9	1.0	1.0	1.0	1.0	1.1
6	1.0	0.9	1.1	0.9	0.9	0.8	0.9	1.0	1.0	1.0	1.0	1.0
7	1.0	1.2	1.3	1.2	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0
8	1.0	1.1	1.2	1.1	1.0	0.8	1.0	1.0	1.0	1.0	1.0	1.0

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.7	0.8	0.6	0.9	0.8	1.0	1.0	0.8	0.9	0.9
1	0.8	0.8	0.8	0.9	0.9	0.9	0.7	0.9	0.9	0.7	0.9	0.9
2	0.8	0.8	0.8	0.9	0.9	0.9	0.7	0.8	0.8	0.7	0.9	0.9
3	0.9	1.0	1.0	1.1	1.1	1.0	0.6	0.8	0.8	0.6	1.0	1.1
4	0.9	0.9	0.9	1.0	1.0	0.9	0.6	0.8	0.8	0.6	1.0	1.0
5	1.0	1.0	1.0	1.1	1.1	1.1	0.9	1.0	1.0	0.9	1.1	1.1
6	1.0	1.0	1.0	1.1	1.1	1.1	0.9	1.0	1.0	1.0	1.1	1.1
7	1.2	1.2	1.2	1.3	1.3	1.3	1.0	1.0	1.0	1.0	1.3	1.3
8	1.1	1.1	1.1	1.3	1.3	1.2	1.0	1.0	1.0	1.0	1.3	1.3

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.7	0.9	0.9	0.9	0.8	1.0	1.0	0.8	0.8	0.7
1	0.8	0.8	0.9	0.9	1.0	1.0	0.9	0.8	0.8	0.8	0.9	0.8
2	0.8	0.8	0.9	0.9	1.0	1.0	0.9	0.8	0.8	0.7	0.9	0.8
3	0.9	1.0	1.0	1.1	1.2	1.1	1.0	0.7	0.7	0.6	1.0	1.0
4	0.8	0.9	1.0	1.0	1.1	1.0	1.0	0.8	0.8	0.7	1.0	0.9
5	0.9	1.0	1.1	1.1	1.2	1.1	1.1	1.0	1.0	0.9	1.1	1.1
6	0.9	1.0	1.1	1.1	1.2	1.1	1.1	1.0	1.0	1.0	1.1	1.1
7	1.2	1.3	1.3	1.3	1.4	1.3	1.3	1.0	1.0	1.0	1.3	1.3
8	1.1	1.1	1.2	1.3	1.4	1.3	1.2	1.0	1.0	1.0	1.3	1.2

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.0	0.8	0.7	0.8	1.3	1.3	1.1	1.2	1.1	0.9	0.9
1	1.2	0.9	0.9	0.8	0.9	1.1	1.2	0.9	1.0	0.9	0.9	0.9
2	1.2	0.9	0.9	0.8	0.9	1.1	1.2	0.8	1.0	0.8	0.9	0.9
3	1.3	1.1	1.0	1.0	1.0	1.3	1.4	0.8	1.0	0.9	1.0	1.0
4	1.3	1.0	0.9	0.9	0.9	1.3	1.3	0.8	1.0	0.9	1.0	1.0
5	1.2	1.1	1.0	1.0	1.0	1.2	1.3	1.0	1.1	1.0	1.1	1.1
6	1.2	1.1	1.0	1.0	1.0	1.2	1.3	1.1	1.0	1.0	1.1	1.1
7	1.4	1.3	1.2	1.3	1.3	1.5	1.6	1.1	1.1	1.1	1.3	1.3
8	1.3	1.2	1.2	1.1	1.2	1.4	1.6	1.0	1.1	1.0	1.3	1.3

MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.2	2.2	2.2	2.1	2.1	2.0	2.0	1.7	1.8	1.9	1.8	1.8
1	2.5	2.4	2.3	2.4	2.4	2.4	2.4	2.4	2.3	1.8	2.1	2.2
2	2.4	2.4	2.3	2.4	2.3	2.3	2.3	2.2	2.2	1.7	2.1	2.1
3	1.6	1.8	1.7	1.8	1.6	1.6	1.6	1.5	1.6	1.7	1.6	1.6
4	3.9	4.0	3.8	3.6	3.5	3.4	3.1	3.1	3.0	2.5	2.8	2.9
5	2.7	2.7	2.7	2.6	2.7	2.6	2.6	2.6	2.5	2.5	2.5	2.5
6	2.7	2.7	2.7	2.6	2.7	2.6	2.6	2.5	2.5	2.5	2.5	2.5
7	1.3	1.6	1.5	1.5	1.4	1.3	1.3	1.3	1.4	1.4	1.3	1.3
8	4.3	4.2	4.1	3.9	3.9	3.8	3.7	3.5	3.5	3.5	3.6	3.6

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.0	2.2	2.1	2.3	2.3	2.3	2.0	1.7	1.7	1.8	1.8	1.8
1	2.3	2.5	2.3	2.5	2.3	2.4	2.5	2.4	2.4	2.2	2.0	2.1
2	2.3	2.5	2.3	2.5	2.3	2.4	2.3	2.3	2.3	2.1	2.0	2.1
3	1.6	1.8	1.8	1.8	1.6	1.7	1.6	1.5	1.5	1.7	1.6	1.6
4	3.5	4.1	3.6	4.1	3.5	4.0	3.6	3.1	3.1	2.8	2.7	2.8
5	2.6	2.7	2.6	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.5	2.5
6	2.6	2.7	2.6	2.7	2.7	2.7	2.7	2.5	2.5	2.5	2.5	2.5
7	1.3	1.7	1.5	1.6	1.3	1.4	1.3	1.4	1.4	1.4	1.4	1.3
8	3.9	4.3	4.0	4.3	4.0	4.3	4.1	3.6	3.6	3.6	3.5	3.6

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.3	2.2	2.3	2.1	2.2	1.9	2.1	1.8	1.8	2.0	1.8	1.8
1	2.4	2.4	2.4	2.3	2.3	2.4	2.5	2.3	2.4	2.5	2.2	2.3
2	2.4	2.4	2.4	2.3	2.3	2.4	2.3	2.2	2.2	2.4	2.2	2.3
3	1.8	1.8	1.8	1.7	1.7	1.8	1.6	1.5	1.5	1.7	1.8	1.8
4	4.1	4.0	4.1	3.5	3.6	3.7	3.5	3.0	3.1	3.3	3.1	3.3
5	2.7	2.7	2.7	2.6	2.6	2.7	2.7	2.6	2.6	2.7	2.5	2.6
6	2.7	2.7	2.7	2.6	2.6	2.7	2.7	2.5	2.5	2.6	2.5	2.6
7	1.6	1.6	1.6	1.5	1.5	1.5	1.3	1.3	1.4	1.4	1.5	1.5
8	4.2	4.2	4.3	4.0	3.9	4.1	4.0	3.5	3.6	3.8	3.7	3.8

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.2	2.2	2.2	2.0	2.1	1.9	2.1	1.8	1.9	2.1	2.0	2.2
1	2.5	2.4	2.3	2.3	2.1	2.2	2.4	2.4	2.4	2.4	2.3	2.4
2	2.5	2.4	2.3	2.3	2.1	2.2	2.4	2.3	2.3	2.3	2.3	2.4
3	1.8	1.8	1.7	1.8	1.6	1.8	1.8	1.6	1.6	1.7	1.8	1.8
4	4.1	4.1	3.8	3.6	3.4	3.5	3.6	3.3	3.3	3.1	3.1	3.8
5	2.7	2.7	2.7	2.6	2.6	2.6	2.7	2.6	2.6	2.7	2.6	2.7
6	2.7	2.7	2.7	2.6	2.6	2.6	2.7	2.6	2.6	2.6	2.6	2.7
7	1.6	1.6	1.5	1.5	1.3	1.5	1.5	1.4	1.4	1.4	1.5	1.6
8	4.3	4.3	4.1	3.9	4.0	4.0	4.0	3.7	3.7	3.8	3.8	4.1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.6	1.7	2.1	2.2	2.2	1.8	1.6	1.7	1.6	1.8	1.8	2.0
1	2.0	2.4	2.4	2.5	2.4	2.2	1.9	2.4	1.5	2.2	2.2	2.4
2	2.0	2.4	2.4	2.5	2.4	2.2	1.9	2.1	1.3	2.0	2.2	2.4
3	1.6	1.7	1.8	1.7	1.7	1.3	1.2	1.3	1.3	1.4	1.8	1.8
4	2.8	3.6	3.7	4.0	4.0	3.6	3.4	3.0	2.1	2.7	3.1	3.5
5	2.1	2.6	2.7	2.7	2.6	2.5	2.5	2.6	2.0	2.4	2.6	2.6
6	2.1	2.6	2.7	2.7	2.6	2.5	2.5	2.4	1.9	2.3	2.6	2.6
7	1.5	1.5	1.5	1.6	1.5	1.2	1.0	1.2	1.2	1.2	1.5	1.5
8	2.9	3.9	4.0	4.3	4.3	4.1	3.9	3.5	2.6	3.2	3.7	3.9

DESCRIPTION OF ALTERNATIVES

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

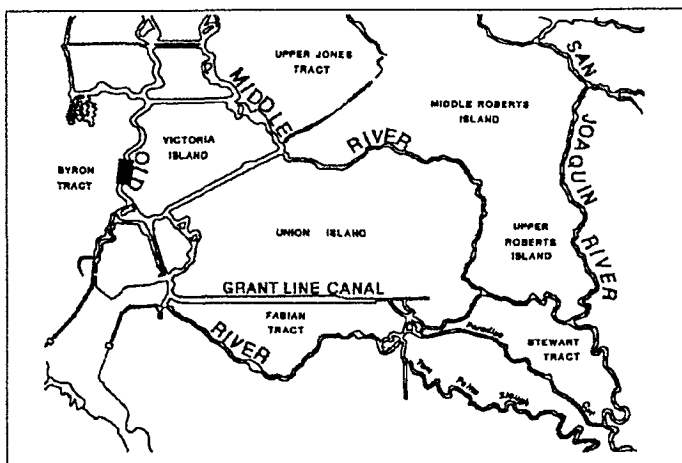

TABLE C-20 (cont.)

PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

OLD RIVER JUST UPSTREAM OF HIGHWAY 4

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.6	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.9	0.9
1	0.7	0.8	0.8	0.9	0.7	0.8	0.7	0.8	0.8	0.7	0.7	0.8
2	0.6	0.8	0.8	0.9	0.7	0.7	0.6	0.7	0.7	0.5	0.6	0.6
3	0.5	0.9	1.0	1.0	0.6	0.6	0.6	0.7	0.7	0.6	0.6	0.6
4	1.4	1.3	1.1	0.9	0.9	0.7	0.6	0.7	0.7	0.6	0.6	0.6
5	0.9	0.9	1.0	1.0	0.9	1.0	0.9	0.9	0.9	0.9	1.0	1.0
6	0.7	0.9	1.0	1.0	0.9	0.9	1.0	0.9	0.9	0.9	0.9	1.0
7	0.9	1.2	1.2	1.2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8	2.4	2.3	2.1	1.9	1.9	1.8	1.8	1.5	1.4	1.4	1.5	1.7

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.8	0.7	0.8	0.6	0.6	0.6	0.8	1.0	1.0	0.9	0.9	0.9
1	0.8	0.7	0.8	0.7	0.7	0.7	0.6	0.8	0.8	0.7	0.7	0.7
2	0.7	0.7	0.8	0.7	0.7	0.6	0.6	0.7	0.7	0.6	0.6	0.6
3	0.6	0.9	1.0	0.9	0.6	0.5	0.6	0.7	0.7	0.6	0.6	0.6
4	0.9	1.3	0.9	1.3	1.1	1.3	1.1	0.7	0.7	0.6	0.6	0.6
5	1.0	0.9	1.0	0.9	0.9	0.8	0.8	0.9	0.9	0.9	1.0	1.0
6	0.9	0.9	1.0	0.9	0.9	0.7	0.8	0.9	0.9	0.9	0.9	0.9
7	0.9	1.2	1.2	1.2	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9
8	2.0	2.3	2.0	2.3	2.1	2.3	2.1	1.5	1.5	1.5	1.5	1.6

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.6	0.6	0.8	0.6	0.8	0.8	1.0	0.9	0.8	0.9	0.9
1	0.7	0.8	0.7	0.9	0.9	0.8	0.6	0.8	0.8	0.7	0.9	0.9
2	0.7	0.8	0.7	0.9	0.9	0.8	0.7	0.7	0.7	0.6	0.9	0.9
3	0.9	0.9	0.9	1.0	1.0	0.9	0.6	0.7	0.7	0.6	1.0	1.0
4	1.2	1.1	1.3	1.0	1.0	0.9	1.1	0.7	0.7	0.6	0.9	0.9
5	0.9	1.0	0.9	1.1	1.1	1.0	0.8	0.9	0.9	0.9	1.0	1.1
6	0.9	1.0	0.9	1.1	1.1	1.0	0.9	0.9	0.9	0.9	1.0	1.1
7	1.2	1.2	1.2	1.3	1.3	1.2	0.9	1.0	0.9	0.9	1.2	1.3
8	2.2	2.1	2.2	2.0	2.0	1.9	2.1	1.5	1.5	1.7	1.5	1.8

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.6	0.8	0.9	0.9	0.8	0.9	0.9	0.7	0.8	0.7
1	0.7	0.8	0.8	0.9	1.0	0.9	0.8	0.8	0.8	0.7	0.8	0.8
2	0.7	0.8	0.8	0.9	1.0	0.9	0.8	0.7	0.7	0.6	0.8	0.8
3	0.9	0.9	1.0	1.0	1.1	1.0	1.0	0.7	0.7	0.6	0.9	0.9
4	1.4	1.3	1.1	0.9	1.1	0.9	0.9	0.7	0.7	0.6	0.9	1.0
5	0.9	0.9	1.0	1.0	1.2	1.1	1.0	0.9	0.9	0.9	1.0	1.0
6	0.9	0.9	1.0	1.0	1.2	1.1	1.0	0.9	0.9	0.9	1.0	1.0
7	1.2	1.2	1.2	1.2	1.4	1.2	1.2	0.9	0.9	0.9	1.2	1.2
8	2.3	2.3	2.1	1.9	2.2	2.0	2.0	1.5	1.5	1.7	1.6	2.1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.2	1.0	0.7	0.6	0.7	1.2	1.2	1.0	1.2	1.0	0.8	0.8
1	1.1	0.9	0.8	0.8	0.8	1.0	1.1	0.8	1.0	0.9	0.9	0.9
2	1.1	0.9	0.8	0.8	0.8	1.0	1.1	0.8	0.9	0.7	0.9	0.9
3	1.2	1.0	0.9	0.9	1.0	1.3	1.3	0.7	1.0	0.8	1.0	1.0
4	1.2	1.0	0.9	1.5	1.6	2.0	1.6	0.8	0.9	0.8	0.9	0.9
5	1.1	1.0	1.0	0.9	1.0	1.2	1.3	0.9	1.0	0.9	1.0	1.0
6	1.1	1.0	1.0	0.9	1.0	1.2	1.3	1.0	0.9	0.9	1.0	1.0
7	1.3	1.2	1.2	1.2	1.3	1.4	1.5	1.0	1.0	1.0	1.2	1.2
8	1.3	1.8	1.9	2.4	2.4	2.6	2.5	1.7	1.0	1.3	1.5	1.9

MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.2	2.1	2.2	2.0	2.0	1.9	1.9	1.7	1.7	1.8	1.7	1.7
1	2.4	2.4	2.3	2.4	2.4	2.4	2.4	2.4	2.3	1.8	2.1	2.2
2	2.3	2.4	2.3	2.4	2.4	2.3	2.3	2.3	2.2	1.7	2.1	2.1
3	1.5	1.7	1.7	1.7	1.5	1.5	1.5	1.4	1.5	1.6	1.5	1.5
4	1.5	1.7	1.7	1.7	1.6	1.5	1.5	1.5	1.5	1.6	1.6	1.5
5	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.5	2.6
6	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.5	2.5	2.5	2.5	2.6
7	1.2	1.5	1.4	1.4	1.3	1.3	1.2	1.3	1.3	1.3	1.3	1.2
8	1.3	1.4	1.4	1.4	1.3	1.3	1.2	1.3	1.3	1.3	1.3	1.3

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.9	2.2	2.0	2.2	2.2	2.2	2.0	1.7	1.7	1.8	1.7	1.7
1	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.4	2.4	2.2	2.0	2.1
2	2.3	2.4	2.4	2.4	2.3	2.4	2.4	2.3	2.3	2.1	2.0	2.0
3	1.5	1.7	1.7	1.7	1.5	1.6	1.6	1.5	1.5	1.6	1.6	1.5
4	1.5	1.7	1.7	1.7	1.5	1.6	1.6	1.5	1.5	1.6	1.6	1.5
5	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.6	2.6	2.6	2.5	2.5
6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.5	2.5	2.6	2.5	2.5
7	1.2	1.6	1.4	1.6	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.2
8	1.3	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.2	2.2	2.2	2.1	2.2	1.8	2.0	1.7	1.8	2.0	1.7	1.8
1	2.4	2.4	2.4	2.3	2.3	2.4	2.5	2.4	2.4	2.5	2.2	2.4
2	2.4	2.4	2.4	2.3	2.3	2.4	2.3	2.2	2.3	2.4	2.2	2.4
3	1.7	1.7	1.7	1.6	1.6	1.7	1.5	1.4	1.5	1.6	1.7	1.7
4	1.7	1.7	1.7	1.6	1.7	1.7	1.6	1.4	1.5	1.6	1.7	1.7
5	2.7	2.7	2.7	2.7	2.7	2.7	2.8	2.6	2.6	2.7	2.6	2.6
6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.5	2.5	2.7	2.6	2.6
7	1.6	1.5	1.6	1.4	1.4	1.4	1.2	1.2	1.3	1.3	1.5	1.4
8	1.5	1.4	1.4	1.4	1.4	1.5	1.3	1.3	1.3	1.4	1.5	1.4

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.2	2.1	2.2	1.9	2.0	1.8	2.0	1.8	1.8	2.1	1.9	2.1
1	2.4	2.4	2.3	2.4	2.1	2.2	2.4	2.4	2.4	2.4	2.3	2.4
2	2.4	2.4	2.3	2.4	2.1	2.2	2.4	2.3	2.3	2.3	2.3	2.4
3	1.7	1.7	1.7	1.7	1.5	1.7	1.7	1.5	1.5	1.6	1.7	1.7
4	1.7	1.7	1.7	1.7	1.5	1.7	1.7	1.5	1.5	1.6	1.8	1.7
5	2.7	2.7	2.7	2.7	2.6	2.7	2.7	2.6	2.6	2.7	2.6	2.7
6	2.7	2.7	2.7	2.7	2.6	2.7	2.7	2.6	2.6	2.6	2.6	2.7
7	1.6	1.5	1.4	1.4	1.3	1.4	1.4	1.3	1.3	1.3	1.5	1.5
8	1.4	1.4	1.4	1.4	1.3	1.5	1.4	1.3	1.4	1.3	1.5	1.5

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.5	1.7	2.0	2.2	2.1	1.7	1.6	1.6	1.5	1.7	1.7	1.9
1	2.0	2.4	2.4	2.4	2.4	2.2	1.9	2.4	1.5	2.1	2.2	2.4
2	2.0	2.4	2.4	2.4	2.4	2.2	1.9	2.2	1.3	2.0	2.2	2.4
3	1.5	1.7	1.7	1.7	1.6	1.3	1.2	1.3	1.2	1.3	1.7	1.7
4	1.5	1.7	1.7	1.7	1.6	1.3	1.2	1.3	1.2	1.3	1.7	1.7
5	2.1	2.7	2.7	2.7	2.7	2.6	2.5	2.6	2.0	2.4	2.6	2.7
6	2.1	2.7	2.7	2.7	2.7	2.6	2.5	2.5	1.9	2.3	2.6	2.7
7	1.4	1.4	1.5	1.5	1.5	1.1	1.0	1.1	1.1	1.2	1.5	1.4
8	1.4	1.5	1.5	1.4	1.3	1.1	1.0	1.1	1.1	1.2	1.5	1.4

DESCRIPTION OF ALTERNATIVES

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

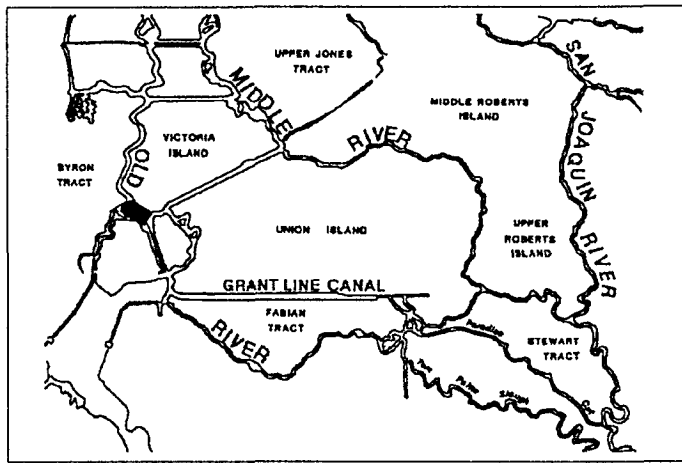

TABLE C-20 (cont.)

PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

OLD RIVER JUST DOWNSTREAM OF NORTH END OF WEST CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.5	0.5	0.5	0.6	0.5	0.6	0.6	0.7	0.7	0.6	0.6	0.6
1	0.5	0.5	0.6	0.6	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5
2	0.3	0.5	0.6	0.6	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3
3	0.3	0.7	0.7	0.7	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3
4	1.0	1.1	0.8	0.7	0.7	0.6	0.3	0.5	0.4	0.3	0.3	0.3
5	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
6	0.5	0.7	0.8	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
7	0.7	1.0	1.0	1.0	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.7
8	2.0	1.9	1.8	1.6	1.6	1.5	1.5	1.3	1.2	1.2	1.3	1.4

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.6	0.5	0.6	0.4	0.4	0.4	0.6	0.7	0.7	0.6	0.6	0.6
1	0.5	0.5	0.6	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.5
2	0.3	0.5	0.6	0.5	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3
3	0.3	0.6	0.7	0.6	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3
4	0.7	1.1	0.7	1.1	0.8	0.9	0.8	0.5	0.5	0.3	0.3	0.3
5	0.7	0.7	0.8	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.7
6	0.6	0.7	0.8	0.7	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6
7	0.7	0.9	1.0	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
8	1.6	1.9	1.7	1.9	1.7	1.9	1.7	1.3	1.3	1.3	1.2	1.3

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.4	0.5	0.4	0.6	0.4	0.6	0.6	0.7	0.7	0.5	0.6	0.6
1	0.5	0.5	0.5	0.6	0.6	0.6	0.4	0.5	0.5	0.4	0.6	0.6
2	0.5	0.5	0.5	0.6	0.6	0.6	0.3	0.4	0.4	0.3	0.6	0.6
3	0.7	0.7	0.7	0.7	0.7	0.7	0.3	0.5	0.4	0.3	0.7	0.7
4	0.9	0.8	1.0	0.8	0.7	0.6	0.8	0.5	0.5	0.3	0.7	0.7
5	0.7	0.7	0.7	0.8	0.8	0.8	0.6	0.7	0.7	0.7	0.8	0.8
6	0.7	0.7	0.7	0.8	0.8	0.8	0.6	0.6	0.6	0.6	0.8	0.8
7	0.9	0.9	0.9	1.0	1.0	1.0	0.7	0.7	0.7	0.7	1.0	1.0
8	1.8	1.8	1.9	1.7	1.7	1.6	1.8	1.3	1.3	1.5	1.3	1.5

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.5	0.5	0.5	0.6	0.7	0.6	0.6	0.7	0.7	0.5	0.6	0.5
1	0.5	0.5	0.6	0.6	0.7	0.6	0.6	0.5	0.5	0.4	0.6	0.5
2	0.5	0.5	0.6	0.6	0.7	0.6	0.6	0.4	0.4	0.3	0.6	0.5
3	0.6	0.7	0.7	0.7	0.9	0.7	0.7	0.4	0.4	0.3	0.7	0.7
4	1.1	1.1	0.8	0.7	0.8	0.7	0.7	0.5	0.5	0.3	0.7	0.7
5	0.7	0.7	0.8	0.8	0.9	0.8	0.8	0.7	0.7	0.7	0.8	0.8
6	0.7	0.7	0.8	0.8	0.9	0.8	0.8	0.6	0.6	0.6	0.8	0.8
7	0.9	1.0	1.0	1.0	1.1	1.0	1.0	0.7	0.6	0.7	1.0	1.0
8	1.9	1.9	1.8	1.6	1.9	1.7	1.7	1.3	1.3	1.4	1.3	1.7

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.9	0.7	0.5	0.5	0.5	1.0	1.0	0.8	0.9	0.8	0.6	0.6
1	0.8	0.6	0.6	0.5	0.6	0.8	0.9	0.5	0.7	0.6	0.6	0.6
2	0.8	0.6	0.6	0.5	0.6	0.8	0.9	0.4	0.5	0.5	0.6	0.6
3	1.0	0.7	0.7	0.7	0.7	1.0	1.0	0.5	0.6	0.5	0.7	0.7
4	1.0	0.7	0.6	1.2	1.3	1.5	1.4	0.7	0.6	0.5	0.7	0.7
5	0.9	0.8	0.8	0.7	0.8	1.0	1.0	0.7	0.8	0.7	0.8	0.8
6	0.9	0.8	0.8	0.7	0.8	1.0	1.0	0.6	0.6	0.6	0.8	0.8
7	1.0	1.0	0.9	1.0	1.0	1.2	1.3	0.7	0.7	0.7	1.0	1.0
8	1.0	1.5	1.6	2.0	2.0	2.2	2.1	1.5	0.7	1.1	1.3	1.6

MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.9	1.9	1.9	1.8	1.8	1.7	1.7	1.6	1.6	1.7	1.7	1.7
1	2.5	2.5	2.6	2.6	2.6	2.5	2.6	2.6	2.5	1.7	2.3	2.4
2	2.5	2.5	2.6	2.6	2.5	2.5	2.4	2.4	2.4	1.6	2.2	2.3
3	1.4	1.4	1.4	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3
4	1.2	1.3	1.3	1.4	1.3	1.2	1.2	1.2	1.2	1.3	1.2	1.2
5	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9
6	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.8	2.8	2.8	2.8	2.8
7	1.1	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.2	1.2	1.2	1.1
8	0.9	1.1	1.1	1.1	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.7	1.9	1.8	2.0	2.0	2.0	1.8	1.6	1.6	1.6	1.5	1.7
1	2.5	2.6	2.6	2.6	2.6	2.6	2.7	2.5	2.5	2.3	2.2	2.2
2	2.5	2.6	2.6	2.6	2.5	2.5	2.6	2.4	2.4	2.2	2.1	2.2
3	1.4	1.5	1.5	1.5	1.4	1.5	1.5	1.3	1.3	1.3	1.3	1.3
4	1.2	1.4	1.3	1.4	1.2	1.3	1.3	1.2	1.2	1.3	1.3	1.2
5	3.0	3.0	3.0	3.0	3.0	3.0	3.1	2.9	2.9	2.9	2.9	2.9
6	2.9	3.0	3.0	3.0	3.0	3.0	3.0	2.8	2.8	2.9	2.8	2.8
7	1.1	1.4	1.2	1.3	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.1
8	1.0	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.0	2.0	2.0	1.9	2.0	1.7	1.8	1.6	1.6	1.8	1.7	1.7
1	2.6	2.6	2.6	2.5	2.5	2.6	2.7	2.5	2.5	2.7	2.4	2.5
2	2.6	2.6	2.6	2.5	2.5	2.6	2.5	2.4	2.4	2.5	2.4	2.5
3	1.5	1.5	1.5	1.4	1.4	1.5	1.4	1.2	1.3	1.4	1.4	1.4
4	1.4	1.4	1.4	1.3	1.3	1.4	1.2	1.1	1.2	1.3	1.4	1.4
5	3.0	3.0	3.0	3.0	3.0	3.1	3.1	2.9	2.9	3.1	2.9	3.0
6	3.0	3.0	3.0	3.0	3.0	3.1	3.0	2.8	2.8	3.0	2.9	3.0
7	1.3	1.3	1.3	1.1	1.2	1.3	1.1	1.1	1.2	1.2	1.2	1.2
8	1.1	1.1	1.1	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.1

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.9	1.9	1.9	1.7	1.8	1.6	1.8	1.6	1.7	1.8	1.7	1.9
1	2.6	2.5	2.6	2.6	2.4	2.5	2.6	2.6	2.6	2.6	2.5	2.6
2	2.6	2.5	2.6	2.6	2.4	2.5	2.6	2.5	2.5	2.5	2.5	2.6
3	1.5	1.4	1.4	1.4	1.3	1.4	1.5	1.3	1.4	1.4	1.4	1.5
4	1.4	1.3	1.3	1.3	1.2	1.4	1.4	1.2	1.2	1.3	1.4	1.4
5	3.0	3.0	3.0	3.0	3.0	3.1	3.0	3.0	3.0	3.0	2.9	3.1
6	3.0	3.0	3.0	3.0	3.0	3.1	3.0	2.9	2.9	2.9	2.9	3.1
7	1.4	1.3	1.2	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.3
8	1.1	1.1	1.1	1.1	0.9	1.1	1.1	1.0	1.1	1.0	1.1	1.1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.6	1.8	2.0	1.9	1.5	1.3	1.5	1.4	1.5	1.7	1.7
1	2.2	2.6	2.6	2.5	2.5	2.1	2.1	2.5	1.5	2.3	2.4	2.6
2	2.2	2.6	2.6	2.5	2.5	2.1	2.1	2.3	1.3	2.1	2.4	2.6
3	1.1	1.5	1.5	1.4	1.4	1.0	0.9	1.1	0.9	1.1	1.4	1.5
4	1.1	1.3	1.4	1.3	1.3	0.9	0.9	1.0	0.9	1.0	1.4	1.4
5	2.4	3.0	3.1	3.0	3.0	2.9	2.9	2.9	2.2	2.8	2.9	3.0
6	2.4	3.0	3.1	3.0	3.0	2.9	2.9	2.7	2.1	2.6	2.9	3.0
7	1.1	1.2	1.3	1.3	1.2	0.9	0.7	1.0	0.9	1.0	1.2	1.2
8	1.1	1.1	1.1	1.1	1.0	0.7	0.6	0.8	0.9	0.9	1.1	1.1

DESCRIPTION OF ALTERNATIVES

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

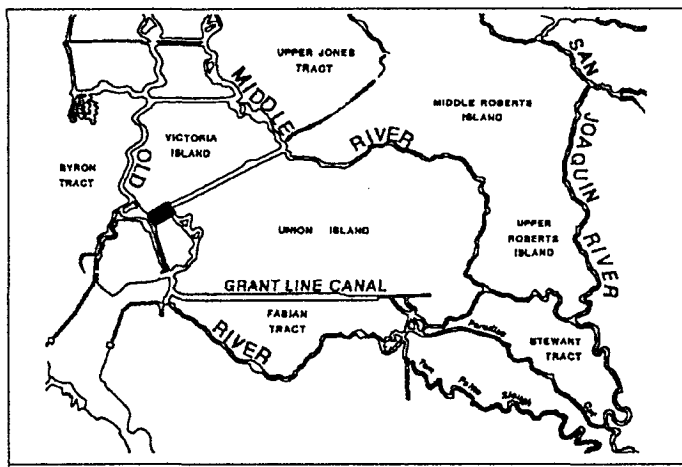

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

OLD RIVER JUST UPSTREAM OF NORTH END OF WEST CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.8
1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	1.2	1.9	2.0
2	2.0	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	1.1	1.9	2.0
3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4
4	2.5	2.5	2.3	2.0	2.0	1.7	1.5	1.5	1.4	0.8	1.2	1.4
5	2.8	2.9	2.9	2.9	2.9	2.8	2.8	2.7	2.7	2.7	2.7	2.8
6	2.8	2.9	2.9	2.9	2.9	2.8	2.8	2.7	2.6	2.6	2.7	2.7
7	0.2	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8	2.8	2.8	2.6	2.5	2.5	2.4	2.3	2.1	2.0	2.0	2.1	2.2

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.7	0.8	0.7	0.6	0.7
1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.1	2.1	1.9	1.8	1.9
2	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.0	2.0	1.8	1.7	1.9
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4
4	1.9	2.5	2.1	2.5	2.2	2.5	2.2	1.6	1.6	1.2	1.1	1.2
5	2.9	2.9	2.9	2.8	2.9	2.9	2.9	2.7	2.8	2.7	2.7	2.7
6	2.8	2.9	2.9	2.8	2.9	2.9	2.9	2.7	2.7	2.7	2.7	2.7
7	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
8	2.5	2.8	2.5	2.8	2.6	2.8	2.6	2.1	2.1	2.1	2.1	2.1

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.8	0.8	0.7
1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.1	2.1	2.2	2.0	2.1
2	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.1	2.0	2.1
3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3
4	2.5	2.5	2.5	2.1	2.0	2.1	2.2	1.5	1.5	1.7	1.3	1.6
5	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.7	2.7	2.9	2.7	2.8
6	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.7	2.7	2.8	2.7	2.8
7	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8	2.8	2.7	2.8	2.5	2.5	2.6	2.6	2.1	2.1	2.4	2.2	2.3

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.8	0.8	0.8	0.8	0.7
1	2.1	2.1	2.1	2.1	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1
2	2.1	2.1	2.1	2.1	2.0	2.0	2.1	2.0	2.0	2.1	2.1	2.1
3	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.2
4	2.5	2.5	2.3	1.9	2.0	1.8	2.1	1.6	1.6	1.5	1.3	2.3
5	2.8	2.8	2.9	2.9	3.0	3.0	2.9	2.8	2.8	2.8	2.8	2.9
6	2.8	2.8	2.9	2.9	3.0	3.0	2.9	2.8	2.8	2.8	2.8	2.9
7	0.1	0.1	0.0	0.1	*	0.0	0.1	0.1	0.1	0.1	0.1	0.0
8	2.8	2.8	2.6	2.5	2.5	2.5	2.6	2.2	2.2	2.3	2.2	2.6

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7
1	1.9	2.1	2.1	2.0	2.0	1.8	1.8	2.1	1.0	2.0	2.0	2.1
2	1.9	2.1	2.1	2.0	2.0	1.8	1.8	2.0	0.9	1.9	2.0	2.1
3	0.3	0.2	0.2	0.2	0.2	0.0	0.1	0.2	0.2	0.2	0.4	0.2
4	1.3	2.0	2.1	2.5	2.5	2.3	2.2	1.6	0.7	1.3	1.3	1.8
5	2.2	2.9	2.9	2.9	2.9	2.9	2.9	2.8	1.9	2.5	2.8	2.9
6	2.2	2.9	2.9	2.9	2.9	2.9	2.9	2.7	1.9	2.4	2.8	2.9
7	0.1	0.1	0.1	0.1	0.0	*	*	0.1	0.2	0.1	0.1	0.1
8	1.5	2.4	2.6	2.8	2.8	2.7	2.5	2.1	1.2	1.8	2.2	2.4

MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2
1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1
3	1.7	1.5	1.5	1.4	1.6	1.3	1.1	1.2	1.0	0.2	0.6	0.8
4	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
7	2.1	1.9	1.9	1.8	2.0	1.9	1.9	1.7	1.7	1.7	1.7	1.8
8	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.3	0.2
1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.2	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1
3	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.2	1.2	0.6	0.4	0.6
4	0.3	0.3	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3
5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
7	2.0	1.9	1.8	1.9	2.0	2.1	2.0	1.8	1.8	1.8	1.7	1.8
8	0.4	0.7	0.4	0.6	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3
1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.1
3	1.5	1.5	1.5	1.5	1.4	1.5	1.6	1.2	1.2	1.2	0.6	1.1
4	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2
5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
7	1.9	1.9	1.9	1.8	1.8	1.8	2.0	1.7	1.8	1.9	1.6	1.7
8	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.3
1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.1
3	1.5	1.5	1.5	1.4	1.5	1.3	1.5	1.3	1.3	1.0	0.6	1.5
4	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.2	0.2
5	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3
6	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3
7	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.7	1.9
8	0.7	0.6	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.4	0.3	0.3	0.3	0.4	0.5	0.5	0.4	0.5	0.4	0.3	0.3
1	0.3	0.2	0.1	0.2	0.2	0.3	0.3	0.1	0.2	0.2	0.1	0.1
2	0.3	0.2	0.1	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.1
3	0.9	1.4	1.4	1.5	1.5	1.5	1.5	1.3	0.4	0.9	0.7	1.3
4	0.4	0.2	0.2	0.3	0.3	0.5	0.5	0.3	0.4	0.4	0.2	0.2
5	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.3	0.3	0.3	0.3	0.3
6	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.3	0.3	0.3	0.3	0.3
7	1.2	1.7	1.8	1.9	1.9	1.9	1.8	1.8	1.0	1.6	1.6	1.8
8	0.4	0.4	0.4	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4

DESCRIPTION OF ALTERNATIVES

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

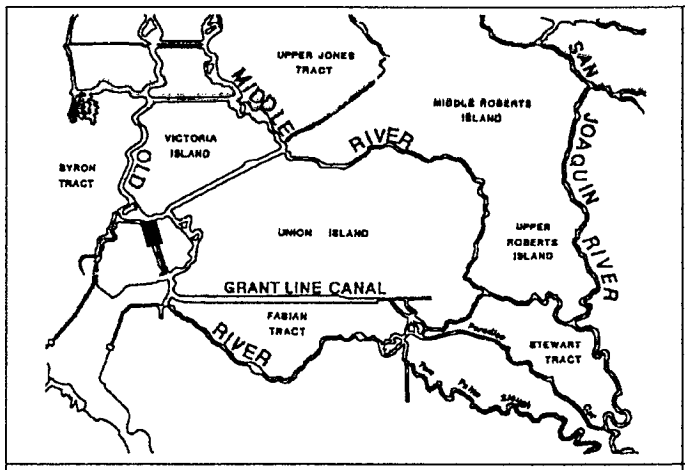

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

NORTH END OF WEST CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.9	0.8	0.6	0.7	0.7	3.3	3.3	3.3	3.1	3.2	3.1	3.1	2.9	3.0	3.2	3.1	3.1
1	1.2	1.2	1.1	0.9	0.7	0.7	0.6	0.8	0.9	0.7	0.7	0.7	2.0	2.0	2.0	2.1	2.1	2.0	2.3	2.1	2.1	2.3	2.1	2.0
2	0.6	1.2	1.1	0.9	0.3	0.2	0.2	0.5	0.4	0.2	0.2	0.2	1.9	2.0	2.0	2.1	2.0	1.9	1.9	1.8	1.8	2.0	2.0	1.9
3	0.3	0.8	0.9	0.9	0.2	0.3	0.2	0.5	0.4	0.2	0.2	0.2	1.8	2.0	2.0	2.0	1.9	1.9	1.8	1.7	1.8	2.0	1.9	1.9
4	0.3	0.7	0.8	0.8	0.2	0.2	0.2	0.5	0.4	0.1	0.2	0.2	1.8	2.0	2.0	2.0	1.9	1.9	1.9	1.7	1.8	2.0	1.9	1.9
5	2.0	2.1	2.1	1.9	1.7	1.7	1.5	1.3	1.2	1.2	1.4	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.7	1.5	1.5
6	1.9	2.1	2.1	1.9	1.8	1.8	1.8	1.6	1.4	1.4	1.5	1.7	1.3	1.5	1.5	1.5	1.5	1.4	1.3	1.4	1.5	1.5	1.4	1.4
7	1.0	1.5	1.4	1.4	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	1.3	1.4	1.4	1.5	1.4	1.4	1.3	1.4	1.4	1.4	1.4	1.3
8	1.4	1.4	1.4	1.3	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	1.3	1.4	1.5	1.5	1.4	1.4	1.3	1.4	1.5	1.5	1.4	1.4

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.7	0.5	0.6	0.5	0.4	0.4	0.6	0.9	0.9	0.7	0.7	0.7	3.1	3.3	3.1	3.4	3.4	3.3	3.1	3.0	3.0	3.1	2.6	3.1
1	0.7	1.2	0.9	1.2	0.7	0.9	0.5	0.8	0.8	0.7	0.7	0.7	2.0	2.1	2.0	2.1	2.0	2.1	2.3	2.1	2.1	2.3	2.1	2.1
2	0.3	1.2	0.9	1.2	0.3	0.5	0.3	0.4	0.4	0.2	0.2	0.2	1.9	2.1	2.0	2.1	1.9	2.0	2.0	1.8	1.8	2.0	2.0	1.9
3	0.3	0.8	0.9	0.8	0.2	0.2	0.2	0.4	0.4	0.2	0.2	0.2	1.8	2.0	2.0	2.0	1.9	1.9	1.9	1.7	1.8	2.0	1.9	1.9
4	0.2	0.7	0.8	0.7	0.3	0.2	0.2	0.5	0.4	0.2	0.2	0.2	1.8	2.0	2.0	2.0	1.9	2.0	1.9	1.8	1.8	2.0	1.9	1.9
5	1.8	2.0	2.0	2.0	1.9	1.8	1.7	1.3	1.3	1.3	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.7	1.6	1.5
6	1.9	2.0	2.0	2.0	1.9	1.8	1.8	1.5	1.5	1.5	1.5	1.6	1.4	1.5	1.5	1.5	1.4	1.5	1.4	1.4	1.5	1.5	1.5	1.4
7	1.0	1.4	1.4	1.4	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.3	1.5	1.5	1.5	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4
8	1.1	1.4	1.3	1.3	1.2	1.3	1.2	0.9	0.9	0.9	0.9	0.9	1.3	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.5	1.4	1.4

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.5	0.5	0.5	0.6	0.5	0.7	0.6	0.9	0.9	0.6	0.7	0.7	3.3	3.3	3.3	3.2	3.3	3.1	3.1	2.9	3.0	3.2	3.1	3.1
1	1.0	1.0	1.2	0.9	0.9	0.8	0.5	0.9	0.8	0.6	0.9	0.9	2.1	2.1	2.1	2.0	2.0	2.1	2.3	2.1	2.1	2.3	2.1	2.1
2	1.0	1.0	1.2	0.9	0.9	0.8	0.3	0.5	0.4	0.2	0.9	0.9	2.1	2.1	2.1	2.0	2.0	2.1	1.9	1.7	1.8	2.0	2.1	2.1
3	0.8	0.8	0.8	0.9	0.9	0.8	0.2	0.5	0.4	0.2	0.8	0.9	2.1	2.0	2.0	1.9	1.9	2.1	1.9	1.7	1.8	2.0	2.1	2.0
4	0.7	0.7	0.7	0.9	0.9	0.7	0.2	0.5	0.5	0.2	0.8	0.8	2.1	2.0	2.0	1.9	2.0	2.1	1.9	1.7	1.8	2.0	2.1	2.0
5	1.9	1.9	2.0	2.1	2.0	1.8	1.7	1.3	1.3	1.5	1.5	1.8	1.6	1.6	1.5	1.5	1.5	1.6	1.7	1.7	1.7	1.7	1.6	1.5
6	1.9	1.9	2.0	2.1	2.0	1.8	1.9	1.6	1.5	1.6	1.5	1.8	1.6	1.6	1.5	1.5	1.5	1.6	1.4	1.4	1.5	1.5	1.6	1.5
7	1.4	1.4	1.4	1.5	1.5	1.4	1.0	0.9	0.9	0.9	1.4	1.4	1.5	1.5	1.5	1.4	1.4	1.6	1.3	1.3	1.4	1.5	1.6	1.5
8	1.3	1.3	1.3	1.4	1.4	1.3	1.2	0.9	0.9	0.9	1.3	1.4	1.5	1.5	1.5	1.4	1.4	1.6	1.4	1.4	1.4	1.5	1.6	1.5

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.5	0.6	0.6	0.7	0.9	0.8	0.6	0.8	0.8	0.5	0.6	0.5	3.3	3.3	3.3	3.0	3.0	3.0	3.1	3.0	3.1	3.2	3.2	3.3
1	1.3	1.3	1.1	0.9	1.2	1.0	0.8	0.8	0.8	0.6	0.8	0.9	2.1	2.0	2.0	2.0	1.8	2.1	2.1	2.1	2.1	2.3	2.2	2.1
2	1.3	1.3	1.1	0.9	1.2	1.0	0.8	0.4	0.4	0.2	0.8	0.9	2.1	2.0	2.0	2.0	1.8	2.1	2.1	1.9	1.9	2.0	2.2	2.1
3	0.8	0.8	0.9	0.9	1.1	0.9	0.8	0.4	0.4	0.2	0.8	0.8	2.0	2.0	2.0	2.0	1.7	2.0	2.0	1.8	1.8	2.0	2.1	2.1
4	0.7	0.7	0.8	0.8	1.1	0.9	0.8	0.4	0.4	0.2	0.8	0.7	2.0	2.0	2.0	2.0	1.7	2.0	2.0	1.8	1.8	2.0	2.1	2.1
5	2.0	2.1	2.1	1.9	2.5	2.2	2.0	1.4	1.4	1.5	1.6	1.9	1.5	1.5	1.5	1.5	1.3	1.6	1.5	1.7	1.7	1.7	1.6	1.6
6	2.0	2.1	2.1	1.9	2.5	2.2	2.0	1.5	1.5	1.6	1.6	1.9	1.5	1.5	1.5	1.5	1.3	1.6	1.5	1.5	1.5	1.5	1.6	1.6
7	1.5	1.5	1.4	1.4	1.7	1.4	1.4	0.9	0.9	0.9	1.4	1.4	1.5	1.4	1.4	1.5	1.2	1.5	1.5	1.5	1.5	1.4	1.6	1.5
8	1.4	1.4	1.4	1.4	1.6	1.4	1.3	0.9	0.9	0.9	1.3	1.3	1.5	1.4	1.5	1.5	1.2	1.5	1.5	1.5	1.5	1.5	1.6	1.5

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	0.9	0.6	0.6	0.7	1.4	1.4	1.0	1.2	1.0	0.7	0.7	2.5	3.0	3.2	3.3	3.3	2.5	2.3	2.8	2.6	2.8	3.2	3.1
1	1.4	1.0	0.8	1.3	1.4	1.9	1.8	0.8	1.2	1.0	0.9	0.9	1.7	2.0	2.2	2.0	1.9	1.3	1.1	2.0	1.8	2.0	2.1	2.1
2	1.4	1.0	0.8	1.3	1.4	1.9	1.8	0.6	0.9	0.6	0.9	0.9	1.7	2.0	2.2	2.0	1.9	1.3	1.1	1.5	1.4	1.6	2.1	2.1
3	1.4	0.9	0.8	0.9	1.0	1.5	1.5	0.5	0.8	0.6	0.8	0.9	1.6	2.0	2.1	1.9	1.9	1.2	1.1	1.5	1.4	1.5	2.1	2.0
4	1.3	0.9	0.7	0.8	0.9	1.4	1.5	0.6	0.8	0.6	0.8	0.8	1.6	2.0	2.1	1.9	1.9	1.2	1.1	1.5	1.4	1.5	2.1	2.0
5	1.5	1.7	1.7	2.2	2.3	2.8	2.8	1.4	1.4	1.3	1.5	1.9	1.5	1.6	1.6	1.5	1.4	0.9	0.7	1.7	1.7	1.7	1.6	1.5
6	1.5	1.7	1.7	2.2	2.3	2.8	2.8	1.9	1.0	1.5	1.5	1.9	1.5	1.6	1.6	1.5	1.4	0.9	0.7	1.2	1.3	1.3	1.6	1.5
7	1.5	1.4	1.3	1.5	1.6	1.8	2.0	1.0	1.0	1.0	1.4	1.4	1.5	1.6	1.6	1.4	1.3	0.9	0.7	1.2	1.2	1.2	1.6	1.5
8	1.4	1.3	1.2	1.5	1.6	1.9	1.9	1.0	1.0	1.0	1.3	1.4	1.5	1.6	1.6	1.4	1.3	0.9	0.7	1.2	1.2	1.3	1.6	1.5

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

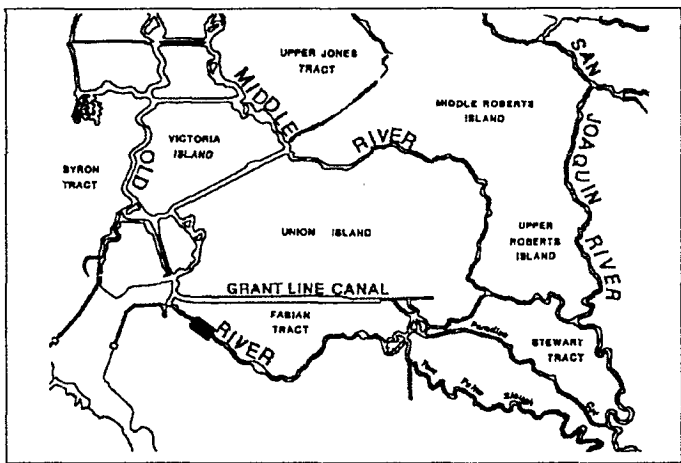

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

OLD RIVER UPSTREAM OF DMC INTAKE

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.0	1.1	1.1	1.0	0.9	0.8	0.8	0.7	0.7	0.8	0.8	0.8
1	0.1	1.0	0.9	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	1.0	0.9	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
3	0.1	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1
4	0.1	0.8	0.9	0.9	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1
5	0.1	1.4	1.4	1.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6	0.1	1.4	1.4	1.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
7	0.1	0.8	0.8	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8	0.1	1.0	1.0	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.9	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.8	0.8	0.9	0.8
1	0.1	1.0	0.9	1.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	1.0	0.9	1.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
3	0.1	0.8	0.9	0.8	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
4	0.1	0.8	0.9	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5	0.1	1.4	1.4	1.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6	0.1	1.4	1.4	1.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
7	0.1	0.8	0.8	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
8	0.1	1.0	0.9	1.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.0	1.0	1.0	1.0	1.0	0.8	0.9	0.8	0.7	0.7	0.8	0.8
1	0.9	0.9	1.0	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.9	0.9
2	0.9	0.9	1.0	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.9	0.9
3	0.8	0.9	0.9	0.9	0.9	0.9	0.1	0.1	0.1	0.1	0.9	0.9
4	0.8	0.8	0.8	0.9	0.9	0.8	0.1	0.1	0.1	0.1	0.9	0.9
5	1.4	1.4	1.4	1.4	1.4	1.3	0.1	0.1	0.1	0.1	1.2	1.3
6	1.4	1.4	1.4	1.4	1.4	1.3	0.1	0.1	0.1	0.1	1.2	1.3
7	0.8	0.8	0.8	0.8	0.8	0.7	0.1	0.1	0.1	0.1	0.8	0.8
8	1.0	1.0	1.0	1.0	0.9	0.8	0.1	0.1	0.1	0.1	0.7	0.8

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.0	1.1	1.1	1.0	1.2	1.0	1.0	0.7	0.7	0.8	0.8	1.0
1	1.0	1.0	0.9	0.9	1.0	0.9	0.9	0.1	0.1	0.1	0.9	0.9
2	1.0	1.0	0.9	0.9	1.0	0.9	0.9	0.1	0.1	0.1	0.9	0.9
3	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.1	0.1	0.1	0.9	0.9
4	0.8	0.8	0.9	0.9	1.0	0.9	0.9	0.1	0.1	0.1	0.9	0.8
5	1.4	1.4	1.4	1.4	1.6	1.5	1.4	0.1	0.1	0.1	1.2	1.4
6	1.4	1.4	1.4	1.4	1.6	1.5	1.4	0.1	0.1	0.1	1.2	1.4
7	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.1	0.1	0.1	0.8	0.8
8	1.0	1.0	1.0	0.9	1.1	1.0	0.9	0.1	0.1	0.1	0.7	0.9

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.8	0.8	0.9	1.1	1.1	1.3	1.3	0.9	0.8	0.9	0.8	0.9
1	0.9	0.9	0.9	1.1	1.1	1.3	1.2	0.1	0.1	0.1	0.9	0.9
2	0.9	0.9	0.9	1.1	1.1	1.3	1.2	0.1	0.1	0.1	0.9	0.9
3	0.9	0.9	0.9	0.9	1.0	1.1	1.1	0.1	0.1	0.1	0.9	0.9
4	0.8	0.8	0.8	0.8	0.9	1.0	1.1	0.1	0.1	0.1	0.9	0.9
5	0.9	1.3	1.3	1.5	1.5	1.7	1.7	0.1	0.1	0.1	1.2	1.4
6	0.9	1.3	1.3	1.5	1.5	1.7	1.7	0.1	0.1	0.1	1.2	1.4
7	0.8	0.8	0.7	0.8	0.9	1.0	1.0	0.1	0.1	0.1	0.8	0.8
8	0.8	0.8	0.8	1.1	1.1	1.2	1.2	0.1	0.1	0.1	0.7	0.9

MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.9	0.9	0.9	0.8	0.8
1	0.9	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	0.9	0.9	0.9
2	0.8	0.8	0.8	0.9	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8
3	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.7
4	0.7	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.7
5	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9
7	0.8	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.8
8	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.8

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8
1	0.8	0.9	0.8	0.8	0.9	0.9	0.9	1.0	1.0	0.9	0.9	0.9
2	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
3	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.7
4	0.7	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.7
5	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	0.8	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8
8	0.8	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.9	0.9	0.8

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8
1	0.9	0.9	0.9	0.8	0.8	0.9	0.9	1.0	1.0	0.9	0.9	0.8
2	0.9	0.9	0.9	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.9	0.8
3	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.9	0.8
4	0.8	0.8	0.8	0.8	0.8	0.9	0.7	0.8	0.8	0.8	0.9	0.8
5	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9
6	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.8	0.9	0.9	1.0	0.9
7	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.9	0.9	0.9
8	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.9	1.0	0.9

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8
1	0.9	0.8	0.8	0.9	0.8	0.9	0.8	1.0	1.0	0.9	0.9	0.9
2	0.9	0.8	0.8	0.9	0.8	0.9	0.8	0.8	0.8	0.8	0.9	0.9
3	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8
4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
5	0.9	0.9	0.9	0.9	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.0
6	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	1.0	1.0
7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9
8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.9	0.8	0.8	0.8	0.7	0.8	0.7	0.8	0.9	0.9	0.9	0.8
1	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.9	1.0	1.0	0.9	0.9
2	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.8	0.7	0.9	0.9
3	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.9	0.8
4	0.9	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.9	0.8
5	0.9	1.0	1.0	0.9	0.9	0.8	0.8	1.0	1.0	1.0	1.0	1.0
6	0.9	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.8	0.8	1.0	1.0
7	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.7	0.8	0.8	1.0	0.9
8	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.7	0.8	0.8	1.0	0.9

DESCRIPTION OF ALTERNATIVES

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

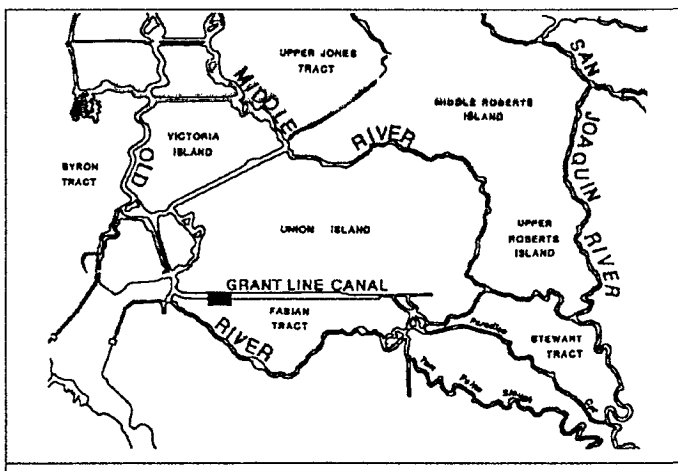

TABLE C-20 (cont.)

PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

WEST END OF GRANT LINE CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.4	1.4	1.4	1.2	1.1	1.2	1.2	1.2	1.1	1.2	1.2	1.2	0.9	0.8	0.8	1.0	1.1	1.0	0.9	1.0	1.1	1.1	1.1	1.0
1	1.6	1.4	1.3	1.3	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.5	0.9	0.9	0.9	1.0	1.0	1.0	1.2	1.2	1.3	1.2	1.0	0.9
2	0.9	1.4	1.3	1.3	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	1.0	1.0	0.9	0.8	0.9	1.0	1.0	0.9	0.9
3	0.9	1.3	1.3	1.3	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.9	1.0	0.9	0.9	0.8
4	0.9	1.3	1.3	1.2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.9	1.0	0.9	0.9	0.8
5	1.6	1.5	1.4	1.1	1.3	1.3	1.1	1.2	1.2	1.2	1.3	1.3	1.0	1.0	1.0	1.1	1.2	1.1	1.3	1.3	1.3	1.3	1.2	1.1
6	0.8	1.5	1.4	1.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.0	0.9	1.0	1.1	1.1	1.1	1.0
7	0.9	1.2	1.2	1.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.0	1.1	1.0	1.0	0.9	1.0	1.1	1.1	1.0	0.9
8	0.8	1.2	1.1	1.1	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.0	0.9	1.0	1.1	1.1	1.1	1.0

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.2	1.4	1.3	1.4	1.3	1.3	1.2	1.1	1.1	1.2	1.2	1.2	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.0
1	1.5	1.3	1.3	1.3	1.4	1.4	1.2	1.3	1.3	1.3	1.4	1.5	0.9	1.0	0.9	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.1	1.0
2	0.8	1.3	1.3	1.3	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.0	0.9	1.0	0.9	1.0	0.9	1.0	1.0	1.0	1.0	0.9
3	0.8	1.2	1.3	1.2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.9	0.8	0.9	0.9	0.9	0.9	0.8
4	0.8	1.2	1.3	1.2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.8
5	1.3	1.3	1.3	1.3	1.3	1.4	1.2	1.2	1.2	1.2	1.3	1.3	1.0	1.1	1.0	1.1	1.1	1.1	1.3	1.3	1.3	1.3	1.2	1.1
6	0.8	1.3	1.3	1.3	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.1	1.0	1.1	1.0	1.1	1.0	1.1	1.1	1.1	1.1	1.0
7	0.8	1.1	1.1	1.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0
8	0.8	1.1	1.1	1.1	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.9	1.1	1.0	1.1	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.0

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.3	1.4	1.4	1.5	1.2	1.2	1.2	1.1	1.1	1.2	1.3	1.0	1.0	0.9	0.8	0.8	1.0	0.9	1.0	1.1	1.1	1.0	0.9
1	1.2	1.3	1.3	1.3	1.3	1.2	1.2	1.3	1.3	1.3	1.2	1.3	1.0	1.0	1.0	0.9	0.9	1.1	1.2	1.2	1.2	1.2	1.1	0.9
2	1.2	1.3	1.3	1.3	1.3	1.2	0.8	0.8	0.8	0.8	1.2	1.3	1.0	1.0	1.0	0.9	0.9	1.1	0.9	0.9	1.0	1.0	1.1	0.9
3	1.2	1.2	1.3	1.3	1.3	1.2	0.8	0.8	0.8	0.8	1.2	1.3	1.0	1.0	0.9	0.8	0.8	1.0	0.8	0.9	0.9	0.9	1.0	0.9
4	1.2	1.2	1.2	1.3	1.3	1.2	0.8	0.8	0.8	0.8	1.2	1.3	1.0	1.0	0.9	0.8	0.8	1.0	0.8	0.9	0.9	0.9	1.0	0.9
5	1.3	1.3	1.4	1.4	1.3	1.1	1.2	1.2	1.2	1.1	1.1	1.2	1.1	1.1	1.1	1.0	1.0	1.2	1.3	1.3	1.3	1.3	1.2	1.0
6	1.3	1.3	1.4	1.4	1.3	1.1	0.8	0.8	0.8	0.8	1.1	1.2	1.1	1.1	1.1	1.0	1.0	1.2	1.0	1.0	1.1	1.1	1.2	1.0
7	1.1	1.1	1.1	1.2	1.2	1.1	0.8	0.8	0.8	0.8	1.1	1.2	1.1	1.1	1.0	0.9	0.9	1.1	0.9	0.9	1.0	1.1	1.2	1.0
8	1.1	1.0	1.1	1.2	1.2	1.0	0.8	0.8	0.8	0.7	1.1	1.1	1.1	1.1	1.0	0.9	1.0	1.1	0.9	1.0	1.0	1.1	1.2	1.0

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.4	1.5	1.5	1.2	1.7	1.3	1.3	1.1	1.1	1.1	1.2	1.3	0.9	0.8	0.8	0.9	0.6	0.9	0.9	1.2	1.2	1.1	1.1	0.9
1	1.4	1.4	1.3	1.3	1.6	1.3	1.3	1.3	1.3	1.3	1.2	1.3	0.9	0.9	0.9	1.0	0.6	0.9	0.9	1.2	1.3	1.2	1.1	1.0
2	1.4	1.4	1.3	1.3	1.6	1.3	1.3	0.8	0.8	0.8	1.2	1.3	0.9	0.9	0.9	1.0	0.6	0.9	0.9	1.1	1.1	1.0	1.1	1.0
3	1.3	1.3	1.3	1.3	1.6	1.3	1.3	0.8	0.8	0.8	1.2	1.3	0.9	0.8	0.9	0.9	0.6	0.9	0.9	1.0	1.0	0.9	1.0	0.9
4	1.2	1.3	1.3	1.3	1.6	1.3	1.3	0.8	0.8	0.8	1.2	1.2	0.9	0.8	0.9	0.9	0.6	0.9	0.9	1.0	1.0	0.9	1.0	0.9
5	1.4	1.5	1.4	1.2	1.6	1.4	1.3	1.2	1.1	1.1	1.1	1.3	1.0	1.0	1.0	1.1	0.7	1.0	1.0	1.3	1.3	1.3	1.2	1.1
6	1.4	1.5	1.4	1.2	1.6	1.4	1.3	0.7	0.7	0.8	1.1	1.3	1.0	1.0	1.0	1.1	0.7	1.0	1.0	1.2	1.2	1.1	1.2	1.1
7	1.2	1.2	1.2	1.1	1.4	1.2	1.1	0.8	0.8	0.8	1.1	1.1	1.0	0.9	1.0	1.0	0.6	1.0	1.0	1.1	1.1	1.0	1.1	1.1
8	1.1	1.2	1.1	1.1	1.4	1.1	1.1	0.7	0.7	0.8	1.1	1.1	1.0	0.9	1.0	1.0	0.7	1.0	1.0	1.1	1.1	1.1	1.2	1.1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.1	1.2	1.1	1.5	1.6	1.8	1.8	1.3	1.2	1.2	1.2	1.2	1.0	1.0	1.1	0.8	0.7	0.3	0.1	0.8	0.9	0.9	1.0	0.9
1	1.2	1.2	1.2	1.4	1.5	1.8	1.9	1.3	1.3	1.3	1.2	1.3	1.1	1.1	1.1	0.9	0.8	0.3	0.1	1.2	1.2	1.2	1.1	0.9
2	1.2	1.2	1.2	1.4	1.5	1.8	1.9	0.9	0.9	0.9	1.2	1.3	1.1	1.1	1.1	0.9	0.8	0.3	0.1	0.7	0.8	0.8	1.1	0.9
3	1.2	1.2	1.2	1.3	1.4	1.7	1.9	0.9	0.9	0.9	1.2	1.3	1.0	1.1	1.1	0.8	0.7	0.3	0.1	0.7	0.8	0.8	1.0	0.9
4	1.2	1.2	1.2	1.3	1.4	1.7	1.9	0.9	0.9	0.9	1.2	1.3	1.0	1.1	1.1	0.8	0.7	0.3	0.1	0.7	0.8	0.8	1.0	0.9
5	1.2	1.1	1.1	1.5	1.6	1.9	1.9	1.2	1.2	1.2	1.1	1.2	1.1	1.2	1.3	1.0	0.8	0.4	0.2	1.3	1.3	1.3	1.2	1.0
6	1.2	1.1	1.1	1.5	1.6	1.9	1.9	0.9	0.9	0.9	1.1	1.2	1.1	1.2	1.3	1.0	0.8	0.4	0.2	0.8	0.9	0.9	1.2	1.0
7	1.1	1.1	1.1	1.2	1.3	1.6	1.8	0.9	0.9	0.9	1.1	1.2	1.1	1.1	1.2	0.9	0.8	0.4	0.1	0.8	0.8	0.8	1.1	1.0
8	1.1	1.0	1.0	1.2	1.3	1.6	1.8	0.9	0.9	0.9	1.1	1.1	1.1	1.2	1.2	0.9	0.8	0.4	0.1	0.8	0.8	0.8	1.2	1.0

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

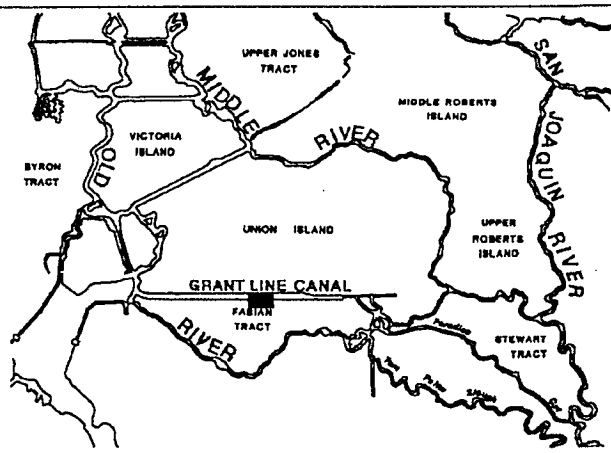

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

GRANT LINE CANAL

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.3	1.3	1.1	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.1	0.7	0.6	0.7	0.8	1.0	0.8	0.8	0.9	1.0	1.0	0.9	0.8
1	1.4	1.2	1.2	1.1	1.3	1.3	1.2	1.1	1.1	1.2	1.3	1.3	0.7	0.7	0.7	0.8	0.9	0.8	1.1	1.1	1.1	1.1	0.9	0.8
2	0.9	1.2	1.2	1.1	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.6	0.7	0.7	0.8	0.9	0.8	0.7	0.8	0.9	0.9	0.8	0.7
3	0.9	1.2	1.2	1.1	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.6	0.6	0.7	0.8	0.8	0.7	0.6	0.7	0.9	0.8	0.8	0.7
4	0.9	1.2	1.2	1.1	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.6	0.6	0.7	0.8	0.8	0.7	0.6	0.7	0.8	0.8	0.8	0.7
5	1.6	1.5	1.5	1.3	1.3	1.4	1.3	1.2	1.1	1.1	1.2	1.3	0.8	0.8	0.8	0.9	1.1	0.9	1.1	1.2	1.2	1.2	1.1	1.0
6	1.1	1.5	1.5	1.3	0.9	1.0	1.0	0.9	0.8	0.8	0.8	0.9	0.7	0.8	0.8	0.9	1.0	0.9	0.8	0.9	1.0	1.0	1.0	0.9
7	0.8	1.1	1.1	1.0	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.7	0.8	0.8	0.9	0.9	0.8	0.8	0.8	1.0	1.0	0.9	0.8
8	1.0	1.2	1.1	1.0	0.7	0.8	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.8	0.8	0.9	1.0	0.8	0.8	0.9	1.0	1.0	1.0	0.8

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.1	1.2	1.2	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.1	1.1	0.8	0.8	0.7	0.8	0.9	0.9	0.8	1.0	1.0	0.9	0.9	0.9
1	1.3	1.2	1.2	1.2	1.3	1.3	1.1	1.1	1.1	1.2	1.3	1.3	0.8	0.8	0.8	0.8	0.8	0.9	1.1	1.1	1.1	1.1	0.9	0.9
2	0.8	1.2	1.2	1.2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8
3	0.8	1.1	1.1	1.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.8	0.8	0.8	0.7
4	0.8	1.1	1.1	1.1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.7	0.8	0.8	0.8	0.8	0.7
5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.2	1.2	1.2	1.2	1.3	0.9	0.9	0.9	0.9	1.0	1.0	1.2	1.1	1.1	1.2	1.1	1.0
6	1.0	1.4	1.4	1.4	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.9	0.8	0.9	0.9	0.9	0.9	1.0	0.9	1.0	1.0	1.0	1.0	0.9
7	0.8	1.0	1.1	1.0	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.8	0.8	0.9	0.8	0.9	0.8	0.9	0.8	0.9	0.9	1.0	1.0	0.9
8	0.8	1.1	1.0	1.0	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.9	0.8	0.9	0.8	0.9	0.9	0.9	1.0	1.0	1.0	0.9

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.2	1.2	1.2	1.3	1.3	1.1	1.1	1.0	1.0	1.0	1.0	1.1	0.8	0.8	0.7	0.6	0.6	0.9	0.8	0.9	1.0	1.0	0.9	0.7
1	1.1	1.1	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.2	0.9	0.8	0.8	0.7	0.7	0.9	1.1	1.1	1.1	1.1	1.0	0.8
2	1.1	1.1	1.2	1.2	1.2	1.1	0.8	0.8	0.8	0.7	1.1	1.2	0.9	0.8	0.8	0.7	0.7	0.9	0.7	0.8	0.9	0.9	1.0	0.8
3	1.1	1.1	1.1	1.2	1.2	1.1	0.8	0.8	0.8	0.8	1.1	1.2	0.8	0.8	0.7	0.6	0.6	0.9	0.6	0.7	0.8	0.8	0.9	0.7
4	1.1	1.1	1.1	1.2	1.2	1.1	0.8	0.8	0.8	0.7	1.1	1.2	0.8	0.8	0.7	0.6	0.6	0.9	0.6	0.7	0.8	0.8	0.9	0.7
5	1.4	1.4	1.4	1.5	1.5	1.2	1.4	1.2	1.2	1.3	1.1	1.4	1.0	1.0	0.9	0.8	0.8	1.1	1.1	1.1	1.1	1.2	1.1	0.9
6	1.4	1.4	1.4	1.5	1.5	1.2	1.0	0.9	0.9	0.9	1.1	1.4	1.0	1.0	0.9	0.8	0.8	1.1	0.8	0.9	1.0	1.0	1.1	0.9
7	1.0	1.0	1.0	1.1	1.1	1.0	0.8	0.8	0.7	0.7	1.0	1.1	0.9	0.9	0.9	0.7	0.8	1.0	0.8	0.8	0.9	1.0	1.0	0.8
8	1.0	1.0	1.1	1.1	1.1	0.9	0.8	0.8	0.7	0.7	0.9	1.0	0.9	0.9	0.9	0.7	0.8	1.0	0.8	0.8	0.9	1.0	1.0	0.9

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.2	1.3	1.3	1.1	1.5	1.2	1.1	1.0	1.0	1.0	1.0	1.2	0.7	0.6	0.6	0.8	0.3	0.7	0.7	1.1	1.1	0.9	0.9	0.8
1	1.2	1.2	1.2	1.2	1.5	1.2	1.2	1.1	1.1	1.1	1.1	1.1	0.8	0.7	0.7	0.8	0.3	0.7	0.8	1.1	1.1	1.1	0.9	0.8
2	1.2	1.2	1.2	1.2	1.5	1.2	1.2	0.7	0.7	0.8	1.1	1.1	0.8	0.7	0.7	0.8	0.3	0.7	0.8	1.0	1.0	0.8	0.9	0.8
3	1.2	1.2	1.2	1.1	1.5	1.2	1.2	0.7	0.7	0.8	1.1	1.1	0.7	0.6	0.7	0.8	0.3	0.7	0.7	0.9	0.9	0.8	0.9	0.8
4	1.1	1.2	1.2	1.1	1.5	1.2	1.1	0.7	0.7	0.8	1.1	1.1	0.7	0.6	0.7	0.8	0.3	0.7	0.7	0.9	0.9	0.8	0.9	0.8
5	1.5	1.5	1.5	1.4	1.8	1.6	1.4	1.2	1.2	1.3	1.1	1.4	0.9	0.8	0.8	0.9	0.4	0.8	0.9	1.1	1.2	1.2	1.1	0.9
6	1.5	1.5	1.5	1.4	1.8	1.6	1.4	0.8	0.8	0.9	1.1	1.4	0.9	0.8	0.8	0.9	0.4	0.8	0.9	1.1	1.1	1.0	1.1	0.9
7	1.1	1.1	1.1	1.0	1.4	1.1	1.0	0.7	0.7	0.7	1.0	1.0	0.8	0.7	0.8	0.9	0.4	0.8	0.8	1.0	1.0	0.9	1.0	0.9
8	1.1	1.2	1.1	1.0	1.4	1.1	1.0	0.7	0.7	0.7	0.9	1.0	0.8	0.8	0.8	0.9	0.4	0.8	0.9	1.0	1.0	0.9	1.0	0.9

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.0	1.0	1.0	1.3	1.4	1.7	1.8	1.2	1.1	1.1	1.0	1.1	0.9	0.9	1.0	0.6	0.5	0.1	*	0.6	0.8	0.7	0.9	0.7
1	1.1	1.1	1.1	1.3	1.4	1.7	1.8	1.1	1.1	1.1	1.1	1.2	0.9	1.0	1.0	0.7	0.5	0.1	*	1.1	1.1	1.1	0.9	0.8
2	1.1	1.1	1.1	1.3	1.4	1.7	1.8	0.9	0.9	0.9	1.1	1.2	0.9	1.0	1.0	0.7	0.5	0.1	*	0.5	0.7	0.6	0.9	0.8
3	1.1	1.1	1.0	1.2	1.3	1.7	1.8	0.9	0.9	0.9	1.1	1.2	0.9	0.9	1.0	0.6	0.5	0.1	*	0.5	0.6	0.6	0.9	0.7
4	1.0	1.0	1.0	1.2	1.3	1.7	1.8	0.9	0.9	0.9	1.1	1.2	0.9	0.9	1.0	0.6	0.5	0.1	*	0.5	0.6	0.6	0.9	0.7
5	1.0	1.2	1.2	1.6	1.7	1.9	2.0	1.2	1.1	1.0	1.1	1.4	0.9	1.1	1.1	0.8	0.6	0.1	*	1.1	1.1	1.1	1.1	0.9
6	1.0	1.2	1.2	1.6	1.7	1.9	2.0	1.1	0.9	1.0	1.1	1.4	0.9	1.1	1.1	0.8	0.6	0.1	*	0.6	0.7	0.7	1.1	0.9
7	1.0	1.0	0.9	1.1	1.2	1.6	1.7	0.9	0.9	0.9	1.0	1.1	0.9	1.0	1.1	0.7	0.6	0.1	*	0.6	0.7	0.7	1.0	0.8
8	1.0	0.9	0.9	1.2	1.4	1.6	1.7	0.9	0.8	0.8	1.0	1.0	0.9	1.0	1.1	0.7	0.6	0.1	*	0.6	0.7	0.7	1.0	0.8

DESCRIPTION OF ALTERNATIVES

NA No-Action
1 Northern Intake, Barrier Configuration A
2 Northern Intake, Barrier Configuration B
3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

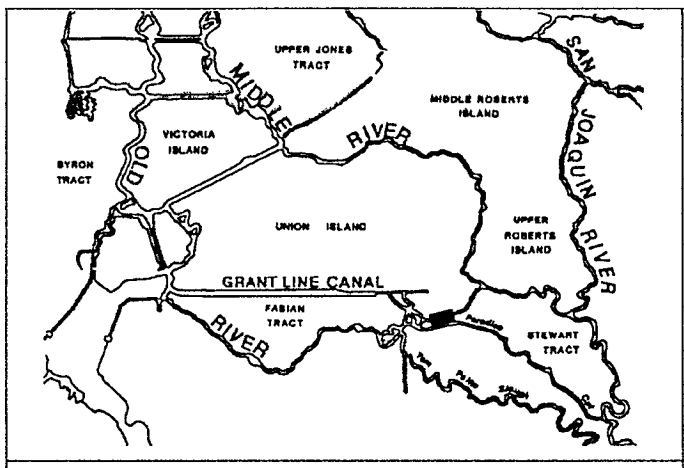

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

OLD RIVER NEAR PARADISE CUT

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.6	1.7	1.7	1.5	1.3	1.5	1.5	1.4	1.3	1.3	1.3	1.4	*	*	*	0.3	0.8	0.3	0.1	0.4	0.8	0.7	0.7	0.4
1	1.7	1.8	1.7	1.5	1.3	1.5	0.8	0.8	0.8	0.9	1.4	1.4	*	*	*	0.4	0.9	0.3	0.9	1.0	1.0	1.0	0.8	0.5
2	1.2	1.8	1.7	1.5	0.8	0.9	1.0	0.9	0.8	0.8	0.8	0.9	*	*	*	0.4	0.8	0.3	0.1	0.4	0.7	0.7	0.7	0.4
3	1.1	1.8	1.7	1.5	0.8	0.9	0.9	0.9	0.8	0.8	0.8	0.9	*	*	*	0.2	0.6	0.1	0.0	0.3	0.6	0.6	0.6	0.3
4	1.2	1.7	1.7	1.5	0.8	0.9	0.9	0.9	0.8	0.8	0.8	0.9	*	*	*	0.2	0.6	0.1	0.0	0.3	0.6	0.5	0.6	0.3
5	1.6	1.7	1.7	1.4	1.2	1.4	1.3	1.2	1.1	1.1	1.2	1.3	0.2	0.1	0.1	0.7	1.1	0.7	1.1	1.1	1.1	1.1	1.0	0.9
6	1.3	1.7	1.7	1.4	0.8	1.0	1.1	1.0	0.8	0.8	0.8	0.9	0.2	0.1	0.1	0.7	1.0	0.6	0.4	0.6	0.9	1.0	1.0	0.8
7	1.0	1.7	1.6	1.4	0.7	0.9	0.9	0.9	0.8	0.7	0.7	0.8	0.1	*	0.1	0.6	0.9	0.5	0.3	0.5	0.8	0.9	0.9	0.7
8	1.2	1.6	1.6	1.4	0.7	0.9	1.0	0.9	0.8	0.7	0.7	0.8	0.1	*	0.0	0.5	1.0	0.5	0.3	0.5	0.8	0.9	0.9	0.7

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.5	1.5	1.6	1.5	1.4	1.4	1.5	1.3	1.3	1.3	1.4	1.4	0.3	0.2	0.1	0.3	0.5	0.5	0.3	0.8	0.8	0.7	0.8	0.6
1	1.5	1.5	1.6	1.5	1.4	1.4	0.7	0.8	0.8	0.8	1.4	1.4	0.4	0.3	0.2	0.4	0.5	0.6	1.0	1.0	1.0	1.0	0.8	0.6
2	0.9	1.5	1.6	1.5	0.9	0.9	1.0	0.8	0.8	0.8	0.8	0.8	0.3	0.3	0.2	0.4	0.5	0.5	0.3	0.7	0.8	0.7	0.8	0.5
3	0.9	1.6	1.6	1.5	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.2	0.2	0.1	0.2	0.3	0.3	0.2	0.6	0.7	0.6	0.7	0.4
4	0.9	1.5	1.6	1.5	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.2	0.1	0.0	0.2	0.3	0.3	0.2	0.6	0.7	0.6	0.6	0.4
5	1.4	1.6	1.5	1.6	1.4	1.5	1.4	1.2	1.2	1.2	1.2	1.3	0.7	0.6	0.5	0.7	0.9	0.9	1.0	1.1	1.1	1.1	1.1	1.0
6	1.0	1.6	1.5	1.6	1.0	1.0	1.1	0.8	0.8	0.8	0.7	0.8	0.7	0.6	0.5	0.7	0.8	0.8	0.7	0.9	1.0	1.0	1.0	0.9
7	0.9	1.5	1.5	1.4	0.8	0.8	0.9	0.8	0.8	0.7	0.7	0.8	0.5	0.4	0.4	0.6	0.7	0.7	0.5	0.8	0.9	0.9	0.9	0.8
8	0.9	1.4	1.5	1.4	0.9	0.9	1.0	0.8	0.7	0.7	0.7	0.8	0.5	0.4	0.3	0.5	0.7	0.7	0.5	0.8	0.9	0.9	0.9	0.8

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.5	1.5	1.5	1.7	1.7	1.4	1.5	1.4	1.3	1.3	1.4	1.6	0.3	0.3	0.1	*	*	0.5	0.1	0.4	0.7	0.7	0.7	0.0
1	1.5	1.5	1.6	1.7	1.7	1.4	0.8	0.8	0.8	0.8	1.4	1.6	0.3	0.4	0.2	*	*	0.6	1.0	1.0	1.0	1.0	0.7	0.1
2	1.5	1.5	1.6	1.7	1.7	1.4	1.1	0.9	0.8	0.8	1.4	1.6	0.3	0.4	0.2	*	*	0.6	0.1	0.3	0.7	0.7	0.7	0.1
3	1.5	1.5	1.6	1.7	1.7	1.4	1.0	0.9	0.8	0.8	1.4	1.6	0.2	0.2	0.1	*	*	0.5	*	0.2	0.6	0.5	0.6	*
4	1.5	1.5	1.6	1.7	1.7	1.4	1.0	0.9	0.8	0.8	1.4	1.6	0.2	0.2	0.0	*	*	0.4	*	0.2	0.5	0.5	0.6	*
5	1.6	1.5	1.6	1.7	1.7	1.4	1.4	1.2	1.2	1.3	1.3	1.5	0.7	0.7	0.5	0.1	0.1	1.0	1.0	1.1	1.1	1.1	1.1	0.4
6	1.6	1.5	1.6	1.7	1.7	1.4	1.1	1.0	0.8	0.9	1.3	1.5	0.7	0.7	0.5	0.1	0.1	1.0	0.4	0.5	0.9	1.0	1.1	0.4
7	1.4	1.4	1.5	1.6	1.6	1.3	0.9	0.9	0.8	0.8	1.3	1.5	0.5	0.6	0.3	0.0	0.1	0.8	0.3	0.4	0.8	0.9	1.0	0.3
8	1.4	1.4	1.4	1.6	1.6	1.3	1.1	0.9	0.8	0.8	1.2	1.5	0.5	0.5	0.3	0.0	0.0	0.8	0.3	0.4	0.8	0.9	0.9	0.3

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.6	1.7	1.7	1.5	2.4	1.7	1.6	1.2	1.2	1.3	1.3	1.5	*	*	*	0.2	*	*	0.0	1.0	1.0	0.7	0.7	0.2
1	1.7	1.8	1.7	1.6	2.4	1.7	1.6	0.8	0.8	0.8	1.4	1.6	0.0	*	*	0.3	*	*	0.1	1.0	1.0	1.0	0.8	0.2
2	1.7	1.8	1.7	1.6	2.4	1.7	1.6	0.7	0.7	0.8	1.4	1.6	0.0	*	*	0.3	*	*	0.1	0.9	1.0	0.6	0.8	0.2
3	1.7	1.8	1.7	1.6	2.4	1.7	1.6	0.7	0.7	0.8	1.4	1.6	*	*	*	0.2	*	*	*	0.9	0.9	0.4	0.6	0.1
4	1.6	1.8	1.7	1.5	2.4	1.7	1.6	0.7	0.7	0.8	1.4	1.5	*	*	*	0.1	*	*	*	0.9	0.8	0.4	0.6	0.1
5	1.7	1.7	1.7	1.5	2.3	1.7	1.6	1.1	1.1	1.3	1.3	1.5	0.3	0.0	0.1	0.6	*	0.2	0.4	1.1	1.1	1.1	1.1	0.6
6	1.7	1.7	1.7	1.5	2.3	1.7	1.6	0.7	0.7	0.9	1.3	1.5	0.3	0.0	0.1	0.6	*	0.2	0.4	1.1	1.1	0.9	1.1	0.6
7	1.6	1.7	1.6	1.4	2.3	1.6	1.5	0.7	0.7	0.8	1.3	1.4	0.2	*	0.0	0.5	*	0.1	0.3	1.0	1.0	0.8	1.0	0.4
8	1.5	1.6	1.6	1.4	2.3	1.6	1.5	0.7	0.7	0.8	1.2	1.4	0.2	*	0.0	0.4	*	0.1	0.3	1.0	1.0	0.8	1.0	0.4

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.4	1.3	1.2	1.7	2.1	2.8	3.1	1.8	1.6	1.7	1.4	1.6	0.7	0.8	1.0	*	*	*	*	*	*	*	0.6	*
1	1.4	1.4	1.3	1.8	2.1	2.8	3.2	0.8	0.9	0.9	1.4	1.6	0.7	0.9	1.0	*	*	*	*	1.0	1.1	1.0	0.7	0.0
2	1.4	1.4	1.3	1.8	2.1	2.8	3.2	1.3	1.1	1.1	1.4	1.6	0.7	0.9	1.0	*	*	*	*	*	*	*	0.7	0.0
3	1.4	1.4	1.3	1.8	2.1	2.8	3.1	1.2	1.1	1.1	1.4	1.6	0.6	0.8	0.9	*	*	*	*	*	*	*	0.5	*
4	1.4	1.3	1.3	1.7	2.1	2.8	3.1	1.2	1.1	1.1	1.4	1.6	0.6	0.8	0.9	*	*	*	*	*	*	*	0.5	*
5	1.4	1.3	1.2	1.8	2.0	2.8	3.1	1.3	0.9	1.1	1.3	1.6	0.8	1.1	1.2	0.0	*	*	*	1.1	1.1	1.1	1.0	0.3
6	1.4	1.3	1.2	1.8	2.0	2.8	3.1	1.4	1.1	1.3	1.3	1.6	0.8	1.1	1.2	0.1	*	*	*	*	0.0	*	1.0	0.3
7	1.4	1.3	1.2	1.7	2.0	2.8	3.1	1.2	1.0	1.1	1.3	1.5	0.7	1.0	1.2	0.0	*	*	*	*	*	*	0.9	0.3
8	1.4	1.2	1.1	1.6	2.0	2.8	3.1	1.3	1.1	1.1	1.3	1.5	0.7	1.0	1.1	*	*	*	*	*	*	*	0.9	0.2

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

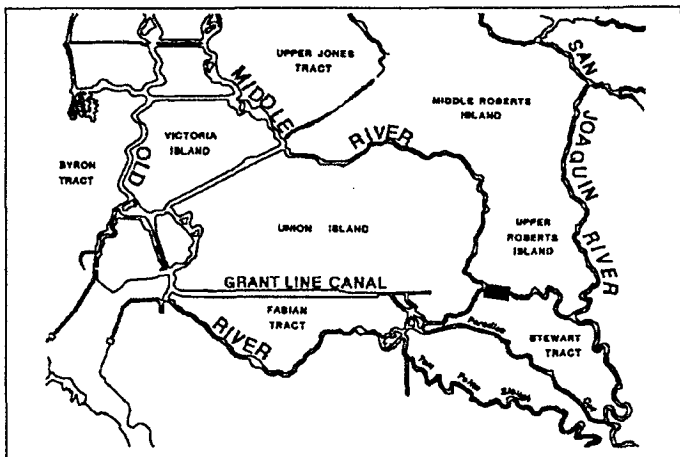

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

OLD RIVER JUST UPSTREAM OF MIDDLE RIVER

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.7	1.8	1.8	1.4	1.2	1.4	1.5	1.4	1.2	1.2	1.2	1.3	*	*	*	*	0.5	*	*	*	0.4	0.3	0.4	0.0
1	1.7	1.8	1.7	1.4	1.2	1.4	0.5	0.5	0.4	0.4	1.2	1.3	*	*	*	*	0.5	*	0.6	0.6	0.6	0.6	0.5	0.2
2	1.6	1.8	1.7	1.4	0.8	1.0	1.0	0.9	0.8	0.8	0.7	0.8	*	*	*	*	0.5	*	*	*	0.4	0.4	0.5	0.1
3	1.4	1.8	1.7	1.4	0.7	0.9	1.0	0.9	0.8	0.8	0.8	0.9	*	*	*	*	0.4	*	*	*	0.3	0.4	0.4	*
4	1.5	1.8	1.7	1.4	0.7	1.0	1.0	0.9	0.8	0.8	0.8	0.9	*	*	*	*	0.4	*	*	*	0.2	0.3	0.4	*
5	1.7	1.8	1.7	1.4	1.1	1.3	0.8	0.7	0.7	0.7	1.1	1.2	*	*	*	0.3	0.8	0.3	0.7	0.7	0.7	0.7	0.7	0.6
6	1.6	1.8	1.7	1.4	1.0	1.2	1.2	1.0	0.8	0.8	0.8	1.0	*	*	*	0.3	0.7	0.2	0.0	0.3	0.6	0.7	0.7	0.5
7	1.3	1.7	1.6	1.3	0.7	0.9	0.9	0.8	0.7	0.7	0.6	0.7	*	*	*	0.2	0.7	0.1	*	0.1	0.5	0.6	0.6	0.4
8	1.5	1.7	1.6	1.3	0.8	1.1	1.1	1.0	0.7	0.7	0.6	0.8	*	*	*	0.1	0.7	0.1	*	0.1	0.5	0.6	0.6	0.4

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.4	1.5	1.5	1.5	1.4	1.4	1.4	1.2	1.2	1.2	1.2	1.3	*	*	*	*	0.1	0.0	*	0.4	0.5	0.4	0.5	0.2
1	1.3	1.6	1.5	1.5	1.3	1.4	0.5	0.5	0.5	0.4	1.2	1.2	*	*	*	*	0.2	0.2	0.6	0.6	0.6	0.6	0.5	0.3
2	1.0	1.6	1.5	1.5	1.1	1.3	1.2	0.7	0.7	0.8	0.7	0.8	*	*	*	*	0.1	0.2	*	0.4	0.5	0.4	0.5	0.3
3	0.9	1.5	1.5	1.4	0.9	1.1	0.9	0.8	0.7	0.8	0.7	0.8	*	*	*	*	*	*	*	0.3	0.4	0.3	0.4	0.2
4	1.0	1.5	1.5	1.4	0.9	1.2	1.0	0.8	0.7	0.8	0.7	0.8	*	*	*	*	*	*	*	0.2	0.4	0.4	0.4	0.2
5	1.3	1.6	1.5	1.6	1.3	1.4	0.8	0.8	0.8	0.8	1.1	1.2	0.4	0.2	*	0.3	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.6
6	1.2	1.6	1.5	1.6	1.2	1.3	1.3	0.9	0.8	0.8	0.7	0.9	0.4	0.2	*	0.3	0.5	0.5	0.3	0.6	0.7	0.7	0.7	0.6
7	0.9	1.4	1.5	1.4	0.9	1.0	1.0	0.7	0.7	0.7	0.6	0.7	0.2	*	*	0.2	0.4	0.4	0.2	0.5	0.6	0.6	0.7	0.5
8	1.1	1.5	1.4	1.4	1.1	1.2	1.2	0.7	0.7	0.7	0.6	0.7	0.2	*	*	0.1	0.4	0.4	0.2	0.5	0.6	0.6	0.6	0.5

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.5	1.5	1.6	1.7	1.8	1.3	1.5	1.4	1.3	1.2	1.3	1.5	*	*	*	*	*	0.1	*	*	0.4	0.3	0.3	*
1	1.5	1.4	1.6	1.7	1.7	1.3	0.5	0.5	0.5	0.5	1.3	1.6	*	*	*	*	*	0.2	0.6	0.6	0.6	0.6	0.4	*
2	1.5	1.4	1.6	1.7	1.7	1.3	1.3	1.0	0.8	0.8	1.3	1.6	*	*	*	*	*	0.2	*	*	0.4	0.3	0.4	*
3	1.5	1.4	1.5	1.7	1.7	1.3	1.0	0.9	0.8	0.8	1.3	1.6	*	*	*	*	*	0.0	*	*	0.3	0.2	0.4	*
4	1.4	1.4	1.5	1.7	1.7	1.3	1.2	0.9	0.8	0.8	1.3	1.6	*	*	*	*	*	*	*	*	0.2	0.1	0.4	*
5	1.6	1.5	1.6	1.6	1.6	1.3	0.8	0.8	0.7	0.8	1.2	1.5	0.3	0.3	*	*	*	0.6	0.7	0.7	0.7	0.7	0.7	*
6	1.6	1.5	1.6	1.6	1.6	1.3	1.3	1.0	0.9	1.0	1.2	1.5	0.3	0.3	*	*	*	0.6	*	0.2	0.6	0.6	0.7	*
7	1.4	1.4	1.5	1.6	1.6	1.3	1.1	0.9	0.7	0.7	1.2	1.5	0.1	0.2	*	*	*	0.5	*	0.0	0.5	0.5	0.6	*
8	1.4	1.3	1.5	1.6	1.6	1.2	1.3	1.0	0.7	0.8	1.2	1.5	0.1	0.1	*	*	*	0.4	*	0.0	0.5	0.5	0.6	*

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.7	1.8	1.8	1.5	2.7	1.7	1.5	1.1	1.1	1.3	1.2	1.5	*	*	*	*	*	*	*	0.7	0.6	0.2	0.4	*
1	1.7	1.8	1.7	1.5	2.7	1.7	1.6	0.5	0.5	0.4	1.3	1.5	*	*	*	*	*	*	*	0.6	0.6	0.6	0.4	*
2	1.7	1.8	1.7	1.5	2.7	1.7	1.6	0.7	0.7	0.8	1.3	1.5	*	*	*	*	*	*	*	0.7	0.6	0.3	0.4	*
3	1.6	1.8	1.7	1.5	2.6	1.7	1.6	0.7	0.7	0.8	1.3	1.5	*	*	*	*	*	*	*	0.6	0.6	0.1	0.4	*
4	1.6	1.8	1.7	1.5	2.6	1.7	1.5	0.7	0.7	0.8	1.3	1.5	*	*	*	*	*	*	*	0.6	0.5	0.0	0.4	*
5	1.7	1.8	1.7	1.4	2.6	1.7	1.5	0.7	0.7	0.8	1.2	1.5	*	*	*	0.2	*	*	*	0.7	0.7	0.7	0.7	0.1
6	1.7	1.8	1.7	1.4	2.6	1.7	1.5	0.7	0.8	1.0	1.2	1.5	*	*	*	0.2	*	*	*	0.8	0.8	0.6	0.7	0.1
7	1.6	1.7	1.7	1.4	2.6	1.6	1.5	0.6	0.6	0.7	1.2	1.4	*	*	*	0.0	*	*	*	0.7	0.7	0.5	0.6	*
8	1.6	1.7	1.6	1.4	2.6	1.6	1.5	0.6	0.6	0.8	1.1	1.4	*	*	*	*	*	*	*	0.7	0.7	0.5	0.6	*

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.2	1.1	1.8	2.2	3.1	3.5	1.9	1.7	1.8	1.3	1.6	0.4	0.5	0.7	*	*	*	*	*	*	*	0.2	*
1	1.3	1.2	1.1	1.8	2.2	3.2	3.5	0.5	0.5	0.4	1.3	1.6	0.4	0.6	0.7	*	*	*	*	0.6	0.7	0.6	0.3	*
2	1.3	1.2	1.1	1.8	2.2	3.2	3.5	1.4	1.1	1.3	1.3	1.6	0.4	0.6	0.7	*	*	*	*	*	*	*	0.3	*
3	1.3	1.2	1.2	1.8	2.2	3.1	3.5	1.3	1.1	1.2	1.3	1.6	0.4	0.5	0.6	*	*	*	*	*	*	*	0.3	*
4	1.3	1.2	1.1	1.8	2.2	3.1	3.5	1.4	1.1	1.2	1.3	1.6	0.4	0.4	0.6	*	*	*	*	*	*	*	0.3	*
5	1.3	1.1	1.1	1.8	2.2	3.1	3.5	0.8	0.4	0.7	1.2	1.5	0.5	0.8	0.9	*	*	*	*	0.7	0.7	0.7	0.6	*
6	1.3	1.1	1.1	1.8	2.2	3.1	3.5	1.4	1.1	1.3	1.2	1.5	0.5	0.8	0.9	*	*	*	*	*	*	*	0.6	*
7	1.3	1.1	1.1	1.7	2.1	3.1	3.4	1.3	1.1	1.2	1.2	1.5	0.4	0.7	0.8	*	*	*	*	*	*	*	0.5	*
8	1.3	1.1	1.0	1.7	2.1	3.1	3.4	1.4	1.1	1.3	1.2	1.5	0.3	0.7	0.8	*	*	*	*	*	*	*	0.5	*

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

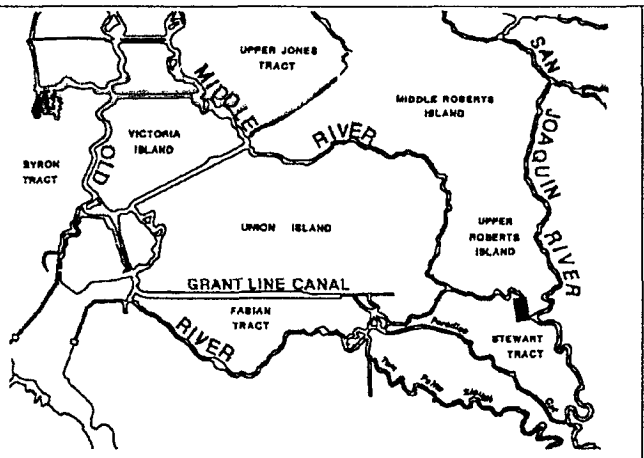

TABLE C-20 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE SOUTH DELTA

OLD RIVER NEAR HEAD

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.2	2.3	2.3	1.8	1.6	1.8	1.9	1.8	1.7	1.7	1.6	1.8	*	*	*	*	0.5	*	*	*	0.3	0.3	0.4	*
1	2.2	2.3	2.0	1.8	1.5	1.7	0.2	0.2	0.2	0.1	1.5	1.6	*	*	*	*	0.5	*	0.2	0.2	0.2	0.2	0.7	0.1
2	2.0	2.3	2.0	1.8	1.2	1.3	1.4	1.3	1.1	1.1	1.1	1.2	*	*	*	*	0.5	*	*	*	0.4	0.6	0.6	0.0
3	1.8	2.1	2.0	1.8	1.1	1.3	1.4	1.3	1.2	1.1	1.1	1.2	*	*	*	*	0.4	*	*	*	0.3	0.6	0.6	*
4	1.9	2.1	2.0	1.8	1.1	1.3	1.4	1.3	1.2	1.1	1.1	1.2	*	*	*	*	0.3	*	*	*	0.2	0.5	0.6	*
5	2.2	2.3	2.2	1.8	1.4	1.6	0.2	0.2	0.2	0.2	1.4	1.5	*	*	*	0.3	0.8	0.2	0.2	0.2	0.2	0.2	0.8	0.6
6	2.0	2.3	2.2	1.8	1.3	1.6	1.6	1.4	1.2	1.1	1.1	1.4	*	*	*	0.3	0.8	0.2	*	0.2	0.6	0.7	0.7	0.5
7	1.7	2.1	2.0	1.7	1.0	1.3	1.3	1.2	1.1	1.1	1.0	1.1	*	*	*	0.1	0.7	0.0	*	0.0	0.5	0.6	0.7	0.4
8	1.9	2.2	2.0	1.7	1.2	1.5	1.5	1.3	1.1	1.1	1.0	1.2	*	*	*	0.0	0.7	*	*	*	0.4	0.6	0.6	0.3

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.8	2.0	1.9	2.0	1.8	1.8	1.8	1.7	1.6	1.6	1.6	1.7	*	*	*	*	*	*	*	0.4	0.5	0.6	0.7	0.2
1	1.6	2.1	1.9	2.0	1.6	1.8	0.2	0.2	0.2	0.1	1.5	1.6	*	*	*	*	0.1	0.1	0.2	0.2	0.2	0.2	0.8	0.5
2	1.4	2.1	1.9	2.0	1.5	1.7	1.6	1.1	1.1	1.1	1.0	1.1	*	*	*	*	0.1	0.1	*	0.4	0.5	0.5	0.7	0.3
3	1.3	1.9	1.9	1.8	1.2	1.5	1.3	1.1	1.1	1.1	1.1	1.1	*	*	*	*	*	*	*	0.2	0.4	0.6	0.7	0.3
4	1.3	1.9	1.9	1.8	1.3	1.6	1.4	1.1	1.1	1.1	1.1	1.1	*	*	*	*	*	*	*	0.2	0.3	0.6	0.7	0.3
5	1.6	2.1	1.9	2.0	1.7	1.8	0.2	0.2	0.2	0.2	1.4	1.5	0.4	0.1	*	0.3	0.5	0.5	0.2	0.2	0.2	0.2	0.8	0.7
6	1.6	2.1	1.9	2.0	1.6	1.7	1.7	1.2	1.1	1.1	1.1	1.2	0.3	0.1	*	0.3	0.5	0.5	0.3	0.6	0.7	0.7	0.8	0.6
7	1.3	1.8	1.8	1.8	1.3	1.4	1.4	1.1	1.0	1.0	1.0	1.1	0.2	*	*	0.1	0.3	0.3	0.1	0.5	0.6	0.6	0.7	0.5
8	1.5	1.9	1.8	1.9	1.5	1.6	1.6	1.1	1.0	1.0	1.0	1.1	0.1	*	*	0.0	0.3	0.3	0.1	0.5	0.6	0.6	0.7	0.5

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.0	1.9	2.1	2.2	2.3	1.7	1.9	1.8	1.7	1.7	1.7	1.9	*	*	*	*	*	0.0	*	*	0.3	0.2	0.3	*
1	1.9	1.8	2.1	2.0	2.0	1.7	0.2	0.2	0.2	0.2	1.7	1.9	*	*	*	*	*	0.2	0.2	0.2	0.2	0.2	0.5	*
2	1.9	1.8	2.1	2.0	2.0	1.7	1.7	1.3	1.1	1.1	1.7	1.9	*	*	*	*	*	0.2	*	*	0.4	0.3	0.5	*
3	1.8	1.8	1.9	2.0	2.0	1.8	1.4	1.3	1.1	1.2	1.7	1.9	*	*	*	*	*	*	*	*	0.2	0.1	0.6	*
4	1.8	1.8	1.9	2.0	2.0	1.7	1.6	1.3	1.1	1.2	1.7	1.9	*	*	*	*	*	*	*	*	0.1	0.0	0.6	*
5	2.0	2.0	2.1	2.1	2.0	1.7	0.2	0.2	0.2	0.2	1.6	1.8	0.2	0.3	*	*	*	0.6	0.2	0.2	0.2	0.2	0.7	*
6	2.0	2.0	2.1	2.1	2.0	1.7	1.8	1.4	1.2	1.3	1.6	1.8	0.2	0.3	*	*	*	0.6	*	0.1	0.6	0.6	0.7	*
7	1.8	1.8	1.9	2.0	2.0	1.7	1.5	1.3	1.1	1.1	1.6	1.8	0.0	0.1	*	*	*	0.4	*	*	0.5	0.5	0.6	*
8	1.8	1.8	1.9	2.0	2.0	1.7	1.7	1.3	1.1	1.2	1.6	1.8	*	*	*	*	*	0.4	*	*	0.4	0.5	0.6	*

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	2.2	2.3	2.3	1.9	3.0	2.1	1.9	1.5	1.5	1.7	1.6	2.0	*	*	*	*	*	*	*	0.7	0.6	0.2	0.3	*
1	2.2	2.3	2.1	1.8	3.0	2.1	1.9	0.2	0.2	0.2	1.7	1.9	*	*	*	*	*	*	*	0.2	0.2	0.2	0.5	*
2	2.2	2.3	2.1	1.8	3.0	2.1	1.9	1.0	1.0	1.2	1.7	1.9	*	*	*	*	*	*	*	0.7	0.7	0.2	0.5	*
3	2.0	2.1	2.1	1.9	3.0	2.1	1.9	1.0	1.0	1.2	1.7	1.9	*	*	*	*	*	*	*	0.6	0.6	0.0	0.6	*
4	2.0	2.2	2.1	1.9	3.0	2.1	1.9	1.0	1.0	1.2	1.7	1.9	*	*	*	*	*	*	*	0.6	0.5	*	0.6	*
5	2.3	2.4	2.2	1.8	3.0	2.1	1.9	0.2	0.2	0.2	1.6	2.0	*	*	*	0.1	*	*	*	0.4	0.3	0.2	0.7	0.0
6	2.3	2.4	2.2	1.8	3.0	2.1	1.9	1.0	1.1	1.3	1.6	2.0	*	*	*	0.1	*	*	*	0.8	0.8	0.6	0.7	0.0
7	1.9	2.1	2.0	1.8	3.0	2.1	1.8	1.0	1.0	1.1	1.6	1.8	*	*	*	*	*	*	*	0.8	0.7	0.5	0.6	*
8	2.1	2.2	2.0	1.8	3.0	2.1	1.8	1.0	1.0	1.1	1.6	1.8	*	*	*	*	*	*	*	0.7	0.7	0.5	0.6	*

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.7	1.6	1.5	2.4	2.7	3.5	3.9	2.2	2.0	2.1	1.7	1.9	0.4	0.5	0.7	*	*	*	*	*	*	*	0.2	*
1	1.7	1.6	1.5	2.3	2.6	3.6	3.9	0.2	0.1	0.1	1.7	1.9	0.4	0.6	0.7	*	*	*	*	0.2	0.2	0.2	0.3	*
2	1.7	1.6	1.5	2.3	2.6	3.6	3.9	1.8	1.5	1.6	1.7	1.9	0.4	0.6	0.7	*	*	*	*	*	*	*	0.3	*
3	1.7	1.6	1.5	2.1	2.6	3.5	3.9	1.7	1.5	1.6	1.7	1.9	0.5	0.5	0.6	*	*	*	*	*	*	*	0.4	*
4	1.7	1.6	1.5	2.2	2.6	3.5	3.9	1.8	1.5	1.6	1.7	1.9	0.5	0.4	0.6	*	*	*	*	*	*	*	0.4	*
5	1.7	1.5	1.4	2.4	2.7	3.5	3.9	0.2	0.2	0.2	1.6	1.9	0.5	0.8	1.0	*	*	*	*	0.2	0.2	0.2	0.6	*
6	1.7	1.5	1.4	2.4	2.7	3.5	3.9	1.8	1.4	1.7	1.6	1.9	0.5	0.8	1.0	*	*	*	*	*	*	*	0.6	*
7	1.7	1.6	1.5	2.1	2.5	3.5	3.8	1.7	1.4	1.6	1.6	1.9	0.4	0.7	0.9	*	*	*	*	*	*	*	0.5	*
8	1.7	1.5	1.4	2.2	2.5	3.5	3.8	1.8	1.4	1.6	1.6	1.8	0.3	0.7	0.8	*	*	*	*	*	*	*	0.5	*

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

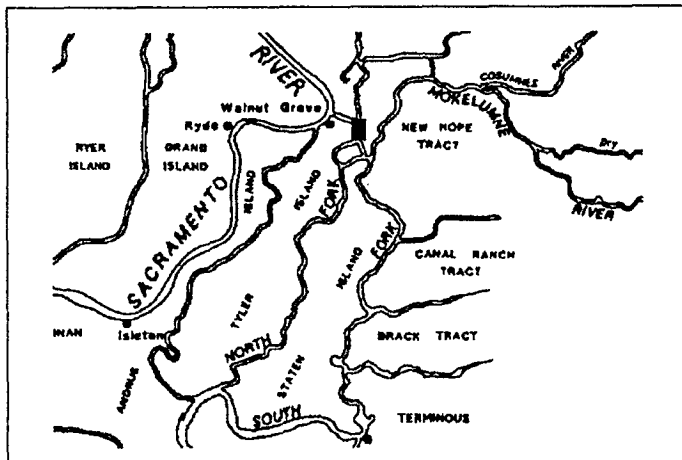

TABLE C-21
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE NORTH DELTA

SNODGRASS SLOUGH

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.7	1.8	1.7	1.6	1.7	1.6	1.7	1.6	1.6	1.7	1.6	1.6	*	*	*	*	*	0.0	*	0.1	0.0	*	0.0	0.1
1	1.8	1.8	1.7	1.6	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	*	*	*	*	*	0.0	*	0.1	0.1	*	0.0	0.1
2	1.8	1.8	1.7	1.6	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	*	*	*	*	*	0.1	*	0.1	0.1	0.0	0.1	0.1
3	1.8	1.8	1.7	1.6	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	*	*	*	*	*	0.1	*	0.1	0.1	0.0	0.1	0.2
4	1.8	1.8	1.7	1.6	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	*	*	*	*	*	0.1	*	0.1	0.1	0.0	0.1	0.2
5	1.8	1.8	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	*	*	*	*	*	0.1	*	0.1	0.1	0.0	0.1	0.1
6	1.8	1.8	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	*	*	*	*	*	0.1	0.0	0.1	0.1	0.0	0.1	0.2
7	1.8	1.8	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	*	*	*	0.0	*	0.1	0.0	0.1	0.1	0.1	0.1	0.2
8	1.8	1.8	1.7	1.6	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	*	*	*	0.0	*	0.1	0.0	0.1	0.1	0.1	0.1	0.2

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.7	1.9	1.7	0.2	1.8	1.8	1.7	1.6	1.7	1.7	1.6	1.6	*	*	*	0.2	*	*	*	*	*	*	0.1	0.1
1	1.7	1.9	1.7	0.2	1.7	1.9	1.8	1.7	1.7	1.7	1.6	1.6	*	*	*	0.2	*	*	*	*	*	*	0.0	0.1
2	1.7	1.9	1.7	0.2	1.7	1.9	1.8	1.7	1.7	1.7	1.6	1.6	*	*	*	0.2	*	*	*	*	*	*	0.1	0.2
3	1.7	1.9	1.7	0.2	1.7	1.9	1.8	1.7	1.7	1.7	1.6	1.6	*	*	*	0.2	*	*	*	*	*	*	0.1	0.2
4	1.7	1.9	1.7	0.2	1.7	1.9	1.8	1.7	1.7	1.7	1.6	1.6	*	*	*	0.2	*	*	*	*	*	*	0.1	0.2
5	1.6	1.9	1.6	0.2	1.7	1.9	1.8	1.6	1.7	1.7	1.6	1.5	*	*	*	0.2	*	*	*	*	*	*	0.1	0.2
6	1.7	1.9	1.6	0.2	1.7	1.9	1.8	1.7	1.7	1.7	1.6	1.6	*	*	*	0.2	*	*	*	*	*	*	0.1	0.2
7	1.7	1.9	1.6	0.2	1.7	1.9	1.8	1.7	1.7	1.7	1.6	1.6	*	*	*	0.2	*	*	*	*	*	*	0.1	0.2
8	1.7	1.9	1.6	0.2	1.7	1.9	1.8	1.7	1.7	1.7	1.6	1.6	*	*	*	0.2	*	*	*	*	*	*	0.1	0.2

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.7	1.8	1.8	0.1	0.1	0.1	1.7	1.7	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	*	0.1
1	1.7	1.8	1.8	0.1	0.1	0.1	1.7	1.7	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	*	0.1
2	1.7	1.8	1.8	0.1	0.1	0.1	1.7	1.7	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	*	0.1
3	1.7	1.8	1.8	0.2	0.2	0.2	1.7	1.7	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	*	0.1
4	1.7	1.8	1.8	0.1	0.1	0.1	1.7	1.7	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	*	0.1
5	1.7	1.8	1.8	0.1	0.1	0.1	1.7	1.6	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	*	0.1
6	1.7	1.8	1.8	0.1	0.1	0.1	1.7	1.7	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	*	0.1
7	1.7	1.8	1.8	0.2	0.2	0.2	1.7	1.7	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	0.0	0.1
8	1.7	1.8	1.8	0.2	0.1	0.1	1.7	1.7	1.7	1.8	1.6	1.6	*	*	*	0.2	0.2	0.2	*	*	*	*	0.0	0.1

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.6	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.9	1.8	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*
1	1.7	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.8	1.7	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*
2	1.7	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.8	1.7	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*
3	1.7	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.8	1.7	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*
4	1.7	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.8	1.7	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*
5	1.7	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.8	1.6	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*
6	1.7	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.8	1.6	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*
7	1.7	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.8	1.6	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*
8	1.7	1.8	1.8	1.8	0.1	0.1	0.1	0.1	1.8	1.8	1.6	1.7	*	*	*	*	0.2	0.2	0.2	0.2	*	*	*	*

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.5	1.7	0.2	0.1	0.1	0.1	0.1	1.8	1.8	1.7	1.6	0.7	0.3	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*
1	1.3	1.7	1.7	0.2	0.1	0.1	0.1	0.1	1.7	1.7	1.7	1.6	0.6	*	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*
2	1.3	1.7	1.7	0.2	0.1	0.1	0.1	0.1	1.7	1.7	1.7	1.6	0.6	*	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*
3	1.3	1.7	1.7	0.2	0.2	0.2	0.1	0.1	1.7	1.7	1.7	1.6	0.6	*	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*
4	1.3	1.7	1.7	0.2	0.2	0.2	0.1	0.1	1.7	1.7	1.7	1.6	0.6	*	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*
5	1.3	1.6	1.7	0.2	0.2	0.2	0.1	0.1	1.7	1.7	1.6	1.6	0.6	*	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*
6	1.3	1.6	1.7	0.2	0.2	0.2	0.1	0.1	1.7	1.7	1.6	1.6	0.6	*	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*
7	1.3	1.7	1.7	0.2	0.2	0.2	0.2	0.2	1.7	1.7	1.6	1.6	0.6	*	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*
8	1.3	1.7	1.7	0.2	0.2	0.2	0.1	0.1	1.7	1.7	1.6	1.6	0.6	*	*	0.2	0.2	0.2	0.2	0.2	*	*	*	*

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

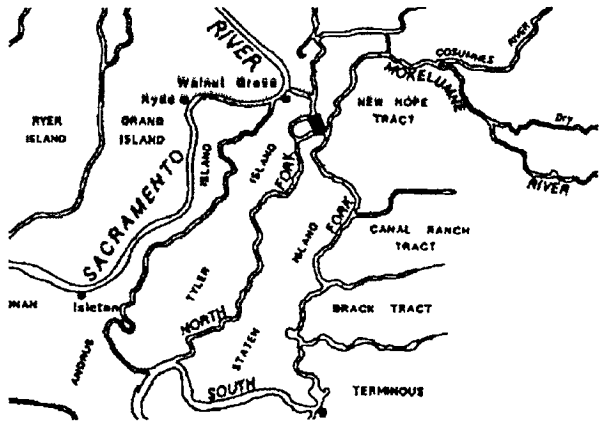

TABLE C-21 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE NORTH DELTA

DEAD HORSE CUT

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.7	0.4	0.6	0.9	0.8	0.9	0.7	1.0	0.9	0.8	0.9	1.0
1	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.5	0.2	0.6	0.9	0.8	0.9	0.9	1.0	1.0	0.9	0.9	1.0
2	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.5	0.2	0.6	0.9	0.8	1.0	0.9	1.0	1.0	0.9	1.0	1.1
3	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.6	0.3	0.7	0.9	0.8	1.0	0.9	1.0	1.0	1.0	1.0	1.1
4	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.5	0.3	0.7	0.9	0.8	1.0	0.9	1.0	1.0	0.9	1.0	1.1
5	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.5	0.3	0.7	0.9	0.8	1.0	0.9	1.0	1.0	0.9	1.0	1.1
6	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.6	0.3	0.7	0.9	0.8	1.0	0.9	1.0	1.0	1.0	1.0	1.1
7	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.6	0.3	0.7	0.9	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.1
8	1.4	2.0	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	0.6	0.3	0.7	0.9	0.8	1.0	0.9	1.0	1.0	1.0	1.0	1.1

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.8	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.8	1.9	1.8	1.8	0.8	0.1	0.8	0.8	0.6	0.5	0.7	0.9	0.9	0.8	1.0	1.1
1	1.8	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.8	1.9	1.9	1.8	0.8	0.1	0.8	0.8	0.8	0.2	0.5	0.8	0.8	0.8	1.0	1.1
2	1.9	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.9	1.9	1.9	1.8	0.9	0.1	0.8	0.8	0.8	0.2	0.5	0.9	0.8	0.8	1.0	1.1
3	1.9	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.9	1.9	1.9	1.8	0.9	0.1	0.8	0.7	0.8	0.3	0.5	0.9	0.8	0.8	1.0	1.1
4	1.9	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.9	1.9	1.9	1.8	0.9	0.1	0.8	0.8	0.8	0.2	0.5	0.9	0.8	0.8	1.0	1.1
5	1.8	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.8	1.9	1.9	1.8	0.9	0.1	0.9	0.8	0.8	0.2	0.5	0.9	0.8	0.8	1.0	1.1
6	1.8	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.8	1.9	1.9	1.8	0.9	0.1	0.9	0.8	0.8	0.3	0.6	0.9	0.9	0.8	1.0	1.1
7	1.8	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.8	1.9	1.9	1.8	0.9	0.2	0.9	0.8	0.8	0.3	0.6	0.9	0.9	0.9	1.0	1.1
8	1.8	1.7	1.9	0.7	1.9	2.0	1.8	1.7	1.8	1.9	1.9	1.8	0.9	0.1	0.9	0.8	0.8	0.3	0.6	0.9	0.9	0.9	1.0	1.1

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.4	1.8	1.6	1.0	0.7	1.1	1.6	1.8	2.0	2.0	1.9	1.9	0.9	0.6	0.5	0.6	0.8	0.6	0.8	0.8	0.7	0.4	0.9	1.0
1	1.4	1.9	1.6	1.0	0.7	1.1	1.6	1.8	1.9	2.0	1.9	1.9	0.8	0.5	0.4	0.6	0.8	0.6	0.8	0.9	0.7	0.5	0.9	1.0
2	1.4	1.9	1.6	1.0	0.7	1.1	1.6	1.8	2.0	2.0	1.9	1.9	0.8	0.5	0.4	0.6	0.8	0.6	0.8	0.9	0.7	0.6	0.9	1.0
3	1.4	1.9	1.6	1.0	0.7	1.1	1.6	1.8	2.0	2.0	1.9	1.9	0.8	0.5	0.4	0.7	0.8	0.6	0.8	0.9	0.7	0.6	0.9	1.0
4	1.4	1.9	1.6	1.0	0.7	1.1	1.6	1.8	2.0	2.0	1.9	1.9	0.8	0.5	0.4	0.6	0.8	0.6	0.8	0.9	0.7	0.6	0.9	1.0
5	1.4	1.8	1.6	1.0	0.7	1.1	1.6	1.8	1.9	2.0	1.9	1.8	0.8	0.5	0.4	0.6	0.8	0.6	0.8	0.9	0.7	0.6	0.9	1.0
6	1.4	1.8	1.6	1.0	0.7	1.1	1.6	1.8	1.9	2.0	1.9	1.8	0.8	0.5	0.4	0.6	0.8	0.6	0.8	0.9	0.7	0.6	0.9	1.0
7	1.4	1.8	1.6	1.0	0.7	1.1	1.6	1.8	1.9	2.0	1.9	1.9	0.8	0.6	0.4	0.7	0.8	0.6	0.8	0.9	0.8	0.6	0.9	1.0
8	1.4	1.9	1.6	1.0	0.7	1.1	1.6	1.8	1.9	2.0	1.9	1.9	0.8	0.6	0.4	0.6	0.8	0.6	0.8	0.9	0.7	0.6	0.9	1.0

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.9	1.8	1.9	*	*	0.1	0.3	1.4	1.9	2.0	1.5	1.0	0.5	0.5	0.4	2.0	2.5	1.3	1.1	0.5	0.3	0.6	0.9
1	1.4	1.9	1.7	1.9	*	*	0.0	0.3	1.4	1.9	1.9	1.5	0.8	0.4	0.5	0.4	2.0	2.5	1.2	1.1	0.5	0.5	0.8	0.9
2	1.4	1.9	1.7	1.9	*	*	0.0	0.3	1.5	1.9	1.9	1.5	0.8	0.4	0.5	0.4	2.0	2.5	1.2	1.1	0.6	0.6	0.8	0.9
3	1.4	1.9	1.7	1.9	*	*	0.0	0.3	1.5	1.9	1.9	1.5	0.8	0.4	0.5	0.4	2.0	2.5	1.3	1.1	0.6	0.6	0.8	0.9
4	1.4	1.9	1.7	1.9	*	*	0.0	0.3	1.5	1.9	1.9	1.5	0.8	0.4	0.5	0.4	2.0	2.5	1.3	1.1	0.6	0.6	0.8	0.9
5	1.4	1.9	1.7	1.9	*	*	0.1	0.3	1.4	1.9	1.9	1.5	0.8	0.4	0.5	0.5	2.0	2.5	1.2	1.1	0.5	0.6	0.8	0.9
6	1.4	1.9	1.7	1.9	*	*	0.1	0.3	1.4	1.9	1.9	1.5	0.8	0.4	0.5	0.5	2.0	2.5	1.2	1.1	0.6	0.6	0.8	0.9
7	1.4	1.9	1.7	1.9	*	*	0.1	0.3	1.4	1.9	1.9	1.5	0.8	0.4	0.5	0.5	2.0	2.5	1.2	1.1	0.6	0.6	0.8	0.9
8	1.4	1.9	1.7	1.9	*	*	0.1	0.3	1.4	1.9	1.9	1.5	0.8	0.4	0.5	0.5	2.0	2.5	1.3	1.1	0.6	0.6	0.8	0.9

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.8	1.8	1.8	*	0.3	0.1	*	0.6	1.9	2.0	1.9	1.9	1.3	1.2	0.8	1.4	1.1	1.2	1.3	0.8	0.5	0.6	0.8	0.9
1	1.8	1.9	1.8	*	0.3	0.1	*	0.6	1.9	1.9	1.9	1.9	1.3	0.8	0.8	1.4	1.1	1.2	1.3	0.8	0.7	0.8	0.8	0.9
2	1.8	1.9	1.8	*	0.3	0.1	*	0.6	1.9	2.0	1.9	1.9	1.3	0.8	0.8	1.4	1.1	1.2	1.3	0.8	0.8	0.8	0.8	0.9
3	1.8	1.9	1.8	*	0.3	0.1	*	0.6	1.9	2.0	1.9	1.9	1.3	0.8	0.8	1.4	1.1	1.2	1.3	0.8	0.8	0.8	0.8	0.9
4	1.8	1.9	1.8	*	0.3	0.1	*	0.6	1.9	2.0	1.9	1.9	1.3	0.8	0.8	1.4	1.1	1.2	1.3	0.8	0.8	0.8	0.8	0.9
5	1.8	1.9	1.8	*	0.3	0.1	*	0.6	1.9	1.9	1.9	1.9	1.3	0.8	0.8	1.4	1.1	1.2	1.3	0.8	0.7	0.8	0.8	0.9
6	1.8	1.9	1.8	*	0.3	0.1	*	0.6	1.9	1.9	1.9	1.9	1.3	0.8	0.8	1.4	1.1	1.2	1.3	0.8	0.8	0.8	0.8	0.9
7	1.8	1.9	1.8	*	0.3	0.1	*	0.6	1.9	2.0	1.9	1.9	1.3	0.8	0.8	1.4	1.1	1.2	1.3	0.8	0.8	0.8	0.9	0.9
8	1.8	1.9	1.8	*	0.3	0.1	*	0.6	1.9	1.9	1.9	1.9	1.3	0.8	0.8	1.4	1.1	1.2	1.3	0.8	0.8	0.8	0.9	0.9

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

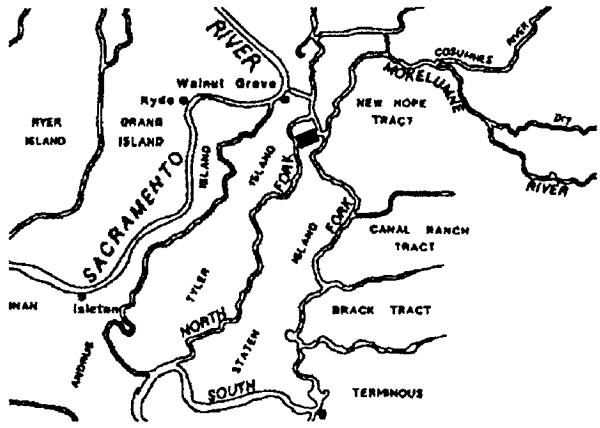

TABLE C-21 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE NORTH DELTA

NORTH FORK MOKELUMNE RIVER

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.4	1.0	1.1	1.0	1.0	0.9	1.0	0.9	0.9	1.0	0.9	0.9	*	0.2	0.2	0.4	0.4	0.5	0.3	0.5	0.5	0.4	0.5	0.5
1	1.4	1.0	1.1	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.0	0.9	*	0.1	0.2	0.4	0.4	0.5	0.4	0.5	0.5	0.4	0.5	0.5
2	1.4	1.0	1.1	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.0	1.0	*	0.1	0.2	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.5
3	1.4	1.0	1.1	0.9	1.0	0.9	1.0	0.9	0.9	1.0	1.0	1.0	*	0.1	0.2	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.6
4	1.4	1.0	1.1	0.9	0.9	0.9	1.0	0.9	0.9	1.0	1.0	1.0	*	0.1	0.2	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.6
5	1.4	1.0	1.1	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	*	0.1	0.2	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.5
6	1.4	1.0	1.1	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	*	0.1	0.2	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.6
7	1.4	1.0	1.1	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	*	0.1	0.2	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.6
8	1.4	1.0	1.1	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	*	0.1	0.2	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.6

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.0	1.3	1.0	0.6	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	0.4	*	0.4	*	0.2	0.2	0.2	0.3	0.4	0.4	0.5	0.5
1	1.0	1.3	1.0	0.6	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	0.4	*	0.4	*	0.3	0.1	0.1	0.3	0.3	0.4	0.5	0.5
2	1.0	1.3	1.0	0.6	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	0.4	*	0.4	*	0.3	0.1	0.1	0.3	0.3	0.4	0.5	0.6
3	1.0	1.2	1.0	0.6	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	0.4	*	0.4	*	0.4	0.1	0.1	0.3	0.4	0.4	0.5	0.6
4	1.0	1.3	1.0	0.6	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	0.4	*	0.4	*	0.3	0.1	0.1	0.3	0.4	0.4	0.5	0.6
5	1.0	1.3	1.0	0.6	1.0	1.0	1.1	1.1	1.0	0.9	0.9	0.9	0.4	*	0.4	*	0.3	0.1	0.1	0.3	0.3	0.4	0.5	0.6
6	1.0	1.3	1.0	0.6	1.0	1.0	1.1	1.1	1.0	0.9	0.9	0.9	0.4	*	0.4	*	0.4	0.1	0.2	0.3	0.4	0.4	0.5	0.6
7	1.0	1.2	1.0	0.6	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	0.4	*	0.4	*	0.4	0.1	0.2	0.3	0.4	0.4	0.5	0.6
8	1.0	1.3	1.0	0.6	1.0	1.0	1.1	1.1	1.0	0.9	1.0	0.9	0.4	*	0.4	*	0.4	0.1	0.2	0.3	0.4	0.4	0.5	0.6

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	0.9	1.0	0.0	0.2	*	0.1	*	0.1	0.2	0.3	0.3	0.2	0.5	0.5
1	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	1.0	1.0	*	0.1	*	0.1	*	0.1	0.1	0.4	0.3	0.2	0.4	0.5
2	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	1.0	1.0	*	0.1	*	0.1	*	0.1	0.2	0.4	0.3	0.3	0.4	0.5
3	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	1.0	1.0	*	0.1	*	0.1	0.0	0.1	0.2	0.4	0.4	0.3	0.4	0.5
4	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	1.0	1.0	*	0.1	*	0.1	0.0	0.1	0.2	0.4	0.3	0.3	0.4	0.5
5	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	0.9	0.9	*	0.2	*	0.1	0.0	0.1	0.2	0.4	0.3	0.3	0.5	0.5
6	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	0.9	0.9	*	0.2	*	0.1	0.0	0.1	0.2	0.4	0.4	0.3	0.5	0.5
7	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	0.9	0.9	*	0.2	*	0.1	0.0	0.1	0.2	0.4	0.4	0.3	0.5	0.5
8	1.3	1.1	1.3	0.4	0.6	0.3	1.2	1.0	1.0	1.0	0.9	0.9	*	0.2	*	0.1	0.0	0.1	0.2	0.4	0.4	0.3	0.5	0.5

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.3	1.1	1.2	1.1	1.2	1.4	0.9	0.8	1.4	1.1	1.0	1.3	0.0	0.2	0.1	0.1	*	*	*	*	*	0.0	0.3	0.2
1	1.3	1.1	1.1	1.1	1.2	1.4	0.9	0.8	1.4	1.1	1.0	1.2	*	0.1	0.1	0.1	*	*	*	*	*	0.2	0.4	0.1
2	1.3	1.1	1.1	1.1	1.2	1.4	0.9	0.8	1.4	1.1	1.0	1.2	*	0.1	0.1	0.1	*	*	*	*	*	0.2	0.4	0.1
3	1.3	1.1	1.1	1.1	1.2	1.4	0.9	0.8	1.4	1.1	1.0	1.2	*	0.1	0.1	0.1	*	*	*	*	*	0.2	0.4	0.1
4	1.3	1.1	1.1	1.1	1.2	1.4	0.9	0.8	1.4	1.1	1.0	1.2	*	0.1	0.1	0.1	*	*	*	*	*	0.2	0.4	0.1
5	1.3	1.1	1.1	1.1	1.2	1.4	0.9	0.8	1.3	1.1	0.9	1.2	*	0.1	0.1	0.1	*	*	*	*	*	0.2	0.4	0.1
6	1.3	1.1	1.1	1.1	1.2	1.4	0.9	0.8	1.4	1.1	0.9	1.2	*	0.1	0.1	0.1	*	*	*	*	*	0.2	0.4	0.1
7	1.3	1.1	1.1	1.1	1.2	1.4	0.9	0.8	1.4	1.1	1.0	1.2	*	0.1	0.1	0.1	*	*	*	*	*	0.2	0.4	0.2
8	1.3	1.1	1.2	1.1	1.2	1.4	0.9	0.8	1.4	1.1	0.9	1.2	*	0.1	0.1	0.1	*	*	*	*	*	0.2	0.4	0.1

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.9	0.9	1.0	1.0	0.8	0.9	0.9	0.6	1.1	1.0	1.0	1.0	0.7	0.6	0.3	*	*	*	*	0.0	0.2	0.3	0.4	0.4
1	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.6	1.1	1.0	1.0	0.9	0.7	0.4	0.3	*	*	*	*	0.0	0.3	0.4	0.4	0.4
2	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.6	1.1	1.0	1.0	0.9	0.7	0.4	0.3	*	*	*	*	0.0	0.3	0.4	0.4	0.4
3	0.9	1.0	1.0	1.0	0.8	0.9	0.9	0.6	1.1	1.0	1.0	1.0	0.7	0.4	0.3	*	*	*	*	0.0	0.3	0.4	0.4	0.4
4	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.6	1.1	1.0	1.0	0.9	0.7	0.4	0.3	*	*	*	*	0.0	0.3	0.4	0.4	0.4
5	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.6	1.1	1.0	0.9	0.9	0.7	0.4	0.3	*	*	*	*	0.0	0.3	0.4	0.4	0.4
6	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.6	1.1	1.0	0.9	0.9	0.7	0.4	0.3	*	*	*	*	0.0	0.3	0.4	0.4	0.4
7	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.6	1.1	1.0	1.0	0.9	0.7	0.4	0.3	*	*	*	*	0.0	0.3	0.4	0.4	0.4
8	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.6	1.1	1.0	0.9	0.9	0.7	0.4	0.3	*	*	*	*	0.0	0.3	0.4	0.4	0.4

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

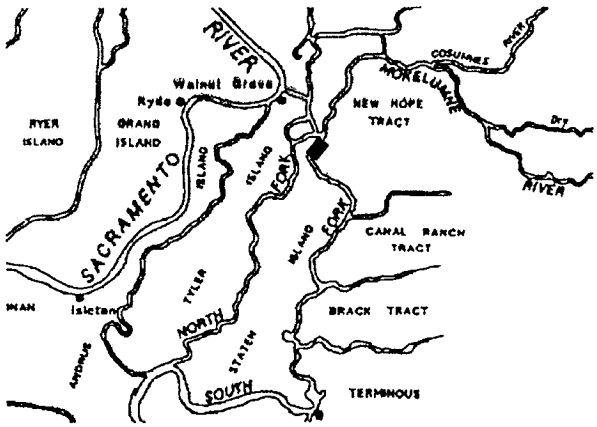

TABLE C-21 (cont.)
PHASE II MODELING

MAXIMUM UPSTREAM AND DOWNSTREAM VELOCITIES IN THE NORTH DELTA

SOUTH FORK MOKELUMNE RIVER

MAXIMUM DOWNSTREAM VELOCITY (FEET PER SECOND) | MAXIMUM UPSTREAM VELOCITY (FEET PER SECOND)

REPRESENTATIVE CRITICAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.0	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.2
1	1.1	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
2	1.1	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
3	1.1	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
4	1.1	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
5	1.1	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
6	1.1	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.9	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
7	1.1	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.9	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
8	1.1	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.9	0.9	*	1.2	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

REPRESENTATIVE DRY YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	1.2	0.8	1.2	0.7	1.2	1.2	1.1	1.0	1.2	1.2	1.2	1.2
1	0.8	0.9	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.9	1.1	0.8	1.2	0.7	1.2	1.2	1.1	1.0	1.2	1.2	1.2	1.2
2	0.8	0.9	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.1	0.8	1.2	0.7	1.1	1.2	1.0	1.0	1.1	1.2	1.2	1.2
3	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.1	0.8	1.2	0.7	1.2	1.2	1.0	1.0	1.1	1.2	1.2	1.2
4	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.1	0.8	1.2	0.7	1.2	1.2	1.1	1.0	1.1	1.2	1.2	1.2
5	0.8	0.9	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.2	0.8	1.2	0.7	1.2	1.2	1.1	1.0	1.2	1.2	1.2	1.2
6	0.8	0.9	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.1	0.8	1.2	0.7	1.2	1.2	1.1	1.0	1.1	1.2	1.2	1.2
7	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.2	0.8	1.2	0.7	1.2	1.2	1.1	1.0	1.1	1.2	1.2	1.2
8	0.8	0.9	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.2	0.8	1.2	0.7	1.2	1.2	1.1	1.0	1.1	1.2	1.2	1.2

REPRESENTATIVE BELOW NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.9	0.7	0.9	0.7	0.8	0.7	0.8	0.8	0.7	0.7	0.8	0.9	0.4	1.1	0.7	0.8	0.7	0.9	0.9	1.1	1.2	1.2	1.2	1.2
1	0.9	0.7	0.9	0.7	0.8	0.7	0.8	0.8	0.7	0.7	0.8	0.8	0.4	1.1	0.7	0.8	0.7	0.9	0.8	1.1	1.2	1.2	1.2	1.2
2	0.9	0.7	0.9	0.7	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.4	1.1	0.7	0.8	0.7	0.9	0.8	1.1	1.2	1.2	1.2	1.2
3	0.9	0.7	0.9	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.9	0.4	1.1	0.6	0.8	0.7	0.9	0.8	1.1	1.2	1.2	1.2	1.2
4	0.9	0.7	0.9	0.7	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.4	1.1	0.7	0.8	0.7	0.9	0.9	1.1	1.2	1.2	1.2	1.2
5	0.9	0.7	0.9	0.7	0.8	0.7	0.8	0.8	0.7	0.7	0.8	0.9	0.4	1.1	0.7	0.8	0.7	0.9	0.8	1.1	1.2	1.2	1.2	1.2
6	0.9	0.7	0.9	0.7	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.9	0.4	1.1	0.7	0.8	0.7	0.9	0.8	1.1	1.2	1.2	1.2	1.2
7	0.9	0.7	0.9	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.9	0.4	1.1	0.7	0.8	0.7	0.9	0.8	1.1	1.2	1.2	1.2	1.2
8	0.9	0.7	0.9	0.7	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.9	0.4	1.1	0.6	0.8	0.7	0.9	0.8	1.1	1.2	1.2	1.2	1.2

REPRESENTATIVE ABOVE NORMAL YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	0.9	0.7	0.7	0.7	1.6	2.1	1.0	0.9	1.0	0.7	0.7	0.9	0.2	1.1	0.9	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7
1	0.9	0.7	0.8	0.7	1.6	2.1	1.0	0.9	1.0	0.7	0.8	0.9	0.2	1.1	0.9	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7
2	0.9	0.7	0.8	0.7	1.6	2.1	1.0	0.9	1.0	0.7	0.8	0.9	0.2	1.1	0.9	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7
3	0.9	0.7	0.8	0.7	1.6	2.1	1.0	0.9	1.0	0.8	0.8	0.9	0.2	1.1	0.9	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7
4	0.9	0.7	0.8	0.7	1.6	2.1	1.0	0.9	1.0	0.7	0.8	0.9	0.2	1.1	0.9	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7
5	1.0	0.7	0.8	0.7	1.6	2.1	1.0	0.9	1.0	0.7	0.8	0.9	0.1	1.1	1.0	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7
6	1.0	0.7	0.8	0.7	1.6	2.1	1.0	0.9	1.0	0.8	0.8	0.9	0.1	1.1	1.0	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7
7	0.9	0.7	0.8	0.7	1.6	2.1	1.0	0.9	1.0	0.8	0.8	0.9	0.2	1.1	1.0	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7
8	0.9	0.7	0.8	0.7	1.6	2.1	1.0	0.9	1.0	0.8	0.8	0.9	0.1	1.1	1.0	1.1	*	*	0.4	0.5	0.2	1.1	1.2	0.7

REPRESENTATIVE WET YEAR

ALT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NA	1.1	0.9	0.8	1.1	0.9	1.0	1.0	0.8	0.7	0.7	0.8	0.8	1.2	1.2	1.2	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2
1	1.0	0.7	0.8	1.1	0.9	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.1	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2
2	1.0	0.7	0.8	1.1	0.9	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.1	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2
3	1.0	0.7	0.8	1.1	0.9	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.1	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2
4	1.0	0.7	0.8	1.1	0.9	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.1	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2
5	1.0	0.7	0.8	1.1	0.9	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.2	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2
6	1.0	0.7	0.8	1.1	0.9	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.2	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2
7	1.0	0.8	0.8	1.1	0.9	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.1	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2
8	1.0	0.8	0.8	1.1	0.9	1.0	1.0	0.8	0.8	0.8	0.8	0.8	1.2	1.2	1.2	0.2	0.5	0.4	0.4	0.7	1.2	1.2	1.2	1.2

DESCRIPTION OF ALTERNATIVES

- NA No-Action
- 1 Northern Intake, Barrier Configuration A
- 2 Northern Intake, Barrier Configuration B
- 3 Enlarged Forebay with North Victoria Intake, Barrier Configuration B
- 4 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B
- 5 Northern Intake, Barrier Configuration A, CVP tie-in to Forebay
- 6 Northern Intake, Barrier Configuration B, CVP tie-in to Forebay
- 7 Enlarged Forebay with North Victoria Intake, Barrier Configuration B, CVP tie-in to Forebay
- 8 Enlarged Forebay with Highway 4 Intake, Barrier Configuration B, CVP tie-in to Forebay

Note: * Indicates that flow is not in this direction.

Note: Outlined values indicate that barriers are operating

APPENDIX D

NEGATIVE DECLARATION FOR SDWMP LAND PURCHASES

State of California
The Resources Agency
Department of Water Resources

Negative Declaration
Proposed South Delta Water Management Program
Land Purchases

The Project. The purpose of this project is to purchase parcels of land adjacent to Clifton Court Forebay that may be needed for the South Delta Water Management Program (SDWMP). One course of action proposed in the SDWMP is to enlarge Clifton Court Forebay by approximately 3,000 surface acres, and place a new intake gate at the north end of the Forebay. Some or all of the land purchased could also be used for State Water Project (SWP) mitigation purposes. The objectives of this project are to (1) determine willing sellers and thus identify land parcels which will facilitate the planning and decision-making process; (2) identify to local land owners, counties, and interests those land parcels that the State has interest in and commitments to, in order that these local entities can make prudent planning decisions; and (3) determine if additional land parcels are available that could later be used for SWP mitigation purposes.

This action will not limit decisions on SDWMP alternatives. This project is associated with the SDWMP planning process; however, the decision to use land acquired under this project will not be made until after necessary environmental documentation has been completed for the SDWMP.

The Finding. The project will have no significant impact on the environment.

Basis for the Finding. Based on the Initial Study, it was determined that there would not be any significant project impacts, nor would this project have any adverse environmental effects. Negotiations for acquiring land parcels adjacent to Clifton Court Forebay will be with willing sellers only. These lands are zoned for agriculture. Arrangements will be made to maintain current land use of acquired parcels until after the SDWMP environmental document is complete and final site selection for the Clifton Court Forebay expansion, if that alternative is selected, and mitigation are implemented. Existing habitats will be unaffected by the acquistion of the land. All required SDWMP environmental clearance will be obtained prior to development of any of the purchased land. Acquired lands that are not developed immediately could be leased, or sold, for continued agricultural use, or used as mitigation areas for future projects.

Land purchases would mainly serve to enhance the SDWMP planning process. They would entail no direct impact on the physical environment and they would not commit the Department to any particular decision under the SDWMP process. Subsequent development actions relating to the SDWMP will be addressed under separate California Environmental Quality Act documentation, currently under way.

Therefore, this Negative Declaration is filed pursuant to Section 15073 of the Guidelines for Implementation of CEQA.

_____
Edward F. Huntley, Chief
Division of Planning

Date_____

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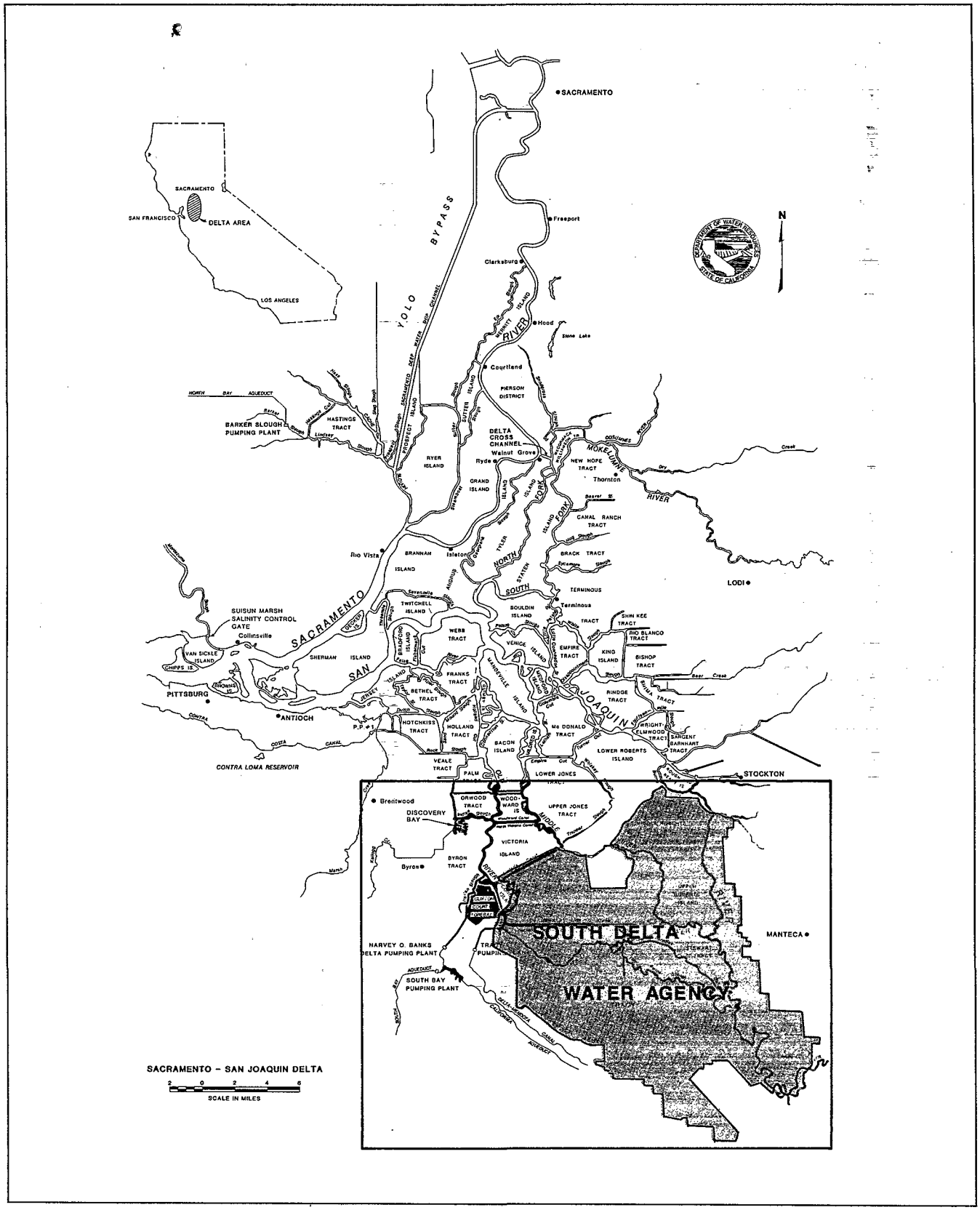

Figure 1. South Delta Study Area

INTRODUCTION

The south Delta study area generally comprises the lands and channels of the Sacramento–San Joaquin Delta southwest of Stockton (Figure 1). Included in this study area is the South Delta Water Agency (SDWA), as defined in the Formation Act, California Statutes of 1973. In addition, important features of the State Water Project (SWP) and the Central Valley Project (CVP) are located in the study area. This area is faced with complex water right, water supply, water quality, and environmental issues.

The area within the SDWA boundaries includes about 150,000 acres, of which about 120,000 acres are used for irrigated agriculture. The remaining area consists of waterways, berms, channel islands, levees, and lands devoted to homes and industries. About 450,000 acre–feet of water is diverted from the south Delta channels each year to irrigate the fully developed and highly productive agricultural land.

Major channels and waterways in the south Delta study area include: San Joaquin River, Old River, Middle River, Woodward and North Victoria canals, Victoria and North canals, Grant Line Canal, Italian Slough, Indian Slough, Tom Paine Slough, and Paradise Cut. The SWP export facilities, operated by the California Department of Water Resources (DWR), consist of Clifton Court Forebay, John E. Skinner Delta Fish Protective Facility, the intake channel, Harvey O. Banks Delta Pumping Plant, and Governor Edmund G. Brown California Aqueduct. The CVP export facilities, operated by the U.S. Bureau of Reclamation (USBR), consist of the Tracy Fish Collecting Facility, the intake channel, the Tracy Pumping Plant, and the Delta Mendota Canal (Figure 2).

In July 1982, SDWA filed a lawsuit concerning the effects of SWP and CVP operations on the south Delta. The suit sought a declaration of the rights of the parties, a preliminary injunction, and permanent injunction requiring that the projects be operated to protect the south Delta. Later, in October 1986, DWR, USBR, and SDWA entered into an agreement on a framework for settling the litigation brought by SDWA. All three parties agreed to work together to develop mutually acceptable, long–term solutions to the water supply problems of water users within SDWA.

In connection with and in addition to the framework agreement, DWR is planning a South Delta Water Management Program (SDWMP) to address objectives of improving the water supply and water quality problems in the south Delta. The SDWMP also takes into account the broader objectives of DWR and USBR, which are to improve water supply reliability, efficiency of SWP and CVP operations, fishery conditions, navigation, water quality, flood control, and recreational opportunities.

The program includes a public review of problems, alternative solutions, impacts, and mitigation to provide information to select a course or courses of action. Several of the alternative courses of action proposed in the SDWMP include enlargement of Clifton Court Forebay by about 3,000 surface acres.

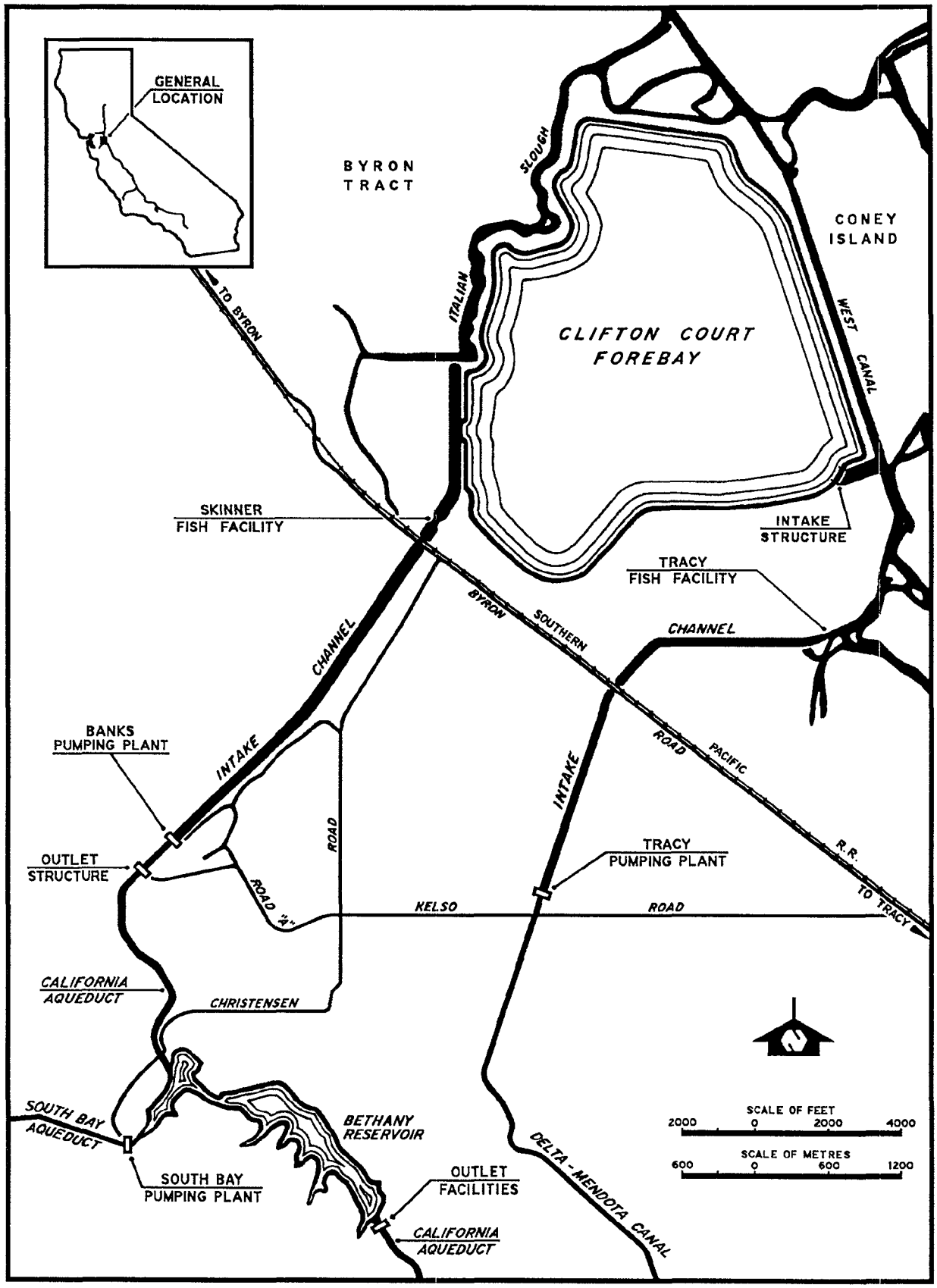

Figure 2. SWP and CVP Export Facilities in the South Delta

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PROJECT OBJECTIVE

The purpose of this project is to acquire land parcels near Clifton Court Forebay that may be needed for the South Delta Water Management Program (SDWMP). The lands acquired could ultimately be used to expand the Forebay or as mitigation areas for future projects.

The objectives of this project are to (1) determine willing sellers and thus identify land parcels that will facilitate the planning and decision-making process; (2) identify to local landowners, counties, and interests those land parcels that the State has interest in and commitments to, so that these entities can make prudent planning decisions; and (3) determine whether additional land parcels are available that could later be used for mitigation.

PROJECT DESCRIPTION

This project is designed to provide the greatest flexibility in planning and selecting SDWMP alternatives, without foregoing any possible options. This project will be limited to land parcels in close proximity to Clifton Court Forebay that are suitable for forebay enlargement. Parcels considered suitable for expansion of the Forebay are located on Victoria Island, Byron Tract, Coney Island, Clifton Court Tract, and Union Island (Figure 3). About 3,000 acres will be required to enlarge the Forebay. Additional land will be needed for mitigation.

The land acquistion process consists of (1) identification of land parcels suitable for enlargement of Clifton Court Forebay, (2) property selection and appraisal, and (3) negotiation of a purchase price with willing sellers. All landowners with property surrounding Clifton Court Forebay that is suitable for enlargement of the Forebay will be contacted. Land values will be based on an appraisal to determine fair market value. Those willing to participate in the project shall be offered a purchase price for their property. The land acquisition process may entail a variety of actions, including the use of options to purchase, purchase agreements, or purchase outright, depending upon the circumstances of the individual parcel. Arrangements will be made to maintain current land use of acquired parcels until after the SDWMP environmental document is complete and the final site for the Clifton Court Forebay expansion is selected, if that alternative is selected, and mitigation is implemented. All required SDWMP environmental clearance will be obtained before any of the acquired land is developed.

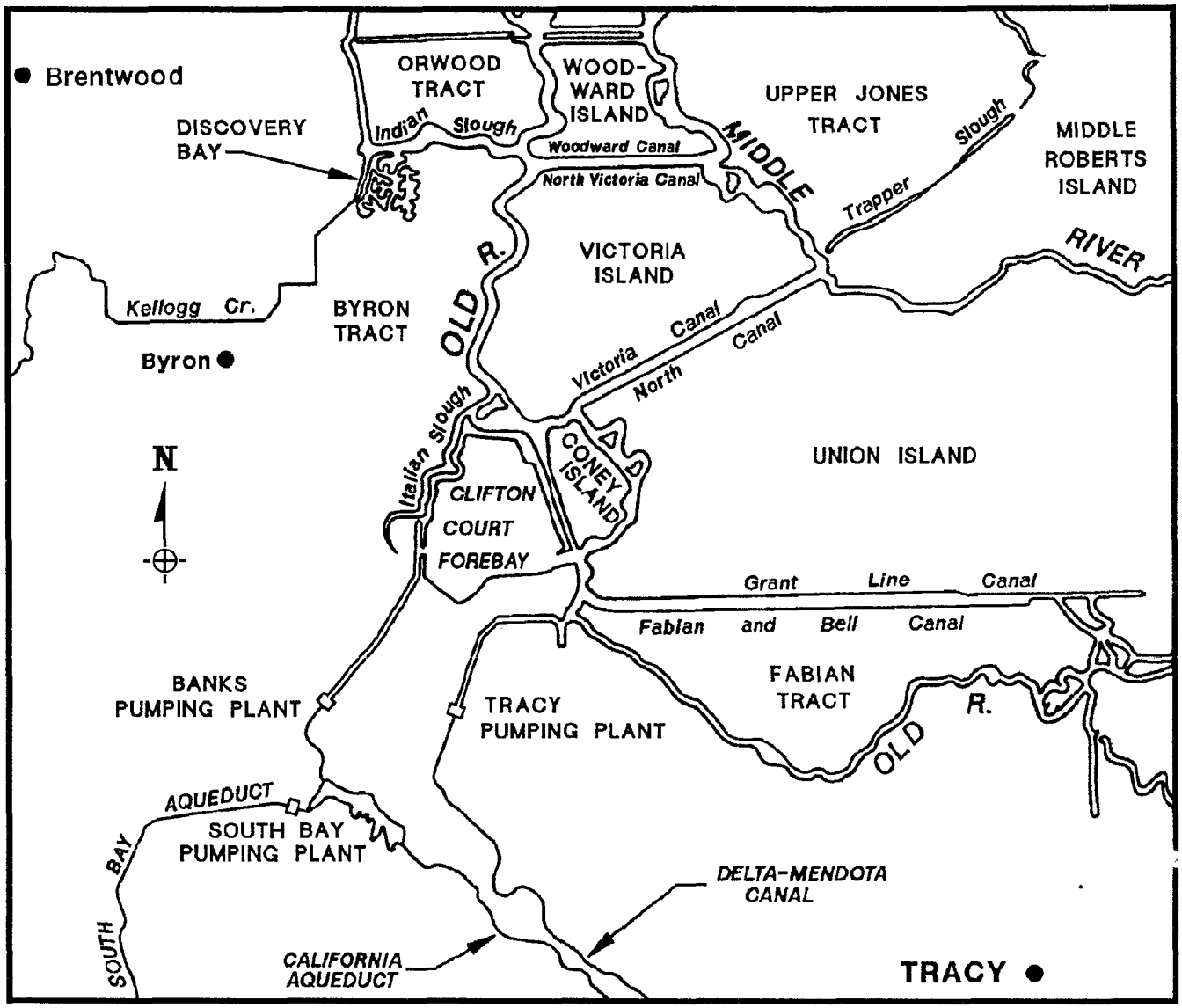

Figure 3. Clifton Court Forebay and Vicinity

RELATED PROJECTS

South Delta Agreements

In June 1986, the Department of Water Resources and the South Delta Water Agency signed a Joint Powers Agreement regarding interim measures to improve water level and circulation problems resulting from various factors, including the construction and operation of the SWP. The agreement included a plan for dredging the upper 5 miles of Tom Paine Slough, installing siphons into Tom Paine Slough, developing Clifton Court Forebay operational criteria, and constructing a weir in Middle River. Dredging of Tom Paine Slough was completed in October 1986, and the siphons were completed in March 1989. The Middle River weir was installed in May 1987, and the center portion was removed at the end of September 1987. The removable weir portion is reinstalled each irrigation season.

In October 1986, a framework agreement for settling SWDA litigation was signed by DWR, USBR, and SDWA. The agreement included (1) negotiations for a long-term plan of physical or operational solutions, (2) provisions for cost-sharing and responsibilities for the implementation of the long-range plan, (3) interim actions, namely New Melones releases, to help improve the south Delta water supply, and (4) action to cancel the April 1987 trial date. The trial date was vacated and legal action was stayed. Also, as part of the agreement, SDWA released claims against DWR for water level damage caused by SWP operations in the south Delta. This release will be in effect during the length of the agreement. The negotiations spelled out in the framework agreement are currently nearing completion, and are being coordinated with the SDWMP environmental impact document work.

South Delta Water Management Program

DWR and USBR are presently preparing a joint environmental impact document for a South Delta Water Management Program (SDWMP). The action was initiated under the framework agreement (October 1986) among DWR, USBR, and SDWA that committed all three parties to work together to develop mutually acceptable, long-term solutions to the water quality and water supply problems of water users within SDWA. The particular objectives of the SDWMP are to improve and maintain water levels, water circulation patterns, and water quality in the south Delta.

Evaluation of multipurpose alternatives to meet these objectives will also take into account broader objectives of USBR and DWR, which are to improve water supply reliability, the efficiency of SWP and CVP operations, fishery conditions, navigation, and flood protection, and enhance recreational opportunities.

SDWMP represents parallel planning and environmental impact documentation to improve conditions in the southern portion of the Delta. This planning and environmental document process is not intended to alter responsibilities under the October 1986 framework agreement. The program includes a public review of problems, alternative solutions, impacts, and mitigation to provide information for selecting corrective action. This process will help bring to light the many interests and concerns related to water resources planning in the south Delta. The program also includes investigation of the cumulative effects of any corrective action, when coupled with other facilities statewide and in the Delta. A draft

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EIR/EIS is scheduled for release during the spring of 1990.

North Delta Water Management Program

The North Delta Water Management Program (NDWMP) represents parallel planning and environmental documentation to improve conditions in the northern portion of the Delta. The study area includes channel systems south of Sacramento, north of the San Joaquin River, east of Rio Vista, and west of Thornton.

Primary objectives of the program are to alleviate flooding along the Mokelumne River, reduce reverse flow in the lower San Joaquin River, improve water quality, reduce fishery impacts, and improve water supply reliability. Secondary objectives are to improve navigation and enhance recreation.

The planning and environmental documentation process for the NDWMP is currently under way. Alternatives being considered include increasing the hydraulic capacity of the South Fork Mokelumne River as a first phase. Later phases could include partial tide gate structures in the Sacramento River, Steamboat Slough, and Threemile Slough and possibly a new Sacramento River connecting channel. A draft EIR/EIS is scheduled for release during the summer of 1990.

West Delta Water Management Program

The West Delta Water Management Program (WDWMP) addresses subsidence, flood control, water quality, water supply reliability, wildlife habitat, highways and utilities protection, and recreation. The importance of these issues to the west Delta, and to the Delta as a whole, has necessitated a broadened scope of planning. Because of its location at the confluence of the Sacramento and San Joaquin rivers, Sherman Island is important in protecting the reliability and the quality of Delta water, and highways and utilities. For these reasons, Sherman Island is the focus of the WDWMP.

The alternative being pursued is a wildlife management plan for Sherman Island. This plan, coordinated with other Delta planning, has the potential to develop a number of significant benefits, such as fish and wildlife enhancement, levee improvements for flood control, land management to slow subsidence, recreational opportunities, and better water supply management.

Los Banos Grandes Reservoir

In 1984, DWR completed a reconnaissance study of potential offstream storage sites south of the Delta. Such reservoirs could be used to store runoff pumped from the Delta during wet periods and delivered via the California Aqueduct. The subsequent report, *Alternative Plans for Offstream Storage South of the Delta*, recommended that future studies focus on the Los Banos Grandes Reservoir site, south of the existing San Luis Reservoir. In 1984, the Legislature authorized the Los Banos Grandes offstream reservoir, and DWR initiated planning. The basic plan would be an SWP water supply facility; with power generated by reservoir releases incorporated into the SWP power resource plan. A draft EIR/EIS is scheduled for release during the summer of 1990.

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ENVIRONMENTAL SETTING

Location

This project is limited to land parcels located near or next to Clifton Court Forebay—specifically, Victoria Island, Coney Island, portions of Byron Tract, the remaining area of Clifton Court Tract, and possibly Union Island.

These lands are predominantly agricultural; however, a significant development exists on Byron Tract at Discovery Bay. State Route 4, which follows an east-west alignment, cuts across Byron Tract and bisects Victoria Island. Western Area Power Administration transmission lines lie diagonally across Byron Tract (NW-SE) and Union Island (SW-NE). The Southern Pacific Railway lies along the southern boundaries of Byron Tract and Clifton Court Tract.

Climate

The climate of the Delta is mediterranean, with warm, dry summers and cool, moist winters. The annual average temperature is about 60° F, with extremes ranging from 100° F in summer (June-September) to 30° F in winter (December-March). Average summer and winter temperatures are 75° F and 45° F, respectively. In spring and summer, winds from the Pacific Ocean enter the Delta through the Carquinez Strait, at times reaching 50 miles per hour. This inflow of marine air moderates what would otherwise be a hot, dry climate. During winter, land breezes prevail, and temperatures vary from 43° F to 82° F. During late fall and winter, a dense ground fog periodically covers the Delta for several days at a time.

Average annual precipitation in the south Delta is about 12 inches. Rainfall during fall and winter accounts for most of this precipitation, with little occurring during summer. The local rainfall is supplemented by irrigation water readily available from the surrounding waterways. The growing season is long. Stockton has an average of 324 frost-free days per year, and farmers often plant and harvest two crops during this time.

Soils

Peat soils composed of organic matter from the ancestral wetlands, and mineral-rich alluvial soils deposited by the rivers cover most of the central part of the Delta. Mineral soils, derived from weathered rock and deposited on the lower slopes of the surrounding valley plains, predominate on the periphery of the Delta.

The original elevation of the Delta was close to mean sea level (MSL); however, much of the Delta is now below sea level and many islands are 20 feet or more below MSL.. The land surface of many of the south Delta islands lies below sea level, with the northern portion of Victoria Island having the lowest surface elevation (14 feet below MSL).

Higher levees are continually necessary to hold back Delta waters, but the levee foundations are made of peat soil that continuously compacts, blows away, or oxidizes. This process is known as subsidence. Much of the south Delta lands are subsiding at a rate estimated to be 1.6 to 3.0 inches per year.

Water Quality

Water conditions in the south Delta are influenced by tidal action, project and local pump diversions, agricultural return flow, and channel capacity. Water quality in the project area is variable, depending on the type of water year and flow conditions. Salt concentrations are lowest during wet water years with

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high-flow conditions, and are highest during critical years with both high-flow and low-flow conditions. Typically, salinity is highest in July and August, regardless of the type of year. In below-normal years, salinity may increase dramatically as early as May.

South Delta channels are used for both delivery of irrigation water and return of local agricultural drainage. Irrigation practices concentrate the salts of the applied water; the disposal of the irrigation drainage degrades the receiving water. During the heavy irrigation season, drain water is recycled several times when flows are insufficient to flush the channels. The water quality deteriorates seriously in dead-end channels such as Tom Paine Slough and Paradise Cut, as well as in reaches of Old River and the San Joaquin River, both of which have limited circulation.

Land Use

The south Delta area contains about 148,000 acres, of which 123,000 acres are used for agriculture. The remaining area consists of waterways, levees, and lands devoted to residential, industrial, and municipal uses.

The fully developed and productive irrigated lands depend on the in-channel irrigation, for which about 450,000 acre-feet per year are diverted. The 75 miles of major channels in the southern Delta also serve as drainage and floodwater canals, as habitat and migratory routes for fish, and as routes for recreational boating. The major waterways to the east are also used for commercial shipping.

Wildlife and Related Habitat

Nearly all the land in the southern Delta islands is used for irrigated agriculture. The natural vegetation on the river banks has been modified in most places by construction and maintenance of levees. Habitat or cover types in the south Delta are mainly agriculture, with smaller areas of forest, riparian forest, riparian scrub-shrub, emergent freshwater marsh, and heavily-shaded riverine aquatic.

Although most of the original wetlands have been reclaimed, the Delta is still one of the most significant waterfowl areas in California. Roughly 10 per cent of the Central Valley waterfowl population winters in the Delta.

In addition to supporting waterfowl, the Delta also supports many birds and animals, including important game and endangered species that are associated with riparian and upland habitats. The rare, threatened, and endangered species that potentially occur in the south Delta area are listed in Table 1.

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Table 1
Rare, Threatened, and Endangered Species Potentially Occurring in the South Delta Project Area

Common Name	Scientific Name	Status*	Distribution	Habitat
		PLANTS		
Suisun Marsh aster	*Aster chilensis lentus*	C2	San Pablo Bay, Suisun Marsh, western Delta	Dense vegetation, stabilized substrate
Delta button celery (Delta coyote thistle)	*Eryngium racemosum*	C2, SE	San Joaquin, Stanislaus, & Calaveras counties	Seasonal wetlands
Slough thistle	*Cirsium crassicaule*	C2	Delta; Kern & Kings counties	Upland areas
Mason's lilaeopsis	*Lilaeopsis masonii*	C2, SR	Delta	Mudbanks
California hibiscus	*Hibiscus californicus*	C2	Delta & Central Valley up to Butte County	Freshwater marsh
Delta tule pea	*Lathyrus jepsonii jepsonii*	C2	Delta	Freshwater marsh
		ANIMALS		
San Joaquin kit fox	*Vulpes macrotis mutica*	FE, ST	From South San Joaquin Valley foothills north through undeveloped valley & foothill lands into southern Contra Costa County	Grasslands in north; alkali sink in south
California black rail	*Laterallus jamaicensis coturniculus*	C2, ST	Coast from Marin County to north Mexico; inland marshes	Fresh and salt water marshes
Tricolored blackbird	*Agelaius tricolor*	C2	Central Valley & Sierra Nevada foothills	Marshes, flooded lands, margins of ponds, grassy fields
Swainson's hawk	*Buteo swainsoni*	ST	Lower Sacramento and San Joaquin valleys; Klamath Basin; Siskiyou County. Winters in South America	Grasslands, irrigated pastures, and open fields near trees for nesting
Giant garter snake	*Thamnophis couchi gigas*	C2, ST	Fresno County north through the Central Valley; east Delta	Freshwater marsh, riparian areas, rice fields, canals
Western pond turtle	*Clemmys marmorata*	C2	Throughout California west of Cascade–Sierra crest	Ponds and waterways lined with emergent vegetation

(Continued on next page)

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Table 1 (continued)
Rare, Threatened, and Endangered Species Potentially Occurring in the South Delta Project Area

Common Name	Scientific Name	Status*	Distribution	Habitat
		ANIMALS (continued)		
California tiger salamander	*Ambystoma tigrinum californiense*	C2	Sonoma to Santa Barbara counties	Reservoirs, ponds, pooles, lakes, and slow-flowing streams in grasslands and open woodlands
California red-legged frog	*Rana aurora draytoni*	C2	Coast, Transverse, Cascade, and Sierra Nevada ranges	Quiet, permanent water in woods, forest clearings, riparian areas, grasslands
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	Lower Sacramento Valley north to Red Bluff	Elderberry bushes in riparian areas
Sacramento anthicid beetle	*Anthicus sacramento*	C2	Yolo, Solano, Butte, & Sacramento counties	Sand dunes near rivers
Curved-footed hygrotus diving beetle	*Hygrotus curvipes*	C2	Contra Costa County	Shallow ponds
Delta smelt	*Hypomesus transpacificus*	C1, SC	Suisun & San Pablo Bays in early fall; spawns in channels & deadend sloughs, December through April	Salinities usually less than 2 parts per thousand
Sacramento splittail	*Pogonichthys macrolepidotus*	(C2)	Suisun Bay from February-April; spawns in upstream deadend sloughs Jan-July	Slower currents; tolerates brackish water
Sacramento perch	*Archoplites interruptus*	(C2)	Sacramento-San Joaquin Delta; Russian River; scattered lakes & reservoirs	Needs beds of rooted & emergent aquatic vegetation; tolerates alkaline water
Chinook salmon (winter-run)	*Oncorhynchus tshawytscha*	FT, SE	Sacramento River system	Cool fresh water with access to ocean

*Status: FT = federal threatened; FE = federal endangered; C1 = federal candidate with sufficient data to support federal listing; C2 = federal candidate currently without sufficient data to support federal listing; ST = State threatened; SE = State endangered; SR = State rare; SC = State candidate for protected status; (C2) = Currently being recommended by the Sacramento Endangered Species Office that the species be proposed as a C2.

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ENVIRONMENTAL IMPACTS

There would not be any project impacts, nor would this project have any adverse environmental effects. Negotiations for acquiring land parcels adjacent to Clifton Court Forebay will be with willing sellers only. These lands are zoned for agriculture. Acquistion of land parcels will not affect land use and are not irreversible. Existing habitats will be unaffected by the acquistion of the land. All required SDWMP environmental clearance will be obtained prior to development of any of the purchased land. Acquired lands that are not developed immediately could be leased, or sold, for continued agricultural use, or used as mitigation areas for future projects.

Table 2. Summary of Environmental Impacts

	Yes	Maybe	No
1. Earth. Will the proposal result in:			
a. Unstable earth conditions or changes in geologic substructures?	____	____	_X_
b. Disruptions, displacements, compaction or overcovering of the soil?	____	____	_X_
c. Change in topography or ground surface relief features?	____	____	_X_
d. The destruction, covering or modification of any unique geologic or physical features?	____	____	_X_
e. Any increase in wind or water erosion of soils, either on or off the site?	____	____	_X_
f. Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet or lake?	____	____	_X_
g. Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazards?	____	____	_X_
2. Air. Will the proposal result in:			
a. Substantial air emissions or deterioration of ambient air quality?	____	____	_X_
b. The creation of objectionable odors?	____	____	_X_
c. Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?	____	____	_X_
3. Water. Will the proposal result in:			
a. Changes in currents, or the course or direction of water movements, in either marine or fresh waters?	____	____	_X_
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	____	____	_X_
c. Alterations to the course or flow of flood waters?	____	____	_X_
d. Change in the amount of surface water in any water body?	____	____	_X_
e. Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen or turbidity?	____	____	_X_

Table 2. Summary of Environmental Impacts (continued)

	Yes	Maybe	No
3. Water *(continued)*			
f. Alteration of the direction or rate of flow of ground water?	___	___	X
g. Change in the quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations?	___	___	X
h. Substantial reduction in the amount of water otherwise available for public water supplies?	___	___	X
i. Exposure of people or property to water related hazards such as flooding or tidal waves?	___	___	X
4. Plant Life. Will the proposal result in:			
a. Change in the diversity of species, or number of any species of plants (including trees, shrubs, grass, crops, and aquatic plants)?	___	___	X
b. Reduction of the numbers of any unique, rare or endangered species of plants?	___	___	X
c. Introduction of new species of plants into an area, or in a barrier to the normal replenishment of existing species?	___	___	X
d. Reduction in acreage of any agricultural crop?	___	X	___
5. Animal Life. Will the proposal result in:			
a. Change in the diversity of species, or numbers of any species of animals (birds, land animals including reptiles, fish and shellfish, benthic organisms or insects)?	___	___	X
b. Reduction of the numbers of any unique, rare or endangered species of animals?	___	___	X
c. Introduction of new species of animals into an area, or result in a barrier to migration or movement of animals?	___	___	X
d. Deterioration to existing fish or wildlife habitat?	___	___	X
6. Noise. Will the proposal result in:			
a. Increases in existing noise levels?	___	___	X
b. Exposure of people to severe noise levels?	___	___	X
7. Light and Glare. Will the proposal produce new light or glare?	___	___	X
8. Land Use. Will the proposal result in a substantial alteration of the present or planned land use of an area?	___	X	___
9. Natural Resources. Will the proposal result in:			
a. Increase in the rate of use of any natural resources?	___	___	X
b. Substantial depletion of any nonrenewable natural resource?	___	___	X
10. Risk of Upset. Will the proposal involve:			
a. A risk of an explosion or the release of hazardous substances (including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?	___	___	X
b. Possible interference with an emergency response plan or an emergency evacuation plan?	___	___	X

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Table 2. Summary of Environmental Impacts (continued)

	Yes	Maybe	No
11. **Population.** Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?	____	____	__X__
12. **Housing.** Will the proposal affect existing housing, or create a demand for additional housing?	____	____	__X__
13. **Transportation/Circulation.** Will the proposal result in:			
a. Generation of substantial additional vehicular movement?	____	____	__X__
b.. Effects on existing parking facilities, or demand for new parking?	____	____	__X__
c. Substantial impact upon existing transportation systems?	____	____	__X__
d. Alterations to present patterns of circulation or movement of people and/or goods?	____	____	__X__
e. Alterations to waterborne, rail or air traffic?	____	____	__X__
f. Increase in traffic hazards to motor vehicles, bicyclists or pedestrians?	____	____	__X__
14. **Public Services.** Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:	____	____	__X__
a. Fire protection?	____	____	__X__
b. Police protection?	____	____	__X__
c. Schools?	____	____	__X__
d. Parks or other recreational facilities?	____	____	__X__
e. Maintenance of public facilities, including roads?	____	____	__X__
f. Other governmental services?	____	____	__X__
15. **Energy.** Will the proposal result in:			
a. Use of substantial amounts of fuel or energy?	____	____	__X__
b. Substantial increase in demand upon existing sources of energy, or require development of new sources of energy?	____	____	__X__
16. **Utilities.** Will the proposal result in a need for new systems, or substantial alterations to the following utilities?			
a. Power or natural gas?	____	____	__X__
b. Communications systems?	____	____	__X__
c. Water?	____	____	__X__
d. Sewer or septic tanks?	____	____	__X__
e. Storm water drainage?	____	____	__X__
f. Solid waste and disposal?	____	____	__X__
17. **Human Health.** Will the proposal result in:			
a. Creation of any health hazard or potential health hazard (excluding mental health)?	____	____	__X__
b. Exposure of people to potential health hazards?	____	____	__X__

Table 2. Summary of Environmental Impacts (continued)

	Yes	Maybe	No
18. Aesthetics. Will the proposal result in the obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?	____	____	_X_
19. Recreation. Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?	____	____	_X_
20. Cultural Resources.			
a. Will the proposal result in the alteration of or the destruction of a prehistoric or historic archaeological site?	____	____	_X_
b. Will the proposal result in adverse physical or aesthetic effects to a prehistoric or historic building, structure or object?	____	____	_X_
c. Does the proposal have the potential to cause a physical change which would affect unique ethnic cultural values?	____	____	_X_
d. Will the proposal restrict existing religious or sacred uses within the potential impact area?	____	____	_X_
21. Mandatory Findings of Significance.			
a. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	____	____	_X_
b. Does the project have the potential to achiev short-term, to the disadvantage of long-term, environmental goals? (A short-term impact on the environment is one which occurs in a relatively brief, definitive period of time, while long-term impacts will endure well into the future.)	____	____	_X_
c. Does the project have impacts which are individually limited, but cumulatively considerable? (A project may impact on two or more separate resources where the impact on each resource is relatively small, but where the effect of the total of those impacts on the environment is significant.)	____	____	_X_
d. Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	____	____	_X_

Explanation of Environmental Impacts

Item 4d. Arrangements will be made to maintain current land use of acquired parcels until after the SDWMP environmental document is complete and final site selection for the Clifton Court Forebay expansion and mitigation is implemented. This could be accomplished through the use of lease back agreements with current landowners or other willing tenants.

Item 8. See Item 4d.

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CONCLUSION AND RECOMMENDATIONS

This project will have no significant adverse effect on the environment.

It is recommended that a Negative Declaration be prepared and processed in accordance with the California Environmental Quality Act and State Guidelines.

Prepared by:

Phillip B. Rutan
Assistant Engineer, Water Resources

David R. Brown
Environmental Specialist IV

RECOMMEND APPROVAL:

Karl P. Winkler, Chief
Delta Planning Branch

Date 4-6-90

C—041648

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APPENDIX E
MEASURING ECONOMIC BENEFITS OF THE SDWMP

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APPENDIX E
MEASURING ECONOMIC BENEFITS OF THE SDWMP

SUMMARY

Water supply and demand reduction alternatives examined in Appendix E are considered ordinary and, in part represent the actions that would be needed to cover potential shortfalls in dependable supplies listed in DWR Bulletin 160-87, *California Water: Looking to the Future*, November 1987.

The analysis presented in Appendix E, and discussed briefly in Chapter 3, is presented by region, including the South Coast Region, South Lahontan Region, Colorado River Region, San Francisco Bay Region, and Central Coastal Region.

Local water management program options were divided into three categories:

- shortage contingency demand management and supply enhancement options;
- long-term demand management and supply enhancement options; and
- risk management.

Shortage management contingency options are measures inplemented during shortages only and are intended to minimize the impacts of those shortages. Such measures include:

- use of banked local ground water;
- use of local carry-over storage;
- reduction of water deliveries to interruptible programs;
- purchasing water to augment normal sources of supply;
- instituting extraordinary water conservation measures; and
- rationing.

Long-term options considered include:

- waste water reclamation;
- desalination of brackish drainage and ground water;
- desalination of sea water; and
- development of water by importation.

Another long-term management strategy evaluated in this analysis is the explicit evaluation of risk with regard to the optimal level of use of long-term management options.

Economic benefits of the proposed South Delta Water Management Program were determined by using the Economic Risk Model directly for the South Coast Region and State Water Project agricultural contractors in Kings and Kern counties. This is accomplished by using:

- the model results indirectly for the Central Coast Region, and
- current water costs to estimate willingness to pay for water in the San Francisco Bay and Sacramento regions.

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APPENDIX F
SDWMP BIOLOGICAL ASSESSMENT

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APPENDIX F
SOUTH DELTA WATER MANAGEMENT PROJECT
BIOLOGICAL ASSESSMENT SUMMARY

A biological assessment was completed by ECOS, Inc., to evaluate potential impacts of the South Delta Water Management Program on threatened, endangered, and candidate species. Two draft reports were prepared. They are *South Delta Water Management Project Biological Assessment,* October 1987, and *Biological Data Report for the Expanded Clifton Court Forebay,* January 1989.

The proposed actions evaluated in this biological assessment include the following:

- channel enlargement and dredging of Old River from Salmon Slough to San Jose Road,
- channel enlargement and dredging of Middle River from the Mokelumne Aqueduct to Highway 4,
- dredging of Victoria and North Victoria canals,
- construction of barrier-type facilities on Old River and Grant Line Canal near the Contra Costa County border, and
- the expansion of Clifton Court Forebay into the surrounding islands.

The proposed actions have the potential to significantly affect several special status species. The fresh water marshes and swamps on instream islands and banks of project area waterways support:

- Mason's *lilaeopsis* (federal candidate 2, state rare),
- California hibiscus (federal candidate 2),
- Delta tule pea (federal candidate 2),
- giant garter snakes (federal candidate 2, state threatened), and
- western pond turtles (federal candidate 2).

Swainson's hawks (federal candidate 2, state threatened) nest along Old River, and also might be affected by the proposed project. Mitigation measures that will reduce impacts to these special status species to less-than-significant levels are discussed in the species accounts.

The results of this assessment are summarized in Table 4-1 of Chapter 4 of the EIR/EIS.

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APPENDIX G
DIRECT FISH IMPACT ANALYSIS

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APPENDIX G
DIRECT FISH IMPACT ANALYSIS

INTRODUCTION

DWR and DFG jointly developed the striped bass and salmon loss model (loss model) as a tool for calculating direct fishery losses as a function of monthly pumping rates at the State Water Project (SWP). For this model, loss is defined as those losses which occur from the time fish are drawn into Clifton Court Forebay until the survivors are returned to the Delta. This program is derived from a model originally developed by Alan Baracco of the California Department of Fish and Game (DFG) in 1984. Barry Collins (DFG) further refined this concept and described it in the "Agreement Between The Department Of Water Resources And The Department of Fish and Game To Offset Direct Fishery Losses To The Harvey O. Banks Delta Pumping Plant" (also known as "The Two Agency Fish or 4-Pumps Mitigation Agreement").

As used in the Two Agency Agreement, the model calculated the direct losses of striped bass, chinook salmon, and steelhead due to SWP pumping through the Banks Pumping Plant. For further details, background, and a listing of the striped bass and salmon survival factors used in this and the above models see "Estimates of Fish Entrainment Losses Associated with the State Water Project and Federal Central Valley Project Facilities in the South Delta" (DFG Exhibit 17 and DWR Exhibit 560 submitted to the SWRCB in Phase I of the Bay/Delta Hearing).

The Department of Water Resources has modified the model to allow user defined values for various parameters to be easily entered to calculate direct losses under various conditions. The model was also put into a machine language (Pascal) to increase computational efficiency.

The Loss Model Program

The loss model is a menu-driven program. The model calculates the following information for striped bass, chinook salmon, and steelhead trout over 20 millimeters (mm) long:

- the number of fish entering Clifton Court Forebay;
- the number of fish encountering the louvers;
- the screening efficiency factor for fish greater than 21 mm long;
- the number of fish released back into the Delta;
- the number of fish directly lost as a result of SWP operations;
- the number of fish lost if they had survived to reach one year of age, or a predetermined length (Yearling Equivalent Factor (YEF); and
- the optimum velocity and the number of bays to be used that allows for maximum fish salvage efficiency.

The striped bass eggs and the larvae under 20 mm long are considered nonsalvagable; therefore, they are counted as 100 percent direct loss. The numbers lost are based on an egg- and larvae-sampling program conducted outside the Clifton Court Forebay intake.

Both the input and output files require that the monthly data be divided into halves. The first half of the month corresponds to the first through the 15th day. The second half of the month is from the 16th to the end of that month.

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The Input File

The input file must be a fixed-field ascii file, with at least two blank columns between fields of data (Table I). Once executed, the program lists all input data in the output file. In the following explanation of the input data, the numbers correspond to those in the column heads in Table I (pages 406-407).

1. **YEAR:** The year of record for the monthly salvage at the Skinner Facility.

2. **MO:** The month of record for the fish salvage.

3. **H:** The monthly fish salvage data must be divided into halves. **H** indicates the half of the month for which the data on that line is calculated.

4. **SWP Rate:** The SWP's average rate of pumping for the month. The program will accept either pumping rate (cfs) or volume pumped (acre-feet per month) and, regardless of input, will compute and list both in the output file. This value is calculated by averaging the daily mean pumping rates at the Bank's pumping plant. In the example file, average monthly pumping rates are input; it is assumed that the first and second monthly halves are similar. The loss calculations can be refined by entering the actual average pumping rate for the half-month interval rather than assuming equal rates (the mean pumping rate for the month) for both halves of the the month.

   Since Clifton Court Forebay came on line in 1971, exports have been taken from this forebay and not directly from Delta channels. The SWP rate must originate from the Bank's pumping plant rate and should not be confused with inflow into Clifton Court Forebay. The forebay inflow is needed to estimate the number of eggs and larvae entrained.

5. **LEN:** Average monthly length of fish. The screening efficiency depends on the length of fish. An overestimation in length would result in 1) an overestimate of the number of fish entering Clifton Court Forebay, the number encountering the screens, the number salvaged, the number released alive, and the screening efficiencies; and 2) an underestimate of the number lost through the screens, and mortalities from predation, trucking, and handling.

6. **SALV:** The bimonthly total of fish salvaged at the Skinner Facility. These values are monthly salvage totals divided into halves. DWR and DFG designed the fish salvage sampling process to provide an estimate of total fish salvaged for the day with an accuracy of 80% ± 50% if the daily total exceeds 10,000, and of 80% ± 100% if the daily total is less than 10,000 fish. (Anadromous Fisheries Branch Administrative Report No. 81-6, 1981). The screening efficiencies regression equations developed to estimate the monthly fish salvage have not been adjusted to account for modifications to the facility in 1984.

7-12. **EGGS AND LARVAE:** The number of striped bass eggs and the number of larvae lost (3-mm incremental length classes ranging from 3 to 20 mm);

   Since 1985, during the striped bass spawning period (May-July), DWR and DFG have been monitoring the striped bass eggs and larvae densities in the vicinity of the intake to Clifton Court Forebay. Based on the assumption that water drawn into the forebay contains the same mean densities of eggs and larvae as the water outside the forebay, these data are the basis for the entrainment values for this size group. The egg and larvae entrainment data entered into the input file to calculate 1979 through 1987 losses are the average of the actual field data collected in the 1985 and 1986 surveys. Work is underway to incorporate the 1987 and 1988 data into the average.

   All eggs and larvae drawn into the forebay are assumed lost. The loss model converts this loss into yearling equivalents in the same manner as for striped bass larger than 20 mm. The loss model lists the number of yearling equivalent striped bass under 20 mm lost under column 27 of the output file (Table II). This number is added to the total striped bass yearling equivalent loss in column 28 of the output file.

13. **LENC AND 15. LENSH:** The monthly average length of chinook salmon (column 13) and steelhead-trout (column 15) (see discussion on lengths above).

14. **SALVCS AND 16. SALVSH:** The bimonthly salvage totals for chinook salmon (column 14) and steelhead-trout (column 16).

The Output File

Output data for striped bass exceeding 21 mm long follow. In this explanation of the output file, the numbers correspond to those in Table II (pages 408-411).

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1. **YEAR:** The year of record that the loss model used to estimate the fish losses.

2. **MO:** The month in which the fish salvage occurred.

3. **H:** Which half of the monthly data the model used.

4. **SWP VOL:** The volume of water pumped during that half of the month; the volume is for the number of days in each portion of the month, so the first and second half volumes may vary.

5. **SWP RATE:** The SWP's monthly rate of pumping.

6. **OPT VOL:** The optimum velocity is the optimum approach velocity required for maximum fish salvage efficiency. Approach velocity is defined as the mean velocity of the water in the channel approaching the fish screens. At the given pumping rate, the model determines the operation of the bays that will result in velocity closest to the optimum velocity possible. From November 1 through May 15, the loss model attempts to achieve 3.25 ft/s (optimum for salmon smolts) and from May 16 through October 31, the model attempts to achieve 1.00 ft/s when small striped bass are abundant near the intakes.

7. **OPT BAYS:** The optimum bays to be used for maximum fish salvage efficiency at the given pumping rate. These bays regulate the water approach velocity needed to maximize the fish screen efficiency. As pumping increases, additional bays become operational. As you face the Banks Pumping Plant, the bays are numbered from left to right.

   Since construction in 1968, bays 1 and 2 have been divided by a center wall and could operate independently of each other. Bays 3 and 4, each of which are equal in size to the total of bays 1 and 2, lacked a center wall. After 1982, the center wall was added, and each half of the bay was renamed. Bay 3 was renamed bays 3a and 3b, and bay 4 was renamed bays 4a and 4b. Bay 5, which is the same size as bay 1, remained the same.

   Prior to installation of the center walls, both screens in each bay had to be operated in conjunction with one another since there was no way to alter the approach velocity in front of one screen and not affect the approach velocity of the facing screen in the same bay. DFG found that although the bays possessing the center wall are more efficient for most fish species, it was not true for salmon. However, the differences in efficiency are believed to be minimal. Neither effects of the the joint operations of these bays nor installation of the center wall are addressed in the model or in any adjustment of the data. The loss model establishes the optimum bay's selection solely on cross-sectional area needed to maintain the optimum approach velocity towards the fish screens.

8. **SFF VEL:** The water velocity flowing through the bays. **SFF VEL** is not the actual channel velocity. It is a value calculated by the model using the SWP's monthly average pumping rate and dividing it by the optimum channel width (numbers of bays times the cross-sectional area of each bay) for that pumping rate. The **SFF VEL** is a calculated velocity, which is the closest the Skinner Facility could get to the optimum velocity with the given operating criteria.

9. **LENG SB:** Average monthly length of striped bass. The loss model obtains this data from the input file and list it in the output file. See discussion of this factor under the input data.

10. **EFF SB:** The screening efficiency factor for striped bass. The program uses this value to estimate the number of fish that encounter the salvage screens (column 12). The loss model bases the screening efficiency factor on both the length of the fish salvaged, and the water velocity through the screens using regressions. Boracco (DFG) developed these equations from data collected during field tests performed in 1973. These regressions do not reflect the modifications to the Skinner Facility completed in 1984. Monthly fish salvage totals since 1984 suggest that the screening efficiencies have increased. If true, the loss model underestimates these efficiencies.

    Screening efficiencies are important in estimating the number of fish salvaged. The fish salvage is used to calculate all other parameters used to determine the direct fish losses. Underestimations of screening efficiencies leads to: 1) underestimates in both the fish salvaged and the number released alive; and 2) overestimates in the number of fish and yearling equivalents lost, the number of fish encountering the screens, the number of fish entering the forebay, and the number of fish lost by predation, trucking and hauling.

11. **SALV SB:** The listing of the striped bass's monthly salvage from the input file. (See Input File # 6.)

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12. **ENCOUNT SCREENS:** The number of striped bass estimated to have encountered the salvage screens. The loss model computes the number of fish encountering the screens as the number of fish salvaged, divided by the screening efficiency.

13. **MORT PRED:** The mortality factor due to predation (P). All losses occurring in Clifton Court Forebay are attributed to predation. This value is: 1–P = number of fish encountering the screens divided by the number of fish entrained into the forebay.

    The predation factor used to calculate the number of fish entering the forebay (column 14). The model permits the user to change the predation rate prior to program execution.

    The loss model reads all mortality rates (predation, trucking, and handling) from a data file (**MORT.DAT**) into a matrix, then determines the mortality based on the average monthly fish lengths.

14. **ENTERCCF SB:** The number of striped bass entering (entrained) Clifton Court Forebay. All fish entering the forebay are considered entrained. The loss model estimates the number of fish entrained by dividing the number of fish encountering the screens.

15. **MORT HAND:** The percentage of fish that die due to handling during the salvage process. As with the mortality due to predation, the program allows the user to change these values prior to execution. The program list these mortality rates that it uses to estimate the number of fish released alive into the Delta.

16. **MORT TRUCK:** The percentage of fish that die from being trucked back to the Delta.

17. **ALIVE SB:** The number of fish released alive back into the Delta. The loss model multiplies the number of fish in the monthly salvage by the survival factors related to the handling and trucking process.

    The number of fish released alive does not address the possibility that some fish released alive may die soon afterwards from the stress of the entrainment process. These stresses include predation, temperature extremes, and disorientation upon release. The entrainment stresses may also weaken fish and decrease their resistance to natural stresses that they normally would have survived.

18. **LOSS SB:** The number of striped bass directly lost due to SWP operations. The loss model computes this as the number of bass entering the forebay subtracted by the number of bass released alive. The loss model uses this value to estimate the number of yearling equivalents lost .

19. **YEF SB:** The yearling equivalent factor for striped bass. The program reads this factor from a data file (**YEFSB.DAT**) into an array, then determines the appropriate value based on the month (first or second half), and the average length. The data base available for the striped bass is semimonthly whereas the chinook and steelhead data are available only on a monthly basis. The program lists the factor used to compute the yearling equivalent loss in this column. The model assumes that the yearling equivalent factor for salmon and steelhead is identical (columns 39 and 50).

20. **LOSSYE SBGE21:** The loss of yearling equivalent striped bass greater than 20 mm long. The model computes this sum as the system loss (column 18) multiplied by the yearling equivalent factor (column 19).

Eggs and Larvae

21–26. **EGGS, AND LARVAE LENGTH CLASSES:** The number of striped bass eggs and larvae in each of the incremented 3-mm length classes. The model obtains these values from the input file and lists them in the output. Since all eggs and larvae entrained are assumed lost, the program directly converts these losses into yearling equivalents (column 27) in the same manner as bass larger than 20 mm discussed above.

27. **LOSSYE SBLT21:** The loss of yearling equivalent bass less than 21 mm long. The model estimates this value as the number of eggs and larvae entrained (columns 21–16) multiplied by the appropriate yearling equivalent factor.

The Total Yearling Equivalent Loss

28. **LOSS YESB:** The total yearling equivalent loss of striped bass. The model estimates this value as the sum of the yearling equivalent loss of striped bass under 21 mm, plus those yearling equivalents over 21 mm.

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Chinook Salmon and Steelhead Output

The loss model computes the output for chinook salmon and steelhead in the same manner as the striped bass. The loss model assumes that the screening efficiency, the mortalities (predation, trucking, and handling), and the yearling equivalent factors for salmon and steelhead are identical. For details of the output, see the appropriate column for striped bass above.

29. **LENG CS and 41. LENG SH:** The average monthly length of chinook salmon (column 29) and steelhead trout (column 41).

30. **EFF CS:** The screening efficiency of chinook salmon and steelhead trout. During the first half of May, the optimum velocity is set at 3.5 ft/s for chinook salmon. In the second half of May the optimum velocity is dropped to 1 ft/s for striped bass. This is reflected in the mid-month change in yearling equivalent salmon losses in May. (See **EFF SB**, #10 above.).

31. **SALV CS and 43. SALV SH:** The monthly salvage for salmon (column 31) and steelhead (column 43) for that half of the month (see striped bass salvage—column 11 above.)

32 and 44. **ENCOUT SCREEN:** The estimated number of salmon (column 32) and steelhead (column 44) encountering the salvage screens. (See **ENTERCCF SB**, #14, above.)

33. **PRED CS:** The mortality factor due to predation for both salmon and steelhead. (See **MORT PRED**, #13 above.)

34 and 46. **ENTER CCF:** The estimated number of salmon and steelhead trout (column 46) entering Clifton Court Forebay. (See **ENTERCCF SB**, #14, above.)

35. **MORT HAND and 36 MORT TRUCK:** The mortality factor due to handling (column 35) and trucking (column 36) for salmon and steelhead. (See **MORT HAND**, #15, **and MORT TRUCK**, #16, above).

37. **ALIVE CS and 49. ALIVE SH:** The number of salmon (column 37) and steelhead (column 49) released alive. (See **ALIVE SB**, #17 above).

38. **LOSS CS and 5.0 LOSS SH:** The estimated total loss for salmon (column 38) and steelhead (column 50). (See **LOSS SB**, #18 above.)

39. **YEF CS and 51. YEF SH:** The yearling equivalent loss factor used to calculate yearling equivalent losses for both steelhead and salmon. This data is available only on a monthly basis for chinook salmon and steelhead. (See **YEF SB**, #19 above.)

40. **LOSSYE CS and 52. LOSSYE SH:** The yearling equivalent losses for salmon (column 40) and steelhead (column 52). See **LOSSYE SBGE 21**, #28 above.)

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TABLE I. Illustration of the data columns in the loss model input file.

(1) YEAR	(2) MO	(3) HA	(4) SWPRate	(5) LENSB	(6) SALVSB	(7) EGGSSB	(8) 3ot6mmSB	(9) 7to10mmSB
1979	1	1	1313.	87.	17234.	0.	0.	0.
1979	1	2	1313.	87.	17234.	0.	0.	0.
1979	2	1	1626.	85.	4059.	0.	0.	0.
1979	2	2	1626.	85.	4059.	0.	0.	0.
1979	3	1	2333.	93.	304.	0.	0.	0.
1979	3	2	2333.	93.	304.	0.	0.	0.
1979	4	1	2645.	139.	298.	0.	0.	0.
1979	4	2	2645.	139.	298.	1696674.	19231000.	2144614.
1979	5	1	3000.	82.	6283.	37840000.	37015000.	7495317.
1979	5	2	3000.	82.	6283.	4861228.	76667000.	4153197.
1979	6	1	3001.	29.	432355.	427201.	22036000.	7500488.
1979	6	2	3001.	29.	432355.	0.	11587000.	7570838.
1979	7	1	4593.	42.	571865.	0.	613418.	693817.
1979	7	2	4593.	42.	571865.	0.	0.	0.
1979	8	1	5635.	65.	161376.	0.	0.	0.
1979	8	2	5635.	65.	161376.	0.	0.	0.
1979	9	1	4666.	102.	5465.	0.	0.	0.
1979	9	2	4666.	102.	5465.	0.	0.	0.
1979	10	1	3634.	89.	23732.	0.	0.	0.
1979	10	2	3634.	89.	23732.	0.	0.	0.
1979	11	1	4735.	93.	60051.	0.	0.	0.
1979	11	2	4735.	93.	60051.	0.	0.	0.
1979	12	1	5859.	102.	73383.	0.	0.	0.
1979	12	2	5859.	102.	73383.	0.	0.	0.

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(TABLE I continued)

(10) 11to14mmSB	(11) 15to18mmSB	(12) 19to20mmSB	(13) LENCS	(14) SALVCS	(15) LENSH	(16) SALVSH
0.	0.	0.	190.	1199.	347.	8.
0.	0.	0.	190.	1199.	347.	8.
0.	0.	0.	194.	593.	285.	12.
0.	0.	0.	194.	593.	285.	12.
0.	0.	0.	185.	1151.	395.	226.
0.	0.	0.	185.	1151.	395.	226.
0.	0.	0.	122.	14496.	384.	505.
0.	0.	0.	122.	14496.	384.	505.
0.	0.	0.	93.	29894.	364.	485.
479746.	0.	0.	93.	29894.	364.	485.
1919741.	347552.	0.	92.	4768.	0.	0.
1025524.	0.	0.	92.	4768.	0.	0.
950834.	94153.	176826.	70.	2823.	0.	0.
0.	0.	0.	70.	2823.	0.	0.
0.	0.	0.	102.	180.	0.	0.
0.	0.	0.	102.	180.	0.	0.
0.	0.	0.	126.	35.	0.	0.
0.	0.	0.	126.	35.	0.	0.
0.	0.	0.	183.	759.	0.	0.
0.	0.	0.	183.	759.	0.	0.
0.	0.	0.	154.	2696.	474.	10.
0.	0.	0.	154.	2696.	474.	10.
0.	0.	0.	161.	2625.	0.	12.
0.	0.	0.	161.	2625.	0.	12.

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TABLE II. Description of data columns in the loss model output file.

(1) YEAR	(2) MO	(3) H	(4) SWP VOL	(5) SWP RATE	(6) OPT VEL	(7) OPT BAYS	(8) SFF VEL	(9) LENG SB	(10) EFF SB	(11) SALV SB	(12) ENCOUNT SCREENS	(13) MORT PRED	(14) ENTERCCF SB	(15) MORT HAND	(16) MORT TRUCK	(17) ALIVE SB
1979	1	1	39065	1313	3.25	1	3.13	87	0.72	17234	23908	0.29	33673	0.06	0.03	15714
1979	1	2	41669	1313	3.25	1	3.13	87	0.72	17234	23908	0.29	33673	0.06	0.03	15714
1979	2	1	48378	1626	3.25	1	3.87	85	0.67	4059	6082	0.29	8566	0.06	0.03	3701
1979	2	2	41927	1626	3.25	1	3.87	85	0.67	4059	6082	0.29	8566	0.06	0.03	3701
1979	3	1	69413	2333	3.25	12	2.78	93	0.75	304	408	0.23	529	0.01	0.00	301
1979	3	2	74040	2333	3.25	12	2.78	93	0.75	304	408	0.23	529	0.01	0.00	301
1979	4	1	78695	2645	3.25	12	3.15	139	0.72	298	414	0.06	441	0.00	0.00	298
1979	4	2	78695	2645	3.25	12	3.15	139	0.72	298	414	0.06	441	0.00	0.00	298
1979	5	1	89257	3000	3.25	3	3.49	82	0.69	6283	9042	0.29	12735	0.06	0.03	5729
1979	5	2	95208	3000	1.00	12345	1.01	82	0.87	6283	7199	0.29	10139	0.06	0.03	5729
1979	6	1	89287	3001	1.00	12345	1.01	29	0.78	432355	550806	0.83	3240034	0.35	0.31	193911
1979	6	2	89287	3001	1.00	12345	1.01	29	0.78	432355	550806	0.83	3240034	0.35	0.31	193911
1979	7	1	136653	4593	1.00	12345	1.54	42	0.83	571865	685286	0.60	1713216	0.26	0.23	325849
1979	7	2	145763	4593	1.00	12345	1.54	42	0.83	571865	685286	0.60	1713216	0.26	0.23	325849
1979	8	1	167655	5635	1.00	12345	1.89	65	0.81	161376	199372	0.42	343746	0.16	0.13	117934
1979	8	2	178832	5635	1.00	12345	1.89	65	0.81	161376	199372	0.42	343746	0.16	0.13	117934
1979	9	1	138825	4666	1.00	12345	1.57	102	0.83	5465	6563	0.18	8003	0.00	0.00	5465
1979	9	2	138825	4666	1.00	12345	1.57	102	0.83	5465	6563	0.18	8003	0.00	0.00	5465
1979	10	1	108121	3634	1.00	12345	1.22	89	0.86	23732	27674	0.29	38977	0.06	0.03	21639
1979	10	2	115329	3634	1.00	12345	1.22	89	0.86	23732	27674	0.29	38977	0.06	0.03	21639
1979	11	1	140878	4735	3.25	13	3.70	93	0.68	60051	88341	0.23	114728	0.01	0.00	59450
1979	11	2	140878	4735	3.25	13	3.70	93	0.68	60051	88341	0.23	114728	0.01	0.00	59450
1979	12	1	174320	5859	3.25	34	3.41	102	0.70	73383	104719	0.18	127706	0.00	0.00	73383
1979	12	2	185941	5859	3.25	34	3.41	102	0.70	73383	104719	0.18	127706	0.00	0.00	73383

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(TABLE II continued)

(18) LOSS SB	(19) YEF SB	(20) LOSSYE SBGE21	(21) EGGS	(22) SB 3-6	(23) SB 7-10	(24) SB 11-14	(25) SB 15-18	(26) SB 19-20	(27) LOSSYE SBLT21	(28) LOSS YESB
17959	0.63694	11439	0	0	0	0	0	0	0	11439
17959	0.69581	12496	0	0	0	0	0	0	0	12496
4865	0.77718	3781	0	0	0	0	0	0	0	3781
4865	0.88158	4289	0	0	0	0	0	0	0	4289
228	1.00000	228	0	0	0	0	0	0	0	228
228	1.00000	228	0	0	0	0	0	0	0	228
143	1.00000	143	0	0	0	0	0	0	0	143
143	1.00000	143	1696674	19231000	2144614	0	0	0	3189	3332
7006	1.00000	7006	37840000	37015000	7495317	0	0	0	8902	15908
4410	1.00000	4410	4861228	76667000	4153197	479746	0	0	12343	16753
3046123	0.00624	19020	427201	22036000	7500488	1919741	347552	0	12334	31354
3046123	0.00648	19754	0	11587000	7570838	1025524	0	0	6569	26323
1387367	0.04625	64171	0	613418	693817	950834	94153	176826	6910	71081
1387367	0.04804	66649	0	0	0	0	0	0	0	66649
225812	0.18710	42249	0	0	0	0	0	0	0	42249
225812	0.19432	43880	0	0	0	0	0	0	0	43880
2538	0.62406	1584	0	0	0	0	0	0	0	1584
2538	0.63974	1624	0	0	0	0	0	0	0	1624
17338	0.44693	7749	0	0	0	0	0	0	0	7749
17338	0.46419	8048	0	0	0	0	0	0	0	8048
55278	0.59944	33136	0	0	0	0	0	0	0	33136
55278	0.62259	34416	0	0	0	0	0	0	0	34416
54323	0.74330	40378	0	0	0	0	0	0	0	40378
54323	0.77200	41938	0	0	0	0	0	0	0	41938

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(TABLE II continued)

(29) LENG CS	(30) EFF CS	(31) SALV CS	(32) ENCOUNT SCREEN	(33) PRED CS	(34) ENTER CCF	(35) MORT HAND	(36) MORT TRUCK	(37) ALIVE CS	(38) LOSS CS	(39) YEF CS	(40) LOSSYE CS	(41) LENG CS
190	0.75	1199	1601	0.75	6403	0.00	0.00	1199	5204	1.0000	5204	347
190	0.75	1199	1601	0.75	6403	0.00	0.00	1199	5204	1.0000	5204	347
194	0.79	593	749	0.75	2994	0.00	0.00	593	2401	1.0000	2401	285
194	0.79	593	749	0.75	2994	0.00	0.00	593	2401	1.0000	2401	285
185	0.73	1151	1579	0.75	6317	0.00	0.00	1151	5166	1.0000	5166	395
185	0.73	1151	1579	0.75	6317	0.00	0.00	1151	5166	1.0000	5166	395
122	0.75	14496	19320	0.75	77279	0.00	0.00	14496	62783	1.0000	62783	384
122	0.75	14496	19320	0.75	77279	0.00	0.00	14496	62783	1.0000	62783	384
93	0.80	29894	37259	0.75	149037	0.02	0.00	29296	119741	0.3200	38317	364
93	0.68	29894	43979	0.75	175917	0.02	0.00	29296	146620	0.3200	46919	364
92	0.68	4768	7014	0.75	28057	0.02	0.00	4673	23385	0.3200	7483	0
92	0.68	4768	7014	0.75	28057	0.02	0.00	4673	23385	0.3200	7483	0
70	0.71	2823	3998	0.75	15991	0.02	0.00	2767	13225	0.3200	4232	0
70	0.71	2823	3998	0.75	15991	0.02	0.00	2767	13225	0.3200	4232	0
102	0.68	180	266	0.75	1063	0.00	0.00	180	883	1.0000	883	0
102	0.68	180	266	0.75	1063	0.00	0.00	180	883	1.0000	883	0
126	0.66	35	53	0.75	213	0.00	0.00	35	178	1.0000	178	0
126	0.66	35	53	0.75	213	0.00	0.00	35	178	1.0000	178	0
183	0.64	759	1189	0.75	4754	0.00	0.00	759	3995	1.0000	3995	0
183	0.64	759	1189	0.75	4754	0.00	0.00	759	3995	1.0000	3995	0
154	0.78	2696	3447	0.75	13787	0.00	0.00	2696	11091	1.0000	11091	474
154	0.78	2696	3447	0.75	13787	0.00	0.00	2696	11091	1.0000	11091	474
161	0.77	2625	3430	0.75	13721	0.00	0.00	2625	11096	1.0000	11096	0
161	0.77	2625	3430	0.75	13721	0.00	0.00	2625	11096	1.0000	11096	0

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(TABLE II continued)

(42) EFF SH	(43) SALV SH	(44) ENCOUNT SCREEN	(45) PRED SH	(46) ENTER CCF	(47) MORT HAND	(48) MORT TRUCK	(49) ALIVE SH	(50) LOSS SH	(51) YEF SH	(52) LOSSYE SH
0.75	8	11	0.75	43	0.00	0.00	8	35	1.0000	35
0.75	8	11	0.75	43	0.00	0.00	8	35	1.0000	35
0.79	12	15	0.75	61	0.00	0.00	12	49	1.0000	49
0.79	12	15	0.75	61	0.00	0.00	12	49	1.0000	49
0.73	226	310	0.75	1240	0.00	0.00	226	1014	1.0000	1014
0.73	226	310	0.75	1240	0.00	0.00	226	1014	1.0000	1014
0.75	505	673	0.75	2692	0.00	0.00	505	2187	1.0000	2187
0.75	505	673	0.75	2692	0.00	0.00	505	2187	1.0000	2187
0.77	485	630	0.75	2520	0.00	0.00	485	2035	1.0000	2035
0.63	485	774	0.75	3098	0.00	0.00	485	2613	1.0000	2613
0.68	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.68	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.71	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.71	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.72	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.72	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.71	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.71	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.69	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.69	0	0	0.75	0	0.02	0.00	0	0	0.8727	0
0.78	10	13	0.75	51	0.00	0.00	10	41	1.0000	41
0.78	10	13	0.75	51	0.00	0.00	10	41	1.0000	41
0.80	12	15	0.75	60	0.02	0.00	12	48	0.8727	42
0.80	12	15	0.75	60	0.02	0.00	12	48	0.8727	42

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APPENDIX H
U.S. FISH AND WILDLIFE SERVICE COORDINATION ACT SUMMARY

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APPENDIX H
U. S. FISH AND WILDLIFE SERVICE'S COORDINATION SUMMARY

U. S. Fish and Wildlife Service's (USF&WS's) Coordination Act Report will contain a complete environmental impact analysis of the South Delta Water Management Program (SDWMP). The report will be incorporated into the EIR.

The impacts of the different features of the SDWMP, and the compensation needs arising from those impacts were evaluated using the USF&WS's Habitat Evaluation Procedures (HEP). HEP is a methodology used to document the quality and quantity of available habitat for selected wildlife species.

Three HEP analysis were completed for features of the SDWMP:

- the enlargement of Clifton Court Forebay by 3,000 surface acres;
- the enlargement of selected south Delta channels; and
- the Delta Mendota Canal intertie to Clifton Court Forebay.

USF&WS has prepared three draft reports that document the impacts and compensation needs analysis, using HEP. These are: *Enlargement of Clifton Court Forebay, Enlargement of Selected Channels in the Southern Delta*, and *A Canal Intertie–Clifton Court Forebay to Delta Mendota Canal*. All three documents are available for review at the Department of Water Resources. The final results of the analysis will be discussed in USF&WS's draft Coordination Act Report.

A HEP application is based on the assumption that habitat for selected wildlife species or communities can be described by a model, which produces a Habitat Suitability Index (HSI). The HSI values are multiplied by the area of available habitat to obtain Habitat Units (HUs). HUs are used to 1) compare the relative value of different areas at the same point in time and 2) compare the relative value of the same area at future points in time. When the two types of comparisons are compared, the impacts of proposed or anticipated land and water use changes on wildlife habitat can be quantified.

Sherman Island was a Delta island evaluated as a possible compensation area for the project in the draft. Delta islands, and tracts other than Sherman Island, especially those having lower existing habitat values for the evaluation species, should be evaluated by the HEP team as possible mitigation areas.

The preliminary results of the analysis for the enlargement of Clifton Court Forebay are discussed in Chapter 5, in the section "Impacts on Wildlife and Wildlife Habitat."

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APPENDIX I
SOUTH DELTA FACILITIES PLANNING

Reconnaissance Designs and Cost Estimates

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SUMMARY OF APPENDIX I
SOUTH DELTA FACILITIES PLANNING

Reconnaissance Designs and Cost Estimates

Design alternatives and costs estimates were prepared for the South Delta Water Management Program (SDWMP) by DWR's Division of Design and Construction. The proposed projects include:

- alternatives for enlargement of Clifton Court Forebay;
- construction of tidal control facilities; and
- dredging of some waterways in the south Delta region.

Possible Tidal Control Facilities

Middle River Tide Gate Structure. The proposed facility will consist of a gate structure and boat lock to be constructed just east of the Highway 4 bridge. Flood flow capacity of the structure is estimated to be 4,000 cubic feet per second (cfs).

Grant Line Canal. The proposed Grant Line Canal tide gate structure will be located at the confluence of Grant Line Canal and Old River. It will consist of a gate structure with four radial gates separated by piers that will accommodate flood flows of up to 20,000 cfs.

Old River. The proposed Old River tide gate structure would be located on Old River at the site of the temporary rock barriers emplaced by DWR during the 1976–77 drought. The structure would consist of three radial gates, a 70–foot–wide flashboard opening, and a boat lock. The design would require construction of a new 1,000–foot–long levee south of the existing levee.

Old River Rubber Dam. An additional project in the vicinity of Old River would consist of an inflatable rubber dam attached to a concrete raft, which would be positioned at the confluence of the Old and San Joaquin rivers. The rubber dam would divert good–quality water into the San Joaquin River during the low–flow autumn months and would provide a positive flow to aid migratory fish.

Enlargement of Clifton Court Forebay

Appendix I discusses five alternatives for the enlargement of Clifton Court Forebay.

Alternative 1 would require 77,000 lineal feet of dam embankment enclosing a forebay expansion on the eastern portion of Byron Tract. The project will require a new intake structure, a breach of an existing levee to connect the new and existing forebay, and construction of a bridge at Highway 4. A pumping plant to service the Byron Bethany Irrigation District would also be required.

Alternative 2 adds about 3,000 acres to the existing forebay in the southwestern portion of Victoria Island. The project will require 46,000 lineal feet of dam embankment, a new intake structure, and a siphon across Old River.

Alternative 3 would use Coney Island and the southeastern portion of Byron Tract to expand the forebay. This alternative will required 77,000 lineal feet of dam embankment, a siphon across West Canal, a new intake structure, and a breach in the levee to join the existing forebay with the new forebay in Byron Tract. Also required for this alternative is a pumping plant to service Byron Bethany Irrigation District.

Alternative 4 does not enlarge the existing forebay but will require relocation of the intake structure to the northeast edge of the forebay.

Alternative 5 would require the use of the northwestern portions of Victoria Island and the southeastern portion ofByron Tract, expanding the existing forebay by some 2,860 acres. The project will require about 82,000 lineal feet of dam embankment, realignment of Highway 4, construction of a siphon across Old River, construction of a new intake structure near the northwest corner of Victoria Island forebay, and a breach in the existing levee at Italian Slough. A pumping plant to service the Byron Bethany Irrigation District would also be required.

Use of the remaining 900 acres on the lower Clifton Court Tract will also be considered with these alternmatives.

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Dredging Channels

Segments of Old River, Middle River, Woodward Canal, Victoria Canal, and Santa Fe Cut will be dredged to provide a minimum cross-sectional area of 7,200 square feet. Dredged materials will be placed behind the existing levees, and a toe drain will be constructed 30 feet from the toe of all new levees. Some segments of these channels will require construction of new levees, which will be riprapped and built up to 1.5 feet above the 100-year-flood elevation.

The following tables list the approximate quantities of materials needed for each component and the costs associated with them. Typical schematics of the components are attached.

Abbreviations Used in Tables I-1—I-12

Bbl	barrel
CMP	corrugated metal pipe
CY	cubic yard
lb.	pound
LF	linear foot
LS	lump sum
Mo.	month
psi	pounds per square inch
SF	square foot

Table I-1
Materials Used for a Typical Intake Structure

Item	Unit	Quantity
Excavation	CY	73,000
Compacted backfill	CY	2,000
Pervious backfill	ton	5,000
Filter material	ton	6,000
Riprap	ton	9,000
Concrete in transition well	CY	900
Concrete in transition floor	CY	700
Concrete in structure	CY	1,500
Cement (type V)	Bbl	4,700
Reinforcement	lb	320,000
Control building	LS	—
Electrical	LS	—
Miscellaneous metal	lb	1,600
Handrail	LF	400
Radial gate, 19'x29'x6"	each	5
Radial gate hoist	each	5
Electrical generator	LS	—
Heat pump	LS	—
Mechanical equipment	LS	—
Chain link fence	LF	18,000
Double drive gate	each	6
Log boom	LS	—
Marker buoy	LS	—
Cathodic protection	LS	—

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C-041670

Table I–2
Estimated Costs of A Typical Intake Structure

Item	Cost ($)
Excavation	438,000
Compacted backfill	20,000
Pervious backfill	75,000
Filter material	90,000
Riprap	180,000
Concrete in transition wall	247,500
Concrete in transition floor	105,000
Concrete in structure	912,500
Cement (Type V)	70,500
Reinforcement	160,000
Control building	25,000
Electrical	66,000
Miscellaneous metal	4,000
Handrail	18,000
Radial gate, 19'x29'x6"	1,055,000
Radial gate hoist	515,000
Electrical generator	50,000
Heat pump	5,000
Mechanical equipment	89,000
Chain link fence	270,000
Double drive gate	3,200
Log boom	30,000
Marker buoy	2,500
Cathodic protection	150,000
Miscellaneous @ 20%	816,200
Subtotal	4,897,000
Low Bid Cost	4,897,000
State operation & contingencies @ 35%	1,714,000
Total First Cost	**6,611,000**

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Table I-3
Materials Used for a Typical Bridge on Highway 4

Item	Unit	Quantity
Concrete	CY	1,700
Reinforcement	lb	192,300
Excavation	CY	230
Filter material	ton	1,300
Riprap	ton	2,400
Cement	Bbl	2,975
Backfill	CY	160
Furnish 70-ton cone pile	LF	8,200
Drive pile	each	105
Metal beam guard rail	LF	60
Joint seal	LF	100
Traffic detour	LS	—
Embankment for approach	ton	94,000
Aggregate base	ton	6,000
Asphaltic concrete	ton	700

Table I-4
Estimated Costs of a Typical Bridge on Highway 4

Item	Cost ($)
Concrete	510,000
Reinforcement	71,150
Excavation	1,380
Filter material	19,500
Riprap	48,000
Cement	44,625
Backfill	1,600
Furnish 70-ton cone pile	82,000
Drive pile	105,000
Metal beam guard rail	2,100
Joint seal	5,000
Traffic detour	50,000
Embankment for approach	423,000
Aggregate base	102,000
Asphaltic concrete	35,000
Miscellaneous @ 20%	300,000
Subtotal	1,800,000
Low bid cost	1,800,000
State operation and contingencies @ 35%	630,000
Total first cost	**2,430,000**

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C-041672

Table I–5
Materials Used for a Typical Siphon Structure

Item	Unit	Quantity
Excavation	CY	341,000
Backfill	CY	205,000
Filter material	ton	6,500
Riprap	ton	22,300
Concrete	CY	29,000
Cement	Bbl	51,000
Reinforcement	lb	1,432,000
Sheet pile	lb	16,000,000
Sand fill for cellular cofferdam	ton	179,000
Transition concrete	CY	5,000
Piles	LF	14,000
CMP pipe	LF	4,000
Timber	LF	9,000

Table I–6
Estimated Costs of a Typical Siphon Structure

Item	Cost ($)
Excavation	1,023,000
Backfill	410,000
Filter material	97,500
Riprap	446,000
Concrete	6,670,000
Cement	765,000
Reinforcement	716,000
Sheet pile	16,000,000
Sand fill for cellular cofferdam	1,342,500
Transition concrete	1,200,000
Piles	350,000
CMP pipe	200,000
Timber	189,000
Miscellaneous @ 20%	5,881,800
Subtotal	35,290,000
Low bid cost	35,290,000
State operation & contingencies @ 35%	12,351,500
Total first cost	**47,641,500**

C—041673

C-041673

Table I-7
Materials Used for a Typical Forebay Expansion

Item	Unit	Quantity
Embankment (imported)	CY	5,835,100
6-inch sand filter	ton	153,000
18-inch riprap	ton	573,000
3-inch aggregate base	ton	29,000
Breach existing levee	CY	152,000
Relocate pump	—	—
36-inch CMP	LF	150

Table I-8
Estimated Costs of a Typical Forebay Expansion

Item	Cost ($)
Embankment (imported)	46,680,800
6-inch sand filter	1,836,000
18-inch riprap	11,460,000
3-inch aggregate base	493,000
Breach existing levee	608,000
Relocate pump	130,000
36-inch CMP	7,500
Miscellaneouos @ 20%	12,243,000
Subtotal	73,458,000
Low bid cost	73,458,000
State operation & contingencies @ 35%	25,710,300
Total first cost	**99,168,300**

C—041674

C-041674

Table I–9
Materials Used for a Typical Barrier Type Facility (Tide Gate)

Item	Unit	Quantity
Concrete	CY	1,450
Radial gate	lb	15,000
Sector gate	lb	42,000
Reinforcement	lb	378,290
Cofferdam sheet pile	SF	198,110
Cofferdam excavation	CY	17,440
Cofferdam backfill	CY	50,670
Gate hoist	each	1
Boat lock building	SF	225
Sheet piling	SF	10,000
Mechanical equipment	LS	—
Structure excavation	CY	1,800
Site work	LS	—
Cathodic protection	LS	—
Mobilization	LS	—
Riprap	ton	4,800
Dewatering	LS	—
Structural backfill	CY	1,240
Electrical	LS	—
Hand railing	LF	1,351
Control building	SF	288
Chain link fencing gate	each	172
Log boom	each	9
Channel excavation	CY	3,560
Sand filter	CY	1,500
Floating dock	each	8
Marker buoy	each	8
Timber piles	LF	1,200
Walkway on sheet piling, 6–ft wide	LF	250
Heating, ventilation, and air conditioning	LS	—

C—041675

C-041675

Table I-10
Estimated Costs of a Typical Barrier Type Facility (Tide Gate)

Item	Cost ($)
Concrete	543,750
Radial gate	48,000
Sector gate	273,000
Reinforcement	189,145
Cofferdam sheet pile	2,971,650
Cofferdam excavation	87,200
Cofferdam backfill	506,700
Gate hoist	32,000
Boat lock building	45,000
Sheet piling	250,000
Mechanical equipment	89,000
Structure excavation	21,600
Site work	260,000
Cathodic protection	150,000
Mobilization	75,000
Riprap	96,000
Dewatering	75,000
Structural backfill	24,800
Electrical	380,000
Hand railing	60,795
Control building	24,480
Chain link fencing and gate	2,580
Log boom	10,000
Channel excavation	28,480
Sand filter	37,500
Floating dock	24,000
Marker buoy	4,000
Timber piles	25,200
Walkway on sheet piling, 6-ft wide	87,500
Heating, ventilation, and air conditioning	14,000
Miscellaneous @ 20%	1,287,436
Subtotal	7,725,000
Low bid cost	7,725,000
State operation & contingencies @ 35%	2,704,000
Total first cost	**10,429,000**

C—041676

C-041676

Table I-11
Materials Used for a Typical Inflatable Barrier Type Facility

Item	Unit	Quantity
Mobilization	LS	—
Barrier rock (200-400 lb)	ton	9,800
Armor rock (600-1,400 lb)	ton	1,700
Sheet piling (0.27/lb/SF)	SF	950
Piling W14x48	LF	560
Water piping (35-in. dia.)	LF	100
Above-water air piping (12-in. dia)	LF	100
(Under water) Prepare and level base bed	LS	—
Concrete caisson	CY	855
Reinforcing steel	lb	220,000
Fabric bag - complete	SF	3,960
Launch and tow caissons	each	1
Set caisson	each	1
Field piping connection	each	2
Position tensing system	LS	—
Navigation aids	LS	—
Under water inspection	Mo.	6
Channel excavation	CY	8,300
Site work	LS	—
Control building	SF	375
Trench excavation	CY	225
Rock backfill	CY	160
Water piping (36-in. dia)	LF	100
Under water air piping (12-in. dia)	LF	100
Above water cathodic protection	LS	—
Water pipe	LS	—
Compressor (700 CPM, 30 psi)	LS	—
Diesel generator 60 KW	LS	—
Electrical switchgear	LS	—
Building HVAC & electrical	LS	—

C—041677

C-041677

Table I–12
Estimated Costs of a Typical Inflatable Barrier Type Facility

Item	Cost ($)
Mobilization	146,600
Barrier rock (200 - 400 lb)	196,000
Armor rock (600 - 1,400 lb)	44,200
Sheet piling (0.27 lb/SF)	23,750
Piling W14x48	12,880
Water piping (35–in. dia)	6,000
Above water air piping (12–in. dia)	20,000
(Under water) Prepare and level base bed	5,200
Concrete caisson	513,000
Reinforcing steel	110,000
Fabric bag — complete	1,124,640
Launch and tow caissons	42,000
Set caisson	25,000
Field piping connection	4,800
Position tensing system	13,800
Navigation aids	1,600
Under water inspection	60,588
Channel excavation	16,600
Site work	56,000
Control building	34,500
Trench excavation	2,700
Rock backfill	3,520
Water piping (36–in. dia)	8,800
Under water air piping (12–in. dia)	2,600
Above water cathodic protection	100,000
Water pump	5,100
Compressor (700 CPM, 30 psi)	30,000
Diesel generator 60 KW	25,000
Electrical switchgear	5,000
Building HVAC and electrical	25,000
Miscellaneous @ 20%	533,000
Subtotal	3,198,000
Low bid cost	3,198,000
State operation & contingencies @ 35%	1,119,000
Total first cost	**4,317,000**

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Preferred Alternative

The preferred alternative, as described in Chapter 3, is to enlarge the existing Clifton Court Forebay from 2,100 surface acres to 5,000 surface acres. Following is the summary of each component and its estimated costs:

Item	Qty	Brief Description	Approximate Cost ($ millions)
Intake Structure	2	One at North Victoria Canal & Midlle River, another at North Victoria Canal & Old River.	14
Siphon	1	Hydraulically connect Victoria Island to Byron Tract	47
Channel Enlargement	1	Middle River east of Woodward Island	10
Highway 4 Realignment	—	Realignment of Highway 4 across Victoria Island	6

Forebay Configuration	Length (mi.)	Brief Description	Approximate Cost ($1,500/LF)
Additional Forebay using Victoria Island	12	North half of Victoria Island	$95 million
Additional Forebay using Byron Tract	5	Eastern portion of Byron Tract south of Highway 4	$39 million
Additional Forebay using Clifton Court Tract	2	Remaining portion of Clifton Court Tract	$16 million

Item	Qty	Brief Description	Approximate Unit Cost ($ millions)
Barrier No. 1	1	Middle River near Tracy Road	10
Barrier No. 2	1	Old River Near Delta Mendota Canal	10
Barrier No. 3	1	Grant Line Canal near Delta Mendota Canal	10
Barrier No. 4	1	Old River at the San Joaquin River Confluence	5

About 6 million cubic yards of borrow material will be imported for construction of additional forebay. All borrow material for the embankment is to be from the high-elevation lands within the forebay area, or from the stored materials within the existing Delta complex right-of-way remaining from previous construction. Materials can also be imported from any commercial borrow sites within a reasonable distance of the project area.

Northern Intake — Barrier A

Following is the summary of each component and its estimated costs for the Northern Intake-Barrier A alternative:

Item	Qty	Brief Description	Approximate Cost ($ millions)
Intake Structure	1	At northeastern corner of the existing forebay.	7
Channel Enlargement	—	Middle River east of Victoria Island	10
Channel Enlargement	—	Victoria and North Canals	8

Item	Qty	Brief Description	Approximate Unit Cost ($ millions)
Barrier No. 1	1	Middle River near Tracy Road	10
Barrier No. 2	1	Old River Near Delta Mendota Canal	10
Barrier No. 3	1	Old River at the San Joaquin River Confluence	5

Northern Intake — Barrier B

Following is the summary of each component and its estimated costs for the Northern Intake-Barrier B alternative:

Item	Qty	Brief Description	Approximate Cost ($ millions)
Intake Structure	1	At northeastern corner of the existing forebay.	7
Channel Enlargement	—	Middle River east of Victoria Island	10
Channel Enlargement	—	Victoria and North Canals	8

Item	Qty	Brief Description	Approximate Unit Cost ($ millions)
Barrier No. 1	1	Middle River near Tracy Road	10
Barrier No. 2	1	Old River Near Delta Mendota Canal	10
Barrier No. 3	1	Grant Line Canal near Delta Mendota Canal	10

Highway 4 Intake — Barrier B

Following is the summary of each component and its estimated costs for the Highway 4 Intake—Barrier B alternative:

Item	Qty	Brief Description	Approximate Cost ($ millions)
Intake Structure	1	Just south of Highway 4 in the northeastern corner of Byron Tract	7
Siphon	1	Hydraulically connect Forebay to Byron Tract/Coney Island	47
Channel Enlargement	1	Middle River east of Woodward Island	10
Channel Enlargement	—	Woodward and North Victoria Canals	6

Forebay Configuration	Length (mi.)	Brief Description	Approximate Cost ($1,500/LF)
Additional Forebay using Coney Island	5	Entire Coney Island	$39 million
Additional Forebay using Byron Tract	5	Eastern portion of Byron Tract, south of Highway 4	$39 million
Additional Forebay using Clifton Court Tract	2	Remaining portion of Clifton Court Tract	$16 million

Item	Qty	Brief Description	Approximate Unit Cost ($ millions)
Barrier No. 1	1	Middle River near Tracy Road	10
Barrier No. 2	1	Old River Near Delta Mendota Canal	10
Barrier No. 3	1	Grant Line Canal near Delta Mendota Canal	10

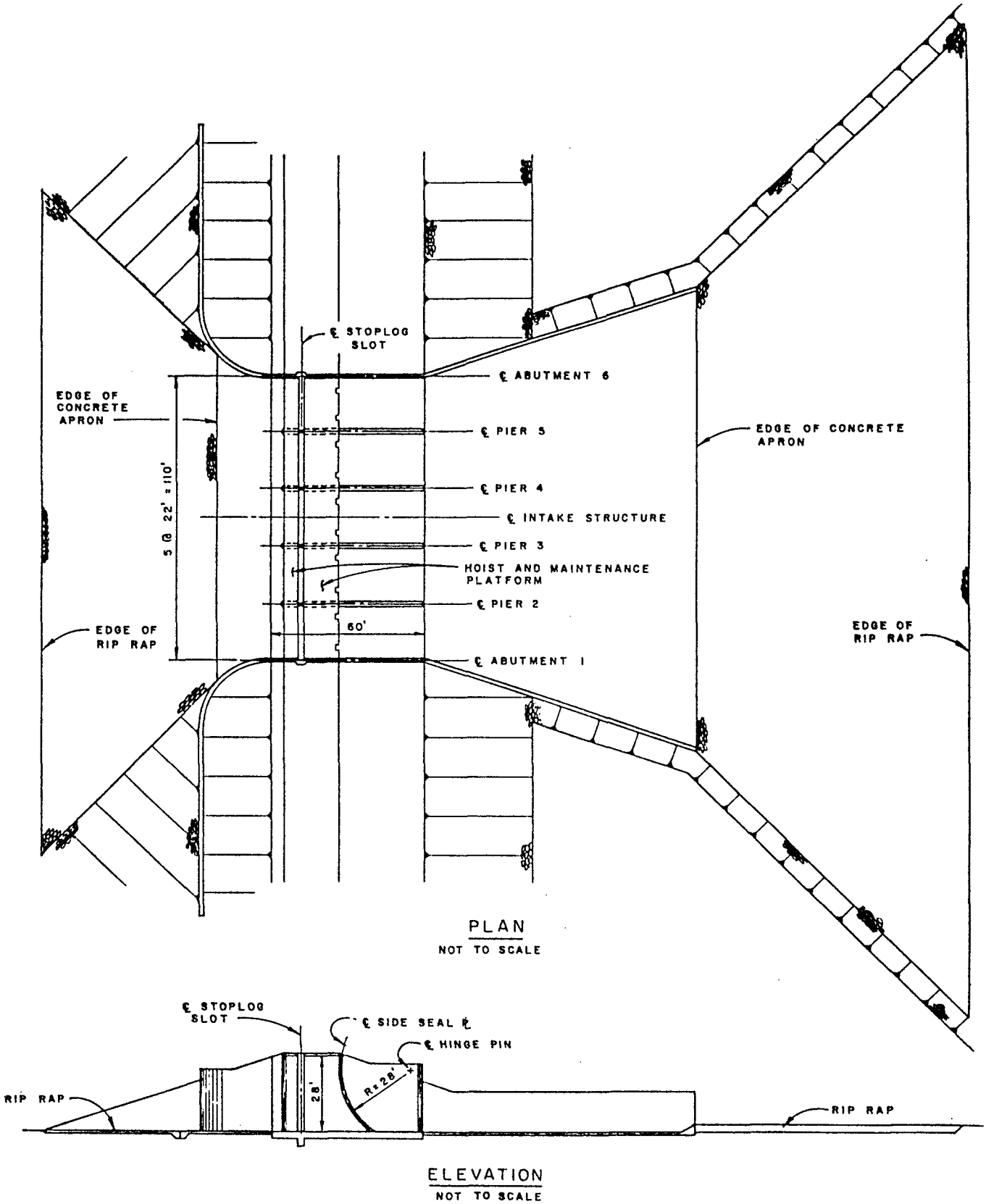

Figure I–1. Typical Intake Structure

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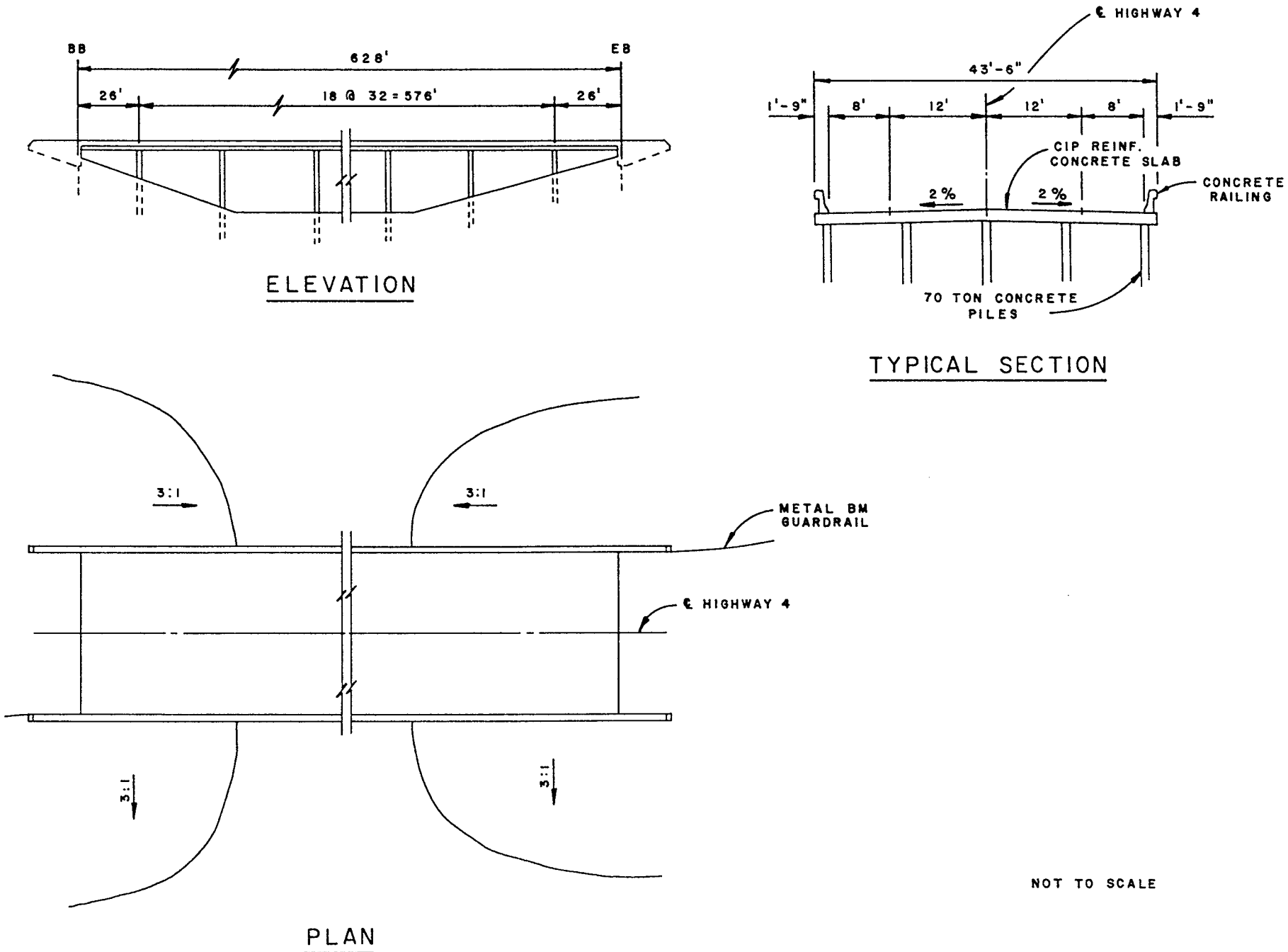

Figure I–2. Typical Highway 4 Bridge

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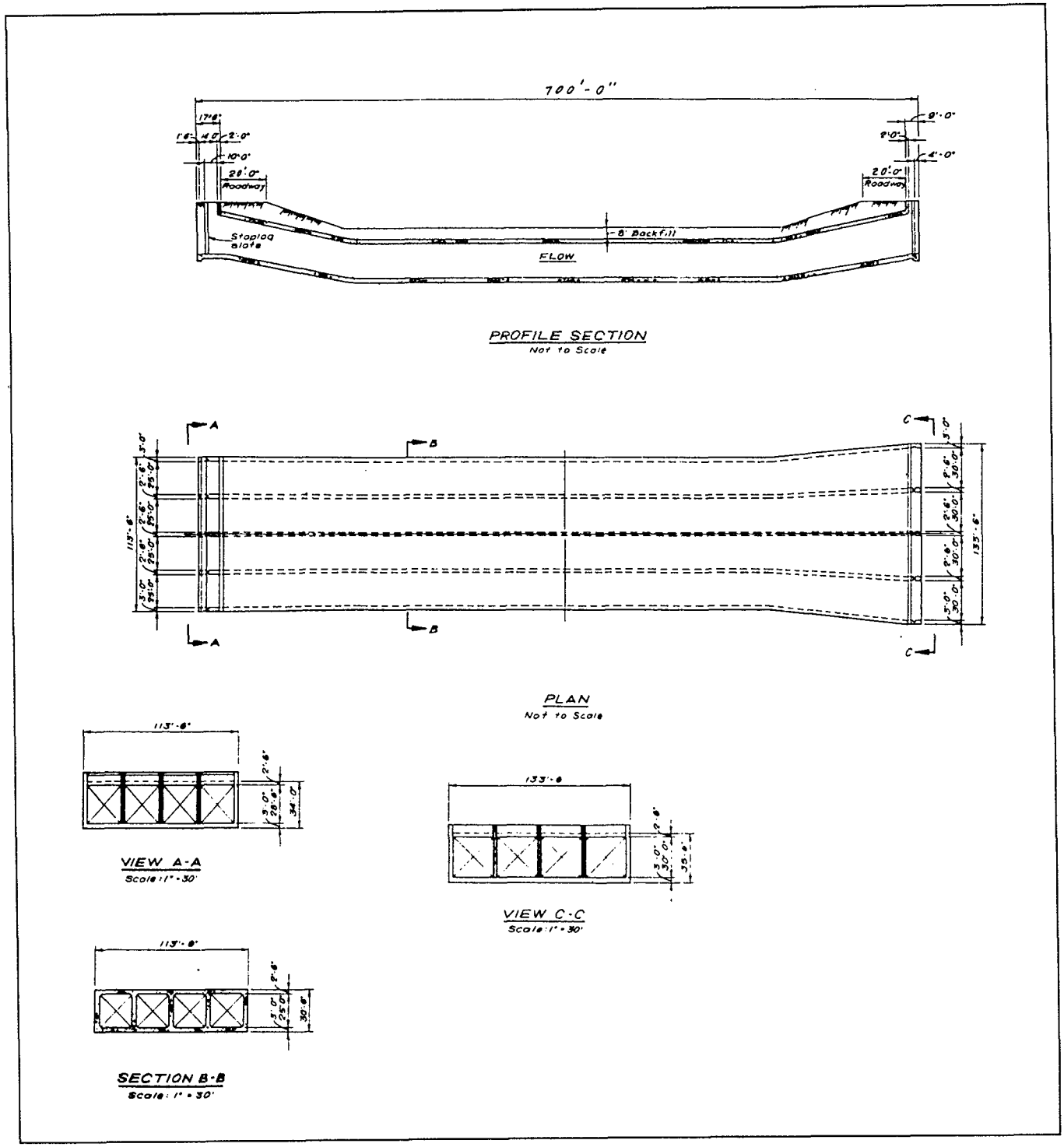

Figure I–3. Typical Siphon Structure

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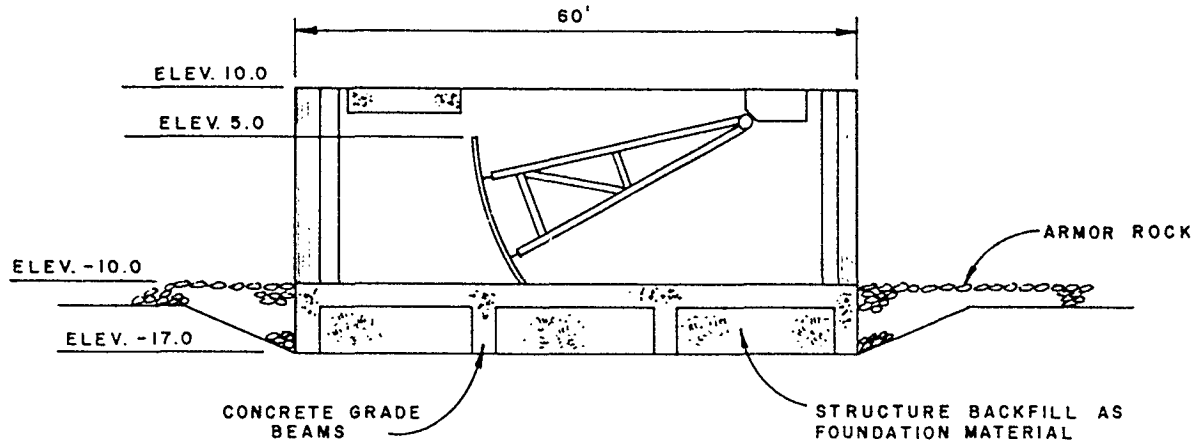
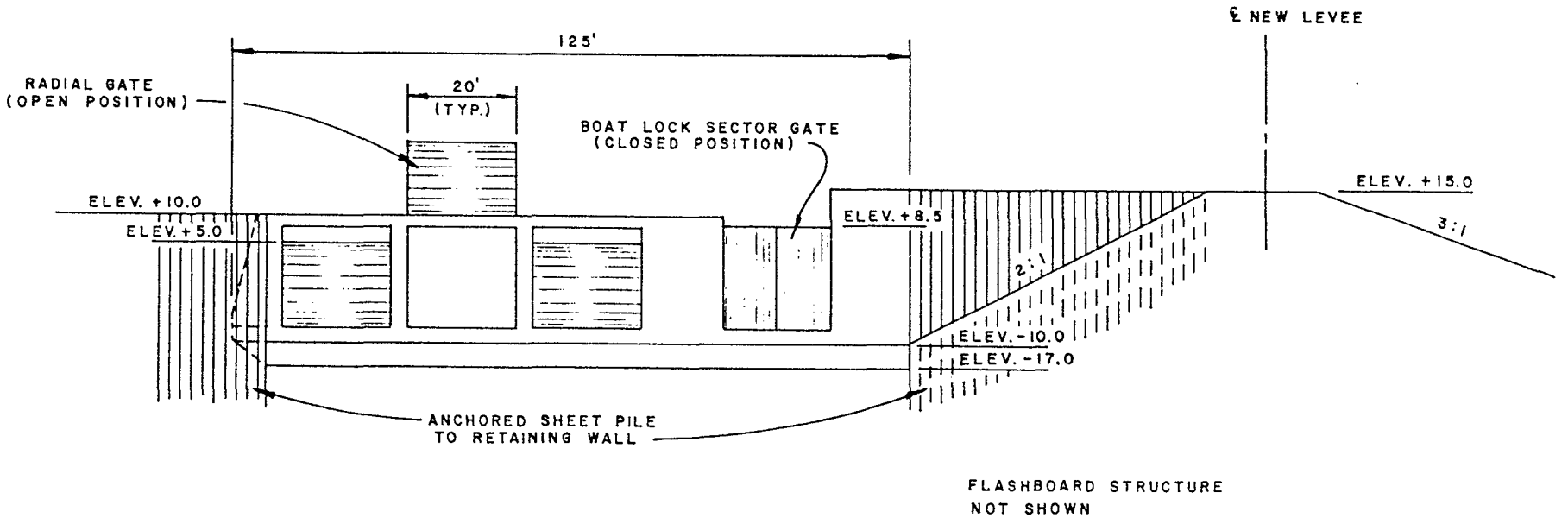
C-041684



SECTION A-A



SECTION B-B

Figure I–4. Typical Tide Gate

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C—041685

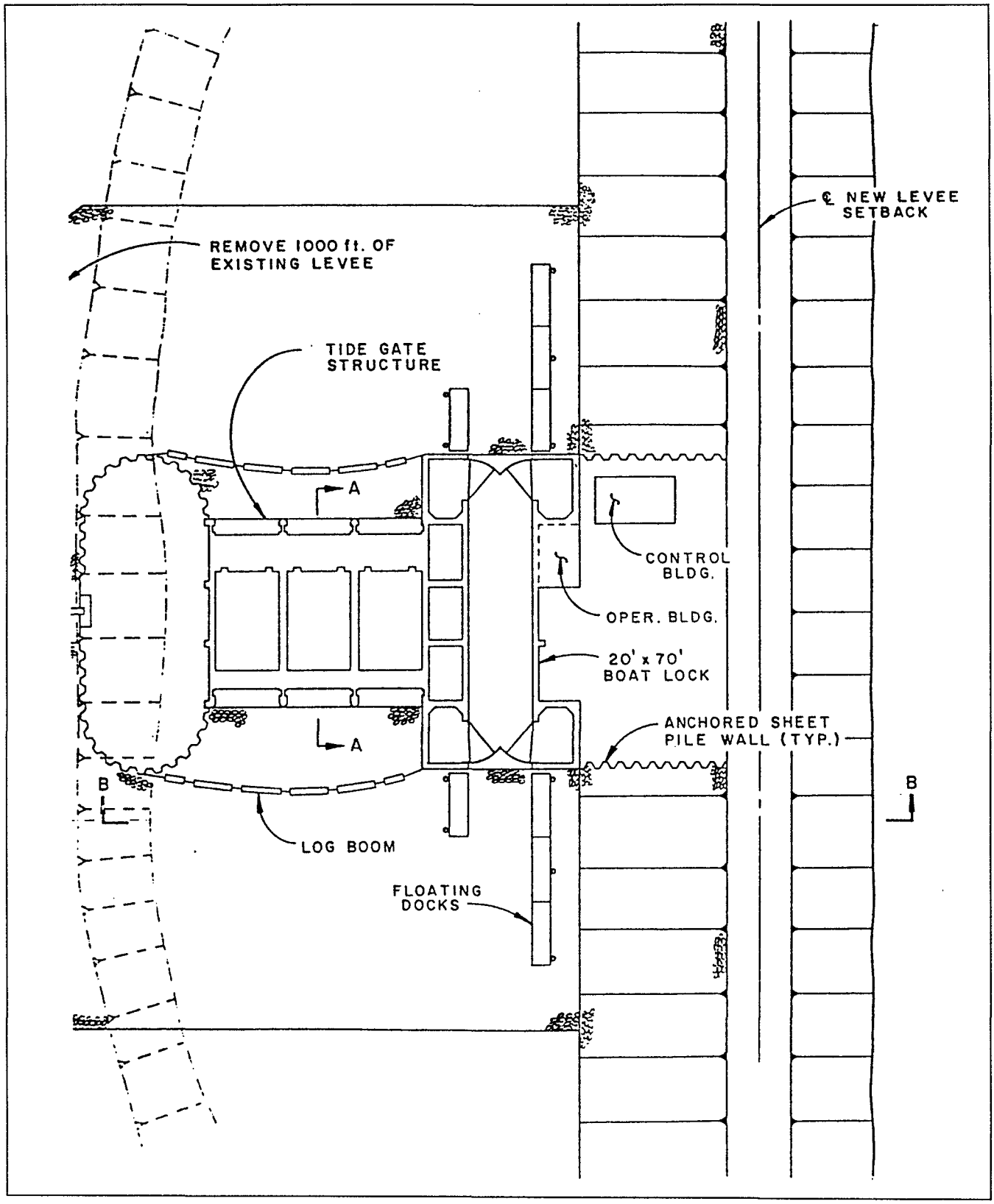

Figure I-5. Typical Tide Gate with Flashboard

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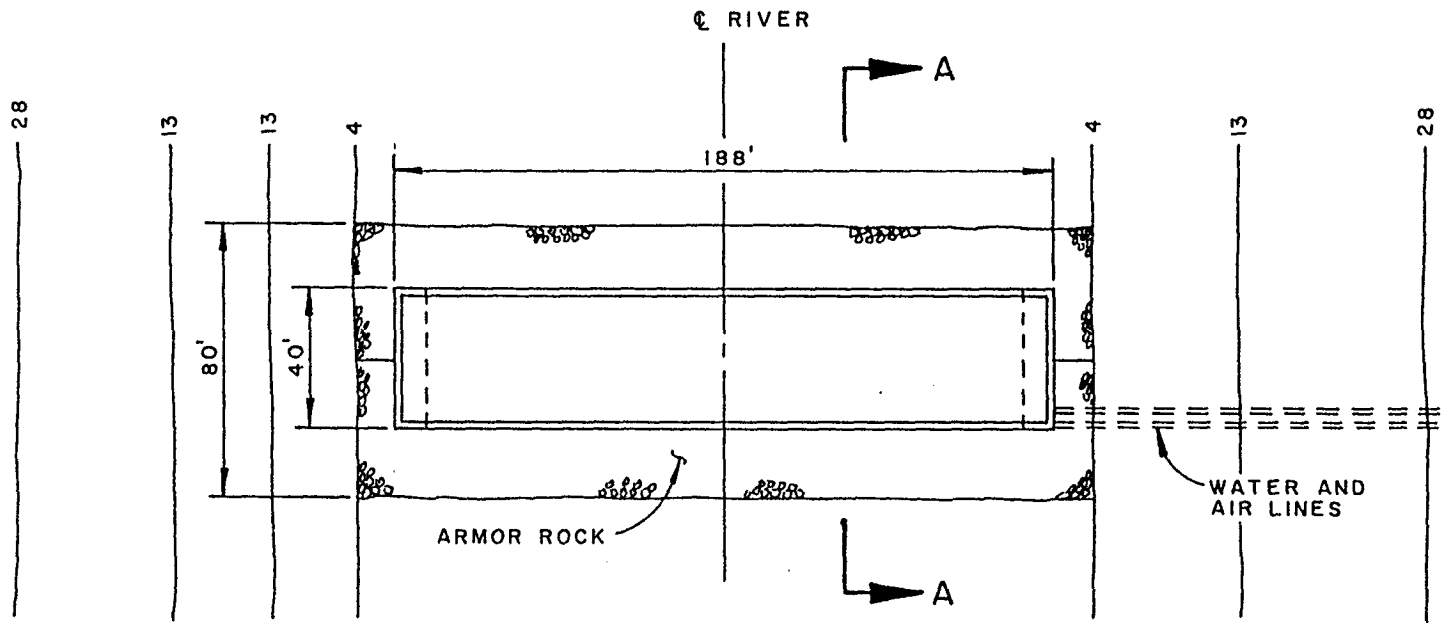
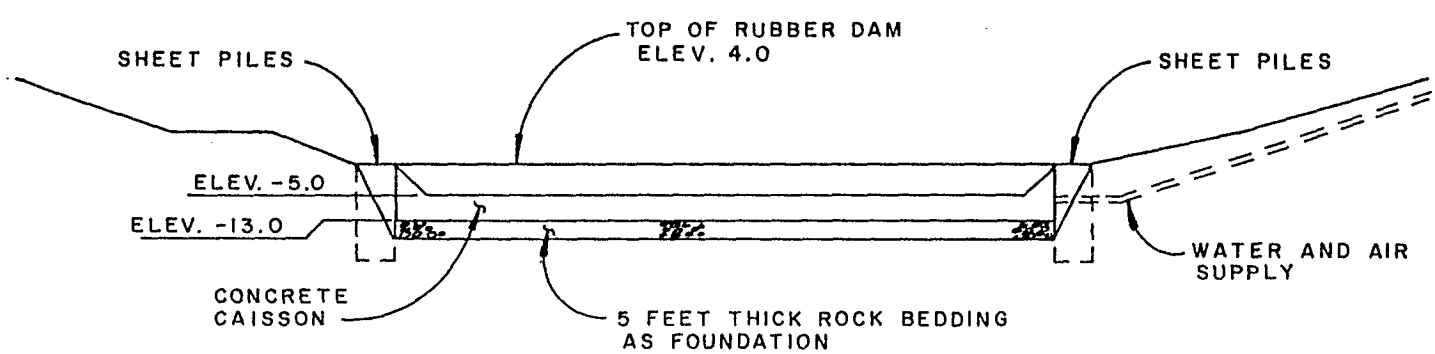


PLAN

SCALE 1" = 50'



ELEVATION

SCALE 1" = 50'

Figure I-6. Typical Inflatable Rubber Dam

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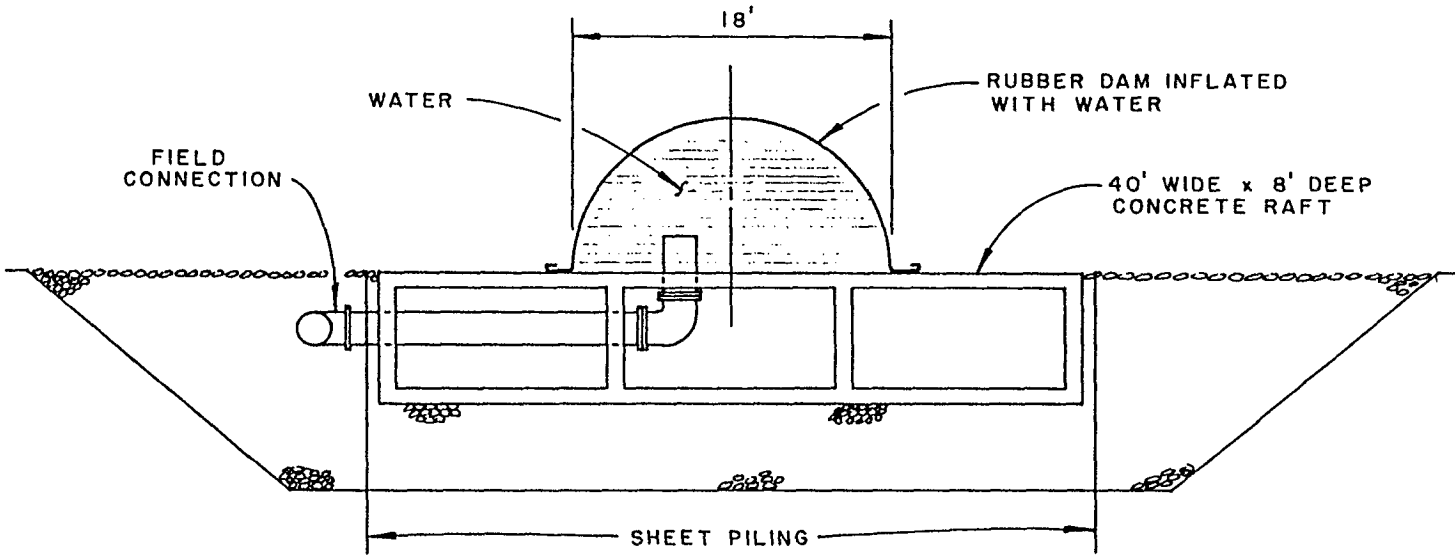

SECTION A-A

SCALE 1" = 10'

Figure I-6 (Continued). Typical Inflatable Rubber Dam

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C-041689

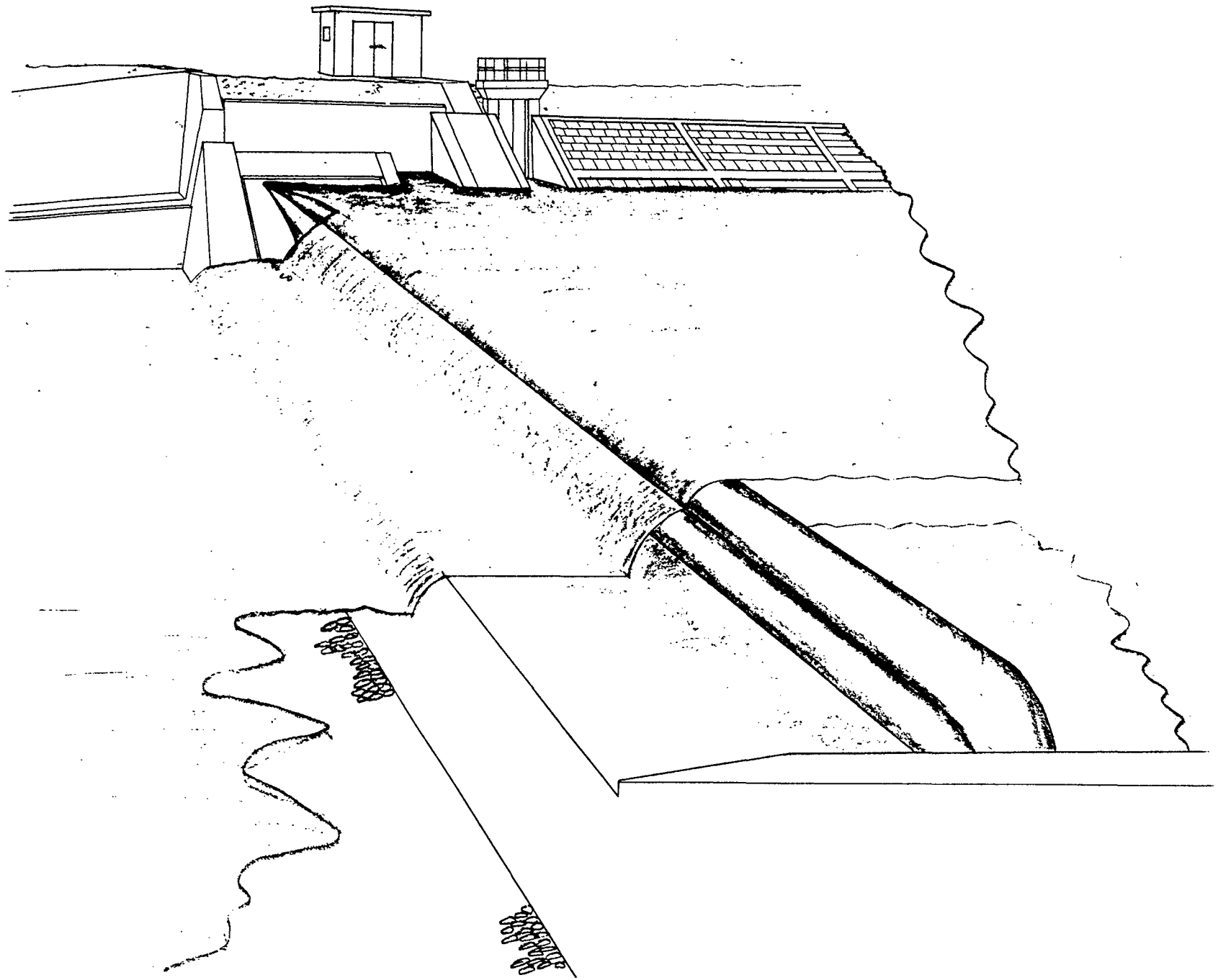
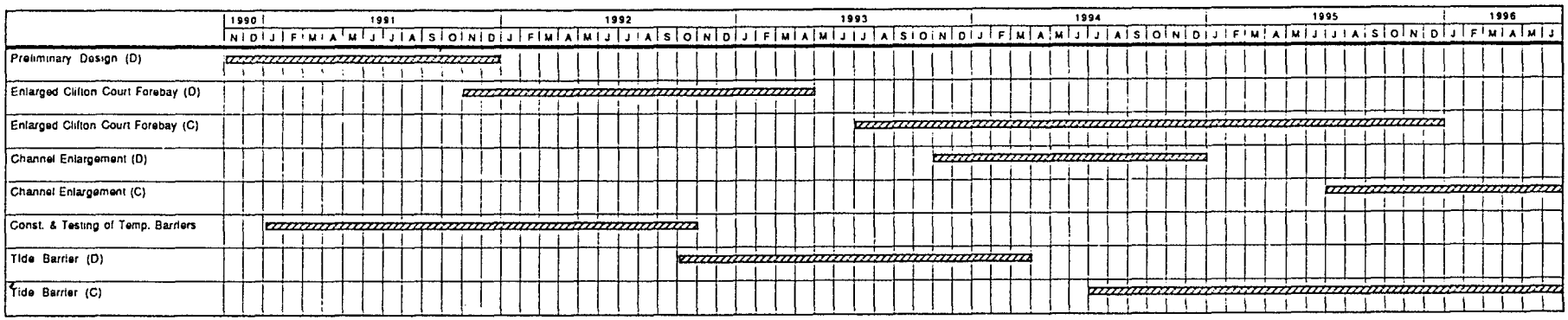


Figure I–7. Artist's Conception of an Inflatable Rubber Dam

C—041689



C: Construction
D: Design

Figure I–8. Proposed Schedule for Design and Construction

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C-041690

APPENDIX J
SEISMIC REPORT SUMMARY

C—041691

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SUMMARY OF APPENDIX J
PRELIMINARY SEISMIC RISK ANALYSIS

A preliminary seismic risk assessment of typical levees within the South Delta study area was performed by Reclamation in February, 1989. The scope of this study was limited and did not include a comprehensive review of existing data for any aspect of the analysis. For this reason many assumptions and generalizations were made in lieu of conducting thorough reviews and initiating additional research and data investigations.

However, inspection of Delta levees following the October 17, 1989 Santa Cruz (Loma Prieta) earthquake revealed no apparent damage or settlement.

The first part of the analysis identifies major sources of seismic activity in the region and briefly describes historical seismic events related to each source. Most of the present-day seismicity which affects the South Delta study area is related to faults which are considered to be part of the San Andreas fault system.

Ground motion parameters for this study were calculated using the computer program SEISRISK III. This probabilistic assessment integrates all relevant earthquake sources in the region, including faults and zones of random seismicity and yields peak horizontal acceleration and velocity values for an exposure period of 100 years and a probability of non-exceedance of 0.9. The maximum values computed were 0.18g and 25.1 cm/sec respectively.

The second part of the study consists of a preliminary geotechnical analysis from which was derived a rough estimate of the behavior of the levee soils in the presence of seismic loading. Two representative South Delta levee sections were analyzed for this study; one is described as an "average" levee section and the other as a "less stable" levee section. Together, these are representative of 85 to 90 percent of the South Delta levees.

The resistance to liquefaction of the levee soils was evaluated in terms of the cyclic stress ratio required to induce liquefaction for a representative magnitude 6.5 earthquake. The computer program SHAKE was used to simulate the dynamic response of the levee soil systems to seismic waves. Results indicate that, for an exposure period of 100 years, seismic loads should equal or exceed levels required to cause liquefaction in 5 to 10 percent of the total levee area.

Seismically induced deformations were evaluated using the computer program DYNDSP. This analysis yielded total estimated deformations, including sliding displacement and settlement of the South Delta levees at 0.15m for the "average" section and 0.3m for the "less stable" section. Since deformation failure is defined for purposes of this study as a total deformation of 0.3m, and because the analysis was performed using a number of conservative assumptions, it was concluded that, for these typical sections, seismically induced deformation failures are not probable for the given seismic loading. For the proportion of levees that are less stable than these typical sections (10 to 15 percent of the total levee area), it is estimated that ground motions will equal or exceed levels required to cause deformation failure.

More comprehensive analyses, including additional data from field and laboratory investigations directed at specific sites in the South Delta, and additional studies of seismic sources in the region, are needed to improve the confidence in the conclusions and to broaden the range of application of this analysis.

A complete preliminary Seismic Risk Analysis report is available for review at DWR.

APPENDIX K
ARCHEOLOGICAL REPORT SUMMARY

C—041693

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APPENDIX K
ARCHAEOLOGICAL REPORT SUMMARY

To complete the Class I survey of cultural resources, the California Archaeological Inventory and the Central California Information Center were contacted for information regarding archaeological, historical and cultural resources in the project area. Confidential reports issued by representatives of these organizations indicate that sites of significant archaeological, historical or cultural value are situated within or located adjacent to the project site. Four recorded prehistoric archaeological sites are listed with the California Archaeological Inventory, one site is listed on the Inventory of Historic Resources, and seven cultural resources are located within a one-mile radius of the project site according to these reports.

Both reports stressed the need for a comprehensive survey of the project site to determine the full extent of unrecorded archaeological or historical cultural resources.

DWR has contracted with the U.S. Bureau of Reclamation for a Class II cultural resources survey and evaluation of areas that may be affected by the South Delta Water Management Program. The study is required by federal law and will result in a report which identifies and evaluates cultural resources in the region.

Although the archeological survey and its sites are confidential, certain information regarding the reports mentioned above will be made available to the public on request.

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APPENDIX L
PROPOSED SOUTH DELTA RECREATION FACILITIES

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APPENDIX L
PROPOSED SOUTH DELTA RECREATION FACILITIES

The proposed South Delta Water Management Program (SDWMP) will consist primarily of channel enlargement, expansion of Clifton Court Forebay and the installation of tidal flow control structures at several sites. This report analyzes the impact of these modifications on recreational activities in the area and recommends additional recreational development alternatives which will increase use by the general public.

It is anticipated that the SDWMP will positively impact recreational activities. For example, channel improvement will greatly enhance navigation and access to South Delta channels. The improvement in water quality will enhance sport fishing due to an improved breeding environment. The recreation land acquisition and development will provide greater public access and diversity of recreation opportunities, and the potential for higher quality recreation experiences.

Public access to most of the South Delta region is limited due to private ownership of much of the land. Although numerous private recreational and special interest clubs operate in this area, currently only a few public recreational facilities are available.

Studies of the demand for recreation facilities in the Delta performed by the U.S. Army Corps of Engineers (Corps) and private concerns indicate that the demand for recreation in the Delta is far greater than the capacity of existing facilities. The reclamation study estimates that peak usage levels exceed 14,000 people per day based on the Corp's estimates of "latent demand".

A total of 128 acres of land are recommended by the reclamation study for acquisition although projected demand would require approximately 500 acres. Due to the fact that some of the area's waterways periodically reach recreation saturation levels, additional land beyond the requested 128 acres may not be needed.

Recommended recreational developments follow:

A. **Barrier Type Facilities.** For each tidal flow control structure, two boat-launch ramps could be installed (one upstream and one downstream) with attendant facilities for picnicking and overnight camping, along with restrooms and facilities for fish cleaning and recreational or sports related activities. Access roads and parking facilities are also recommended.

B. **Camping.** Remote camping facilities with restrooms are recommended for certain areas of the Delta.

C. **Clifton Court Forebay.** Primary activities recommended for Clifton Court Forebay are surf sailing and sail boating. To accommodate these activities, parking, overnight camping, picnicking, and restroom facilities, as well as boat launch ramps, are recommended. Hunting and fishing from the shore are also being considered.

D. **Clifton Court Forebay Enlargement.** Facilities similar to those recommended for the existing forebay are also recommended for the forebay enlargement, except that the area would be reserved for small motorized craft (primarily jet skis).

E. **Fishing Access.** Improved fishing access to South Delta waterways is recommended with attendant parking facilities, picnic tables, and possible docking facilities to accommodate sports fishing activities.

F. **Wetlands/Wildlife Preserves.** Re-establishment of a total area of up to 65 acres of wetlands/wildlife preserves is also recommended. These areas are to be used as a natural preserve for passive recreational activities with boat access only. To support these activities, floating docks with boardwalks that will provide hard surface paths of travel onto the islands are suggested along with a small number of picnic facilities and restrooms. Informational interpretation kiosks are also recommended.

Additional recommendations include "staging areas" to be used primarily by water skiers and optional fee collection facilities to be used by a managing agency if needed. The total cost of possible improvements is approximately $1.9 million. Table L-1 contains detailed information on the south Delta recreation study and costs associated with each facility.

The location of a particular recreational development and the types of facilities developed at that location will be selected based on factors such as cost, environmental considerations, recreational demand and the concerns of area residents and local governmental entities. It is anticipated that only a minimum number of recreational facilities will be developed at some of the sites recommended for such development.

A South Delta Recreation Study was prepared pursuant to a September, 1988 agreement between the California Department of Water Resources and the U.S. Bureau of Reclamation, Ecological Resources Division. This study describes current recreational use patterns and existing facilities, analyzes projected demand for such facilities and proposes several recreation development alternatives.

A complete draft of the South Delta Recreation Study is available for review at DWR.

Table L-1
Estimated Costs of the South Delta Recreational Facilities ($)

Facility	Barrier-Type Facilities	Fishing Access	Clifton Court Forebay	Forebay Expansion	Camping Facilities	Wetland/ Wildlife Preserve
Boat Launch Ramps	35,200	—	2,500	2,500	—	—
Boat Docks	35,200	8,250	—	—	60,000	16,500
Vehicle Parking	192,000	10,000	48,000	48,000	—	—
Vehicle with Trailer	576,000	—	—	—	—	—
Camping	96,000	—	19,200	19,200	14,000	—
Picnic Units	40,000	2,000	5,000	5,000	—	2,000
Restrooms	140,000	10,000	70,000	70,000	122,500	20,000
Boardwalk	—	—	—	—	—	72,000
Secondary Activities[1]	—	—	2,700	2,700	—	—
Kiosk[1]	—	—	—	—	—	6,000
Fish Cleaner[1]	120,000	—	—	—	—	—
Trash	4,500	375	1,125	1,125	1,125	750
Total Cost[2]	1,238,900	30,265	148,525	148,525	197,625	117,250

[1]Optional
[2]Cost of land not included.

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APPENDIX M
NARROWING OF ALTERNATIVES

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APPENDIX M
NARROWING OF ALTERNATIVES

Proposals for Delta water facilities were made as early as 1890 when early Californians proposed a salt water barrier. During water resources planning studies of the 1920s and 1930s, it became apparent that transfers of water from north of the Delta to south of the Delta would be needed to meet the growing water demands. In 1961, the Interagency Delta Committee (IDC) compared various Delta proposals and classified the plans into four basic concepts: 1) Hydraulic Barriers; 2) Physical Barriers; 3) Waterway Control Plans; and 4) a Peripheral Canal (isolated channel). After public hearings, the IDC recommended the Peripheral Canal in 1965.

1974 Draft Environmental Impact Report, Peripheral Canal Project, August 1974

This draft EIR had objectives of providing transfer capabilities to both the SWP and CVP, improved water quality, improved flow patterns, improved fishery and wildlife habitat, and opportunities for recreation.

The studies looked at six major alternatives and evaluated 34 parameters,including water quality, water levels, and fishery. These parameters were evaluated on a scale from A (best) to D (least). This information was summarized in Table VIII-3 of the 1974 Draft EIR and included in this Appendix as Table M-1.

Reappraisal of Water Management

Under the direction of a new Governor and Department Director, DWR began a reappraisal of the management of the project, including the water supply, and in particular, the need for and types of Delta facilities.

1976-77 Drought

The 1976-77 drought emphasized the need for reevaluations of water supplies, water demands, additional facilities, and improved water management.

1978 Bulletin 76, *Delta Water Facilities*, July 1978

This bulletin was the result of the new State administration policy and the desire to review past planning work. This comprehensive program incorporates several other elements that are essential for the successful resolution of the Delta controversy and for future water management in California. These include:

- serious water conservation efforts;
- the use of water recycling and reclaimed waste water to stretch existing water supplies;
- conjunctive use of the California Aqueduct and presently dewatered ground water storage capacity south of the Delta to bank water during wet years for withdrawal during dry years;
- the development of new water storage reservoirs using the off-stream concept which avoids damming free-flowing rivers;
- construction of the Peripheral Canal and related facilities in the Delta and Suisun Marsh; and most important,
- the necessary environmental and Delta guarantees, which have been lacking in past efforts.

Appendix B of Bulletin 76 included a comprehensive reevaluation of alternatives and components. The alternatives were divided into five categories: 1) actions to reduce Delta export (nine); 2) institutional,legal, and physical measures to provide Delta protection (fifteen); 3) construction of Delta transfer facilities (thirty); 4) provisions for additional facilities south of the Delta (thirteen); and 5) development of additional supplies north of the Delta (twenty-three). Tables from Appendix B of Bulletin 76, follow in this appendix as Tables M-2 through M-9. The tables are titled:

M-2 Alternative Components

M-3 Summary of Alternatives and Plan Components Eliminated or Deferred During Initial Screening

M-4 Plan Components to be Rated

M-5 Plan Components Evaluation Criteria

M-6 Summary of Alternative Component Rating

M-7 Planning Precepts

M-8 Components Comprising the Alternative Plans

M-9 Summary of Composite Plan Rating

1978 State Senate Bill 346

SB 200, which incorporated DWR's program, failed to pass the State Legislature.

1982 State Senate Bill 200

SB 200, which included much from SB 346, contained both statewide water management facilities and specific Delta facilities.

1982 Proposition 9

The June 1982 Proposition 9 referendum measure included Senate Bill 200 but was overturned by the California voters after an emotional campaign against the Peripheral Canal.

1982 Urban Water Management Planning Act of 1983

This act required more than 300 of the urban water suppliers to prepare water management plans that identify the water conservation programs they have implemented and proposed for the future.

1983 DWR Report, *Alternatives for Delta Water Transfer,* Released in November 1983

This report discusses physical alternatives to the Peripheral Canal for transferring water across the Sacramento-San Joaquin Delta. Four basic alternatives, which were considered the most promising, have been selected from a large number of alternatives. All four are variations of "through-Delta" plans, in which water is conveyed through existing channels of the central Delta.

1986 Agricultural Water Management Planning Act of 1986

This act requires all major agricultural water retailers to report to DWR on how they manage their water. The suppliers must also adopt an agricultural water management plan that identifies their water conservation programs.

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1987 **Scoping Meeting**

The South Delta Water Management Program and North Delta Water Management Program held public scoping meetings to obtain local and statewide input.

1988 **Planning Reports**

The objectives of each program were defined in the planning reports for the North, South, and West Delta Water Management Programs.

1990 **Draft EIR/EIS proposed to be released.**

> **NOTE:** The following tables, M-1 through M-10, have been reproduced from the 1974 Draft EIR on the Peripheral Canal and from Bulletin 76, *Delta Water Facilities*, dated July 1978. The tables are presented to help readers understand past methods and the criteria used during the narrowing process. Figures M-1 and M-2 are block diagrams of the California Water Plan and the proposed SDWMP preferred alternative, respectively.

Table M-1
Comparison of Delta Alternatives with the Proposed Action

IMPACT RANKING
ACCEPTABLE IMPACT
A- BEST
B-
C-
D - LEAST

E- ACCEPTABILITY QUESTIONABLE
F- UNACCEPTABLE IMPACT
U- RELATIVE NET EFFECT UNKNOWN

Impact Parameters	Peripheral Canal	State-only Gravity Canal	Waterway Control	Modified Folsom-South	Physical Barrier	Hyd. Barrier No Project
Export Water Supply	B	B	B	E	A	D
Export water Quality	A	B	A	B	C	D
Local water Quality	C	C	B	B	A	C
Water Level	A	B	B	B	C	B
Seepage	B	A	A	A	A	A
Delta Flood Control	A	A	A	B	A	B
Channol Scour (Delta)	A	B	A	B	A	C
Navigation (Delta)	A	A	D	B	C	A
Transportation (Delta)	C	C	A	B	C	C
Land Out of Production (Delta)	C	C	B	B	A	A
Recreation	A	B	C	C	C	C
Fish						
General Factors						
1. Salinity Gradient and	A	B	C	C	E	B
Dissolved Oxygen	A	C	B	C	E	D
2. Food Supply						
Striped Bass						
1. Sacramento River	A	B	B	D	C	C
2. San Joaquin R iver	A	C	A	B	C	D
3. Nursery Area	A	C	B	C	F	D
Sacramento Salmon						
1. Upstream Migrants	B	A	B	E	C	A
2. Downstream Migrants	A	A	A	B	E	C
San Joaquin Salmon						
1. Upstream Migrants	A	D	B	C	F	E
2. Downstream Migrants	A	C	A	C	E	D
Mokelumne Salmon	A	C	C	C	E	D
Shad	U	U	U	U	D	U
Sturgeon	U	U	U	U	U	U
Resident Game Fish						
1. Dead-end Sloughs	A	B	C	C	D	C
2. Main Delta Channe1s	A	C	B	B	C	C
Non-Game Fish	A	C	C	B	E	C
Suisun Marsh Fish	A	A	A	A	A	A
Bay Fish	A	A	A	A	A	A
Wildlife						
Delta	A	A	B	C	C	C
Suisun Marsh	C	C	C	C	A	B
Turbidity	B	B	B	A	D	B
Water Temperature	B	A	B	A	C	A
Bay Circulation and Dispersion	B	B	B	B	C	A
Energy Requirement	B	A	A	C	A	A

NOTE: This is Table VIII-3 of Draft EIR, Peripheral Canal Project, August 1974

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Table M-2
Alternative Components

1. *Reduction of Delta Export*
   - *Water Conservation
   - *Waste Water Reclamation
   - *Reduce Export During Dry Years and Critical Fish Periods
   - Desalting Sea Water
   - Desalting Geothermal Brines
   - Amend Water Service Contracts
   - Curtail Water to New Lands
   - Reduced Central Arizona Project
   - Icebergs

2. *Delta Protection*
   - Institutional and Legal Measures
     - *Environmental Monitoring
     - *Four-Agency Fish and Wildlife Agreement
     - *Limits on Delta Diversions
     - *SWP-CVP Operation Agreement
     - *Federal Participation in Delta Protection
     - *Review and Revision of Delta Water Quality Standards
     - *Delta Water Agency Contracts
   - Physical Measures
     - *Western Delta Overland Water Facilities
     - *South Delta Water Quality Improvement Facilities
     - *Relocation of Contra Costa Canal Intake
     - *Suisun Marsh Facilities
     - Delta-Woodbridge Canal
     - Fish Screens on In-Delta Diversions
     - Fish Hatcheries
     - Improved Delta Levee Maintenance

3. *Delta Water Transfer Alternatives*
   - Existing Channel Conveyance
     - Continue Present Method ("No Project" Alternative)
     - Enlarge Clifton Court Forebay
     - Union Island Forebay
     - Enlarge South Delta Channels
     - Enlarge North Delta Channels
   - Modified Channel Conveyance
     - Waterway Control Plan
     - Cross Delta Transfer Plan
     - Central Delta Plan
     - Combination Waterway Control Plan and Central Delta Plan
     - North Stub Canal
     - South Stub Canal
     - Mathena Landing Cross Channel and South Stub Canal
     - New Hope Cross Channel and Enlarged Clifton Court Forebay
     - New Hope Cross Channel and South Delta Intake Channel
     - Isleton Cross Channel and Enlarged Clifton Court Forebay
     - Isleton Cross Channel and South Stub Canal
   - Isolated Channel Conveyance
     - *Peripheral Canal
     - East Delta Canal
     - East Central Delta Canal
     - Central Delta Canal
     - West Delta Canal
     - Montezuma Hills Reservoir and Canal
     - Isleton Cross Channel Alignment
     - Mathena Landing Isolated Canal
   - Modified and Isolated Channel Conveyance
     - Modified Folsom-South Canal
     - Western Delta Diversion
   - Physical Barriers
     - Chipps Island Barrier
     - Dillon Point Barrier
     - Point San Pablo Barrier
     - Submerged Barrier in Carquinez Strait

4. *Facilities South of the Delta*
   - Off-stream Surface Storage
     - *Los Vaqueros Reservoir
     - Los Banos Grandes Reservoir (alternate)
     - Los Banos Grandes—Los Vaqueros Combination Reservoirs
     - Sunflower Reservoir
   - Ground Water Storage
     - *South San Francisco Bay Basin
     - San Joaquin Valley Basins
       - *Kern River Fan
       - *White Wolf Basin
     - Southern California Basins
       - *San Fernando Valley Ground Water Basin
       - *Chino Ground Water Basin
       - *Southern Mojave River Valley Ground Water Basin (alternate)
       - *Raymond Ground Water Basin (alternate)
       - *Santa Ana Ground Water Basin (alternate)
   - *Mid-Valley Canal

5. *Additional Supply North of the Delta*
   - Revise Operation of SWP and CVP Reservoirs
   - Weather Modification
   - Long-range Weather Forecasting
   - Purchase Dry Year Supplies
   - Purchase Interim Water Supplies from CVP
   - Sacramento Valley Tributary Storage
     - *Cottonwood Creek Project
     - Millville Reservoir
     - Wing Reservoir
     - Schoenfield Reservoir
     - Gallatin Reservoir
     - Newville Reservoir
     - Rancheria Reservoir
     - Marysville Reservoir
     - Nashville Reservoir
   - Sacramento Valley Off-stream Storage
     - Tuscan Buttes Reservoir
     - *Glenn Reservoir—River Diversion
     - *Colusa Reservoir—River Diversion (alternate)
     - Enlarged Lake Berryessa
   - Sacramento Valley Mainstream Storage
     - Enlarged Shasta Reservoir
   - Sacramento Valley Ground Water
     - Stony Creek Fan Basin
     - Thermalito Basin
   - Importation from North Coast Rivers
     - Dos Rios Reservoir
     - English Ridge Reservoir

*Included in Selected Plan as discussed in Chapter V.

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Table M-3
Summary of Alternatives and Plan Components Eliminated or Deferred During Initial Screening

NAME OF ALTERNATIVE OR PLAN COMPONENT	*BASIS FOR DECISION*										
	ADVERSE IMPACT						*OTHER REASONS*				
	Economics	Energy	Water Supply	Fish, Wildlife, and/or Recreation	Water Quality	Other Environmental Concerns	Technology	Legal, Institutional, and Political	Better Similar Proposal	Part of Another Proposal	Other
REDUCTION OF DELTA EXPORT											
Desalting Sea Water	●	●				●					
Desalting geothermal brines	●					●	●				
Amend water service contracts								●			
Curtail water to new lands											●
Reduced Central Arizona Project								●			
Icebergs		●					●				
DELTA PROTECTION											
Fish hatcheries							●				
DELTA WATER TRANSFER ALTERNATIVES											
Existing channel conveyance											
Union Island Forebay									●		
Enlarge South Delta channels										●	
Enlarge North Delta channels										●	
Modified channel conveyance											
Cross Delta Transfer Plan									●		
Isolated channel conveyance											
Central Delta Canal									●		
Montezuma Hills Resv & Canal (Resv only)	●								●		
Modified and isolated channel conveyance											
Modified Folsom-South Canal		●	●	●							
Western Delta Diversion			●	●							
Physical barriers											
Chipps Island Barrier				●	●						
Dillon Point Barrier				●	●						
Point San Pablo Barrier				●	●						
Submerged Barrier, Carquinez Strait											●
FACILITIES SOUTH OF THE DELTA											
Sunflower Reservoir	●								●		
Raymond Ground Water Basin									●		
ADDITIONAL SUPPLY NORTH OF THE DELTA											
Revise operation of SWP and CVP reservoirs		●		●							
Weather modification							●				
Long-range weather forecasting							●				
Purchase dry year supplies											●
Purchase interim water supplies from CVP										●	
Sacramento Valley tributary storage											
Millville Reservoir									●		
Wing Reservoir									●		
Schoenfield Reservoir									●		
Gallatin Reservoir									●		
Newville Reservoir									●		
Rancheria Reservoir									●		
Nashville Reservoir			●						●		
Sacramento Valley offstream storage											
Tuscan Buttes Reservoir									●		
Enlarged Lake Berryessa						●		●	●		
Importation from north coast rivers											
English Ridge Reservoir								●	●		

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Table M-4
Plan Components to be Rated

NORTH OF DELTA COMPONENTS	**DELTA COMPONENTS (Continued)**
Surface Reservoirs	Combination Waterway Control-Central Delta Plan
Cottonwood Creek Project	West Delta Canal
Glenn Reservoir – River Diversion	Montezuma Hills Canal
Enlarged Shasta Reservoir	**SOUTH OF DELTA COMPONENTS**
Dos Rios Reservoir	**Offstream Surface Storage**
Marysville Reservoir	Los Vaqueros Reservoir – Los Banos Grandes Comb.
Ground Water Basins	Los Vaqueros Reservoir
Stony Creek Fan	Los Banos Grandes Reservoir
Thermalito	**Southern California Groundwater Basins**
DELTA COMPONENTS	San Fernando Valley
Peripheral Canal	Chino
East Delta Canal	Southern Mojave
East Central Delta Canal	**San Joaquin Valley Groundwater Basins**
Isleton Cross Channel	Kern River Fan
South Stub Canal	White Wolf
North Stub Canal	**South San Francisco Bay Groundwater Basin**
Mathena Landing Cross Channel – South Stub Canal	**WATER MANAGEMENT COMPONENTS**
Mathena Landing Isolated Canal	**Waste water Reclamation**
Enlarged Clifton Court Forebay	South Bay Area
Isleton Cross Channel – South Stub Canal	Central Coastal Area
Isleton Cross Channel – Enlarged Forebay	Southern California
Waterway Control Plan	**Water Conservation**
Central Delta Plan	

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Table M-5
Plan Component Evaluation Criteria

CATEGORY: SYSTEM EFFECTIVENESS (75%)
DEFINITION: The degree to which the proposal is implementable, flexible with time, and reliable.

SUBCATEGORY: IMPLEMENTABILITY (100%)
DEFINITION: The degree to which the proposal can be implemented, considering public acceptance, institutional constraints and financial implications.

CRITERION: PUBLIC ACCEPTANCE (100%)
DEFINITION: The degree to which the proposal is acceptable to those with permit power, elected officials, water users, DWR, USBR, DFG, citizen and environmental groups.

SUBCRITERION: PUBLIC ENTITIES (100%)
DEFINITION: The degree to which the proposal is acceptable to those Public Agencies with permit power, water users, DWR, USBR, DFG, and elected officials, legislative and executive, of various jurisdictions.

SUBCRITERION: CITIZENRY AND ENVIRONMENTAL GROUPS (100%)
DEFINITION: The degree to which the proposal is acceptable to environmental groups and the citizen at large.

CRITERION. FINANCIAL IMPLEMENTABILITY (100%)
DEFINITION: The degree to which the financial requirements of the proposal vary from those of the initially proposed alternative.

The ease with which the financial requirements of the proposal can be met.

CRITERION: LEGAL-INSTITUTIONAL (100%)
DEFINITION: The degree to which the proposal is possible within the constraints of existing federal and state law, authorization, contracts and agreements.

SUBCATEGORY: FLEXIBILITY WITH TIME (70%)
DEFINITION: The degree to which the proposal can respond to change in technology, new standards and changing needs.

CRITERION: NEW TECHNOLOGY (100%)
DEFINITION: The degree to which the proposal or its individual components can incorporate expected advances in technology.

CRITERION: NEW STANDARDS (97%)
DEFINITION: The degree to which the proposed project can respond to foreseeable new environmental quality standards (water quality, air quality, conservation, etc.).

CRITERION: CHANGING NEEDS (100%)
DEFINITION: The degree to which the proposed project can respond to changing population, industrial, and agricultural distribution.

SUBCATEGORY: RELIABILITY (90%)
DEFINITION: The degree to which the proposal can operate reliably, when considering its vulnerability to natural disasters or sabotage and capability to mitigate failures.

CATEGORY: ADEQUACY OF SUPPLY (75%)
DEFINITION: The degree to which the proposal will satisfy the quantity and quality requirements of the Delta and the Service Area.

SUBCATEGORY. DELTA (100%)
DEFINITION: The degree to which the proposal will satisfy the quantity and quality requirements of the Delta.

CRITERION· WATER QUALITY (100%)
DEFINITION: The degree to which the proposal will satisfy water quality requirements in the Delta.

CRITERION: WATER QUANTITY (100%)
DEFINITION: The degree to which the proposal satisfies Delta Water quantities requirements (water levels).

SUBCATEGORY: SERVICE AREAS (97%)
DEFINITION: The degree to which the proposal will satisfy both water quality and quantity requirements in the Service Area.

CRITERION: WATER QUALITY (100%)
DEFINITION. The degree to which the proposal will satisfy water quality requirements in the Service Area.

CATEGORY: ADEQUACY OF SUPPLY (75%) (continued)

CRITERION: WATER QUANTITY (100%)
DEFINITION: The degree to which the proposal will satisfy the water quantity requirements in the Service Area.

CATEGORY: PHYSICAL ENVIRONMENT (100%)
DEFINITION: The degree to which the proposed project affects the physical environment including biota and landforms.

SUBCATEGORY: BIOTA (100%)
DEFINITION· The degree to which the proposal affects the biota of the physical environment, including terrestrial and aquatic ecosystems, and areas of special biological significance.

CRITERION: TERRESTRIAL ECOSYSTEMS (100%)
DEFINITION: The degree to which the proposal affects terrestrial ecosystems, including flora and fauna, with respect to species diversity, productivity, habitats, populations and trophic levels.

CRITERION: AQUATIC ECOSYSTEMS (100%)
DEFINITION: The degree to which the proposal affects aquatic ecosystems, including flora and fauna, with respect to species diversity, productivity, habitats, populations, and trophic levels.

CRITERION: SUISUN MARCH ECOLOGY (100%)
DEFINITION: The degree to which the proposal provides water of sufficient quality to maintain fish and wildlife resources of the marsh.

SUBCATEGORY: LANDFORM ALTERATION (50%)
DEFINITION: The degree to which the proposal would result in changes in the topography of immediate and adjacent areas.

CRITERION: DRAINAGE AND FLOODING (100%)
DEFINITION: The degree to which the proposal modifies existing drainage patterns (including flooding and siltation) in the affected areas.

CRITERION: STABILITY AND EROSION (100%)
DEFINITION: The degree to which the proposal changes landforms which affect stability and erosion of existing lands and features.

CATEGORY: SOCIO-CULTURAL FACTORS (55%)
DEFINITION: The degree to which the proposal affects the human environment.

SUBCATEGORY: LAND USE AND DEMOGRAPHY (100%)
DEFINITION. The degree to which the proposal affects land use, population patterns, and social inter-relationships in the affected areas.

CRITERION: COMPATIBILITY WITH PLANNED USE (100%)
DEFINITION: The degree to which the proposal is compatible with planned land use in the local area as specified in the General Plan, in its absence by current zoning patterns, or in their absence, by existing land use.

CRITERION· COMPATIBILITY WITH RELATED PLANS (100%)
DEFINITION: The degree to which the proposal is compatible with plans of federal, state and local agencies (other than land use), e.g. water basin studies, regional air quality plans, transportation, energy conservation, etc.

CRITERION: DEMOGRAPHY (100%)
DEFINITION: The degree to which the proposal affects population patterns in the affected areas in terms of project-caused population displacement and relocation.

SUBCATEGORY: AMENITIES (15%)
DEFINITION: The degree to which the proposal affects facilities of cultural and recreational value.

CRITERION: ARCHAEOLOGICAL, PALEONTOLOGICAL AND HISTORICAL SITES (100%)
DEFINITION: The degree to which the proposal affects local sites of archaeological, or paleontological, and historical interest.

CATEGORY: SOCIO-CULTURAL FACTORS (55%) (continued)

CRITERION: RECREATIONAL ACTIVITIES (100%)
DEFINITION: The degree to which the proposal affects the availability and quality of recreational opportunities, i.e. hunting, fishing and boating, etc.

SUBCATEGORY: AESTHETICS (55%)
DEFINITION: .The degree to which the appearance of the proposal tends to disrupt or enhance the aesthetic impression of the landscape (including waterways).

CATEGORY: ECONOMIC FACTORS (30%)
DEFINITION: The degree to which the proposal causes economic changes in the affected area, in terms of public revenue and costs, employment and business effects, including agriculture and the cost burden imposed by the project.

SUBCATEGORY: PUBLIC FISCAL EFFECTS (55%)
DEFINITION: The degree to which the operation of the completed proposal causes changes in public revenues and costs, by virtue of changes in tax revenues and municipal service costs.

SUBCATEGORY: EMPLOYMENT AND BUSINESS EFFECTS (90%)
DEFINITION: The degree to which the operation of the completed proposal creates or removes job and business revenues in the affected areas.

SUBCATEGORY: AVERAGE ANNUAL EQUIVALENT COST (100%)
DEFINITION: The degree to which the financing and operation of the proposal will be a cost to the water user, as reflected by an amount equal to the annual payment necessary to amortize facilities' capital costs over 50 years at 6%, plus estimated annual O&M cost of the facilities.

CATEGORY: CONSTRUCTION FACTORS (10%)
DEFINITION: The degree to which construction activities affect local economy and transportation networks.

SUBCATEGORY: TRANSPORTATION (60%)
DEFINITION: The degree to which the construction activities associated with the proposal affect ground and water-borne traffic.

SUBCATEGORY: ECONOMIC EFFECTS (100%)
DEFINITION: The degree to which the construction activities affect the level of employment, business, and net public revenues.

CRITERION: PUBLIC FISCAL EFFECTS (100%)
DEFINITION: The degree to which the direct and indirect costs to local government are offset by construction-generated revenues.

CRITERION· EMPLOYMENT AND BUSINESS (100%)
DEFINITION: The degree to which the construction of the facility affects the level of employment and business in the local area.

SUBCATEGORY: LOCAL PUBLIC SERVICE SYSTEMS (80%)

DEFINITION: The degree to which the proposal, during construction, will increase or decrease the actual burden of providing municipal services, in terms of man-power needs, consumption of excess capacities, equipment needs, etc.

CATEGORY: RESOURCE SUPPLY AND DEMAND (60%)
DEFINITION: The degree to which the proposal affects the availability of energy, water, forest, agricultural, or mineral resources in an affected area.

SUBCATEGORY: NET ENERGY USE (100%)
DEFINITION: The degree to which the proposal is a net user or net producer of energy.

SUBCATEGORY: MATERIALS (50%)
DEFINITION· The degree to which the proposal affects present availability and possible future scarcity of resources (land, construction materials).

NOTE: NUMBERS IN PARENTHESIS (100%) ARE WEIGHTING FACTORS.

C—041706

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Table M–6. Summary of Alternative Component Ratings

| RATED ITEMS | NORTH OF DELTA | | | | | SACTC VALLEY GROUND WATER BASINS | | DELTA | | | | |

Table M–7
Planning Precepts

TABLE B-6. PLANNING PRECEPTS	
WATER DEMANDS AND TIMING	Each eligible plan shall be capable of supplying sufficient water to meet the expected service area demands for water at all times up to the year 2000 (within dry-year deficiency limitations provided for in the SWP and CVP contracts or as they may be proposed for revision). Each plan shall also be capable of satisfying the probable maximum demands projected through the year 2000 by merely shifting the dates of construction of key components or programs.
SYSTEM COMPATIBILITY	Any component added to the existing SWP and CVP systems should be compatible with those systems and also be able to be incorporated into a complete plan for meeting the demands of the year 2000 without the necessity for abandonment of that component or any other component in the future.
STATE OF THE ART	Any plan proposed shall contain components which are within engineering technology now available, but be flexible enough to accept substitution with the advent of new engineering technology.
WATER RIGHTS AND OTHER LEGAL ASPECTS	Any plan, during its various stages of implementation, shall be compatible with existing water right permits for the SWP and CVP and with all other legal requirements.
WATER QUALITY	Each eligible alternative plan, during its various stages of implementation, shall be capable of complying with applicable State and Federal Delta water quality standards (as they may be from time to time modified) and with SWP and CVP export water quality criteria.
FISH AND WILDLIFE	No component added to the existing SWP and CVP systems shall preclude the eventual attainment of the fish and wildlife objectives.
FLOOD CONTROL	Any plan shall maintain or improve the flood-carrying capacity of Delta channels or include alternative means for conveying flood flows so as to reduce or prevent any material increase in the threat of flooding Delta lands. In this regard, any proposed changes to Delta channels or levees should be made compatible with recommendations in DWR Bulletin No. 192, "Plan of Improvement of the Delta Levees," May 1975.
NAVIGATION	Any plan shall maintain the use of Delta waterways for commercial, recreational, and military navigation. Any proposed change in present conditions will be governed by requirements of the Corps of Engineers and Coast Guard in their capacities of issuing permits for any project affecting navigable waters.
SEEPAGE AND DRAINAGE	Any alternative plans shall provide for control of any increase in seepage or drainage to Delta lands that may be caused by construction and operation of Delta facilities.
GROUND WATER	Ground water requirements imposed by any alternative plan shall be such that existing long-term overdrafts are not increased.

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Table M-8
Components Comprising the Alternative Plans

COMPONENT	PLAN 1 "No Project"	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6	PLAN 7	PLAN 8	PLAN 9	PLAN 10
EXISTING FACILITIES										
SWP & CVP Facilities	•	•	•	•	•	•	•	•	•	•
New Melones Reservoir (under construction)	•	•	•	•	•	•	•	•	•	•
Auburn Reservoir (under construction)	•	•	•	•	•	•	•	•	•	•
DELTA WATER TRANSFER ALTERNATIVES										
Peripheral Canal		•								•
North Stub Canal – South Stub Canal			•							
North Stub Canal – South Stub Canal/Future Connection				•						
Mathena Landing Isolated Canal					•					
Mathena Landing Cross-Channel – South Stub Canal						•				
Mathena Landing Cross-Channel – South Stub Canal/Future Connection							•			
North Stub Canal – Enlarged Clifton Court Forebay								•		
North Stub Canal – Enlarged CCF/Future Connection									•	
OTHER DELTA COMPONENTS										
Environmental Monitoring	•	•	•	•	•	•	•	•	•	•
Four – Agency F&W Agreement (limits on Delta Diversions)		•	•	•	•	•	•	•	•	•
SWP – CVP Operation Agreement		•	•	•	•	•	•	•	•	•
Federal Participation in Delta Protection		•	•	•	•	•	•	•	•	•
Delta Water Agency Contracts		•	•	•	•	•	•	•	•	•
Review and Revision of Delta Water Quality Standards		•	•	•	•	•	•	•	•	•
Install Four Pumps in Delta Pumping Plant (SWP)		•	•	•	•	•	•	•	•	•
Completion of Delta Fish Protective Facility (SWP)		•	•	•	•	•	•	•	•	•
South Delta Water Quality Improvement Facilities		•	•	•	•	•	•	•	•	•
Relocation of Contra Costa Canal Intake		•	•	•	•	•	•	•	•	•
Suisun Marsh Facilities		•	•	•	•	•	•	•	•	•
Western Delta Overland Water Facilities										•
SOUTH OF DELTA COMPONENTS										
Water Conservation		•	•	•	•	•	•	•	•	
Waste Water Reclamation		•	•	•	•	•	•	•	•	
Enlargement of East Branch California Aqueduct		•	•	•	•	•	•	•	•	
Mid-Valley Canal		•	•	•	•	•	•	•	•	•
Los Vaqueros Reservoir		•	•	•	•	•	•	•	•	
Storage in Southern California Ground Water Basins		•	•	•	•	•	•	•	•	
Storage in San Joaquin Valley Ground Water Basins		•	•	•	•	•	•	•	•	
NORTH OF DELTA COMPONENTS										
Marysville Reservoir		•	•	•	•	•	•	•	•	•
Cottonwood Creek Project		•	•	•	•	•	•	•	•	•
Sacramento Valley Ground Water		•	•	•	•	•	•	•	•	
Glenn Reservoir – River Diversion		•	•	•	•	•	•	•	•	
Dos Rios Reservoir										•
RELATED ACTIONS										
Improved Delta Levee Maintenance	•	•	•	•	•	•	•	•	•	•
Fish Screens on In-Delta Diversions		•	•	•	•	•	•	•	•	•
Deepening Baldwin and Stockton Ship Channels		•	•	•	•	•	•	•	•	•

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Table M-9
Summary of Composite Plan Ratings

RATED ITEMS	PLAN NO. 1 No Project	2 Peripheral Canal	3 North Stub - South Stub	4 North Stub - South Stub - Future Isolation	8 North Stub - Enlarged Clifton Court	9 North Stub - Enlarged CCF - Future Isolation
SYSTEM EFFECTIVENESS	-11.4	-11.9	8.3	10.4	9.4	10.1
IMPLEMENTABILITY	10.0	-6.3	-2.5	-5.5	-.8	-6.3
PUBLIC ACCEPTANCE	-20.0	10.0	12.5	12.5	22.5	15.0
PUBLIC ENTITIES	-25	40	30	35	25	35
CITIZEN AND ENVIRONMENTAL GROUPS	-15	-20	-5	-10	20	-5
FINANCIAL IMPLEMENTABILITY	100	-44	-30	-39	-35	-44
LEGAL - INSTITUTIONAL	-50	15	10	10	10	10
FLEXIBILITY WITH TIME	-56.6	8.4	-4.0	8.1	-2.7	8.1
NEW TECHNOLOGY	-50	-35	-35	-35	-35	-35
NEW STANDARDS	-60	38	-2	35	-3	33
CHANGING NEEDS	-60	23	25	25	30	27
RELIABILITY	0	35	30	30	30	30
ADEQUACY OF SUPPLY	-37.0	49.6	35.8	43.3	34.6	40.8
DELTA	-20.0	22.5	7.5	15 0	7.5	12.5
WATER QUALITY	-25	-5	-15	-10	-10	-10
WATER QUANTITY	-15	50	30	40	25	35
SERVICE AREA	-54.5	77.5	65.0	72.5	62.5	70.0
WATER QUALITY	-10	95	70	85	65	80
WATER QUANTITY	-99	60	60	60	60	60
PHYSICAL ENVIRONMENT	-8 5	13.5	-3.2	13.1	-10.8	11.3
BIOTA	-4.0	4.0	-21.0	3.3	-25.0	2.0
TERRESTRIAL ECOSYSTEMS	0	-6	-6	-6	-8	-8
AQUATIC ECOSYSTEMS	-10	20	-55	18	-65	16
SUISUN MARSH ECOLOGY	-2	-2	-2	-2	-2	-2
LAND FORM ALTERATION	-17.5	32.5	32.5	32.5	17.5	30.0
DRAINAGE AND FLOODING	-25	80	80	80	70	80
STABILITY AND EROSION	-10	-15	-15	-15	-35	-20
RESOURCE SUPPLY AND DEMAND	-20.0	-11.7	-11.7	-11.7	-11.7	-11.7
NET ENERGY USE	-25	-10	-10	-10	-10	-10
MATERIALS	-10	-15	-15	-15	-15	-15
SOCIO-CULTURAL FACTORS	-14.8	20.5	17.0	18.8	17.1	16.1
LAND USE AND DEMOGRAPHY	-15.0	-3.3	-6.0	-3.3	-8.0	-7.3
COMPATIBILITY WITH PLANNED LAND USE	-30	-15	-13	-14	-23	-27
COMPATIBILITY WITH RELOCATION PLANS	-10	18	8	17	12	18
DEMOGRAPHY	-5	-13	-13	-13	-13	-13
AMENITIES	-12.5	16.5	13.0	15.0	9.0	11.5
ARCH., PALEO. AND HIST. SITES	0	-50	-50	-50	-55	-55
RECREATION ACTIVITIES	-25	83	76	80	73	78
AESTHETICS	-15	65	60	60	65	60
ECONOMIC FACTORS	-41.8	17.4	21.4	19.4	19.4	17.4
PUBLIC FISCAL EFFECTS	-50	50	50	50	50	50
EMPLOYMENT AND BUSINESS EFFECTS	-50	50	50	50	50	50
AVERAGE ANNUAL EQUIVALENT COST	-30	-30	-20	-25	-25	-30
CONSTRUCTION FACTORS	-7.5	-6.5	-6.5	-6.5	-6.5	-6.5
TRANSPORTATION	0	-25	-25	-25	-25	-25
ECONOMIC EFFECTS	-10.0	7.5	7.5	7.5	7.5	7.5
PUBLIC FISCAL EFFECTS	-10	-10	-10	-10	-10	-10
EMPLOYMENT AND BUSINESS	-10	25	25	25	25	25
LOCAL PUBLIC SERVICE SYSTEMS	-10	-10	-10	-10	-10	-10
NUMERICAL AVERAGE OF RATINGS*	-19.9	13.8	8.5	12.8	7.2	11.5
WEIGHTED AVERAGE OF RATINGS**	-19.31	16.91	9.41	15.28	7.33	13.82

[-19.9] WEIGHTED RATINGS FROM S.E.S. COMPUTER PROGRAM

[-35] UNWEIGHTED RATINGS

* TOTAL OF ALL RATINGS DIVIDED BY THE NUMBER OF RATED ITEMS (32)

** CATEGORIES AND SUBCATEGORIES WEIGHTED TO REFLECT RELATIVE IMPORTANCE

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Table M-10
Proposed Program, Delta Alternatives Study Status, October 1976

COMPONENT	COMMENTS
DELTA PROTECTION PROGRAM	
ENVIRONMENTAL MONITORING	Monitor water quality and fish and wildlife resources.
FOUR-AGENCY FISH AND WILDLIFE AGREEMENT	(DWR, USBR, DFG, & USFWS) specifying needs and means of protecting fish and wildlife.
SWP CVP OPERATION AGREEMENT	Spell out responsibility of the two projects in meeting Delta and and project needs.
LIMITS ON DELTA DIVERSIONS	Low in dry years, intermediate in normal years, and high in wet years.
REVIEW AND REVISION OF DELTA WATER QUALITY STANDARDS	To assure criteria for protecting the Delta constitutes a reasonable, beneficial use of water.
FEDERAL PARTICIPATION IN DELTA PROTECTION	Provide for CVP to operate within the same rules for protecting Delta as SWP and federal participation in Delta Water Facilities and Suisun Marsh Protection.
SOUTH DELTA WATER QUALITY IMPROVEMENT FACILITIES	To distribute good quality water to areas that now have poor quality water.
SUISUN MARSH FACILITIES	To improve water quality for Marsh management.
FACILITIES SOUTH OF THE DELTA	
WATER CONSERVATION	Estimated that by year 2000, water conservation of 500 cubic hectometres (400,000 acre-feet) per year could be achieved.
WASTE WATER RECLAMATION	Estimated that by year 2000, 120 cubic hectometres (100,000 acre-feet) per year could be developed.
GROUND WATER STORAGE	To provide about 500 cubic hectometres (400,000 acre-feet) per year of firm project yield.
ENLARGE EAST BRANCH OF CALIFORNIA AQUEDUCT	To provide necessary aqueduct capacity to deliver water for storage in Chino Ground Water Basin.
LOS VAQUEROS RESERVOIR	To provide 200 cubic hectometres (160,000 acre-feet) per year of firm yield and other benefits.
MID-VALLEY CANAL	USBR Project to deliver water from California Aqueduct to east side of San Joaquin Valley to reduce existing ground water overdraft.
FACILITIES NORTH OF THE DELTA	
SACRAMENTO VALLEY GROUND WATER	To provide approximately 250 cubic hectometres (200,000 acre-feet) per year of firm yield.
COTTONWOOD CREEK PROJECT	USCE project to provide about 210 cubic hectometres (170,000 acre-feet) of firm yield for purchase by State.
MARYSVILLE RESERVOIR	USCE Project to provide about 200 cubic Hectometres (160,000 acre-feet) of water to offset loss from Ship Channel Projects.
GLENN RESERVOIR-RIVER DIVERSION	To provide 1.2 cubic kilometres (1 million acre-feet) of additional firm yield annually.
RELATED FACILITIES AND ACTIONS	
RELOCATE CONTRA COSTA CANAL INTAKE	To improve water quality and insure water supply for Contra Costa Canal; and to save water otherwise needed for water quality control at the present canal intake.
IMPROVE DELTA LEVEE MAINTENANCE	To protect Delta agriculture by reducing the threat of flooding and salt water intrusion from levee failure.
FISH SCREENS ON IN-DELTA DIVERSIONS	To help protect Delta fisheries by screening some of the 1.9 cubic kilometre (1.6 million acre-feet) in-Delta diversions.
DELTA WATER AGENCY CONTRACTS	To assure Delta Water Agencies of adequate quality water supply and provide repayment for project benefits.
SELECT ONE OF THREE ALTERNATIVE DELTA WATER TRANSFER FACILITIES	
NEW HOPE CROSS CHANNEL – SOUTH DELTA INTAKE CHANNEL	
NEW HOPE CROSS CHANNEL – ENLARGED CLIFTON COURT FOREBAY	
PERIPHERAL CANAL	

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APPENDIX N
DOCUMENTS INCORPORATED BY REFERENCE

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APPENDIX O
LIST OF PREPARERS

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This Environmental Impact Report/Environmental Impact Statement was prepared by the California Department of Water Resources, Division of Planning, 1416 Ninth Street, Sacramento, CA 95814 and the U.S. Bureau of Reclamation, Mid-Pacific Region, 2800 Cottage Way, Sacramento, CA 95825. A list of persons who prepared various sections of the document, significant background material, or participated to a significant degree in preparing the document is presented below.

Name	Qualifications	Participation
Department of Water Resources		
Fred H. Bachmann	B.S. Civil Engineering, P.E.; Chief, South Delta Management Section; water resources planning, 31 years	Project Manager; engineering analysis and mitigation
George Barnes	B.S., M.S. Civil Engineering, P.E.; Chief, Delta Modeling Support Branch; 26 years with DWR	Statewide and Delta operation studies
Naser J. Bateni	B.S., M.S. Engineering, P.E.; Senior Engineer, Water Resources; 1 years w/ SWRCB, 11 years w/ DWR	EIR/EIS coordinator; engineering and impacts analysis
David Brown	B.S., M.S. Biology; Chief, Environmental Support Section; Environmental specialist, 17 years	Environmental analysis
Randy Brown	PhD. Ecology; Chief, Environmental Studies Branch;	Fishery impacts and coordination
Francis Chung	B.S., M.S., Ph.D., Civil Engineering, P.E.; Chief, Delta Modeling Section; water resources engineering, 15 years	Statewide and Delta operation studies
Jake Compton	B.S. Civil Engineering, P.E.; Associate Engineer, Water Resources; 16 years in construction and design, 12 years in Delta facilities planning	Engineering analysis and cumulative impacts
Steve Cowdin	B.A. Public Administration; Research Program Specialist II; water resources economics, 13 years	Service area impact analysis
Bellory Fong	B.S. Biological Conservation; Environmental Specialist IV; Chief, Bay/Delta Interagency Program; 17 years	Fisheries studies

Name	Qualifications	Participation
Sheila Greene	B.S. Biological Science; Environmental Specialist I; Bay/Delta Interagency Program, 4 years	Fisheries studies
Kamyar Guivetchi	B.S. Civil Engineering; Graduate work in environmental engineering; Assistant Engineer, Water Resources; 6 years in Delta modeling	Delta hydrodynamic and water quality modeling studies
Ray Hoagland	B.A. Economics and Mathematics; Graduate studies at U.C. San Diego; Research Manager III; Chief, Economic Analysis Section; water resources economics, 15 years	Economic benefits analysis
Edward F. Huntley	Registered Civil Engineer; Chief, Division of Planning; water resources planning, 32 years	Coordination with statewide planning
Ron Landingham	B.A. Economics; Research Program Specialist I; water resources economics, 6 years	Economic analysis
Elaine Merritt	B.S. Civil Engineering; Assistant Engineer, Water Resources; 4 years with DWR	Engineering analysis
Mohammad "Mike" Mirmazaheri	B.S. Civil Engineering; Assistant Engineer, Water Resources; 4 years with DWR	Engineering analysis; Construction, economics, socio-economics, and energy coordination
Robert Nozuka	B.S. Civil Engineering; Assistant Engineer, Water Resources; Delta planning, 3 years	Engineering analysis
Robert Plath	M.S. Statistical Economics; Operations Research Specialist II; Delta Modeling, 5 years	Operation Studies
Dwight Russell	B.S. Civil Engineering, P.E.; Senior Engineer, Water Resources; 20 years in hydrological systems modeling	Hydrodynamic modeling studies
Robert Suits	M.S. Civil Engineering, P.E.; Associate Engineer, Water Resources; Delta planning, 5 years	Engineering analysis

Name	Qualifications	Participation
Karl P. Winkler	B.S. Civil Engineering, P.E.; Chief, Delta Planning Branch; water resources planning, 17 years	Coordination of Delta programs; Engineering analysis and mitigation
Waiman Yip	B.S. Civil Engineering, P.E.; Associate Engineer, Water Resources; Delta planning, 5 years	EIR/EIS coordination assistance; Engineering analysis
Robert Zettlemoyer	B.S., M.S. Civil Engineering, P.E.; Senior Engineer, Water Resources; 25 years with DWR	Water supply and demands evaluations
U. S. Bureau of Reclamation		
Charles L. Borda	B.A. History, M.A. Economics; Forest Economist, USDA, Forest Service, 6 years; Economist, Reclamation, 3 years	Recreation economic analysis
Richard Crysdale	B.A. Geography & Economics, M.S. Outdoor Recreation; Environmental Specialist and Outdoor Recreation Planner, Reclamation, 19 years	Outdoor recreation
Douglas Kleinsmith	M.S. Biology; Environmental Biologist, FERC, 3 years; Natural Resources Specialist, BLM, 2 yr; Environmental Specialist, Reclamation, 8 years	EIS coordination and review; prepared miscellaneous EIR/EIS sections
Roland C. LaForge	B.A. Geology, M.S. Geology; 10 years with Reclamation as Seismologist in seismo-tectonics	Seismic risk analysis
Dean A. Ostenaa	B.A. Geology, M.S. Geological Engineering; 15 years with Reclamation in engineering geology and seismotectonics	Seismic risk analysis
Chester Robison	B.S. Biology & Mathematics, M.S. General Science; 21 years with Reclamation as Educator, Natural Resources Specialist, and Outdoor Recreation specialist	Outdoor recreation
Val G. Rhode	B.A. Psychology, M.Ed. Educational Psychology; Social Factors Analyst; 23 years, Reclamation, 9 years Psychologist, 5 years Program Manager, 9 years Public Involvement and Social Factors Analyst	Public involvement and social analysis

Name	Qualifications	Participation
G. James West	Ph.D. Anthropology; Regional Archeologist, Reclamation, 10 years; Archeologist, Department of Parks and Recreation, 3 years; Instructor, U.C. Davis, 3 years	Cultural resources
John Wilson	B.S. Geology, M.S. Geological Engineering; 11 years with Reclamation in embankment dams design and analysis, Earthquake Engineering specialty	Recreation economic analysis

Copies of this report may be obtained FREE from

State of California
DEPARTMENT OF WATER RESOURCES
P.O. Box 94236
Sacramento, CA 94236-0001