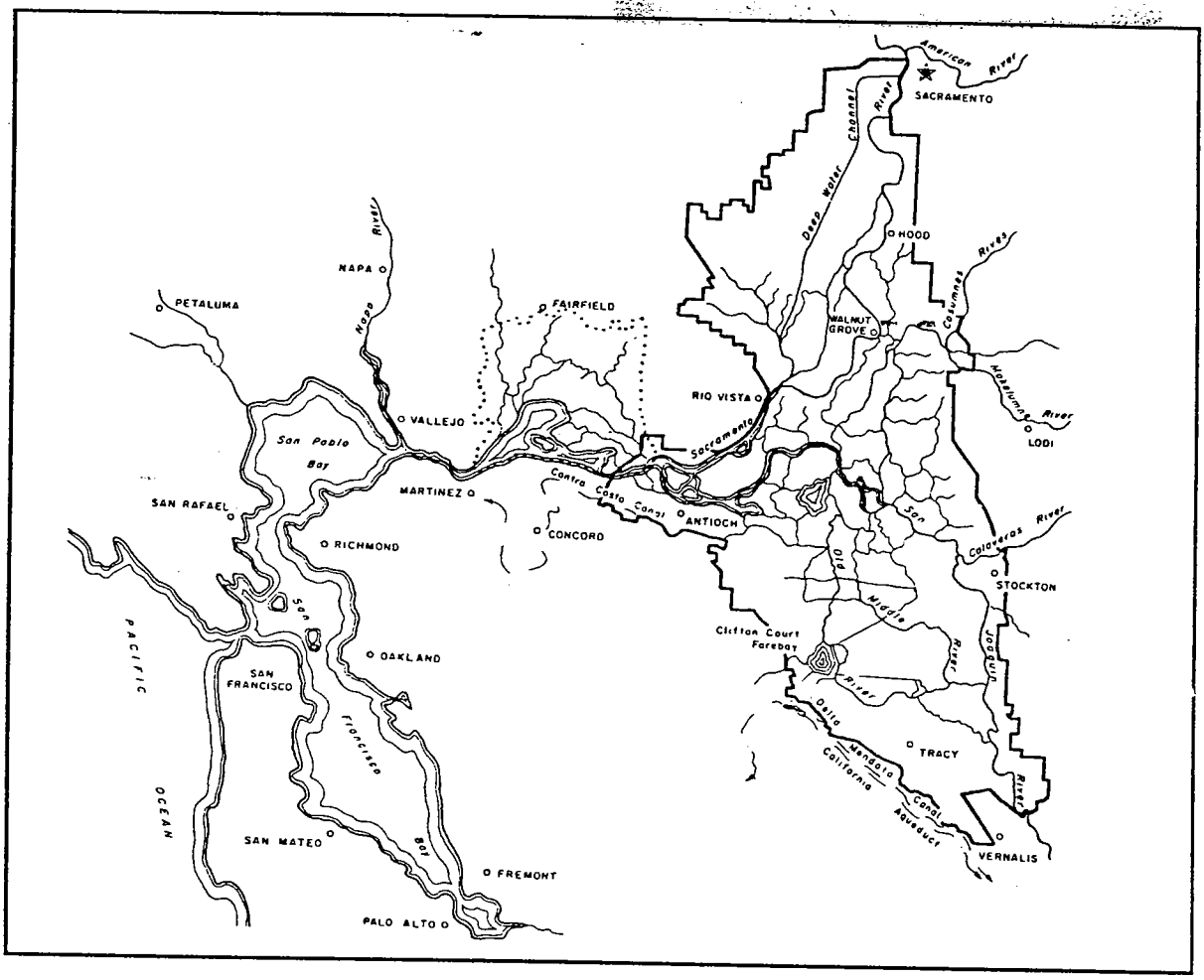

WATER QUALITY CONTROL PLAN FOR SALINITY

San Francisco Bay/ Sacramento - San Joaquin Delta Estuary

91-15WR

May 1991

WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

STATE OF CALIFORNIA
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COVER:
Bay-Delta Map

SOURCE:
Division of Water Rights

To reorder this publication refer to publication number: **91-15 WR**
Report on Water Quality Control Plan

WATER QUALITY
CONTROL PLAN FOR SALINITY

San Francisco Bay/
Sacramento - San Joaquin
Delta Estuary

Report Number, 91-15 WR

May 1991

Prepared by the Bay-Delta Section
Division of Water Rights
WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 91-34

ADOPTION OF THE WATER QUALITY CONTROL PLAN FOR SALINITY --
SAN FRANCISCO BAY/SACRAMENTO-SAN JOAQUIN DELTA ESTUARY

WHEREAS:

1. The State Water Resources Control Board is responsible for the regulation of activities and factors which affect or may affect the quality of the waters of the State (Water Code Section 13001).

2. The State Board has undertaken a process, under its water quality authority, to develop a set of water quality objectives for salinity, temperature, and dissolved oxygen to protect beneficial uses of the Estuary.

3. The State Board has conducted 60 days of evidentiary hearing initiated on July 7, 1987, and concluded on August 23, 1990, in accordance with the Federal Clean Water Act (33 U.S.C.A. Sections 1251 to 1387) and the California Water Code, and has considered the evidence introduced at the hearing.

4. A draft Water Quality Control Plan for Salinity -- San Francisco/Sacramento-San Joaquin Delta Estuary was formulated and submitted for public review on January 18, 1991.

5. The State Board conducted a public hearing on the draft water quality control plan on March 11, 1991, after notice to all interested parties, in accordance with Federal and State requirements and has considered the oral and written comments submitted.

6. The Water Quality Control Plan, consisting of the Water Quality Control Plan for Salinity -- San Francisco/Sacramento-San Joaquin Delta Estuary, accompanying Technical Appendix, and the comments and responses thereto, has been revised to incorporate appropriate comments received from the interested parties.

7. The water quality objectives in the Water Quality Control Plan--San Francisco Bay/Sacramento-San Joaquin Delta Estuary will be reviewed at least once every three years.

8. The Water Quality Control Plan is an adjunct to the Basin Plans; together with the Basin Plans, it includes all necessary elements of water quality control plans in accordance with Sections 13241 and 13242 of the California Water Code and Federal requirements.

9. The State Board has prepared the Water Quality Control Plan under a certified program as a substitute document for an environmental impact report under Section 21080.5 of the California Public Resources Code (California Environmental Quality Act).

THEREFORE BE IT RESOLVED:

1. That the State Board adopts the Water Quality Control Plan--San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Plan) in accordance with Section 13170 of the Water Code.

2. That the Executive Director is directed to forward copies of the Beneficial Use Designation and Water Quality Objectives portions of the Plan to the United States Environmental Protection Agency for review and approval in accordance with requirements of the Federal Clean Water Act [33 U.S.C.A. Section 1313(c)].

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on May 1, 1991.

Maureen Marché
Administrative Assistant to the Board

FOREWORD

Introduction

Consider water in California and you face a complex brew of physical, technical, political and cultural elements. Most of the State's water supply falls as rain and snow in the north, in the wintertime. Most of the consumptive use occurs south of the Sacramento-San Joaquin Delta, in the summer.

During the past century, the challenge was how best to capture, redistribute and safeguard this resource. As a consequence, pioneering projects dot the landscape with reservoirs and water transport canals which lace together the northern and southern parts of the State.

The current challenge is how to balance the redistribution of water to ensure maximum benefit to all of California, its people, its agriculture, its industry and its environment, including how best to protect its quality so that it serves our needs.

Balancing this redistribution is a major function of the State Water Resources Control Board.

Comprehensive Protection for the State's Waters

In California, the use of water must be planned within the framework of source availability, current as well as future needs and principles embodied in State law. California needs a water supply of sufficient quality to meet all reasonable uses. Although there exist sufficient water sources to meet all reasonable needs, these sources are insufficiently managed and/or developed to provide a reliable supply for all needs.

The Bay-Delta water system is a major source of supply to the State, providing more than half of all water used in California. Therefore, comprehensive planning for the ongoing protection, development and management of this unparalleled resource is needed.

The State Board has major planning and regulatory responsibilities for the State's water resources, and specifically the Bay-Delta system. The State Board is uniquely designed for this task: it has the dual responsibility of protecting the State's water resources as well as allocating the State's existing water supply.

The Basin Plans prepared by the Central Valley and San Francisco Regional Boards establish water quality objectives to protect beneficial uses of Bay-Delta waters. To supplement those efforts, in 1987, the State Board embarked on a major comprehensive program to protect the waters of the Bay-Delta system. That program is composed of five interrelated components. Each of the components is important and builds on the others.

The five components are: the California Water Quality Assessment, adopted in April, 1990; the Pollutant Policy Document, adopted in June 1990; the Inland Waters Plan and the Enclosed Bays and Estuaries Plan, adopted in April, 1991; the Water Quality Control Plan for Salinity for the Bay-Delta, adopted May 1991; and the Scoping and Water Right phases of the Bay-Delta proceedings (the Scoping Phase of which began in March, 1991).

Viewed in the context of these other Plans and actions, the Water Quality Control Plan for Temperature and Salinity represents but one step in a coordinated five-point program.

Genesis of the Bay-Delta Plan

In 1978, the Board issued several comprehensive reports on the uses and protections of the Delta. The proceedings were limited to current and near-term conditions in the Delta. When the original Delta Plan and accompanying Water Right Decision (D-1485) were issued, the Board realized that the Delta's importance would require another examination. The State Board committed itself to review the Delta Plan in about ten years.

This commitment as well as applicable court decisions have resulted in the current proceedings and have expanded the scope of the proceeding.

In 1986, the State Court of Appeal issued a decision, also known as the Racanelli or Delta Water Cases decision, addressing legal challenges to the Delta Plan and D-1485. The Court directed the State Board to take a global view toward its dual responsibilities to the State's water resources. According to the Court, the State Board's duty in its water quality role is to provide reasonable protection for beneficial uses, considering all demands made on the water. Moreover, the State Board's water allocation role is not confined to the consideration of existing water rights. The Court also recognized that a program to implement protections for the system would be lengthy and complex; the program would involve entities over which the State Board has little or no control, whose actions, however, affect the waterscape.

Content of the Current Bay-Delta Plan: Use of Water Quality Objectives for the Bay-Delta Waters

The current Plan is primarily concerned with salinity and temperature factors.

Numerous water quality objectives, protecting water quality and the beneficial uses of Bay-Delta waters (see Table 1-1), have been established for:

- Salinity at municipal and industrial intakes,
- Salinity levels to protect Delta agriculture,
- Salinity levels to protect export agriculture,
- Salinity for fish and wildlife resources in the Estuary.

Water quality objectives have also been established to provide:

- Expansion of the period of protection for striped bass spawning, and
- Temperature and dissolved oxygen levels for fisheries in the Delta.

Most importantly, this Plan sets the stage for the real heart of the Bay-Delta proceedings -- determining reasonable protection for all uses, and determining who will share responsibility for meeting the established water quality objectives.

The Scoping and Water Right Phases of the Proceedings

Immediately after adoption of this Plan, the State Board will conduct scoping hearings on other actions necessary to protect beneficial uses, including flow requirements.

The flow issue is critical to the State Board's final decision. Flow requirements yet to be established will ultimately determine how much water can be exported for consumptive use, as well as how much water is needed to protect fish and wildlife.

Central to all these issues is the question of what amount of water is available and who is required to manage it.

Currently, two major water systems, one State and one Federal, export Delta water to other areas in California. These systems -- the State Water Project (SWP), operated by the California Department of Water Resources (DWR), and the Central Valley Project (CVP), operated by the U.S. Bureau of Reclamation (Bureau) -- are responsible for meeting salinity objectives in the Bay-Delta. There are, however, approximately 7,000 parties which divert Delta water for usage throughout the State.

In order to establish an equitable means of water supply and distribution as embodied in Racanelli, the State Board has determined that other parties diverting Delta water, not only the CVP and SWP, should be required to meet water quality objectives in the Delta.

A primary task, among many others, of the Scoping and Water Right phases of the proceedings therefore will be the identification of appropriate requirements and of the parties responsible for providing for these needs. Initially, the State Board will review the operations of Sacramento and San Joaquin Valley reservoirs of 100,000 acre-feet and larger, as well as those of major direct water diverters, to determine how responsibility will be allocated for meeting the Bay-Delta Estuary's water quality and quantity needs. The extent to which smaller projects will be included will be considered during the Scoping Phase.

To complete the Scoping and Water Right phases, consideration will also be given to these issues:

- o The record to date, plus the continuation of low runoff and depleted storage, clearly show that there are insufficiently managed fresh water flows to protect fully all beneficial uses during dry and critical years, and perhaps in subnormal years. Consequently, decisions are needed regarding new facilities, agreements on how to mitigate adverse impacts, modifications on water use and possibly new directives from the Legislature.

- o At the end of the current proceedings (that is, after adopting a water right decision), the State Board will incorporate in a revised Plan of Implementation that will:

  - establish a time table to carry out best practicable management of the resources and uses thereof;
  - identify potential new facilities and time schedules for planning and construction to achieve best practicable management;
  - outline suitable mitigation measures based on negotiated agreements to offset losses if some specified beneficial uses are not reasonably protected by direct requirements;
  - establish requirements to modify uses to reasonably balance the allocation of fresh water resources and the beneficial uses; and
  - propose potential new legislative directives.

In addition, the State Board must evaluate new major facilities, and consider other actions that are already in the planning stages or under public discussion. These include but are not limited to:

Upstream from Delta	Auburn Dam and reservoir (could modify water right terms); additional fish hatcheries for salmon and steelhead.
In Delta	Delta island storage (permit terms and conditions) enlarge channels; isolated conveyance.
In Export Areas	Los Banos Grandes and Los Vaqueros reservoirs (permit terms and conditions); conjunctive use of ground water basins; southern California surface reservoirs.
Mitigation	Wetlands additions; improve fish hatchery outputs; improve planting of fish; improve aquatic habitat; reduce infestations of injurious phytoplankton, clams, etc.
Water Use Modification	Improve irrigation efficiencies; increase artificial ground water recharge; increase waste water reclamation.

Potential Legislation	Set priorities for types of beneficial uses; explore and propose agricultural land retirement where corrective drainage costs are excessive (similar to buy out of environmentally sensitive lands at Lake Tahoe).

Completion of the water right process will be a complex task. The most difficult decisions lie ahead. Scoping has already begun in March. As we move into the Water Right Phase, the State Board needs the guidance of all parties on the appropriate range of alternatives that should be evaluated -- toward the goal of having a balanced water right decision adopted in late 1992.

WATER QUALITY CONTROL PLAN
CONTENTS

APPENDICES

TECHNICAL APPENDICES
(Available Upon Request)

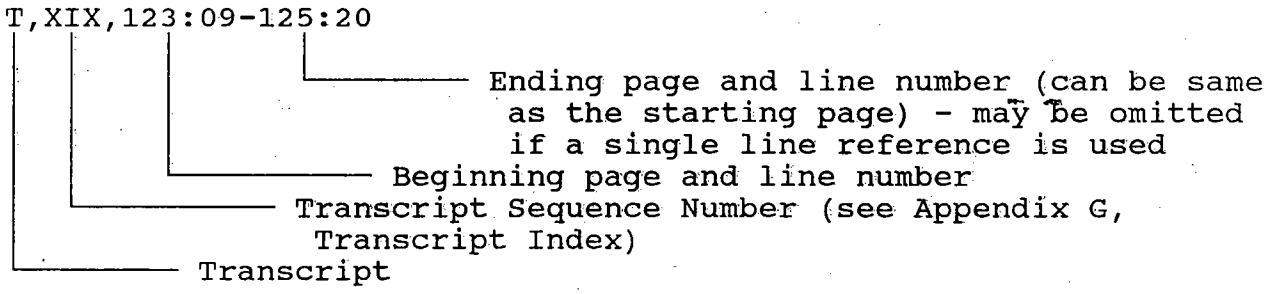
FIGURES

TABLES

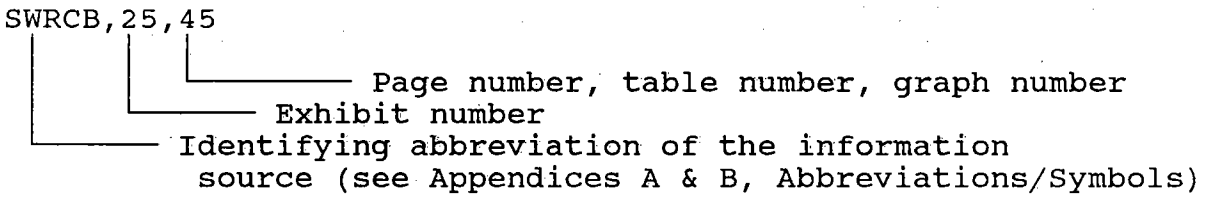
CITING INFORMATION

When citing evidence in the hearing record, the following conventions have been adopted:

Information derived from the TRANSCRIPT:



Information derived from an EXHIBIT SUBMITTED DURING PHASE I:



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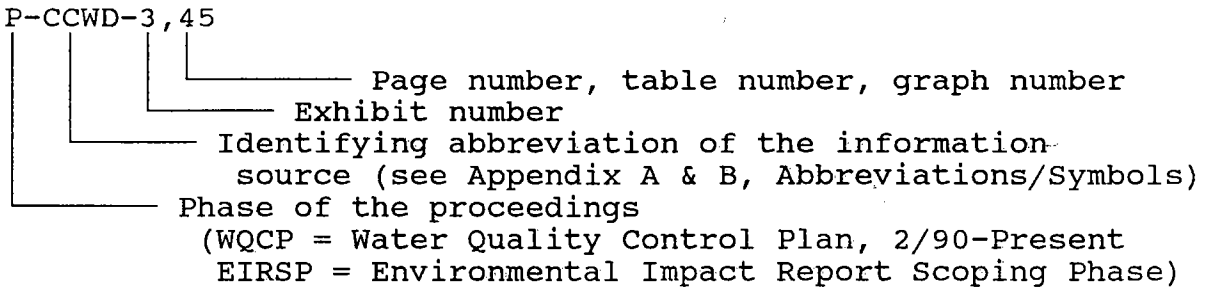
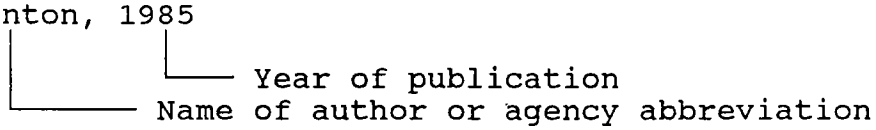


When citing REFERENCES from outside of the hearing record, the following conventions have been adopted:

Information derived from published documents,
(a) in the text of the Plan:



(b) at the end of the appropriate Plan Chapter:

Denton, R.A. 1985. Currents in Suisun Bay. SWRCB, Publication No. 85-3wr. January 1985.

- Complete publication source
- Complete title of document cited
- Publication date
- Name of author or agency abbreviation

Information derived from Phase I closing BRIEFS:
(a) in the text of the Plan:

RIC,Brief,8

- Page number
- "Brief"
- Identifying abbreviation of the information source

(b) at the end of the appropriate Plan Chapter:

Brief of the Rice Industry Committee on Pollutants in the Bay-Delta Estuary, pg. 8.

For a complete list of the abbreviations for information sources, citations and symbols used in this document, see Appendix A and B.

Appendix C is a Glossary of Terms; Appendix G is a Index of Transcripts listing Transcript Sequence Numbers.

1.0 EXECUTIVE SUMMARY

1.1 Background

The San Francisco Bay and Sacramento-San Joaquin Delta Estuary (Bay-Delta Estuary) includes the Sacramento-San Joaquin Delta (Delta), Suisun Marsh and the embayments upstream of the Golden Gate. The Delta and Suisun Marsh are located where California's two major river systems, the Sacramento and San Joaquin rivers, converge to flow westward to where they meet incoming seawater tides flowing through the San Francisco Bay. The beneficial uses of the waters in this system are set forth within the water quality control plans adopted by the San Francisco and the Central Valley Regional Water Quality Control Boards. The beneficial uses of Delta waters encompass almost all uses of water imaginable. The watershed of the Bay-Delta Estuary provides drinking water to two-thirds of the State's population and water for a multitude of other urban uses; it supplies some of the State's most productive agricultural areas both inside and outside the Delta; it is one of the largest systems for fish and waterfowl habitat and production in the United States. The Sacramento-San Joaquin Delta serves as a critical link for projects which transfer water from surplus to deficient areas.

Two major water distribution systems divert water from the Delta: the State Water Project (SWP) operated by the California Department of Water Resources (DWR) and the Central Valley Project (CVP) operated by the United States Bureau of Reclamation (USBR). Numerous other water diversion and management efforts influence the inflows into, flows through, and outflows from the Bay-Delta estuary.

1.2 Procedural Setting

In July 1987, the State Water Resources Control Board (State Board) opened a public proceeding consistent with direction from the California Court of Appeal in U.S. v. State Water Resources Control Board, 182 Cal.App.3d 82, 227 Cal.Rptr.161 (1986). To provide a comprehensive approach to water quality management, the Board has reviewed and approved amendments to the two relevant regional basin plans, and has adopted a separate Pollutant Policy Document (PPD), the Enclosed Bays and Estuaries and Inland Surface Water Plans, and a Water Quality Assessment.

This Water Quality Control Plan for Salinity, San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Plan), supersedes the regional water quality control plans for the Bay and Delta to the extent of any conflict. This document supersedes the 1978 Delta Plan to the extent that the 1978 Plan addresses the water quality parameters which are the subject of this Plan. In addition to setting water quality objectives for salinity, the 1978 Delta Plan established Delta outflow standards and operational constraints implemented through Water Right Decision 1485 (D-1485). These flow requirements are established for the purpose of assuring flows consistent with the reasonable protection of beneficial uses. The Board has determined that modification of these flow requirements is premature until the Water Right Phase of these proceedings is completed. Because changes

to these flow requirements are not being proposed as part of the Water Quality Phase of these proceedings, the flow requirements and operational constraints in the 1978 Delta Plan will remain in effect until the conclusion of the Water Right Phase.[1]

Further, this document is a substitute for an environmental document, consistent with the process certified under Public Resources Code Section 21080.5.

After adoption of this Plan, the Board will commence comprehensive scoping hearings consistent with the California Environmental Quality Act. The purpose of the scoping hearings is to receive evidence from participants to: (1) develop specific alternatives for reasonable levels of protection for beneficial uses; (2) identify the current and potential role that proposed physical facilities, negotiated settlements, legislative action, and the actions of other agencies should play in the protection of beneficial uses of Bay-Delta waters; (3) draft a matrix of alternatives (to include flow amounts as appropriate); (4) assess implementation of the alternatives; and (5) compile a draft EIR.

Following the public review of the draft EIR prepared by the State Board, a hearing will be held on the draft EIR and on water right matters to which it applies. This Water Right Phase will be conducted as a quasi-adjudicative proceeding at several locations throughout the state. It will conclude with the adoption of a final EIR and a water right decision.

The product of the current Water Quality Phase of the planning process will be updated to reflect findings and conclusions at the end of the Water Right Phase and periodically, thereafter, whenever sufficient new information is received.

As set forth above, it is important to note that water quality objectives and water right permit terms for the Delta exist today. They were recognized by the court in U.S. v. State Water Resources Control Board. Current permit conditions which seek to protect the Delta are in effect and enforceable pending completion of these full proceedings.

In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement.

1/ The flow requirements established in the 1978 Delta Plan are implemented in the Board's Decision 1485 and will be enforced by the Board pursuant to its water rights authority until new terms and conditions are adopted in the Water Rights Phase of these proceedings. At the end of the Water Right Phase, this document will also be updated. At that point the Board will have evaluated all of the requirements of the 1978 Delta Plan, and will have retained or modified those requirements, as appropriate. It will no longer be necessary for any provision of the 1978 Delta Plan to remain in effect, except where the Board has decided to adopt that provision, with appropriate modifications, in the Water Quality or Water Right Phase of these proceedings.

The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The SMPA also describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards.

1.3 Scope of the Plan

This Plan is the product of extensive hearings. In this Plan, we make a distinction between thermal loadings and salinity effects caused by man's traditional land use and waste water additions to the waters of the state and those influences directly related to and resulting from the allocation of water for use through water control and diversion. This distinction is premised upon the different way federal and state laws treat waste discharges and the allocation of water for beneficial use. Waste dischargers are governed by both state and federal law. The appropriate regional boards adopt basin plans designed to regulate thermal loadings and salinity effects, as well as other pollutant components, of waste discharges. These plans are submitted to the Environmental Protection Agency in accordance with the provisions of the Clean Water Act. The allocation of water recognizes both the intended and unintended results of water control and diversion such as those resulting in salinity variations within the Estuary.

This Plan primarily addresses temperature and salinity objectives (for a complete listing, see Table 1-1). Water rights proceedings and other actions will follow in order to implement these objectives and others which can best be addressed in the allocation process. Initially, the State Board will be reviewing operations of Sacramento and San Joaquin Valley reservoirs of 100,000 acre-feet and larger, and major direct diverters, to determine how responsibility will be allocated for meeting the Bay-Delta Estuary's water quality and quantity needs. The extent to which small projects will be included will be considered during the Scoping Phase. The need for determining the specific responsibilities of other water right holders will be analyzed as we proceed. When the process is completed, the combination of water quality planning and the amended water right permits will provide the statutorily mandated reasonable protection of the beneficial uses.

1.4 General Comments

* State Water Planning Programs and the Federal Act

This Plan fully complies with the State's water quality statutes and with applicable federal law. The State's water quality planning is consistent with the federal Water Pollution Control Act as amended by the Clean Water Act Amendments of 1987. California's water planning program is more broad-based than the federal act, and encompasses planning and implementation powers affecting: determinations of waste and unreasonable use, allocations of water use through water rights decisions, review and approval of changes in the manner, timing and location of water use, and sources of pollution.

* Fish Migration

In the course of these proceedings, evidence was introduced that significant impacts to the fishery are due to the location, method and timing of diversions of water from and upstream of the Delta and are not related to the quality of the water. The impacts to the fishery are due in part to such factors as:

- direct entrainment losses at the points of diversion from the Delta;
- diversion of fish through the Delta Cross Channel into the interior Delta;
- reverse flows in various reaches of the San Joaquin River, Old River, Middle River and other Delta channels, caused by the CVP, SWP, CCC and local agricultural diversion pumps; and
- the lack of flows in some water years to either hold the entrapment zone in the proper location to provide a nursery area for young striped bass or to move (flush) the young striped bass into Suisun Bay where habitat conditions should be better than in the Delta.

These flow-related issues will be addressed by the State Board in the Scoping and Water Right phases of these proceedings. The State Board retains the option of setting flow objectives, if appropriate. However, in an effort to expand the Board's, and others', understanding of the potential benefits to the fishery and the cost in terms of reductions of available offstream water supply, operational information will be needed addressing the above issues. The study needs are discussed in more detail in Chapter 7. Such studies will permit the Board to evaluate a full range of social and economic benefits and costs, and to identify management options that could be implemented to reasonably protect the fishery resources.

* Fish versus People

During the proceedings an issue was raised and described as "fish v. people". Some parties wanted the Board to assign value or weight to people's needs for the water versus fish needs if the circumstances so required. The State Board must ensure reasonable protection of beneficial uses. In this case, municipal and industrial uses and aquatic life are the two beneficial uses to be protected. The court in U.S. v SWRCB directed

that the Board was to equitably distribute the dry year shortages as well as the wet year benefits. Such balancing and distribution is the essence of allocation and will be undertaken during the Water Rights Phase of these proceedings. In establishing the reasonable objectives and goals of this Plan, there is no need to choose one beneficial use over the other. All beneficial uses are being reviewed for the reasonable protection of each use, and then for the reasonable protection of all uses as they relate to each other.

* Location and Operation of the Pumps and Cross Channel Facilities

The location and operation of the diversion pumps and cross-channel facilities within the Delta have direct impacts upon uses in and out of the Delta. Evidence was submitted which dealt with the hydraulic effects of the state and federal diversions and their impacts on fishery resources. The record contains evidence that one of the chief impacts upon fishery beneficial uses is the operation of the diversion pumps, cross channel facilities and other physical facilities within the Delta, during critical times of migration and spawning. The record also reflects the serious potential impacts inherent in the location of the pumps to the beneficial uses of drinking water. The existence of disinfection by-products, caused by the treatment of water containing organic materials that result from decomposition of peat soils, may present a risk to drinking water supplies both in and out of the Delta.

In addressing both the fishery and drinking water impacts, it is necessary to understand their profound implications to uses throughout the state. These are examples of where it is necessary to protect the same resource for two equally important beneficial uses. Any attempt to set numeric objectives or to single out any one permanent implementation condition without a full balancing of the impacts to all uses in and out of the Delta would result in numerous and widespread inequities within California's water supply system.

The Board has broad powers to address these impacts and will also do so in the Scoping and Water Right phases. In light of the impacts to the fishery and to drinking water supplies, a solution may be to relocate the existing points of diversion for the projects. Therefore, the parties should provide necessary information within the Scoping Phase to enable the State Board to weigh alternatives to the existing places of diversion.

* Role of Fish Hatcheries as a Mitigation Measure

There is evidence of economic, social and resource benefits and impacts from the use of fish hatcheries and growout facilities as resource management tools. Potential negative impacts include disease transmissions and genetic effects on fish. Further evaluation of the influences and impacts of those management tools is required within the scoping and subsequent implementation stages of this process.

* Flow Requirements for the Bay

Requests have been made for the Plan to contain requirements for more flows to protect the Bay (downstream of Carquinez Straits). To have meaning the concept of "more flows" must include such factors as water year types, time

of year, tidal influences, the relationship of demand to water availability, etc. There must be a demonstrated connection between flow and the reasonable protection of beneficial uses. Although data were presented on this topic, the Board finds the information inconclusive. The Board will consider Bay flow requirements during the Scoping and Water Right phases of these proceedings and may decide to set flow objectives.

The State Board is supporting a program to produce information about the Bay-Delta system that would be relevant to management decisions (e.g., what appropriate water quality objectives should the State Board set to reasonably protect beneficial uses being made of waters within the Bay-Delta Estuary complex). The program should:

1. Identify the activities that have an effect on the Bay and Delta and that can be managed (i.e., differentiate between natural phenomena and man-induced activities having an impact on the Bay-Delta);

2. Identify responsibilities for developing studies to allow resources agencies to better manage the Bay-Delta system.

3. Develop a stable funding mechanism for the needed studies through fees on point dischargers, nonpoint dischargers and upstream water users.

4. Develop time schedules and oversight committees to ensure timely implementation and coordination.

Since planning and executing studies of the Estuary require DFG to work closely with the other member agencies of the IESP, more stable and consistent funding of all IESP programs is required to achieve maximum benefits from these studies and to achieve effective Estuary management.

* Pulsing/Seasonal Flows

There was testimony given that the Board should establish pulsing/seasonal flows in order to improve stratification within the south Bay. Because the physical and biological importance of stratification is largely unknown, further information is needed and should be developed to determine if and how stratification influences or impacts beneficial uses. Further, there appears to be a need to examine stratification, or the ability to influence stratification, through operation of control and diversion facilities. Therefore, the Board believes that pulsing/seasonal flows should be further analyzed by the Operations Workgroup, with a progress report to be provided during the Scoping and Water Right phases of these proceedings.

* Exclusion of Unimpaired Flows

In an examination of the record and review of existing objectives, the Board determined that unimpaired flows are not a feasible alternative to the existing operations. Therefore they are not an appropriate basis for examining, evaluating and balancing the protection of beneficial uses. The Board has considered the existing facilities, reviewed operational data, analyzed relevant management tools and deliberated upon all submitted economic information. There are sufficient data available to support a partial evaluation of existing conditions. Such an evaluation is necessary

to establish objectives and to ultimately refine these objectives after completion of the next portions of these proceedings. Unimpaired flows continue to be used as a basis for estimating available water supply and for determining year types.

* Limitations Upon Existing Supplies

Water supplies to southern California have been restricted by court decree and physical circumstance. California's supply from the Colorado River is limited and except for unusual circumstances fixed. Water available to Los Angeles from the Owens Valley and the Mono Lake Basin has been reduced by judicial decree. Various ground water basins within areas using Delta water supplies are facing serious limitations due to pollution or salt water intrusion. The record reflects that substantial increases in population are expected within all areas making use of water from the Delta.

* Water Resources Management

While the general public perception of reasonable conservation efforts includes such measures as odd-even watering days, low flush toilets, flow restrictors, and reasonable use of water by agriculture, much more needs to be done to expand conservation among all water users. Any determination of the reasonable use of water must be prefaced upon a demonstration that reasonable conservation efforts are being undertaken. The showing is the obligation of all users and advocates for the uses. This obligation extends to public trust uses. Temporary changes in fishery harvest regulations should be considered as part of an overall short-term approach to improve the situation until longer-term measures may be instituted. The Board does not believe that such measures should substitute for its own responsibilities to provide suitable habitat. Other public trust management activities may conserve water while maintaining the value of the resource.

Another measure that may be required is the use of water meters throughout the state. Meters draw attention to the fact that conservation is so fundamental that it requires recognition of the individual's impacts upon water use and demand. Coupled with the need to heighten each individual's understanding of his or her impact upon water use and demand is the need to heighten understanding of the impacts of individual loadings of waste and pollution into our water systems. Source controls, waste minimization and pollution prevention are necessary conservation measures to be planned for and implemented by all those using the resource.

Along with heightened awareness of conservation must come an understanding and full acceptance of the potential for reclaimed water. While many understand the need to protect the environment through recycling of aluminum, glass and paper, too few appreciate the waste that occurs whenever water is used once and then treated and dumped into the ocean. A good illustration of reclamation occurs in the Santa Ana River Basin. The need to maximize the beneficial use of all water, particularly that which can be reasonably treated and reused, must become part of the demonstration that reasonable conservation efforts are being undertaken.

A process being called Urban Water Conservation Best Management Practices (BMP) is being developed by urban water suppliers, environmental organizations, and other public interest groups statewide. The BMP process represents a consensus among the above groups on the issue of urban water conservation for the Bay-Delta hearing. The State Water Resources Control Board encourages such consensus recommendations.

During the course of the proceedings a number of effective urban and agricultural conservation and reclamation measures were demonstrated. Yet, concerns, attitudes and apprehensions were expressed about the following aspects of conservation, including:

* Apprehension that water users who were already exercising effective conservation measures would be penalized if sufficient credit wasn't given for voluntary or existing effort. While the obligation to prove such pre-existing conservation measures remains the burden of those seeking credit for conservation measures, any entity capable of showing historic or existing practices would receive credit in the balancing equation. Additional measures will be required only if they are feasible and reasonable.

* Concern that agricultural users are not conserving as much as they could. Some contend that if agriculture would retire marginal land from production and alter the kinds of crops grown to less water intensive crops, there would be enough water for all present and foreseeable future needs. All parties agreed that there is more that all sectors of California could do to conserve. But, conservation alone will not be the answer to the State's supply needs. Further, conservation imposed upon one sector of users based solely upon the amount used by that sector is not a demonstration of the balancing and integration of California's complex water needs. The parties should include more complete data during the Scoping Phase with respect to the potential for conservation by agriculture. During subsequent phases of the proceedings, the State Board will give significant consideration to the Interagency Report of the San Joaquin Valley Drainage Program.

1.5 General Conclusions
(With references to chapter and section, where appropriate)

o The State Board has a major but not all-inclusive role in the allocation and protection of water resources. Its decisions are a dynamic part of the total management and protection program affecting water resources.

o Reasonable protection of beneficial uses means that the Board considers available evidence and strikes a balance between the benefit of a water quality objective and the achievability of that objective. A partial, nonprioritized listing of factors considered in the balancing of benefit and achievability includes:

- Agreements and accords offered by participating parties for the protection and management of the Bay-Delta Estuary, and reviewed by the Board as to their reasonableness;
- Intrinsic values of the beneficial use in addition to quantitative data;

- Legal requirements to protect rare, threatened and endangered species;
- Present and future water supplies and demands;
- Social and economic values (including impacts to housing and agriculture);
- Alternatives to achieve comparable protection; and
- Existing water quality and water allocation laws.

WATER YEAR TYPES (Chapter 3)

- The Bay-Delta Estuary is a dynamic system characterized by wide annual, seasonal, and daily fluctuations in fresh water inflows and ocean derived salinities.

- Defining water year types is an essential tool in evaluating the amount of water available.

- Water availability is an essential factor in establishing reasonable objectives for ocean derived salts.

- The Board adopts the "40-30-30 Water Year Index" for the Sacramento River Basin as proposed by the Operational Studies Workgroup. In subsequent phases of the proceedings, the Board wishes to examine critically the use of the "subnormal snowmelt" and "year following dry or critical year" provisions which allow alterations of objectives.

- Changes to water year types will include development and refinement of an appropriate index before it can be implemented for the San Joaquin River Basin.

CURRENT AND FUTURE WATER SUPPLY CONDITIONS

- On the average, precipitation supplies about 193 MAF per year in California with another 6 MAF coming from out-of-state sources. About 58 percent of this water is used by native vegetation and unirrigated lands; about 25 percent flows to the sea, to salt sinks, or to Nevada; about 14 percent is diverted for offstream uses; and about 3 percent goes to the natural recharge of ground water basins.

- The watershed of the Bay-Delta is a major source of supply critical in satisfying the water needs of the entire State.

- The Bay-Delta watershed is influenced by water diversion and control. On the average about 40 percent of the flow entering the Delta is unmanaged. However, in dry years less than five percent is unmanaged.

- As California's population grows to over thirty-six million people by 2010, the currently developed water supplies will be inadequate to meet the needs of a growing population, expanding economy, and the aquatic environment.

- There are about 9.2 million acres of irrigated agricultural land in California, of which approximately 7.3 million are in the Central Valley.

- o Agricultural acreage is currently not expected to increase.

- o Agricultural demands are partially being met by groundwater overdraft in the San Joaquin Valley.

- o The Final Report of the Interagency San Joaquin Valley Drainage Program addresses various aspects of agricultural conservation. The State Board will consider this and any additional submitted information concerning these matters.

- o Planning for municipal and industrial water needs must focus on the primary requirements of a reliable supply of high quality drinking water at an affordable cost.

- o Reductions in reliable water supplies could have adverse impacts on the economy and the environment of the state.

- o Conservation, reclamation and conjunctive use of local ground water basins are important components of reliable water supplies.

- o California water supplies have been affected by recent court decisions. The state's dependable share of water from the Colorado River has been reduced to 4.4 MAF per year. Interim court decisions have reduced the City of Los Angeles' water supply from tributaries in the Mono Lake Basin by 50 to 65 TAF. Also, court decisions have limited export of ground water from the Owens Valley Basin to levels lower than originally anticipated by the City of Los Angeles.

- o Water conservation by the Imperial Irrigation District consistent with State Board Order 88-20 could make water available for use in other parts of the state by 100 TAF in the early 1990s, with a goal of about 368 TAF.

- o Ground water is a diminishing resource upon which the state relies. Factors limiting the availability of that resource include toxics, overdraft, salt water intrusion, land use practices and lack of recharge and coordinated administrative practices.

WATER QUALITY OBJECTIVES

- o There are numerous influences on the Estuary's beneficial uses. Some are not fully defined, including the impacts of commercial and sport fishing (legal and illegal), the adverse effects of accidentally introduced species (e.g., the clam Potamocorbula amurensis), and the potential problems with genetic alteration in fish resulting from reliance on hatcheries. There are also known harmful effects from toxic materials, dredging, structures, and others, on the health of the aquatic habitats in the Bay-Delta Estuary.(See 5.0)

Salinity Requirements for Municipal and Industrial Water Use

- o There is a need for water from the best available sources to meet the drinking water need of all Californians. There is a need to design and implement a comprehensive trihalomethane formation potential (THMFP) monitoring program, and to develop best management practices, or other appropriate means, to control discharges of THMFP.

- For all municipal and industrial intakes within the Bay-Delta Estuary, the Board adopts the 250 mg/l chloride (salinity) objective which is the secondary standard for aesthetics (taste) and corrosion established by the Department of Health Services. However, additional salinity protection may be needed in some areas to protect drinking water supplies from disinfection by-products (DBPs).(5.1)

- The D-1485 objective of 150 mg/l chloride at the Contra Costa Water District's Rock Slough intake protects the municipal and industrial beneficial uses in Contra Costa County and provides benefits to the municipal supplies exported from the Delta. If and when additional storage capacity is built or other information is developed, this objective and its monitoring location will be reviewed. Meanwhile, deleting the 150 mg/l chloride objective in D-1485 at the Rock Slough Intake could result in increased bromide concentrations and increased salinity and consumer complaints due to the salty taste in the water.(5.1)

- Delta water at times contains bromides (often measured via correlations with chlorides) and organic substances which, upon disinfection, increase the risk of forming by-products (including trihalomethanes (THMs)) that are human health concerns.(5.2)

- In the Delta THM precursors come from organic carbon in Delta peat soils and from the watershed upstream. Bromides which naturally occur in ocean water and connate water exacerbate the formation of THMs upon disinfection.(5.2)

- Existing drinking water standards are being met through a combination of source water controls and current drinking water treatment processes.(5.2)

- If drinking water standards on DBPs are revised, the State Board will consider modifying existing salinity objectives.(5.2)

- In the future the Board will review and weigh all factors that might result in more stringent salinity objectives for drinking water after disinfection. This includes alternative water disinfection methods.(5.2)

- Due to the concerns with DBPs in treated water from the Delta and in keeping with the goal (not objective) of obtaining the best available drinking water, the Board finds that, whenever feasible, municipal water supply agencies should strive to obtain bromide levels of 0.15 mg/l or less (about 50 mg/l chloride in the Delta). Appropriate actions by these supply agencies include encouraging DWR and USBR to work with the SWRCB to ensure development of facilities to make maximum use of uncontrolled flows through off-stream storage, encouraging those agencies to move water supply intakes to better locations, working with the State and Regional Boards to eliminate problem discharges within the Delta, and continuing the development of alternative water treatment technologies.(5.2)

Western and Interior Delta Agriculture (5.3)

- To reasonably protect crops grown in the western and interior Delta, water quality objectives were developed using corn as the representative salt-sensitive crop.

- Assuming improved leaching practices are used, salinities up to 1.5 mmhos/cm EC could be allowed during the irrigation season without affecting crop yield. However, the economic costs of these practices are not in the record.

- Until adequate economic data are available on leaching costs, the Board will maintain the existing salinity objectives.

Southern Delta Agriculture (5.3)

- To reasonably protect crops grown in the southern Delta, water quality objectives were developed using beans and alfalfa as representative salt-sensitive crops.

- The objective of 0.7 mmhos/cm EC in the southern Delta protects beans during the summer irrigation season and the objective of 1.0 mmhos/cm EC protects alfalfa during the winter irrigation season. These or other adequately protective objectives at specified locations will be implemented over time.

Exported Water for Agriculture (5.17)

- Water is exported from the Delta for agricultural use in the San Joaquin Valley and southern California.

- To reasonably protect crops grown in the export areas, water quality objectives were developed using almond orchards as the representative salt-sensitive crop.

- The Board finds that the objective of 1.0 mmhos/cm EC reasonably protects salt-sensitive crops grown in the San Joaquin Valley and southern California.

Estuarine Habitat (5.4)

Fisheries: (Beneficial uses - Warm, Cold, Migration, Spawning, Rare)

- The State Board supports the natural perpetuation of species affected by water and water quality. It is the policy of the State to significantly increase the natural production of salmon by the end of this century.

- Because of the amounts of data, past practices and public interest, striped bass and Central Valley Chinook salmon will be given separate consideration in the development of water quality objectives.

- Fish hatcheries for some species are a management tool that will be evaluated for their benefit and operation within the watershed during subsequent phases of the Bay-Delta proceedings.

- With respect to temperature and salinity, the objectives set in this Plan protect selected estuarine habitat beneficial uses. There is insufficient information in the record to set specific salinity and temperature objectives for the protection of Delta smelt, American shad, benthos, resident fish or marine habitat outside the Estuary.

Chinook Salmon in the Central Valley (5.5)

- The Estuary is a migratory corridor and rearing area for Chinook salmon.
- Hatchery production has kept the total number of fall-run salmon relatively stable.
- The diversity of the gene pool from naturally produced salmon is desirable.
- The Sacramento River winter-run of the Chinook salmon has been listed as an endangered species and will receive additional consideration in the final phases of these proceedings.
- The Board finds that salinity is not a factor affecting salmon as they migrate through the Estuary.
- Elevated temperature is one of the factors which can affect Chinook salmon during their migration through the Delta.
- Temperatures no greater than 68°F during the periods of April through June and September through November at Freeport on the Sacramento River and Vernalis on the San Joaquin River should be achieved by controllable factors, such as waste discharge controls, increases in riparian canopy, and bypass of warming areas (e.g., Thermalito Afterbay).
- Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the water of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs, and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.
- No temperature requirements were submitted for winter-run Chinook salmon. To provide some protection for this endangered species, the more conservative temperature objective of 66°F (developed for the fall-run) is provided for the winter-run. This objective should be achieved by controllable factors, as noted above, during the period January through March at Freeport on the Sacramento River.

Striped Bass (5.6)

- Studies over many years indicate that there are numerous factors affecting striped bass abundance, including diversions from the Delta, reduced Delta outflow, flow patterns in the interior Delta, fewer adults, toxic effects, changes in the food chain due to introduced species, recreational angler harvest, and illegal poaching.
- Studies should be continued and additional water operation tests should be conducted to determine the effects on striped bass and the best means for their protection.

- In light of various impacts on the fishery, particularly of the export pumps, it is necessary to examine existing points of water diversion. Within the Scoping Phase, the Board will consider alternatives to the existing points of diversion.

Striped Bass - Spawning Habitat from Prisoners Point to Vernalis

- Review of the evidence indicates that it may be desirable to expand existing spawning habitat for striped bass in the Delta. However, the State Board concludes that the most significant factor in the decline of striped bass is entrainment[1] due to pumping. The State Board will consider actions to be taken concerning entrainment losses during the Scoping and Water Right phases of the proceedings. Upon examination of the results of these actions, the State Board will consider the issue of expansion of spawning habitat.

Striped Bass - Spawning Habitat from Antioch to Prisoners Point

- The major spawning areas for striped bass are the Sacramento River above the Delta and the San Joaquin River area between Antioch and Prisoners Point.

- The Board finds benefits for the resource in maintaining spawning habitat in this reach by establishing boundary salinities at Antioch of 1.5 and at Prisoners Point of 0.44 mmhos/cm EC from April 15 through May 31. The end date of May 31 may be shortened if data indicate that spawning has ceased.

- Deficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated.

- The Board needs better information than is currently available to consider the complete economic relationship between improvements in striped bass spawning habitat and water availability.

Marshes

- The Board believes that the managed portions of Suisun Marsh are currently being protected by D-1485 as amended in 1985. The protections, including the operation of the Suisun Marsh Salinity Control Gate, are being used and evaluated.(5.10)

- A biological assessment is needed to assess the water quality requirements of the rare, threatened and endangered plants and animals (and their habitats) in the wetlands surrounding Suisun Bay to determine reasonably necessary amendments and additions to the Suisun Marsh objectives. The results will likely not be available in time for inclusion in the final Bay-Delta Environmental Impact Report or water right decision in 1992. When the bioassessment is completed the water quality objectives will be evaluated and incorporated as warranted.(5.10)

- Water quality objectives for San Pablo Bay exist in the Statewide Water Quality Plan for Enclosed Bays and Estuaries of California and in the Water Quality Control Plan for Region 2.(5.11)

1/ Entrainment means primarily the effects of project operations, such as operation of the Delta Cross Channel gates, export pumping, and reverse and low river flows, plus local non-project diversions.

1.6 Summary of Implementation Requirements

Water Year Classification (see 7.5.3.1)

- The current Sacramento River Water Year Classification approximates annual conditions of water availability with five distinct categories. DWR has proposed the addition of a sliding scale to the classification to smooth the transitions between categories. There is a need for the parties to study this proposal, and submit the results for review during the Scoping Phase of the proceedings.

- Due to a previous lack of analytical tools, the San Joaquin River Basin classification needs refinement. The State Board requests the parties to develop a San Joaquin River Basin classification with similar methodology as used for the Sacramento River Basin and submit the results for review during the Scoping Phase of the proceedings. This system, together with the Sacramento River classification, will be used during the Scoping and Water Right Phases to determine how the responsibilities of meeting water quality objectives should be distributed.

Municipal and Industrial

- There is a need for water from the best available sources to meet the drinking water needs of all Californians. The parties should advise the State Board during the Scoping Phase on their plans and programs to obtain high quality drinking water through the year 2010.(7.2.2.1)

- An Interagency Program led by DWR has been formed to continue the work conducted by the Delta Health Effects Study and the Delta M&I Workgroup. The primary task of the new workgroup is to investigate conditions that adversely affect drinking water. The State Board requests this workgroup to design and implement a comprehensive THMFP monitoring program for the Delta by June 1991, and to present annual progress reports to the State Board commencing in January 1992.(7.4.2.1)

- Additional information is required to assess adequately the impact of Delta agricultural drains on THM formation. There is a need to conduct appropriate, comprehensive monitoring of agricultural discharges. The Central Valley Regional Board shall require the development and implementation of best management practices or other means to appropriately control these discharges. This task should begin in the Rock Slough area.(7.4.2.1)

Western and Interior Delta Agriculture (7.4.2.2)

- The Corn Study provides important information on the sensitivity of corn. A leaching study was recently begun to evaluate its effectiveness, practicality, and costs. This information is needed before a new objective can be set to protect the western and interior Delta agriculture. This study should be completed and the results submitted during the Water Right Phase of the proceedings.

Salt-Load Reduction (7.2.2.2)

- Upon adoption of this Plan, the State Board will request the Central Valley Regional Board to develop an initial salt-load reduction program. The goal of this initial program will be to reduce annual salt-loads discharged to the San Joaquin River by at least 10 percent and to adjust the timing of salt discharges from low flow to high flow periods. During the Water Right Phase of these proceedings, the Regional Board should discuss how it intends to implement this program (for example, drainage operation plans and best management practices).

Modeling Needs (7.4.3.2)

- The Board recognizes the need to develop its own water right modeling capability which will assist in the consideration of water transfers, new water rights, review of existing water rights and future alterations of Delta water quality and flow requirements.

- The three-dimensional model currently being developed by USGS for evaluating hydraulic and biological processes in the various embayments of the San Francisco Bay should be finalized.

- An Interagency Modeling Development and Use Committee should be formed to:

  - Facilitate exchange of modeling information and to reduce duplication,
  - Improve access of information by all interested parties
  - Simulate operation of major reservoirs in addition to the CVP and SWP,
  - Consider effects of antecedent conditions,
  - Improve temperature modeling for the Sacramento and San Joaquin River basins,
  - Improve Delta channel depletion estimates in DAYFLOW,
  - Improve both water quality and flow modeling for the San Joaquin River basin,
  - Update hydrology to reflect current land use and groundwater/surface water interactions.

Monitoring

- There is a need to develop, with the State Board's assistance, a coordinated monitoring program plan to ensure compliance with the water quality objectives contained in this Plan, and to identify meaningful changes in any significant water quality parameters potentially related to implementation of this Plan. The programs specified in Chapter 7 of the Plan should be carried out.

Special Temperature Considerations

- Analysis is needed of the effectiveness of various means to control factors which will help maintain cooler waters in the Sacramento and San Joaquin rivers and their tributaries for the protection of all runs of Chinook salmon.

- The parties maintaining the continuous temperature gauges at Freeport on the Sacramento River and at Vernalis on the San Joaquin River should develop data related to the 68°F temperature objective for protection of salmon. The State Board directs DWR to continue the dissolved oxygen monitoring in the lower San Joaquin River between Turner Cut and Stockton to protect salmon migration.

Special Salinity Monitoring (7.4.2.4)

- Continuous EC and temperature monitoring equipment should be installed at various locations in the San Joaquin River between Antioch and Vernalis to obtain data on salinity conditions for striped bass spawning.

- The temperature data collected are to be submitted to the State Board which will then make a determination whether controllable factors should be controlled.

Estuarine Habitat (7.4)

- Past studies of the estuarine habitat have been extensive. Relatively few investigators have been able to specifically quantify the lower level of conditions that protect the beneficial uses. The studies discussed below should lead to interim actions that can be implemented to protect these uses more effectively.

Salmon (7.4.2.3)

- Identify the critical factors influencing smolt survival, including evaluation and implementation of the studies indicated in Chapter 7 of this Plan.

Marshes around Suisun Bay (7.4.2.6)

- A comprehensive biological assessment is being prepared for the rare, threatened and endangered species (and their habitat) of the managed and unmanaged wetlands around Suisun Bay. Studies are needed to determine the relationship between channel water salinity and soil water salinity in the unmanaged tidal wetlands around Suisun Bay.

Scoping and Water Right Issues (7.5)

- Only a few parties are currently responsible for meeting water quality and flow requirements and for compliance monitoring activities within the Delta. The Board requests that information be developed on how these burdens should be distributed over more water right holders and waste dischargers. This information will be considered and used by the Board during the Scoping and Water Right phases of the proceedings.

- For the development of alternatives to existing points of diversion and for the coordination of preparedness planning by other agencies, information should be presented during the Scoping Phase on the impact of flood control measures, levee conditions, dredging, channel deepening, barriers and seismic activities.

Striped bass (7.5.2.4)

- The direct entrainment losses of striped bass and other fish at the major diversions in the Delta are well documented. The Bureau of Reclamation and the Contra Costa Water District should each negotiate a fishery agreement with the Department of Fish and Game that would provide for mitigation of the direct entrainment losses at the Tracy Pumping Plant and Contra Costa Pumping Plant No. 1. These agreements should be completed prior to the conclusion of the Water Right Phase. Direct entrainment losses at Delta agricultural diversions are not well documented. The parties should evaluate such losses and identify corrective measures.

- A real-time monitoring program should be developed and used to assess the daily densities of striped bass eggs and larvae in the Sacramento River during the spring and initiate periodic closure of the Delta Cross Channel to reduce diversion of striped bass into interior Delta channels. Closure of the Delta Cross Channel should be coordinated with short duration pulsed flows in the Sacramento River, in combination with short term reductions in export pumping and reduced reverse flows, to transport striped bass eggs and larvae into the Suisun Bay.

- There is the need to initiate a detailed investigation and evaluation of alternative sites for establishing facilities for rearing juvenile striped bass salvaged from the SWP and CVP facilities for subsequent release to the Bay-Delta system.

- A detailed review and evaluation of alternative recreational angler harvest management options including, but not limited to, specific area and seasonal closures, alternative size limits including initiation of a slot limit, and restrictions on fishing gear such as use of single barbless hooks should be conducted. In addition, the impacts of poaching on the striped bass population should be evaluated, funding sources for expanded enforcement should be sought, and the unrestricted sale of striped bass in California should be eliminated. Temporary changes in fishery harvest regulations should be considered as part of an overall short-term approach to improve the situation until longer-term measures may be instituted. The Board does not believe such measures should substitute for its own responsibilities to provide suitable habitat.

- Additional water project operation tests should be conducted in the Delta to better determine the effects of diverting water from and upstream of the Delta on striped bass.

Other Aquatic Species (7.5.3)

- Additional means should be developed to assess the general health of the Estuary and serve as a basis for determining the impacts of new projects, physical and operational changes, introduced species, etc. DFG should develop a priority list of tasks to be performed. Consideration should be given to specific components, such as American shad, Delta smelt, and the benthos. Also, use of biocriteria should be considered.

San Francisco Bay (7.5.3)

- There is a need to examine further the impacts of San Francisco Bay inflows on fish, invertebrates, and other public trust resources, particularly as these inflows, including pulse flows, affect the distribution, abundance, and reproductive success of species inside the Estuary. Studies are also needed to provide the linkage, if any, between phytoplankton and higher trophic levels.

Entrapment Zone (7.5.3.3)

- Studies are needed to provide the degree of linkage between the location and productivity of the entrapment zone and the effects on the population levels of important fish species.

The State Board retains the option of setting flow objectives if appropriate.

1.7 Water Quality Objectives

To protect beneficial uses of the Bay-Delta Estuary, the State Board adopts the salinity, temperature and dissolved oxygen objectives listed in Table 1-1.

TABLE 1-1 WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Calendar Year shown in parenthesis)*	*Sac R 40-30-30*		*No. of days each Cal. Year < 150 mg/l Cl-*	
- or -					*W*		*240 (66%)*
San Joaquin River at Antioch Water Works Intake	*D-12(near) RSAN007*	*Chloride (Cl-)*		*Sac R 40-30-30*	*AN*		*190 (52%)*
					BN		*175 (48%)*
					D		*165 (45%)*
					C		*155 (42%)*
West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Cache Slough at City of Vallejo Intake [1]	*C-19 SLCCH16*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
and/or							
Barker Slough at North Bay Aqueduct Intake	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*

TABLE 1 - 1 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			1) WESTERN DELTA				
Sacramento River at Emmaton	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos/cm (mmhos)*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*July 1*	*0.63*
					BN	*June 20*	*1.14*
					D	*June 15*	*1.67*
					C	--	*2.78*
San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	--
					AN	*Aug. 15*	--
					BN	*June 20*	*0.74*
					D	*June 15*	*1.35*
					C	--	*2.20*

TABLE 1 – 1 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
2) INTERIOR DELTA							
South Fork Mokelumne River at Terminous	*C-13 RSMKL08*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	*--*
					AN	*Aug. 15*	*--*
					BN	*Aug. 15*	*--*
					D	*Aug. 15*	*--*
					C	*--*	*0.54*
San Joaquin River at San Andreas Landing	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	*--*
					AN	*Aug. 15*	*--*
					BN	*Aug. 15*	*--*
					D	*Jun. 25*	*0.58*
					C	*--*	*0.87*

TABLE 1 - 1 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
(To be implemented by 1996) [3]		**3) SOUTH DELTA**					
San Joaquin River at Airport Way Bridge, Vernalis *Old River near Middle River* *Old River at Tracy Road Bridge* *San Joaquin River at Brandt Bridge [site]*	*C-10* *RSAN112* *C-8* *ROLD69* *P-12* *ROLD59* *C-6* *RSAN073*	*Electrical Conductivity (EC)*	*Maximum 30-day running average of mean daily EC, in mmhos*	*Not Applicable* *If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.*	*All*	*Apr 1-Aug 31* *Sep 1-Mar 31* *or*	*0.7* *1.0*
		4) EXPORT					
West Canal at mouth of Clifton Court Forebay -and- *Delta Mendota Canal at Tracy Pumping Plant*	*C-9* *CHWST0* *DMC-1* *CHDMC004*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily EC, in mmhos*	*Not Applicable*	*All*	*Oct-Sep*	*1.0*

TABLE 1-1 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
CHINOOK SALMON							
DISSOLVED OXYGEN							
San Joaquin River between Turner Cut & Stockton	*RSAN050-RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*Not Applicable*	*All*	*Sep 1-Nov 30*	*6.0*
TEMPERATURE							
Sacramento River at Freeport and	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*"The daily average water temperature shall not be elevated by controllable factors above 68 deg. F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types." [4]*	
San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*		
Sacramento River at Freeport	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*"The daily average water temperature shall not be elevated by controllable factors above 66 deg. F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31." [4]*	

TABLE 1-1 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS-SALINITY:1.ANTIOCH-SPAWNING							
Sacramento River at Chipps Island	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*Not Applicable*	*All*	*Apr 1-Apr 14*	*6,700*
San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 15-May 31 (or until spawning has ended)*	*1.5*
STRIPED BASS-SALINITY:2.ANTIOCH-SPAWNING-RELAXATION PROVISION							
San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily not more than value shown corresponding to deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds, for the period shown, or until spawning has ended. The specific representative projects and amounts of deficiencies will be defined in subsequent phases of the proceedings.*	*Total Annual Imposed Deficiency (MAF)*		*Apr 1-May 31 EC in mmhos*	
						Dry	*Critical*
This relaxation provision replaces the above Antioch & Chipps Island standard whenever the projects impose deficiencies in firm supplies.				*0.0*		*1.5*	*1.5*
				0.5		*1.8*	*1.9*
				1.0		*1.8*	*2.5*
				1.5		*1.8*	*3.4*
				2.0 or more		*1.8*	*3.7*
				Linear interpolation is to be used to determine values between those shown.			
STRIPED BASS-SALINITY:3.PRISONERS POINT-SPAWNING							
San Joaquin River at: Prisoners Point	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*

TABLE 1-1 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS-SALINITY-4.PRISONERS POINT-SPAWNING-RELAXATION PROVISION							
When the relaxation provision for Antioch spawning protection is in effect:							
San Joaquin River at: Prisoners Point	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than the value shown, in mmhos*	*Not Applicable*	*D&C*	*Apr 1-May 31 (or until spawning has ended)*	*0.55*

SUISUN MARSH

In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement. The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The SMPA also describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6 of the plan) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards.

FOOTNOTES:

[1] The Cache Slough objective to be effective only when water is being diverted from this location.

[2] When no date is shown, EC limit continues from April 1.

[3] South Delta Agriculture objectives will be implemented in stages: two interim stages and one final stage. The first interim stage will be implemented with the adoption of the WQCP, the second interim stage by 1994, and the final stage by 1996. Interim Stage 1 -- 500 mg/l mean monthly TDS all year at Vernalis. Interim Stage 2 -- (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge; with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge, and an additional interior monitoring station on Middle River at Howard Road Bridge. Final Stage -- (to be implemented no later than 1996) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge on the San Joaquin River; with two interior stations at Old River Near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old river and Middle River at Howard Road Bridge.

OR

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/montioring locations noted above, as appropriate.

[4] Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

TABLE 1-2 IMPLEMENTATION REQUIREMENTS FOR SUISUN MARSH

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	EFFECTIVE DATES	MONTHS	VALUES
Sacramento River at Collinsville	*C-2 RSAC081*	*Eletrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos/cm (or demonstrate that equivalent or better protection will be provided at the location)*	*Oct 1,1988*	*Oct*	*19.0*
					Nov	*15.5*
					Dec	*15.5*
Montezuma Slough at National Steel	*S-64(new) SLMZU25*				*Jan*	*12.5*
					Feb	*8.0*
					Mar	*8.0*
Montezuma Slough near Beldon Landing	*S-49 SLMZU11*				*Apr*	*11.0*
					May	*11.0*
Chadbourne Slough at Chadbourne Road (proposed)	*S-21(prop.) SLCBN1*					
and				*Oct 1,1991*		
Cordelia Slough 500 ft west of S.P.R.R. crossing at Cygnus	*S-33 SLCRD04*					
-or-				*or*		
Chadbourne Slough at Chadbourne Road (proposed)	*S-21(prop.) SLCBN1*					
and				*Oct 1,1993*		
Cordelia Slough at Cordelia Goodyear Ditch (proposed)	*S-97(prop.) SLCRD06*					
Goodyear Slough at Morrow Island Clubhouse	*S-35(new) SLGYR03*			*Oct 1,1991*		
-or-				*or*		
Goodyear Slough, 1.3 mi south of Morrow Island [Drainage] Ditch at Pierce	*S-75 SLGYR04*			*Oct 1,1994*		
Suisun Slough, 300 ft south of Volanti Slough	*S-42 SLSUS12*			*Oct 1,1997*		
Water Supply Intakes for Waterfowl Management Areas on Van Sickle and Chipps islands	*No Locations specified*					

2.0 SCOPE OF THE PLAN

2.1 Introduction

The initial evidentiary hearing of the Bay-Delta proceedings, Phase I, has been completed. Succeeding phases have been renamed to clarify the purposes each is to serve. They are:

- o The Water Quality Phase
- o The Scoping Phase
- o The Water Right Phase

The Water Quality Phase will continue the review, revision and adoption of the Plan. A separate Pollutant Policy Document (PPD) for the Bay-Delta Estuary adopted by the State Board (June, 1990) addresses the effects of certain pollutants on beneficial uses in the Bay-Delta Estuary; it contains policy guidance to be used by the San Francisco Bay Region (2) and the Central Valley Region (5) when they update their Basin Plans. Other pollutants of concern are addressed in the Statewide Water Quality Control Plans for Inland Surface Waters and for Enclosed Bays and Estuaries. The Scoping Phase has already begun on issues related to water quality in the Estuary; it will include scoping hearings on such matters as the public trust, physical facilities, negotiated agreements and potential, administrative and legislative actions. A draft Environmental Impact Report (EIR) will be developed and circulated as a result of the Scoping Phase. Various alternatives developed in the Scoping Phase will be explored in the draft EIR. The Water Right Phase will include a water right hearing with adoption of a final EIR and water right decision(s). In these water right decisions the Board will decide which water users will help meet water quality objectives and flow requirements in the Estuary.

During the course of the water quality proceedings the Board received evidence on:

- o The beneficial uses being made of water flowing into, within, and from the Bay-Delta Estuary;
- o The levels of protection which should be afforded these beneficial uses;
- o Reasonable consumptive uses made of Bay-Delta waters;
- o The effects of pollutants on beneficial uses of Bay-Delta Estuary waters; and
- o Implementation measures available to achieve the levels of protection necessary to protect the beneficial uses.

2.2 Scope and Purpose of the Plan

o Scope

This Plan is a narrowly focused Basin Plan for the waters of the Bay-Delta Estuary. It is to be considered together with other water quality control plans applicable to the waters of the Bay-Delta Estuary, such as the 1978 Delta Plan, the Pollutant Policy Document for the Bay-Delta Estuary, and the Statewide Water Quality Control Plans for Inland Surface Waters and for Enclosed Bays and Estuaries in California, as well as all applicable San Francisco Bay (Region 2) and Central Valley (Region 5) Regional Basin Plans. This Plan supersedes any existing salinity and temperature objectives to the extent of any conflict.

o Review and Revision

The water quality objectives established in the Plan, together with other currently effective controls, will protect established beneficial uses in compliance with all applicable state laws.

This Plan is a substitute for a separate environmental document (Public Resources Code Section 21080.5). It therefore includes a discussion of alternatives in order to comply with CEQA's mandate to consider all reasonable alternatives to the preferred project.

This Plan is not meant to supersede any designation of beneficial uses, objectives (except where conflict exists), or other matter set forth in either the Basin 2 Plan or the Basin 5B Plan. Any questions of whether this Plan supersedes any provisions in either Regions' Plans, or in any other water quality control plan adopted by the State Board for the waters of the Bay-Delta Estuary, should be addressed to the State Board for an interpretation.

The Plan will undergo public review either on a triennial basis or sooner if needed.

o Flow Considerations

Although flow requirements are not set as objectives in this Plan, the State Board recognizes that flow requirements and salinity objectives are largely met by the regulation of water flow. The reasonableness of a salinity objective can be evaluated by using operation studies to estimate the impacts of these objectives on water supplies. Effects on these supplies may be used to evaluate the economic and social costs.

o Established Objectives

The State Board has established the following categories of objectives:

- Salinity for municipal and industrial uses,
- Salinity for Delta agriculture,
- Salinity for export agriculture,
- Salinity for fisheries in the Delta,
- Temperature and dissolved oxygen for fisheries in the Delta, and
- Salinity for Suisun Marsh habitat.

2.3 Authority for Regulation of Water in the Bay-Delta Estuary

The State Board is responsible for formulating and adopting state policy for water quality control (WC Section 13140). The authorities for regulation of water in the Bay-Delta Estuary are found in Appendix 2.0, State Board Authority.

3.0 BASIN AND HYDROLOGY DESCRIPTION

Conclusions: WATER YEAR TYPES

- **The Bay-Delta Estuary is a dynamic system characterized by wide annual, seasonal, and daily fluctuations in fresh water inflows and ocean derived salinities.**
- **Defining water year types is an essential tool in evaluating the amount of water available.**
- **Water availability is an essential factor in establishing reasonable objectives for ocean derived salts.**
- **The Board adopts the "40-30-30 Water Year Index" for the Sacramento River Basin as proposed by the Operational Studies Workgroup. In subsequent phases of the proceedings, the Board wishes to examine critically the use of the "subnormal snowmelt" and "year following dry or critical year" provisions which allow alterations of objectives.**
- **Changes to water year types will include development and refinement of an appropriate index before it can be implemented for the San Joaquin River Basin.**

3.1 Introduction

The Bay-Delta Estuary and tributary areas described in this Plan include:

- The Delta (Figure 3-1);
- The Delta's tributary areas, that is, the Sacramento River, the Central Sierra, the San Joaquin River basins[1/] (Figure 3-2); and
- The San Francisco Bay and its tributary hydrologic basin (Figure 3-3).

The Estuary and tributary areas provide about two-thirds of all the water used in California, including 40 percent of the state's drinking water.

This chapter and Appendix 3.0, Basin Description, outline the hydrologic conditions of the Estuary and its tributary areas by providing a description of each area's:

Physical Characteristics -- the geographical and legal dimensions; and

Hydrology -- the characteristics and nature of water movement, which can include:

- Unimpaired Flow Conditions -- the flow that would be available assuming no upstream impoundments, use, or diversions of runoff under current upstream and Delta channel configurations (SWRCB,3,8).

1/ *The Tulare Lake Basin (Central Valley Regional Water Quality Control Board Basin 5D), although part of the Central Valley, is not considered to be tributary to the Delta for the purposes of this Plan.*

FIGURE 3-1 Boundary of the Bay-Delta Estuary and locations of Estuary exports (From: SWRCB, 3, 5)

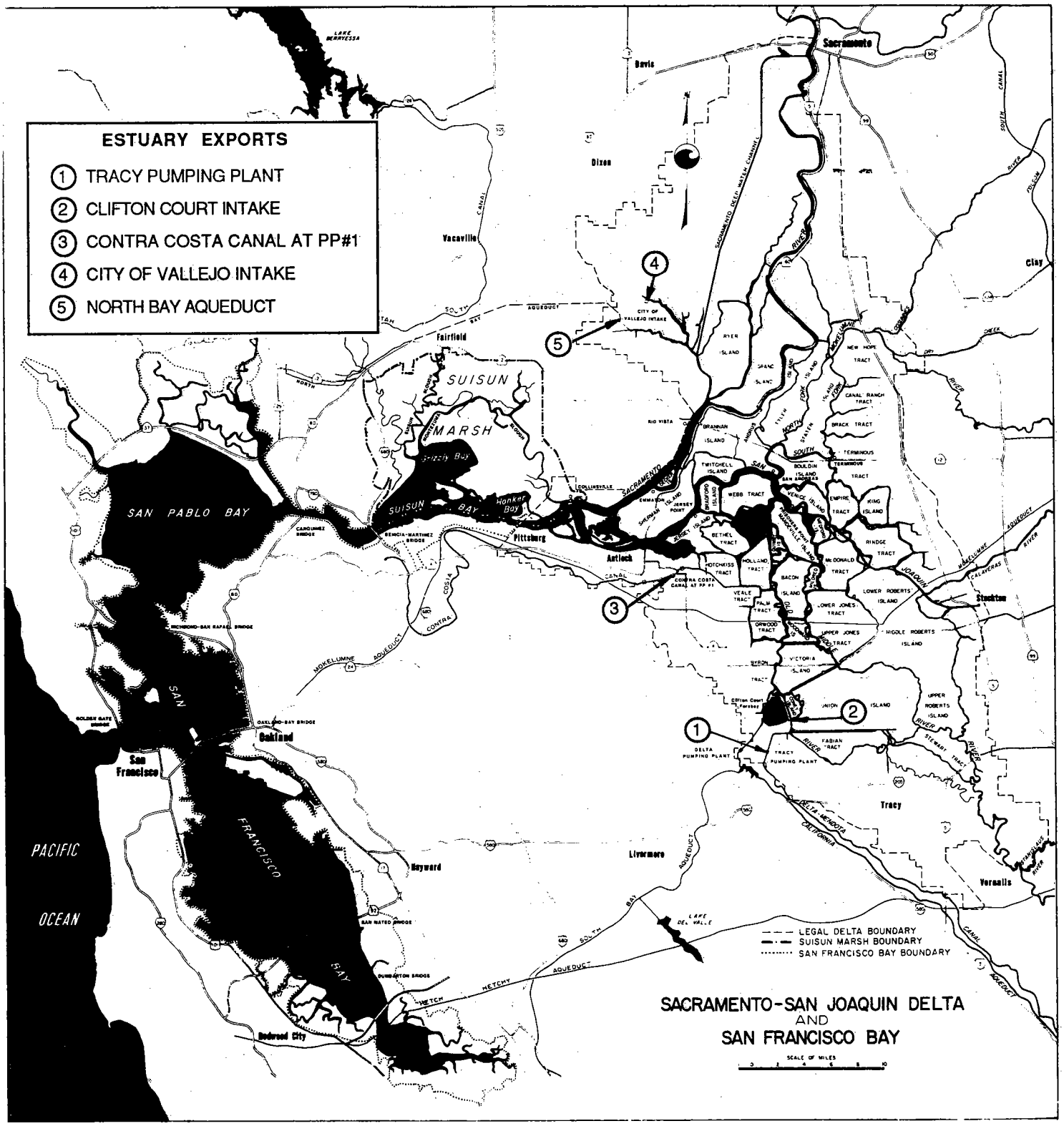


FIGURE 3-2 Boundaries of the Sacramento River (5A), Central Sierra and Delta (5B), and San Joaquin (5C) Basins (From: RWQCB 5, 1975)

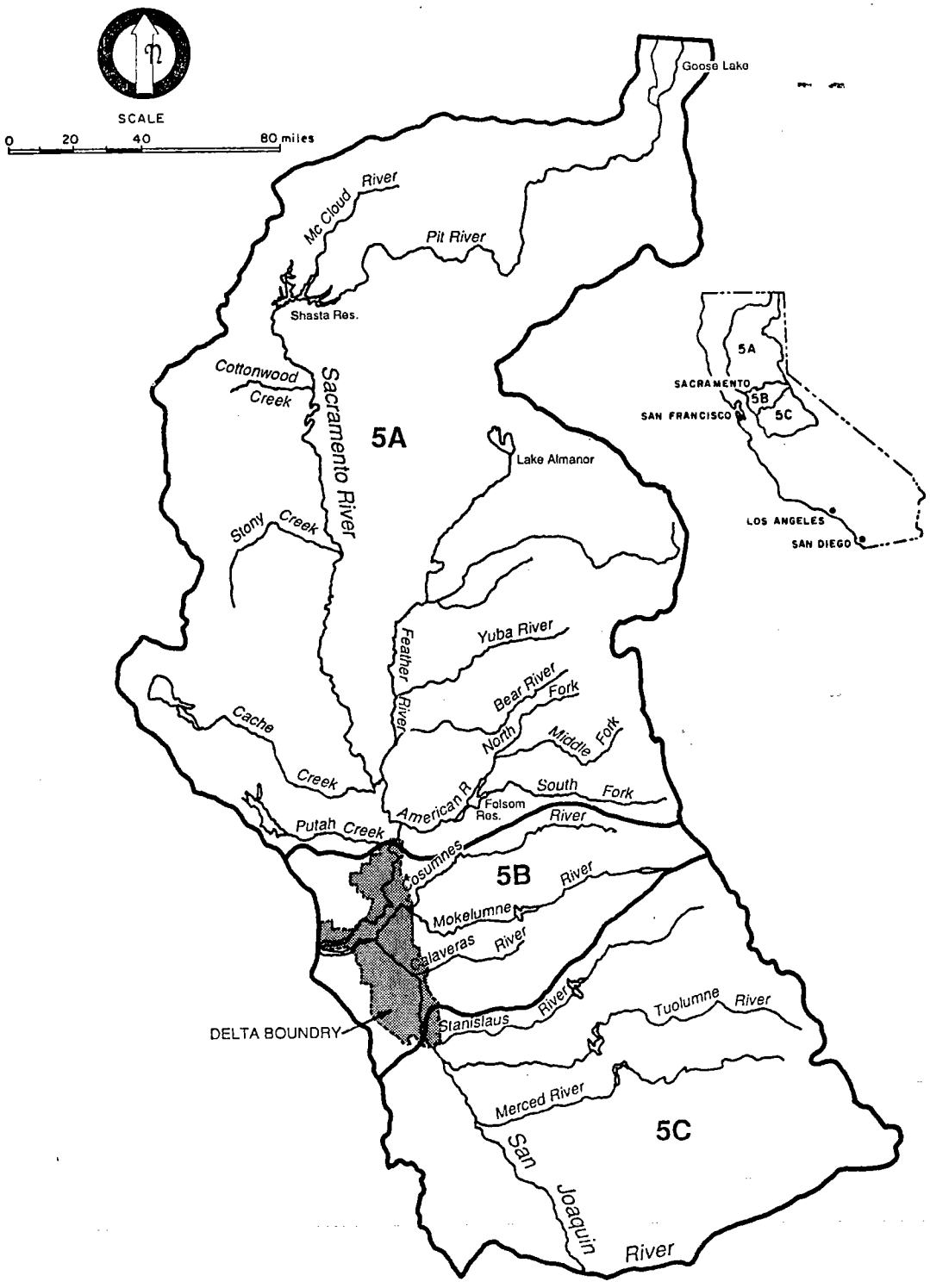
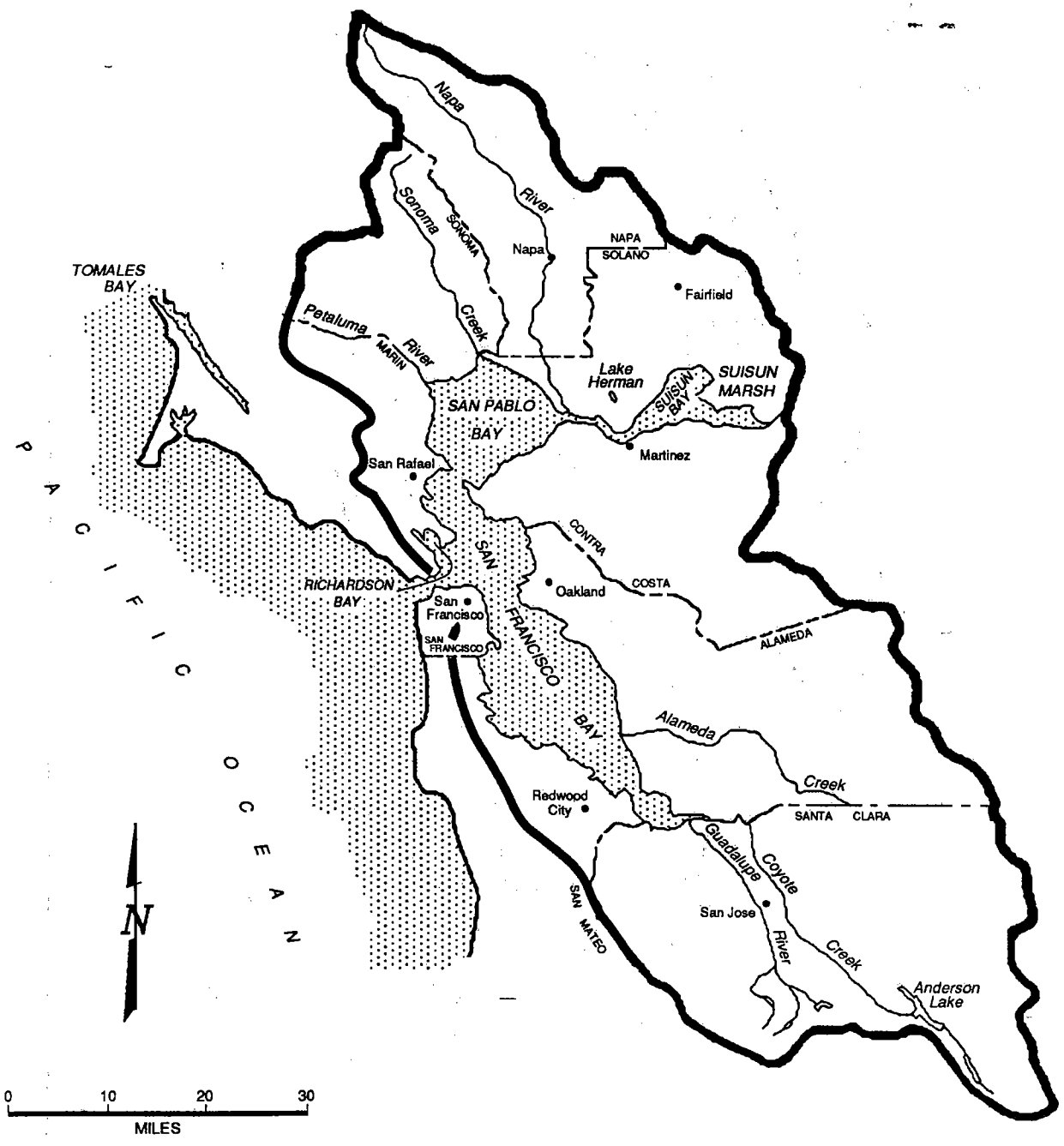


FIGURE 3-3 Boundary of the San Francisco Bay Basin
(From: SWRCB, 3, 12)



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Unimpaired flow could also be defined as the present-day conditions if all storage and diversion were to cease. It is not a measure of natural or historic conditions (T,II,114:2-15).

- Historic Flow Conditions -- the flow conditions that actually occurred over the historic hydrological period and were measured at various locations in the Central Valley Basin using flow measuring devices. These flows reflect upstream impoundments, use or diversions of runoff under the existing upstream storage, and channel configuration at the time of measurement.

- Present Level Flow Conditions--the historic flow conditions that have been adjusted to reflect the present level-of-development reservoir operations, consumptive demands and Delta Plan standards or, where appropriate, the recent historic flow conditions from 1972 to the present. Present level-of-development flows are those estimated by DWR's 1990 level-of-development operations study. The Operations Study, which is conducted using DWR's Planning Simulation Model (DWRSIM), uses the hydrologic sequence of flows for the years 1922 through 1978. The 1972 to present historical flows represent the conditions under recent levels of water resource development. Compared with the pre-1972 development, the water resources development within the Bay-Delta watershed has been relatively minor since 1972. New Melones Reservoir, which became operational in 1978, and increasing Delta exports over these years are notable exceptions (SWRCB,3,8).

3.2 Water Year Types

3.2.1 Classifying Water Years for a Basin

Water Year (WY) classification systems provide relative estimates of the amount of water originating in a basin from rainfall and snowmelt runoff, and ground water accretion which is available to meet all demands.

This Plan improves the WY classification system used in the 1978 Delta Plan. The new classification system includes consideration of water availability from storage facilities as well as seasonal runoff.

Modified Water Year Classification System

This new WY classification uses the forecasted unimpaired runoff in millions of acre-feet (MAF) from two separate periods of the current water year (April through July and October through March) and a third parameter which accounts for the effects of reservoir storage, in order to determine the runoff classification for any particular year. This new method was used to develop the modified Sacramento Four River Index (Figure 3-4). Refer to Appendix 3.1 for an expanded description of the components of the new classification.

FIGURE 3-4
Sacramento Valley
Water Year Hydrologic Classification

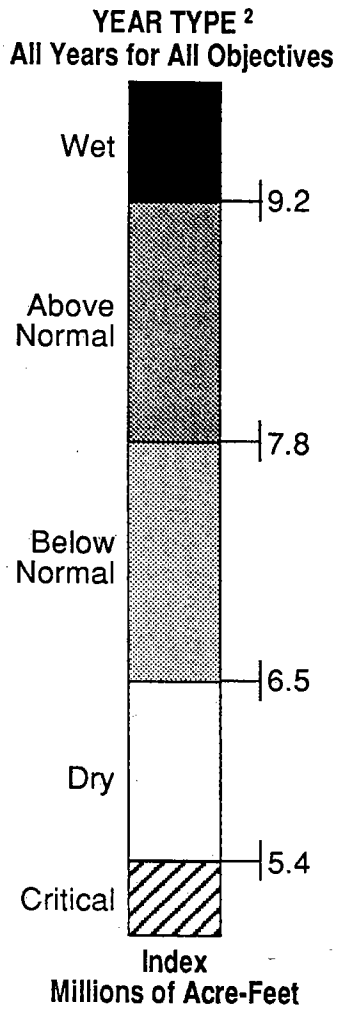
Year classification shall be determined by computation of the following equation:

INDEX = 0.4 * X + 0.3 * Y + 0.3 * Z

Where:
- X = Current years April – July Sacramento Valley unimpaired runoff
- Y = Current October – March Sacramento Valley unimpaired runoff
- Z = Previous years index [1]

The 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 is a forecast of 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.

Classification	**Index Millions of Acre-Feet**
Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8 and less than 9.2
Below Normal	Equal to or less than 7.8 and greater than 6.5
Dry	Equal to or less than 6.5 and greater than 5.4
Critical	Equal to or less than 5.4



[1] A cap of 10.0 MAF is put on the previous years index (Z) to account for required flood control reservoir releases during wet years.

[2] 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.

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3.2.1.1 Sacramento Basin Index Description

The modified classification splits the index into three terms. The form of the index equation is as follows:

$$\text{Index} = C1*X + C2*Y + C3*Z$$

Where:

C1, C2, and C3 are weighting coefficients of 0.4, 0.3 and 0.3, respectively.

And:

X = April through July Four River Unimpaired Flow (MAF)
Y = October through March Four River Unimpaired Flow (MAF)
Z = Previous year's WY index (MAF) having a maximum cap value of 10 MAF.

Division of the index into three terms recognizes that there are distinct differences in seasonal contribution to water availability and accounts for reservoir carryover storage. The April-through-July period's runoff (factor X) is the most important contribution to water availability. The runoff contribution during October through March (factor Y) is less important due to flood control limitations on available reservoir storage space. The previous year's index (factor Z) is important because it accounts for carryover reservoir storage. A maximum value or cap of 10 MAF expressed in the third term sets a maximum level of the previous year's hydrology that can be maintained as carryover storage due to the limitations of total reservoir capacity and the requirement to maintain a flood control reservation space.

Water Year Classification Breakpoints

The method used to determine the index breakpoints that define the boundaries of the five water year types in the Delta Plan was also used to determine the breakpoints for this modified approach. This method is discussed in Appendix 3.1.

Regression Results

Table 3-1 lists some of the regression results of these statistical analyses. These results indicate that breaking the index into two separate hydrologic periods and adding the effect of the previous year's hydrology enhances the index's predictability.

TABLE 3-1
SELECTED RESULTS OF THE STATISTICAL ANALYSIS TO
DETERMINE OPTIMAL WEIGHTING COEFFICIENTS

Classification[1/]	Weighting Coefficients(%)	R Squared Value
Proposed Modified	40 -- 30 -- 30 w/cap.	.85[2/]
Selected Alternatives	40 -- 20 -- 40	.88
	40 -- 30 -- 30	.87
Delta Plan w/new BP[3/]	33 -- 67 -- 00	.74
April through July	100 -- 00 -- 00	.66

3.2.1.2 San Joaquin Basin Index

Because of the differences in hydrology between the Sacramento and San Joaquin basins, a separate San Joaquin River Basin classification is needed.

The tools that were used in developing the Sacramento Basin Index were not available to develop an index for the San Joaquin Basin. These tools, a San Joaquin River Basin Operations Model and data base, recently became available. Development of the San Joaquin Basin Classification will soon begin. An example of a possible San Joaquin River Basin Classification using Sacramento River Basin coefficients is shown in Figure 3-5.

3.2.1.3 Eastside Basin

A separate classification for the Eastside Basin was not developed. The contribution to the Delta from the eastside rivers, the Cosumnes, Mokelumne and the Calaveras, is small compared to the Sacramento and San Joaquin Basins. Based on information that indicates the hydrologies of the Eastside Basin and the Sacramento Basin are similar (DWR,1,1-2;1978 D-1485 Hearing exhibit), the Sacramento Basin WY classification was also applied to the Eastside Basin.

3.2.1.4 Adjustments to Water Year Classification

In the 1978 Plan classification, two adjustments were created to account for unusual hydrologic conditions: a second classification for a year which follows a critical year, and a sub-normal snowmelt adjustment.

The "year following critical year" classification was developed to account for the effects that depleted reservoir and ground water storage have on the ability of project operations to meet their demands. Because the effects of previous year's conditions are included in the third term of the 40-30-30 Index, the "year following critical year" adjustment is not necessary. The "year following critical year" adjustment applies only to fish and wildlife standards.

1/ All classifications except proposed modified have no cap on third term.

2/ The R squared value for the Proposed Modified and Selected Alternatives classifications are very similar, with the values for the latter being slightly higher. It was the consensus of the subworkgroup that the 40-30-30 W/CAP Index was the preferable index.

3/ Breakpoint (BP), or threshold values are revised to reflect 1906 -- 1987 hydrology.

FIGURE 3-5
San Joaquin Valley
Water Year Hydrologic Classification [1]

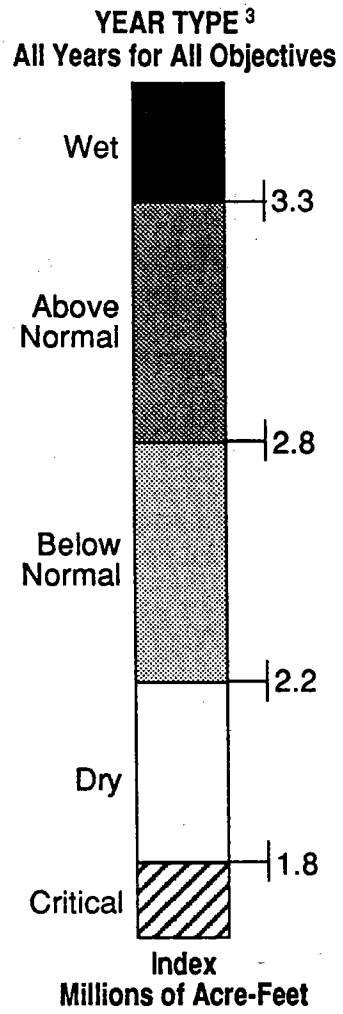
Year classification shall be determined by computation of the following equation:

INDEX = 0.4 * X + 0.3 * Y + 0.3 * Z

Where:
- X = Current years April – July San Joaquin Valley unimpaired runoff
- Y = Current October – March San Joaquin Valley unimpaired runoff
- Z = Previous years index [2]

The San Joaquin 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 is a forecast of the sum of the following locations: Stanislaus River, total flow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total flow to Exchequer Reservoir; San Joaquin River, total inflow to Millerton Lake. 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.

Classification	**Index Millions of Acre-Feet**
Wet	Equal to or greater than 3.3
Above Normal	Greater than 2.8 and less than 3.3
Below Normal	Equal to or less than 2.8 and greater than 2.2
Dry	Equal to or less than 2.2 and greater than 1.8
Critical	Equal to or less than 1.8



[1] This is example of the San Joaquin River Basin classification using Sacramento River Basin coefficients. When the San Joaquin Basin operations model is finished the San Joaquin River Basin classification will be developed using the same analytical techniques used for the Sacramento River Basin.

[2] A cap of 4.0 MAF is put on the previous years index (Z) to account for required flood control reservoir releases during wet years.

[3] 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.

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The subnormal snowmelt adjustment was developed to account for years having spring runoff from snowmelt much less than expected. In the current objectives, the adjustment only applies to fish and wildlife flow standards. The 40-30-30 Index accounts for subnormal snowmelt from a water supply aspect but not from a level of protection aspect (when linked to the current flow standards in D-1485). The application of the 40-30-30 Index to determine the effects of various alternatives is discussed in Chapter 6, Section 6.2.1B.

3.2.1.5 Differences in Classification

The differences between the current and modified WY classifications for the Sacramento Basin are shown in Table 3-2. Two differences make these classifications not strictly comparable. First, the periods of the databases that were used to develop these classifications are not the same --1922-71 was used for the current classification used in the 1978 Delta Plan, and 1906-88 was used for the modified classification. This difference causes a shift in the threshold values. Second, where the current classification modifies the year type for subnormal snowmelt years and years following critical years, the modified classification does not. Together, these differences between the two classifications seem to show that the modified classification shifts the average classification to a drier condition. If, however, the conditions discussed above are accounted for in this comparison, the averages of these two classification systems are very similar. For the Sacramento River Basin (Table 3-2), as an example, about 35 percent of the years are classified by both systems as wet; about 33 percent as above normal, below normal (or below normal with subnormal snowmelt); and about 31 percent as dry or critical.

TABLE 3-2
SACRAMENTO RIVER BASIN:

COMPARISON OF PROPOSED MODIFIED 40-30-30 AND
DELTA WATER YEAR CLASSIFICATION

WATER YEAR	DELTA PLAN CLASSIFICATION	INDEX 40-30-30	WATER YEAR	DELTA PLAN CLASSIFICATION	INDEX 40-30-30
1906	W	W	1948	AN	BN *
1907	W	W	1949	D	D
1908	BN/SS	BN *	1950	BN	BN
1909	W	W	1951	W/SS	AN *
1910	W	W	1952	W	W
1911	W	W	1953	W	W
1912	D	BN *	1954	AN	AN
1913	BN	D *	1955	D	D
1914	W	W	1956	W	W
1915	W	W	1957	BN	AN *
1916	W	W	1958	W	W
1917	AN	AN	1959	D	BN *
1918	D	D	1960	BN/SS	D *
1919	BN	BN	1961	D	D
1920	C	C	1962	BN	BN
1921	W	AN *	1963	W	W
1922	AN	AN	1964	D	D
1923	BN	BN	1965	W	W
1924	C	C	1966	BN/SS	BN *
1925	AN	D *	1967	W	W
1926	D	D	1968	BN/SS	BN *
1927	W	W	1969	W	W
1928	AN/SS	AN *	1970	W/SS	W *
1929	C	C	1971	W	W
1930	BN/D	D *	1972	BN/SS	BN *
1931	C	C	1973	W	AN *
1932	BN/D	D *	1974	W	W
1933	C	C	1975	AN	W *
1934	C	C	1976	C	C
1935	AN	BN *	1977	C	C
1936	AN	BN *	1978	W	AN *
1937	BN	BN	1979	D	BN *
1938	W	W	1980	W	AN *
1939	C	D *	1981	D	D
1940	W/AN	AN *	1982	W	W
1941	W	W	1983	W	W
1942	W	W	1984	W/SS	W *
1943	W	W	1985	D	D
1944	D	D	1986	W/SS	W *
1945	BN	BN	1987	C	D *
1946	AN	BN *	1988	C	C
1947	D	D	1989		

* Indicates year type has changed from Delta Plan year type

4.0 BENEFICIAL USES OF BAY-DELTA ESTUARY WATER

4.1 Introduction

The beneficial uses of Bay-Delta water are presented here in summary form. For a detailed account, see Appendix 4.0, Beneficial Uses of Bay-Delta Estuary Water.

4.2 Beneficial Uses

Agricultural Supply (AGR)	Includes crop, orchard and pasture irrigation, stock watering, support of vegetation for range grazing and all uses in support of farming and ranching operations. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Cold Fresh-Water Habitat (COLD)	Provides a coldwater habitat to sustain aquatic resources associated with a coldwater environment. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Estuarine Habitat (EST)	Provides an essential and unique habitat that serves to acclimate anadromous fishes (salmon, striped bass) migrating into fresh or marine conditions. This habitat also provides for the propagation and sustenance of a variety of fish and shellfish, numerous waterfowl and shore birds, and marine mammals. [RWQCB2, Water Quality Control Plan, San Francisco Bay Basin (2), December 1986]
Fish Migration (MIGR)	Provides a migration route and temporary aquatic environment for anadromous or other fish species. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Fish Spawning (SPWN)	Provides a high quality aquatic habitat especially suitable for fish spawning. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Groundwater Recharge (GWR)	Natural or artificial recharge for future extraction for beneficial uses and to maintain salt balance or halt saltwater intrusion into freshwater aquifers. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]

Industrial Process Supply (PROC)	Includes process water supply and all uses related to the manufacturing of products. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Industrial Service Supply (IND)	Includes uses which do not depend primarily on water quality such as mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection and oil well repressurization. [SWRCB, ~~Stan~~dard Beneficial Uses, Management Memorandum No. 20, March 1973]
Municipal and Domestic Supply (MUN)	Includes usual uses in community or military water systems and domestic uses from individual water supply systems. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Navigation (NAV)	Includes commercial and naval shipping. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Non-Contact Water Recreation (REC-2)[1]	Recreational uses which involve the presence of water but do not require contact with water, such as picnicking, sunbathing, hiking, beachcombing, camping, pleasure boating, tidepool and marine life study, hunting and esthetic enjoyment in conjunction with the above activities as well as sightseeing. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Ocean Commercial and Sport Fishing (COMM)	The commercial collection of various types of fish and shellfish, including those taken for bait purposes, and sport fishing in ocean, bays, estuaries and similar non-freshwater areas. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]

1/ DHS has recently (10/24/90) suggested different language and three separate parts, Rec. 1, 2 and 3.

Preservation of Rare and Endangered Species (RARE)	Provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare and endangered species. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Shellfish Harvesting (SHELL)	The collection of shellfish such as clams, oysters, abalone, shrimp, crab and lobster for either commercial or sport purposes. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Warm Fresh-Water Habitat (WARM)	Provides a warm-water habitat to sustain aquatic resources associated with a warmwater environment. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Water Contact Recreation (REC-1)	Includes all recreational uses involving actual body contact with water, such as swimming, wading, waterskiing, skin diving, surfing, sport fishing, uses in therapeutic spas, and other uses where ingestion of water is reasonably possible. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]
Wildlife Habitat (WILD)	Provides a water supply and vegetative habitat for the maintenance of wildlife. [SWRCB, Standard Beneficial Uses, Management Memorandum No. 20, March 1973]

5.0 ALTERNATIVE LEVELS OF PROTECTION FOR BENEFICIAL USES OF BAY-DELTA ESTUARY WATER

Conclusions: WATER QUALITY OBJECTIVES

- **There are numerous influences on the Estuary's beneficial uses. Some are not fully defined, including the impacts of commercial and sport fishing (legal and illegal), the adverse effects of accidentally introduced species (e.g., the clam Potamocorbula amurensis), and the possible problems with genetic alteration in fish resulting from reliance on hatcheries. There are also known harmful effects from toxic materials, dredging, structures, and others, on the health of the aquatic habitats in the Bay-Delta Estuary.**

5.0.1 Overview

Chapter 4 and Appendix 4.0 identified the beneficial uses of Bay-Delta waters. In this chapter, the evidence supporting these uses is analyzed. Where the data are determined to be both appropriate and adequate to develop water quality objectives and the issue is within the scope of this Plan, potential objectives are established.

The water quality objectives in the Delta Plan were adopted in 1978. Water Rights Decision 1485 (D-1485) was adopted at the same time as the primary way to implement the Delta Plan. While water quality objectives for the southern Delta were included in the Delta Plan, they were not part of D-1485 and therefore have not been implemented. Water quality objectives in Suisun Marsh were set but consideration of alternative objectives proposed in the Suisun Marsh Preservation Agreement (SMPA) is pending (see 5.10). All of these matters are time consuming since they require substantial funds from the state and federal government, construction of physical facilities, and subsequent testing of these facilities to ensure that the desired objectives can be achieved.

Water quality objectives for parts of San Francisco Bay other than the Suisun Marsh were not adopted in the Delta Plan. Development of objectives for the south Delta will commence upon receipt of a negotiated agreement between the South Delta Water Agency (SDWA), USBR, and DWR.

The "estuarine habitat" beneficial use designation, for the purposes of this Plan, is broken down into various components, such as specific fisheries and fish protective habitat, to develop protection for those components addressed during the Phase I hearing. Further, there are several designated beneficial uses addressed in the Basin Plans of Regions 2 and 5 for which the State Board received evidence. However, that evidence did not indicate that salinity, temperature or dissolved oxygen would affect the beneficial uses of either contact or non-contact recreation or navigation. Therefore, even though discussed in this Plan, salinity, temperature and dissolved oxygen objectives are not proposed for these beneficial uses.

Specific water quality objectives have been developed for designated beneficial uses. In the case of estuarine habitat, the State Board has identified certain areas and life stages for the protection of specific fish species. These objectives, the State Board believes, will provide protection for other species until more appropriate measures are developed. The following uses are designated as beneficial uses to be specially protected by objectives in this Plan: (See Chapter 4 for more details)

USE	AREA
Municipal and Industrial (ind, proc, mun, gwr)	San Francisco Bay-Delta, Export Area
Agriculture (agr)	Delta, Export Area
Estuarine Habitat (est, migr, spwn, cold, warm, comm)	
Chinook Salmon (fall and winter run)	Delta
Striped Bass	Delta
Marsh Resource	Suisun Marsh

5.0.2 Hydrologic Considerations

Salinity at any particular location in the Delta is dependent upon Delta inflows, agricultural drainage return flows, consumptive uses, exports, tidal stage and the operation of the Delta Cross-Channel gates. The southern Delta is almost exclusively influenced by the San Joaquin River. The internal Delta, on the other hand, is influenced to some degree by both river systems, especially when Delta exports are high. For the purpose of considering river effects on the beneficial uses discussed in this chapter, all of the Estuary locations were considered to be part of the hydrologic classification of the Sacramento River system, except for the following which were considered to receive water from the San Joaquin River system: San Joaquin River at Vernalis, at Mossdale, at Rough and Ready Island, at Buckley Cove, and at the former location of Brandt Bridge; the bifurcation of Old and Middle River; Middle River at Howard Road Bridge; and Old River at Tracy Road Bridge.

5.0.3 Alternative Levels of Protection for Beneficial Uses

The following sections describe alternative levels of each protection for beneficial use in categories:

1. Present Conditions -- The current water quality conditions. These are usually reflected in the requirements set forth in D-1485 as amended or in a few cases more protective requirements contained in agreements between Delta interests and certain water projects. In many cases quality is better than objectives because of uncontrolled flow.

2. State Board Considerations -- State Board analysis of existing objectives, advocated levels of protection, any additional data obtained from agencies with appropriate expertise (e.g., DFG), peer reviewed literature, etc.

3. Potential Objectives -- Appropriate Alternatives proposed for each beneficial use. These potential objectives are further analyzed for economic and environmental effects in Chapter 6.

Levels of Protection advocated by the various parties are contained in Appendix 5.0, under the heading Advocated Levels of Protection. A matrix of the present, advocated and proposed potential objectives concludes the chapter (Table 5-5, Alternative Water Quality Objectives).

5.1 Municipal and Industrial

Conclusions: Salinity Requirements

- **For all municipal and industrial intakes within the Bay-Delta Estuary, the Board adopts the 250 mg/l chloride (salinity) objective which is the secondary standard for aesthetics (taste) and corrosion established by the Department of Health Services. However, additional salinity protection may be needed in some areas to protect drinking water supplies from disinfection by-products (DBPs).**

- **The D-1485 objective of 150 mg/l chloride at the Contra Costa Water District's Rock Slough intake protects the municipal and industrial beneficial uses in Contra Costa County and provides benefits to the municipal supplies exported from the Delta. If and when substantial additional storage capacity is built or other information is developed, this objective and its monitoring location will be reviewed. Meanwhile, deleting the 150 mg/l chloride objective in D-1485 could result in increased bromide concentrations and increased salinity and consumer complaints due to the salty taste in water.**

5.1.1 Present Conditions - (Salinity and Sodium)

Municipal and Industrial (M&I) use is currently protected by standards specified in the 1978 Delta Plan or D-1485 (in this Plan referred to as D-1485 or current objectives) (see Table 5-5). The 250 mg/l (maximum) chlorides level of protection considered adequate to protect municipal uses is based on the secondary standard for aesthetics (taste) and corrosion set by the Department of Health Services (DHS) and adopted by the Board in 1978 as being in the public interest.

The present objective of 150 mg/l chlorides was established at the Contra Costa Canal Intake during a portion of the year, depending on water year type, in order to protect industrial uses. This standard was intended to protect the historical water supply of two paper manufacturers in the Antioch area by providing a salinity necessary to maintain the quality of industry products. In adopting this standard the State Board recognized that it also provided better water quality to municipal customers.

5.1.2 State Board Considerations

Chlorides

The D-1485 objectives, with the inclusion of a MUN objective at Barker Slough and a conditional MUN objective at Cache Slough, sufficiently protect M&I uses (see Table 5-5).

MUN use is protected with respect to salinity, and taste and odor by the 250 mg/l chloride drinking water standard.

Industrial use is protected by the D-1485 150 mg/l periodic chloride objective at Rock Slough and Antioch. Industries requiring water quality of 150 mg/l chloride or less are negotiating with DWR to obtain alternative sources of high quality water; negotiations have been successful, although one industry is still negotiating with DWR. The negotiations to eliminate this objective have not been concluded; this is one reason that this objective will be maintained.

The 50 mg/l objective recommended for blending purposes for MUN use is addressed in the following section on trihalomethanes.

Because the North Bay Aqueduct diversion point is at Barker Slough and the old diversion point at Cache Slough will be used on occasion as an alternative point of diversion, objectives will be needed at both of these diversion points.

Sodium

Another issue related to salinity involves the consumption of sodium. Diets high in sodium, especially for people with a history of cardiovascular problems, can contribute to such problems. Some participants in the hearing suggested a sodium objective be adopted to protect against such concerns. Others were concerned that water containing high levels of sodium may reduce the efficiency of dialysis machines. The information presented to the State Board shows that sodium contained in drinking water represents a very small portion of normal daily sodium intake. People on restricted sodium diets should consult their physician and dietitian to revise their diet based on their local water supply or in rare cases consider bottled water low in sodium.

These sodium issues were all debated before adoption of D-1485. No new information was presented compelling a specific sodium objective. Concerns involving sodium levels can be resolved by achieving the 250 mg/l chloride objective in Delta waters or special action by health professionals.

5.1.3 Potential Objectives

No change (see Table 5-5).

5.2 Trihalomethanes (THMs) and other Disinfection By-Products (DBPs)

Conclusions:

- **Delta water at times contains bromides (often measured via correlations with chlorides) and organic substances which, upon disinfection, increase the risk of forming by-products (including trihalomethanes (THMs)) that are human health concerns.**

- **In the Delta THM precursors come from organic carbon in Delta peat soils and from the watershed upstream. Bromides which naturally occur in ocean water and connate water exacerbate the formation of THMs upon disinfection.**

- **Existing drinking water standards are being met through a combination of source water controls and current drinking water treatment processes.**

- **If drinking water standards on DBPs are revised, the State Board will consider modifying existing salinity objectives.**

- **In the future the Board will review and weigh all factors that might result in more stringent salinity objectives for drinking water after disinfection. This includes alternative water disinfection methods.**

- **Due to the concerns with DBPs in treated water from the Delta and in keeping with the goal (not objective) of obtaining the best available drinking water, the Board finds that, whenever feasible, municipal water supply agencies should strive to obtain bromide levels of 0.15 mg/l or less (about 50 mg/l chloride in the Delta). Appropriate actions by these supply agencies include encouraging DWR and USBR to work with the SWRCB to ensure development of facilities to make maximum use of uncontrolled flows through off-stream storage, encouraging those agencies to move water supply intakes to better locations, working with the State and Regional Boards to eliminate problem discharges within the Delta, and continuing the development of alternative water treatment technologies.**

5.2.1 Present Conditions

Trihalomethanes (THMs) are a subset of chemicals known as disinfection by-products (DBPs) which are formed when waters are disinfected. THMs are produced when dissolved organic substances, such as fulvic and humic acids produced by decaying crop residues or peat soil in fresh or saline waters, come in contact with the oxidizing agents used to disinfect drinking water (T,VI,38:3-5; T,XLVI,99:11-19). The levels of dissolved organic materials in water are most often assumed to be represented by the total organic carbon (TOC) concentration of the water. However, since TOC is a measure of all organic carbon, not just precursor molecules, it has not been found to be a consistent predictor of THM formation potential (THMFP) in Delta waters. Bromides contribute to the production of THMs and other DBPs. Bromides enter the Delta predominantly from ocean water. Minor sources of bromides are the Sacramento, and San Joaquin rivers, and connate water.

Drinking water supplies with THMs may pose a significant problem because health effects studies have indicated that chloroform and bromoform are animal carcinogens and are suspected human carcinogens (T,VI,38:12-16;DWR,226,2). For regulatory purposes, EPA assumes that all THMs are equally toxic to humans (T,VI,46:5-7) and in 1979 adopted a water quality standard for total THMs of 100 ug/l (EPA National Primary Drinking Water Regulations, 40 CFR 141). This standard is monitored in distribution systems of domestic water supplies. Sampling is performed at three month intervals and compliance is based upon a running average of four samples (T,XLVI,118:1-5). The EPA THM maximum contaminant level (MCL) applies to

treated drinking water, rather than to sources of water, such as the Delta. D-1485 did not include any water quality objective for THMs. It was concluded that for public health reasons protection from THMs in water from the Delta is more properly addressed through the use of alternative water treatment techniques or relocation of problem intakes rather than through the setting of more stringent salinity or TOC objectives (Second Triennial Review of the Delta Plan, October 1984).

Data presented by the Metropolitan Water District of Southern California (MWD) show that chlorinated Delta water with postammoniation occasionally has produced finished drinking water with THM concentrations close to the present EPA water quality MCL (Krasner, 1989). In addition, it has been shown that when a water supply, such as the Delta, contains a significant concentration of bromide, THMs and DBPs can also be formed using disinfectants other than chlorine (e.g., ozone) (Delta Municipal and Industrial Water Quality Workgroup, 1989, p.4.; T,VI,44:8-45:1).

Data presented to the Delta Municipal and Industrial Water Quality Workgroup (Delta M&I Workgroup) by several researchers demonstrate that the presence of bromide exacerbates the problem of DBP formation in general, as well as the problem of THM formation. As bromide concentrations in Delta water increase, brominated forms of DBPs and THMs increase and at times dominate the total THM concentration (Krasner, 1989).

By analyzing THMFP data which were generated using a consistent set of collection and analytical techniques, it is possible to draw general conclusions regarding the sources of THMs in drinking water supplies taken from the Delta. Sources of THMFPs in Delta water appear to be ocean tidal waters, Delta organic soils and decaying crop residues, and Sacramento and San Joaquin river inflows to the Delta. One set of calculations concludes that "within-Delta" sources appear to contribute approximately 25 percent of the THMFPs in Delta water (SWC, Brief on Phase 1, February 1, 1988; p. V-7). DWR is currently conducting a study to determine the THMFP contribution to Delta water quality coming from local agricultural drainage returns (T,XLVI,83:14-84:12). To date, studies show that the mineral soils in the Delta contribute less THM precursors than the organic soils (T,XLVI,84:13-22).

If EPA's MCL for THM is lowered, it is likely that conventionally treated (chlorinated) Delta water with current inputs of total organic carbon and bromide will not be usable as a direct source of drinking water. At present, because of the correlation between chloride and bromide, when chloride concentrations exceed 100 mg/l and standard chlorination treatment is used, THM concentrations approach, but do not exceed, the current EPA THM MCL of 100 ug/l (Delta M&I Workgroup, Appendix A.10, 1989).

5.2.2 State Board Considerations

Information compiled by members of the Delta M&I Workgroup suggest that alternative water treatment techniques may not resolve all the concerns related to THMs. Reasons for this include:

1. The presence of bromide ions in the Delta (the majority of which come from seawater) and the inability of conventional and non-conventional treatment processes to remove either the bromide ion or the brominated forms of THMs;

2. The formation of other disinfection by-products (DBPs) which are suspected human health hazards by conventional and non-conventional water treatment processes;

3. The statement by EPA that it will be proposing maximum contaminant levels (MCLs) for disinfectants currently used to treat drinking water (e.g., chlorine and chloramines). New MCLs are also expected for DBPs. These MCLs are likely to include the DBPs formed by chlorination (e.g., trihalomethanes) as well as other oxidant DBPs.

A discussion of the three reasons mentioned above is found in Appendix 5.1, Trihalomethanes. The discussion is limited to information provided by the Delta M&I Workgroup, from the hearing record of Phase I, and to other information cited concerning formation of DBPs resulting from ozonation/chlorination treatment of drinking water.

Based on a detailed review of the information presented the State Board has concluded the following:

1. THMs, DBPs and some disinfectants (e.g., chlorine, chloramine and chlorine dioxide) currently in use present possible hazards to human health. Brominated THMs and chloroform are suspected human carcinogens.

2. EPA may be revising the total THM MCL in the near future. The revised standard may be more stringent. Under the current timetable, compliance is expected in 1994.

3. EPA is expected to set MCLs for other disinfection by-products and for disinfectants. Ranges of MCLs are unknown at this time. Under the current timetable, compliance is expected in 1994.

4. Every disinfectant currently being used produces some kind of disinfectant by-products. New treatment technologies contain technical and economic uncertainties which compound those associated with the health effects and potential regulation of disinfectant by-products.

5. The presence of bromide ions in the source water exacerbates the THM and DBP concerns. Bromide ions in the source water significantly increase levels of brominated DBPs produced by chlorination, chloramination and ozone.

6. A major source of bromide ions in Delta waters is sea water and a relationship has been documented to exist between chloride levels and bromide levels in seawater. However, the relationship between chloride and bromide levels in the Delta needs further study.

7. In addition to bromide, TOC is an important factor in the production of THMs and DBPs. Sources of TOC include seawater and estuarine water, the Sacramento River, the San Joaquin River and the Delta.

8. While the existing MCL for THMs is usually met with the current chloride objective in the Delta, concern exists that a new MCL for THMs is expected from EPA which may not be achieved without great cost to municipal users who divert from the Delta.

Solutions for the THM concern and newly recognized DBP concern do not lie solely with alternative water treatment techniques or relocation of existing intakes. Before costly and unproven steps are taken, there is urgent need for monitoring and research. Also, basic decisions by EPA are needed before objectives can be set to help address the DBP concerns which include THMs. Finally, the State Board realizes that while THMs are the DBP of current concern, further studies may indicate that other DBPs are of greater concern.

5.2.3 Potential Objectives

1. The current 150 mg/l chloride industrial objective which provides ancillary protection to municipal uses.

2. None. A water quality objective for THMFP is not appropriate at this time. The non-standardized nature of the analytical technique and the lack of a THMFP to THM correlation work together to render such a water quality objective scientifically unsound. A THM workgroup should be formed to address this, and other THM related issues (see Chapter 7.

3. A 0.15 mg/l bromide (about 50 mg/l chloride) level as advocated by the Delta M&I Workgroup. The State Board wants to examine the effects of setting such an objective. Therefore this concentration level will be identified as a "goal" for further analysis.

5.3 Agriculture

Conclusions:

Western and Interior Delta Agriculture

- **To reasonably protect crops grown in the western and interior Delta, water quality objectives were developed using corn as the representative salt-sensitive crop.**

- **Assuming improved leaching practices are used, salinities up to 1.5 mmhos/cm EC could be allowed during the irrigation season without affecting crop yield. However, the economic costs of these practices are not in the record.**

- **Until adequate economic data are available on leaching costs, the Board will maintain the existing salinity objectives.**

Southern Delta Agriculture

- **To reasonably protect crops grown in the southern Delta, water quality objectives were developed using beans and alfalfa as representative salt-sensitive crops.**

- **The objective of 0.7 mmhos/cm EC in the southern Delta protects beans during the summer irrigation season and the objective of 1.0 mmhos/cm EC protects alfalfa during the winter irrigation season. These objectives or other adequately protective objectives at specified locations will be implemented over time.**

o Southern Delta

The implementation plan is comprised of two interim stages and a final stage.

Interim Stage 1 -- 500 mg/l mean monthly TDS all year at Vernalis.

Interim Stage 2 -- (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31; 30-day running average at Vernalis and Brandt Bridge, with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge; and an additional interior monitoring station on Middle River at Howard Road Bridge.

Final Stage -- (to be implemented no later than 1996)
0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31; 30-day running average at Vernalis and Brandt Bridge on the San Joaquin River, with two interior stations at Old River near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old River and Middle River at Howard Road Bridge.

or

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.

5.3.1 Present Conditions

5.3.1.1 Western Delta

In D-1485, an agricultural water quality objective with a base level of 0.45 mmhos/cm EC was set for applied water in the western Delta. This objective is based upon estimates presented in the University of California exhibits. The information provided estimates of the quality needed to provide 100 percent corn yield in this region's subirrigated organic soil (1978 Delta Plan, UC ex. 1,2, and 8). On varying dates during the irrigation season, depending on year type, this objective is adjusted to a lower quality. This adjustment is made for all water year types except wet years at Emmaton and Jersey Point, and above normal years at Jersey Point. The amount of the adjustment is based on the time-weighted average of water quality over the period April 1 to August 15 for conditions that would exist without the CVP and the SWP (without project conditions).

5.3.1.2 Interior Delta

The D-1485 agricultural water quality objectives for the interior Delta uses the same estimates as the western Delta. However, under "without project" conditions, water quality in the interior Delta during the irrigation season was better than in the western Delta. Therefore, water year type adjustments for the interior Delta were smaller.

Table 5-5 lists western and interior Delta water quality objectives used as the present condition objectives.

5.3.1.3 Southern Delta

Three requirements primarily control current agricultural conditions in the southern Delta. These are:

- o Regional Water Quality Control Board 5 Basin Plan (Basin 5 Plan)
- o State Water Resources Control Board Decision 1422
- o The terms of the draft contract for settling litigation brought by the SDWA against the USBR and DWR.

Current controlling conditions are set by the Basin 5 Plan objective for southern Delta agriculture (Table 5-5). This objective provides that "[i]n the San Joaquin River near Vernalis, the mean average TDS concentration shall not exceed 500 mg/l over any consecutive 30-day period" (Basin 5 Plan). This objective is set forth in Water Right Decision 1422 (New Melones Decision) (Table 5-5). Upon completion of the New Melones Reservoir the Bureau was required to meet the Basin 5 Plan objective with the necessary reservoir releases (SWRCB Decision 1422, April 1973).

This objective has not always been met, particularly in the recent years of drought. South Delta Water Agency and USBR have agreed on a number of occasions to release the limited supply from New Melones in a pattern which causes the objective to be violated at certain times of year, in order to preserve the dilution capability for more critical periods.

The USBR, SDWA and DWR entered into the Framework Agreement in October 1986 in an attempt to settle litigation brought by SDWA against the USBR and DWR. Since that time the parties have negotiated a proposed contract to settle the SDWA litigation. The proposed contract was agreed to by DWR's Director, USBR's Director of the Mid-Pacific Regional Office and SDWA's Board of Directors in August 1990. Each party also has its own approval process that must take place before the contract is fully executed.

5.3.2 State Board Considerations

Table 5-1 presents selected information concerning salt threshold and yield levels for sensitive and moderately sensitive surface irrigated crops grown on mineral soils (DWR,328). The salt threshold for a particular crop is the level below which no loss in yield is experienced due to soil salinity conditions.

TABLE 5-1

DELTA SERVICE AREA CROP SALT SENSITIVITY
(DWR,328)

Crop	Crop Salt Sensitivity	
	Threshold ECe[1]	Incremental Loss[2]
Sensitive Crops		
Beans	1.0	19%
Onion	1.2	16%
Moderately Sensitive Crops		
Fruits & Nuts		
Almonds	1.5	19%
Apricots	1.6	24%
Peaches	1.7	21%
Grapes	1.5	9.6%
Corn	1.7[3]	12%
Corn (subirrigated, organic soil)	2.1	20.2%
Potatoes	1.7	12%
Miscellaneous Truck Crops		
Carrots	1.0	14%
Lettuce	1.3	13%
Cabbage	1.8	9.7%
Broccoli	2.8	9.2%
Alfalfa	2.0	7.3%
Tomatoes	2.5	9.9%
Sudan	2.8	4.3%
Rice	3.0	12%

[1] *ECe means Electrical Conductance of the soil saturation extract, reported as deciSiemens per meter (dS/m). With the exception of corn, which has both organic and mineral values, all crop values are based on mineral soil sensitivity.*

[2] *Loss in Yield per Unit Increase in dS/m Beyond Threshold.*

[3] *This tolerance of corn shown is for corn grown on a mineral soil using conventional methods of surface irrigation (furrow or sprinklers). The Delta corn trials (a.k.a. Corn Study) (reported by Hoffman et al., 1983) indicated that subirrigated corn has a slightly higher salt tolerance when grown on Delta peat soils. It is reported to be ECe=2.1 dS/m, or 23 percent higher. This is probably due to the higher water content of the peat. The usual tolerance (for mineral soils) can be multiplied by a factor of 1.23 to obtain tolerance of similar crops grown on subirrigated organic soils.*

5.3.2.1&2 Western and Interior Delta

Protection for western and interior Delta agriculture is primarily based on the protection of corn grown on organic subirrigated soil.

In this region corn is a major salt-sensitive crop. Corn is grown on more than 21 percent of the total Delta land area, including more than 26 percent of the Delta lowlands (DWR,304). To help ensure a reasonable level of protection for agriculture in the western and interior Delta, the following information on leaching practices is needed:

(1) The effects of irrigation and leaching water quality on crop yield,
(2) The economics of implementing leaching practices, and
(3) The practicality of implementing leaching practices and their effectiveness.

Based on results from the Corn Study and the subworkgroup on western and interior Delta agriculture, it appears that corn can be grown and maintained with saltier water than proposed in D-1485; however, controlled leaching would be required periodically. The controlled leaching would be in addition to any leaching effect from rainfall and winter ponding. (See Appendix 5.2, Analysis of Corn Study to Variations in Applied Water and Leach Water Salinity). Information on the effectiveness, practicality, and the economics of such leaching needs field demonstration. Until this information is obtained, the D-1485 objectives will be continued for the protection of western and interior Delta agriculture.

5.3.2.3 Southern Delta

Beans and alfalfa, the two most widely grown salt-sensitive crops in the southern Delta, were chosen as target crops for the purpose of setting objectives. Meeting the objectives for these crops will protect the less salt-sensitive crops. In developing objectives for beans and alfalfa, the evidence and exhibits from the Phase I hearings, information from the DWR-sponsored South Delta Agriculture Subworkgroup, and the southern Delta negotiations were taken into consideration.

Within the subworkgroup, three key issues were discussed that influence the level of salinity required for the protection of beans and alfalfa: crop response during the early stages of growth, the determination of leaching fractions[1] and the effectiveness of rainfall in reducing soil salinity during the irrigation season. The members of the subworkgroups have been unable to reach consensus. The State Board will base its analysis on the University of California's "Guidelines for The Interpretation of Water Quality for Agriculture" and the Delta Plan (1978, Delta Plan, UC ex.D).

The subject of agricultural objectives for the southern Delta should consider ongoing negotiations between DWR, USBR, and SDWA. Care should be exercised in setting objectives so as not to undermine negotiations but to bring the negotiations to a timely and fruitful conclusion. Any agreement resulting from the negotiations will be reviewed by the State Board before the objectives are revised to reflect those contained in the agreement.

1/ Leaching fraction is that fraction of the total amount of applied water that passes through a crop root zone (SWRCB,29,2).

5.3.2.4 San Francisco Bay

No data have been presented nor a need demonstrated to protect agriculture in the San Francisco Bay area. Therefore, no alternatives are being considered for Bay agriculture in this Water Quality Control Plan.

5.3.3 Potential Objectives

5.3.3.1 Western and Interior Delta

No change (see Table 5-5).

5.3.3.2 Southern Delta

A staged implementation of objectives is one alternative. For the reasons stated under "State Board Considerations" it is the only alternative to the existing objective which will be carried forward. The staged implementation plan, which contains two interim stages and a final stage, is discussed in Chapter 7, Program of Implementation. The objectives for the final stage are presented in Table 5-5.

The final stage (to be implemented by 1996) will be 0.7 mmhos/cm EC April 1 to August 31 and 1.0 mmhos/cm EC September 1 to March 31; 30-day running average at Vernalis, Brandt Bridge, Old River near Middle River, and Tracy Road Bridge.

In the final stage of the phased Plan, the State Board will consider requiring full implementation of water quality objectives as set forth in the 1978 Delta Plan for the southern Delta area. Also, any agreement affecting south Delta water quality will be fully reviewed by the State Board prior to implementation of the final stage. The objectives and locations at that time may be revised as the State Board deems appropriate.

5.4 Fish and Wildlife Beneficial Uses

Conclusions:

- **The State Board supports the natural perpetuation of species affected by water and water quality. It is the policy of the state to significantly increase the natural production of salmon by the end of this century.**
- **Because of the amounts of data, past practices and public perception, striped bass and Central Valley Chinook salmon will be given separate consideration in the development of water quality objectives.**
- **Fish hatcheries for some species are a management tool that will be evaluated for their benefit and operation within the watershed during subsequent phases of the Bay-Delta proceedings.**

- **With respect to temperature and salinity, the objectives set in this Plan protect selected estuarine habitat beneficial uses. There is insufficient information in the record to set specific salinity and temperature objectives for the protection of Delta smelt, American shad, benthos, resident fish or marine habitat outside the Estuary.**

5.4.1 Present Conditions -- Fishery Habitat Protection (Entrapment Zone) in the Bay-Delta Estuary

In recent years there have been extensive changes in the Bay-Delta Estuary area, the effects of which are not well understood. These changes include:

1. The introduction of the Asian copepod, Sinocalanus doerrii, and its apparent displacement of the native copepod, Eurytemora affinis, from the entrapment zone area (DFG,28,25-28);

2. Changes in phytoplankton bloom patterns in the Delta and Suisun Bay, with the appearance of dense blooms of the chain diatom, Melosira, in the central Delta (DFG,28,14-19);

3. Changes in Delta outflow, salinity, and rate of water exports from the Delta (DFG,20,22-25);

4. Increases in releases of water from New Melones Reservoir for interim improvement of southern Delta water quality (T,XV,21:1-9); and

5. The introduction and rapid increase in numbers and range of the Asian clam Potamocorbula and its possible adverse effects on phytoplankton and zooplankton abundance.

The largest concentrations of phytoplankton, zooplankton, and detritus are generally found in the entrapment zone, an area where suspended materials concentrate as a result of two-layered flow circulation (USBR,112). Depending upon season, the type of water year, the tidal stage, and the preceding freshwater flow patterns, the entrapment zone could occur anywhere from upstream of the mouth of the Sacramento River to San Pablo Bay. The timing of phytoplankton blooms and the size of the resulting standing crop have been directly associated with the tidally-averaged location of the entrapment zone adjacent to or just upstream of extensive shallow shoal waters (T,XLVI,44:9-11,48:6-10; CCCWA/EDF,9). The location of the entrapment zone can be approximated from specific conductance values of 2 to 10 millimhos/cm (approximately 1 to 6 parts per thousand (ppt) salinity) (CCCWA/EDF,9).

The various species of zooplankton are found at different salinities. Neomysis mercedis are most abundant in areas with surface salinities ranging from 1.2 to 4.6 ppt (CCCWA/EDF,8). As salinity intrusion decreases, Neomysis abundance increases (T,XLI,54:23-24).

Neomysis feed on a variety of phytoplankton; diatoms are the most important class eaten and are also the most abundant class in the estuary (T,XLI,54:25-55:3). Other zooplankton also constitute a significant portion of their diet (T,XLI,55:4-5). Both phytoplankton and zooplankton concentrations have declined, thus reducing the food supply for Neomysis (T,XLI,55:6-8). Statistical analyses indicate that the abundance of Neomysis increases as its food supply increases (T,XLI,54:21-23).

Phytoplankton and zooplankton are important parts of the food chain supporting fish and larger invertebrates in the Estuary. There are no current water quality objectives specifically to protect phytoplankton and zooplankton. There are some benefits provided by water quality objectives set for other beneficial uses, e.g., Delta agriculture or Delta outflow for striped bass spawning and survival.

5.4.2 State Board Considerations

The location of the entrapment zone plays a role in the abundance of phytoplankton and zooplankton in the Suisun Bay area. Salinity is an indication of its location. Because the location of the entrapment zone in Suisun Bay is related primarily to the freshwater outflow, however, the State Board will defer consideration of this issue to the Scoping and Water Right phases of the proceedings.

5.4.3 Potential Objectives

To be discussed in the Scoping and Water Right phases.

5.5 Chinook Salmon

Conclusions:

- **The Estuary is a migratory corridor and rearing area for Chinook salmon.**
- **Hatchery production has kept the total numbers of fall-run salmon relatively stable.**
- **The diversity of the gene pool from naturally produced salmon is desirable.**
- **The Sacramento River winter-run of the Chinook salmon has been listed as an endangered species and will receive additional consideration in the final phases of these proceedings.**
- **The Board finds that salinity is not a factor affecting salmon as they migrate through the Estuary.**
- **Elevated temperature is one of the factors which can affect Chinook salmon during their migration through the Delta.**
- **Temperatures no greater than 68°F during the periods of April through June and September through November should be achieved by controllable factors, such as waste discharge controls, increases in riparian canopy, and bypass of warming areas (e.g., Thermalito Afterbay).**

- **Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the water of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs, and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.**

- **No temperature requirements were submitted for winter-run Chinook salmon. To provide some protection for this endangered species, the more conservative temperature objective of 66°F (developed for the fall-run) is provided for the winter-run. This objective should be achieved by controllable factors, as noted above, during the period January through March at Freeport on the Sacramento River.**

5.5.1 Present Conditions

Flow requirements in D-1485 were established at Rio Vista on the Sacramento River for the protection of Chinook salmon, Oncorhynchus tshawytscha. There are no fishery flow requirements for the San Joaquin portion of the Delta. In addition to flow requirements, D-1485 contains a provision to close the Delta Cross Channel to minimize cross-Delta movement of salmon. D-1485 does not include any water quality objectives for the protection of salmon.

5.5.1.1 Salinity, Temperature and Dissolved Oxygen

Various water quality conditions can affect Chinook salmon survival in the Delta. The water quality variables under consideration were temperature, dissolved oxygen (DO) and salinity. During and after Phase I of the proceedings, data were presented on some water quality requirements of the different runs of Chinook salmon during the freshwater life stages. Most of the information concerning water quality is related to temperature requirements.

No salinity objectives exist for salmon in the Sacramento and San Joaquin basins and Delta, and no salinity objectives have been proposed. Chinook salmon (adults and juveniles) tolerate and even benefit from a gradual salinity gradient from the upstream headwaters to the ocean. The Chinook salmon as they migrate through the Delta are genetically adapted to migrate well beyond the fresh and salt water boundary.

Natural populations of San Joaquin and Sacramento salmon are declining and San Joaquin populations are undergoing extreme fluctuations (USFWS,31,58). Natural populations of the fall-, late fall-, winter- and spring- Chinook salmon runs are smaller than they were when first recorded by DFG in 1959. The catch of fall-run Chinook salmon has been relatively stable over time because the increasing number of hatchery-produced fish has offset the decline in naturally-produced fish.

The winter-run Chinook salmon has been listed as an Endangered Species under State law by the Fish and Game Commission and as a Threatened Species under federal law by the National Marine Fisheries Service (NMFS). Additional information about this run has been submitted to the State Board (see below).

San Joaquin River flow at Vernalis during smolt emigration has been identified as a major factor affecting subsequent adult escapement of hatchery and naturally-produced Chinook two and one-half years later (T,XXXVI,139:17-22) (Figures 5-1 and 5-2). The temperatures in the south Delta are often too high for smolts (WQCP-USFWS-5). Survival of the hatchery fish transported by truck and released below the Delta is six to eight times better than naturally or hatchery-produced fish emigrating from upstream through the Delta (T,XXXVII,153:2-154:1,161:22-162:1).

Very little water quality information is available about the effects of present conditions on salmon smolts migrating through San Francisco Bay. The USFWS did however determine that Chinook survival through San Francisco Bay in 1985 was estimated to be 93 percent based on the ratio of tag recoveries of two and three-year-olds released at both Port Chicago and the Golden Gate Bridge, respectively (Table 15, see USFWS Exhibit 31 for methods). The survival rate in 1984 was 81 percent. Both years had a delta outflow of about 10,000 cfs during the smolt out-migration (WQCP-USFWS-3,54).

5.5.1.2 Legislation for Upper Sacramento River Fishery Resources and Riparian Vegetation Restoration

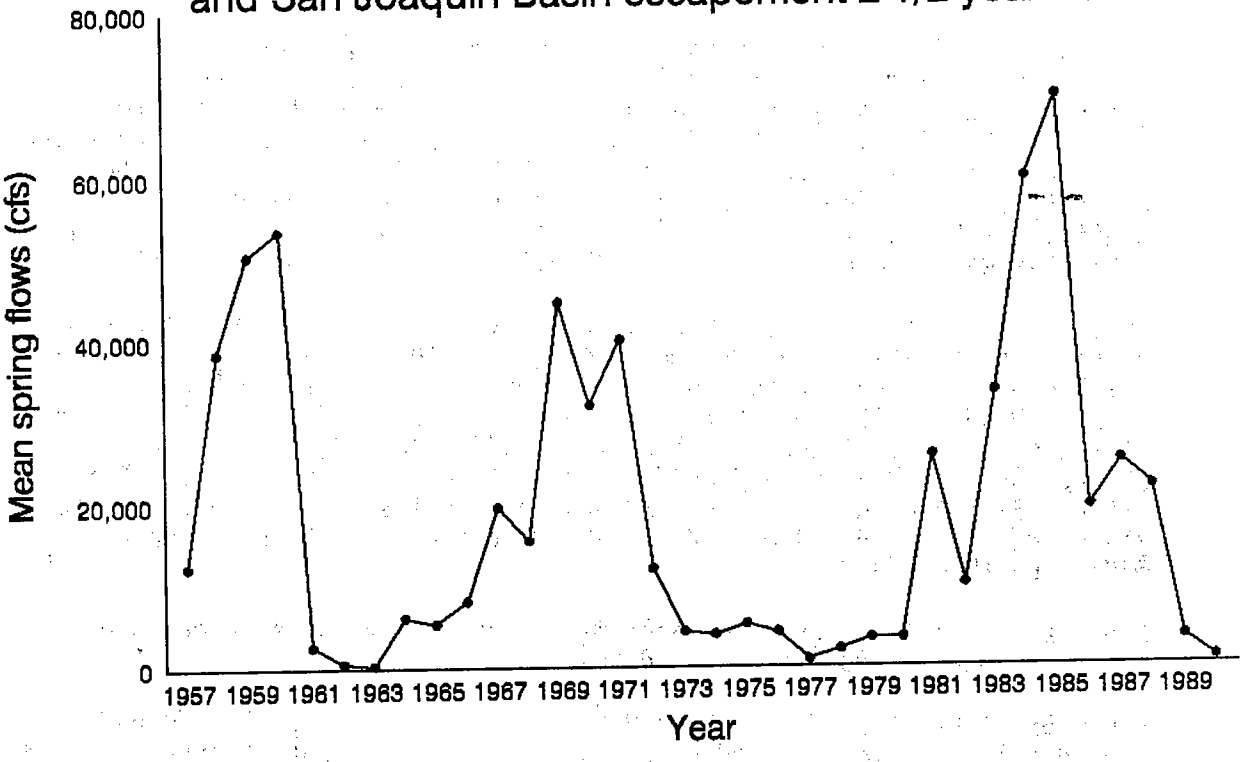
A number of efforts are being made in both the state legislature and congress to improve the anadromous fishery and the riparian vegetation in the upper Sacramento River. In 1986, Senate Bill 1086 (Nielsen) created an advisory council and action team of federal, state and local agencies and interested parties to develop the Upper Sacramento River Fisheries and Riparian Habitat Management Plan. The plan, submitted in 1989, addressed the issues concerning the declining population of anadromous fish in the Sacramento River and listed 22 specific actions to restore and protect the fisheries and riparian vegetation. The plan includes priority issues such as flows, modification of diversion facilities, and temperatures and turbidity control in the Sacramento River. Senate Concurrent Resolution 62 (Nielsen), filed as a follow-up to SB 1086, passed in October, 1989. The Resolution declares that it is state policy to proceed with appropriating sufficient funds to implement the various recommendations in the management plan.

5.5.2 State Board Considerations

5.5.2.1 Temperature

There are a number of factors that influence water temperatures in the Delta; they include water temperatures of tributary inflow, amount of inflow, solar radiation, ambient temperatures, temperature of irrigation return flow and the extent of the riparian vegetation or shade. There is

Figure 5-1 Mean spring flows at Vernalis
and San Joaquin Basin escapement 2 1/2 years later



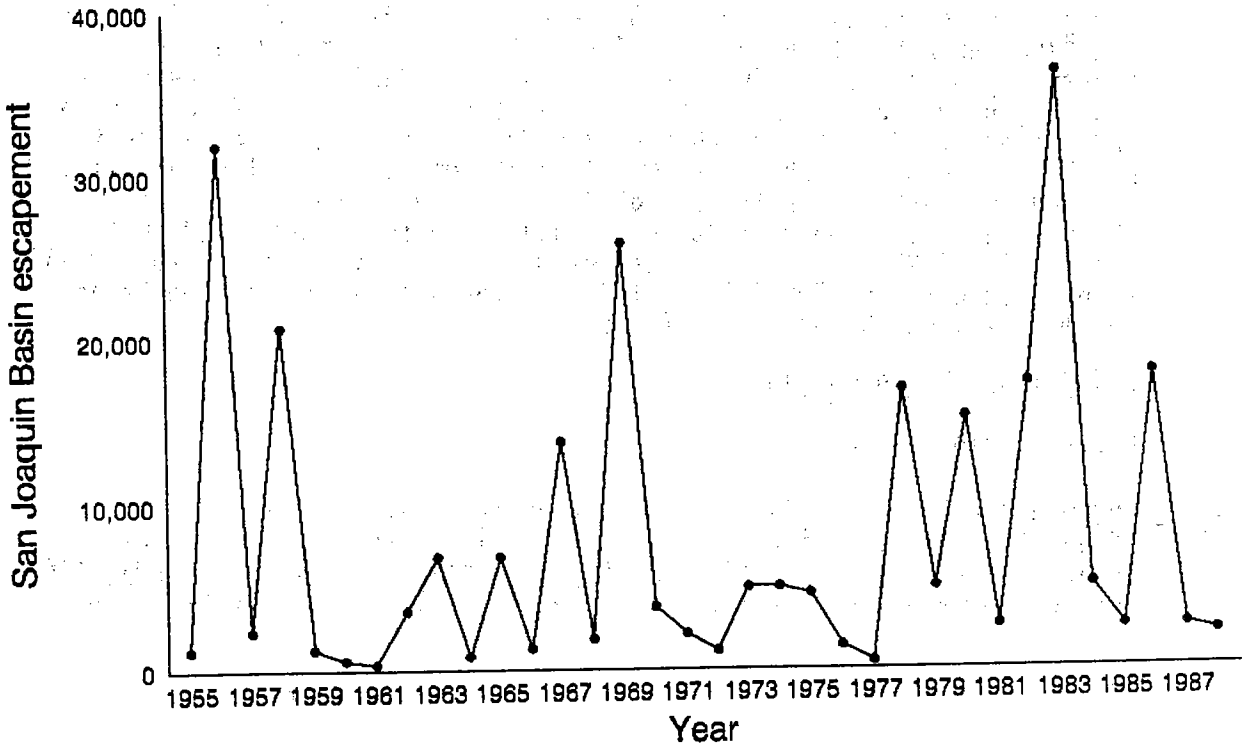
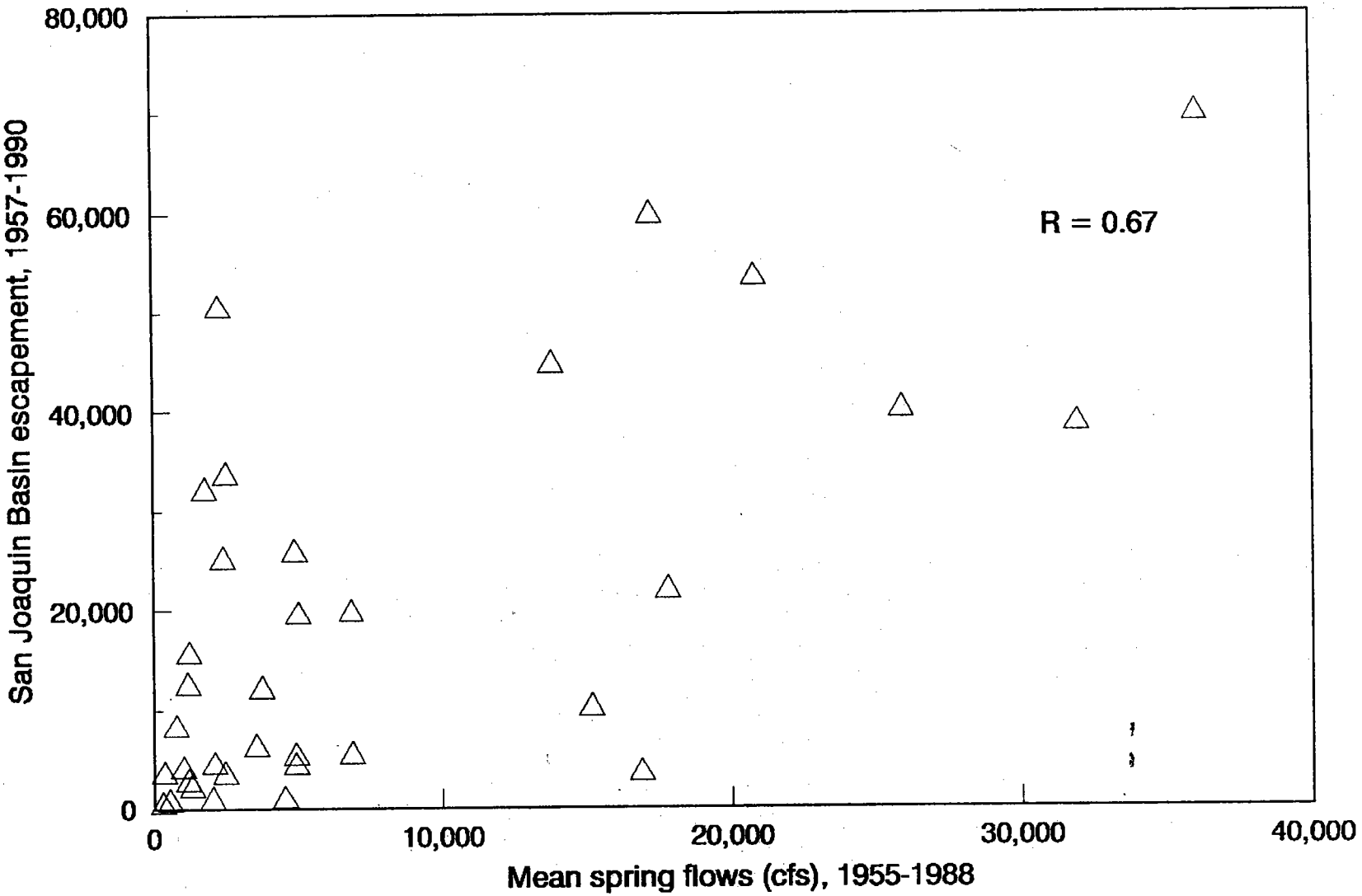


Figure 5-2 Relationship between mean spring flows
at Vernalis and San Joaquin Basin escapement 2 1/2 years later



a general relationship between temperature and flow, with a considerable amount of variation in temperature at any given flow (DFG,15,145) (DWR,562). Water temperatures in the Delta/Estuary range from optimal to lethal to Chinook salmon depending on at least the above factors. Several methods are being pursued to improve the water temperatures in the Sacramento River and increase the survival rate of the various runs of Chinook salmon. Increased flows to move the juvenile salmon more quickly downstream, thus reducing exposure time to potential hazards, could have an effect on temperature.

The critical periods for fall- and winter-run Chinook salmon in the lower Sacramento and San Joaquin rivers are between December 1 and June 30 and September 1 and November 30 of each year, because these encompass the spawner migration and the juvenile outmigration phases through this area (See Appendix 5.3, Chinook Salmon). The ability and options available to attain a desired temperature objective at Freeport on the Sacramento River or Vernalis on the San Joaquin River during the various water year types have not been fully investigated.

Cooler water temperatures in the Sacramento River during the spring, early summer and fall months benefit different life stages of the winter-run as well as the fall-run Chinook salmon. In the spring and early summer, cooling the river for the outmigrating fall-run smolts would also benefit the winter-run adults spawning upstream. In the fall, cooling the water for the fall-run spawners would concurrently benefit the rearing of juvenile winter-run salmon in the river and the beginning of their emigration.

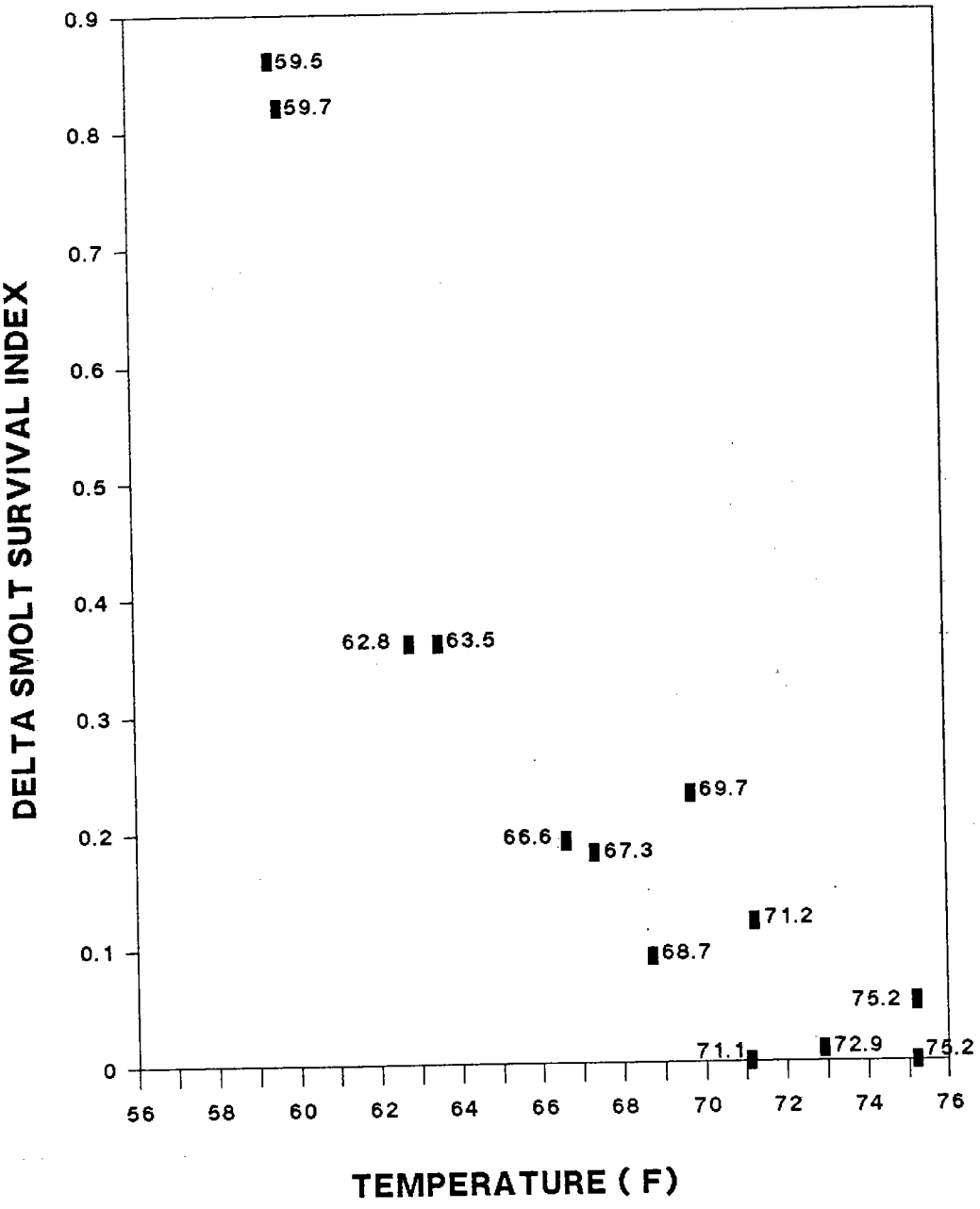
DWR's consultant testified that, since 1978, temperatures in the Sacramento River at Sacramento have been two to three degrees centigrade (about four to six degrees Fahrenheit) higher than before 1978 (T,XXXVII,157:11-15) (DWR,562,2). An evaluation of this theory might be possible by using the USBR Sacramento River temperature model (WQCP-USBR-127). Smolts emigrating in the months of warmer water temperatures are likely to suffer higher mortalities (T,XXXVII,226:15-20). Both wild and hatchery fish from both river systems are vulnerable to loss due to high temperature (WQCP-USFWS-5). The San Joaquin River portion of the Delta warms sooner than the Sacramento River system and is often about 70°F in early May. In the last few years, fishery investigators have determined that high water temperatures as well as low flows are a major problem for smolts emigrating through the San Joaquin River and Delta. Based on ocean tag recoveries, smolt survival through the Delta decreased as mean water temperatures in the Delta increased (USFWS,31,43). The same relationship is illustrated in Figure 5-3 which indicates the effect of temperature on the survival of emigrating juvenile salmon (See also Appendix 5.3, Chinook Salmon).

In contrast, the survival index generally exceeded 0.50 when the Sacramento River temperature at Freeport was 66°F or less (USFWS,31,43).

5.5.2.2 Fall-run Chinook Salmon

The upstream migration of fall-run Chinook salmon extends from approximately September through November in both the lower San Joaquin and Sacramento rivers. High water temperatures have blocked or delayed

FIGURE 5-3 Adjusted survival index of Chinook salmon smolts based on trawl recovery versus maximum daily water temperature on release day at Freeport, Reach 1 (WQCP-USFWS-1)



the upstream migration of fall-run Chinook in the years when there were high water temperatures in the fall. Temperatures above 70°F in the San Joaquin River have prevented salmon from migrating upstream from the Delta. This has often coincided with low dissolved oxygen levels especially between Stockton and Turner Cut. (Dissolved oxygen levels can be affected by temperature both directly and indirectly and the solubility of oxygen in the water varies inversely with temperature.) In the fall months in which DFG studied the situation, Chinook salmon were blocked by high water temperature in the lower San Joaquin River and upstream migration resumed when temperatures declined to 65°F. Temperatures between 65°F and 70°F created a partial block to salmon migration (Hallock et al., 1970). Although comparable findings have not been made for conditions in the Sacramento River, temperatures in the lower river, and in the tributaries as well, have sometimes been higher than optimum for adult migrants during the fall months.

Given the timing of the up- and downstream migration of the fall-run Chinook salmon, and the testimony and evidence of the parties at the hearing, the potential temperature objective for fall-run Chinook salmon is 68°F from April 1 through June 30 and from September 1 through November 30.

The fall-run Chinook salmon population has been supported by artificial propagation in hatcheries in both the Sacramento and San Joaquin rivers.

5.5.2.3 Winter-run Chinook Salmon

The winter-run has not been successfully produced in the hatcheries, in spite of numerous attempts. The population of the winter-run has declined in recent years, with the 1990 adult population estimated to be less than 500 fish. Given the current endangered status of the fish and its recent decline, a more conservative approach should be taken when determining a temperature objective for the winter-run Chinook salmon.

Both adult and young winter-run Chinook salmon would benefit from having a gradual salinity gradient from the Delta to the ocean and temperatures that do not exceed the mid-60 degrees Fahrenheit (memorandum to SWRCB from DFG, August 9, 1989). Temperature tolerances of winter-run Chinook salmon are unknown, although the Department of Fish and Game believes that they are similar to other Chinook runs. The timing of the outmigration of juveniles and the duration of rearing of the winter-run in the Delta are generally unknown. However, the time of the winter-run outmigration has been estimated from counts made in the upstream areas and subsequent catches of appropriately sized fish in the Delta area. These Chinook are determined to be winter-run by comparison with growth curves of winter-run hatchery fish. From these data, the DFG has determined that the period of peak outmigration through the Delta for juvenile winter-run Chinook salmon is between the months of January and April, with occasional downstream movements of fry during the fall months.

The adult winter-run Chinook salmon begin entering San Francisco Bay in November and continue to be found in the Sacramento-San Joaquin Delta into June. Peak adult migration through the Delta probably occurs from January to March.

Although there was no testimony presented on temperature requirements specifically for the winter-run, based on the hearing record and the testimony presented at the hearing, consideration of the more conservative temperature objective (66°F) for the fall-run Chinook salmon would be appropriate for the winter-run (Appendix 5.3, Chinook Salmon) during the period they are in the Sacramento River.

The winter-run Chinook salmon temperature objective is a cap to prevent water temperature from going higher than the present temperatures in the Delta. It is not a goal. This objective is just one of several ways of providing protection from elevated water temperatures. Other such protection measures include the Thermal Plan (see in Section 5.5.2.5) and the State Board "anti-degradation policy", "Statement of Policy With Respect to Maintaining High Quality of Water in California," Resolution 68-16.

5.5.2.4 Dissolved Oxygen

No objectives for dissolved oxygen were developed in D-1485.

The Central Valley Basin Plan (1975, Vol. I-4-12) states that: "The following objectives apply to Delta waters: The dissolved oxygen concentrations shall not be reduced below the following levels:

- 7.0 mg/l in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge; and,

- 5.0 mg/l in all other Delta waters except for those bodies of water which are constructed for special purposes and from which fish have been excluded or where the fishery is not important as a beneficial use."

"Temperatures over 65°F have partially blocked migrations in the San Joaquin River past Stockton and ... dissolved oxygen concentrations of less than 5 mg/l constitute a virtual barrier to adult migrants" (USFWS,31,94). According to Hallock et al. (1970), after four years of investigation, "... no salmon moved past Stockton until the dissolved oxygen had risen to about 4.5 ppm, and the run did not become steady until oxygen levels were above 5 ppm." To address the problem of low dissolved oxygen levels in the San Joaquin River, an agreement was reached in 1969 between the USFWS, USBR, DWR, and DFG, in part, to take specific actions "...to maintain the dissolved oxygen content in the Stockton Ship Channel generally above 6 ppm when necessary...." DWR monitors DO levels in the San Joaquin River between Stockton and Turner Cut (Stockton Ship Channel) during the fall Chinook salmon migration. (Monitoring data are summarized and a report is submitted by DWR to the SWRCB annually in accordance with Water Right Decision 1485, Order 4(f)). If DO levels drop to 6 mg/l, a temporary rock barrier is installed across the head of Old River to increase San Joaquin River flows past Stockton, thus improving DO levels (T,XXXVII,85:4-22). Better treatment of cannery wastes since 1978 (reducing the biochemical oxygen demand) and improved flows and water quality from New Melones Reservoir operations were reported to have helped alleviate this problem (USFWS,31,94). Since then, the Old River barrier has been installed in the fall of 1979, 1981, 1984, 1987, 1988 and 1989 (H. Proctor, DWR, pers. comm.).

In the lower Sacramento River, no problems with dissolved oxygen levels were identified.

5.5.2.5 Miscellaneous Considerations for Salmon

o Pulse Flows as an Operational Option

Various operational options are available which may be beneficial to the salmon smolts but have not been not fully tested. "Pulse flows" are released from Shasta Dam on the Sacramento River to increase flows at the same time salmon smolts are released from the USFWS Coleman Hatchery on Battle Creek (tributary to the Sacramento River). The purpose of the "fish flush" is to move hatchery fish rapidly down the Sacramento River, past a number and variety of potential hazards. Pulse flows (fish flush flows) provide a window of time in which to coordinate the operation of various water diversion facilities, such as the Delta Cross Channel Gates, to maximize survival of the smolts. The fish are released as early in the season as possible to reduce the exposure to adverse water temperatures in the river.

The "pulse flow" experiment has been conducted for the last four years; however, the effects of the experimental operation on the hatchery fish as well as naturally produced fish are not yet fully known. Questions remain on the effects of the pulse flows on the rearing, timing of emigration and survival of the natural fish. The pulse flow experiment was conducted because it would have a beneficial effect, with spring flows higher than in recent years, but substantially less than would have occurred under natural conditions (WQCP-USFWS-2,-3 and-5). Pulse flow experiments are being considered in the San Joaquin River system as well.

o Temperature Model

The USBR temperature model (WQCP-USBR-127) may be helpful in evaluating the Sacramento River flows required to achieve various temperature alternatives at points in the Sacramento River or Delta during different months. The report on the temperature model describes a monthly time-step reservoir and river model developed as a tool to try to evaluate the effects of CVP and SWP project operations on water temperatures as they affect Chinook salmon in the Sacramento River Basin. Because it is a monthly rather than a daily model, it provides only a qualitative comparison of various operating scenarios. Average monthly temperatures can mask short-term fluctuations in temperature that could be lethal to certain salmonid life stages. The model, however, given operational flexibility and sufficient water, indicates relative benefits of various options to the instream life stages of the salmonids. A review of the model should be made to help clarify further the factors influencing temperatures in the Delta.

Because the runs of Chinook salmon can be impacted by temperatures in the spring, early summer and fall, it will be imperative to evaluate the flexibility of the operations and achieve the coldest temperatures possible in the different water year types. The Five-Agency Salmon Management Group is evaluating the costs and benefits of decreasing water temperature and the use of other measures in the Delta to improve salmon smolt survival. A temperature model at present is not available but would be useful for the San Joaquin River.

o Regional Water Quality Control Board Temperature Objectives

The temperature objective in the Central Valley Regional Board's Basin Plan for the Sacramento River is as follows: "The temperature shall not be elevated...above 68°F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery." This objective is based upon "controllable factors" discussed below. There is no temperature objective on the San Joaquin River system.

The fishery's temperature objective for the Delta specifies: "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses." (Water Quality Control Plan Report, Central Valley Region 5, Vol. I, p.I-4-9)

o Thermal Plan

The State Water Resources Control Board adopted on May 18, 1972, A "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed bays and Estuaries in California," referred to as the "Thermal Plan." The Plan specifies limiting conditions of temperature in wastewaters discharged into interstate and coastal waters, estuaries and enclosed bays. For example, elevated temperature waste discharges into interstate waters designated as "cold" waters are prohibited while this type of discharge into "warm" interstate waters cannot be more than 5°F warmer than the receiving water and shall not cause the temperature in the receiving water to rise more than 5°F. Existing thermal discharges into coastal waters, estuaries and enclosed bays must comply with limitations necessary to assure protection of the beneficial uses and, for coastal waters, areas of special biological significance. (Water Quality Control Plan Report, Central Valley Region 5, Vol. II, p.II-9-14).

o Controllable Factors

Water temperature objectives in the Central Valley Basin Plan apply to controllable water quality factors which are defined as: "...those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board or the Regional Board, and that may be reasonably controlled." (Revised Region 5 Basin Plan for Basins 5A, 5B, and 5C as approved by the State Board on March 22, 1990; also please see Tables 1-1 and 6-3, page 8 of 8).

In order to implement a water quality objective for temperature in the Delta, the Board will examine the controllable factors, and, where reasonable, require maintenance of the water temperatures such that they will not impact, and perhaps will improve, survival of anadromous salmonids.

5.5.3 Potential Objectives for Chinook Salmon

5.5.3.1 Temperature for Fall-Run Salmon

The following objective will be considered for the protection of the fall-run Chinook salmon:

The daily average water temperature shall not be elevated by controllable factors above 68°F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types.

When other factors result in the degradation of water quality beyond the levels of limits established as water quality objectives, then controllable factors shall not cause further degradation of water quality.

5.5.3.2 Temperature for Winter-Run Salmon

The following objective will be considered for the protection of the adult and juvenile life stages of the endangered winter-run Chinook salmon:

The daily average water temperature shall not be elevated by controllable factors above 66°F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31 in all water years.

5.5.3.3 Dissolved Oxygen

Factors that may contribute to the low levels of dissolved oxygen, in addition to low flows in the San Joaquin River during the fall months, include: 1) the recently deepened ship channel; 2) the enlarged turning basin at the Port of Stockton; 3) the Stockton Sewage Treatment Plant; 4) upstream BOD sources; and 5) commercial use of the dead-end portion of the ship channel.

The following objective is proposed for consideration for the protection of the Chinook salmon in the San Joaquin River:

Minimum dissolved oxygen levels shall not fall below 6 mg/l from September 1 through November 30 in all water year types between Stockton and Turner Cut in the San Joaquin River.

Measures to implement this objective include the following: 1) regulation of the effluent from the Stockton Sewage Treatment Plant and other upstream discharges contributing to the BOD load; 2) installation of the temporary barrier or additional barriers as may be needed, 3) investigation of mechanical or chemical methods to oxygenate the water at critical points along the river channel, and 4) increase of flows in the San Joaquin River. A decision on the precise implementation measures will be made during the forthcoming proceedings.

5.6 Striped Bass

Conclusions:

- Studies over many years indicate that there are numerous factors affecting striped bass abundance, including diversions from the Delta, reduced Delta outflow, flow patterns in the interior Delta, fewer adults, toxic effects, changes in the food chain due to introduced species, recreational angler harvest, and illegal poaching.

- Studies should be continued and additional water operation tests should be conducted to determine the effects on striped bass and the best means for their protection.

- In light of various impacts on the fishery, particularly of the exports pumps, it is necessary to examine existing points of water diversion. Within the Scoping Phase, the Board will consider the alternatives to the existing points of diversion.

Striped Bass - Spawning Habitat from Prisoners Point to Vernalis

- Review of the evidence indicates that it may be desirable to expand existing spawning habitat for striped bass in the Delta. However, the State Board concludes that the most significant factor in the decline of striped bass is entrainment[1] due to pumping. The State Board will consider actions to be taken concerning entrainment losses during the Scoping and Water Right phases of the proceedings. Upon examination of the results of these actions, the State Board will consider the issue of expansion of spawning habitat.

Striped Bass - Spawning Habitat from Antioch to Prisoners Point

- The major spawning areas for striped bass are the Sacramento River above the Delta and the San Joaquin River area between Antioch and Prisoners Point.

- The Board finds benefits for the resource in maintaining spawning habitat in this reach by establishing boundary salinities at Antioch of 1.5 and at Prisoners Point of 0.44 mmhos/cm EC from April 15 through May 31. The end date of May 31 may be shortened if data indicate that spawning has ceased.

- Deficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated.

- The Board needs better information than is currently available to consider the complete economic relationship between improvements in striped bass spawning habitat and water availability.

1/ Entrainment means primarily the effects of project operations, such as operation of the Delta Cross Channel gates, export pumping, and reverse and low river flows, plus local non-project diversions.

5.6.1 Present Conditions

5.6.1.1 Background: D-1485 Objectives

Striped bass are specifically protected in D-1485 (Table II,38,39,40). These requirements evolved out of negotiations conducted among DFG, DWR, USFWS, and USBR prior to the 1978 hearing as part of a draft Four-Agency agreement; this agreement was never signed (DFG,25,133). Salinity (EC) objectives at Antioch and at Prisoners Point on the San Joaquin River establish a striped bass spawning area estimated to be about 17 miles in length from April 1 to May 5 in all water years. These objectives were first established (in an earlier form) by Water Right Decision 1379, adopted in July 1971. They were established after a review of an earlier State Board Resolution (68-17; Supplemental Water Quality Control Policy) indicated that striped bass spawning was not being protected. The recommended protection measures were similar to those proposed by a Department of Interior task force on Delta salinity objectives (Decision 1379, 32).

The objective at Antioch is 1.5 mmhos/cm EC (the first two weeks of protection are provided by a Delta Outflow Index requirement of 6,700 cfs rather than an EC objective to provide some ramping capability for the CVP and SWP water projects). This objective also includes a relaxation provision when the SWP or CVP declares deficiencies in delivery of firm project supplies. Upstream, the objectives provide for a maximum of 0.55 mmhos/cm EC at Prisoners Point; no relaxation provision is included.

In May, June and July, minimum Delta Outflow Index flows and limitations on export levels come into effect for protection of young bass. These requirements were designed to help move eggs and young into suitable nursery areas and to reduce entrainment into the SWP and CVP export systems. The Delta outflows were also expected to provide equivalent protection for later spawning in the San Joaquin River, at least in wet, above normal, and below normal water years; outflows during these periods were expected to be higher than the 6,700 cfs estimated to be required to maintain the 1.5 mmhos/cm EC at Antioch under steady-state conditions (1978 Delta Plan, VI-4). Provisions for periodic closure of the Delta Cross Channel gates (to reduce translocation of Sacramento River striped bass eggs and young into the central Delta) and recommendations (not mandatory requirements) for the operation of the projects' fish recovery facilities are included in D-1485. Other than the Delta Cross Channel gate closure, there are no specific objectives for protection of spawning or young bass in the Sacramento River.

5.6.1.2 Current Status

The adult population of striped bass in the Estuary has declined in recent years to about one-third or one-fourth of the population levels seen in the 1960s. A variety of sampling programs are employed to monitor various components of the striped bass population (see Appendix 5.4.1). While the decline rates and patterns may vary somewhat, all programs measuring striped bass abundance show large declines (DFG,25,6,9). The primary means of evaluating the overall condition of striped bass between years has been the Striped Bass Index (SBI). The objectives in D-1485 were designed to maintain the SBI at a long-term

average of 79 (the so-called "without project" conditions). This goal has not been achieved; in 1990, the actual SBI reached an all-time low of 4.3; 1988 was the second-lowest on record with 4.6, and in 1989 the SBI was 5.1. The average SBI for the period 1979-1990 is 19.1 (see Appendix 5.4.2).

In the late 1970s declining striped bass populations indicated that the requirements in D-1485 for protection of striped bass were not achieving their intended and expected results. In response, the State Board organized a Striped Bass Work Group composed of staff from several state and federal agencies and outside consultants to investigate the cause(s) of this decline and to make recommendations on actions to correct it. Subsequent discussion and data analysis have resulted in an expanded and refined list of possible causative factors. These are discussed in Appendix 5.4.3. The relationship of the export area striped bass fishery to the Estuary fishery is discussed in Appendix 5.4.4. In large part, while the reasons for the striped bass decline are known, the relative importance of each factor is not completely understood (WQCP-DFG-3).

5.6.2 State Board Considerations

General: Salinity Objectives

Salinity objectives for striped bass apply to the spawning conditions and limitations for adult striped bass in the San Joaquin River. Striped bass in the Sacramento River spawn well above the influence of ocean-derived salinity, and, unlike the San Joaquin River, water quality and river flow are sufficient to prevent the formation of upstream salinity barriers to fish passage due to land-derived salts. No D-1485 objectives or advocated positions consider this area, and no alternatives are offered for consideration.

The D-1485 salinity objectives were expected to provide minimal, yet adequate, spawning habitat from approximately Antioch to Prisoners Point to sustain a healthy striped bass population. However, the continuing decline indicates that some new actions must be considered. Therefore, as one part of an overall program to increase protection for estuarine habitat, it is appropriate to consider modifying the three D-1485 San Joaquin River spawning objectives.

This section considers temperature in addition to salinity objectives at Antioch and Prisoners Point:

5.6.2.1 Antioch: Period of Protection for Spawning
5.6.2.2 Antioch: Relaxation Provision
5.6.2.3 Prisoners Point: EC Modification
5.6.2.4 Prisoners Point: Relaxation Provision
5.6.2.5 Temperature Objectives

5.6.2.1 Antioch: Period of Protection for Spawning

The current D-1485 objectives provide for striped bass spawning protection in the lower San Joaquin River for a period of 35 days, from April 1 to May 5. Protection during the first two weeks of this period is permitted to be met by a Delta Outflow Index (DOI) value of 6,700 cfs, rather than the EC objective of 1.5 mmhos/cm, to provide some operational flexibility for the SWP and CVP without significantly degrading protection of spawning habitat. Since spawning activity is minimal in early April in most years, the small variations in salinity which may occur under this provision are not significant.

After May 5, striped bass spawning habitat is not specifically protected, although spawning in the Delta continues through most of May and occasionally even into June, depending upon water temperatures and perhaps other factors. Some collateral protection is provided by DOI flows designated for protection of young bass. The flow requirements in wet, above normal, and below normal water years are generally sufficient to maintain the 1.5 mmhos/cm EC salinity in the vicinity of Antioch (the lower end of the spawning area) or even farther downstream. However, in subnormal snowmelt, dry and critical water years, DOI requirements are reduced, resulting in loss of spawning habitat. DFG testified that the spawning habitat protection provided under present D-1485 objectives is minimal rather than optimal, and that striped bass would be put under additional stress if the relaxation provision were in effect (see below) (1978 Delta Plan testimony, May 30, 1978, 67:14-19). DFG also testified that the flow requirements (DOI) set for striped bass do not provide adequate protection during dry or critical water years, or those of subnormal snowmelt (T,LXVIII,76:2-4). Therefore, several alternative spawning habitat objectives which provide various levels of protection are considered.

The current objectives provide protection through May 5. Table 5-2 shows the results of DFG egg sampling in the San Joaquin River. For each year, the date on which a specified percentage of total eggs collected is noted. For example, in 1985, 30 percent of the total number of eggs collected by DFG that year were collected by May 1. These data are analogous to, and derived in part from, the cumulative total curves in Turner (1976). This table indicates that a May 5 cutoff date for protection of spawning means that only 30 to 40 percent of the total spawning activity (as measured by eggs collected) in any given year has occurred by that date. The data in Table 5-2 indicate that extending the cutoff date to May 31 protects about 95 percent of the spawning activity in most years.

Alternative levels of protection may be summarized as follows:

TABLE 5-2
STRIPED BASS SPAWNING PATTERNS, SAN JOAQUIN RIVER
PERCENT OF LIVE EGGS COLLECTED, BY DATE
WATER YEAR IS 40/30/30

YEAR	WATER YEAR	PERCENT OF TOTAL EGGS COLLECTED												
		>0	5	10	20	30	40	50	60	70	80	90	95	100
1963*	AN	4/26	5/01	5/05	5/14	5/15	5/16	5/16	5/17	5/19	5/21	5/23	5/27	6/13
1964*	D	4/15	4/15	4/27	5/06	5/15	5/16	5/16	5/17	5/18	5/19	5/23	5/25	6/05
1965*	W	Very few eggs collected; sampling program missed most of spawning; eggs present through 6/19												6/19
1966*	BN	4/14	4/15	4/16	4/20	4/25	4/27	5/01	5/02	5/05	5/07	5/08	5/14	6/18
1967*	W	5/03	5/04	5/04	5/06	5/09	5/17	5/18	5/19	5/20	5/23	6/13	6/18	6/22
1968+	BN	4/03	4/12	4/26	5/02	5/08	5/08	5/08	5/08	5/10	5/10	5/17	5/24	6/14
1969*	W	4/08	4/11	4/15	4/21	5/02	5/08	5/14	5/17	5/20	5/24	5/27	6/01	6/12
1970+	AN	4/21	5/02	5/04	5/05	5/14	5/14	5/15	5/15	5/17	5/18	5/19	5/21	6/30
1971+	W	Sampling begun in late May, eggs present from 5/23 to 7/12; bulk of spawning probably somewhat earlier												7/12
1972+	D	4/29	5/07	5/08	5/10	5/10	5/10	5/11	5/12	5/13	5/19	5/23	5/31	7/06
1973+	AN	Sampling begun in late May; eggs present from 5/29 to 7/04; bulk of spawning probably somewhat earlier												7/04
1975+	W	5/01	5/08	5/11	5/13	5/18	5/21	5/24	5/26	5/27	5/28	6/05	6/06	7/14
1977	C	4/19	4/20	4/21	4/30	5/01	5/01	5/09	5/14	5/15	5/15	5/15	5/28	6/10
1984+	W	4/16	4/23	4/25	5/02	5/07	5/08	5/09	5/13	5/13	5/14	5/15	5/17	7/01
1985+	BN	4/16	4/19	4/24	4/29	5/01	5/03	5/06	5/12	5/13	5/15	5/19	5/22	6/27
1986+	W	4/16	4/21	4/21	4/23	4/30	5/09	5/10	5/11	5/12	5/17	5/22	5/25	7/01
1988+	C	4/12	4/14	4/21	4/23	4/25	4/26	4/27	5/07	5/08	5/09	5/18	5/24	6/15
1989+	D	4/12	4/17	4/18	4/20	4/24	5/03	5/04	5/05	5/06	5/10	5/26	6/01	6/23
AVERAGE DATE OF COLLECTION FOR PERCENT INDICATED		--	4/23	4\26	4/30	5/05	5/08	5/11	8/13	5/14	5/17	5/22	5/27	6/21

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* = Values derived from curves in Figure 2 of Turner (1976);
remaining years from cumulative totals of live eggs from DFG data (Lee Miller)

+ = Eggs present on first day of sampling (date in >0 column); some spawning probably occured prior to date shown

Alternatives	Approximate percent of spawning activity protected
1. April 1 through May 5, with ramping* (present condition)	30-40%
2. April 15 through May 15, without ramping	55-65%
3. April 1 through May 15, with ramping	60-70%
4. April 15 through May 31, without ramping	90%
5. April 1 through May 31, with ramping	95%
6. April 1 through May 31, without ramping	>95%

* ramping = 6,700 cfs Delta Outflow Index value for period April 1 through April 14

The percent of spawning activity assumed protected under each alternative in the table above is determined directly from Table 5-2. The range of percent spawning activity protected is simply the amount of spawning activity measured (i.e., percent of total eggs collected) by the end date of each alternative. There is assumed to be relatively little spawning which occurs before about April 15 each year, so the absence of ramping (i.e., appropriate salinity from April 1 rather than ramping flows to April 14) was assumed to add only about 5 percent additional spawning activity protection over that provided by ramping. The relative lack of data before April 15 makes this somewhat speculative, but in any case it is probably not significant.

The State Water Contractors proposed extending protection of spawning activity only to May 21 in dry and critical years (WQCP-SWC-627,3-4).

The present Antioch standard of 1.5 mmhos/cm EC was primarily designed, as is described in Section 5.6.1.1, to provide a suitable spawning habitat upstream of Antioch, not at the Antioch location itself. According to the recollection of Don Stevens of DFG (pers. comm., 3/91), Antioch was chosen as a monitoring point because a salinity monitoring station was already established at the Antioch Water Works. The use of 1.5 mmhos/cm EC at Antioch for spawning protection appears not to be generally appropriate, since DFG's own testimony indicates that striped bass prefer to spawn in freshwater, and that a spawning objective of 0.44 mmhos/cm EC represents the "best scientific evidence" of the water quality needed to restore spawning in the historical spawning area of the San Joaquin River (DFG-WQCP-9,4) (see Section 5.6.2.3). However, the Antioch water quality objective may continue to serve the purpose of being an ultimate delimiter of spawning habitat; the Antioch objective can also be considered an "implementing measure" since maintaining that objective should produce less saline, and thus more suitable habitat, upstream of Antioch in the San Joaquin River. DFG has observed some spawning in the Antioch to Jersey Point reach, sometimes in ECs of 1.5 mmhos/cm or higher, in some very dry years (1972 and 1977). Laboratory

studies also indicate that egg survival is not affected adversely in water with ECs up to 1.5 mmhos/cm (DFG,25,46). These conditions have typically produced some of the lowest abundance indices, however. We also agree that the striped bass spawning objectives, as proposed, do not in fact designate a spawning reach, but only a single location (Prisoners Point) where appropriate salinities for the majority of spawning, as determined by DFG, are required to be present.

5.6.2.2 Antioch: Relaxation Provision

Decision 1485 provides for a relaxation of the protection for striped bass spawning when the SWP or CVP impose deficiencies in their firm supplies. The EC objective is relaxed proportional to the amount of deficiency imposed. Under extreme conditions, when the projects impose deficiencies of 4.0 MAF or more, D-1485 in theory allows the EC at Antioch to degrade to 25.2 mmhos/cm, which would result in substantial reduction of spawning habitat to an estimated reach of about 9.5 miles or less (Delta Plan and D-1485 Final EIR,V-24 to V-26). However, it was believed that the Suisun Marsh protection objectives (critical years) or Delta agricultural objectives (dry years) would in fact control salinity in the lower San Joaquin River throughout the month of May. Therefore, the actual EC at Antioch, regardless of the size of the deficiency imposed, was not expected to exceed 3.7 mmhos/cm in critical years, and 1.8 mmhos/cm in dry years (letter from SWRCB to EPA April 3, 1979 -- information based on DWR 1978 Hearing Ex. 7B).

As several participants have pointed out, there is considerable confusion about the appropriateness of the proposed relaxation criteria, in terms of what salinity is appropriate at Antioch for various deficiency levels. As has been discussed, the 1978 Delta Plan and EIR based the relaxations on a salinity/flow relationship for the Sacramento River, which was assumed to be applicable to the San Joaquin River as well. In addition, the theoretical extent of salinity degradation was supposedly limited to a maximum of 3.7 mmhos/cm EC because of the Chipps Island Suisun Marsh standard. The entire process is built on a series of artificial relationships which are unrelated to the main issue at hand, which is the establishment and maintenance of suitable spawning habitat for striped bass in the San Joaquin River and the relaxation of that habitat requirement when water project firm deliveries are reduced.

The State Board continues to believe that, as stated in its conclusions on striped bass (Section 5.6), the "[d]eficiencies in firm supplies and the level of protection afforded by the striped bass spawning objective should be correlated." The present deficiency schedule does not do that, since no specific relationship between extent of habitat and change in salinity intrusion has been made. The present relationship is based on a Sacramento River salinity/flow relationship. Several participants have appropriately questioned the basis for this relationship.

In 1990, the projects declared a deficiency and invoked the relaxation provision. Despite compliance with other D-1485 standards, the theoretical expected Antioch maximum EC of 3.7 mmhos/cm was exceeded. In addition, monitoring data from 1990 suggest that ECs greater than 0.44 mmhos/cm occurred throughout nearly all of the striped bass spawning area, not simply at the downstream end.

The State Board would like to relate deficiencies to spawning area in a direct, measurable way: by simply making increases in deficiencies directly related to the shortening of the length of river reach in which suitable spawning habitat will be required to be maintained. The Board believes this approach would have a negligible effect on water supplies during most years because D-1485 provides some umbrella spawning protection upstream of Antioch by means of the central and western Delta agricultural standards. These standards are presently under review, and the required water quality at some locations may be reduced (salinity increased). By establishing a separate spawning habitat objective, no re-evaluation of the effects of water quality degradation on striped bass habitat will be required. The present agricultural water quality objective includes a level of 0.45 mmhos/cm EC at Jersey Point from April 1 to August 15 (in all but critical years). This objective essentially duplicates the current EC and starting date requirements for striped bass spawning protection. In Section 7.5.2.4, Program of Implementation, the State Board outlines a proposal for evaluation of the concept of establishment of a specific spawning protection zone and a directly related relaxation provision.

5.6.2.3 Prisoners Point: EC Modification

The D-1485 objective for EC at Prisoners Point on Venice Island is 0.55 mmhos/cm for the period April 1 to May 5, in all water years, to delimit the upstream end of the San Joaquin River spawning area. No relaxation provision for deficiencies is included. Transfer of water across the Delta to the export pumps results in relatively low salinity in the Prisoners Point area of the San Joaquin River. Salinity in the San Joaquin River increases upstream of Prisoners Point due to reduced freshwater inflow and saline agricultural return flows from the eastern and southern Delta and from the River above the Delta. Thus, the absence of salinity objectives above Prisoners Point effectively establishes a barrier to adult migration and spawning farther upstream on the San Joaquin River.

Three issues are involved with this standard: period of protection, extension of spawning habitat farther upstream, and appropriate EC levels.

Period of Protection

As noted above, there is substantial spawning in the Delta throughout May. Flows through the Mokelumne River system, especially the movement of Sacramento River water through the Delta Cross Channel, most likely provide considerable protection of water quality in the area around Prisoners Point throughout much of the spring months.

For consistency with the objectives proposed for Antioch, the State Board will examine the effect of setting the same period of protection as at Antioch: April 1 to May 31 in all water years.

Extension of Available Spawning Habitat Upstream

The major issue involving the current striped bass spawning objectives is whether the spawning area should be expanded beyond its present size. The present objective results in substantial spawning in the channels which move water to the export pumps in the south Delta; for part of the spawning period (April), there are no restrictions on export rates. This undoubtedly results in substantial losses of eggs and young. In its comments on the proposed objectives in D-1485, DFG noted that the designated spawning area provided "minimal suitable conditions" (Testimony, 1978 Delta Plan, 4/27/77, XXII, 160:17-19).

In Phase I, DFG testified that striped bass used to spawn farther up the San Joaquin River than at present, but do not do so now because of increased salinity (T,XLI,68:3-20). Despite testimony to the contrary (see for example, U.S. Department of Interior comments, 4/23/90, p.6), numerous records from the early decades of this century indicate that striped bass regularly migrated up the San Joaquin River and its tributaries. As late as 1963, substantial spawning in the San Joaquin River occurred in the reach between Stockton and Mossdale (Farley, 1966). Spawning occurred above Vernalis in 1968, with many of the eggs appearing near Patterson, 104 miles above the mouth of the river (Turner, 1976). In wetter years large striped bass are still seen in the San Joaquin River tributaries (W. Loudermilk, DFG, pers. comm., 1988). It appears that the upper Delta and the tributary rivers may still support striped bass spawning when appropriate habitat conditions are provided.

On the other hand, several arguments have been offered to support retention of the present objective (limit spawning to west of Prisoners Point). These arguments are based primarily on two factors: (1) assumptions that eggs and young that were produced farther upstream would be carried to the export pumps and lost to the Delta; and (2) lack of a strong experimentally-derived correlation between salinity and spawning success. These arguments are discussed in Appendix 5.4.5.

Appropriate Electrical Conductivity Levels

The Phase I testimony and exhibits indicate that striped bass prefer to spawn in water with an EC of less than 0.3 mmhos/cm (TDS=170 mg/l) (DFG,25,46 and 47). Farley (1966) concluded that striped bass require a TDS of less than 250 mg/l (= 0.44 mmhos/cm EC). It is DFG's belief that this represents the "best scientific evidence" to restore spawning in the historical spawning area of the San Joaquin River (WQCP-DFG-4,9). Higher salinities may affect egg survival as well as spawning activity. Turner (1976) found that, in water of 600-800 mg/l TDS (= 1.03-1.36 mmhos/cm EC) on the San Joaquin River above the Delta in 1968, 94 percent of the eggs he collected were dead. However, it is not clear whether this high percent of dead eggs was caused by salinity or some other factor.

Establishing an objective of 0.55 mmhos/cm EC in the reach from Prisoners Point to Vernalis would not expand the spawning area since, based on prior testimony, that EC level would still act as a barrier to migration upstream of Prisoners Point. Likewise, establishing any objective at a single location well up in the Delta (such as at Vernalis) will not

assure that the intervening stretch of river will be of quality adequate for spawning. The appropriate objective must be applied at several points along the San Joaquin River to assure continuity.

5.6.2.4 Prisoners Point: Relaxation Provision

The D-1485 objective for Prisoners Point did not include a relaxation provision. However, consideration of a relaxation provision is appropriate, should one of the alternatives which improve water quality above the present objective of 0.55 mmhos/cm EC be selected.

5.6.2.5 Temperature Objectives

Evidence presented in Phase I, and analysis of other data, indicate that high water temperatures may result in some possible losses of bass eggs and young. However, these losses are not considered significant. Temperature issues are discussed in Appendix 5.4.6. Based on the information available, no special measures are warranted at this time.

5.6.3 Potential Objectives

In view of the above considerations, the State Board has developed the following potential objectives at these locations, in addition to the possible retention of the current objectives.

5.6.3.1 Antioch: Period of Protection for Spawning
5.6.3.2 Antioch: Relaxation Provision
5.6.3.3 Prisoners Point: EC Modification
5.6.3.4 Prisoners Point: Relaxation Provision
5.6.3.5 Temperature Objectives

5.6.3.1 Antioch: Period of Protection for Spawning

Objective 1-A The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than 1.5 mmhos/cm for the period April 1 to May 31, or until spawning has ended, in all water years.

Objective 1-B The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than 1.5 mmhos/cm for the period April 1 to May 31, or until spawning has ended, in all water years, except that protection during the period April 1 to April 14 may be provided by maintenance of an average Delta Outflow Index for that period of not less than 6,700 cfs.

Objective 1-C The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than 1.5 mmhos/cm for the period April 1 to May 31, or until spawning has ended, in wet, above normal, and below normal water years; or for the period April 1 to May 21, or until spawning has ended, in dry and critical water years; except that protection during the period April 1 to April 14 in all water years may be provided by maintenance of an average Delta Outflow Index for that period of not less than 6,700 cfs.

5.6.3.2 Antioch: Relaxation Provision

Objective 2-A No relaxation provision.

Objective 2-B The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than the values (shown in the table below) corresponding to the deficiencies in firm supplies declared by the SWP and CVP, in dry and critical water years, for the period April 1 to May 31, or until spawning has ended.

Total Annual Declared Deficiencies (MAF)	April 1 to May 31 EC in mmhos/cm	
	Dry	Critical
0.0	1.5	1.5
0.5	1.8	1.9
1.0	1.8	2.5
1.5	1.8	3.4
2.0 or more	1.8	3.7

Linear interpolation is to be used to determine values between those shown.

Objective 2-C Same as 2-B, except that deficiencies are defined as deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds. The specific representative projects and amounts of deficiencies would be defined in subsequent phases of the proceedings under this alternative.

Objective 2-D Same as Objective 2-B or 2-C except the period of protection is April 1 to May 21.

Objective 2-E The 14-day running average of the mean daily EC at the Antioch Waterworks Intake on the San Joaquin River shall be not more than 3.7 mmhos/cm for the period April 1 to May 31, or until spawning has ended, when the April 1, 40-30-30 Sacramento Basin Index is equal to or less than 4.8 MAF.

5.6.3.3 Prisoners Point: EC Modification

Objective 3-A The 14-day running average of the mean daily EC shall be not more than 0.30 mmhos/cm (TDS=170 mg/l) for the period April 1 to May 31, or until spawning has ended, in all water years, at the following stations: Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge (site), Mossdale Bridge, and Vernalis.

Objective 3-B The 14-day running average of the mean daily EC shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, in all water years, at the following stations: Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge (site), Mossdale Bridge, and Vernalis.

Objective 3-C The 14-day running average of the mean daily EC shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, in wet, above normal, and below normal water years; or for the period April 1 to May 21, or until spawning has ended, in dry and critical water years, at the following stations: Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge (site), Mossdale Bridge, and Vernalis.

Objective 3-D The 14-day running average of the mean daily EC shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, in wet, above normal, and below normal water years, at the following stations: Prisoners Point, Buckley Cove, Rough and Ready Island, Brandt Bridge (site), Mossdale Bridge, and Vernalis. In dry and critical water years, the EC objective would be met only at Prisoners Point.

Objective 3-E The 14-day running average of the mean daily EC shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, at the following river reaches in the respective water years:

Wet	Prisoners Point to Vernalis
Above Normal	Prisoners Point to Mossdale Bridge
Below Normal	Prisoners Point to Rough and Ready Island
Dry	Prisoners Point to Buckley Cove
Critical	Prisoners Point only

Objective 3-F The 14-day running average of the mean daily EC at Prisoners Point shall be not more than 0.44 mmhos/cm (TDS=250 mg/l) for the period April 1 to May 31, or until spawning has ended, in all water years.

5.6.3.4 Prisoners Point: Relaxation Provision

Objective 4-A No relaxation provision.

Objective 4-B The 14-day running average of the mean daily EC shall be not more than 0.55 mmhos/cm for the period April 1 to May 31, or until spawning has ended, at Prisoners Point only, when the Antioch relaxation provision for spawning protection is in effect.

(It can be argued that the use of the Sacramento Basin 40-30-30 Water Year Index, or SWP and CVP deficiency declaration, to trigger a relaxation on an upper San Joaquin River objective is inappropriate. However, since consensus has not yet been reached on an appropriate San Joaquin Basin Index, it cannot be applied here. On the other hand, the hydrologic record shows that a critical year in the Sacramento Basin is almost always accompanied by similar conditions in the San Joaquin Basin. The State Board urges participants to complete development of a San Joaquin Basin Index for application to upper San Joaquin River objectives as soon as possible.)

5.6.3.5 Temperature Objectives

No temperature objectives are proposed at the present time for protection of adult striped bass migration and spawning, or for survival of young striped bass.

5.7 American Shad

5.7.1 Present Conditions

There are no D-1485 objectives specifically for the protection of American shad, although the striped bass standards were expected to provide collateral protection for American shad as well. DFG estimates of population size based on sampling in the mid-1970s suggest that the population is one-third to two-thirds as large as it was in the early decades of this century (DFG,23). About this same time, DFG lowered the daily catch limit from 50 to 25 fish (Michael Meinz, SWRCB, pers. comm., 6/90). Abundance of adult shad has been relatively stable over the past two decades. However, abundance of juvenile shad may vary by more than an order of magnitude between years, with the strongest year classes occurring with the highest river flows during the spawning and nursery periods (DFG,23).

5.7.2 State Board Considerations

The decline of American shad in the Estuary from levels found early in the century appears to parallel, although perhaps not so severely, the great decline seen in East Coast shad populations (USFWS & NMFS, 1977, viii). Declines in East Coast stocks have been attributed to a variety of causes, including pollution, lack of floodplain management, construction of barrier dams without fish passage facilities, and expanded and indiscriminate inshore and offshore fishing (USFWS & NMFS, 1977, vii-viii). Most of these elements may also be playing a part in the decline in Estuary stocks (DFG,23,23), although DFG cites flows and diversions as the primary areas of concern (T,XXXIX,16:4-18:18;47:7-16). DFG also testified that temperature and salinity, as well as flow, were important to production of American shad (T,XXXIX,24:22-25:1), but did not specify what temperature and salinity requirements were critical to shad production.

Because no information on salinity requirements for shad was presented or obtained from other sources, no salinity objective is offered. However, shad feed on Neomysis and other zooplankton during their spawning migration through the Delta (see Table A4-8), which suggests that the entrapment zone may serve an important function for adults as well as young of the year of this species. The nature of this function warrants study.

The Delta and its tributary streams, especially in the Sacramento Valley, are major spawning and nursery areas for American shad. If young shad react to high temperatures as many other fish species do, they are most sensitive during their first few days to weeks of growth. Young are found in the Delta and at the SWP facilities in midsummer, indicating substantial summer spawning activity within or near to the Delta (DFG,23,8-10). DFG observations indicate that these eggs and young are susceptible to considerable risk from elevated water temperatures: eggs appeared deformed and failed to develop normally when water temperatures were 70°F and above (Michael Meinz, SWRCB, pers. comm., October 1989). As indicated in Table A4-8, the optimum spawning temperature for American shad is between 60° and 70°F. The temperature objective for salmon may serve to protect American shad to some degree. The actual status and population trend of American shad remains unclear. Substantial additional work is recommended in the areas of population, reproduction and ecological requirements for this species, to provide a firm basis for possible future actions.

5.7.3 Potential Objectives

On the basis of the foregoing discussion, no objectives for protection of American shad are proposed at this time.

5.8 Delta Smelt

5.8.1 Present Conditions

Currently there is no D-1485 objective specifically for the protection of the Delta smelt, Hypomesus transpacificus, in the Delta. The Delta smelt is endemic to the Sacramento-San Joaquin Delta-Estuary (Moyle, 1989) and, at present, is not known to exist anywhere else in the world (Federal Register, Volume 154, No. 4). Their range extends from below Mossdale on the San Joaquin River and Isleton on the Sacramento River to Suisun Bay, Carquinez Strait and San Pablo Bay during portions of the year (Moyle, 1976).

The population of Delta smelt, once very common in the upper Estuary, has been declining over time and appears to be critically low. Several sources of information regarding long-term trends in Delta smelt numbers are available, the primary ones being: (1) DFG, mid-water trawl surveys (Stevens et al., 1990); (2) research and monitoring data from the University of California at Davis (UC Davis) (Moyle and Herbold, 1989; Moyle and Herbold, 1990); and (3) and screen salvage data from the Byron and Tracy Pumping Plants (SWC,1990;DFG,17,1-20). The data from the

pumping plants are not very reliable due to the lack of an effective quality control program which may have resulted in misidentification (e.g., other species of smelt or other fish altogether) and other recording errors (SWC, 1990). Each data set however indicates a decline in the numbers of Delta smelt.

DFG (Stevens et al., 1990) stated that like the summer townet survey, the fall midwater trawl survey indicates that abundance of Delta smelt has been highly variable and has suffered a major decline. Bay survey catches show a striking decline in Delta smelt abundance after 1981, and since 1981 there has been an irregular but persistent decline. Part of this is due to the fact that the four of the last five years were low flow years and the population has been concentrated in the Delta. In the seine survey, the lowest average catches of adult Delta smelt occurred in 1980 and 1984-1989. The persistent low catches from 1984-1989 are consistent with the population decline exhibited by the midwater trawl and summer townet surveys. The DFG concluded that "the relatively stable, albeit low, population is not in imminent danger of extinction," however the Delta smelt may well "become an endangered species in the foreseeable future."

The Delta Smelt Index (Stevens and Miller, 1983) has been calculated annually from 1967-1990, except for 1974 and 1979 when no surveys were conducted; it shows an overall decrease in population size, especially from 1980-1988 (see Table 5-3; Figure 5-4). The population has fluctuated a great deal over the years; however, since 1983, the population has been consistently low. The UC Davis data show a similar trend. Several factors have possibly contributed to the decline, including invasions of exotic phytoplankton and invertebrates, entrainment into diversions and modification of the Delta smelt habitat.

5.8.2 State Board Considerations

Delta smelt are affected by the location of the entrapment zone, which appears to be important to their survival. When the entrapment zone is located in the deep, narrow channels of the Delta and Sacramento River, or in Carquinez Strait and the deeper parts of San Pablo Bay, primary productivity is lower (Moyle and Herbold, 1989). When the entrapment zone is located in Suisun Bay, the nutrients and algae can circulate in sunlit water, allowing algae to grow and reproduce rapidly, in turn, providing an abundance of food for plankton-feeding fish, such as the Delta smelt (Moyle, 1989). Years of major decline in the Delta Smelt Index occurred not only in dry years (1987,1988) but also wet years (1982,1986); in both cases, the entrapment zone moved out of Suisun Bay. Thus, Stevens and Miller (1983) did not develop a regression model for Delta smelt because all of the correlations between their abundance and flow measurements were not statistically significant. One of the strongest determinants of Delta smelt abundance is high primary productivity (as reflected by phytoplankton abundance) in late spring, April to June (Moyle and Herbold, 1989).

Table 5-3

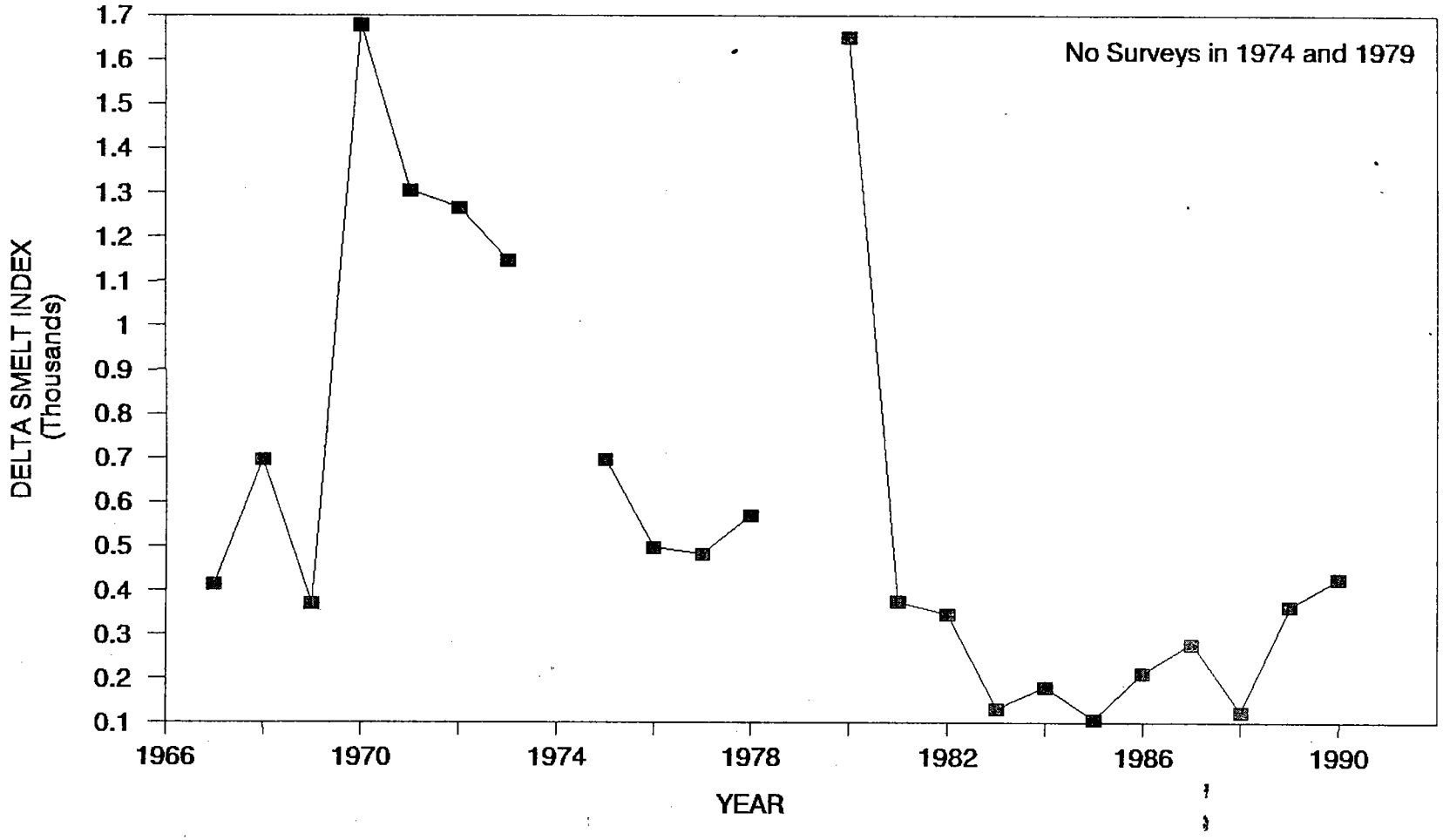
DELTA SMELT ABUNDANCE INDEX
MIDWATER TRAWL SURVEY
1967-1990

YEAR	INDEX
1967	415
1968	697
1969	371
1970	1678
1971	1305
1972	1267
1973	1146
1974	
1975	698
1976	497
1977	483
1978	570
1979	
1980	1651
1981	375
1982	346
1983	132
1984	181
1985	109
1986	212
1987	280
1988	126
1989	364
1990	427

Note: Trawl surveys were not conducted in 1974 & 1979.

From Stevens, D.E., L.W. Miller and B.C. Bolster. 1990. Report to the Fish and Game Commission: A status review of the Delta smelt (Hypomesus transpacificus) in California.

Figure 5-4 Delta Smelt Index Values



Stevens, D.E., L.W. Miller and B.C. Bolster. 1990. Report to the Fish and Game Commission: A status review of the Delta smelt (Hypomesus transpacificus) in California. Department of Fish and Game.

Further study will be required to define more specifically the habitat requirements of the Delta smelt and identify the variables contributing to their decline. The Fish and Game Commission has made a decision not to place the Delta smelt on the endangered species list; however, further analyses are being conducted in part for the requirements of the state and federal Endangered Species Acts.

Delta smelt habitat indicates a salinity preference of less than 2 ppt and seldom greater than 10 ppt (Ganssle, 1966 in SWC 1990) (less than 15 mmhos/cm EC). Another critical life history characteristic is that they spawn in sloughs and channels in the upper Delta, although spawning has also been recorded in Montezuma Slough in Suisun Bay (Moyle, 1989; SWC, 1990). They spawn from January through May and where they spawn may be influenced by the location of the fresh-saltwater interface during this time period (Moyle and Herbold, 1990). Peak numbers of smelt are salvaged at the SWP and CVP pumping plants each year during April and May (SWC, 1990, Figure 7). These smelt are either the spawning adults or the larval smelt (the information presented does not indicate which stage of development). One effective means of reducing impacts to the Delta smelt would be to reduce entrainment into the SWP and CVP pumping plants.

The location of the entrapment zone appears to be important to the survival of the Delta smelt. Although the precise level of salinity that separates acceptable and unacceptable spawning conditions is not known, existing knowledge suggests that salinities of 2 ppt or less are desired in Suisun Bay from March through June. The same needs exist for protection of the Delta smelt nursery area in Montezuma Slough (WQCP-USFWS-5). As the entrapment zone is a flow issue, this will be discussed in the Scoping and Water Right Phases of the proceedings.

There is insufficient information to set an EC or salinity objective for spawning for Delta smelt at present. Further study may provide an objective to help reverse their decline. Further studies are proposed for determining, with greater accuracy, the abundance and the factors affecting Delta smelt abundance in the Delta. The details of these studies will be discussed in the Program of Implementation, Chapter 7. Subsequent review of data may lead to appropriate water quality objectives.

5.8.3 Potential Objectives

No potential salinity or temperature objectives can be specified at this time.

5.9 Other Resident Fish in the Bay-Delta Estuary

5.9.1 Present Conditions

The Department of Fish and Game presented information on several species of resident fish found in the Bay-Delta Estuary (Appendix 4). The information on water quality habitat criteria was of a very general nature. Some species, for example, were said to have a relatively greater preference, or tolerance, for higher levels of dissolved solids or turbidity than other species. DFG recently submitted a report on white sturgeon that states the fish move up or downstream in response to salinity changes and that management of the volume of freshwater flow may be important in maintaining the sturgeon population (WQCP-DFG-1).

5.9.2 State Board Considerations

For the majority of the resident fish of the Estuary, the material presented is insufficient to be used to develop water quality objectives.

5.9.3 Potential Objectives -- None

5.10 Suisun Marsh

Conclusions:

- **The Board believes that the managed portions of Suisun Marsh are currently being protected by D-1485 as amended in 1985. The protections, including the operation of the Suisun Marsh Salinity Control Gate, are being used and evaluated.**

- **A biological assessment is needed to assess the water quality requirements of the rare, threatened and endangered plants and animals (and their habitats) in the wetlands surrounding Suisun Bay to determine reasonably necessary amendments and additions to the Suisun Marsh objectives. The results will likely not be available in time for inclusion in the final Bay-Delta Environmental Impact Report or water right decision in 1992. Shortly thereafter, the objectives will be evaluated and incorporated as warranted.**

5.10.1 Present Conditions

Since adoption of the Delta Plan and D-1485 in 1978, the SWP and CVP have been operated to meet the "interim standards." The water quality has thus been equal to or better than the interim standards.

Since the adoption of the 1978 Delta Plan and D-1485, the Four Parties have worked to implement the Plan of Protection (see Appendix 5.6). The interim Suisun Marsh standards in the 1978 Delta Plan, as implemented by D-1485, were met consistently by the DWR and the USBR. The internal marsh control stations on Montezuma Slough at National Steel and near Beldon's Landing became effective on October 1, 1988, in accordance with the amended schedule of compliance approved by the State Board on December 5, 1985 ("amended D-1485").

The improved duck club management schemes discussed in the Plan of Protection have been, for the most part, implemented. Some other intake or drainage improvements may still be needed. Construction of the Suisun Marsh Salinity Control Gate (referred to in the 1978 Delta Plan and described in more detail in the Plan of Protection) was completed in 1988; testing was begun in the winter of 1988-89 and continued through 1990. Full operation of the control gates causes a fairly rapid drop in salinity at Beldon's Landing, with a slower and more limited change in salinity in the western Marsh (farther downstream). Further testing to refine the optimal scheme for operation of the structure was done during the winter of 1990-91. The extent of the control gate's effects on western Suisun Marsh water quality will help determine whether or not additional structures mentioned in the Plan of Protection are needed, and, if any are needed, which one(s) would be best.

5.10.2 State Board Considerations

A technical analysis of the water quality standards in the SMPA is found in Appendix 5.6, Technical Analysis of the SMPA.

The 1978 Delta Plan listed eight salinity control stations for the original Suisun Marsh objectives. Seven of these stations were interior marsh stations; the eighth was on the Sacramento River at Collinsville Road, upstream of Montezuma Slough. In 1985 the State Board amended D-1485 to change both some control station locations and the compliance schedule.

The control stations on the Sacramento River at Collinsville (C-2) and Suisun Slough near Volanti Slough (S-42) were not changed. The station on Cordelia Slough above S.P.R.R. (mis-labeled S-32 in the Delta Plan) is actually the same as the station on Cordelia Slough, 500 feet west of the Southern Pacific crossing at Cygnus (S-33).

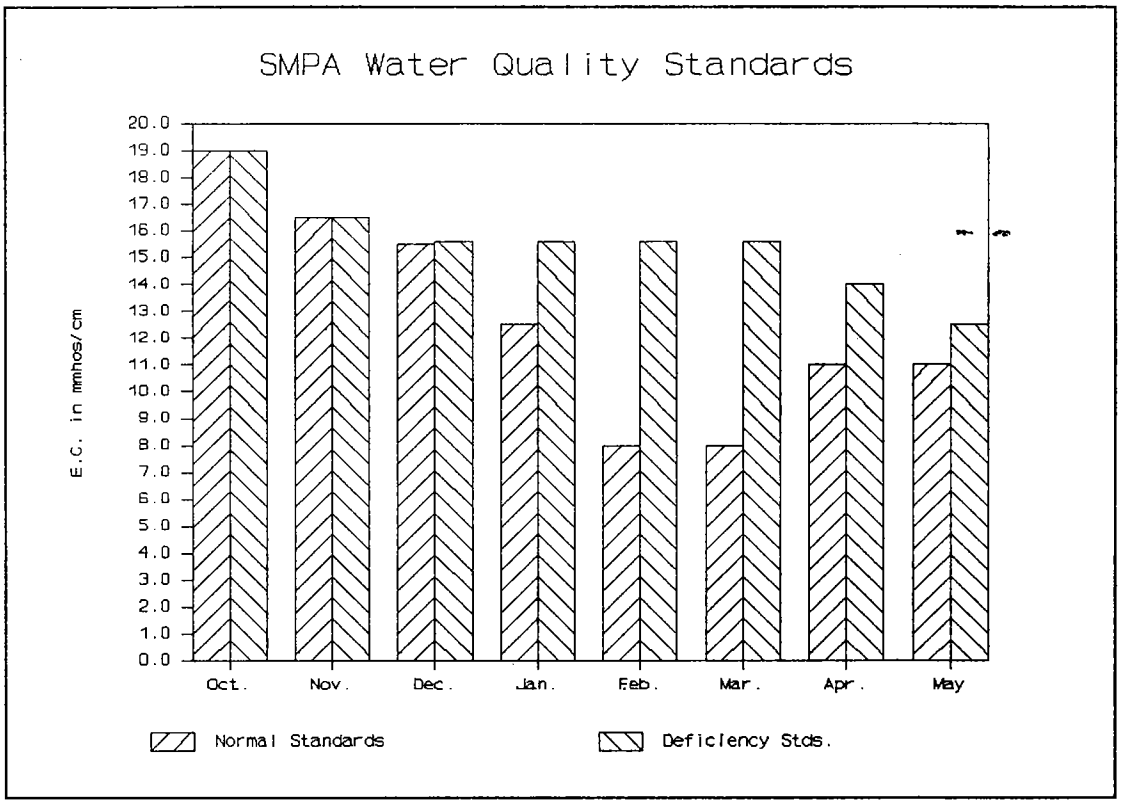
The station at Miens Landing on Montezuma Slough (S-64) was replaced with National Steel on Montezuma Slough (also S-64), three miles to the south (upstream) of Miens Landing. The station on Montezuma Slough at Cutoff Slough (S-48) was replaced with Montezuma Slough near Beldon's Landing (S-49), 0.35 miles east of Grizzly Island Bridge, approximately one-half mile upstream from the old station. The station on Goodyear Slough south of Pierce Harbor (S-35) was moved about one-half mile upstream to the Morrow Island Clubhouse, but is still designated S-35. These changes would not seem to change the level of protection afforded by the original Delta Plan stations.

The major change that the amended D-1485 made in the salinity control stations was the elimination of the two westernmost stations in Suisun Slough near its mouth (mis-labeled S-31 in the Delta Plan, actually designated S-36) and Montezuma Slough near its mouth (no exact designation in the Delta Plan, but often called D-7 in other documents). No substitutes for S-36 and D-7 are proposed. The managed marshes in this area now receive water from inland sources rather than Grizzly or Suisun bays.

Based upon the work done to date, the "Normal Standards" (see Figure 5-5) in the SMPA may adequately protect the managed wetland habitat of the Suisun Marsh. However, the SMPA also contains relaxations of these conditions during dry periods. The State Board needs additional information on the water quality requirements of the rare, threatened, and endangered species identified since DWR prepared the 1984 Plan of Protection before it can consider modifying the current water quality objectives.

A biological assessment under CESA and ESA is needed to determine the water quality requirements of the rare, threatened, and endangered plants and animals (and their habitats) in the wetlands surrounding Suisun Bay (see Chapter 7 for a description of the information needed). Based upon the results of the biological assessment, the State Board will review the proposed water quality objectives and determine if any changes are needed. The State Board will then, in a later action, assign responsibilities for meeting any changed objectives.

Figure 5-5



Month	SMPA-Normal Standards (Mean Monthly High Tide, E.C. in mmhos/cm)	SMPA-Deficiency[1] Standards (Mean Monthly High Tide, E.C. in mmhos/cm)
Oct.	19.0	19.0
Nov.	16.5	16.5
Dec.	15.6	15.6
Jan.	12.5	15.6
Feb.	8.0	15.6
Mar.	8.0	15.6
Apr.	11.0	14.0
May	11.0	12.5

[1] SMPA Article 1(f): "Deficiency Period" shall mean (1) a Critical Year following a Dry or Critical Year; or (2) a Dry Year following a year in which the Four Basin Index was less than 11.35; or (3) the second consecutive Dry Year following a Critical Year.

SMPA Article 1(r): "Wet Year", "Above Normal Year", "Below Normal Year" and "Subnormal Snowmelt Year" are as defined in Footnote 2 of Table II of D-1485 as adopted by the SWRCB in August 1978. "Critical Year" and "Dry Year" are also as defined in Footnote 2 of Table II of D-1485 except that runoff for the remainder of the water year shall be assumed to be equal to the lower value of the 80 percent probability range, as shown in the most recent issue of Bulletin 120, "Water Conditions in California".

5.10.3 Potential Objectives

In order to allow sufficient time for the biological assessment to be completed, the State Board will continue implementation of the interim standards for Suisun Marsh as identified in the 1978 Delta Plan. An implementation plan is proposed, with the first stage based on D-1485 as amended in 1985. A discussion of this implementation plan is found in Chapter 7 (see also Table 1-2).

5.11 Wildlife Habitat in Other Tidal Marshes

- **Water quality objectives for San Pablo Bay exist in the Statewide Water Quality Plan for Enclosed Bays and Estuaries of California and in the Water Quality Control Plan for Region 2.**

5.11.1 Present Conditions

The tidal marshes outside the legally-defined Suisun Marsh include the southern shore of Suisun Bay (essentially from Pittsburg to Martinez) as well as the marshes around San Pablo Bay, Central Bay, and South Bay.

The current objectives provide protection for the managed marshes within the legally-defined Suisun Marsh. No water quality objectives were set specifically for tidal marshes either inside or outside the legally-defined Suisun Marsh.

5.11.2 State Board Considerations

The marshes of Central San Francisco Bay and South Bay support mostly pickleweed or cordgrass. DFG testified that they have concluded that these salt marshes would not be adversely affected by changes in the salinity regime in the northernmost portion of the Bay-Delta area (T,XXIX,146:22-147:2). The State Board concurs with the conclusions of DFG and therefore does not plan to set water quality objectives specifically for the protection of the Central and South Bay salt marshes.

San Pablo Bay is a transition zone between the saline waters of Central Bay and the brackish to fresh waters of Suisun Bay (T,XXIX,147:3-6). DFG testified that reductions in Delta outflow could result in a vegetative shift from cattails and tules to more salt-tolerant plant species such as cordgrass and pickleweed (T,XXIX,186:18-25; DFG,7,11-12). Such a vegetative shift would be detrimental to some wildlife species and beneficial to others (T,XXIX,187:1-8,223:15-224:7; DFG,7,11-13). DFG considers some impacts on rare plants to be possible.

There is no evidence that might allow the Board to set water quality objectives at this time specifically for the protection of the San Pablo Bay marshes.

The south shore of Suisun Bay is outside the legally-defined Suisun Marsh. Many of the plants and animals found in the unmanaged wetlands of the Suisun Marsh are also found in the tidal marshes of the south shore (also called the Contra Costa County shoreline). The federal and state-listed threatened, endangered, and candidate species found within the legally-defined Suisun Marsh may also be found in the south shore marshes. In addition, the federal and state-listed endangered California least tern (Sterna antillarum browni) has two nesting colonies on the south shore (USFWS,20). Additional information regarding listed species is found in Appendix 4.6.2 and Appendix 5.5.

In addition to the possible direct effects on the habitat (for animals) or on the survival (for plants, especially) of the listed species, changes in the salinity regime could indirectly affect a species by effects on its prey base. The most sensitive species in this regard is the endangered California least tern. The least terns require a nearby supply of small fish in shallow water areas (DFG, At the Crossroads 1980, p.101). USFWS testified that changes in water quality standards that could result in changes in the location of the entrapment zone could significantly affect the prey base for the tern (T,XXX,6:1-6).

Staff compared the water quality objectives proposed by BCDC for protection of the unmanaged tidal marshes outside of the legally-defined Suisun Marsh (BCDC,5,T4) and those for Suisun Marsh in the 1978 Delta Plan (SWRCB,1978,Table VI-1,p.VI-33). The BCDC proposal is based on historical records for the period 1950 to 1977 when brackish tidal marshes persisted in the area (BCDC,5,31-32). Direct comparison of the two sets of values is difficult since BCDC presented only the high-high tide salinities (mean tide salinities adjusted to high tide salinities [BCDC,5,31]) while the 1978 Delta Plan used the daily mean of both high tide salinities.

It is not possible to determine at this time whether or not the stations proposed by BCDC would provide better locations than the 1978 Delta Plan stations at Chipps Island and in Grizzly Bay at which protective levels for south shore tidal marshes can be accurately measured.

5.11.3 Potential Objectives

As stated in Section 5.10.2 a new biological assessment will be prepared. Based on the results of the biological assessment, the State Board will decide if additional objectives should be adopted.

5.12 Benthos

5.12.1 Present Conditions

Densities of benthic organisms are highly variable in the Estuary. At any location their survival, growth and reproduction can be affected by factors such as predation, disease, parasites, currents which carry them away, salinity regime, and broodstock population size (DFG,60,57). Density estimates[1] as high as 910 to 1153 grams of biomass per square meter (g/m^2) are reported in South Bay channels, and as low as 4 to 17 g/m^2 in the channels of San Pablo Bay. Suisun Bay has benthic

1/ Abundance or density of benthic organisms measured by biomass per square meter.

invertebrate biomass ranging from 25 to 34 g/m^2 in channel substrates and from 6 to 30 g/m^2 in shoal areas (CCCWA/EDF,10,T2). The number of organisms varies much more than the biomass, with a few large animals sometimes equalling the biomass of many smaller ones. At the Carquinez Strait, this biomass was made up of about 160,000 and 40,000 organisms/m^2 in June and October of 1976; 25,000 organisms/m^2 in March of 1977; and less than 1,000 organisms/m^2 in October 1977 and in 1978 (Markmann,1986,F8-F11). Numbers of organisms per square meter at all stations were low in 1978; numbers appeared to recover to about 40,000 organisms/m^2 in the western Delta (Station D4) in 1979 and 1981, although Carquinez Strait stations were no longer sampled (Markmann,1986,F8-F11). The brief peak in organism numbers ~~in~~ ~~1~~976 and 1977 during a major drought was due in part to an invasion of Suisun Bay by the filter-feeding clam, Mya arenaria, which replaced the usual deposit-feeding fauna (CCCWA/EDF,7,383).

Only limited evidence on the uses of benthic organisms was presented by participants in Phase I. Sport shellfishing is one use of benthic organisms, but their acceptability may be limited by pollutants (T,LIV,56:10-58:4). Both CBE and CCCWA/EDF noted that benthic organisms, especially shellfish, were food for several species of fish in the Estuary, including striped bass, starry flounder, sturgeon, English sole and staghorn sculpin (T,LIV,59:14-16;192:5-8).

5.12.2 State Board Considerations

Understanding of the benthos and its relationship to the overall estuarine ecosystem is still limited, and the introduction and rapid proliferation of Potamocorbula amurensis have further complicated benthic data analysis. Substantial additional information is required to provide a basis for possible future actions.

5.12.3 Potential Objectives

No objectives are proposed for the protection of benthic organisms at this time.

5.13 Marine Habitat

5.13.1 Present Conditions

The marine habitat outside the Golden Gate is not formally included in the definition of the San Francisco Bay-Delta Estuary (Workplan). However, the nearshore ocean habitat in the Gulf of the Farallones is closely interrelated with the Estuary by means of freshwater outflow, gravitational circulation, and tidal exchange.

Testimony presented in Phase I concerning outflows from San Francisco Bay described two main effects on marine habitat. The first is that the plume of freshwater in the Gulf of the Farallones provides for an abundant amount of marine life and thus serves as a concentrated feeding habitat for fish, marine mammals and birds (T,LIV,142:13-153:3). Two bird species which particularly use this plume area are the Brandt's cormorant and the common murre (T,LIV,154:3-13). The second effect of

San Francisco Bay outflow is related to the movement of organisms, especially the larvae and juveniles of finfish and shellfish, into the Bay (T,LI,267:23-268:4). In certain cases, such as for bay shrimp, movement of larvae out of the Bay into the Gulf of the Farallones and their return later in the year is facilitated by higher Bay outflows (T,LI,272:6-19). In some circumstances, pulse flows, and their timing, were shown to be important in the determination of abundance of larvae (T,LI,289:5-25). The larvae or adults of English sole, Dungeness crab, Pacific herring and northern anchovy are transported back into the Bay on the bottom current inflows (T,LI,292:15-25).

5.13.2 State Board Considerations

All evidence presented relates to flow rather than salinity factors. The relationship between outflow and effect on beneficial uses has not been quantified. Therefore, protection for marine habitat will be considered if further information becomes available.

5.13.3 Potential Objectives -- None

5.14 Navigation

5.14.1 Present Conditions

At present, U.S. Army Corps of Engineers (COE) criteria provide primary protection for the navigation beneficial use in the Estuary and its tributaries. For example, the CVP is required to maintain a flow of 5,000 cfs at Wilkins Slough, just below the Tisdale Wier on the Sacramento River, for protection of shallow water commercial navigation (T,I,43:15-21). In critical years the flow required is 4,000 cfs (Mike Jackson, USBR, pers. comm., 10/17/89). Likewise, the SWP and CVP export pumps currently operate to COE criteria: maximum flow rates for Clifton Court Forebay are stipulated for various times of the year to maintain minimum depths in South Delta channels (DWR,708,10). There are no Delta Plan objectives in effect specifically for the protection of this beneficial use.

5.14.2 State Board Considerations

The issues of water quality objectives for navigation are concentrated in a few specific areas: present effects of navigation channels and dredging, effects of planned projects to enhance navigation, and consideration of the effects of other projects on the navigation beneficial use. The present COE requirements are not directly related to salinity or temperature objectives for protection of the navigation beneficial use.

Navigation in the Estuary is enhanced by a network of deepwater channels to the major ports, including Sacramento and Stockton. These channels have two major effects. The deeper channels allow increased salt water intrusion into the Estuary (T,LVI,176:9-178:8;DWR,709,1-2). The proposed deepening of the Sacramento River Deep Water Ship Channel from its current 30-foot depth to 35 feet (COE, pers. comm., 10/89) could result in additional salt water penetration into the Delta in the future.

This increased salinity may have impacts on other beneficial uses such as recreational boating, which could see greater maintenance costs from hull fouling, corrosion of propellors and structures, and related problems (T,LV,158:1-7). Increased salinity intrusion could increase the amount of carriage water required to maintain Estuary salinity objectives, and may have impacts on other beneficial uses, such as recreation and sport fishing.

The second effect of the deepwater channels is the impact of dredging and dredge spoils disposal on water quality (see, for example, T,XLVIII,71:20-102:9). In 1985, nearly 8.6 million cubic yards of material were dredged in the Estuary, at a cost of more than $17 million (NOAA, 1986,97). Current and proposed actions, such as the disposal of dredge spoils from Oakland Harbor on Delta island levees, have water quality implications, but these are primarily related to pollutants and turbidity. The water quality impacts of dredging are discussed in the Pollutant Policy Document.

Other proposed projects, such as North Delta and South Delta facilities, could affect the navigation beneficial use, but the effects would primarily be the disruption or blockage of navigation channels. Effects of new projects on the navigation beneficial use will be considered when these projects are formally proposed.

5.14.3 Potential Objectives

At present there is no information which indicates that salinity or temperature objectives are needed to protect the navigation beneficial use.

5.15 Estuary Recreation Beneficial Use

5.15.1 Present Conditions

There are no Delta Plan objectives for the protection of the estuary recreation beneficial use. The waters of the Estuary are used for a variety of contact and non-contact forms of recreation, including swimming, boating, fishing, hunting, water skiing, and houseboating. The waters are also used for competitive events, marine parades and emerging activities, such as boardsailing and jetskiing. There are a variety of water-oriented, non-contact activities, such as sightseeing and bird watching, which depend on the esthetics or visual quality of the Estuary's waters to some degree (EBRPD,1,33).

Delta

SWC presented figures for projected user-days and economic values for freshwater recreation in the Delta as compared to similar types of recreation at storage and export reservoirs and facilities (SWC,65,24). Freshwater-oriented recreation in the Delta was estimated to be 8.3 million user-days in 1977-78, although this number includes some activities which do not depend entirely on the Delta's waters. However, brackish and ocean water activities were not included in the total (SWC,66,5). Testimony and evidence indicated that recreation visits to

Estuary shoreline park facilities have been growing rapidly compared to the projections used by SWC, i.e., 122 percent in two years vs. 0.8 percent/year (EBRPD,24,T1). Millions of user-days per year and daily values of $20 or more per user day for water use are calculated for recreational use of Estuary water (BISF,38,T4). An extrapolation of old studies of Delta recreation has generated estimates in the range of 13 million recreation-days annually (PICYA,2,51). No recent information based on recreation use studies is available (T,LV,137:13-16).

Suisun Marsh and Carquinez Straits Area

Some evidence was submitted on the recreational use of the Suisun Marsh or Carquinez Straits area of the Bay-Delta Estuary. BAAC submitted evidence inferring that bird-watching goes on in the Suisun Marsh (BAAC,20,26,27). From evidence submitted by EBRPD, estimated recreation at its Contra Costa shoreline facilities (Antioch and Martinez shoreline) has increased rapidly from 1981 to 1987, growing from 84,000 visitors to 287,000 visitors, or about 240 percent in six years (EBRPD,34,T1). There is little evidence linking the quantity of recreation in this reach to water quality. Both BAAC and EBRPD expressed concern that visitors to these recreational areas would experience losses of the value they place on wildlife and fish resources if those resources were harmed by flow decreases and resulting salinity increases (T,XXX,45:12-23; T,LV,184:15-25,185:1-2).

Recreational use in EBRPD units with water quality problems, Point Isabel and San Leandro Bay, increased from 71,000 to 487,000 users between 1981 and 1987, an increase of over 680 percent (EBRPD,34,T1). In comparison, the rate of growth at the nearby, unpolluted Hayward and Miller-Knox shorelines has moved from 21,000 users to 196,000, an increase of 830 percent in the same time. There was no specific information on the features which prompt users to attend the various park units, nor on the method by which use estimates were made. It does not seem reasonable to suppose that a moderate change (of one or two parts per thousand) in salinity would substantially change future recreational use. This might not be true if the change were such as to convert a freshwater beach to saltwater; however, no data are in the record on this subject.

San Francisco Bay and Adjacent Ocean

The Basin Plan for Region 2, the San Francisco Bay Basin, identifies most of the same forms of recreation as in the Delta. Recreational uses are identified for the Pacific Ocean, the San Francisco Bay system and all other surface waters (RWQCB,2,1975). Water-oriented recreation in the San Francisco Bay area was estimated to total over 127 million user-days (BISF,38,T3).

5.15.2 State Board Considerations

Water quality objectives to protect specific fish species and marsh habitat areas are intended to protect recreational uses also.

5.15.3 Potential Objectives

No other objectives for recreational use are proposed for consideration.

5.16 Export Recreation and Export Fishery Habitat

5.16.1 Present Conditions

There are no specific Delta Plan objectives for the protection of the export recreation and export fishery habitat. The SWP and CVP reservoirs and conveyance channels provide a warm water fishery habitat, and export area recreation occurs primarily at the reservoirs. Salinity throughout the system is largely controlled by the quality of the Delta water being exported. Water temperature in the export system is a function of ambient Delta water temperatures, export area weather, and project operations (flow rates, reservoir storage levels, etc.). Water temperatures in reservoirs tend to become critical primarily under conditions of extreme drawdown.

5.16.2 State Board Considerations

No participant proposed any salinity or temperature objectives specifically for protection of export recreation and fisheries. As stated before, the SWP and CVP operate to not exceed a minimum export water quality of 250 mg/l chlorides.

5.16.3 Potential Objectives

Because the factors which determine water temperature and salinity in the facilities in the export areas are influenced primarily by operation of these facilities, local water conditions, and Delta water quality, establishment of a separate specific objective for protection of export recreation and export fishery habitat is not warranted.

5.17 Export Agriculture

Conclusions:

- **Water is exported from the Delta for agricultural use in the San Joaquin Valley and southern California.**
- **To reasonably protect crops grown in the export areas, water quality objectives were developed using almonds orchards as the representative salt-sensitive crop.**
- **The Board finds that the objective of 1.0 mmhos/cm EC reasonably protects salt-sensitive crops grown in the San Joaquin Valley and southern California.**

5.17.1 Present Conditions

The Delta Plan does not contain any water quality objectives for export agriculture.

5.17.2 State Board Considerations

The drinking water objective, which is about 1.0 mmhos/cm EC, would protect most agricultural uses (see Potential Objectives in this section) of the exported water for irrigation of crops grown in the San Joaquin Valley and southern California. However, whenever a beneficial use of water exists and an appropriate objective can be specified, the use should be provided with specific protection.

5.17.3 Potential Objectives

A water quality objective of 1.0 mmhos/cm EC will be considered for the CVP and SWP export pumps for the protection of export agriculture. This objective fully protects the most sensitive crop in the CVP and SWP service area which constitutes at least 5 percent of each service area, respectively, and provides reasonable protection for minor crops. Based on information on CVP crop acreages (CVPWA,12; EDF,11,G-148), and SWP crop acreages (DWR,489h), the crops which constitute at least 5 percent of either service area are shown in Table 5-4. Salinity tolerances, in terms of EC, of several crops shown in export areas were presented by DWR (DWR,327).

TABLE 5-4

CROPS COMPRISING AT LEAST FIVE PERCENT OF EITHER THE CVP OR SWP SERVICE AREAS AND THEIR SALINITY TOLERANCES

Crop	Salinity Tolerances, EC (mmhos/cm)	Crop as % of CVP Service Area	Crop as % of SWP Service Area	Crop as % of CVP & SWP Service Area
Cotton	5.1	36.5	47.2	39.4
Alfalfa	1.3	8.5	9.0	8.6
Wheat	4.0	7.1	6.7	7.0
Tomatoes	1.7	6.9	0.4	5.0
Orchards	1.0	6.3	15.5	8.8

5.18 Matrix of Alternative Water Quality Objectives

Table 5-5, Alternative Water Quality Objectives, summarizes beneficial uses according to three categories described in this chapter and Appendix 5.0:

- Present Objectives
- Advocated Levels (of Protection)
- Potential Objectives

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TABLE 5-5 ALTERNATIVE WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
PRESENT OBJECTIVES								
D-1485	*Cache Slough at City of Vallejo Intake*	*C-19 SLCCH16*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
D-1485	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
D-1485	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Calendar Year shown in parenthesis)*	*D-1485 (Water Year)*			*No. of days each Cal. Year < 150 mg/l Cl-*
	- or -					*W*		*240 (66%)*
	San Joaquin River at Antioch Water Works Intake	*D-12(near) RSAN007*	*Chloride (Cl-)*		*D-1485 (Water Year)*	*AN*		*190 (52%)*
						BN		*175 (48%)*
						D		*165 (45%)*
						C		*155 (42%)*
D-1485	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
ADVOCATED LEVELS								
DWR	*Barker Slough at North Bay Aqueduct Intake*	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
USBR	*Barker Slough at North Bay Aqueduct Intake*	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*Barker Slough at North Bay Aqueduct Intake*	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
DWR	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
DWR	*Old River near Rancho Del Rio*	*D-28A ROLD21*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
ADVOCATED LEVELS (cont.)								
USBR	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*Old River near Rancho Del Rio*	*D-28A ROLD21*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
CCWD	*Contra Costa Canal at Pumping Plant #1 [1]*	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Apr-Jun*	*50*
CCWD	*Contra Costa Canal at Pumping Plant #1*	*C-5 CHCCC06*	*Sodium (Na+)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*20*
DWR	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
DWR	*Delta Mendota Canal at Tracy Pumping Plant*	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
USBR	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
USBR	*Delta Mendota Canal at Tracy Pumping Plant*	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
SWC	*Delta Mendota Canal at Tracy Pumping Plant*	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*250*
DWR/SWC CONTRACT	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Max monthly average, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*100*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
ADVOCATED LEVELS (cont.)								
DWR/SWC CONTRACT	*West Canal at mouth of Clifton Court Forebay*	*C-9 CHWST0*	*Chloride (Cl-)*	*Max 10-year average, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*55*
	West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Total Dissolved Solids (TDS)*	*Max monthly average, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*440*
	West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Total Dissolved Solids (TDS)*	*Max 10-year average, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*220*
POTENTAL OBJECTIVES								
	Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Calendar Year shown in parenthesis)*	*Sac R 40-30-30*		*No. of days each Cal. Year < 150 mg/l Cl-*	
	- or -					*W*		*240 (66%)*
	San Joaquin River at Antioch Water Works Intake	*D-12(near) RSAN007*	*Chloride (Cl-)*		*Sac R 40-30-30*	*AN*		*190 (52%)*
						BN		*175 (48%)*
						D		*165 (45%)*
						C		*155 (42%)*
	West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	Cache Slough at City of Vallejo Intake [2]	*C-19 SLCCH16*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
	and/or							
	Barker Slough at North Bay Aqueduct Intake	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

TRIHALOMETHANES

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
PRESENT OBJECTIVES								
EPA Standards [3]	*All points of delivery*		*Trihalomethanes (THMs)*	*Running average of quarterly sampling, in ug/l*	*Not Applicable*	*All*	*Oct-Sep*	*100 [3]*
ADVOCATED LEVELS								
MWD	*All M&I supply intakes in Delta*		*Trihalomethane Precursors (THM Precursors)*		*None Specified*	*None Specified*	*None Specified*	*To be developed by SWRCB*
Delta M&I Workgroup	*All M&I supply intakes in Delta*		*Chloride (Cl-)*	*To limit bromide to <= 0.15 mg/l*	*None Specified*	*None Specified*	*When Feasible*	*50 mg/l*
POTENTIAL OBJECTIVES								
	Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calender Year. Must be provided in intervals of not less than two weeks duration. (% of calendar years shown in parenthesis)*	*Sac R 40-30-30*	*W*	*No. of days each Cal. [4] Year < 150 mg/l Cl-*	*240 (66%)*
						AN		*190 (52%)*
						BN		*175 (48%)*
						D		*165 (45%)*
						C		*155 (42%)*
	All M&I supply intakes in Delta		*Chloride (Cl-)*	*To limit bromide to <= 0.15 mg/l*	*None Specified*	*None Specified*	*When Feasible*	*50 mg/l*

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			1) WESTERN DELTA					
PRESENT OBJECTIVES								
D-1485	*Sacramento River at Emmaton*	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos/cm (mmhos)*	*D-1485 (Water Year)*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	*--*
						AN	*July 1*	*0.63*
						BN	*June 20*	*1.14*
						D	*June 15*	*1.67*
						C	*--*	*2.78*
	San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	*--*
						AN	*Aug. 15*	*--*
						BN	*June 20*	*0.74*
						D	*June 15*	*1.35*
						C	*--*	*2.20*
ADVOCATED LEVELS								
CVPWA, SWC	*Sacramento River at Emmaton - and -*	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*		*1.5 EC April 1 to Date Shown*	*3.0 EC Date Shown to Aug. 15 [5]*
	San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*W*	*Aug. 15*	*--*
						AN	*Aug. 15*	*--*
						BN	*Aug. 15*	*--*
						D	*Aug. 15*	*--*
						C	*Jul. 31*	*Aug. 1*
DWR	*Sacramento River at Emmaton -and- San Joaquin River at Jersey Point*	*D-22 RSAC092 D-15 RSAN018*	*Electrical Conductivity (EC)*	*Average monthly, in mmhos*	*None Specified*	---------- *Based on Corn Study* ----------		

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			1) WESTERN DELTA (cont.)					
ADVOCATED LEVELS (cont.)								
CCCWA	*Sacramento River at Emmaton -and- San Joaquin River at Jersey Point*	*D-22 RSAC092 D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Aug 15*	*0.45*
CDWA	*Sacramento River at Emmaton -and- San Joaquin River at Jersey Point*	*D-22 RSAC092 D-15 RSAC018*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ adjustments not quantified ------		
			Electrical Conductivity (EC)	*Maximum monthly average of mean daily, in mmhos*		*All*	*Apr 1-Mar 31*	*0.45*
						------ adjustments not quantified ------		
POTENTIAL OBJECTIVES								
	Sacramento River at Emmaton	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos/cm*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	*--*
						AN	*July 1*	*0.63*
						BN	*June 20*	*1.14*
						D	*June 15*	*1.67*
						C	*--*	*2.78*
	San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	*--*
						AN	*Aug. 15*	*--*
						BN	*June 20*	*0.74*
						D	*June 15*	*1.35*
						C	*--*	*2.20*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			2) INTERIOR DELTA					
PRESENT OBJECTIVES								
D-1485	*South Fork Mokelumne River at Terminous*	*C-13 RSMKL08*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Aug. 15*	--
						C	--	*0.54*
	San Joaquin River at San Andreas Landing	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Jun. 25*	*0.58*
						C	--	*0.87*
ADVOCATED LEVELS		[6]						
NDWA/ DWR CONTRACT	*Sacramento River at Emmaton*	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*	*per contract*	*per contract*	*0.45-3.6 [7]*
	South Fork Mokelumne River at Terminous	*C-13 RSMLK08*	"	"	"	"	"	*0.45-1.1 [7]*
	San Joaquin River at San Andreas Landing	*C-4 RSAN032*	"	"	"	"	"	*0.45-1.2 [7]*
	Sacramento River at Rio Vista Bridge	*D-24 RSAC101*	"	"	"	"	"	"
	North Fork Mokelumne River near Walnut Grove (exact location not specified)	*- RMKL020 (?)*	"	"	"	"	"	*0.45-0.6 [7]*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			2) INTERIOR DELTA					
ADVOCATED LEVELS (cont.)		[6]						
NDWA/ DWR CONTRACT	*Sacramento River at Walnut Grove -and- Steamboat Slough at Sutter Slough*	- *RSAC124* - *SLSBT11*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*	*not shown*	*not shown*	*0.45-0.6 [7]*
ECCID/DWR CONTRACT	*Old River at Indian Slough*	- *ROLD32*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*	*not shown*	*not shown*	*0.45-1.2 [7]*
DWR	*South Fork Mokelumne River at Terminous* *San Joaquin River at San Andreas Landing -and- Cache Slough near Junction Point (proposed)*	*C-13 RSMLK08* *C-4 RSAN032* *CS-1(prop.) SLCCH00*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	----- *Based on Corn Study* -----		
DTAC	*Central Delta*	-	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*All except C*	*Apr 1-Aug 15*	*1.5-2.5*
						C	*"*	*None*
CCCWA	*Delta lowlands with organic soils*	-	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Aug 15*	*0.45*
CDWA	*San Joaquin River at San Andreas Landing*	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
							------ *except for* ------	
							Aug Sep Oct	
						D	*--- 0.65 0.60*	
						C	*0.54 0.80 0.90*	

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			2) INTERIOR DELTA (cont.)					
ADVOCATED LEVELS (cont.)		[6]						
CDWA	*South Fork Mokelumne River at Terminous*	*C-13 RSMLK08*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ adjustments not quantified ------		
	Old River near Holland Tract (exact loc. not spec.) -or- Old River near Rancho Del Rio	*- ROLD19(?) D-28A ROLD21*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ adjustments not quantified ------		
	Turner Cut near McDonald Island Bridge	*MD-4 CFTRN1*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily, in mmhos*	*None Specified*	*All*	*Apr 1-Mar 31*	*0.45*
						------ adjustments not quantified ------		
POTENTIAL OBJECTIVES								
	South Fork Mokelumne River at Terminous	*C-13 RSMKL08*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Aug. 15*	--
						C	--	*0.54*
	San Joaquin River at San Andreas Landing	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [5]*
						W	*Aug. 15*	--
						AN	*Aug. 15*	--
						BN	*Aug. 15*	--
						D	*Jun. 25*	*0.58*
						C	--	*0.87*

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			3) SOUTH DELTA					
PRESENT OBJECTIVES								
D-1422 [8]	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10 RSAN112*	*Total Dissolved Solids (TDS)*	*Mean monthly, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*500*
Region 5 Water Quality Control Plan	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10 RSAN112*	*Total Dissolved Solids (TDS)*	*Maximum 30-day running average of mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*500*
USBR/SDWA AGREEMENT	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10 RSAN112*	*Total Dissolved Solids (TDS)*	*Maximum 14-day running average of mean daily EC, in mmhos*	*Not Applicable*	*All*	*Apr 1-Oct 31*	*450 **
							Nov 1-Mar 31	*500 **
				** May be modified by agreement of parties or because of emergency conditions. Releases from New Melones Reservoir will be limited to a maximum of 150,000 AF/water year in addition to releases to maintain Fish & Water Quality in accordance with D-1422*				
ADVOCATED LEVELS		[6]						
SDWA	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10 RSAN112*	*Total Dissolved Solids (TDS)*	*Maximum monthly average of mean daily, in mg/l*	*None Specified*	*All*	*Mar 1-Sep 30*	*400 [9]*
	Old River at Tracy Road Bridge	*P-12 ROLD59*		*Maximum 7-day running average of mean daily, in mg/l*	*None Specified*	*All*	*Mar 1-Jun 30*	*400 [9]*
	Old River near Middle River	*C-8 ROLD69*		*Maximum 7-day running average of mean daily, in mg/l*	*None Specified*	*All*	*Jul 1-Oct 31*	*500 [9]*
	San Joaquin River at Brandt Bridge [site]	*C-6 RSAN073*		*Maximum 7-day running average of mean daily, in mg/l*	*None Specified*	*All*	*Nov 1-Feb 28*	*500 [9]*
	San Joaquin River at Mossdale Bridge	*C-7 RSAN087*						
	Middle River at Howard Road Bridge	*P-11 RMID34*						
	Old River at Westside ID Intake	*-- ROLD51*						

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			3) SOUTH DELTA (cont.)					
ADVOCATED LEVELS (cont.)								
USBR	*Delta Uplands*	--	*Total Dissolved Solids (TDS)*	*Maximum monthly average of mean daily, in mg/l*	*None Specified*	*Normal* *C*	*Apr 1-Mar 31* *"*	*800* *600*
CVWPA	*San Joaquin River at Airport Way Bridge, Vernalis*	*C-10* *RSAN112*	*Total Dissolved Solids (TDS)*	*Maximum 30-day running average of mean daily, in mg/l*	*None Specified*	*All*	*Oct-Sep*	*500*
POTENTIAL OBJECTIVES		*(To be implemented by 1996) [10]*						
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10* *RSAN112*	*Electrical Conductivity (EC)*	*Maximum 30-day running average of mean daily EC,in mmhos*	*Not Applicable*	*All*	*Apr 1-Aug 31* *Sep 1-Mar 31*	*0.7* *1.0*
	Old River near Middle River	*C-8* *ROLD69*					*or*	
	Old River at Tracy Road Bridge	*P-12* *ROLD59*			*If a three-party contract has been implemented among DWR, USBR and the SDWA, that constract wil be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.*			
	San Joaquin River at Brandt Bridge [site]	*C-6* *RSAN073*						
			4) EXPORT					
PRESENT OBJECTIVES								
	None specified for export agriculture.							
ADVOCATED LEVELS								
	None advocated for export agriculture.							
POTENTIAL OBJECTIVES								
	West Canal at mouth of Clifton Court Forebay -and- Delta Mendota Canal at Tracy Pumping Plant	*C-9* *CHWST0* *DMC-1* *CHDMC004*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily EC,in mmhos*	*Not Applicable*	*All*	*Oct-Sep*	*1.0*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			FISHERY HABITAT PROTECTION (ENTRAPMENT ZONE)					
PRESENT OBJECTIVES								
	None specified							
ADVOCATED LEVELS								
CCCWA/ EDF	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Electrical Conductivity (EC)*	*28-day tidally averaged mean bottom salinity less than value shown in mmhos*	*D-1485 (Water Year)*	*All except C*	*Apr 1-Sep 30*	*2.0*
CCCWA/ EDF	*Suisun Bay at Martinez*	*D-6 RSAC056*	*Salinity (TDS)*	*Tidally averaged bottom salinity less than value shown in parts per thousand (ppt) over at least a 28-day period between dates shown*	*D-1485 (Water Year)*	*All except C*	*Oct 1-Apr 30*	*5.0*
POTENTIAL OBJECTIVES								
	None Specified							
			CHINOOK SALMON					
PRESENT OBJECTIVES - DISSOLVED OXYGEN								
Region 5 Water Quality Control Plan	*Sacramento River and all Delta waters west of the Antioch Bridge*	*All*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*All year*	*7.0*
	All other Delta waters except: - Man-made bodies of water - Sites where fishery is not a beneficial use	*All*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*All year*	*5.0*
DFG,USFWS DWR & USBR Agreement	*San Joaquin River between Turner Cut & Stockton*	*RSAN050-RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*All year*	*6.0*
ADVOCATED LEVELS - DISSOLVED OXYGEN								
USFWS, DFG	*San Joaquin River between Turner Cut and Stockton*	*RSAN050-RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*Sep 1-Nov 30*	*6.0*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
CHINOOK SALMON (cont.)								
POTENTIAL OBJECTIVES - DISSOLVED OXYGEN								
	San Joaquin River between Turner Cut & Stockton	*RSAN050-RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*None Specified*	*All*	*Sep 1-Nov 30*	*6.0*
PRESENT OBJECTIVES - TEMPERATURE								
Regional Water Quality Control Board Basin Plan 5	*Sacramento River from Hamilton City to I Street Bridge*		*Temperature*	*Narrative Objective*		*All*		*
				* *The temperature shall not be elevated above 68 degrees F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery (also see page III-6 of Basin Plan 5).*				
Regional Water Quality Control Board Basin Plans 2 & 5	*All Delta waters*	-	*Temperature*	*Narrative Objective*		*All*		**
				** *The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses.*				
Thermal Plan	*Estuary Waters*	-	*Temperature*	*Narrative Objective*		*All*		***
				*** *The plan specifies limiting conditions of temperature in wastewaters discharged into interstate and coastal waters, estuaries and enclosed bays. For example, elevated temperature waste discharges into interstate waters designated as "cold" waters are prohibited while this type of discharge into "warm" interstate waters cannot be more than 5 degrees F warmer than the receiving water and shall not cause the temperature in the receiving water to rise more than 5 degrees F. Existing thermal discharges into coastal waters, estuaries and enclosed bays shall comply with limitations necessary to assure protection of the beneficial uses and, for coastal waters, areas of special biological significance.*				
ADVOCATED LEVELS - TEMPERATURE								
USFWS	*Sacramento River at Freeport*	*RSAC155*	*Temperature*	*When temperature increases are controllable, they shall be limited to a maximum 7 day surface temperature.*		*W*	*May 1-Jun 15*	*66 degrees F*
						AN	*May 1-Jun 15*	*66 degrees F*
						BN	*May 1-Jun 15*	*66 degrees F*
	San Joaquin River at Airport Way Bridge, Vernalis and	*C-10 RSAN112*	*Temperature*			*D*	*May 1-May 31*	*66 degrees F*
						C	*May 1-May 31*	*66 degrees F*
	(Other locations, e.g., Isleton and Jersey Point)							

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			CHINOOK SALMON (cont.)					
ADVOCATED LEVELS - TEMPERATURE (cont.)								
DFG	*Sacramento River at Freeport and*	*RSAC155*	*Temperature*	*Narrative Objective*		*All*		*The temperaure shall not be elevated above 68 degrees F during periods when temperature increases will be detrimental to the fishery.*
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*		*All*		
SWC	*Sacramento River at Freeport and*	*RSAC155*	*Temperature*	*7-day average of maximum mean daily surface temperatures*		*All*	*Oct-Sep*	*An objective of 68 degrees F at Freeport and Vernalis would be acceptable as long as the plan states clearly that an objective cannot be met with flows.*
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*7-day average of maximum mean daily surface temperatures*		*All*		
CVPWA	*Sacramento River at Freeport and*	*RSAC155*	*Temperature*	*Narrative Objective*		*"During the months of May and June, the water temperature to which juvenile chinook are exposed should not exceed temperatures which are reasonable, taking into account all demands on water supplies, the total values involved, and the limited ability to implement specific objectives."*		
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*				
POTENTIAL OBJECTIVES - TEMPERATURE								
	Sacramento River at Freeport and	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	All		*The daily average water temperature shall not be elevated by controllable factors above 68 degrees F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all year types. [11]*
	San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*	*Not Applicable*	All		

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			CHINOOK SALMON (cont.)					
POTENTIAL OBJECTIVES - TEMPERATURE (cont.)								
	Sacramento River at Freeport	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*The daily avearge water temperature shall not be elevated by controllable factors above 66 degrees F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31. [11]*	
			STRIPED BASS-SALINITY.1 ANTIOCH-SPAWNING					
PRESENT OBJECTIVES								
D-1485	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*D-1485 (Water Year)*	*All*	*Apr 1-Apr 14*	*6,700*
D-1485	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*Average of mean daily for the period not more than the value shown, in mmhos*	*D-1485 (Water Year)*	*All*	*Apr 15-May 5*	*1.5*
ADVOCATED LEVELS								
	None other than above							
POTENTIAL OBJECTIVES								
1-A	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*1.5*
1-B	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*Not Applicable*	*All*	*Apr 1-Apr 14*	*6,700*

TABLE 5 - 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			STRIPED BASS - SALINITY: 1 ANTIOCH - SPAWNING (cont.)					
POTENTIAL OBJECTIVES (cont.)								
	San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos.*	*Not Applicable*	*All*	*Apr 15-May 31 (or until spawning has ended)*	*1.5*
1-C	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*Not Applicable*	*All*	*Apr 1-Apr 14*	*6,700*
	San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*W,AN&BN*	*Apr 15-May 31 (or until spawning has ended)*	*1.5*
						D&C	*Apr 15-May 21 (or until spawning has ended)*	*1.5*
			STRIPED BASS - SALINITY: 2 ANTIOCH - SPAWNING - RELAXATION PROVISION					
PRESENT OBJECTIVES								
D-1485	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*Average of mean daily for the period, not more than the values shown corresponding to the deficiencies taken by the SWP and CVP, in mmhos*	*D-1485 (Water Year)*	*All*	*Apr 1-May 5*	*--*
	This relaxation provision replaces the above Antioch & Chipps Island standard whenever the projects impose deficiencies in firm supplies.					*Total Annual Imposed Deficiency in Firm Supplies (MAF)*		*EC*
						0.0		*1.5*
						0.5		*1.9*
						1.0		*2.5*
						1.5		*3.4*
						2.0		*4.4*
						3.0		*10.3*
						4.0	*or more*	*25.2*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS - SALINITY - 2. ANTIOCH - SPAWNING - RELAXATION PROVISION (cont.)								
ADVOCATED LEVELS								
	None other than above							
POTENTIAL OBJECTIVES								
2-A	*No relaxation provision*							
2-B	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily not more than values shown corresponding to deficiencies in firm supplies declared by the SWP & CVP for the period shown, or until spawning has ended.*	*Total Annual Declared Deficiencies (MAF)*		*Apr 1-May 31 EC, in mmhos*	
							Dry	*Critical*
	This relaxation provision replaces the above Antioch & Chipps Island standard whenever the projects impose deficiencies in firm supplies.				*0.0*		*1.5*	*1.5*
					0.5		*1.8*	*1.9*
					1.0		*1.8*	*2.5*
					1.5		*1.8*	*3.4*
					2.0 or more		*1.8*	*3.7*
					Linear interpolation is to be used to determine values between those shown.			
2-C	*Same as 2-B, except that deficiencies are defined as deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds. The specific representative projects and amounts of deficiencies will be defined in subsequent phases of the proceedings.*							

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS - SALINITY 2. ANTIOCH - SPAWNING - RELAXATION PROVISION (cont.)								
POTENTIAL OBJECTIVES (cont.)								
2-D	*Same as Objective 2-B except the period of protection is April 1 to May 21.*							
2-E	*San Joaquin River at Antioch Water Works Intake*	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos, when the April 1, 40-30-30 Sacramento Basin Index is equal to or less than 4.8 MAF. [12]*	*Sac R 40-30-30*		*Apr 1-May 31 (or until spawning has ended)*	*3.7*
STRIPED BASS - SALINITY 3. PRISONERS POINT - SPAWNING								
PRESENT OBJECTIVES								
D-1485	*San Joaquin River at Prisoners Point*	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*Average of mean daily for the period not more than value shown, in mmhos*	*D-1485 (Water Year)*	*All*	*Apr 1-May 5*	*0.55*
ADVOCATED LEVELS								
	None other than above							
POTENTIAL OBJECTIVES								
3-A	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.30*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*						
	Rough and Ready Island	*- RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
		STRIPED BASS - SALINITY: 3. PRISONERS POINT - SPAWNING (cont.)						
POTENTIAL OBJECTIVES (cont.)								
3-B	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*						
	Rough and Ready Island	*RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						
3-C	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*SJ River (when developed)*	*W,AN, &BN*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*				*D&C*	*Apr 1-May 21 (or until spawning has ended)*	*0.44*
	Rough and Ready Island	*RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			STRIPED BASS - SALINITY: 3. PRISONERS POINT - SPAWNING (cont.)					
POTENTIAL OBJECTIVES (cont.)								
3-D	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*SJ River (when developed)*	*W,AN, &BN*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*				*D&C (EC would only be met at Prisoners Point)*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Rough and Ready Island	*RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						
3-E	*San Joaquin River at:*		*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*SJ River (when developed)*		*Apr 1-May 31 (or until spawning has ended)*	*0.44*
	Prisoners Point	*D-29 RSAN038*						
	Buckley Cove	*P-8 RSAN056*						
	Rough and Ready Island	*RSAN062*						
	Brandt Bridge [site]	*C-6 RSAN073*						
	Mossdale Bridge	*C-7 RSAN087*						
	Airport Way Bridge, Vernalis	*C-10 RSAN112*						

W - Prisoners Point to Vernalis
AN - Prisoners Point to Mossdale
BN - Prisoners Point to Rough and Ready Island
D - Prisoners Point to Buckley Cove
C - Prisoners Point only

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS-SALINITY-3. PRISONERS POINT-SPAWNING (cont.)								
POTENTIAL OBJECTIVES (cont.)								
3-F	*San Joaquin River at Prisoners Point*	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*
STRIPED BASS-SALINITY-4. PRISONERS POINT-SPAWNING RELAXATION PROVISION								
4-A	*No relaxation for Prisoners Point when the Antioch relaxation provision for spawning protection is in effect.*							
				When the Antioch relaxation provision for spawning protection is in effect:				
4-B	*San Joaquin River at Prisoners Point*	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*D,C*	*Apr 1-May 31 (or until spawning has ended)*	*0.55*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
				SUISUN MARSH				
PRESENT OBJECTIVES								
D1485 (Interim)	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Electrical Conductivity (EC)*	*Max 28-day running average of mean daily, in mmhos*	*D-1485 (Water Year)*	*All*	*Oct 1-May 31*	*12.5*
						------- except for ----------		
						D/C only if projects are taking deficiencies in scheduled water supplies	*Oct 1-Dec 31*	*15.6*
D-1485	*Sacramento River at Collinsville*	*C-2 RSAC081*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1984)*	*Oct*	*19.0*
							Nov	*15.5*
	Montezuma Slough at Miens Landing	*S-64(old) SLMZU20*					*Dec*	*15.5*
							Jan	*12.5*
	Montezuma Slough at Cutoff Slough	*S-48 SLMZU10*					*Feb*	*8.0*
							Mar	*8.0*
	Montezuma Slough near mouth	*D-7(near) SLMZU01*					*Apr*	*11.0*
							May	*11.0*
	Suisun Slough 300 ft south of Volanti Slough	*S-42 SLSUS12*						
	Suisun Slough near mouth	*S-36 * SLSUS01*						
	Goodyear Slough south of Pierce Harbor	*S-35(old) SLGYR02*						
	Cordelia Slough above S.P.R.R. crossing at Cygnus	*S-33 * SLCRD05*						

* *Station numbers were incorrect in D-1485, these are the corrected numbers.*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH (cont.)					
PRESENT OBJECTIVES (cont.)								
Amended D-1485	*Sacramento River at Collinsville* *Montezuma Slough at National Steel* *Montezuma Slough near Beldon Landing*	*C-2 RSAC081* *S-64(new) SLMZU25* *S-49 SLMZU11*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1988)*	*Oct* *Nov* *Dec* *Jan* *Feb* *Mar* *Apr* *May*	*19.0* *15.5* *15.5* *12.5* *8.0* *8.0* *11.0* *11.0*
	Chadbourne Slough at Chadbourne Road (proposed) *and* *Cordelia Slough 500 ft west of S.P.R.R. crossing at Cygnus* *or* *Chadbourne Slough at Chadbourne Road (proposed)* *and* *Cordelia Slough at Cordelia Goodyear Ditch (proposed)*	*S-21(prop.) SLCBN1* *S-33 SLCRD04* *S-21(prop.) SLCBN1* *S-97(prop.) SLCRD06*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1991)* *or* *All (effective Oct 1,1993)*	*Oct* *Nov* *Dec* *Jan* *Feb* *Mar* *Apr* *May*	*19.0* *15.5* *15.5* *12.5* *8.0* *8.0* *11.0* *11.0*
	Goodyear Slough at Morrow Island Clubhouse *or* *Goodyear Slough, 1.3 mi south of Morrow Island [Drainage] Ditch at Pierce*	*S-35(new) SLGYR03* *S-75(old) SLGYR04*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1991)* *or* *All (effective Oct 1,1994)*	*Oct* *Nov* *Dec* *Jan* *Feb* *Mar* *Apr* *May*	*19.0* *15.5* *15.5* *12.5* *8.0* *8.0* *11.0* *11.0*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH (cont.)					
PRESENT OBJECTIVES (cont.)								
Amended D-1485	*Suisun Slough, 300 ft south of Volanti Slough*	*S-42 SLSUS12*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*D-1485 (Water Year)*	*All (effective Oct 1,1997)*	*Oct*	*19.0*
							Nov	*15.5*
							Dec	*15.5*
							Jan	*12.5*
	Water Supply Intake locations for Waterfowl Manangement Areas on Van Sickle Island and Chipps Island	*No Locations specified*					*Feb*	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*
ADVOCATED LEVELS								
BCDC	*Sacramento River at Chipps Island*	*D-10 RSAC075*	*Electrical Conductivity (EC)*	*Monthly average of daily higher high tide values not to exceed the values shown. in mmhos*	*D-1485 (Water Year)*	*All (effective Oct 1,1984)*	*Oct*	*19.0*
	Sacramento River at Collinsville	*C-2 RSAC081*					*Nov*	*16.5*
	Montezuma Slough at Miens Landing	*S-64(old) SLMZU20*					*Dec*	*15.5*
	Montezuma Slough at Cutoff Slough	*S-48 SLMZU10*					*Jan*	*12.5*
	Montezuma Slough near mouth	*D-7(near) SLMZU01*					*Feb*	*8.0*
	Suisun Slough 300 ft south of Volanti Slough	*S-42 SLSUS12*					*Mar*	*8.0*
	Suisun Slough near mouth	*S-36 SLSUS01*					*Apr*	*11.0*
	Goodyear Slough south of Pierce Harbor	*S-35(old) SLGYR02*					*May*	*11.0*
	Cordelia Slough above S.P.R.R. crossing at Cygnus	*S-33 SLCRD05*						

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ SOURCE	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH (cont.)					
ADVOCATED LEVELS (cont.)								
SMPA[13] "Normal Standards" and "Deficiency Standards"	*Monitoring Stations same as for Amended D-1485*		*Electrical Conductivity (EC)*	*Monthly mean of both daily high tide values in mmhos*	*D-1485 (Water Year)*	*Normal Standards*	*Oct*	*19.0*
							Nov	*16.5*
							Dec	*15.5*
							Jan	*12.5*
							Feb	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*
						Deficiency Standards	*Oct*	*19.0*
							Nov	*16.5*
							Dec	*15.6*
							Jan	*15.6*
							Feb	*15.6*
							Mar	*15.6*
							Apr	*14.0*
							May	*12.5*
POTENTIAL OBJECTIVES								
Amended D-1485	*Sacramento River at Collinsville*	*C-2 RSAC081*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*Not applicable*	*All (effective Oct 1,1988)*	*Oct*	*19.0*
	Montezuma Slough at National Steel	*S-64(new) SLMZU25*					*Nov*	*15.5*
	Montezuma Slough near Beldon Landing	*S-49 SLMZU11*					*Dec*	*15.5*
							Jan	*12.5*
							Feb	*8.0*
							Mar	*8.0*
							Apr	*11.0*
							May	*11.0*

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			SUISUN MARSH (cont.)					
POTENTIAL OBJECTIVES (cont.)								
Amended D-1485	*Chadbourne Slough at Chadbourne Road (proposed) and Cordelia Slough 500 ft west of S.P.R.R. crossing at Cygnus or Chadbourne Slough at Chadbourne Road (proposed) and Cordelia Slough at Cordelia Goodyear Ditch (proposed)*	*S-21(prop.) SLCBN1 S-33 SLCRD04 S-21(prop.) SLCBN1 S-97(prop.) SLCRD06*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*Not applicable*	*All (effective Oct 1,1991) or All (effective Oct 1,1993)*	*Oct Nov Dec Jan Feb Mar Apr May*	*19.0 15.5 15.5 12.5 8.0 8.0 11.0 11.0*
	Goodyear Slough at Morrow Island Clubhouse or Goodyear Slough, 1.3 mi south of Morrow Island [Drainage] Ditch at Pierce	*S-35(new) SLGYR03 S-75(old) SLGYR04*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*Not applicable*	*All (effective Oct 1,1991) or All (effective Oct 1,1994)*	*Oct Nov Dec Jan Feb Mar Apr May*	*19.0 15.5 15.5 12.5 8.0 8.0 11.0 11.0*
	Suisun Slough, 300 ft south of Volanti Slough	*S-42 SLSUS12*	*Electrical Conductivity (EC)*	*Monthly average of both daily high tide values not to exceed the values shown, in mmhos (or demonstrate that equivalent or better protection will be provided at the location)*	*Not applicable*	*All (effective Oct 1,1997)*	*Oct Nov Dec Jan Feb Mar Apr May*	*19.0 15.5 15.5 12.5 8.0 8.0 11.0 11.0*
	Water Supply Intake locations for Water-fowl Management Areas on Van Sickle Island	*No Locations specified*						

TABLE 5 – 5 (cont.) ALTERNATIVE WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

ALTERNATIVES/ *SOURCE*	LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
			OTHER TIDAL MARSHES					
PRESENT OBJECTIVES								
	None specified							
ADVOCATED LEVELS								
BCDC	*Suisun Bay at Martinez*	*D-6 RSAC056*	*Electrical Conductivity (EC)*	*Monthly average of daily higher high tide values not to exceed the values shown, in mmhos*	*D-1485 (Water Year)*	*All except C*	*Feb*	*15.0*
							Mar	*15.0*
	Suisun Slough at mouth	*S-36 SLSUS00*					*Apr*	*18.0*
							May	*20.0*
	Suisun Bay at Seal Islands (Port Chicago)	*D-2 RSAC063*						
	Sacramento River at Chipps Island	*D-10 RSAC075*						
POTENTIAL OBJECTIVES								
	Suisun Bay at Martinez	*D-6 RSAC056*	*Electrical Conductivity (EC)*	*Monthly average of daily higher high tide values not to exceed the values shown, in mmhos*	*D-1485 (Water Year)*	*All except C*	*Feb*	*15.0*
							Mar	*15.0*
							Apr	*18.0*
							May	*20.0*

FOOTNOTES:

[1] Exact location of diversion point is yet to be determined; West Canal at mouth of Clifton Court Forebay is a possible alternate diversion point.

[2] The Cache Slough objective to be effective only when water is being diverted from this location.

[3] EPA safe drinking water maximum contaminant level.

[4] To prevent exacerbating potential problems with THMs and other DBPs.

[5] When no date is shown, EC limit continues from April 1.

[6] Many participants made recommendations that are not quantifiable.

[7] Exact value chosen in the indicated range depends on a number of factors and conditions, e.g., Sac. Basin Four-River Index, deficiencies in entitlement deliveries, season, etc.

[8] A water right permit term is a standard not an objective.

[9] Objective applies to all seven South Delta stations identified by SDWA.

[10] South Delta Agriculture objectives will be implemented in stages; two interim stages and one final stage. The first interim stage will be implemented with the adoption of the WQCP, the second interim stage by 1994, and the final stage by 1996. Interim Stage 1 -- 500 mg/l mean monthly TDS all year at Vernalis. Interim Stage 2 -- (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge; with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge, and an additional interior monitoring station on Middle River at Howard Road Bridge. Final Stage -- (to be implemented no later than 1996) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge on the San Joaquin River; with two interior stations at Old River Near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old river and Middle River at Howard Road Bridge.

OR

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/montioring locations noted above, as appropriate.

[11] Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of

reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

[12] Only the April 1 Sacramento Valley 40-30-30 Index value shall be used to determine whether the relaxation provision will be in effect in any particular year. Determination of the April 1 Index value shall assume normal precipitation conditions for the calculation of the April to July Four River Unimpaired Flow.

[13] Suisun Marsh Preservation Agreement:

1(f)..."Deficiency Period" shall mean (1) a Critical year following a Dry or Critical Year; or (2) a Dry Year following a year in which the Four Basin Index was less than 11.35; or (3) the second consecutive Dry Year following a Critical Year.

1(r)... "Critical Year" and "Dry Year" are also defined as in Footnote 2 of Table II of D-1485 except that runoff for the remainder of the water year shall be assumed to be equal to the lower value of the 80 percent probability range, as shown in the most recent issue of Bulletin 120, "Water Conditions in California".

6.0 EVALUATION OF ALTERNATIVE WATER QUALITY OBJECTIVES

6.1 Introduction

In Chapter 5 potential objectives for salinity, temperature and dissolved oxygen were developed to protect the beneficial uses made of Bay-Delta water. In this chapter, the adequacy and reasonableness of the potential objectives are evaluated to determine if they or other objectives should be developed by the State Board.

CEQA requires that cumulative impacts be addressed and that alternatives to the project being analyzed be considered. In this case the project is the adoption of a water quality control plan to address the direct effects of salinity, temperature and dissolved oxygen. The State Board's total planning and regulatory processes include consideration of a much broader suite of alternatives than those which fall within the scope of this Plan. The record clearly shows that an important means of helping protect beneficial uses and mitigating for the effects of development is by setting instream flow requirements. Flow standards address problems other than the direct effects of salinity, etc. Therefore the Board has elected to set them in the subsequent broader phases of this process. In order to comply with the spirit of CEQA and to help set the stage for the Scoping and Water Right phases, the State Board has reviewed the effects of differing flow regimes to a limited extent. The results of the analysis are presented herein for information and guidance. A detailed analysis of flow regimes will be done during the Water Right Phase of these proceedings.

Water Code §13241 requires that the State Board consider, at a minimum, the following factors when establishing water quality objectives:

1) the past, present, and probable future beneficial uses of water;
2) the environmental characteristics of the hydrographic unit, including the quality of water available to it;
3) the water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;
4) economics considerations; and
5) the need for developing housing within the region.

- The State Board has reviewed the beneficial uses designated for Bay-Delta waters that are included in the Basin Plans for Regions 2 and 5 and finds that the designations are still appropriate.

- The environmental characteristics of the hydrographic unit can be found in Chapter 3 and Appendix 3.0 of this Plan. The State Board took those characteristics into account in developing possible water quality objectives.

- "The coordinated control of all factors" is discussed in the implementation program found in Chapter 7.

- The only direct economic consequences for which any evidence is forthcoming are the costs of changing leaching practices for Delta agriculture; this analysis is in progress. For reasons which are summarized in Section 6.7, all other economic effects were analyzed using water availability as an indicator of economic cost. These discussions are found in the evaluation of each alternative.

- Protecting the quality of waters designated as M&I supplies is an essential part of meeting housing needs within the Bay-Delta watershed and export areas.

6.2 Water Quality Alternatives

Several specific objectives have been chosen for consideration in this chapter, ones that cover a broad range of possible protective measures; they represent a 'framework' or 'set of limits' within which alternative mixes of objectives can be compared. Some indication of the protection offered by intermediate alternatives can in this way be provided.

Table 6-1 contains a list of seven potential sets of water quality objectives for the Delta. The alpha-numeric code under the number of the alternative refers to the operation model run (DWRSIM) which was used to evaluate the relative water supply effects of the alternative. The State Board selects Alternative 3 based on the following discussion in this chapter.

The alternatives were evaluated using DWR's Planning Simulation Model, DWRSIM, a generalized computer model designed to simulate the operation of the CVP and SWP project reservoirs and conveyance facilities. These operation studies are conducted on a monthly time basis and use the historical 57-year hydrologic sequence of flows from water years 1922 through 1978. In addition, these studies account for system operational objectives, physical constraints, statutes, and agreements. These parameters include requirements for flood control in system reservoirs, hydropower generation, pumping plant capacities and limitations, and Delta operations to meet water quality objectives. A more detailed description of the DWRSIM model as well as the operations criteria used in the studies is presented in Appendix 6.1, Analysis Assumptions for Water Supply Impacts.

Operation studies are run with adjustments to the combined CVP-SWP system only. The local non-project reservoirs upstream of the Delta and the CVP Friant Reservoir on the San Joaquin River are pre-operated or have a "predetermined" operation throughout the simulation period. They are not operated to meet Delta objectives. Therefore, the combined CVP-SWP system acts as a surrogate to reflect water supply consequences of the alternatives on all users in the watershed.

Currently the operations study is not designed to analyze the water needed to meet water quality objectives for interior stations of the south Delta, nor is it designed to analyze the water distribution effects of the interior Suisun Marsh objectives. Until the Suisun Marsh hydrodynamic and salinity models presently being developed by DWR are completed, any prediction of the effects of changing the interior marsh objectives on Delta outflow (as measured at Chipps Island) or on water exports must be used with caution.

TABLE 6-1

ALTERNATIVE SETS OF WATER QUALITY OBJECTIVES

BENEFICIAL USE OR PARAMETER	ALTERNATIVE [1,2]						
	1A (A7)	1B (B7)	2 (L7)	3 (H7)	4 (P7)	5 (K7)	6 (N7)
Alternative Name	BASE	BASE w/ 40-30-30	250 CL CCC/1.5 W DEL AG	S DEL AG/ANT SPAWN	50 CL BANKS PP	50 CL CCC/0.44 VERN SP	R,T, & E/0.3 VERN SP
Water Year Classification	Decision 1485 Water Year	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)	40-30-30 (w/ Subn Snowmelt)
Municipal and Industrial	250 Cl except 150 Cl 42-66% of the time at CCC Intake	Same as Base	250 Cl All Year at CCC Intake	Same as Base [3]	Same as Base Plus 0.15 Br (= 50 Cl) All Year at Banks PP [4]	0.15 Br (= 50 Cl) All Year at CCC Intake [4]	0.15 Br (= 50 Cl) All Year at CCC Intake [4]
Western / Interior Delta Agriculture	0.45-2.78 EC Apr 1-Aug 15	Same as Base	1.5-3.0 EC Apr 1-Aug 15 [5]	Same as Base	Same as Base	Same as Base	Same as Base
Southern Delta Agriculture	USBR Agreement: [6] 450 TDS Apr 1-Oct 31 500 TDS Nov 1-Mar 31	Same as Base	Same as Base	0.7 EC Apr 1-Aug 31 1.0 EC Sep 1-Mar 31 [7]	0.7 EC Apr 1-Aug 31 1.0 EC Sep 1-Mar 31 [7]	0.7 EC Apr 1-Aug 31 1.0 EC Sep 1-Mar 31 [7]	0.7 EC Apr 1-Aug 31 1.0 EC Sep 1-Mar 31 [7]
Export Agriculture	None	Same as Base	Same as Base	1.0 EC All Year	1.0 EC All Year	1.0 EC All Year	1.0 EC All Year
Antioch Striped Bass Spawning	1.5 EC Apr 15-May 5 1.6-25.2 EC in Deficiency Years	Same as Base	Same as Base	1.5 EC Apr 15-May 31 or When Spawning Ends 1.6-3.7 EC in Def. Yrs.	1.5 EC Apr 15-May 31 or When Spawning Ends 1.6-3.7 EC in Def. Yrs.	1.5 EC Apr 15-May 31 or When Spawning Ends 1.6-3.7 EC in Def. Yrs.	1.5 EC Apr 1-May 31 w/o Apr 1-Apr 15 Ramping Flow
Prisoners Point / Vernalis Striped Bass Spawning	0.55 EC Apr 1-May 5 at Prisoners Pt.	Same as Base	Same as Base	0.44 EC Apr 1-May 31 at Prisoners Pt. or When Spawning Ends 0.55 EC at Prisoners Pt. in Deficiency Years	0.44 EC Apr 1-May 31 at Prisoners Pt. or When Spawning Ends 0.55 EC at Prisoners Pt. in Deficiency Years	0.44 EC Apr 1-May 31 Vernalis to Prisoners Pt. or When Spawning Ends 0.55 EC at Prisoners Pt. in Deficiency Years	0.3 EC Apr 1-May 31 Vernalis to Prisoners Pt.
Suisun Marsh Wildlife [8]	Interim Objectives of 12.5-15.6 EC at Chipps 1978 Delta Plan Interior Marsh Obj's of 8.0-19.0 EC to be Phased In	Same as Base	Interim Objectives of 12.5-15.6 EC at Chipps Suisun Marsh Preservation Agreement	Same as Base [9]	Same as Base [9]	Same as Base [9]	Same as Base except 1978 Delta Plan Objectives [9]
Tidal Marshes R, T, & E Species	None	Same as Base	Same as Base	Same as Base [9]	Same as Base [9]	Same as Base [9]	15-20 EC Feb 1-May 31 at Martinez
Salmon [8] (Temperature)	Region 5 Basin Plan: 68 F when needed in Sacramento R., (If Controllable) [10]	Same as Base	Same as Base	68 F Apr 1-Jun 30 & Sep 1-Nov 30 in Sac R. and SJR 66 F Jan 1-Mar 31 in Sac R., (If Controllable)	68 F Apr 1-Jun 30 & Sep 1-Nov 30 in Sac R. and SJR 66 F Jan 1-Mar 31 in Sac R., (If Controllable)	68 F Apr 1-Jun 30 & Sep 1-Nov 30 in Sac R. and SJR 66 F Jan 1-Mar 31 in Sac R., (If Controllable)	66 F Apr 1-Jun 30 & Sep 1-Nov 30 in Sac R. and SJR 66 F Jan 1-Mar 31 in Sac R., (If Controllable)
Salmon [8] (Dissolved Oxygen)	Region 5 Basin Plan: [10] 5.0-7.0 DO All Year Depending on Delta Area	Same as Base	Same as Base	6.0 DO Sep 1-Nov 30 Stockton to Turner Cut	6.0 DO Sep 1-Nov 30 Stockton to Turner Cut	6.0 DO Sep 1-Nov 30 Stockton to Turner Cut	6.0 DO Sep 1-Nov 30 Stockton to Turner Cut
Flow	D-1485 Objectives	Same as Base	Same as Base	Same as Base	Same as Base	Same as Base	Same as Base

[1] The letter/number combination in parentheses below the alternative numbers identify the corresponding DWR operation study.
[2] Chlorides (Cl), Bromides (Br), Total Dissolved Solids (TDS), Dissolved Oxygen (DO) in mg/l :: Electrical Conductivity (EC) in mmhos/cm :: Temperature in degrees Fahrenheit (F).
[3] Alternative also includes a goal of 0.15 mg/l bromides, which is approximately equivalent to 50 mg/l chlorides. This goal, however, was not modeled as part of alternative 3.
[4] Operation studies P7, K7, and N7 use an M&I objective of 40 mmhos/cm chlorides to provide an operational buffer.
[5] Operation study L7 includes a 1.7 mmhos/cm EC leaching provision, which is not part of Alternative 2.
[6] At Vernalis: 450 mg/l TDS = 0.775 mmhos/cm EC; 500 mg/l TDS = 0.860 mmhos/cm EC.
[7] The ultimate Southern Delta agricultural objectives will be phased in through 1996. The objectives and locations may be revised as the Board deems appropriate.
[8] The temperature goals and interior Suisun Marsh and dissolved oxygen objectives were not included in the operation studies due to a lack of adequate analytic modeling tools.
[9] These alternatives also include a biological assessment.
[10] All Regional Board objectives remain in effect for all alternatives.

LEGEND: SELECTED ALTERNATIVE

05/02/91

At this time, only rough estimates of a projected salmon survival index can be made, based on general assumptions of flow and temperature. The ability to analyze the impacts on salmon from the model runs is limited. Therefore, the discussion of the alternatives is a comment on the relative benefit or impact of a particular alternative on the Chinook salmon.

Water Supply Impacts

The "water supply impacts" of the alternatives are defined as the change in base flows and exports caused by the implementation of the alternative sets of water quality objectives. The base condition, Alternative 1A in Table 6-1, incorporates a present (1990) level of development operations study that uses the water quality objectives of the 1978 Delta Plan, the flow requirements of D-1485, and Bureau Agreement on the New Melones Reservoir as the controlling Delta criteria.

Table 6-2 presents the water supply consequences of the seven alternative sets of water quality objectives shown in Table 6-1. The water supply impacts are analyzed in terms of the following factors:

- o San Joaquin River Inflow
- o Sacramento River Inflow
- o Total Delta Exports
- o Other Flows/Diversions
- o Total Delta Outflow

Figure 6-1 shows the water supply parameters used in Table 6-1.

The Table 6-2 results are presented on average annual and April through July bases for the 57-year hydrologic period 1922 through 1978 and the critically-dry hydrologic period May 1928 through October 1934. Figures 6-2 and 6-3 graphically show the 57-year average annual water supply results from Table 6-2. The values shown in Table 6-2 and Figures 6-2 and 6-3 represent the combined effects of the water quality objectives and the new 40-30-30 water year classification. Positive values indicate an increase in flow or export; negative values indicate a decrease.

The following discussion includes, for each alternative, a short summary of the model results presented in Table 6-2 and brief comments on the reason(s) for any changes from the base condition. The statistical significance of these results cannot be determined.

It must be recognized that the impacts shown on Table 6-2 and Figures 6-2 and 6-3 and discussed in the following pages do not include the potential impacts on water supply of meeting any changes in current Suisun Marsh objective, the revised Antioch relaxation provisions for striped bass or the objectives for interior stations in the south Delta. Each of these objectives could cause a reduction in water available for other beneficial uses. When the impact of one or more of these objectives is known, the State Board will review such objectives for reasonableness and amend them, if necessary.

TABLE 6-2

WATER SUPPLY IMPACTS
OF THE
ALTERNATIVE SETS OF WATER QUALITY OBJECTIVES

WATER SUPPLY PARAMETER	BASE CONDITIONS (TAF)	CHANGE IN BASE CONDITIONS NEEDED TO MEET OBJECTIVES (TAF) [1]															
		ALTERNATIVE [2]															
		1A (A7)		1B (B7) [3]		2 (L7)		3 (H7) [4]		4 (P7) [4,5]		5 (K7) [4,5]		6 (N7) [4,5]	
ALTERNATIVE NAME	D-1485 BASE	BASE		BASE w/ 40-30-30		250 CCC/1.5 W AG		S DEL AG/ANT SP		50 BANKS PP		50 CCC/.44 VER SP		R,T, & E/.3 VER SP	
	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul	Annual	Apr-Jul
Average																	
San Joaquin River Inflow	1996	624	0	0	0	0	0	0	1	21	1	21	9	86	150	290	
Sacramento River Inflow	15624	5087	0	0	-6	-16	-9	-73	-6	-37	-8	-85	-8	-127	-6	-179	
Total Delta Exports [6]	6295	1762	0	0	4	1	50	20	-1	3	-207	-57	-399	-123	-674	-224	
Other Flows/Diversions [7]	1652	-211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total Delta Outflow [8]	12977	3738	0	0	-10	-17	-59	-93	-6	-19	200	-7	400	82	818	335	
Critically-Dry Period																	
San Joaquin River Inflow	1153	315	0	0	0	0	0	0	-6	29	-6	29	58	91	247	273	
Sacramento River Inflow	8890	3141	0	0	-21	-23	-47	-36	-18	-51	-19	-190	-9	-223	-4	-183	
Total Delta Exports [6]	5290	1448	0	0	6	1	63	12	-11	6	-364	-147	-984	-393	-1078	-321	
Other Flows/Diversions [7]	-726	-645	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total Delta Outflow [8]	4027	1363	0	0	-27	-24	-110	-48	-13	-16	339	-14	1033	261	1321	411	

Footnotes:

[1] Change in base conditions = Alternative minus Base; Positive values indicate an increase in flow or export.

[2] The letter/number combination in parentheses below the alternative numbers identify the corresponding DWR operation study. The temperature goals and interior Suisun Marsh and dissolved oxygen objectives were not included in the operation studies due to a lack of adequate analytic modeling tools.

[3] Alternative 1B is the base case (1A) with the new 40-30-30 water year classification.

[4] The ultimate Southern Delta objectives will be phased in through 1996. The objectives and locations may be revised as the Board deems appropriate.

[5] Operation studies P7, K7, and N7 use an M&I objective of 40 mg/l chlorides to provide an operational buffer. P7, K7, and N7 include base Delta outflows of 3500, 6000, and 6000 cfs, respectively.

[6] Total Delta Exports include Contra Costa Canal, North Bay Aqueduct, and Banks and Tracy Pumping Plants.

[7] Other Flows/Diversions include Net Delta Consumptive Use, City of Vallejo diversions, Yolo Bypass inflow, and East Side Streams inflow. The Base Conditions values are negative when the Net Consumptive Use plus the City of Vallejo diversions are greater than the Yolo Bypass inflow plus the East Side Streams inflow.

[8] Total Delta Outflow equals the San Joaquin River inflow + Sacramento River inflow - Total Delta Exports + Other Flows/Diversions.

LEGEND:

SELECTED ALTERNATIVE

03/07/91

FIGURE 6-1

DELTA HYDROLOGIC SCHEME USED IN THE WATER SUPPLY IMPACT ANALYSIS

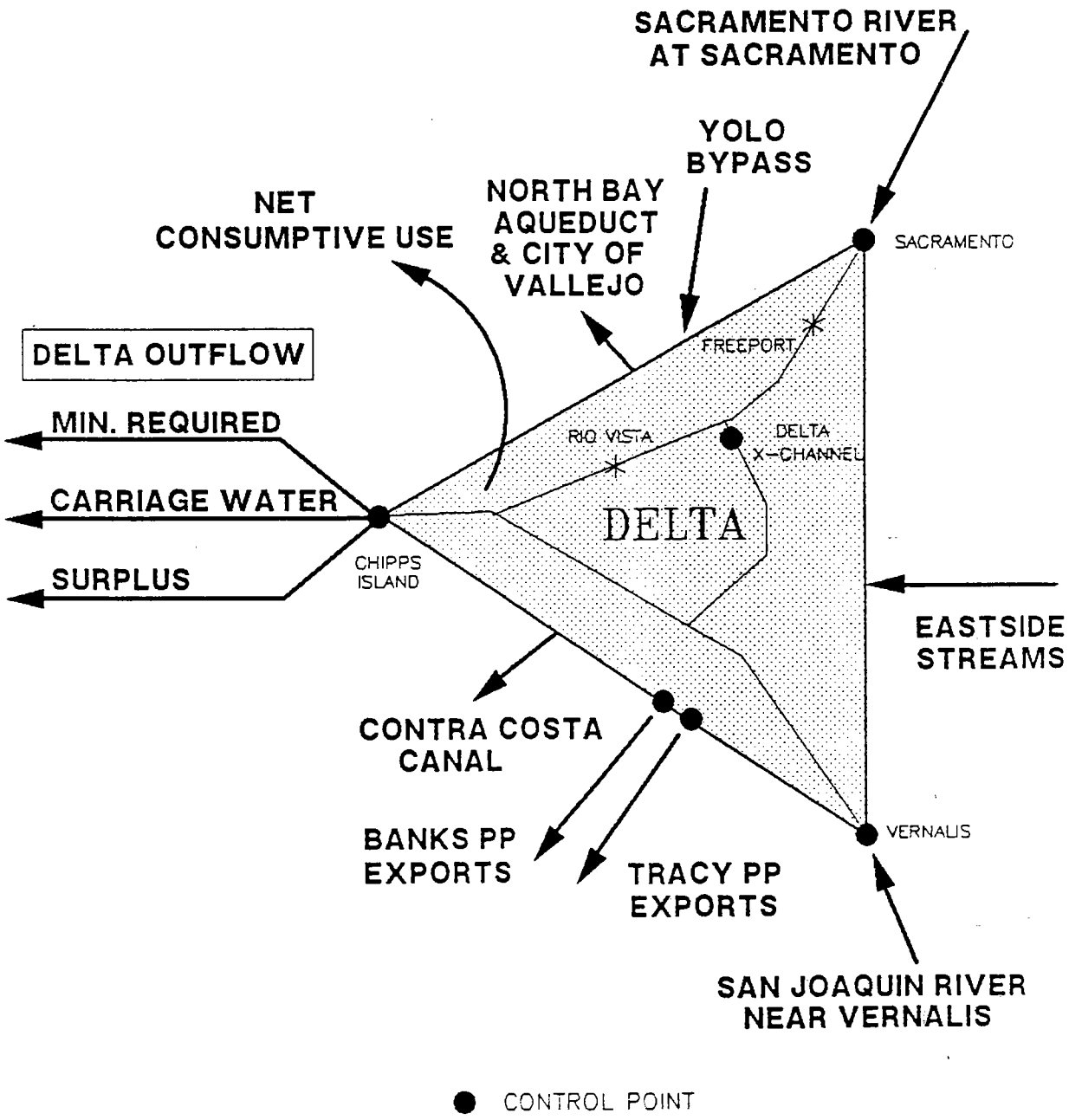
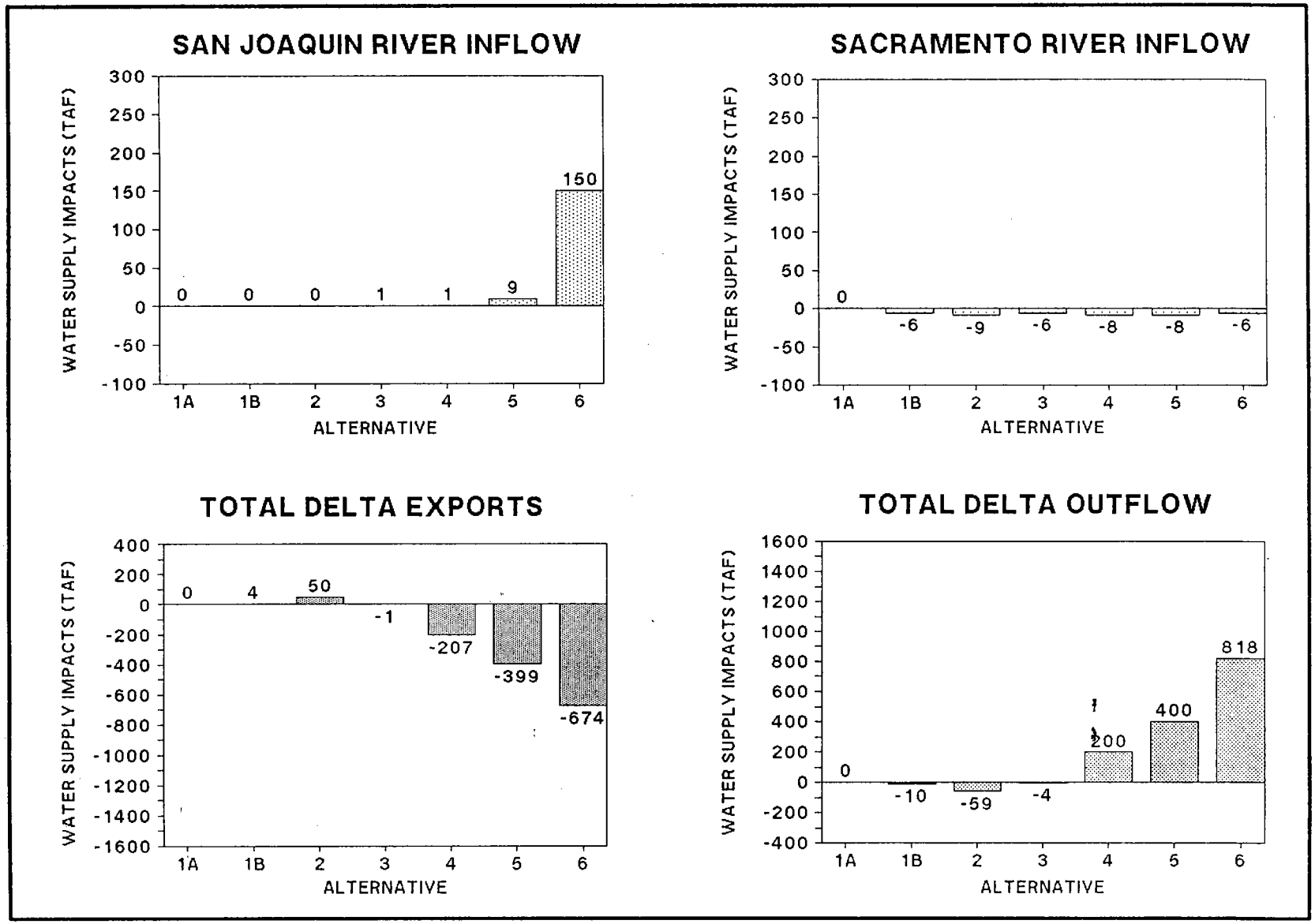


FIGURE 6-2

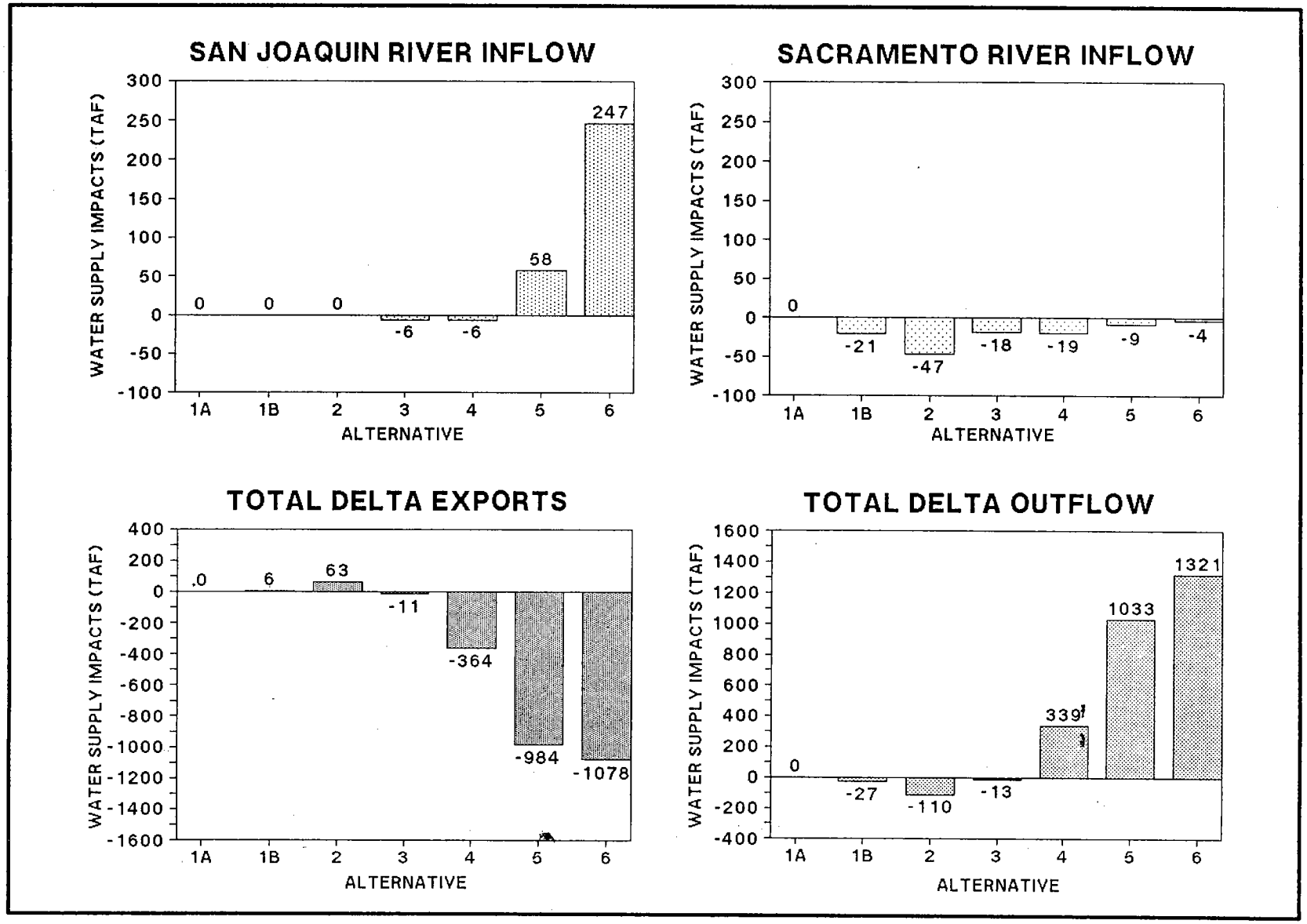
AVERAGE ANNUAL WATER SUPPLY IMPACTS



03/08/91

FIGURE 6-3

CRITICALLY DRY PERIOD WATER SUPPLY IMPACTS



03/08/91

6.2.1A

Alternative 1A. This is the base: it represents the 'present conditions' against which the other alternatives are compared. The base conditions include the set of water quality objectives contained in D-1485 (for more details, see Appendix 6.2, D-1485). Therefore, the model results show no changes from the base. Given the variety of locations and uses, our discussion of the alternatives has considered D-1485 objectives, special modifications used in the operations models, and actual conditions, as appropriate.

The current objectives protect striped bass spawning habitat only through May 5, and protection thereafter declines substantially in dry and critical water years because Delta Outflow Index requirements for protection of eggs and young are substantially lower. The experience of 1990 also shows that in extremely dry years when water deficiencies are imposed the expected maximum Antioch EC of 3.7 mmhos/cm was exceeded, and ECs exceeded 0.44 mmhos/cm at most locations in the central Delta spawning area and approached the present objective (0.55 mmhos/cm) at Prisoners Point.

6.2.1B

Alternative 1B is the same as the base condition with the exception of the water year classification. The year type classification used in the water supply impact analysis is the 40-30-30 year type classification described in Chapter 3.[1] Although the 40-30-30 classification does not have any adjustments, the special Decision 1485 subnormal snowmelt adjustment is retained for the reasons explained below. The subnormal snowmelt adjustment only applies to fish and wildlife flows when spring runoff from snowmelt is much less than normal. It is invoked in wet, above normal, and below normal years when the April through July unimpaired runoff is 5.9 million acre-feet or less.

The Decision 1485 subnormal snowmelt adjustment and its flow requirements are retained in the operation studies for two reasons. First, the consideration of flow requirements has been deferred to the Scoping and Water Right phases of the proceedings. Second, the use of the 40-30-30 classification with the subnormal snowmelt flow relaxation maintains approximately the same level of flow protection for fish and wildlife as under Decision 1485. Elimination of the subnormal snowmelt adjustment would prematurely alter the flow requirements before the next phase of the proceedings and would compromise the intent to isolate the effect of the technical adjustment to the classification system.

The Water Year Classification Workgroup has reviewed operation study results to determine the relative impact of the flow reduction for subnormal snowmelt on Delta flows and exports. These studies show that the removal of the subnormal snowmelt flow requirements would increase the Delta outflow and reduce the critically-dry period exports (WQCP-DWR-5,4). During the critically dry period, the operations studies results show an average loss in exports of approximately 29 TAF, or a total of about 189 TAF (29 TAF x 6.5 years). During the 57-year period, the average annual export loss is about 20 TAF.

1/ The interim Suisun Marsh objectives were analyzed using the Decision 1485 water year type classifications, including the subnormal snowmelt adjustment.

Another "classification adjustment" examined in Chapter 3 is the "year following dry or critical year" relaxation. This relaxation was not included in the water supply impact analysis since the use of the 40-30-30 classification without the "year following dry or critical year" relaxation maintains approximately the same level of flow protection for fish and wildlife as under Decision 1485.

The new year type classification has a relatively small effect; it allows decreases in the total Delta outflow during the 57-year dry and critically-dry periods by 10 and 27 TAF, respectively. The Delta outflow changes are also relatively small for the April through July periods.

These modest changes occur because the new classification shifts the average classification to a slightly drier condition.

The 40-30-30 water year type classification does not affect the flows past Vernalis on the San Joaquin River since, under the controlling USBR southern Delta Agreement, the south Delta agricultural objectives do not vary by year type. The new classification allows for some decreases in Delta inflow from the Sacramento River Basin as well as some additional export from the Delta.

The addition of the 40-30-30 Water Year Index to the base case provides little change in protection for instream uses. As discussed above, the model runs retained the "subnormal snowmelt" category. If a complete 40-30-30 Index (without this category) were implemented some additional outflow would result. The deletion of the "year following dry or critical year" category theoretically would result in additional outflow. However, the new Index offsets this effect by including the previous water year in the formula, resulting in a reclassification of the current water year into a drier category compared to the base case. Thus the Delta outflow remains essentially unchanged. This may result in a small decrease in protection for spawning and for eggs and young after May 5 compared to the base case. The frequency of occurrence or severity of deficiency for the relaxation provision is probably not changed significantly under this alternative.

Further, like the basic condition, Alternative 1B retains the 150 mg/l chloride industrial objective for a portion of the year at the Contra Costa Canal intake. This was retained for evaluation so as to avoid exacerbation of public health hazards that may be caused by the formation of disinfection by-products when the water is treated. Alternative 3 has the same proviso.

6.2.2

Alternative 2 has four differences from the base condition including the use of the 40-30-30 water year classification. The M&I objective is 250 mg/l all year at the Contra Costa Canal Intake. The western/interior Delta Agriculture objective is 1.5 mmhos/cm EC for April 1 through August 15 at Emmaton and Jersey Point and adjusted to 3.0 mmhos/cm EC from August 1 through August 15 in critical years. The SMPA Suisun Marsh objectives are the deficiency standards: 12.5 to 15.6 EC, depending on the month, at Chipps Island.

6.2.2.1 Municipal and Industrial Impacts

Salinity - A 250 mg/l chloride objective at the Contra Costa Canal Intake year-round would make paper industries unable, at times, to produce salt-sensitive products without some form of water treatment. The 1978 Delta Plan specified a chloride objective of 150 mg/l for a portion of the year solely to protect the paper industries. However, the continued need of that objective is questionable because no evidence was presented indicating that such a need still exists.

6.2.2.2 THM Formation Potential

As new and pending drinking water standards take effect, the water quality objectives in Alternative 2 may result in negative impacts for purveyors of Delta water. These negative impacts may take the form of violation of state and federal drinking water standards for disinfection by-products. It is not possible to accurately quantify those impacts at present.

6.2.2.3 Agricultural Impacts

Western and Interior Delta - The 1.5/3.0 mmhos/cm EC objectives are based on the results of the interagency Corn Study. These objectives would allow salinity to increase during wet, above normal, and below normal years, and a decrease in dry and critical years in the western Delta. In the interior Delta the objectives would allow an increase in all but critical years, and decrease in critical years. There should be little or no effect on corn yield due to these objectives if adequate leaching is performed. However, the effectiveness and economic effects of additional leaching practices are not yet known.

Southern Delta - Same as base, no impact.

6.2.2.4 Salmon - Same as base.

6.2.2.5 Striped Bass

This alternative does not make any direct changes in striped bass protection, but may have indirect effects because of changes in the Contra Costa Canal and western Delta objectives. Reduced Sacramento River inflow and increased exports may have some negative impact on survival of eggs and young in most years. However, the increased protection for western Delta agriculture may provide some incremental increased protection in critical years, as is shown by the slight increased Sacramento River inflow in these years.

6.2.2.6 Water Supply

This alternative would produce the largest reduction in total Delta outflow and, consequently, the largest increase in exports. This alternative would allow decreases in the total Delta outflow during the 57-year and critically-dry periods by 59 and 110 TAF, respectively. The corresponding increases in exports during the two hydrologic periods are 50 and 63 TAF, respectively.

These changes are caused by the modifications in the municipal and industrial objective and the western/interior Delta agricultural objectives.

The impact of the interior Suisun Marsh objectives specified in the Suisun Marsh Preservation Agreement has not been quantified because of a lack of adequate flow/salinity relationships.

6.2.3

Alternative 3 in Table 6-1 is the "Selected" alternative. Seven objectives in this alternative (in addition to the water year classification) differ from the base. The southern Delta agriculture objective is based on the UC guidelines for the water quality requirement of two important salt-sensitive crops, beans and alfalfa. The recommended water quality for beans is an EC of 0.7 mmhos/cm from April 1 to September 30; for alfalfa it is an EC of 1.0 mmhos/cm from October 1 through March 31. Export agriculture is set at an EC of 1.0 mmhos/cm in all year types. For fish and wildlife, the recommended objective for striped bass spawning at Antioch is an EC of 1.5 mmhos/cm from April 15 (with ramping) to May 31, or until spawning has ended (to be determined by monitoring), and 1.6 to 3.7 mmhos/cm in deficiency years. The other objectives for striped bass spawning are 0.44 mmhos/cm at Prisoners Point from April 1 through May 31, or until spawning has ended, and 0.55 mmhos/cm in deficiency years.

The recommended temperature objective for Chinook salmon is 68°F from April 1 to June 30 for the protection of fall-run Chinook smolts and from September 1 to November 30 for the protection of fall-run Chinook salmon adults both at Freeport on the Sacramento River and Vernalis on the San Joaquin River. A temperature of 66°F is specified from January 1 to March 31 at Freeport for the protection of winter-run Chinook salmon smolts and adults. The objective is subject to available "controllable factors" as defined in Chapter 5, Section 5.5. The dissolved oxygen objective is 6.0 mg/l from September 1 through November 30 at Vernalis for the upstream migration of fall-run Chinook salmon in the San Joaquin River.

Also, while the Suisun Marsh objective is the same as the base condition, a biological assessment is to be conducted. This assessment would include the tidal marshes and inventory of rare, threatened and endangered species habitat as well.

6.2.3.1 Municipal and Industrial

Salinity - Same as base, no impact. Note that the 150 mg/l chloride objective for industry for a portion of the year was evaluated for the same reasons stated in Alternative 1B.

6.2.3.2 THM Formation Potential

Alternative 3 will not result in any measurable negative or positive impact on THM formation over base conditions, assuming standard chlorination treatment is used.

6.2.3.3 Agriculture

Western and Interior Delta - With the hydrologic conditions that have occurred and the leaching practices that have been used since D-1485 was adopted, agriculture in the western and interior Delta has been maintained or enhanced under the base level of protection. This alternative retains this same level of protection and does not impose additional management or other economic costs on western or interior Delta farmers.

Southern Delta - The objectives were set to protect beans and alfalfa, based on University of California guidelines. However, allowable salinity levels were lowered to account for leaching limitations in the southern Delta. The impact of these objectives could be an improvement in overall growing conditions.

6.2.3.4 Salmon

Under Alternative 3 during the April through July period, San Joaquin River inflow would increase in average years; the Sacramento River inflow would decrease. The degree to which the increased flow would affect water temperatures in the San Joaquin River cannot be determined at present. A salmon smolt survival model based on spring water temperatures in the San Joaquin River has not yet been developed. The correlation that has been demonstrated between spring outflow in the San Joaquin River and adult returns two and a half years later indicates that the increased flow in the spring months may improve conditions for the outmigrating salmon smolts in the San Joaquin River.

Using the smolt survival index for the Sacramento River (USFWS), based on average April to June flow at Rio Vista, and the flow computed under this alternative, the only year type in which average salmon smolt survival index would be greater than 0.50 would be in wet years. Above normal water years would provide an average survival index of 0.42 and the remainder of the year types less than 0.30.

The implementation of the dissolved oxygen objective has not been fully explored. Apparently there is at least one source of effluent in the vicinity which contains high BOD; the lack of natural circulation in the Stockton turning basin may also negatively affect the DO levels. A partial analysis estimating the flow required (September and November only) to change the dissolved oxygen level 1 mg/l using a multiple regression analysis was submitted. Further analysis of the impacts of the water quality objectives will be made in the forthcoming proceedings. Several methods to improve DO levels besides increasing inflow are available including the traditional installation of the seasonal barrier in Old River.

6.2.3.5 Striped Bass

This alternative provides direct increased protection for striped bass spawning compared to the base case. The period of protection is extended through May 31, which covers nearly all of the period of spawning on the San Joaquin River. In addition, the 3.7 mmhos/cm EC limit on the Antioch

relaxation provision should provide some small additional protection. The definition of deficiency will be re-examined in later phases of these proceedings; the frequency of the deficiency declaration, as well as the numerical salinity limits, will further define the level of impact on striped bass spawning.

Likewise, the change in the maximum EC at Prisoners Point from 0.55 to 0.44 mmhos/cm should theoretically improve spawning conditions in this area. However, due to umbrella protections, water quality is almost always better than 0.44 mmhos/cm EC at this location. The State Board prefers specific protection rather than relying on umbrella protection. Also, the protection period has been extended from May 5 to May 31. The relaxation to 0.55 mmhos/cm EC during deficiency periods retains the base condition, and appears not to be exceeded (based on 1990 data), so there is no change in protection here.

The model run used to simulate Alternative 3 assumes some increase in San Joaquin River flow, little change in exports, reduced Sacramento River flow and reduced Delta outflow. The impacts on indirect protection for eggs and young under this alternative, as modeled, are unclear.

Potential Objective 2E in Section 5.6.3.2 for the Antioch relaxation provision called for a relaxation to 3.7 mmhos/cm EC whenever the Sacramento Valley 40-30-30 Index was equal to or less than 4.8 MAF. This alternative was not modeled, and it is not included in Table 6-1. However, it is discussed here for informational purposes. Since it was designed to reflect actual or anticipated years of deficiency (1977, 1990, 1928-1934, etc.), the impacts of using this alternative should be essentially the same as Alternative 1B with a 3.7 mmhos/cm EC limit on the Antioch relaxation provision. Its substitution in Alternatives 3 through 5 should result in somewhat reduced protection because the Antioch value goes immediately to 3.7 mmhos/cm EC regardless of the amount of deficiency, rather than according to a sliding scale as in these alternatives and D-1485. However, direct comparisons with these other alternatives are not possible because the definition and frequency of deficiency conditions have not yet been defined.

6.2.3.6 Water Supply

Without considering the potential impact of meeting the revised Antioch relaxation provision for striped bass and the interior objectives in the south Delta, and assuming that the existing Suisun Marsh standards are not revised, Alternative 3 would allow decreases in the total Delta outflow as shown in Table 6-2. This water is obtained by decreasing the total Delta exports and decreasing the Delta inflows from both the Sacramento and San Joaquin River basins.

The principal reason for the decrease in Delta outflow is the new 40-30-30 year type, which allowed for more water to be stored in the Sacramento River Basin.

The level of impact on water supplies of this alternative, not including the impact of the striped bass relaxation provision and the interior south Delta objectives, is less than 0.5 percent of the dry period exports of the CVP and SWP.

6.2.4

Alternative 4 is the same as Alternative 3 except for the M&I objective. Alternative 4 adds a bromide (Br^-) objective of 0.15 mg/l (50 mg/l) Cl in all years at Banks Pumping Plant.

6.2.4.1 Municipal and Industrial

Drinking Water Quality - Salinity - The impact of setting a 50 mg/l chloride objective at Banks Pumping Plant will be to lower chloride levels at the Contra Costa Canal intake to less than 140 mg/l if seawater intrusion were the primary source of the chlorides. The chloride levels at the Banks Pumping Plant will be improved significantly; the lower salinity levels in SWP water delivered via the Banks Pumping Plant will enhance reclamation efforts and will improve the taste of the water and reduce corrosion.

6.2.4.2 THM Formation Potential

Alternative 4 will result in improved water quality, that is, less THM formation potential, over Alternative 3, particularly at the Banks Pumping Plant. This positive effect at Banks Pumping Plant may result in lower THM formation potential in the water at Rock Slough. It is not possible to quantify these impacts.

6.2.4.3 Agriculture

Western and Interior Delta - Same as Alternative 3

Southern Delta - Same as Alternative 3

6.2.4.4 Salmon - Same as Alternative 3

6.2.4.5 Striped Bass

This provides the same level of direct protection for striped bass spawning as Alternative 3. The indicated increase in San Joaquin River inflow and Delta outflow, combined with reductions in exports, may provide additional indirect protection for eggs and young even though Sacramento River inflow is reduced.

6.2.4.6 Water Supply

Alternative 4 is the same as Alternative 3 except for the additional 0.15 mg/l bromide objective at the Banks Pumping Plant to meet the trihalomethane objective. The changes in exports and total outflow are shown in Table 6-2.

6.2.5

Alternative 5 is also the same as Alternative 3 except for a change in the M&I and striped bass objectives. This alternative changes the location of M&I bromide objective of 0.15 mg/l to the Contra Costa Canal intake all year. It extends the location of the striped bass spawning objective from Prisoners Point to the area between Vernalis and Prisoners Point.

6.2.5.1 Municipal and Industrial

The 50 mg/l chloride objective at Contra Costa Canal will significantly reduce salinity levels at this intake. This will result in more improvement in water quality than Alternative 4.

6.2.5.2 THM Formation Potential

Alternative 5 would result in more positive impacts for Delta water purveyors (less THM formation potential) than Alternative 4. It is believed that the chloride/bromide levels provided by this alternative would result in THM levels well below the current maximum contaminant level (MCL) of 100 parts per billion (ppb).

6.2.5.3 Agriculture

Western and Interior Delta - Same as base

Southern Delta - Same as Alternative 3

6.2.5.4 Salmon - Same as Alternative 3

6.2.5.5 Striped Bass

This alternative provides for expansion of spawning habitat beyond Prisoners Point to Vernalis, potentially restoring access to spawning habitat formerly available in the upper San Joaquin River and its tributaries. The effects of deficiencies are the same as for Alternative 3. This alternative also provides additional protection for eggs and young because of reduced exports and additional San Joaquin River inflow. It has been hypothesized that allowing spawning farther upstream will simply expose these eggs and young to entrainment, and other effects of the projects, through Old River. Even if some are lost by this method, there may still be a net increase in survival because of reductions in exports and reverse flows, since substantial spawning would still occur in the central Delta area where reverse flows and entrainment have substantial impacts. Given the recommendations of DFG, consideration of this alternative will be deferred until the entrainment question of project operations is dealt with.

6.2.5.6 Water Supply

Alternative 5 is the same as Alternative 4 except for the additional 0.15 mg/l bromide objective at the Contra Costa Canal Pumping Plant #1 and the extension of the Prisoners Point striped bass spawning objective upstream on the San Joaquin River to Vernalis. The principal reason for the

increase in total Delta outflow is the increased carriage water needed to meet the 0.15 mg/l bromide (50 mg/l chloride) objective at the Contra Costa Canal. Like Alternative 4, the primary source of this additional water is from a corresponding reduction in exports and/or reduction in upstream diversion and use.

The combined effect of the southern Delta agricultural objective and the Prisoners Point to Vernalis (0.44 mmhos/cm EC) striped bass spawning objective requires an additional 9 and 58 TAF, respectively, in the 57-year and critically-dry period flows. Since Alternative 4, which includes the agriculture objective and the Vernalis inflow, is independent of the change in exports, the differences in the Alternative 4 and 5 Vernalis flows represent the additional water needed for the Prisoners Point striped bass spawning objective. Consequently, about 8 and 64 TAF of additional Vernalis flows are needed to meet the striped bass objective during the average and dry conditions, respectively.

The overall water supply effects of this alternative are considered more adverse than Alternative 4.

6.2.6

Alternative 6 includes the bromide objective of 0.15 mg/l at the Contra Costa Canal Intake and changes five other objectives from the "Recommended" alternative. In the striped bass spawning objective at Antioch, the provision for the higher EC values during deficiency years (1.6 to 3.7 mmhos/cm) is deleted. It also eliminates both the provision for raising the EC during this period if spawning ends earlier and the ramping flow between April 1 and April 15. The striped bass spawning objective between Vernalis and Prisoners Point is changed to an EC of 0.3 mmhos/cm from April 1 to May 31. The Suisun Marsh wildlife objective is modified from the Alternative 3 to include the original D-1485 objectives. For the protection of the Tidal Marshes and Rare, Threatened and Endangered Species, an objective of 15 to 20 mmhos/cm EC is set from February 1 through May 31 at Martinez in all years. The final change is the Chinook salmon temperature objective. The water temperature in the Sacramento and San Joaquin rivers in the fall and spring is reduced to 66°F for the protection of fall-run Chinook salmon.

6.2.6.1 Municipal and Industrial

While it is likely that this alternative would provide water quality equal to or slightly better than Alternative 5, the degree of improvement would be dependent upon the source of water to the San Joaquin River. Currently there is no model adequately sensitive to quantify the water quality changes.

6.2.6.2 THM Formation Potential - See 6.2.6.1

6.2.6.3 Agriculture

Western and Interior Delta - While the objectives are the same as in Alternative 3, the "umbrella" protection provided by the other objectives is likely to provide water of lower salinity to the Delta agricultural areas. This should, in turn, reduce the need for leaching.

Southern Delta - See 6.2.6.3

6.2.6.4 Salmon

This alternative provides an increase in San Joaquin River inflow on the average during the months April through July. However, the Sacramento River inflow is decreased during this period. Therefore this alternative would probably not improve the temperature conditions in the Sacramento River in the spring but temperatures may be improved in the San Joaquin River. In addition, because total Delta outflow is increased over the base condition and exports are decreased, it is possible that salmon rearing habitat in the Suisun Bay would be improved and reverse flows and entrainment into the pumps may be reduced. These conditions should result in minor improvements for salmon.

6.2.6.5 Striped Bass

This alternative provides full protection for striped bass spawning from April 1 to May 31 from Antioch to Vernalis, with no relaxation provision. Substantial increases in San Joaquin River inflow and Delta outflow, combined with substantial decreases in exports, also would provide extensive additional protection for eggs and young, especially in dry and critical years.

6.2.6.6 Water Supply

Alternative 6 provides the largest change from the base conditions. The additional increase in required Delta outflow, compared to Alternative 5, is due to the tidal marshes objective at Martinez and the more stringent striped bass objective. The 57-year exports decrease by 674 TAF or about 11 percent. The critically-dry period exports decrease by 1078 TAF or about 20 percent.

The water supply impacts of the "original" Decision 1485 Suisun Marsh objectives, if met solely with Delta outflow, were estimated to be 2 million acre-feet per year in the 1978 Plan (SWRCB,3, VI-11). However, this estimate should be used with caution since no documentation was provided to support it. Furthermore, this estimate has not been re-evaluated to reflect the effect of the Suisun Marsh Salinity Control Gate or future Marsh facilities.

The 0.3 mmhos/cm Vernalis to Prisoners Point striped bass spawning objective significantly increases the required Vernalis flow.

A comparison of the historical temperature data in the Sacramento River with the temperature objectives shows that, from 1978 through 1985, the five-day average temperatures are greater than the temperature objective of 66°F approximately 2 percent of the time in April, 23 percent of the time in May, and 79 percent of the time in June. A similar comparison for the San Joaquin River shows that the five-day average temperatures are greater than 66°F approximately 27 percent of the time in May and 43 percent of the time in June (WQCP-CVPWA-202).

6.3 Issues to be Considered in Establishing Water Quality Objectives

The implications of these alternatives are substantial. Any changes in salinity and temperature objectives can have pronounced effects on the economic health of California and on the protection of such resources as fish and wildlife. The total amounts of, and the parties responsible for fresh water flows in the watershed have yet to be determined. Attempts to model the effects of these factors is limited but improving rapidly. Any figures used to estimate the effects of these alternatives must be viewed with caution -- and with the commitment that these objectives can and must be altered when appropriate.

6.3.1 Cumulative Impacts of Flow Alternatives

The overall approach to the flow objectives is to provide increased protection for the salmon outmigration period and most of the striped bass spawning season, protecting both the adults and the young. The establishment and maintenance of the entrapment zone would be for the benefit of the Chinook salmon and the striped bass, as well as numerous other vertebrate and invertebrate species. It is recognized that a number of the parties are actively negotiating in an attempt to reach agreement on fishery protection measures. The State Board encourages these efforts. Any product of these negotiations will be evaluated along with flow alternatives and other options which may be proposed.

During the course of the proceedings, evidence was introduced stating that the addition of physical solutions, such as facilities, could greatly benefit the various beneficial uses of Bay-Delta waters. Evidence was also introduced that the most significant impacts to the fishery are due to the location, method, and timing of diversions, all of which affect instream flows.

As stated in Chapter 6.1 and to the extent discussed, two different flow alternatives were developed to analyze their water supply effects. One flow alternative used the objectives developed for the selected Alternative 3; the other used the objectives developed for Alternative 6. The same flows were added to both. They range, depending upon water year type, from 2,900 to 30,000 cfs at Chipps Island for the protection of striped bass eggs and larvae; from 2,500 to 22,500 cfs at Rio Vista for salmon outmigration in the Sacramento River and from 500 to 14,000 cfs at Vernalis in the San Joaquin River; and about 15,000 cfs for placement of the entrapment zone around Chipps Island.

These additional flows would result in Delta exports decreasing by 800 and 983 TAF, respectively, while the San Joaquin River inflow to the Delta would increase by 575 and 300 TAF, respectively. These comparative estimates are based upon operation study outputs.

6.3.2 Operation Studies

In this evaluation, the effects of the potential objectives were compared insofar as possible with the existing condition, or base case. The alternative objectives were reviewed for environmental impact, economic consequences and water cost.

One of the tools used in this analysis is the modelling results produced by DWR under the guidance of the operations studies workgroup. The modelling results provide valuable insight into the effects of various objectives. There are important limitations that must be recognized. The operations model generally uses the conditions of Water Right Decision 1485 (under which the CVP and SWP have operated for the past 12 years) as the base case. However, some changes have been made in recent months to improve the models, and all of the variations have not been rerun with the new assumptions. Further, the "1990 level of development" used in the model does not reflect actual diversions at this time. The modelling for the San Joaquin Basin is not as refined as is the case for the Sacramento/Delta. In recent years salinity objectives in the south Delta have been specified in Water Right Decision 1422, but the modelling uses slightly different objectives, based on a USBR/South Delta agreement. Given the variety of locations and beneficial uses, our discussion of the alternatives has considered D-1485 objectives, special modifications used in the operations models, and actual conditions, as appropriate.

The DWR representatives most familiar with the models agree that their work products should not be used to attempt to quantify effects of changes in objectives precisely. However, it has been agreed that they are very useful in establishing the relative effects of various assumptions.

In summary, better information will become available as the efforts to refine the models continue. This will be true in the foreseeable future. Despite the limitations described above, there is no valid basis for delaying our evaluation or for deferring use of the currently available model runs as a primary tool in our analysis of alternatives (See Appendix 6.3, Operation Studies.)

6.3.3 Fish and Wildlife

We recognize the importance of the protection of aquatic resources which may be primarily dependent upon aquatic habitat in the Delta. However, the State Board has received inconsistent recommendations regarding one of the most obvious problems, i.e., striped bass. With respect to spawning objectives, DFG has recommended deferring actions to restore this habitat to later phases of the hearing process, in part because it has concerns about the benefits which will accrue in view of possible large diversions of eggs and larvae to the SWP and CVP pumps via Old River. DFG does agree that expansion of appropriate habitat would be beneficial in the long run.

USFWS also recognizes that the benefits to striped bass which would be obtained by improving habitat at this time may be limited. However, it identified the issue as a water quality issue, and recommended establishing the additional salinity objectives at this time as a first step, to be combined with flows, diversion restrictions and/or physical facilities developed in later phases to provide overall increased protection.

Various participants have argued that there is no evidence that striped bass spawning habitat is limiting, and that striped bass have been observed to spawn in water with salinity higher than 0.44 mmhos/cm EC. Laboratory tests also suggest that eggs can survive and hatch in higher salinity water (see Section 5.6.2.1). On the other hand, observations on other striped bass populations indicate that, given a choice, all prefer to spawn above the limits of seawater intrusion. In the San Joaquin River, upstream salinity barriers appear to inhibit their ability to move entirely out of the effects of ocean salinity. We agree that the evidence for whether spawning habitat is limiting for striped bass, and what the maximum allowable salinity might be, is not definitive, particularly when comparing laboratory and field observations. However, we also recognize that spawning success, as measured by survival of eggs and young bass, is inextricably linked to the effects of flows, toxics, and other factors, so that distinguishing the effects of spawning habitat salinity alone may be impossible. Additional studies and data analysis on actual spawning conditions, spawning locations in different year types, and spawning success are sorely needed. We invite all participants to evaluate this question further, and we propose that a thorough review of this objective be undertaken at the next Triennial Review of this Plan (see Program of Implementation, Section 7.5.2.4).

Data supporting the 0.44 mmhos/cm EC are not without question and the data on the potential effects of extending the striped bass spawning protection from Prisoners Point to Vernalis are too inconclusive to warrant setting the potential objective as the water quality objective.

6.4 The Water Quality Objectives

The State Board believes that, on balance, the objectives contained in Table 6-3 (Alternative 3 in Table 6-1) best protect the beneficial uses of the waters of the Bay-Delta Estuary.

- Minor improvements are provided from the 1978 Delta Plan.
- The State Board did not hear any compelling testimony nor did it receive any exhibits indicating that major changes were needed in salinity, temperature or dissolved oxygen water quality objectives for the Bay-Delta Estuary.
- The 150 mg/l chloride objective is being retained in order to protect municipal water quality at present levels until more is known about the public health hazards of disinfection by-products.
- The objectives for agriculture continue the existing water quality objectives or the recognized agreements containing them.
- The change in the striped bass objective for Prisoners Point recognizes the existing condition in the area, sets a lower salinity objective to prevent degradation and extends the spawning period protection.
- This alternative will have some minimal effect on water distribution. Therefore, the economic impacts of this plan will also be minimal.

TABLE 6-3 WATER QUALITY OBJECTIVES

A) MUNICIPAL AND INDUSTRIAL

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Contra Costa Canal at Pumping Plant #1	*C-5 CHCCC06*	*Chloride (Cl-)*	*Maximum mean daily 150 mg/l chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Calendar Year shown in parenthesis)*	*Sac R 40-30-30*		*No. of days each Cal. Year < 150 mg/l Cl-*	
- or -					*W*		*240 (66%)*
San Joaquin River at Antioch Water Works Intake	*D-12(near) RSAN007*	*Chloride (Cl-)*		*Sac R 40-30-30*	*AN*		*190 (52%)*
					BN		*175 (48%)*
					D		*165 (45%)*
					C		*155 (42%)*
West Canal at mouth of Clifton Court Forebay	*C-9 CHWST0*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Delta Mendota Canal at Tracy Pumping Plant	*DMC-1 CHDMC004*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
Cache Slough at City of Vallejo Intake [1]	*C-19 SLCCH16*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*
and/or							
Barker Slough at North Bay Aqueduct Intake	*- SLBAR3*	*Chloride (Cl-)*	*Maximum mean daily, in mg/l*	*Not Applicable*	*All*	*Oct-Sep*	*250*

TABLE 6 – 3 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
1) WESTERN DELTA							
Sacramento River at Emmaton	*D-22 RSAC092*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos/cm (mmhos)*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	*--*
					AN	*July 1*	*0.63*
					BN	*June 20*	*1.14*
					D	*June 15*	*1.67*
					C	*--*	*2.78*
San Joaquin River at Jersey Point	*D-15 RSAN018*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	*--*
					AN	*Aug. 15*	*--*
					BN	*June 20*	*0.74*
					D	*June 15*	*1.35*
					C	*--*	*2.20*

TABLE 6-3 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
2) INTERIOR DELTA							
South Fork Mokelumne River at Terminous	*C-13 RSMKL08*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	*--*
					AN	*Aug. 15*	*--*
					BN	*Aug. 15*	*--*
					D	*Aug. 15*	*--*
					C	*--*	*0.54*
San Joaquin River at San Andreas Landing	*C-4 RSAN032*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily, in mmhos*	*Sac R 40-30-30*		*0.45 EC April 1 to Date Shown*	*EC from Date Shown to Aug. 15 [2]*
					W	*Aug. 15*	*--*
					AN	*Aug. 15*	*--*
					BN	*Aug. 15*	*--*
					D	*Jun. 25*	*0.58*
					C	*--*	*0.87*

TABLE 6 – 3 (cont.) WATER QUALITY OBJECTIVES

B) AGRICULTURAL

AREA

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
(To be implemented by 1996) [3]		**3) SOUTH DELTA**					
San Joaquin River at Airport Way Bridge, Vernalis *Old River near Middle River* *Old River at Tracy Road Bridge* *San Joaquin River at Brandt Bridge [site]*	*C-10 RSAN112* *C-8 ROLD69* *P-12 ROLD59* *C-6 RSAN073*	*Electrical Conductivity (EC)*	*Maximum 30-day running average of mean daily EC, in mmhos*	*Not Applicable* *If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.*	*All*	*Apr 1-Aug 31* *Sep 1-Mar 31* *or*	*0.7* *1.0*
		4) EXPORT					
West Canal at mouth of Clifton Court Forebay -and- Delta Mendota Canal at Tracy Pumping Plant	*C-9 CHWST0 DMC-1 CHDMC004*	*Electrical Conductivity (EC)*	*Maximum monthly average of mean daily EC, in mmhos*	*Not Applicable*	*All*	*Oct-Sep*	*1.0*

TABLE 6-3 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
CHINOOK SALMON							
DISSOLVED OXYGEN							
San Joaquin River between Turner Cut & Stockton	*RSAN050-RSAN061*	*Dissolved Oxygen (DO)*	*Minimum dissolved oxygen, in mg/l*	*Not Applicable*	*All*	*Sep 1-Nov 30*	*6.0*
TEMPERATURE							
Sacramento River at Freeport and	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*"The daily average water temperature shall not be elevated by controllable factors above 68 deg. F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types." [4]*	
San Joaquin River at Airport Way Bridge, Vernalis	*C-10 RSAN112*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*		
Sacramento River at Freeport	*RSAC155*	*Temperature*	*Narrative Objective*	*Not Applicable*	*All*	*"The daily average water temperature shall not be elevated by controllable factors above 66 deg. F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31." [4]*	

TABLE 6-3 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS-SALINITY-1 ANTIOCH-SPAWNING							
Sacramento River at Chipps Island	*D-10 RSAC075*	*Delta outflow Index (DOI)*	*Average for the period not less than the value shown, in cfs*	*Not Applicable*	*All*	*Apr 1-Apr 14*	*6,700*
San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 15-May 31 (or until spawning has ended)*	*1.5*
STRIPED BASS-SALINITY-2 ANTIOCH-SPAWNING-RELAXATION PROVISION							
San Joaquin River at Antioch Water Works Intake	*D-12 (near) RSAN007*	*Electrical Conductivity (EC)*	*14-day running average of mean daily not more than value shown corresponding to deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds, for the period shown, or until spawning has ended. The specific representative projects and amounts of deficiencies will be defined in subsequent phases of the proceedings.*	*Total Annual Imposed Deficiency (MAF)*		*Apr 1-May 31 EC in mmhos*	
						Dry	*Critical*
This relaxation provision replaces the above Antioch & Chipps Island standard whenever the projects impose deficiencies in firm supplies.				*0.0*		*1.5*	*1.5*
				0.5		*1.8*	*1.9*
				1.0		*1.8*	*2.5*
				1.5		*1.8*	*3.4*
				2.0 or more		*1.8*	*3.7*
				Linear interpolation is to be used to determine values between those shown.			
STRIPED BASS-SALINITY-3 PRISONERS POINT-SPAWNING							
San Joaquin River at: Prisoners Point	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than value shown, in mmhos*	*Not Applicable*	*All*	*Apr 1-May 31 (or until spawning has ended)*	*0.44*

TABLE 6 – 3 (cont.) WATER QUALITY OBJECTIVES

C) FISH AND WILDLIFE

HABITAT/SPECIES

LOCATION	SAMPLING SITE NOs. (I-A/RKI)	PARAMETER	DESCRIPTION	INDEX TYPE	YEAR TYPE	DATES	VALUES
STRIPED BASS-SALINITY:4 PRISONERS POINT-SPAWNING-RELAXATION PROVISION							
			When the relaxation provision for Antioch spawning protection is in effect:				
San Joaquin River at: Prisoners Point	*D-29 RSAN038*	*Electrical Conductivity (EC)*	*14-day running average of mean daily for the period not more than the value shown, in mmhos*	*Not Applicable*	*D&C*	*Apr 1-May 31 (or until spawning has ended)*	*0.55*

SUISUN MARSH

In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement. The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The SMPA also describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6 of the plan) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards.

FOOTNOTES:

[1] The Cache Slough objective to be effective only when water is being diverted from this location.

[2] When no date is shown, EC limit continues from April 1.

[3] South Delta Agriculture objectives will be implemented in stages: two interim stages and one final stage. The first interim stage will be implemented with the adoption of the WQCP, the second interim stage by 1994, and the final stage by 1996. Interim Stage 1 -- 500 mg/l mean monthly TDS all year at Vernalis. Interim Stage 2 -- (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge; with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge, and an additional interior monitoring station on Middle River at Howard Road Bridge. Final Stage -- (to be implemented no later than 1996) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge on the San Joaquin River; with two interior stations at Old River Near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old river and Middle River at Howard Road Bridge.

OR

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/montioring locations noted above, as appropriate.

[4] Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State, that are subject to the authority of the State Board, or the Regional Board, and that may be reasonably controlled. Based on the record in these proceedings, controlling temperature in the Delta utilizing reservoir releases does not appear to be reasonable, due to the distance of the Delta downstream of reservoirs and uncontrollable factors such as ambient air temperature, water temperatures in the reservoir releases, etc. For these reasons, the State Board considers reservoir releases to control water temperatures in the Delta a waste of water; therefore, the State Board will require a test of reasonableness before consideration of reservoir releases for such a purpose.

Table 6-4 provides a qualitative assessment of the impacts of the various alternatives and illustrates the basis for the selection of Alternative No. 3. Alternatives 1A, 1B, and 2 would fail to implement several water quality improvements which are within the scope of this plan and which are now reasonably achievable. Alternative 4 would provide positive, but unquantified benefits with respect to M&I use. There would be a definite cost in water supply to provide the benefit. As explained in Chapter 5, the uncertainty surrounding the issue of disinfection by-products makes it premature to attempt a final analysis of the benefits and detriments of this alternative. Alternatives 5 and 6 suffer the same defects. Additionally, expansion of the bass spawning area is premature, as is amendment of marsh objectives in advance of the biological assessment. Work on those issues must be completed before the benefits of more stringent objectives can be fairly compared to the high water supply cost. None of those alternatives (except No. 2) have any potential for growth inducing impacts. In conclusion, Alternative No. 3 is the most reasonable of those evaluated.

6.5 Environmental Effects

The State Board will prepare a separate EIR for the upcoming water right decision(s). The Scoping Phase of this Proceeding will help the State Board identify the issues to be addressed in that EIR; the EIR may refer to and build upon this environmental analysis, if appropriate.

The analysis of impacts in this discussion is confined to the effects of adopting or revising certain selected water quality objectives in the 1978 Delta Plan and D-1485, as amended. This discussion does not, and indeed cannot, thoroughly analyze the effects of decisions which may be made in the future by the State Board or other public or private entities. In particular, this analysis assumes that the flow standards contained in the 1978 Delta Plan (and implemented in D-1485) will remain in effect. The impacts of any future changes in flow standards will be fully analyzed in conjunction with any decision or decisions to change those standards in the upcoming EIR on the water rights decision.

An environmental checklist of possible impacts from the proposed State Board objectives is presented in Table 6-5. The State Board has concluded that the Plan will not have any significant or potentially significant effects. Impacts of specific objectives are analyzed in Chapter 5 and in the preceeding sections of this chapter.

6.6 Implementation

The means of implementing these objectives are discussed in Chapter 7 of this Plan.

6.7 Economic Considerations

During these proceedings, the State Board has often been told that California's water resources are vital to its economy, both in areas where water originates and where it is imported.

TABLE 6-4
QUALITATIVE ASSESSMENT OF IMPACTS

BENEFICIAL USE / IMPACT CRITERIA	ALTERNATIVE						
	1A	1B	2	3	4	5	6
	BASE	BASE w/ 40-30-30 YT	250 CL CCC/ 1.5 W DEL AG	S DEL AG/ ANT SPAWN	50 CL BANKS PP	50 CL CCC/ 0.44 VERN SP	R,T, & E/ 0.3 VERN SP
MUNICIPAL AND INDUSTRIAL							
SALINITY	O	O	—	O	+	+ +	+ +
TRIHALOMETHANE FORMATION POTENTIAL	O	O	—	O	+	+ +	+ +
AGRICULTURE							
WESTERN / INTERIOR DELTA WATER QUALITY	O	O	—	O	O	O	+
SOUTHERN DELTA WATER QUALITY	O	O	O	+	+	+	+ +
EXPORT WATER QUALITY	O	O	O	O	O	O	O
FISH AND WILDLIFE							
STRIPED BASS HABITAT	O	O	—	+	+	+	+ +
SUISUN MARSH WILDLIFE HABITAT	O	O	O	O	O	O	+
TIDAL MARSHES R, T, & E SPECIES HABITAT	O	O	—	O	O	O	+
SALMON HABITAT	O	O	O	+	+	+	+
WATER SUPPLY							
WATER SUPPLY	O	O	O	O	—	— —	— —

LEGEND:

\+ BENEFICIAL IMPACT
O INSIGNIFICANT IMPACT
— ADVERSE IMPACT

SELECTED ALTERNATIVE

NOTE:

This summary provides a gross, subjective indication of the direction and magnitude of changes in conditions.

01/10/91

Revised 11 January 1991

TABLE 6-5

ENVIRONMENTAL CHECKLIST

I. BACKGROUND

Name of Proponent: State Water Resources Control Board
Address: Executive Director
P.O. Box 100
Sacramento, CA 95810
Telephone: (916) 445-3085, James W. Baetge
Date of Checklist: December 13, 1990
Agency Requiring Checklist: State Water Resources Control Board
Proposal: Adoption of Water Quality Control Plan for Salinity and Temperature for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary

II. ENVIRONMENTAL IMPACTS

Legend: Y=yes
?=maybe
N=no

1 Earth. Will the proposal result in:	
a. Unstable earth conditions or in changes in geologic substructures?	N
b. Disruptions, displacements, compaction or overcovering of the soil?	N
c. Change in topography or ground surface relief features?	N
d. The destruction, covering or modification of any unique geologic or physical features?	N
e. Any increase in wind or water erosion of soils, either on or off the site?	N
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?	N
g. Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazards?	N
2 Air. Will the proposal result in:	
a. Substantial air emissions or deterioration of ambient air quality?	N
b. The creation of objectionable odors?	N
c. Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?	N

TABLE 6 – 5 (CONT.)

II. ENVIRONMENTAL IMPACTS (CONT.)

Legend: Y=yes
?=maybe
N=no

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?	N
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	N
c. Alterations in the course or flow of flood waters?	N
d. Change in the amount of surface water in any water body?	N
e. Discharge into surface waters, or in any alteration of surface water quality including but not limited to temperature, dissolved oxygen, or turbidity?	N
f. Alteration of the direction or rate of flow of ground waters?	N
g. Change in quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations?	N
h. Substantial reduction in the amount of water otherwise available for public water supplies?	N
i. Exposure of people or property to water related hazards such as flooding or tidal waves?	N
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)?	N
b. Reduction of the numbers of any unique, rare, or endangered species of plants?	N
c. Introduction of a new species of plants into an area, or in a barrier to the normal replenishment of existing species?	N
d. Reduction of acreage of any agricultural crop?	N
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?	N
b. Reduction of the numbers of any unique, threatened or endangered species?	N

TABLE 6-5 (CONT.)

II. ENVIRONMENTAL IMPACTS (CONT.)

Legend: Y=yes
?=maybe
N=no

c. Introduction of new species of animals into an area, or result in a barrier to the migration or movement of animals?	N
d. Deterioration to existing fish or wildlife habitat?	N
6 Noise. Will the proposal result in:	
a. Increases in existing noise levels?	N
b. Exposure of people to severe noise levels?	N
7 Light and Glare. Will the proposal produce new light or glare?	N
8 Land Use. Will the proposal result in a substantial alteration of the present or planned use of an area?	N
9 Natural Resources. Will the proposal result in:	
a. Increase in the rate of use of any natural resources?	N
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?	N
b. Possible interference with an emergency response plan or an emergency evacuation plan?	N
11 Population. Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?	N
12 Housing. Will the proposal affect existing housing, or create a demand for additional housing?	N
13 Transportation and Circulation. Will the proposal result in:	
a. Generation of substantial additional vehicular movement?	N
b. Effects on existing parking facilities, or demand for new parking?	N

TABLE 6 - 5 (CONT.)

II. ENVIRONMENTAL IMPACTS (CONT.)

Legend: Y=yes
?=maybe
N=no

c. Substantial effect on existing transportation systems?	N
d. Alterations to present patterns of circulation or movement of people and/or goods?	N
e. Alterations to waterborne, air, or rail traffic?	N
f. Increase in traffic hazards to motor vehicles, bicyclists, or pedestrians?	N
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:	
a. Fire protection?	N
b. Police protection?	N
c. Schools?	N
d. Parks or other recreational facilities?	N
f. Maintenance of public facilities, including roads?	N
g. Other governmental services?	N
15 Energy. Will the proposal result in:	
a. Use of substantial amounts of fuel or energy?	N
b. Substantial increase in demand upon existing sources of energy, or require the development of new sources of energy?	N
16 Utilities. Will the proposal result in a need for new systems, or substantial alterations to the following utilities:	
a. Sewerage?	N
b. Water?	N
c. Electricity?	N
d. Natural gas?	N
e. Telephone?	N
17 Human Health. Will the proposal result in:	
a. Creation of any health hazard or potential health hazard (excluding mental health)?	N
b. Exposure of people to potential health hazards?	N
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?	N

TABLE 6 – 5 (CONT.)

II. ENVIRONMENTAL IMPACTS (CONT.)

Legend: Y=yes
?=maybe
N=no

19	Recreation. Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?	N
20	Cultural Resources.	
	a. Will the proposal result in the alteration or the destruction of a prehistoric or historic archaeological site?	N
	b. Will the proposal result in adverse physical or aesthetic effects to a prehistoric or historic building, structure, or object?	N
	c. Does the proposal have the potential to cause a physical change which would affect unique ethnic cultural values?	N
	d. Will the proposal restrict existing religious or sacred uses within the potential impact area?	N
21	Mandatory Findings of Significance.	
	a. Does the proposal 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 or animal community, reduce the number or restrict the range of a rare, threatened, or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory?	N
	b. Does the project have the potential to achieve short-term, to the disadvantage of long-term, environmental goals?	N
	c. Does the project have impacts which are individually limited, but cumulatively considerable?	N
	d. Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	N

TABLE 6 – 5 (CONT.)

III. DISCUSSION OF ENVIRONMENTAL IMPACTS

Responses to any Y or ? answers are found in the text.

IV. DETERMINATION

On the basis of this evaluation, I find that the proposed project will not have any significant adverse effects on the environment because the State Board has set the water quality objectives at levels designed to adequately protect the designated beneficial uses of the Sacramento–San Joaquin Delta and San Francisco Bay waters.

Gerald E. Johns — 5/1/91

Signature — Date

Environmental Program Manager II

Title

for the State Water Resources Control Board

The following data were offered as policy statements. The degree of dependency on imported water varies, but is high in the San Francisco Bay area and in the San Joaquin Valley; dependency is also high in southern California. The San Diego region is 96 percent dependent on imported water (T,LXXIPOL,48).

For municipal and industrial use, the prime requirements are reliability of supply and high quality drinking water. Planning for the future must focus on improved reliability of supply and improvement in water quality.

Population and economic projections indicate growing M&I water demands. California's population today is just under 30 million. The state's population grew by 750,000 in 1989 (SWC,612,p.1). The Department of Finance has estimated that the state's population will increase to 36,280,000 by 2010 (DOF,1987). The DOF expects the population of the six most populated counties in southern California--Ventura, Los Angeles, Orange, Riverside, San Bernardino, and San Diego counties to increase from the 1986 level of 15,290,000 people to 20,200,000 by 2010 (SWC,6,7). With average daily water use of 188 gallons per capita, this implies a rise in California water use of approximately 1,322,000 AF, and a rise in southern California water use of a little over 1,033,000 AF by 2010 (DWR,14,91-113). The expected additional M&I demand for Bay Delta water supply is a result both of the loss of alternative water supplies and of the increase in population (SWC,4,6).

A reliable supply of imported water is one of the most important elements of southern California's economic strength. Southern California has an estimated 6.5 million jobs, about 50 percent of the people employed in the state, income of around $260 billion, which accounts for about 55 percent of the state's tax revenue (T,LXXIPOL,114). A reduction in water supply will cause a loss of productivity, income, and jobs. The analysis of this must rest on examination of marginal costs of water to marginal industries. SWC estimates suggest that a 45 percent reduction in the M&I projected water supply (approximately 2,592,000 AF) in the year 2000, would cause a loss of 1.5 million jobs and cause a potential income loss estimated at $98 billion (SWC,51,16;SWC,3,3). These estimates and others will be studied to determine the marginal costs of developing replacement water supplies, and the effects of shifting part of the burden from the industrial to the municipal sector.

The loss of jobs and income in southern California would have economic impacts beyond the region. Related jobs and income would be lost in other areas of the state as a result of jobs and income loss in southern California. This would also mean a significant loss of sales tax and income tax revenue to the state of California. Local governments would also lose tax revenues such as the occupancy tax for motels and hotels. Some examples from policy statements indicate the importance of imported water to the economic well being of the state and southern California. The building industry is said to generate about $55 billion in business activity representing about 22 percent of the economy of the region (T,LXXIIIPOL,54). Flower and ornamental plant sales in San Diego county total about $400 million per year and about 5,000 jobs are dependent on this industry in San Diego county (T,LXXIPOL,71). It is estimated that

the flower and ornamental plant industry uses about 600,000 AF of water per year (T,LXXIPOL,73). A related industry, landscape contractors, is said to have 1,700 members statewide with sales of $10.2 billion (T,LXXIPOL,109).

The value of agriculture, using water exported from the Bay-Delta, is discussed in the Technical Appendix (see Sections 4.0.4.1 and 4.0.9.2).

In the future the SWP and the CVP plan to expand deliveries to new areas and to areas experiencing increased need. SWP is studying a Coastal Branch which will supply water to Santa Barbara and San Luis Obispo counties, and an East Branch enlargement which will increase deliveries to the eastern part of the MWD's service area, and to San Bernardino County and the Antelope Valley. CVP is studying an extended San Felipe Branch which will supply water to Monterey and Santa Cruz counties, as well as an American River Aqueduct which will increase deliveries to EBMUD's service area in the Bay Area. SWP is also planning additional transfer and storage facilities at the following locations to increase its water distribution capabilities: the Kern Water Bank, Los Banos Grandes Reservoir, the south Delta, the north Delta, and additional pumps at the Delta Pumping Plant (DWR,707,42-53).

The issues discussed in this section address water quantity rather than quality. The availability of water for export uses is not significantly affected by this Plan. As stated in Section 6.1 and elsewhere, flow (water quantity) issues will be dealt with in detail during the Water Rights Phase of the proceedings. Interested parties that have provided testimony during the water quality phase should be prepared to discuss marginal costs and marginal value of water in their areas of interest.

7.0 PROGRAM OF IMPLEMENTATION

7.1 Introduction

A program of implementation is required in all water quality control plans (Water Code Section 13242). This chapter provides the program of implementation; it includes a discussion of how and when the water quality objectives set forth in this Plan are to be implemented, along with issues that need further study and that will be considered in the Scoping and Water Right phases of the proceedings and beyond.

To outline actions that will, or need to be taken, the discussion in this chapter has been divided into:

7.2 Implementation Measures
7.3 Compliance Monitoring
7.4 Special Studies and Reviews
7.5 Scoping and Water Right Issues.

7.1.1 Outstanding Scoping and Water Right Issues to be Discussed

The State Board will use its water quality and water right authorities and actions by others to implement the objectives in this Plan. Implementation alternatives will be further examined during the Scoping Phase. Those measures requiring water allocation adjustments will be determined by the State Board during the Water Right Phase of the proceedings.

At the end of the current proceedings (that is, after adopting a water right decision), the State Board will incorporate a revised Plan of Implementation that:

- establishes a timetable to carry out best practicable management of the resources and uses thereof;

- identifies potential new facilities and time schedules for planning and construction to achieve best practicable management;

- outlines suitable mitigation measures based on negotiated agreements to offset losses if some specified beneficial uses are not reasonably protected;

- requires modified uses to reasonably balance the allocation of fresh water resources to the beneficial uses; and

- proposes either new legislative directives or suggestions for that kind of legislation.

In addition, the State Board will evaluate new major facilities:

Upstream from Delta	Auburn Dam and Reservoir (could modify water right terms); additional fish hatcheries for salmon and steelhead.

In Delta	Delta island storage (permit terms and conditions) enlarge channels; isolated conveyance.
In Export Areas	Los Banos Grandes and Los Vaqueros (permit terms and conditions); conjunctive use of ground water basins; southern California surface reservoirs.
Mitigation	Wetlands additions; improve fish hatchery outputs; improve planting of fish; improve aquatic habitat; reduce infestations of injurious phytoplankton, clams, etc.
Water Use Modification	Improve irrigation efficiencies; retire agricultural land that causes drainage and other problems; increase artificial ground water recharge; increase waste water reclamation.
Potential Legislation	Set priorities for types of beneficial uses; fund agricultural land retirement where corrective drainage costs are high (similar to buy out of environmentally sensitive lands at Lake Tahoe).

7.1.2 Statewide Water Management

Achievement of reasonable protection for beneficial uses will require better management of California's water resources and equitable sharing of responsibilities to meet water quality objectives in the Bay-Delta Estuary.

All users of Estuary waters must share in the responsibility of meeting objectives to protect Bay-Delta beneficial uses. All users should pursue reclamation and conservation of water to their full feasible potential.

Currently, only certain permits of the CVP and SWP facilities are required to meet Bay-Delta Estuary water quality and flow objectives. (Other users are required to cease diversion when those projects are releasing stored water for Delta Water Quality). These projects represent only about one-half of the almost 30 million acre-feet of storage capacity within the watershed. The State Board will consider an equitable sharing of this responsibility among all users of Bay-Delta Estuary waters during the Scoping and Water Right phases of these proceedings. A first step that the State Board will consider during the Scoping Phase is expansion of the responsibility for maintaining Estuary water quality to all in-basin reservoirs larger than 100,000 acre-feet. This action would add 31 reservoirs to the list of those assigned this responsibility. Almost 90 percent of the water stored in the watershed would then be operated to help maintain Estuary objectives. The extent to which smaller projects will be included will be considered during the Scoping Phase.

7.2 Implementation Measures

7.2.1 General

New measures are limited to a Salt Load Reduction Program and a staged implementation of water quality objectives in the southern Delta.

In regard to the Suisun Marsh, the water quality objectives for Suisun Marsh are unchanged from the 1978 Delta Plan. The implementation vehicle, Water Right Decision 1485 (D-1485), was amended in 1985 to change (or delete) some monitoring stations and to revise the schedule for implementation. The DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) have signed and adopted a set of three agreements concerning the Suisun Marsh. These are the Suisun Marsh Preservation Agreement (SMPA), the Monitoring Agreement, and the Mitigation Agreement. The SMPA contains water quality standards for the managed marshes of Suisun Marsh which the four signatories would like the State Board to adopt as water quality objectives. The SMPA also describes the physical facilities that the four signatories have agreed would serve the managed marshes in order to maintain production of preferred waterfowl food plants. The facilities built so far, including the Suisun Marsh Salinity Control Gates (previously called the Montezuma Slough Control Structure), have changed the physical regime in the Marsh.

Revised water quality objectives incorporating the SMPA (with any modifications necessitated by the biological assessment) will be adopted by the State Board after the biological assessment (discussed in Section 7.4.2.6) is completed. Until that time, the water quality standards in the amended D-1485 will continue to be implemented; see Table 1-2 for a summary of these standards.

7.2.2 Achieving Objectives for Beneficial Uses

7.2.2.1 Municipal and Industrial Uses

General Requirements

- **There is a need for water from the best available sources to meet the drinking water needs of all Californians. The water supply agencies should advise the State Board during the Scoping Phase on their plans and programs to obtain high quality drinking water through the year 2010.**

  - Within the Delta and in Export Areas

There are no differences between the M&I water quality objectives developed in this Plan and those developed in D-1485. With minor exceptions, these objectives are currently being met. The existing requirements and operations include mechanisms for dealing with violations which occur. Therefore, no new implementation measures are needed. Currently DWR and USBR are responsible for meeting these objectives.

7.2.2.2 Agriculture

o Western and Interior Delta

There are no differences between the objectives for agriculture on the Western and interior Delta developed in this Plan and those developed in D-1485. With minor exceptions these objectives are currently being met.

o Southern Delta

The implementation plan is comprised of two interim stages and a final stage.

Interim Stage 1 -- 500 mg/l mean monthly TDS all year at Vernalis.

Interim Stage 2 -- (to be implemented no later than 1994) 0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge; with water quality monitored at three current interior stations -- Mossdale, Old River, near Middle River and Tracy Road Bridge, and an additional interior monitoring station on Middle River at Howard Road Bridge.

Final Stage -- (to be implemented no later than 1996)
0.7 mmhos/cm EC April 1 to August 31, 1.0 mmhos/cm EC September 1 to March 31, 30-day running average, at Vernalis and Brandt Bridge on the San Joaquin River; with two interior stations at Old River near Middle River and Old River at Tracy Road Bridge. Monitoring stations will be at Mossdale at head of Old River and Middle River at Howard Road Bridge.

or

If a three-party contract has been implemented among DWR, USBR and the SDWA, that contract will be reviewed prior to implementation of the above and, after also considering the needs of other beneficial uses, revisions will be made to the objectives and compliance/monitoring locations noted above, as appropriate.

o Export Agriculture

The export agriculture EC objective is presently met at virtually all times. The salt load reduction goal discussed here will help to continue achieving this objective.

o Salt Load Reduction Goal

o **Upon adoption of this Plan, the State Board will request the Central Valley Regional Board to develop and adopt a salt-load reduction program. The goal of this initial program will be to reduce annual salt-loads discharged to the San Joaquin River by at least 10 percent and to adjust the timing of salt discharges from low flow to high flow periods. During the Water Right Phase of these proceedings, the Regional Board should discuss how it intends to implement this program (for example, drainage operation plans and best management practices).**

The goal of this program shall be to reduce the salt load discharged to the San Joaquin River by at least 10 percent. This amount should be achieved by increasing the irrigation efficiency on the west side of the San Joaquin River Basin to a target level of 73 percent with a five percent leaching fraction as recommended by the Agricultural Water Conservation Workgroup. This should reduce the annual subsurface drainage from tile drained portions of the west side by about 40 percent as envisioned by the State Board's Technical Committee and the San Joaquin Valley Drainage Program (see EDF,11,V-13-20 and San Joaquin Valley Drainage Program, 1990). Since about 25 percent of the annual San Joaquin River salt load is from west side subsurface drainage, this drainage reduction amounts to a 10 percent reduction in annual San Joaquin River salt load (0.40 x 0.25 = 0.10) based on State Board staff modeling results (see EDF,11,Appendix C). Annual salt loads could be further decreased by reducing and recycling tailwater discharges to the San Joaquin River from the west side.

In addition to annual reduction in salt load, it would also be possible to adjust the timing of salt load discharge from the west side of the San Joaquin River Basin through storage of drainage flows (see Pickett and Kratzer, 1988). The need for dilution flows from the east side of the San Joaquin River Basin to meet seasonal water quality standards in the southern Delta would be reduced.

The salt load reduction policy, which would help to protect beneficial uses in the southern Delta, should be achieved through development of best management practices and waste discharge requirements for non-point source dischargers. The Central Valley Regional Board should present the policy to the State Board no later than the Water Right Phase of the proceedings. If adequate progress is not being made, the State Board will proceed under its authorities.

7.2.2.3 Chinook Salmon

The temperature objectives at Freeport on the Sacramento River and at Vernalis on the San Joaquin River are to be implemented through controllable factors (see Section 5.5.2.5). Methods of implementation will be discussed during the Scoping Phase.

7.2.2.4 Striped Bass

The striped bass spawning protection objectives set specific EC requirements at Antioch and Prisoners Point. These objectives will be implemented by flows, primarily by Sacramento River flows in most years. Responsibility for meeting these requirements by specific water rights holders will be determined in the Scoping and Water Rights phases.

7.2.2.5 Other Fish and Wildlife

No implementation measures are needed currently, since there are insufficient data to set water quality objectives for this beneficial use. Additional data are requested to help determine if objectives are needed.

7.2.2.6 Suisun Marsh

The implementation schedule for the Suisun Marsh objectives is the schedule in D-1485, as amended in 1985 (see Table 1-2). Once the biological assessment described in Section 7.4.2.6 is completed, the implementation schedule will be reviewed and, if necessary, revised.

7.3 Compliance Monitoring

7.3.1 General

The goals of the compliance monitoring program are to (1) ensure compliance with the water quality objectives contained in this Plan; and (2) identify meaningful changes in any significant water quality parameters potentially affecting the designated beneficial uses. In the main, the compliance monitoring stations in Table 7-1 are the same, or only slightly relocated, stations as in the original D-1485 adopted in 1978. The only differences are in Suisun Marsh and south Delta agriculture. The Suisun Marsh control stations have been changed to those in the 1985 amendment to D-1485. Some compliance monitoring stations have been added in the south Delta (see Table 7-1 for details). Any additional monitoring not required by D-1485 will have to be adopted in future actions by the Board.

- o Operate and maintain continuous electrical conductivity recorders at the stations indicated in Table 7-1 to report representative water quality conditions.

- o Conduct water quality profiles in the main navigation channels in South Bay and between the Golden Gate Bridge on the west and Stockton and Rio Vista on the east, using a boat-mounted continuous recorder for the following parameters: water temperature, electrical conductivity, pH, dissolved oxygen, turbidity, and in vivo chlorophyll.

- o Establish continuous recorders at representative stations in selected channel sections of the Bay-Delta Estuary to collect information on air and water temperature, wind velocity and direction, pH, dissolved oxygen, turbidity, and, where feasible, in vivo chlorophyll. These data should be evaluated and correlated with conditions as they exist in the adjacent main channels.

- o Conduct ongoing and future monitoring surveys recommended by DFG and concurred with by the State Board, concerning food chain relationships and fish and wildlife impacts as they are affected by implementation of this Plan. The responsibility for funding and performing these surveys and preparing a report will be addressed and assessed during the Scoping and Water Right Phases of the proceedings.

The results of the above monitoring should be provided to the State Board and other interested agencies upon request. Detailed annual reports summarizing the previous water year's findings and detailing future study plans shall be submitted to the State Board by April 1 of each year. This report will not be required until after the Water Right Phase.

TABLE 7-1
BAY-DELTA ESTUARY WATER QUALITY MONITORING PROGRAM [1]

	Station Location	E.C. *	Base* Param. [2]	Phyto.* [3]	Phos.,TDS* & Cl [4]	H.M/Pest [5] *	Benthos [6]
C2	Sacramento River @ Collinsville	C					
C3	Sacramento River @ Greens Landing	C	SM/M	SM/M	M	SA	SA
C4	San Joaquin River @ San Andreas Landing	C					
C5	Contra Costa Canal @ PP#1	C [7]					
C6	San Joaquin River @ Brandt Bridge (site)	C					
C7	San Joaquin River @ Mossdale	C	SM/M	SM/M	M	SA	SA
C8	Old River near Middle River	C					
C9	West Canal @ mouth/intake to Clifton Ct. Forebay	C [7]	SM/M	SM/M	M		
C10	San Joaquin River near Vernalis	C/TEMP	SM/M		M		
C13	Mokelumne River @ Terminous	C					
C19	Cache Slough @ City of Vallejo Intake	C [7]					
NBA	North Bay Aqueduct Intake @ Barker Slough	C [7]					
D4	Sacramento River above Point Sacramento		SM/M	SM/M	M	SA	SA
D6	Suisun Bay at Bulls Head Point nr. Martinez		SM/M		M	SA	SA
D7	Grizzly Bay @ Dolphin nr. Suisun Slough		SM/M	SM/M	M		SA
D8	Suisun Bay off Middle Point nr. Nichols		SM/M	SM/M	M		
D9	Honker Bay near Wheeler Point		SM/M	SM/M	M	SA	SA
D10	Sacramento River @ Chipps Island	C/FLOW	SM/M		M		
D11	Sherman Lake near Antioch		SM/M		M	SA	SA
D12	San Joaquin River @ Antioch Ship Canal		SM/M	SM/M	M	SA	
D12N	San Joaquin River @ Antioch Water Works	C [7]					
D14A	Big Break near Oakley		SM/M		M	SA	SA
D15	San Joaquin River @ Jersey Point	C	SM/M	SM/M	M		
D16	San Joaquin River @ Twitchell Isl.		SM/M		M		
D19	Franks Tract near Russo's Landing		SM/M		M	SA	SA
D22	Sacramento River @ Emmaton	C	SM/M		M		
D24	Sacramento River below Rio Vista Bridge	FLOW	SM/M	SM/M	M		
-	Sacramento River @ Freeport (RSAC155)	TEMP					
D26	San Joaquin River @ Potato Point		SM/M	SM/M	M		
D28A	Old River near Rancho Del Rio	C	SM/M		M	SA	SA
D29	San Joaquin River @ Prisoners Point	C					
D42	San Pablo Bay near Rodeo		SM/M	SM/M	M		
DMC1	Delta Mendota Canal	C [7]					
MD6	Sycamore Slough near Mouth		SM/M		M		SA
MD7	South Fork Mokelumne River below Sycamore Sl.		SM/M	SM/M	M		SA
MD10	Disappointment Slough @ Bishop Cut Turner Cut @		SM/M	SM/M	M		
-	Light 26 (RSAN050)	C					
-	San Joaquin River @ mouth of Fourteen-mile Slough (RSAN052)	C	SM/M				
P8	San Joaquin River 1.5 Km NW of Rough & Ready Island @ Light 40 (Buckley Cove) (RSAN056)	C	SM/M	SM/M	M	SA	SA
-	San Joaquin River @ Country Club Landing @ Light 43 (RSAN059)	C	SM/M				
-	San Joaquin River @ Rough & Ready Island (RSAN062)	C	SM/M				
-	San Joaquin River between Turner Cut & Stockton (RSAN050 - RSAN061)	D.O. cont.					

TABLE 7–1 (cont.)
BAY–DELTA ESTUARY WATER QUALITY MONITORING PROGRAM [1]

	Station Location	E.C. *	Base* Param. [2]	Phyto.* [3]	Phos.,TDS* & Cl [4]	H.M/Pest [5] *	Benthos [6]
P10	Middle River @ Borden Highway	C/G.H.	SM/M		M		
P11	Middle River @ Howard Road Bridge	C/G.H.					
P12	Old River @ Tracy Road Bridge	C	SM/M		M		
S21	Chadbourne Slough @ Chadbourne Road	C/G.H.					
S33	Cordelia Slough, 550 ft. west of Southern Pacific crossing at Cygnus	C/G.H.					
S35	Goodyear Slough at Morrow Island Clubhouse	C/G.H.					
S36	Suisun Slough near Mouth	C/G.H.					
S42	Suisun Slough 300 ft. south of Volanti Slough	C/G.H.	SM/M	SM/M	M		
S49	Montezuma Slough near Beldon's Landing	C/G.H.					
S54	Montezuma Slough @ Hunter's Cut	C/G.H.					
S64	Montezuma Slough @ National Steel	C/G.H.					
S75	Goodyear Slough 1.3 mi. south of Morrow Island [Drainage] Ditch @ Pierce	C/G.H.					
S97	Cordelia Slough @ Cordelia–Goodyear Ditch (proposed)	C/G.H.					
-	Water supply intake locations on Van Sickle Island and Chipps Island	C/G.H.					

* Column Abbreviation Key

E.C. – Electrical Conductivity

B.P. – Base Parameters

Phyto.– Phytoplankton

Phos. TDS & Cl– – Phosphorous, Total Dissolved Solids, and Chlorides

H.M/Pest.– Heavy Metals , Pesticides

C – Continuous

SM – Semi–Monthly (twice a month)

M – Monthly

SA – Semi–annually (spring and fall)

G.H. – Gage Height

[1] The compliance monitoring needed for this plan or Decision 1485 are shaded.

[2] Air and water temperature, electrical conductivity, pH, dissolved oxygen, turbidity, water depth to 1% light intensity, secchi disc depth, volatile and non–volatile suspended solids, nitrate,nitrite, ammonia, total organic nitrogen, chlorophyll a, silica.

[3] Enumeration and identification to the species level where possible.

[4] Orthophosphate and total phosphorus.

[5] Heavy metals – arsenic, cadmium, chromiun (all valences), copper, iron, lead, manganese, mercury, zinc.

Pesticides – chlorinated hydrocarbones to include: Aldrin, Altrazine, BHC, Chlodane, Dacthal, DDD, DDE, DDT, Dieldrin, Endrin, Endosulfan, Heptachlor, Kelthane, Lindane, Methoxychlor, Simazine, Toxaphene, PCB.

Sampling to take place in water column and bottom sediments. Sediment samples are to be taken in transects across the channel.

[6] Benthic samples are to include identification and enumeration to the lowest taxonomic level possible. Samples to be taken in transects across the channel. Continuation of this aspect of the monitoring program will be reevaluated annually.

[7] Municipal and Industrial Intake objectives are specified in chlorides. EC can be monitored and converted to chlorides.

7.3.2 Compliance Monitoring for Specific Beneficial Uses

7.3.2.1 Municipal and Industrial

Barker Slough, the diversion point for the recently completed North Bay Aqueduct, is monitored and additional monitoring requirements are needed. The Cache Slough Intake, the previous location of the diversion point for the Vallejo M & I water supply, will be used only on a limited and irregular basis. Therefore, monitoring need only be done at the Cache Slough Intake when diversions occur.

7.3.2.2 Agriculture

See Table 7-1 for appropriate monitoring requirements.

7.3.2.3 Salmon

Monitoring of temperature to verify achievement of the proposed objective would require recording and reporting daily temperatures at Freeport on the Sacramento River and Vernalis on the San Joaquin River. This requirement should be carried out by USGS until other responsible parties are identified.

The temperature data collected are to be submitted to the State Board, which will then make a determination whether controllable factors should be controlled.

DO levels in the lower San Joaquin River have been monitored by DWR between Turner Cut and Stockton since at least 1969. DWR should continue the monitoring for the protection of Chinook salmon in the lower San Joaquin River.

7.3.2.4 Striped Bass

Compliance with the Antioch objective is presently documented by continuous monitoring of EC at Antioch, as well as by grab samples taken as part of the DWR compliance monitoring program. Prisoners Point does not have a continuous monitor in place since D-1485 does not require one. Apparently, no monitoring was required at Prisoners Point because the objective was in effect for such a short time period each year. Some monitoring has been accomplished by the taking of occasional grab samples at Prisoners Point, and by extrapolation from observations taken at a monitoring location in Potato Slough. These data have indicated that ECs at Prisoners Point have apparently not exceeded the current objective of 0.55 mmhos/cm EC for the period April 1 to May 5. Given the proposed lowered EC objective in the present Plan and the extended period of protection, continuous monitoring should be instituted at Prisoners Point (see also discussion in Special Studies, 7.4).

7.3.2.5 Other Fish and Wildlife

o Benthos

For the present time, the 1978 Delta Plan benthic monitoring program will continue unchanged, pending any changes resulting from input received during the Scoping and Water Right phases.

7.3.2.6 Suisun Marsh

See Table 7-1 for appropriate monitoring requirements.

7.4 Special Studies and Reviews

o **Past studies of the estuarine habitat have been extensive. Relatively few have led to specifically quantify the lower levels of conditions that protect the beneficial uses. The studies discussed below should lead to actions that can be implemented to protect these uses more effectively.**

7.4.1 General

The purpose of special studies is to develop a better understanding of the hydrology, hydrodynamics, water quality, water use, and significant ecological interactions of the Bay-Delta Estuary and its watershed and export areas. The activities necessary to accomplish this goal include performing special studies and developing and enhancing physical, chemical, and biological predictive tools. This information will be necessary for future revisions of this Plan and for use in the Scoping and Water Right phases of the proceedings.

7.4.2 Special Studies for Beneficial Uses

7.4.2.1 Municipal and Industrial Uses

o **Additional information is required to assess adequately the impact of Delta agricultural drains on THM formation. There is a need to conduct appropriate, comprehensive monitoring of agricultural discharges. The Central Valley Regional Board shall require the development and implementation of best management practices or other means to appropriately control these discharges. This task should begin in the Rock Slough area.**

o An Interagency Program led by DWR has been formed to continue the work conducted by the Delta Health Effects Study and the Delta M&I Workgroup. The primary task of the new workgroup is to investigate conditions that adversely affect drinking water. The State Board requests this workgroup to design and implement a comprehensive THMFP monitoring program for the Delta by June 1991, and to present annual progress reports to the State Board commencing in January 1992.

The primary tasks of the new workgroup should be to:

1) Continue the studies conducted by DWR to assess completely the impact of agricultural drain discharges affecting the Delta with relation to THMFP. Agricultural drains located near municipal water supply intakes which are suspected of causing significant effects on drinking water quality should be given priority. The State and Regional Boards shall employ appropriate measures to ensure monitoring can be conducted. Design and implement a comprehensive THMFP monitoring program for the Delta by July 1991. This program should be designed around the Municipal Water Quality Investigation. Results and recommended actions should be completed no later than January 1, 1993.

2) Encourage continued research on various techniques of disinfection which may reduce or eliminate the production of hazardous DBPs. Research should focus on promising techniques such as PREOZONATION and ozonation/chlorination/ammoniation. Progress of research and recommended actions should be reported by January 1, 1992.

3) Develop a correlation between THMFP, as measured by the monitoring program, and THM concentrations in treated drinking water.

7.4.2.2 Agriculture

o Western and Interior Delta

o **The Corn Study provides important information on the sensitivity of corn. A leaching study was recently begun to evaluate its effectiveness, practicality, and costs. This information is needed before a new objective can be set to protect the western and interior Delta agriculture. This study should be completed and the results submitted during the Water Right Phase of the proceedings.**

o Southern Delta Agriculture

The information presented in Phase I and in the Southern Delta Agriculture Subworkgroup has shown that more information is needed to resolve differences. A study in the following areas is needed:

- crop requirements during germination and the early stage of growth,

- potential leaching fractions,

- effectiveness of rainfall in reducing leaching requirement,

- timing of the objective, and

- response of crops other than beans and alfalfa.

This proposed study should be jointly-funded by the beneficiaries, performed by the University of California Cooperative Extension and completed in time to be used in the next Triennial Review.

7.4.2.3 Salmon

The Five Agency Salmon Committee (composed of DFG, DWR, USBR, USFWS, and NMFS) will continue to pursue studies which identify the critical factors influencing smolt survival. In the short-term, studies will probably be designed to investigate the influence of temperature, especially in the San Joaquin River, on smolt survival. The effect of temperature will be analyzed in relation to various release sites, diversion curtailments, export levels, reverse flows, total outflow levels, migratory routes, Bay survival, etc. The State Board recommends that the Committee work with agricultural representatives to study whether agricultural methods can be modified to minimize increasing the temperature of the receiving water in the Sacramento and San Joaquin River waters during April through June.

SWC recommended that a salmon and striped bass punchcard management system be implemented by DFG to assist them in more accurately assessing the total annual catch of salmon and striped bass in the inland sport fishery. Such a program could be useful as well for the ocean sport fishery.

Water quality parameters, such as temperature and dissolved oxygen, have been discussed in terms of the fall-run Chinook salmon. Winter-run may also be adversely affected by these parameters. There is no evidence of a winter-run in the San Joaquin River system; however, the winter-run of Sacramento River (and possibly Calaveras River) origin may be drawn into the central and south Delta during the up-or downstream migrations. Therefore, two things need to be investigated: 1) when and where do the winter-run migrate through the Delta, and 2) what are the ranges of temperatures and dissolved oxygen in those areas during those times. The Five Agency Salmon Management Committee should investigate the particular methods possible to better define the critical pathways and times of occurrence of winter-run in the Delta. As stated in Chapter 5.5.2.3 in the Bay-Delta DFG differentiates winter-run salmon from fall-run salmon by size difference. We recommend that DFG continue its effort to find a better method of differentiation.

Salmon Smolt Survival in the Delta

There is a great variety of potential studies that would improve our understanding of salmon smolt survival in the Sacramento-San Joaquin Delta. Some of these have been implemented and will be continued. The studies listed below (Kjelson et al., 1990) are not necessarily listed by priority and should be considered by the Five Agency Committee for implementation.

All appropriate studies will be considered; the list of studies is not meant to be exclusive.

- Evaluate the survival of smolts under a wide range of inflow/export ratios with particular emphasis to ratios between 1.0 and 5.0 when inflow is greater than about 5000 cfs.

- Document the proportion of smolts that are diverted into upper Old River under varied flows, export rates and tidal conditions.

- Measure survival of fish released above the upper Old River diversion point (i.e., Vernalis or Mossdale) to compare with survival data from past releases in upper Old River and in the San Joaquin River at Dos Reis Park.

- Evaluate survival of smolts, tagged with coded wires and released in the lower Mokelumne River, at Jersey Point, Dos Reis Park, and lower Old River at varied export and inflow levels.

- Evaluate the effect of high cross Delta flow on smolt survival migrating out of the San Joaquin River as would characterize conditions with DWR's Delta alternative projects. A barrier in upper Old River with high exports would yield such conditions.

- Evaluate the relative proportion of smolts entering the intakes to Clifton Court Forebay and the CVP's Tracy Facility.

- Evaluate direct and indirect mortality in the Delta using multiple release locations in varied channels and control release sites at the intakes to Clifton Court Forebay and the Tracy Facility.

- Evaluate the louver efficiencies and general effectiveness of the Tracy Fish Facility.

- Evaluate smolt survival in the San Joaquin Delta at varied temperatures (60° to 70°F).

- Evaluate the difference in survival of smolts that are restricted to salvage at the Tracy Facilities to those that are vulnerable to both Clifton Court and the CVP intakes.

- Evaluate the effectiveness of pulse flows of different timing, magnitude and duration in the Sacramento and San Joaquin rivers.

The studies already implemented are evaluated on an annual basis and are compared among years. Study designs are evaluated and improved each year prior to the fall-run Chinook salmon smolt emigration period. Any modification of water quality objectives should be based on the results of the annual studies compiled to date.

7.4.2.4 Striped Bass

o **Continuous EC and temperature monitoring equipment should be installed at various locations in the San Joaquin River between Antioch and Vernalis to obtain data on salinity conditions for striped bass spawning.**

The Interagency Ecological Study Program and others need to study:

1. EC and the effects of different salinities on striped bass and their habitat between Antioch and Prisoners Point;

2. Water quality effects of salinity and temperature on eggs and larval development, particularly in the San Joaquin River;

3. The annual die-off of striped bass to determine if it is due to water quality factors;

4. The effects of agricultural return flows on striped bass;

5. The actual patterns of spawning periodicity, locations, water quality conditions, and fate of eggs and young; and

6. The impact of introduced exotic organisms, e.g., Potamocorbula amurensis, and other factors on striped bass food chains.

These studies could provide data which are critical to our understanding of the effects of water quality on striped bass migration and spawning success.

7.4.2.5 Other Fish and Wildlife Studies

o American Shad

The DFG data on American shad suggest a pattern of relationships between upstream migration into tributary streams for spawning and subsequent early rearing of young. The role of the Delta and Suisun Bay areas as spawning and nursery habitat is not clearly presented in terms which can be quantified to establish water quality objectives, flow requirements or operational constraints. Substantial additional information is required before the State Board can implement either water quality objectives or water right permit terms and conditions for the protection of this fishery in the Estuary. Participants should plan to present information and any demonstrations that specific objectives are needed at the next Triennial Review.

o Delta Smelt

In 1991, DFG should analyze existing data on environmental conditions, including reverse flows, affecting Delta smelt growth, survival, reproductive success and spatial distribution; this information should be ready for submittal to the State Board during the Scoping Phase.

The feasibility of a mark and recapture study or other study to better document seasonal movements and habitat preferences of Delta smelt in its various life stages should be investigated by DFG. Such a study would require a few years of sampling to document trends, and should be completed and analyzed by the Triennial Review of the Plan.

Historical SWP and CVP data on Delta smelt salvage has not been very reliable. DFG is confident that, currently, quality control is sufficient for the enumeration of trends in species composition. DFG will be assuming responsibility for enumerating fish at the SWP facility this next year. Improvements in procedures will be made in future. Salvage data on Delta smelt from both facilities, including sampling methods, should be submitted during the forthcoming proceedings.

o Benthos

Benthic communities in various parts of the Estuary must be viewed in terms of their role in the overall Estuary. Their relative value, particularly in terms of balancing the needs of various beneficial uses, is difficult to determine when compared to striped bass, agricultural crops or other beneficial uses which can be more readily measured and compared. Parties should be prepared to discuss ways to answer these questions in terms of the overall functioning of the Estuary, as well as the specific reactions of individual species or groups of species (such as bay shrimp) to changing salinity, flow, and other conditions. Parties should plan to present these discussions during the Scoping and Water Right Phases.

7.4.2.6 Marshes around Suisun Bay

A. Biological Assessment

o **A new comprehensive Biological Assessment is being conducted concerning the rare, threatened and endangered species (and their habitat) of the managed and unmanaged wetlands around Suisun Bay.**

The information needed for the Biological Assessment under CESA includes:

1. A full description of the Sacramento-San Joaquin Delta/San Francisco Bay region, with an explanation of the area affected by any proposed changes in the water quality objectives, plus maps.

2. The known and potential distribution of rare, threatened, and endangered species in the region and affected area based on recent field surveys. In addition, the State Board needs information about any federal candidate species and any species of special concern to DFG in order to discuss fully possible impacts on those species as required under CEQA.

3. Any additional information on species distribution and habitat requirements from the literature, scientific data review, and discussion with experts.

4. Analysis of the possible effects of the proposed water quality objectives on these listed species, including any cumulative effects.

5. An analysis of alternatives designed to reduce or eliminate adverse effects to listed species.

For Item 1, the State Board has sufficient information to describe the Bay-Delta region. The State Board is as yet unable to delineate in any clear way the actual area where the water quality objectives could result in detectable changes in water quality. Adoption of the SMPA water quality objectives for the Suisun Marsh and Bay would, according to DWR, result in higher salinities in Grizzly and Honker bays, but the full extent of the affected area is not clear (DWR,511,11-18,27,60). Salinity modeling studies are needed to allow the State Board to predict the effects of these objectives better.

For items 2 and 3, the State Board has information for some of the listed species, but in some cases it is neither recent nor geographically comprehensive. Most of the information has been collected or noted during work done for other purposes, and is thus spotty both in time and geography. Where information is missing, additional studies will be needed. Compilation of information from the literature as well as from unpublished data sources can be done in parallel with field work. Additional laboratory studies determining the salinity requirements of some of the rare plants may be needed.

For item 4, once a sufficiently accurate salinity model is operable and the environmental requirements of the various species are known, this analysis can proceed. The relative effects of alternatives on other beneficial uses can then be estimated and a final set of objectives chosen.

DWR has volunteered to conduct the biological assessment to evaluate the impacts of adopting the SMPA standards as water quality objectives. The State Board will need an acceptable biological assessment on or before April 1, 1996, allowing review of the results of the assessment as part of its regular triennial review.

B. Studies

- **Studies are needed to determine the relationship between channel water salinity and soil water salinity in the tidal wetlands around Suisun Bay.**

These studies should include at least:

1) A regular monitoring program for the managed areas of one or more of the channel islands (Roe, Ryer, Snag, and Freeman islands) including a) the EC of the applied water, the EC of water in the root zone, and the seed production per acre at two or more sites; and b) continuous EC measurements of the applied water and monthly measurements of the soil water from October through June (the results should be reported as mean monthly EC of applied water, monthly EC of soil water, and annual seed production per acre).

2) A regular monitoring program for the unmanaged tidal wetlands within the legally-defined Suisun Marsh including: at least one site on either Joice or Grizzly Island near the mouth of Montezuma Slough, a site north of Cutoff Slough, a site on one or more of the channel islands or on the shore of Simmons Island facing the channel islands, and a site on Van Sickle or Wheeler Island facing Honker Bay. This

distribution of sites should give the State Board sufficient information to determine the effects of the water quality objectives and to estimate the effects of any changes that may be proposed or needed in the future.

3) The interagency programs, including the Suisun Marsh Fish Monitoring Program, and the Neomysis/Zooplankton Survey, are on-going; coordination of these activities should provide the State Board with the information necessary to monitor the effects of the water quality objectives.

7.4.3 Other Special Studies and Reviews

7.4.3.1 Aquatic Habitat Status Report

Although many individual studies on various aspects or species have been conducted over the years, an integrated picture of the overall condition or "health" of the Estuary has not been produced. Such an overall condition or status report is needed to provide a context for past, present and future conditions in the Delta. The data are sufficient in many areas to provide at least an overall view of recent (last 20 to 25 years) changes and current status. Such a status report would provide an overall context in which to view proposals for new projects, physical structures and operational changes, and for the impacts of newly introduced species, etc. Future sampling and monitoring programs should be designed and executed with a view to integrating the results obtained into a comprehensive overview.

Parties should discuss during the Scoping Phase the feasibility of preparing such a report, the responsibilities and plans for developing it and means to update and revise this status report on a regular basis. Parties should consider the idea of an annual oral summary review and presentation to the State Board as one way to communicate and update this status report, combined with appropriate documentation and timely data analysis.

7.4.3.2 Modeling Needs

A. Current Modeling

- **The three-dimensional model currently being developed by USGS for evaluating hydraulic and biological processes in the various embayments of the San Francisco Bay should be finalized.**

- **An Interagency Modeling Development and Use Committee should be formed to:**

  - **facilitate exchange of modeling information and to reduce duplication,**

  - **improve access of information to all interested parties**

  - **simulate operations of major reservoirs in addition to the CVP and SWP,**

  - **consider effects of antecedent conditions,**

- **improve temperature modeling for the Sacramento and San Joaquin River basins,**

- **improve Delta channel depletion estimates in DAYFLOW,**

- **improve both water quality and flow modeling for the San Joaquin River Basin,**

- **update hydrology to reflect current land use and groundwater/surface water interactions.**

To facilitate the exchange of modeling information and to reduce the duplication of modeling work, some members of the modeling community have suggested that an Interagency Modeling Development and Use Committee should be formed. As envisioned, this committee would meet periodically to perform the following tasks:

o Work cooperatively to develop and improve computer models and data bases;

o Train new model users on the proper use of existing and new computer models;

o Inform others on the advances in computer technology, including geographic information systems (GIS); and

o Review various study modeling assumptions, and assure that when assumptions are varied they are clearly documented when reporting model outputs.

DWR, USBR, CCWD, the State Board and other participants of the Operation Studies Workgroup are already working together to improve the operation studies model, DWRSIM. DWRSIM, which simulates the operation of the CVP and SWP reservoirs and conveyance facilities, is being revised by incorporating the following:

o Flow/salinity relationships that consider antecedent (preceding) conditions.

o A new up-to-date hydrology, which is the result of more recent land use information.

o The new Central Valley Ground Water Simulation Model, which significantly improves the estimates of ground and surface water interaction.

The Board encourages DWR to link DWRSIM with major M&I operations models such as those in the Los Angeles, San Diego, Sacramento and San Francisco Bay areas.

The Board believes that models would be improved by incorporating field data from the following types of studies:

- o Water quality profiles in the main navigation channels in South Bay and between the Golden Gate Bridge on the west and Stockton and Rio Vista on the east, by the use of a boat-mounted continuous recorder for the following parameters: water temperature, electrical conductivity, pH, dissolved oxygen, turbidity, and in vivo chlorophyll;

- o Better description of Delta hydrology, including inflow and outflow measurements, amount of in-Delta diversions, and channel velocities; and

- o Water quality, tidal height, water temperature, turbidity, meteorological and other data throughout the Estuary.

B. State Board Modeling Capability

- o **The Board recognizes the need to develop its own modeling capability which will assist in the consideration of appropriate water transfers, new water rights, review of existing water rights and future alterations of Delta water quality and flow requirements.**

To further improve the modeling capability of the water community, the State Board is conducting a management study to determine the feasibility of enhancing the State Board's modeling capability. The purpose of this enhancement would be to ensure that the State Board (and others) have adequate resources to evaluate the water supply, environmental, and economic impacts of future water quality objectives, flow standards, or facility proposals. The possible modeling enhancement study approaches include, but are not limited to: (1) no-action, (2) more reliance on other state and federal water agencies, (3) more reliance on private consulting firms, and (4) enhancement of the State Board's "in-house" modeling capability. In addition, the management study will address the need for enhancement of water right and water resources databases that will be needed for modeling purposes.

C. Fishery Models

The following fishery models, in addition to any others that may be proposed, may be considered, as appropriate, in the impact analysis:

- o Abundance and Survival of Delta Smolts in the Sacramento-San Joaquin Estuary by the USFWS.

The USFWS (since 1978) has annually conducted research on the survival and abundance of Chinook smolts and fry as they migrate down the Sacramento through the Estuary. The research has led to the development of several different models, including: annual index of abundance of fall-run smolts; smolt survival based on adults returns 2-1/2 years later; and smolt survival index using flow, temperature, percent diverted at Walnut Grove, export rates and migration route variables. A San Joaquin River smolt survival index is being developed based on different release sites, various levels of inflow from the San Joaquin River, SWP and CVP export rates and ocean recoveries of adults.

o Chinook Salmon Population Model for the Sacramento River Basin by BioSystems Analysis, Inc.

This model estimates the abundance of fall-run Chinook salmon under a given set of flow and temperature conditions, mortality parameters, and assumptions about harvest in the ocean and river fisheries for the Sacramento River Basin. At present it serves as an indicator of the population trends as it has not yet been calibrated. Another version is presently being developed for winter-run Chinook salmon.

o Draft San Joaquin River System Chinook Salmon Population Model by EA Engineering, Science and Technology.

This is mechanistic simulation model representing the principle factors influencing the abundance and production of fall-run Chinook salmon in the San Joaquin River Basin.

7.5 Scoping and Water Right Issues

o **Only a few parties are currently responsible for meeting water quality and flow requirements and for compliance monitoring activities within the Delta. The Board requests that information be developed on how these burdens of meeting the objectives should be distributed over more water right holders and waste dischargers. This information will be considered and used by the State Board during the Scoping and Water Right phases of the proceedings.**

o **For the development of alternatives to existing points of diversion and for the coordination of preparedness planning by other agencies, information should be presented during the Scoping Phase on the impact of flood control measures, levee conditions, dredging, channel deepening, barriers and seismic activities.**

7.5.1 General

In addition to implementation issues related to water quality objectives in this Plan, other issues, as illustrated in Chapter 7.1.1, will be considered in the Scoping and Water Rights phases. To facilitate preparation for those phases, expected issues are summarized below. The list includes matters which have been discussed specifically in earlier sections.

7.5.2 Summary of Beneficial Use Issues

7.5.2.1 Municipal and Industrial Uses

- Retention of the 150 mg/l chloride objective for industry,

- Within the Delta Export water quality to enhance reclamation,

- Relative advantages and disadvantages of maintaining high water levels in SWP terminal reservoirs.

7.5.2.2 Agriculture

o Western and Interior Delta

- Consideration of objectives for crops other than corn

- Cost and feasibility of leaching

o Southern Delta Agriculture

A request by SDWA that "[w]ater quality required at the inflow points would be specified as a function of net daily inflow rate and of channel depletion by months for the channel reaches receiving water from each inflow point."; and that "[t]he required net daily inflow rates at each inflow point would be in accordance with a monthly schedule sufficient to maintain the required unidirectional net flow in each channel reach" (SDWA,116,2).

7.5.2.3 Salmon

- Flow needs of migrating salmon

- Use, timing and quantity of water for pulse flows

- Appropriate use of hatcheries to supplement natural production

7.5.2.4 Striped Bass

Agreements and information on the following issues will be helpful for developing an appropriate environmental impact report.

o **The direct entrainment losses of striped bass and other fish at the major diversions in the Delta are well documented. The Bureau of Reclamation and the Contra Costa Water District should each negotiate a fishery agreement with the Department of Fish and Game that would provide for mitigation of the direct entrainment losses at the Tracy Pumping Plant and Contra Costa Pumping Plant No. 1. These agreements should be completed prior to the conclusion of the Water Right Phase. Direct entrainment losses at Delta agricultural diversions are not well documented. The parties should evaluate such losses and identify corrective measures.**

o **A real-time monitoring program should be developed and used to assess the daily densities of striped bass eggs and larvae in the Sacramento River during the spring and initiate periodic closure of the Delta Cross Channel to reduce diversion of striped bass into interior Delta channels. Closure of the Delta Cross Channel should be coordinated with short duration pulsed flows in the Sacramento River, in combination with short-term reductions in export pumping and reduced reverse flows, to transport striped bass eggs and larvae into the Suisun Bay.**

- **There is the need to initiate a detailed investigation and evaluation of alternative sites for establishing facilities for rearing juvenile striped bass salvaged from the SWP and CVP facilities for subsequent release to the Bay-Delta system.**

- **A detailed review and evaluation of alternative recreational angler harvest management options including, but not limited to, specific area and seasonal closures, alternative size limits including initiation of a slot limit, and restrictions on fishing gear such as use of single barbless hooks should be conducted. In addition, the impacts of poaching on the striped bass population should be evaluated, funding sources for expanded enforcement should be sought, and the unrestricted sale of striped bass in California should be eliminated. Temporary changes in fishery harvest regulations should be considered as part of an overall short-term approach to improve the situation until longer-term measures may be instituted. The Board does not believe such measures should substitute for its own responsibilities to provide suitable habitat.**

- **Additional water project operation tests should be conducted in the Delta to better determine the effects of diverting water from and upstream of the Delta on striped bass.**

To make certain that the State Board develops water quality objectives that are based on sound scientific data, and which are appropriately protective of striped bass spawning habitat, we request DFG to analyze the protective values of setting up a specific spawning habitat zone of 0.44 mmhos/cm EC, or some other more appropriate EC value, in the river reach between Jersey Point and Prisoners Point. Analysis of historical springtime EC data indicates that 0.44 mmhos/cm EC at Jersey Point would apparently maintain an EC at Antioch of just about 1.5 mmhos/cm, which DFG would like to retain. DFG should also analyze the possibility and the effects of relating a relaxation provision to declared deficiencies. Specifically, DFG should be prepared to discuss the effects of reducing the spawning habitat by moving the downstream end of the spawning habitat reach upstream from Jersey Point a distance proportional to the percent reduction in delivery of firm supplies, along the lines proposed in the table below. In the remaining reach, the 14-day running average of the mean daily EC would be no more than 0.44 mmhos/cm EC for the period April 1 to May 31, or until spawning has ended.

Percent Delivery Reduction	Percent River Reach Reduced
0	0
1-10	10
11-20	20
21-30	30
31-40	40
>40	40

Deficiencies are defined as deficiencies in firm supplies declared by a set of water projects representative of the Sacramento River and San Joaquin River watersheds. The specific projects and amounts of deficiencies would be defined in subsequent phases of these proceedings.

DWR should be prepared to discuss the potential effects, i.e., water costs, that would result if the State Board were to adopt water quality objectives as outlined above. The Board would like to hear from USBR, USFWS and any other interested parties on this subject at the next Triennial Review.

7.5.2.5 Other Fish and Wildlife Issues

o Marine Habitat

Issues concerning marine habitat center on the effects of Bay outflow rather than salinity, and so will be considered in the Scoping and Water Right phases.

o Navigation

Effects on beneficial uses of deepening the Sacramento Deep Water Ship Channel

o Export Recreation and Export Fishery Habitat

In the Scoping Phase, participants should be prepared to discuss the effects of more variable levels and flows on fishery habitat, especially as related to temperature stress, turbidity, algal growth, dissolved oxygen depressions and other water quality considerations.

Documentation is required of the types and extent of water-associated recreational activities, particularly in terms of present usage of both reservoir activities and flowing-stream activities (fly-fishing, rafting, kayaking, etc.). In addition, estimates are needed of the potential impacts of changes in operations on recreational activities, or on storage levels of reservoirs both upstream and in the export areas. Participants should be prepared to discuss these topics in at least qualitative terms during the Scoping Phase, and have quantitative data available by the Water Right Phase. With the type of information addressed above, the State Board will be better able to develop a balanced water management program.

o Estuary Recreation

The information presented during Phase I was based upon data gathered over ten years ago. Current surveys of recreational uses of facilities within the Estuary are needed. Appropriate agencies should provide current data.

7.5.2.6 Marshes around Suisun Bay

A biological assessment will be continuing during these phases.

7.5.3 Other Scoping and Water Right Issues

- **Additional means including the use of biocriteria should be developed to assess the general health of the Estuary and serve as a basis for determining the impacts of new projects, physical and operational changes, introduced species, etc. DFG should develop a priority list of tasks to be performed. Consideration should be given to specific components such as American shad, Delta smelt, and the benthos. Also, use of biocriteria should be considered.**

- **There is a need to examine further the impacts of San Francisco Bay inflows on fish, invertebrates, and other public trust resources, particularly as these inflows, including pulse flows, affect distribution, abundance, and reproduction success of species inside the Estuary. Studies are also needed to provide the linkage, if any, between phytoplankton, and higher trophic levels.**

7.5.3.1 Water Year Classification

- **The current Sacramento River Water Year Classification approximates annual conditions of water availability with five distinct categories. The Water Year Classification subworkgroup has adopted, in concept, the addition of a sliding scale to the classification to smooth the transitions between categories. There is a need for the parties to study this proposal and submit the results for review during the Scoping Phase of the proceedings.**

- **Due to a previous lack of analytical tools, the San Joaquin River Basin classification needs refinement.**

There is a need for the parties to develop a San Joaquin River Basin classification with similar methodology as used for the Sacramento River Basin and submit the results for review during the Scoping Phase of the proceedings. Other issues, such as the variation in hydrologies among tributary basins, and the absence of coordination between the major San Joaquin River basin reservoirs, can then also be addressed. This system, together with the Sacramento River classification, will be used during the Scoping and Water Right phases to determine how the responsibilities of meeting water quality objectives should be distributed.

Development of Annual Four Basin Unimpaired Flow

Part of the process to determine each water year's classification is the estimation of the Sacramento and San Joaquin basins' Four River Unimpaired Flow Indexes, a measure of seasonal wetness. For the months of February through May, estimates of these unimpaired flow indices are made on the first of each month. Unimpaired flow is estimated from both measured and forecasted flows and snowpack amounts. The hydrologic portion of the water year index that relies on forecasts is subject to assumptions made by the forecaster. This forecasting process is performed by DWR. There is no documentation explaining this process. The assumptions and process should be documented and readily available. DWR should convene a technical forum for interested parties for the purpose of providing the parties with the details of the methodology and assumptions used in the forecasting process. After this initial forum,

additional meetings should be convened only when the methodology or the assumptions are changed.

7.5.3.2 Economic Analysis

The Scoping Phase will help identify alternative methods to provide the protections needed for the beneficial uses made of Bay-Delta waters. To determine if an alternative is reasonable the State Board considers economic effects. For example, studies will be needed to determine the costs of south Delta facilities, the cost of dilution releases to the farmers required to forego use of water, and the secondary costs associated with reservoir reoperation and other actions. Determination of the overall costs of alternatives will require input from technical studies on the appropriate mixes of required actions.

7.5.3.3 Entrapment Zone

- **Studies are needed to better define the degree of linkage between the location and productivity of the entrapment zone and the effects on the population levels of important fish species.**

The Phase I hearing record includes many pages of exhibits and testimony concerning the importance of the entrapment zone. The definition and placement of the entrapment zone is more closely tied to freshwater outflow than to salinity. Further consideration of this issue will occur in the Scoping and Water Right Phases of these proceedings. During the Scoping Phase, the State Board seeks further information on the following:

1. The location of the entrapment zone in relation to freshwater outflow;

2. The importance of the entrapment zone organisms in the fish food chains, especially with regard to striped bass, Delta smelt, and out-migrating salmon smolts;

3. The significance of introduced invertebrates, both benthic filter-feeders and zooplankton, on food supplies in the Bay-Delta waters,

4. The relative importance of phytoplankton, bacteria and detritus as food sources for higher trophic levels in the entrapment zone;

5. The relationship between entrapment zone location and level of primary productivity or phytoplankton concentrations; and

6. The relationship between phytoplankton abundance, zooplankton abundance and fish productivity.

These topics are not exclusive; if any parties believe that other subjects need to be addressed, they are welcome to introduce them.

7.5.3.4 Physical Facilities

Information Needed on Physical Facilities

During the first two phases of the Bay-Delta proceedings several parties indicated that proper facilities would help stretch the water supply to

meet more of the needs of various beneficial uses. Included in these discussions were several isolated facilities to provide better water quality for export M&I, hatcheries to help supplement the populations of specific fisheries and reservoirs to help store water from times of surplus for distribution during times of need (see below). While the State Board supports these concepts in theory, it must have detailed information as to their effects on beneficial uses in the Estuary.

Isolated facilities can provide better water quality for M&I use. However, some questions need to be answered:

- Are there appropriate and cost-effective ways of isolating this water from that large volume of water exported for agriculture purposes which do not need the higher quality? What would be the effects of this facility on areas of origin, on the Bay-Delta Estuary's aquatic habitat, etc.

- Since this water would be expensive, should consideration of separate plumbing for internal domestic use be addressed? To help reduce project cost should the use of existing rights-of-way be considered?

New reservoirs are being planned south of the Delta. The State Board believes that additional information is needed particularly in regard to the timing and amount of diversions to these facilities. During the Scoping Phase, parties should be prepared to discuss the potential effects of diversions to South-of-the-Delta reservoirs on beneficial uses in the Estuary.

Specific Physical Facilities and Projects to be Discussed in the Scoping Phase

A. Delta Water Management Facilities - Three DWR Delta Water management programs comprise a plan to enhance the SWP capability to increase exports while attempting to solve problems affecting Delta beneficial uses. These programs are:

1) The North Delta Water Management Program - The 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. Under this program the South Fork Mokelumne River will be dredged, the Delta Cross Channel gates may be modified, partial tide gate structures in the Sacramento River may be built to raise water levels in the Sacramento to divert additional water into the Delta Cross Channel, a partial tide gate structure in Three-Mile Slough may be built, and a new Sacramento River connecting channel near Hood or Isleton may be built to divert additional flow through the interior of the Delta.

2) The Western Delta Management Program - This program includes four major issues: flood control, water quality, wildlife concerns, and water supply reliability. Sherman Island, the major Delta island situated farthest west, is the focus of this program. Levee rehabilitation and land acquisition for the development of wildlife and wetland habitat will be a part of this program.

3) The South Delta Water Management Program - The objectives of this program are to help solve the following problems: water level and water circulation related to agricultural needs in the south Delta, water quality, project water supply reliability, and fishery impacts. Under this program four barriers will be installed in the south Delta, a portion of Middle River will be enlarged, Clifton Court Forebay will be enlarged, and an additional forebay will be constructed on the northern half of Victoria Island with a siphon connection to Clifton Court Forebay (DWR & USBR, 1990).

B. Isolated Facilities - The purpose of such a facility is to isolate water being conveyed from the Sacramento River to Clifton Court, from the Delta. This facility would improve the salinity, and drinking water quality of this water, while theoretically reducing the carriage water requirement and permitting better control of Delta circulation (Brown and Caldwell, Delta Drinking Water Quality Study, May 1989). The reduction of the carriage water requirement and the control of circulation patterns has the potential for enhancing the beneficial uses that continue to be made of water directly from the Estuary. There is a great concern among many, especially northern Californians, that the isolated facility would be operated in a manner that would harm the Estuary. Proponents of the isolated facility have stated that protection of all Delta beneficial uses is a primary concern, and that an isolated facility would not be built without guaranteeing this protection. A number of alternative isolated facilities have been suggested. The facilities most often discussed are the following:

1) Peripheral Canal - This is a 42-mile-long isolated channel rejected by California voters in 1982. This facility would convey water from the Sacramento River around the Delta, releasing a portion of it for Delta channel flow improvement, and delivering the remaining water to Clifton Court Forebay and then to the Delta export pumps.

2) Dual Transfer System - This facility would convey about half of the water being exported from the Delta through existing channels, and the remainder in a isolated channel extending from Hood on the Sacramento River to the Clifton Court Forebay.

3) Bifurcated System - This facility is the same as the Dual Transfer System, except that it would provide a bifurcated transmission system south of the Delta so that only high quality water would be delivered to southern California for M&I purposes.

4) Sierra Source-to-User System - This isolated facility would be comprised of a number of facilities used to convey water for M&I water use from the Feather River/Sacramento River confluence around the Delta and directly to the Tracy Pumping Plant.

C. Auburn Dam - The proposed Auburn Dam was originally designed to be a 2.3 MAF multipurpose reservoir for water supply, power, recreation, flood control, and fishery enhancement. Construction was begun in 1967 but stopped in 1976 to permit further study of seismic and design issues. Environmental issues have further affected the future of the Auburn Dam. Currently, there are three proposals for an Auburn Dam: a dry dam used only for flood control, a flood control dam with the

flexibility to allow later expansion to a multi-purpose dam, and a full multi-purpose dam (DWR & USBR, 1990).

D. Kern Water Bank - The Kern Water Bank (KWB) is a conjunctive use ground water project being developed by DWR, in conjunction with the Kern County Water Agency and local water districts, to augment the dependable water supply of the SWP. The KWB would allow storage and extraction of ground water, 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. The first stage, with a capacity of 300 TAF, is planned for development by 1991, with maximum capacity of 1 MAF planned for development by 1994 or 1995 (DWR & USBR, 1990).

E. Los Banos Grandes Reservoir - The Los Banos Grandes Reservoir (LBG) is proposed to be solely an SWP off-stream water supply facility filled with water from the California Aqueduct. LBG will provide operational flexibility for the SWP to allow improved operation for the fisheries and enable a greater shift in exports to months when fish are not as abundant and when very high Delta outflows occur. The current schedule estimates that the LBG facilities could be completed and in operation by the year 2002 (DWR & USBR, 1990).

F. Los Vaqueros Reservoir - The proposed Los Vaqueros Reservoir, to be operated by the Contra Costa Water District, will be a 100,000-AF reservoir in the hills southeast of Contra Costa County. The purpose of this reservoir is to improve the quality and reliability of delivered water and is scheduled for completion in 1995 (Jones & Stokes, 1991).

G. Delta Wetlands Project - The Delta Wetlands Project is proposed by Bedford Properties, a land development company, to store water seasonally on four Delta islands (Bacon and Bouldin islands, and Holland and Webb tracts) and to manage the islands for wetland wildlife habitat during July-December. Stored water would be diverted from unregulated Delta outflow when available during January-April of each year. Stored water (up to 270,000 AF) would be discharged from the islands during May-July for sale to various water users (Jones & Stokes, 1990).

H. Additional Banks Pumping Plant Capacity - DWR is installing four additional pumping units at the Banks Pumping Plant, increasing the pumping capacity from 6,400 cfs to 10,300 cfs. In order to operate the Banks Pumping Plant above 6,400 cfs a revised Corps of Engineers permit is required. These pumps begin operation in 1991 and will provide standby capacity for the present units and permit a larger share of the pumping with cheaper off-peak power. DWR plans to divert more water during the winter to facilitate offstream storage reservoirs and groundwater recharge operations south of the Delta (DWR & USBR, 1990).

I. Baldwin and Stockton Ship Channel Projects - These two ship channel projects, undertaken by the Corps of Engineers, will deepen existing or create new channels that will allow larger commerce shipping access to inland ports.

J. Desalination Projects - 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. The principal limitation of desalting is its high cost, which is directly linked to its high energy requirements. Of various desalting techniques, the membrane processes (reverse osmosis and electro-dialysis) offer the best potential to further reduce costs and thus increase use. Recent research has been able to reduce the energy requirements dramatically. With further reductions in the energy requirements and future increases in competition for water supplies, desalting is becoming a viable alternative for the development of marginal water supply (DWR & USBR, 1990). Currently, Santa Barbara, Marin, and MWD are considering construction of desalting facilities to develop marginal water supply during dry periods.

K. Reclamation Projects - Reclaimed water is used for various purposes, including crop and landscape watering, industrial cooling, and ground water recharge. Industries sometimes recycle water at a facility to recover heat or materials, to save water, and to eliminate the cost of discharge to a municipal system. Waste water can be treated to drinking water quality, but the higher cost of such treatment, institutional prohibitions, and public reluctance to use reclaimed water discourages its use when water of equal quality is available from other sources. Urban water managers continue to seek suitable locations to replace drinking quality water with treated municipal waste water for such applications as landscape and crop irrigation. The greatest potential for wider use exists in the coastal areas of southern California where hundreds of thousands of acre-feet of treated water are discharged to the ocean every year. Dual or separate delivery water systems are being studied. These dual delivery systems will separate water delivered for human consumption from reclaimed water delivered for irrigation or industrial uses. Use of wastewater for M&I purposes has not received complete acceptance by the public and the health authorities (DWR, Bulletin 160-87, pp. 53-54).

The parties should be prepared to discuss in detail these and other issues concerning physical facilities during the Scoping Phase of the proceedings. The Board will use this information to form a balanced decision in the Water Right Phase.

7.5.3.5 Agricultural Water Conservation

The overall goal of the Agricultural Water Conservation Workgroup and its Subworkgroups is to identify potential water savings (annual and seasonal) through increased irrigation efficiency within the following constraints:

1) Maintain present level of crop production (i.e., protection of "present" beneficial use),

2) Maintain present amount of annual net recharge to ground water in non-saline sink areas,

3) Reduce annual net recharge to ground water in saline sink areas (if possible) by increasing irrigation efficiencies to the minimum target efficiency for irrigation, and

4) Maintain salt balance in the crop root zone as necessary to maintain present crop productivity.

The Workgroup will attempt to identify annual savings in saline sink areas and seasonal savings in non-saline sink areas. The State Board anticipates receiving valuable information from the Agricultural Water Conservation Workgroup during the Scoping Phase.

7.5.3.6 Conjunctive Use

The State Water Project Conjunctive Use (SWPCU) Workgroup is evaluating both put-and-take or seasonal storage, and long-term storage forms of conjunctive use. The SWPCU Workgroup's study area is primarily the SWP service areas. The workgroup intends to provide the State Board with a report for the Scoping Phase. This report should detail the following information for the major ground water basins of California:

(1) existing ground water production capacity, (2) imported water delivery capacity, (3) ground water-surface water delivery overlap, (4) existing recharge capacity, (5) available capacity by month, (6) potential existing recharge facility expansion, (7) potential new recharge facility projects, and (8) ground water basin constraints.

7.5.3.7 Suggested Legislation

Water Rights Monitoring

Under the Porter-Cologne Act (Water Code Section 13267(b)), a Regional Board may require any discharger of waste to prepare technical or monitoring program reports. No similar provision allows the State Board to require technical or monitoring program reports from water right holders who divert and use water from a watercourse. The diversion and use of water may cause adverse effects to downstream beneficial uses of water. For example, the diversion and use of water may adversely affect aquatic life downstream, cause seawater intrusion into underground water supplies, cause pollution as a result of return flows into rivers, and impair the water supplies of other water users.

While the State Board is able to require new appropriators of surface water to monitor potential impacts, the State Board cannot conveniently require existing water right holders to initiate new monitoring programs. In order to require an existing water right holder to conduct a monitoring program under current law, the State Board must conduct an enforcement action, a change petition proceeding, a proceeding to prevent waste and unreasonable use under Article X, Section 2 of the Constitution or a proceeding to apply the public trust doctrine.

Legislation should authorize the State Board through administrative means to require monitoring by individual water right holders where such a requirement is related to the individual's diversion. The legislation should also authorize the State Board to impose annual fees on all permit

and license holders to assure that an adequate compliance monitoring program can be implemented.

Screening of Agricultural Diversions

Screening of agricultural diversions in the Delta has been identified as a method of improving young striped bass and salmon survival in the Estuary. A recent survey by DWR determined there are over 1,900 pumps and siphons in the Delta with intake pipe diameter ranging from 3 to 36 inches (Sato et al., 1987 in Hopelain 1989). Salmon entrainment data collected in the Delta and Feather River ranged from averages of 1.38 to 4.66 salmon per acre foot, respectively and average numbers of juvenile striped bass lost through Delta agricultural diversions during April through July, 1978 and 1979 were 19 and 12 million, respectively (Hopelain, 1989).

Fish and Game Code, Sections 5980 through 6028 apply to screening and preventing fish losses through water diversion intakes. The sections essentially state that if a diversion was constructed after 1971 and adversely affects fish populations, the owner is required to construct, operate and maintain a screen on the diversion. If the diversion was constructed prior to 1971 and is larger than 250 cfs, the costs of screening is to be shared equally by the owner and DFG. If the diversion was constructed prior to 1971 and is less than 250 cfs, the entire cost of screening is to be borne by DFG. Most Delta agricul-tural diversion fall into the latter category with the financial responsibility resting with DFG; consequently, the agricultural diversions remain unscreened. DFG should prepare a report to SWRCB presenting a plan of action and possible sources of funding and proposed legislation by the beginning of the Water Right Phase of the proceedings.

Finally, a program is needed to produce information about the Bay-Delta system relevant to management decisions. Such a program should:

1) Identify the manageable (man-induced) effects on the Bay-Delta;

2) Identify responsibilities for developing studies to allow resource agencies to better manage the Bay-Delta system;

3) Develop a stable funding mechanism through fees on point source dischargers, non-point source dischargers and upstream water users; and

4) Develop time schedules and oversight committees to ensure timely implementation and coordination.

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APPENDICES

A. Abbreviations for Information Sources and Citations
B. List of Abbreviations/Symbols
C. Glossary
D. Monitoring Stations by Interagency Number and by River Kilometer Index
E. Map of Salinity Control Stations
F. Notice of Filing
G. Transcript Index

APPENDIX A
ABBREVIATIONS FOR INFORMATION SOURCES AND CITATIONS

ABBREVIATION	NAME
ACH	THE CITIES OF AVENAL, COALINGA & HURON
ACWD	ALAMEDA COUNTY WATER DISTRICT
AFC&WCD	ALAMEDA FLOOD CONTROL AND WATER CONSERVATION DISTRICT
AHI	AQUATIC HABITAT INSTITUTE
ANTIOCH	THE CITY OF ANTIOCH
ASA	CALIFORNIA ASSOCIATION OF SANITATION AGENCIES
BAAC	BAY AREA AUDUBON COUNCIL
BADA	BAY AREA DISCHARGERS ASSOCIATION
BALIA	BAY AREA LEAGUE OF INDUSTRIAL ASSOCIATIONS
BCDC	SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
BISF	THE BAY INSTITUTE OF SAN FRANCISCO
BUSCH	ANHEUSER-BUSCH COMPANIES
Bureau	U.S. BUREAU OF RECLAMATION (also USBR)
CALCWD	CALAVERAS COUNTY WATER DISTRICT
CBE	CITIZENS FOR A BETTER ENVIRONMENT
CCCWA	CONTRA COSTA COUNTY WATER AGENCY
CCIQW	CONCERNED CITIZENS FOR IMPROVED QUALITY WATER
CCWD	CONTRA COSTA WATER DISTRICT
CDWA	CENTRAL DELTA WATER AGENCY
CFBF	CALIFORNIA FARM BUREAU FEDERATION
CMWD	CASITAS MUNICIPAL WATER DISTRICT
CNPS	CALIFORNIA NATIVE PLANT SOCIETY
COE	U. S. ARMY CORPS OF ENGINEERS (also U.S. Corps)
CSPA	CALIFORNIA SPORTFISHING PROTECTION ALLIANCE
CVAWU	CENTRAL VALLEY AGRICULTURAL WATER USERS
CVPWA	CENTRAL VALLEY PROJECT WATER ASSOCIATION
CVWD	COACHELLA VALLEY WATER DISTRICT
CWA	CALIFORNIA WATERFOWL ASSOCIATION

APPENDIX A
ABBREVIATIONS FOR INFORMATION SOURCES AND CITATIONS

ABBREVIATION	NAME
CWPC	COMMITTEE FOR WATER POLICY CONSENSUS
CWPC	COMMITTEE FOR WATER POLICY CONSENSUS
CWPCA	CALIFORNIA WATER POLLUTION CONTROL ASSOCIATION
CWPCA	CALIFORNIA WATER POOLUTION CONTROL ASSOCIATION
DAWDY	DAVID R. DAWDY
DDWD	DEVILS DEN WATER DISTRICT
DELTAWET	DELTA WETLANDS (a.k.a. BEDFORD PROPERTIES, INC.)
DFG	CALIFORNIA DEPARTMENT OF FISH AND GAME
DOF	DEPARTMENT OF FINANCE
DRWD	DUDLEY RIDGE WATER DISTRICT
DTAC	DELTA TRIBUTARY AGENCIES COMMITTEE
DUNNING	HARRISON C. DUNNING, PROFESSOR OF LAW
DWA	DESERT WATER AGENCY
DWR	DEPARTMENT OF WATER RESOURCES
EA	EA ENGINEERING, SCIENCE AND TECHNOLOGY, INC.
EBMUD	EAST BAY MUNICIPAL UTILITY DISTRICT
EBRPD	EAST BAY REGIONAL PARK DISTRICT
ECCID	EAST CONTRA COSTA IRRIGATION DISTRICT
EDF	ENVIRONMENTAL DEFENSE FUND
EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY (also Agency)
EWID	EMPIRE WESTSIDE IRRIGATION DISTRICT
FAO	FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS
HOOPA	HOOPA VALLEY TRIBE
KCWA	KERN COUNTY WATER AGENCY
LADWP	LOS ANGELES DEPARTMENT OF WATER AND POWER
LCC	LEAGUE OF CALIFORNIA CITIES
LWVC	LEAGUE OF WOMEN VOTERS OF CALIFORNIA
MAS	MARIN AUDUBON SOCIETY
MET	SEE MWD
MID	MODESTO IRRIGATION DISTRICT
MWD	THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA (formerly MET)

APPENDIX A
ABBREVIATIONS FOR INFORMATION SOURCES AND CITATIONS

ABBREVIATION	NAME
NASOC	NATIONAL AUDUBON SOCIETY
NDWA	NORTH DELTA WATER AGENCY
NHI	NATURAL HERITAGE INSTITUTE
NMFS	U.S. NATIONAL MARINE FISHERIES SERVICE
NOAA	U.S. NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION
NRDC	NATURAL RESOURCES DEFENSE COUNCIL
OFWD	OAK FLAT WATER DISTRICT
OWD	OAKLEY WATER DISTRICT
PALMDALE	PALMDALE WATER DISTRICT
PCFFA	PACIFIC COAST FEDERATION OF FISHERMEN'S ASSOCIATIONS
PCWD	PLACER COUNTY WATER DISTRICT
PG&E	PACIFIC GAS & ELECTRIC
PICYA	PACIFIC INTER-CLUB YACHT ASSOCIATION
PRBO	POINT REYES BIRD OBSERVATORY
RIC	RICE INDUSTRY COMMITTEE
RWQCB_2	SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD (REGION 2)
RWQCB_4	LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD (REGION 4)
RWQCB_5	CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD (REGION 5)
Region 2	See RWQCB_2
Region 5	See RWQCB_5
SACTO	THE CITY OF SACRAMENTO
SACTOCO	THE COUNTY OF SACRAMENTO
SAVESF	SAVE THE SAN FRANCISCO BAY ASSOCIATION, THE
SAWPA	SANTA ANA WATERSHED PROJECT AUTHORITY
SCLDF	THE SIERRA CLUB LEGAL DEFENSE FUND
SCVWD	SANTA CLARA VALLEY WATER DISTRICT
SCWC	SOUTHERN CALIFORNIA WATER COMMITTEE, INC.
SDIEGO	SAN DIEGO COUNTY WATER AGENCY AND THE CITY OF
SDWA	SOUTH DELTA WATER AGENCY
SFBAWUA	SAN FRANCISCO BAY AREA WATER USERS ASSOCIATION
SFEP	EPA's SAN FRANCISCO ESTUARINE PROJECT

APPENDIX A
ABBREVIATIONS FOR INFORMATION SOURCES AND CITATIONS

ABBREVIATION	NAME
SFRISCO	THE CITY AND COUNTY OF SAN FRANCISCO
SHELL	SHELL OIL COMPANY
SIERRA	SIERRA CLUB, THE
SJVAWC	SAN JOAQUIN VALLEY AGRICULTURAL WATER COMMITTEE
SMUD	SACRAMENTO MUNICIPAL UTILITY DISTRICT
SRCD	SUISUN RESOURCE CONSERVATION DISTRICT
SRWCA	SACRAMENTO RIVER WATER CONTRACTORS ASSOCIATION
SWC	STATE WATER CONTRACTORS
SWRCB	CALIFORNIA STATE WATER RESOURCES CONTROL BOARD (also State Board)
TIBCEN	THE ROMBERG TIBURON CENTER FOR ENVIRONMENTAL STUDIES
TID	TURLOCK IRRIGATION DISTRICT
TLBWSD	TULARE LAKE BASIN WATER STORAGE DISTRICT
TRACY	THE CITY OF TRACY
TRI-TAC	TRI-AGENCY TECHNICAL ADVISORY COMMITTEE -- LCC, CASA AND CWPCA
TRICO	TRINITY COUNTY
UAC	UNITED ANGLERS OF CALIFORNIA
USBR	U.S. BUREAU OF RECLAMATION (also Bureau)
USDA-SCS	U.S. DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE (also SCS)
USDI	U.S. DEPARTMENT OF THE INTERIOR (also DOI)
USFDA	U.S. FOOD AND DRUG ADMINISTRATION (also FDA)
USFWS	U.S. FISH AND WILDLIFE SERVICE
USGS	U.S. GEOLOGICAL SURVEY
VCC	VALLEJO CHAMBER OF COMMERCE
WACOC	WATER ADVISORY COMMITTEE OF ORANGE COUNTY
YCWD	YUBA COUNTY WATER DISTRICT
YOLO	YOLO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

APPENDIX B
LIST OF ABBREVIATIONS/SYMBOLS

ABBREVIATION/ SYMBOL	DEFINITION
AF	Acre-Foot = 43,560 cubic feet = 325,900 gallons
AF/yr	Acre-Feet per year
AW	Total applied water (in acre-feet per acre)
As	Arsenic
BAT	Best available technology
BOD	Biochemical oxygen demand
BU	Beneficially used applied water (in acre-feet per acre)
Br	Bromine
Br-	Bromide ion
CAC	California Administrative Code (OBSOLETE--Now Cal. Code of Regulations, CCR)
CCC	Contra Costa Canal
CCR	California Code of Regulations (formerly Cal. Administrative Code, CAC)
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	U.S. Code of Federal Regulations
COD	Chemical oxygen demand
CP	Amount of water applied due to cultural practices (in ac-ft/ac)
CVP	Central Valley Project
CWC	California Water Code
Cl	Chlorine
Cl-	Chloride ion
D-1485	SWRCB Water Rights Decision 1485 (1978)
DBP(s)	Disinfection by-product(s)
DMC	Delta-Mendota Canal
DO	Dissolved oxygen
DOI	Delta outflow index
Delta	Sacramento-San Joaquin Delta
Delta Plan	1978 SWRCB WQCP - Sacramento-San Jouquin Delta and Suisun Marsh
EC	Electrical conductivity (also refered to as specific conductance)
ECe	Electrical conductivity of a soil saturation extract (generally in dS/m)

APPENDIX B
LIST OF ABBREVIATIONS/SYMBOLS

ABBREVIATION/ SYMBOL	DEFINITION
ECi	Electrical conductivity of applied irrigation water
ECsw	Electrical conductivity of soil water in the root zone (ECsw approx. = ECe / 0.6
Estuary	San Francisco Bay and Sacramento-San Joaquin Delta Estuary
FSA(s)	Flow study area(s)
GAC	Granular activated carbon
I-A/RKI	Interagency/River Kilometer Index Station Code
IDHAMP	Interagency Delta Health Aspects Monitoring Program
IE	Irrigation efficiency (in acre-feet per acre)
M&I	Municipal and Industrial (generally associated with "water supply")
MAF	Million acre feet
MCL(s)	Maximum contaminant level(s) (associated with drinking water)
MCLG(s)	Maximum contaminant level goal(s)
MGD	Million(s of) gallons per day
MLLW	Mean lower low water
Mn	Manganese
Ni	Nickel
PIE	Preirrigation efficiency
PPD	Pollutant Policy Document
Plan	1988 or 1990 Draft Water Quality Control Plan (also WQCP)
Region 2	San Francisco Bay Basin (also Basin 2). See RWQCB_2
Region 5A	Sacramento River Basin (also Basin 5A)
Region 5B	Sacramento-San Joaquin Delta Basin (also Basin 5B)
Region 5C	San Joaquin River Basin (also Basin 5C)
SBI	Striped bass index
SMPA	Suisun Marsh Preservation Agreement
SMR	Applied water needed for soil moisture replacement (in ac-ft/ac)
SS	Suspended solids

APPENDIX B
LIST OF ABBREVIATIONS/SYMBOLS

ABBREVIATION/ SYMBOL	DEFINITION
SWP	State Water Project
Se	Selenium
TAF	Thousand acre feet
TDS	Total dissolved (filterable) solids
THM(s)	Trihalomethane(s)
THMBr(s)	Brominated trihalomethane(s)
THMFP	Trihalomethane formation potential
TOC	Total organic carbon
TTHMFP	Total trihalomethane formation potential
WQCP	1988 or 1990 Draft Water Quality Control Plan (also Plan)
WY	Water year (October 1 through September 30)
YOY	Young-of-year
ac	Acre = 43,560 square feet
cfs	Cubic feet per second = 448.8 gallons per minute = 1.983 acre-feet per day
dS/m	DeciSiemen/meter = 1.0 milliSiemen/cm (a measure of electrical conductivity)
ft	Foot or feet
g/l	Grams per liter
g/sq. m.	Gallons per square meter
gpcd	Gallons per capita per day
hr(s)	Hour(s)
lb	Pound (avdp.) = 16 oz (avdp.) = 453.6 grams
m	Meter or meters = 3.28 feet
mS/cm	milliSiemens per centimeter = millimhos per centimeter
mg/l	Milligrams per liter (approximately equal to ppm in aqueous solutions)
mmhos/cm	Millimhos per centimeter = 1,000 umhos/cm (a measure of EC)
ppb	Parts per billion (approximately equal to ug/l in aqueous solutions)
ppm	Parts per million (equal to mg/kg, approx. equal to mg/l in aqueous solutiions)
ppt	Parts per thousand (approximately equal to g/l in aqueous solutions)

APPENDIX B
LIST OF ABBREVIATIONS/SYMBOLS

ABBREVIATION/ SYMBOL	DEFINITION
sq. ft.	Square foot or feet
sq. mi.	Square mile = 640 acres = 259 hectares
uS/cm	MicroSiemens per centimeter = micromhos per centimeter (a measure of EC)
ug/l	Micrograms per liter (approximately equal to ppb in aqueous solutions)
umhos/cm	Micromhos per centimeter (a measure of EC)

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
1-in-20 dry year	A statistical term refering to a water year with a total annual runoff exceeded by 95% of the water years which are likely to occur.
Acaricide (Miticide)	A material used primarily in the control of plant-feeding mites (acarids) especially spider mites. Typical acaricides with little insect-killing efficiency are chlorobenzilate, Kelthane, and Omite. Some insecticides, especially phosphorous compounds, are effective also against mites. [Farm Chemicals Handbook, 1987]
Acre-foot (AF)	The quantity of water which will cover an acre of land to a depth of one foot (i.e. 43,560 cubic feet or 325,900 gallons).
Alevin	See Fry.
Algae	Simple rootless plants that grow in bodies of water at rates in relative proportion to the amounts of nutrients available in the water or, in the case of nitrogen, in the atmosphere overlying the water body.
Ambient	The prevailing condition in the vicinity, usually relating to some physical measurement such as temperature. Sometimes used as a synonym for background. [SWRCB Order No. WQ 85-1]
Anadromous	Pertaining to fish that spend part of their life cycle in the ocean and return to freshwater streams to spawn. [SWRCB Order No. WQ 85-1]
Anaerobic	Life or processes that can occur without free oxygen.
Applied water	The quantity of water delivered to the intake to a city's water system, the farm head gate, the factory, and for wildlife, the amount of water supplied to a marsh or other wetland either directly or by incidental drainage flows. [DWR Bulletin 160]
Aquifer	State of California definition: A geologic formation, group of formations or part of a formation that is water bearing and which transmits water in sufficient quantity to supply springs and pumping wells. [DWR Bulletin 74-81] Federal definitions: (1) A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	yield significant quantities of water to wells and springs (10 CFR 960.2) (2) A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs. Any saturated zone created by uranium or thorium recovery operations would not be considered an aquifer unless the zone is or potentially is (a) hydraulically interconnected to a natural aquifer, (b) capable of discharge to surface water, or (c) reasonably accessible because of migration beyond the vertical projection of the boundary of the land transferred for long-term government ownership and care (10 CFR 40 Appendix A). (3) A zone, stratum, or group of strata that can store or transmit water in sufficient quantities for specific use (30 CFR 710.5). (4) A geological formation, groups of formations, or part of a formation, that is capable of yielding a significant amount of water to a well or spring (40 CFR 146.03; 260.10; 270.2). (5) A geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of ground water to wells or springs (40 CFR 257.3-4). [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Arsenic (As)	A highly poisonous metallic element. Arsenic and its compounds are used in insecticides, weed killers and industrial processes. [SWRCB Order No. WQ 85-1] Arsenic occurs in two environmentally significant valence states, As +3 or As III (trivalent) and As +5 or As V (pentavalent), with different toxic properties. The various organic forms of arsenic include: methylated forms, arseno-lipids, arseno-sugars, arseno-betaine, and arseno-choline.
Bacteria	Single-cell, microscopic organisms that possess rigid cell walls; may be aerobic (need oxygen), anaerobic (no oxygen present), or facultative (either with or without oxygen); can cause disease; and some are important in the stabilization of solid wastes. [Resources Conservation Glossary]
Banks Pumping Plant, Harvey O.	The Department of Water Resources' State Water Project main deltapumping plant located West of Tracy. The source of the

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	water in the California Aquaduct.
Basin Plan	A plan for the protection of water quality prepared by a Regional Water Quality Control Board in response to the Porter Cologne Water Quality Control Act also contains Water Quality Standards for the federal Clean Water Act.
Bathymetry	Measurements of the differences in depth between mean lower low water and the bottom of the bay.
Bay-Delta Estuary (the Estuary)	San Francisco Bay, the Sacramento-San Joaquin Delta and Suisun Marsh, as defined in Sec. 6610 and 6611 of the Cal. Government Code, Sec. 12220 of the Cal. Water Code, and Sec. 29101 and 29101.5 of the Cal. Public Resources Code, respectively.
Beneficial uses	"Beneficial uses" of the waters of the state that may be protected against quality degradation include but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; esthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. [CWC Sec. 13050(f)] Equivalent to "designated uses" under federal law.
Benthos	The whole assemblage of plants or animals living on the bottom of a water body: distinguished from plankton.
Best available technology (BAT)	The best technology, treatment technique, or other means which the Administrator [of the EPA] finds, after examination for efficacy under field conditions and not solely under laboratory conditions, are available (taking cost into consideration). For the purposes of setting MCLs for synthetic organic chemicals, any BAT must be at least as effective as granular activated carbon. [40 CFR 141.2]
Best management practices (BMPs)	State definition: A practice, or combination of practices, that is the most effective and feasible means of controlling pollution generated by nonpoint sources for the attainment of water quality objectives. [23 CCR 2601] Federal definition: A practice, or combination of practices, that is determined after ...problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological,

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals. [40 CFR]
Bioaccumulative	A characteristic of a chemical species when the rate of intake into a living organism is greater than the rate of excretion or metabolism. This results in an increase in tissue concentration relative to the exposure concentration.
Bioassay	A method for determining the relative toxicity (or other biological activity) of a substance by observing its effects on a suitable organism under controlled conditions.
Biochemical oxygen demand (BOD)	The results of an empirical test in which standardized laboratory procedures are used to determine the relative oxygen requirements of wastewaters, effluents, and polluted waters. [Standard Methods ..., 14th ed., 1975] Usually considered, the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions. The BOD test is widely used to determine the pollutional strength of domestic and industrial wastes in terms of the oxygen that they will require if discharged into natural watercourses in which aerobic conditions exist. The test is essentially a bioassay procedure involving the measurement of oxygen consumed by living organisms (mainly bacteria) while utilizing the organic matter present in a waste, under conditions as similar as possible to those that occur in nature. [Sawyer, C.N. and McCarty, P.L., Chemistry for Sanitary Engineers, 1967]
Bioconcentration	The positive difference in concentration of a chemical between water and that in an organism living in that body of water due to direct uptake of the chemical from the water. [SWRCB Order No. WQ 85-1]
Biocriterion (plural biocriteria)	Short for "biological criterion" The numerical or narrative expression of the biological characteristics of ambient aquatic communities (often structural measures, e.g., species composition, organism abundance or diversity). Biocriteria, as generally applied in State programs, are designed to reflect attainable characteristics under minimally impacted conditions. As such, biocriteria describe the ecological potential for aquatic community health in a given watershed, drainage basin or ecological region. [EPA, Report of the National Workshop on Instream Biological Monitoring and Criteria, Lincolnwood, IL, 12/2-4/87]

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Biodegradable	Any substance that decomposes through the action of microorganisms.
Biomagnification	The net accumulation and increase of a substance in an organism as a result of consuming organisms from lower trophic levels, e.g., the consumption of algae by fish or water plants by ducks. [SWRCB Order No. WQ 85-1]
Biomass	The total amount of living material, plants and/or animal, above or below ground in a particular habitat or area. [40 CFR]
Biota	All living organisms that exist in an area.
Bloom	A proliferation of algae and/or higher aquatic plants in a body of water.
Cancer	Any disorder of cell growth that results in invasion and destruction of surrounding healthy tissue by the abnormal cells.
Carcinogen	Any agent that produces cancer, e.g. tobacco smoke, silica and asbestos particles, certain industrial chemicals, and ionizing radiation (such as X-rays and ultraviolet rays).
Carquinez Strait	The narrow strait between Suisun and San Pablo bays. It has a mean surface area of 12 sq. mi., mean depth of 29 ft., and mean volume of 223,000 AF.
Carriage water	The amount of Delta outflow needed to meet all of the water quality requirements of D-1485 less (minus) that needed to meet the requirements excluding those for Contra Costa Canal at Pumping Plant No. 1 (D5) and Clifton Court Forebay Intake at West Canal (C9). The quantity of additional Delta outflow (carriage water) is a function of Delta export pumping and south Delta inflow rates. It is necessary to reduce the effects of sea water intrusion into the Delta around the south side of Sherman Island (reverse flows up the San Joaquin River). This definition differs from that used by others in that it does not include additional Delta outflow which may be needed to meet certain contractual obligations of the Department of Water Resources. [T,III,8:25-10:23]
Central Bay	Central San Francisco Bay. That portion of San Francisco Bay bounded by the Golden Gate, San Francisco-Oakland Bay and Richmond-San Rafael bridges. Surface area = 103 sq. mi. at MLLW, mean depth = 35 ft, and mean volume = 2.307 MAF.

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Chemical oxygen demand (COD)	The results of a laboratory chemical analytical technique which is used to measure the amount of oxygen required to oxidize all compounds in a sample of water, organic and inorganic. [Environmental Glossary 4th ed.]
Chlorammination	The use of a combination of chlorine and ammonia to disinfect water supplies.
Chloride (Cl-)	The ionic form of the gaseous element chlorine, usually found as a metallic salt with potassium or sodium. [SWRCB Order No. WQ 85-1]
Chlorinated hydrocarbons	A class of pesticides which contain chlorine, carbon, and hydrogen. See Chlorinated organic insecticides and acaricides. [Farm Chemical Handbook, 1987] They include solvents (e.g., TCE, TCA), heat exchangers (e.g., PCBs), contaminants (e.g., TCDD, TCDF), herbicides (e.g., ZAP), and wood preservatives (e.g., Pentachlorphenol).
Chlorinated organic insecticides and acaricides	The organic-chlorine chemicals form one of three principal pesticide families. This class in the insecticides and acaricides has related pharmacological effects, and EPA has limited the total amount of these related chemicals for residue purposes. Included are the following chemicals and their metabolites: Aldrin BHC (benzene hexachloride) Chlorbenside Chlordane Chlorobenzilate DDT Dicofol Dieldrin Endosulfan Endrin Heptachlor Lindane Methoxychlor Mirex Ovex TDE Tetradifon Toxaphene [Farm Chemicals Handbook, 1987]
Chlorination	The application of chlorine to drinking water, sewage, or industrial waste to disinfect or oxidize undesirable compounds.
Chlorine (Cl)	A greenish yellow, poisonous, readily liquified gaseous element of the halogen group, with a suffocating odor, obtained principally from common salt, and widely used in industry, medicine, etc. [Funk & Wagnalls Standard College

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	Dictionary, 1973]
	Commonly used to disinfect drinking water and to bleach paper pulp.
Chromosomes	Thread-like bodies occurring in animal and plant cell nuclei; they contain genes, the material that makes possible the transfer of characteristics from parent to offspring.
Coagulation	A clumping of particles in water or wastewater which may result in the settling out of suspended materials. often induced by the addition of chemicals such as lime or alum, or a change in the dissolved ions in a water body such as that which occurs in an estuary when the fresh water inflow mixes with intruding seawater (i.e., in the entrapment zone).
Coliform organisms	All of the aerobic and faculative anaerobic, gram-negative, nonspore-forming, rodshaped bacteria that ferment lactose with gas formation within 48 hr at 35 degrees C. [Standard Methods ..., 14th ed., 1975]
	Large numbers of these organisms are found in the intestinal tracts of humans and warm-blooded animals, their presence in water is often used as an indicator of pollution or potentially pathogenic bacterial contamination.
Colloidal matter	Finely divided solids which will not settle by gravity but may be removed by coagulation or biological action or membrane filtration.
Conductance (Specific)	See Electrical conductivity.
Conjunctive use	The management of surface-and ground-water resources in a coordinated operation to the end that the total yield of such a system over a period of years exceeds the sum of the yields of the separate components of the system resulting from the uncoordinated operation.
	The objective of conjunctive use is to increase the yield, reliability of supply, and general efficiency of a water system by diverting water from streams or surface reservoirs for conveyance to and storage in ground-water basins for latter use when surface water is not available. [Coe, J.J., Conjunctive Use-Advantages, Constraints, and Examples, ASCE Journal of Irrigation and Drainage, v. 116, no. 3, May/June 1990]
Connate water	State definition:

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	Water entrapped in the interstices of a sedimentary rock at the time it was deposited. These waters may be fresh, brackish, or saline in character. Usually applies only to water found in geologically older formations. [DWR Bulletin 74-81] Federal definition: Water entrapped in the interstices of a sedimentary or extrusive igneous rock at the time of its deposition. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Conservative constituent (or property)	A constituent (or property) the concentration of which is not effected by chemical or biological processes. [T,XLV,5:16-5:25]
Contaminant	Federal definition: Any physical, chemical, biological, or radioactive substance or matter in water. [40 CFR 141.2]
Contamination	State definition: An impairment of the quality of the waters of the state by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease...includ[ing] any equivalent effect resulting from the disposal of waste, whether or not waters of the state are affected. [CWC Sec. 13050(k)] Federal definition: The addition to water of any substance or property preventing the use or reducing the usability of water. Sometimes considered synonymous with pollution. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Copepod	One of an order (Copepoda) of small, free-swimming, fresh-water and marine crustaceans. [Funk & Wagnalls Standard College Dicionary, 1973]
Crustacea	A class of anthropoids containing over 35,000 species distributed worldwide, mainly in freshwater and marine habitats, where they constitute a major component of plankton. Crustaceans include shrimps, crabs, and lobsters, copepods, and the terrestrial woodlice. The segmented body usually has a distinct head (bearing compound eyes, two

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	pairs of antennae, and various mouth parts), thorax, and abdomen, and is protected by a shell-like carapace. Each body segment may bear a pair of branched (biramous) appendages used for locomotion, as gills, and for filtering food particles from the water. Appendages in the head region are modified to form jaws and in the abdominal region are often reduced or absent. Typically, the eggs hatch to produce a free-swimming nauplius larva. This develops either by a series of moults or undergoes metamorphosis to the adult form. [Dictionary of Biology, Warner Books]
Current flow conditions	Flow conditions as they exist at present. The factors considered when defining flow conditions include: land and water use patterns, reservoir capacities and operating rules, channel configurations, diversion point locations aand capacities, etc. Hydrologic investigations typically impose various sets of flow conditions upon the available "hydrologic record" and analyze the resultant effects. Within this Plan current flow conditions are those used by the Department of Water Resources to produce the results from their 1990 level of development Operations Study (e.g., DWR Exhibit 30). The DWR Operations Study used the hydrologic record for WY 1922 through 1978.
DAYFLOW	A Department of Water Resources flow accounting model used to calculate daily Delta outflow at Chipps Island. It also estimates interior Delta flows at specified locations, and fish-related parameters and indices.
DDT	The first chlorinated hydrocarbon insecticide It has a half-life of 15 years and can collect in fatty tissues of certain animals. EPA banned registration and interstate sale of DDT for virtually all but emergency uses in the U.S. in 1972 because of its persistence in the environment and accumulation in the food chain. CHEMICAL NAME: Dichloro diphenyl trichloroethane. The principal isomer present (not less than 70%) is 1, 1,1-trichloro-2, 2-bis (p-chlorophenyl)-ethane. [Farm Chemicals Handbook, 1987]
Dabbling duck	A duck which feeds in shallow water, usually from the surface or by "tipping-up." Generally a species in the family Anatidae.
Deep percolation	The drainage of soil water downward by gravity below the maximum effective depth of the root zone toward storage in subsurface strata. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Defoliant	Any substance or mixture of substances intended for causing the leaves or foliage to drop from a plant, with or without causing abscission. [Federal Insecticide, Fungicide, and Rodenticide Act]
Degradation	The act or process of degrading, specifically: A process of transition from a higher to a lower quality or level. [American Heritage Dictionary]
Delta	The Sacramento-San Joaquin rivers delta as defined in the CWC Sec. 12220.
Delta channel depletion	The diversions of Delta channel waters via pumps, siphons, and subsurface seepage onto the Delta uplands and lowlands for consumptive use by agriculture and native plants. [T,I,121: et. seq.] The consumptive use values used by the USBR and DWR to operate the CVP and SWP were fixed in the Federal-State Memorandum of Agreement dated April 9, 1969.
Demersal	Free-swimming on or near the bottom of a water body (as opposed to benthic, which is within or attached to the bottom, and pelagic, which is free-swimming in the water column).
Deterioration	An impairment of water quality. [DWR Bulletin 74-81]
Diatom	A marine or fresh-water plankton, unicellular or colonial, belonging to the family Chlorophyceae of microscopic green algae, characterized by bivalve walls containing silica. [Funk & Wagnalls Standard College Dictionary, 1973]
Disinfectant	Any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone added to water that in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms. [40 CFR 141.2]
Disinfection	A process which inactivates pathogenic organisms in water by chemical oxidants or equivalent agents. [40 CFR 141.2]
Dissolved oxygen (DO)	A measure of the amount of oxygen available for biochemical activity in a given amount of water. Adequate levels of DO are needed to support aquatic life. Low dissolved oxygen concentrations can result from inadequate waste treatment. [Environmental Glossary 4th ed.]
Diving duck	A duck which feeds on bottom organisms while swimming,

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	usually fully submerged. Generally in the family Aythyidae.
Dredge sediment (spoil)	The material removed from the bottom of a water body by the process of dredging which must be disposed of.
Dredging	The removal of material from the bottom of water bodies using a scooping or suction machine.
Drinking water	(Excluding Surface Water) Ground waters suitable, or potentially suitable, for municipal or domestic water supply are defined to be: All ground water, with the exception of: (1) portions of aquifers with waters in excess of 10,000 mg/l TDS, (2) waters with existing or potential beneficial use designations which are unsuitable for domestic or municipal use, and (3) subsurface oil-bearing zones. (This definition is not intended for any purpose other than this document)
Ebb tide	The reflux of tide water; the outgoing or falling tide: opposed to flood tide. [Webster's New Universal Unabridged Dictionary, 2nd. ed., 1979]
Economic poisons	Chemicals used to control pests, disinfect, preserve wood, and other agricultural products; anti-foulant paints, and defoliants for cash crops such as cotton (see pesticide).
Edmonston, A.D. Pumping Plant	The Department of Water Resources State Water Project (SWP) pumping plant located at the south end of the San Joaquin Valley. The prime mover for all SWP water used south of the Tehachapi Mountains, in Southern California.
Effluent	(1) Solid, liquid, or gaseous wastes that enter the environment as a by-product of man-oriented processes. (2) The discharge or overflow of fluid from ground or subsurface storage.
El Nino	A weather phenomenon also know as the "Southern Oscillation" which refers to a periodic failure of upwelling off Peru and associated wind and current changes in the Pacific Ocean.
Electrical conductivity or conductance (EC)	The EC of a water sample is an indirect measure of the total dissolved solids (TDS) or salinity levels of a water sample (i.e., the higher the EC the greater the TDS). Electrical conductivity, or specific conductance, is generally measured

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	in milli- or micro- mhos, or milliSiemens per centimeter (mmhos/cm, umhos/cm or dS/cm, respectively.).
	State definitions:
	The relative ability of water to conduct electrical current. It depends on the ion concentration of and can be used to approximate the total filterable residue (total dissolved solids) in the water. [23 CCR 2601]
	A measure of the ability of water to conduct electricity current at 77 degrees F (25 degrees C). It is related to the total concentration of ionizable solids in the water. [DWR Bulletin 74-90]
	Federal definition:
	[A] measure of the ability of material to conduct an electrical current. For water samples, it depends on the concentration and type of ionic constituents in the water and temperature of the water; and it is expressed in siemens per meter. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Enrichment	Sewage effluent, or agricultural drainage or runoff adding nutrients (nitrogen, phosphorus, carbon compounds) to a water body, greatly increasing the growth potential for algae and aquatic plants.
Entrainment	For purposes of this report entrainment is meant to include primarily the effects of project operations, such as closure of the Delta Cross Channel gates, pumping, and reverse and low flows.
Entrapment zone	An area in an estuary where suspended materials (including certain biota) accumulate. Net upstream transport of the particulate materials that settle into the bottom density current is nullified by the net downstream transport of materials in the river inflow. As a result, certain suspended materials concentrate in the area where the bottom currents are nullified (see Null Zone). [Arthur, J.F. and Ball, M.D., The Significance of the Entrapment Zone Location to the Phytoplankton Standing Crop in the SF Bay-Delta Estuary, USBR, November 1980]
Escapement	The number of adult salmon escaping harvest and returning to the spawning grounds.
Estuary	The mouth of a stream which serves as a mixing zone for fresh and ocean water. Mouths of streams which are

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	temporarily separated from the ocean by sandbars are considered as estuaries by the SWRCB. Estuarine waters are generally considered to extend from a bay or the open ocean to a point upstream where there is no significant mixing of fresh water and seawater. Estuarine waters are considered to extend seaward if significant mixing of fresh and seawater occurs in the open coastal waters. [SWRCB, Water Quality Control Policy for the Enclosed Bays and Estuaries of California, May 1974] In this document Estuary is used when referring to the San Francisco Bay and Sacramento-San Joaquin Delta Estuary.
Euryhaline	Designating aquatic organisms that can tolerate a wide range of salinity. Euryhaline organisms may be found in an estuary (salt content approximately 14 parts per 1000) or in the open sea (salt content 35 parts per 1000). [Dictionary of Life Sciences, 2nd ed., revised, 1983]
Evaporation	The process by which a substance passes from liquid or solid state to the vapor state. [Glossary of Geology, 1972]
Evapotranspiration	The combined loss of water from a given area by evaporation from the land and transpiration from plants. [USGS, Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport, August 1989]
Exchange contractors	Those who formerly diverted water from the San Joaquin River, but exchanged their diversion rights for a contract that granted more consistent water supplies from the Delta Mendota Canal. The maximum contractual entitlement of these users is 0.84 million AF/yr. [USBR, Factsheet: "Exhibits and Testimony before SWRCB, Bay-Delta Hearing 1987", 1987]
Fertilizer	Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply elements essential to plant growth. [Resources Conservation Glossary]
Filter feeding	A method of feeding, found in many aquatic invertebrates, in which minute food particles are ingested from the surrounding water. Filter feeders are common in plankton and benthos communities. [Martin, E.A., Dictionary of Life Sciences, 2nd ed., 1983]
Flocculation	A process to enhance agglomeration or collection of smaller floc particles into larger, more easily settleable particles through gentle stirring by hydraulic or mechanical means. [40 CFR 141.2]
Flood tide	The rising tide: opposed to ebb tide. [Webster's New

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	Universal Unabridged Dictionary, 1979]
Flow-weighted sampling	Samples taken in a manner that allows determination of mass emissions, i.e., samples taken in proportion to the rate of flow of a river or stream.
Flushing	The process by which contaminant concentrations in a body of water are diluted by river inflow and, where applicable, tidal exchange of "new" uncontaminated water combined with the net advection of the contaminants away from their source by residual currents.
Food chain	The pyramidal relationship of producers (plants) and consumers (animals) by which solar energy is converted through photosynthesis to plant tissue which is consumed by animals which are in turn consumed. At each step up the food chain consumers are usually larger but fewer in number.
Food web	The sum of the interacting food chains in an ecological community. [SWRCB Order No. W.Q. 85-1]
Fry	The stage in the life of a fish between the hatching of the egg and the absorption of the yolk sac (same as sac fry or alevin). From this stage until they attain a length of one inch the young fish are considered advanced fry. [Bell, M.C., Fisheries Handbook of Engineering Requirements and Biological Criteria, U.S. COE, 1986]
Geochemistry	The science dealing with the chemistry of the earth's crust.
Geometric mean	The antilogarithm of the mean of a group of logarithms of a measured variable. The geometric mean is used to transform logarithmically distributed numbers for statistical purposes. (See definitions for Logarithm and Logarithmic Distribution.)
Grab sample	A single sample taken at an instant in time to represent the conditions at that instant.
Gravitational circulation	Net internal motions caused by horizontal density gradients. The denser fluid flows along the bottom and lighter fluid along the surface in an attempt to restore a stable vertical stratification. In the case of a longitudinal salinity gradient, this produces a net landward bottom current and compensating seaward current of fresher water at the surface. Also refered to as Baroclinic Circulation. (Also see Null Zone.)
Gravitational overturn	The formation of a lens of fresh water on the surface of an estuary during a period of high runoff. Also refered to as

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	Gravitational Overflow. This surface layer can spread beyond the mouth of the estuary into the ocean.
Ground water	(1) That part of the subsurface water that is in the saturated zone.
	(2) Loosely, all subsurface water as distinct from surface water.
	(3) All water which occurs below the land surface. It includes both water within the unsaturated and saturated zones.
	(4) The water below the land surface in a zone of saturation, for purposes of this appendix, ground water is the water contained within an aquifer (10 CFR 40 Appendix A).
	(5) All water which occurs below the land surface (10 CFR 60.2).
	(6) All subsurface water as distinct from surface water (10 CFR 960).
	(7) Subsurface water that fills available openings in rock or soil materials to the extent that they are considered water- saturated (30 CFR 710.5).
	(8) water below the land surface in a zone of saturation (40 CFR 270.2; 40 CFR 146.3; 40 CFR 144.3).
	(9) water in a saturated zone or stratum beneath the surface of land or water (40 CFR 300.6; 40 CFR 257.3-4).
Ground water banking	The act, by a public agency, of recharging or replenishing a ground water basin. There is an account kept on the water recharged and it is extracted in dry years to meet dry-year needs. A ground water bank is operated very much the same as a surface reservoir. The extraction of the stored water is controlled by the public agency and is not restricted to overlying users such as is the case with normal ground water use. See Overdraft correction programs.
Ground water basin	A ground water basin consists of an area underlain by permeable materials which are capable of storing or furnishing a significant water supply; the basin includes both the surface area and the permeable materials beneath it. [DWR Bulletin 74-81]
Ground water	The condition of a ground water basin in which the amount of

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
overdraft	ground water withdrawn under current development exceeds the amount of water that replenishes the basin over a hydrologically mean period. [DWR Bulletin 118]
Grow-out facilities	Ponds at a hatchery or pumping facility where fish are kept until they are large enough to survive on their own.
Gyre	A circular or spiral motion: whirl: revolution.
Habitat	The sum of environmental conditions in a specific place that is occupied by an organism, population, or community.
Hard water	Those waters that require considerable amounts of soap to produce a foam or lather and that also produce scale in hot-water pipes, heaters, boilers, and other units in which the temperature of water is increased materially. [Sawyer, C.N. and McCarty, P.L., Chemistry For Sanitary Engineers, 1967]
Hardness	A waters content of metallic (i.e., positive) polyvalent ions, principally calcium and magnesium, that react with sodium soaps to produce solid soaps and that react with negative ions, when the water is evaporated in boilers, to produce solid boiler scale. Hardness is usually expressed as mg/l of equivalent calcium carbonate ($CaCO_3$). [Camp, T.R. and Meserve, R.L., Water And Its Impurities, 1974]
Hazardous material	(a) "Hazardous material" means a substance or combination of substances which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may: (1) Cause, or significantly contribute to an increase in serious irreversible, or incapacitating reversible, illness; or (2) Pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported or disposed of or otherwise managed. (b) Unless expressly provided otherwise, the term "hazardous material" shall be understood to also include extremely hazardous material. [22 CCR 66100 et seq.]
Heavy metals	Metallic elements like mercury (Hg), chromium (Cr), cadmium (Cd), arsenic (As), and lead (Pb), with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain.
Herbicides	All substances or mixtures of substances used to control or destroy undesirable plants.

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Historic flows	Depending on the context used can mean either; (1) those flows before man began influencing river flows (i.e., the Natural Flow), [SWRCB,3] or (2) flow conditions that actually occured over the historic hydrological period and were measured at various locations in the Central Valley Basin using flow measuring devices. These flows reflect upstream impoundments, diversions or use of runoff under the existing upstream storage and channel configurations at the time of measurement. [SWC Comments on January 19, 1990 Draft Revised WQCP, p. 6, April 9, 1990]
Homologous	In Biology: Anatomical features of different organisms (species) which correspond in structure and evolutionary origin, as the flipper of a seal and the arms of a human being. [American Heritage Dictionary 2nd ed.] In Chemistry: The members of a series of organic compounds having the same structure, but in which each differs from the preceding one by a constant increment, as the methane series. [Funk & Wagnalls Standard College Dictionary, 1973]
Hybrid	An offspring of two animals or plants of different races, breeds, varieties, species, or genera.
Hybridization	The act or process of producing hybrids.
Hydraulics	The branch of physics having to do with the mechanical properties of water and other liquids and with the application of these properties in engineering.
Hydrocarbons	A large and important group of organic compounds that contain only hydrogen and carbon. There are two types, saturated and unsaturated. Saturated hydrocarbons are those in which adjacent carbon atoms are joined by a single valence bond and all other valences are satisfied by hydrogen. Unsaturated hydrocarbons have at least two carbon atoms that are joined by more than one valence bond and all remaining valences are satisfied by hydrogen. The saturated hydrocarbons form a whole series of compounds starting with one carbon atom and increasing one carbon atom, stepwise. These compounds are also known as the paraffin series, the methane series, and as the alkanes. The principal source is petroleum. Gasoline is a mixture containing several of them; diesel fuel is another such mixture.

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	The unsaturated hydrocarbons are usually seperated into four classes: (i) the ethylene series of compounds all contain one double valence bond between two adjacent carbon atoms; (ii) the diolefin series of compounds all contain two double bonds in their molecules; (iii) the polyenes contain more than two double bonds, these compounds occur in the wastewaters produced by the canning industry (the chlorine demand of wastewaters containing polyenes is extremely high); (iv) the acetylene series of unsaturated hydrocarbons have a triple bond between adjacent carbon atoms, these compounds are found in some industrial wastewater (particularly those from the manufacture of some types of synthetic rubber).
Hydrodynamics	The motion and action of water and other liquids, i.e., the dynamics of liquids, and the study thereof.
Hydrology	The science of water in nature: its properties, distribution, and behavior.
Impairment	A change in quality of water which makes it less suitable for beneficial use. [DWR Bulletin 74-81]
In vivo	Designating biological processes that are performed, outside living organisms, traditionally in a test tube. [Dictionary of Life Sciences, 2nd ed., 1976]
Injection well	Any bored, drilled, driven shaft, dug pit, or hole in the ground into which water or fluid is discharged, and any associated subsurface appurtenances, and the depth of which is greater than the circumference of the shaft, pit, or hole. [CWC Sec. 13051]
Insecticides	All substances or mixtures of substances intended for preventing or inhibiting the establishment, reproduction, development, or growth of, destroying or repelling any member of the Class Insecta or other allied Classes in the Phylum Arthropoda considered to be a pest.
Irrigation efficiency (IE)	The efficiency of a single on-farm irrigation; the ratio of the depth of water beneficially used (BU) to the depth of applied water (AW), expresses as a percent. IE = (BU/AW) x 100 [Westlands Water District, Water Conservation and Drainage Reduction Programs, 1987-1988, Definition of Terms, November 1989]

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Kesterson National Wildlife Refuge (Kesterson NWR)	A waterfowl management area adjacent to Kesterson Reservoir in Merced county California which was originally planned to utilize San Luis Drain water. When first established, Kesterson National Wildlife Refuge (NWR) used a mixture of fresh CVP water and local tailwater to develop wetland habitat. As the use of San Luis Drain water, including an increasing proportion of tile drain waters, was phased in, deformities and reproductive abnormalities began to affect the birds nesting there. [SWRCB Order No. WQ 85-1]
Kesterson Reservoir	A water storage facility adapted as an interim evaporation basin for the Central Valley Project San Luis Drain. [SWRCB Order No. WQ 85-1]
Larvae	The juvenile stage in the life cycle of most invertebrates, amphibians, and fish, which hatch from eggs, is unlike the adult in form, and is usually incapable of sexual reproduction. It develops into the adult by undergoing metamorphosis. Larvae can feed themselves and are otherwise self-supporting. Examples are the tadpoles of frogs, the caterpillars of butterflies, and the ciliated planktonic larvae of many marine animals. [Dictionary of Biology. Warner Books]
Leachate	Any fluid formed by the drainage of liquids from waste or by the percolation of liquid through waste. It includes any constituents extracted from the waste and dissolved or suspended in the fluid. [23 CCR 206]
Leaching	The flushing of salts from the soil by the downward percolation of water.
Leaching fraction	That fraction of the total amount of applied water that passes through a crop root zone. [SWRCB, 29, 2]
Lead (Pb)	A soft, malleable, ductile, bluish white dense metallic element, with a variety of toxic salts. [SWRCB Order No. WQ 85-1]
Levee	An embankment, especially along the shore of a river, built for portection against floods. [Funk & Wagnalls Standard College Dictionary, 1973]
Logarithm (Log)	The exponent expressing the power to which a fixed number (the base) must be raised in order to produce a given number (the antilogarithm). The most common logarithms are for the base 10. For example, 3 is the base 10 logarithm of 1,000 -- 100 is the base 10 antilogarithm of 2. See Natural logarithum

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Logarithmic distribution	The distribution of a set of observations of a variable which is limited at its lower end by zero (i.e., cannot have a value of less than zero) but is otherwise unrestrained. The logarithms of the observations of a logarithmically distributed variable are symmetrical about (i.e., 50% above and 50% below) the logarithm of the geometric mean of the variable.
Logarithmic mean (or log mean)	See definition of geometric mean.
Lunar day	The time of rotation of the moon about the earth, 24.84 hours.
Manganese (Mn)	A hard, brittle, grayish white metallic element, oxidizing readily and forming an important component of certain alloys, as manganese steel. [Funk & Wagnalls Standard College Dictionary, 1973]
Marsh or marshland	A tract of low, wet, soft land; swamp; bog; morass; fen.
Maximum contaminant level (MCL)	The maximum permissible level of a contaminant in water which is delivered to the free flowing outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition. [40 CFR 141.2]
Maximum contaminant level goal (MCLG)	The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health or persons would occur, and which allows an adequate margin of safety. Maximum contaminant level goals are nonenforceable goals. [40 CFR 141.2]
Maximum total trihalomethane potential (MTTP or MTP)	The maximum concentration of total trihalomethanes produced in a given water containing a disinfectant residual after 7 days at a temperature of 25 degrees C or above. [40 CFR 141.2]
Measured flow	The flow of water determined with a measuring device.
Mho	A unit of measure for electrical conductivity equal to the reciprocal, or inverse, of the standard unit of electrical resistance, the ohm. One mho is equal to one Siemen, the standard unit of electrical conductivity.

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Mutagenic	An agent that causes an increase in the number of mutants (see mutation) in a population. Mutagens operate either by causing changes in the DNA of the genes, so interfering with the coding system, or by causing chromosome damage.
Mutation	A sudden random change in the genetic material of a cell that may cause it and all cells derived from it to differ in appearance or behavior from the normal type. A relatively abrupt and permanent change in DNA that can be transmitted during cell division.
National Pollutant Discharge Elimination System (NPDES)	The national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 318, 402, and 405 of the Clean Water Act. The term includes appoved state programs. [40 CFR]
Natural or true natural flow	The embayment and channel flows which existed at the time of the first Spanish exploration of California, i.e., before the Gold Rush.
Neap tide	The tide occurring just after the first and third quarters of the lunar month: at these times the difference between high and low tides is smallest. [Webester's New Universal Unabridged Dictionary, 2nd. ed., 1979]
Nekton	The aggregate of animal organisms capable of swimming freely, relatively independent of currents, waves, etc., ranging in size from microorganisms to whales. Compare to "Plankton"
New water	Water which has not entered the Bay for at least several tidal cyclee. [Denton and Hunt, 1986]
Nickel (Ni)	A hard, ductile, mallable, silver-white metallic element of the iron-cobalt group.
Nitrate	An ion composed of one atom of nitrogen bound to three atoms of oxygen. An important plant nutrient. In high concentrations, it can bind to hemoglobin resulting in methemoglobinemia. also refers to salts of the nitrate ion with other ionic substances, usually metals. [SWRCB Order No. WQ 85-1]
Non-point source	Causes of water pollution that are not associated with point sources, such as agricultural fertilizer runoff, or sediment from construction. Examples include (i) Agriculturally related non-point sources of pollution including runoff from manure disposal areas, and from land used for livestock and

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	crop production; (ii) Siviculturally related non-point sources of pollution; (iii) Mine-related sources of pollution including new, current and abandoned surface and underground mine runoff; (iv) Construction activity related sources of pollution; (v) Sources of pollution from disposal on land, in wells or in subsurface excavations that affect ground and surface water quality; (vi) Salt water intrusion into rivers, lakes, estuaries and ground water resulting from reduction of fresh water flow from any cause, including irrigation, obstruction, ground water extraction, and diversion; and (vii) Sources of pollution related to hydrologic modifications, including those caused by changes in the movement, flow, or circulation of any navigable waters or ground waters due to construction and operation of dams, levees, channels, or flow diversion facilities.
Null zone	The region in a partially- or well-mixed estuary where the residual bottom currents are effectively zero. Landward of this point there is a net seaward residual velocity along the bottom caused by river inflow and seaward of the null zone, gravitational circulation produces a net landward transport of denser more saline water along the bottom. The null zone is the theoretical upstream boundary of the entrapment zone.
Organic	Referring to or derived from living organisms. In chemistry, any compound containing carbon. [Environmental Glossary 4th ed.]
Organism	Any living thing. [Environmental Glossary 4th ed.]
Organochlorines	A range of compounds used mainly as pesticides, and the polychlorinated biphenyls (PCBs), which are of industrial origin. These compounds share a range of properties which set them apart from other types of pollutants. They are generally of relatively low water solubility, also known as chlorinated hydrocarbons. [AHI, 304]
Overdraft correction programs	Programs wherein water is imported or local waters are used to recharge a basin for the benefit of all overlying users in the basin. There is no ownership of the recharged water. It becomes part of the safe yield of the basin. See Groundwater banking.
Oxidizing agent	A substance (such as oxygen, chlorine, or bromine) that oxidizes by taking up electrons.
Ozonation	The municipal water treatment process wherein ozone is used to disinfect a water supply.

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Ozone	An unstable allotropic form of oxygen, O3, with a pungent odor like that of chlorine, formed variously, as by the passage of electricity through the air. It is a powerful oxidizing agent, much more active than ordinary oxygen, and is used for bleaching oils, waxes, ivory, flour, [paper bulp] and starch, and for disinfecting drinking water. [Funk & Wagnalls Standard College Dictionary, 1973]
PEROXONE	A combination of ozone and hydrogen peroxide.
Partially-mixed estuary	An estuary in which vertical mixing due to tidal currents is large enough to prevent a distinct vertical density stratification between fresh and seawater but not strong enough to completely remove any vertical variation in density. The northern reach of San Francisco Bay is typical of a partially-mixed estuary.
Peat	A substance consisting of partially carbonized vegetable material, chiefly mosses, found usually in bogs. [Funk & Wagnalls Standard College Dictionary, 1973]
Pelagic	Describes open-water (or deep-water) habitat or those organisms which depend upon it.
Perozonation	The use of PEROXONE to disinfect water.
Pesticide	All chemical agents which are used for the control of some noxious insect, plant, or animal. Pesticide compounds, synthetic as well as substances which occur in nature, can be categorized into four groups as follows: (1) Chlorinated hydrocarbons containing carbon, hydrogen, and chlorine. Examples are DDT, toxaphene, lindane, chlordane, and endrin. (2) Organic phosphorus (thiophosphate) compounds of phosphorus, oxygen, carbon, and hydrogen. Examples are parathion and malathion. (3) Organic compounds including organic sulfur compounds, organic mercurials, dinitrophenols, carbamates, and natural products such as rotenone, nicotine, and strychnine. (4) Inorganic compounds of copper sulfate, arsenate of lead, zinc, chlorine, thallium, calcium arsenate, and sodium floroacetate. [ASCE, SA 5, p. 28, October, 1967]
Phytoplankton	Free-floating aquatic plants.
Piscivore	Fish eater.

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Plankton	The animal and plant organisms that drift or float with currents, waves, etc., unable to influence their own coures, ranging in size from microorganisms to jellyfish: distinguished from benthos. Compare to "Nekton". [Funk & Wagnalls Standard College Dictionary, 1973]
Point source	Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture. [CWA, Sec. 502 (14)]
Pollution	An alteration of the quality of the waters of the state by waste to a degree which unreasonably affects (1) such waters for beneficial uses, or (2) facilities which serve such beneficial uses. "Pollution" may include "contamination". [CWC Sec. 13050(l)]
	The introduction into the groundwater of the state of an active ingredient, other specific product, or degradation product of an active ingredient of an economic poison above a level, with an adequate margin of safety, that does not cause adverse health effects. [CFAC Sec. 13142]
Polychlorinated biphenyls (PCBs)	A mixture of compounds composed of the biphenyl molecule which has been chlorinated to varying degrees. [Environmental Glossary, 4th ed.]
	PCBs are considered an environmental problem because of their abundance, very great persistence, and considerable toxicity to aquatic biota. [AHI,304]
Postammoniation	The addition of ammonia to water as the last step in municipal water treatment.
Potable water	Suitable for drinking. [Funk & Wagnalls Standard College Dictionary, 1973]
Preammoniation	The addition of ammonia to water as it first enters a municipal water treatment, prior to the application of any other water treatment process.
Precipitation	The discharge of water (as rain, snow or hail) from the atmosphere upon the earth's surface. [DWR Bulletin 118]
Preirrigation	The efficiency of an on-farm preirrigation; the ratio of the

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
efficiency (PIE)	sum of the depth of water used for soil moisture replacement (SWR1) and cultural practices (CP1) to the depth of applied water (AW1), expressed as a percent. No leaching requirement is included. [Westlands Water District, Water Conservation and Drainage Reduction Programs, 1987-1988, Definition of Terms, November 1989]
Progressive wave	A tidally-driven wave which travels along an estuary. This type of wave occurs in long shallow estuaries where there is a significant frictional resistance to the tidal flow and only weak wave reflection at the head of the estuary. The tide in the northern reach of San Francisco Bay travels upstream as a progressive wave.
Pulse flow	A substantial increase in the flow of water followed by a decrease within a relatively short period of time.
Quality of water	The chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use. [CWC Sec. 13050(h)]
Rare species	A species, subspecies, or variety is rare when, although not presently threatened with extinction, it is in such small numbers throughout its range that it may become endangered if its present environment worsens. [CFGC Sec. 1901]
Recharge	The flow to ground water storage from precipitation, infiltration from streams, and other sources of water. [DWR Bulletin 118]
Reclaimed water	Water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur. [CWC Sec. 13050(n)]
Recruitment	Addition by reproduction of new individuals to a population.
Reservoir reoperation	A quantitative study in which the operating rules for a reservoir are changed from the rules actually used in the historical operation of the reservoir. The new operating rules result in different releases from the reservoir than actually occurred historically.
Residual current	The net transport of a particle averaged over a complete tidal cycle.
Residual disinfectant concentration	The concentration of disinfectant measured in mg/l in a representative sample of water. [40 CFR 141.2]
Residue	Generally refers to that portion of a sample remaining after

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	drying at 103-105 degrees C or 180 degrees C to a constant weight. [Standard Methods ... 14th ed.,1975]
	Under certain circumstances, the toxic material found when a sample has been analyzed; usually refers to a toxicant in a food or tissue sample, expressed as a proportion of the original weight. [SWRCB Order No. WQ 85-1]
Resource	That which is, or may be, readily available as a source of supply or support; anything that can be drawn upon when needed, whether material or non-material. [Resource Conservation Glossary]
Reverse flow	In the context of this report, the term reverse flow refers to net flow being in the upstream direction in the Southern and Western Delta. This condition occurs between approximately the western end of Sherman Island (in the Delta) and the export pumps when Delta inflow is relatively, low and Delta consumptive uses and exports are high.
Riparian	Pertaining to the banks and other terrestial environs adjacent to water bodies, watercourses, and surface-emergent aquifers (e.g. springs, seeps, oases), whose waters provide soil moisture significantly in excess of that otherwise available through local precipitation. Vegetation typical of this environment is dependent on the availability of excess water.
Riparian water right	The right to use water on land bordering a stream. See also Water rights. [SWRCB Order No. WQ 85-1]
Riparian wetland	A zone which may be periodically inundated by water, characterized by moist soil and associated vegetation; typically bounded on one border by a drier upland and on the other by a freshwater body. [SWRCB Order No. WQ 85-1]
Riverine	Pertaining to or like a river; riparian. [Funk & Wagnalls Standard College Dictionary, 1973]
Run	To migrate, especially to move in a shoal in order to spawn. [American Heritage Dictionary 4th ed.]
Runoff	That part of precipitation which is not absorbed by soil, evaporated, or transpired by plants, but finds its way into streams as surface flow. [Fundamentals of Ground Water Contamination Glossary, 1985]
	Any precipitation, leachate, or liquid that drains from any part of a waste management unit. [23 CCR 2601]

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Salinity	The total concentration of dissolved ions in water, a conservative property. [T,XLV,5:12-5:25] The salt content of a water. [SWRCB Order No. WQ 85-1] Usually expressed as ppt (g/l), or ppm (mg/l).
Salvage	Those fish diverted away from or removed from screens at intakes to diversion structures and subsequently returned to a water body.
San Pablo Bay	The portion of San Francisco Bay encompassing the area from the Richmond-San Rafael Bay Bridge on the south side to the Petaluma River on the north and the Carquinez Strait on the east. It has a surface area of 105 sq. mi. at MLLW, mean depth of 9 ft., and mean surface area of 605,000 AF.
Saturated zone	An underground zone in which all openings in and between natural geologic materials are filled with water. [23 CCR 2601]
Secondary treatment	Biochemical treatment of wastewater after a primary stage, using microorganisms to consume the organic material in the wastewater. Use of trickling filters, or the activated sludge process, removes floating and settleable solids and about 90 percent of oxygen demanding substances (BOD) and suspended solids (TSS).
Selenium (Se)	A non-metallic element chemically resembling sulfur. Essential for animals at trace concentrations, selenium is toxic to animals in deficient or excessive dietary exposure. [SWRCB Order No. WQ 85-1] Selenium occurs in three environmentally significant valence states Se -2 (selenide), Se +4 (selenite), and Se +6 (selenate), with different toxic properties.
Semidiurnal tide	A tidal variation consisting of two high and two low tides per lunar day (24.84 hrs). In San Francisco Bay, the cycle typically consists of a high high followed by a low low, a low high, a high low and back to a high high tide.
Shoal	A shallow place in any body of water, or an assemblage or multitude; throng (i.e., a school of fish). [Funk & Wagnalls Standard College Dictionary, 1973]
Shorebird	Any of various birds (suborder Charadrii) that frequent beaches and also the shores of inland waters, including the snipe, sandpiper, and plover. [Funk & Wagnalls Standard

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	College Dictionary, 1973]
Siemen	The standard unit of electrical conductivity, equal to 1 mho. The reciprocal, or inverse, of the standard unit of electrical resistance, the ohm.
Slot limit	Fishing regulation which permits taking of fish only with specified lengths, usually medium-sized fish to protect both very young or immature fish and very large, older and typically more fecund (high reproductive capacity) fish.
Slough	A stagnant swamp, backwater, bayou, inlet, or pond in which waterbacks up. [Funk & Wagnalls Standard College Dictionary, 1973]
Sludge	Residual solids and semi-solids from the treatment of water, wastewater, and other liquids. It does not include liquid effluent discharged from treatment processes. [23 CCR 2601]
Smolt	An anadromous fish that is physiologically ready to undergo the transition from fresh to salt water; age varies depending on species and environmental conditions. [Bell, M.C., 1986]
Soluble, e.g., soluble selenium	Any substance capable of passing through a membrane filter with a rated pore diameter of 0.45 microns. [Standard Methods..., 14th ed., 1975]
	Capable of entering into solution or of being dissolved; as, a soluble substance. [Webster's New Universal Unabridged Dictionary, 1979]
South Bay	The portion of the San Francisco Bay stretching from the San Francisco-Oakland Bay Bridge on the north to Mountain View in the south. It has a surface area of 214 sq. mi. at MLLW, mean depth of 11 ft. and mean volume of 1,507,000 AF
Species	A unit used in the classification of plants and animals. Ideally a species is defined as a group of organisms that interbreed with each other to produce fertile offspring. Members of different animal species do not normally interbreed; if they do, the progeny are sterile. Hybrids of two plant species are usually sterile but may occasionally be made fertile by allopolyploidy [doubling the number of chromosomes present in the sterile hybrid]. Members of the same species usually resemble each other closely, but when species are subdivided into subspecies, clines, or cultivated varieties, the members of these subgroups often

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	differ from one another in appearance. [Dictionary of Life Sciences, 2nd ed., 1976]
Spring tide	(1) The tide that appears at or soon after the new moon and the full moon: it is normally the highest tide of the month. (2) Any great flow, rush or flood. [Webster's New Unabridged Dictionary, 1979]
Standard	See Water Quality Standard.
Standing wave	A wave which does not travel so the point of maximum amplitude (crest to trough) remains fixed in space. Standing waves occur in an estuary when the resistance to the flow is small. The tide in South Bay is an example of a standing wave.
Statewide plan	A water quality control plan adopted by the State Water Resources Control Board in accordance with the provisions of Cal.Water Code Sec. 13240 to 13244, for waters where water quality standards are required by the Federal Water Pollution Control Act. Such plans supersede regional water quality control plans for the same waters to the extent of a conflict. [CWC Sec. 13170]
Striped bass index (SBI)	An index of the number of young bass which have survived through their first summer. Young bass are sampled with nets which are most efficient for fish about 1.5 inches in length. Sampling methods are consistent (with respect to location, frequency, technique, etc.) so that the number of young striped bass caught may be compared with the catch at various locations year to year. The number of young bass caught by the standard sampling methods allows statistical treatment of data to estimate the abundance of young striped bass and to correlate changes in the number caught with changes in environmental factors. [SWRCB, Final EIR for the 1978 WQCP and D-1485]
Subsurface agricultural drainage system	A set of tile drains, collectors and, in most cases, one or more sump pumps which are installed in a field to remove water from the root zone of any crops which may be planted. Generally installed in areas with shallow perched water tables.
Suisun Bay	The portion of San Francisco Bay between the entrance to the Carquinez Strait and Chipps Island, including Grizzly and Honker bays. It has a surface area of 36 sq. mi. at MLLW, mean depth of 14 ft. and mean volume of 323,000 AF.

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Suisun Marsh	The marshlands generally located in southern Solano County, south of the cities of Fairfield and Suisun City. It is bordered on the south by Suisun Bay including Grizzly and Honker bays, and the confluence of the Sacramento and San Joaquin rivers; on the east from Denverton along Shiloh Road to Collinsville. Suisun Marsh occupies an area of 116,000 acres, including about 88,000 acres below the five-foot contour It is the largest contiguous brackish water marsh in the United States. Suisun Marsh's boundaries are legally defined in CPRC Sec. 29101 and 29101.5.
Suspended solids (SS)	Tiny particles of solids dispersed but undissolved in a solid, liquid, or gas. Suspended solids in sewage cloud the water and require special treatment to remove (Environmental Glossary 4th ed.). Generally considered those particles subject to Brownian diffusion.
Threatened or endangered	Fish and wildlife, and plants are in danger of or threatened with extinction because their habitats are threatened with destruction, adverse modification, or severe curtailment, or because of over exploitation, disease, perdition, or other factors. [CFGC Sec. 2051]
Tidal prism	The increase in water volume landward of a given cross-section from low tide to high tide. Related to the tidal volume on the ebb and flood tide and the cumulative upstream inflows.
Tile drains	A System of clay pipes installed beneath irrigated lands to artificially remove water saturating the soil of the crop root zone by gravity flow.
Total dissolved solids (TDS)	A measure of the salinity equal to the amount of material remaining after evaporating a water sample at 103 to 105 degrees Celsius (formerly centigrade) for one hour. [SWRCB Order No. WQ 85-1] Total dissolved solids levels are expressed in units of weight per unit of volume (e.g. mg/l).
Toxic pollutants (elements, metals or organics)	Those pollutants, or combinations of pollutants, [elements, metals,or organics] including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	deformations, in such organisms or their offspring. [Resource Conservation Glossary]
Toxicant	(1) A chemical that controls pests by killing rather than repelling them. (2) A harmful substance or agent that may injure an exposed organism. [Environmental Glossary 4th ed.]
Trace elements (metals or organics)	Those elements [metals or organics] generally present in natural water samples at concentrations of less than one milligram per liter. [SWRCB Order No. WQ 85-1]
Tracy Pumping Plant	The U.S. Bureau of Reclamation Central Valley Project pumping plant in the Delta west of Tracy. The source of the water in the Delta-Mendota Canal.
Transpiration	The photosynthetic and physiological process by which plants release water into the air in the form of water vapor. [Resource Conservation Glossary]
Tributary area	The whole area or region from which a waterbody receives its supply of water. An alternative phrase for watershed.
Triennal basis	Once every three years.
Trihalomenthane formation potential (THMFP)	The analytical results from a non-standard laboratory technique which is used on raw water supplies in an attempt to quantify the likelihood that trihalomethanes will be formed when the water is disinfected.
Trihalomethanes (THMs) or Total trihalomethanes (TTHMs)	Singular; One of the family of organic compounds, named as derivatives of methane (CH4), wherein three of the four hydrogen atoms are each substituted by a halogen atom [e.g., chlorine, bromine] in the molecular structure. [40 CFR 141.2] Plural; (1) A subset of chemicals known as disinfection by-products (DBPs) which are formed when waters are disinfected. THMs are produced when dissolved organic substances, such as fulvic and humic acids produced by decaying crop residues or peat soil in fresh or saline waters, come in contact with the oxidizing agents used to disinfect drinking water. [T,VI,38:3-5; T,XLVI,99:11-19] (2) The sum of the concentration in mg/l of the trihalomethane compounds (trichloromethane [chloroform], dibromochloromethane, bromodichloromethane, and tribromomethane [bromoform]), rounded to two significant figures. [40 CFR 141.2]

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Tule	A large bulrush (Scirpus acutus) growing on damp or flooded land in the southwestern United States. [Funk & Wagnalls Standard College Dictionary, 1973]
Turbidity	Hazy air due to the presence of particles and pollutants; a similar cloudy condition in water due to suspended silt or organic matter. [Environmental Glossary 4th ed.]
Unimpaired flow	The embayment and channel flows which would exist in the absence of upstream impoundments and diversions of rainfall or snowmelt runoff, but in the presence of existing channel configurations, both upstream and in the Delta.
Unsaturated zone	The underground zone in which not all openings in and between natural geologic material are filled with water. The zone may contain water or other liquid held by capillary forces, or percolating liquids. [23 CCR 2601]
Usable storage capacity	The quantity of ground water that can be economically withdrawn from storage. [DWR Bulletin 118]
Waste	Sewage and any and all other waste substances, liquid, solid, gaseous, or radioactive, associated with human habitation, or of human or animal origin, or from any producing, manufacturing, or processing operation of whatever nature, including such waste placed within containers of whatever nature prior to, and for purposes of, disposal. [CWC Sec. 13050(d)]
Water borne	(1) Floating on or supported by water; afloat. (2) Transported by water, as freight. (3) Transmitted in water, as a disease germ. [American Heritage Dictionary]
Water quality	See Quality of water.
Water quality control	The regulation of any activity or factor which may affect the quality of the water of the state and includes the prevention and correction of water pollution and nuisance. [CWC Sec. 13050(i)]
Water quality control plan	A designation or establishment for the waters within a specified area of (1) beneficial uses to be protected, (2) water quality objectives, and (3) a program of implementation needed for achieving water quality objectives. [CWC Sec. 13050(j)]

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
Water quality objective	The limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area and time frame. Water quality objectives may be either numerical or narrative. [CWC Sec. 13050] Factors to be considered in establishing water quality objectives shall include, but not be limited to all of the following: (a) past, present, and probable future beneficial uses of water, (b) environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto, (c) water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area, (d) economic considerations, and (e) the need for developing housing within the region. [CWC Sec. 13241]
Water quality standard	A term used in connection with the federal Clean Water Act which is roughly equivalent to water quality objectives and designated beneficial uses.
Water rights	A form of property rights which give their holder the right to use public waters. During the history of California, a variety of procedures have been in effect by which a person could acquire a water right A summary follows: Appropriative rights initiated prior to December 19, 1914 - prior to the 1914 statutes which established the present system for appropriating water (taking water and putting it to a use removed from property adjoining the water source) two methods of appropriation existed. Prior to 1872, appropriative rights could be acquired simply by taking water and putting it to beneficial use. In 1872, Sections 1410 through 1422 of the California Civil Code enacted a permissive procedure by which priority of rights could be established as of the date of posting of notice of intention to appropriate water, subject to a show of diligence in carrying out construction of diversion works and actual use of water. Appropriators who did not follow the permissive procedure had priority from the date of actually putting the water to use. Because in an appropriative water rights system, first in priority means first served by available water, considerable advantage attaches to an earlier date of

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	appropriation. Appropriative rights initiated after December 19, 1914 - an appropriation of water must now comply with provisions of Part Two, Division Two of the California Water Code. The right to use water appropriated under earlier procedures as well as under the current procedure maybe lost by abandonment or non-use. Riparian rights - an owner of land adjoining a water source has, under common law, the right to use a share of the water available from the source. Only those parcels of land adjoining the source may be served by it under riparian right, unless a nonadjoining parcel was at one time part of a riparian parcel and the riparian right was transferred when the parcel was sold. No priority is established for riparian rights, and all riparian users must share the available supply. Riparian owners have priority of use over all appropriators. Prescriptive rights - rights obtained when water is taken and put to use for five years even though other right holders' interests are damaged, if the injured parties take no action in their own defense. California Water Code Section 1225 and State Water Resources Control Board policies have made obtaining secure prescriptive rights essentially impossible since 1914. [SWRCB Order No. WQ 85-1]
Waters of the state	Any water, surface or underground, including saline waters within the boundaries of the state. [CWC Sec. 13050(e)]
Watershed	The land area that drains into a body of water. [Environmental Glossary 4th ed.] Also see Tributary area
Winter ponding	The practice of flooding large agricultural field areas for the purpose of controlling weeds, and reducing salt concentrations in the upper region of the soil profile. Secondary benefits are recreation, possible salt leaching.
Yearling	An organism that is one year old but has not completed its second year.
Yolk	The store of food material, mostly protein and fat, that is present in the eggs of most animals. [Martin, E.A., Dictionary of Life Sciences, 2nd ed., 1983]
Yolk sac	The four extraembryonic membranes that surround vertebrates during early development. The yolk sac forms as a ventral

APPENDIX C

GLOSSARY

WORD/PHRASE	DEFINITION
	outgrowth of the embryonic gut of most fish, reptiles, and birds. As the yolk is absorbed the sac is withdrawninto the embryo. [Martin, E.A., Dictionary of Life Sciences, 2nd ed., 1983]
Young-of-year (YOY)	Fish of other organisms less than one (1) year old.
Zooplankton	Free-floating aquatic animals.

APPENDIX D
MONITORING STATIONS
(ORDERED BY INTERAGENCY NUMBER)

INTERAGENCY (I-A) NUMBER	RIVER KILOMETER INDEX (RKI) NUMBER	STATION NAME
	RMKL020(?)	NORTH FORK MOKELUMNE RIVER NEAR WALNUT GROVE (EXACT LOCATION NOT SPECIFIED)
	ROLD19 (?)	OLD RIVER NEAR HOLLAND TRACT (EXACT LOCATION NOT SPECIFIED)
	ROLD32	OLD RIVER AT INDIAN SLOUGH
	ROLD51	OLD RIVER AT WESTSIDE IRRIGATION DISTRICT INTAKE
	RSAC124	SACRAMENTO RIVER AT WALNUT GROVE
	RSAC155	SACRAMENTO RIVER AT FREEPORT
	RSAN050	SAN JOAQUIN RIVER AT TURNER CUT
	RSAN061	SAN JOAQUIN RIVER AT STOCKTON
	RSAN062	SAN JOAQUIN RIVER AT ROUGH AND READY ISLAND
	SLSBT11	STEAMBOAT SLOUGH AT SUTTER SLOUGH
D-02	RSAC063	SUISUN BAY AT SEAL ISLANDS (PORT CHICAGO)
D-06	RSAC056	SUISUN BAY AT MARTINEZ
D-07	LSBB11	GRIZZLY BAY DOLPHIN 2.5 KM. NORTH OF GARNET POINT
D-07 (NEAR)	SLMZU01	MONTEZUMA SLOUGH NEAR MOUTH
D-28A	ROLD21	OLD RIVER NEAR RANCHO DEL RIO
MD-04	CFTRN1	TURNER CUT NEAR MCDONALD ISLAND BRIDGE
P-08	RSAN056	SAN JOAQUIN RIVER AT BUCKLEY COVE
S-10	SLSUS18	SUISUN SLOUGH AT BOYNTON SLOUGH
S-17	SLCRD07	CORDELIA SLOUGH AT IBIS CUT
S-31	SLSUS01	SUISUN SLOUGH NEAR MOUTH
S-32	SLCRD05	CORDELIA SLOUGH ABOVE SOUTHERN PACIFIC R.R. CROSSING AT CYGNUS
S-35 (NEW)	SLGYR03	GOODYEAR SLOUGH AT MORROW ISLAND CLUBHOUSE
S-36	SLSUS00	SUISUN SLOUGH AT MOUTH
S-48	SLMZU10	MONTEZUMA SLOUGH AT CUTOFF SLOUGH
S-63	SLDEN01	DENVERTON SLOUGH
S-64 (NEW)	SLMZU25	MONTEZUMA SLOUGH AT NATIONAL STEEL
S-75 (OLD)	SLGYR04	GOODYEAR SLOUGH 1.3 MILES SOUTH OF MORROW ISLAND [DRAINAGE] DITCH AT PIERCE

APPENDIX D
MONITORING STATIONS
(ORDERED BY INTERAGENCY NUMBER)

INTERAGENCY (I-A) NUMBER	RIVER KILOMETER INDEX (RKI) NUMBER	STATION NAME
S-93	SLMCYO (?)	HILL SLOUGH (EXACT LOCATION NOT SPECIFIED)
S-94	SLSUS07	SUISUN SLOUGH AT HUNTER CUT

APPENDIX D
MONITORING STATIONS
(ORDERED BY RIVER KILOMETER INDEX)

INTERAGENCY (I-A) NUMBER	RIVER KILOMETER INDEX (RKI) NUMBER	STATION NAME
MD-04	CFTRN1	TURNER CUT NEAR MCDONALD ISLAND BRIDGE
D-07	LSBB11	GRIZZLY BAY DOLPHIN 2.5 KM. NORTH OF GARNET POINT
	RMKL020(?)	NORTH FORK MOKELUMNE RIVER NEAR WALNUT GROVE (EXACT LOCATION NOT SPECIFIED)
	ROLD19 (?)	OLD RIVER NEAR HOLLAND TRACT (EXACT LOCATION NOT SPECIFIED)
D-28A	ROLD21	OLD RIVER NEAR RANCHO DEL RIO
	ROLD32	OLD RIVER AT INDIAN SLOUGH
	ROLD51	OLD RIVER AT WESTSIDE IRRIGATION DISTRICT INTAKE
D-06	RSAC056	SUISUN BAY AT MARTINEZ
D-02	RSAC063	SUISUN BAY AT SEAL ISLANDS (PORT CHICAGO)
	RSAC124	SACRAMENTO RIVER AT WALNUT GROVE
	RSAC155	SACRAMENTO RIVER AT FREEPORT
	RSAN050	SAN JOAQUIN RIVER AT TURNER CUT
P-08	RSAN056	SAN JOAQUIN RIVER AT BUCKLEY COVE
	RSAN061	SAN JOAQUIN RIVER AT STOCKTON
	RSAN062	SAN JOAQUIN RIVER AT ROUGH AND READY ISLAND
S-32	SLCRD05	CORDELIA SLOUGH ABOVE SOUTHERN PACIFIC R.R. CROSSING AT CYGNUS
S-17	SLCRD07	CORDELIA SLOUGH AT IBIS CUT
S-63	SLDEN01	DENVERTON SLOUGH
S-35 (NEW)	SLGYR03	GOODYEAR SLOUGH AT MORROW ISLAND CLUBHOUSE
S-75 (OLD)	SLGYR04	GOODYEAR SLOUGH 1.3 MILES SOUTH OF MORROW ISLAND [DRAINAGE] DITCH AT PIERCE
S-93	SLMCY0 (?)	HILL SLOUGH (EXACT LOCATION NOT SPECIFIED)
D-07 (NEAR)	SLMZU01	MONTEZUMA SLOUGH NEAR MOUTH
S-48	SLMZU10	MONTEZUMA SLOUGH AT CUTOFF SLOUGH
S-64 (NEW)	SLMZU25	MONTEZUMA SLOUGH AT NATIONAL STEEL
	SLSBT11	STEAMBOAT SLOUGH AT SUTTER SLOUGH
S-36	SLSUS00	SUISUN SLOUGH AT MOUTH

APPENDIX D
MONITORING STATIONS
(ORDERED BY RIVER KILOMETER INDEX)

INTERAGENCY (I-A) NUMBER	RIVER KILOMETER INDEX (RKI) NUMBER	STATION NAME
S-31	SLSUS01	SUISUN SLOUGH NEAR MOUTH
S-94	SLSUS07	SUISUN SLOUGH AT HUNTER CUT
S-10	SLSUS18	SUISUN SLOUGH AT BOYNTON SLOUGH

Appendix E: Map of Salinity Control Stations

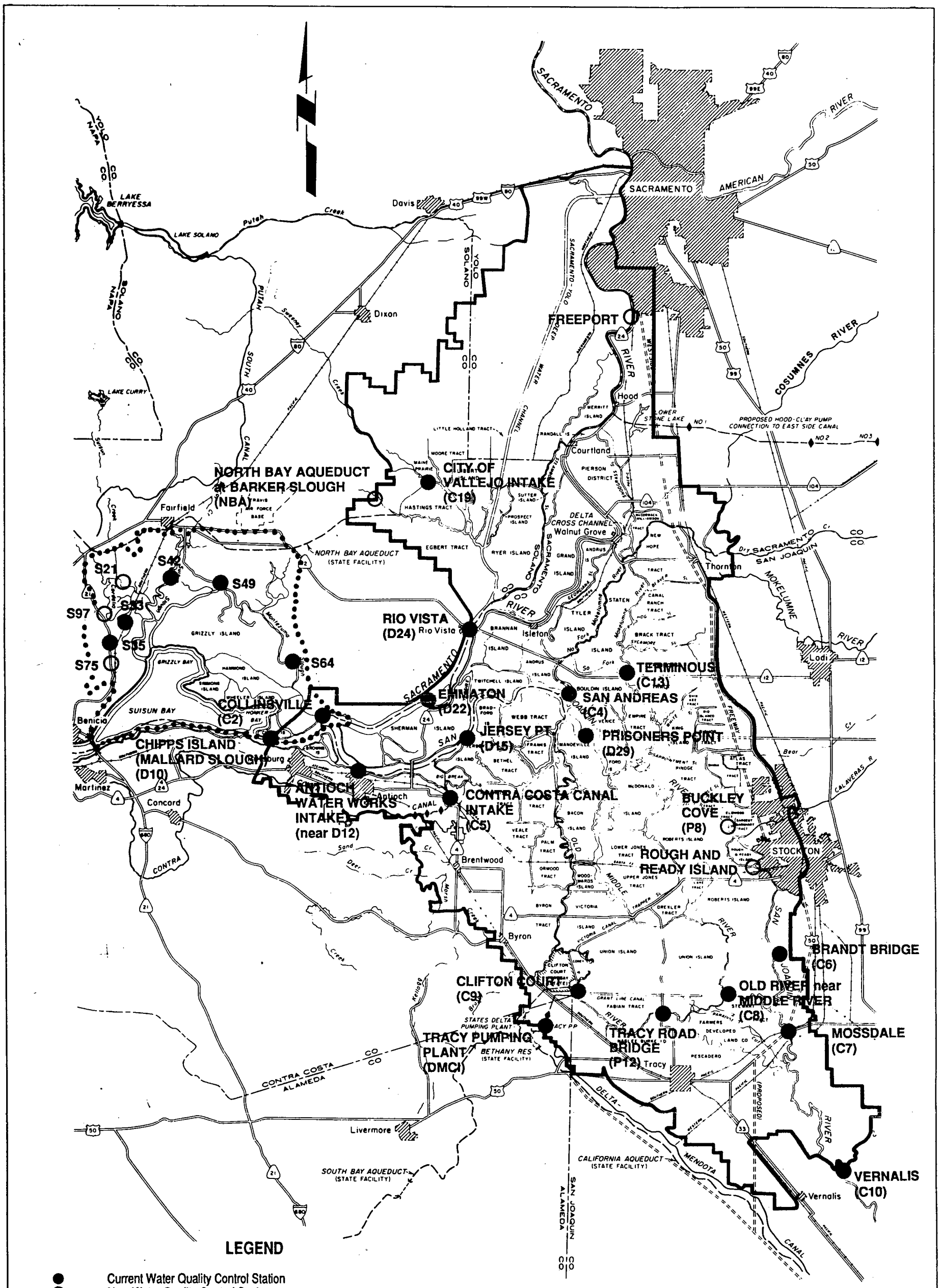

Figure 6 - 3

Appendix F

NOTICE OF FILING

TO: Any Interested Person

FROM: State Water Resources Control Board, Division of Water Rights
P.O. Box 2000
Sacramento, CA 95810

SUBJECT: Notice of Filing Submitted under Section 21080.5 of the Public Resources Code

PROJECT PROPONENT: State Water Resources Control Board

PROPOSED PROJECT: Water Quality Control Plan for Salinity and Temperature for San Francisco Bay and the Sacramento-San Joaquin Delta Estuary

CONTACT PERSON: Ronald Bachman (916) 322-9869

PROJECT LOCATION: San Francisco Bay and the Sacramento-San Joaquin Delta Estuary (Bay-Delta Estuary)

PROJECT DESCRIPTION: Adoption of the Water Quality Control Plan described above.

This is to advise all interested parties that the State Water Resources Control Board is going to consider the adoption of a water quality control plan for the Bay-Delta Estuary. Action on this proposed plan will be taken in accordance with Section 21080.5 of the Public Resources Code, which exempts this regulatory program from the requirement to prepare an environmental impact report under the California Environmental Quality Act (Public Resources Code 21000 et seq.), and with other applicable laws and regulations.

Copies of the substitute document, including a proposed Environmental Checklist and a discussion of reasonable alternatives and feasible mitigation measures to minimize any significant adverse environmental impacts, can be obtained from Mr. Bachman (see above).

Comments on the proposed adoption should be submitted by March 11, 1991.

Signed: Walt Pettit

Title: Division Chief
for the State Water Resources Control Board

Date: Jan 15, 1991

APPENDIX G
TRANSCRIPT INDEX

HEARING PHASE	HEARING DATE	TIME	REPORTERS VOLUME NUMBER	TRANSCRIPT SEQUENCE NUMBER
I	07/07/87	AM	I	I
I	07/08/87	AM	II	II
I	07/09/87	AM	III	III
I	07/13/87	AM	IV	IV
I	07/14/87	AM	V A	VA
I	07/14/87	AM	V B	VB
I	07/21/87	AM	VI	VI
I	07/22/87	AM	VII	VII
I	07/23/87	AM	VIII	VIII
I	07/23/87	AM	IX	IX
I	07/27/87	AM	X	X
I	07/28/87	AM	XI	XI
I	07/29/87	AM	XII	XII
I	07/30/87	AM	XIII	XIII
I	07/30/87	PM	XIV	XIVPOL
I	07/31/87	AM	XV	XV
I	08/11/87	AM	XVI	XVI
I	08/12/87	AM	XVII	XVII
I	08/12/87	PM	XVIII	XVIIIPOL
I	08/13/87	AM	XIX	XIX
I	08/13/87	AM	XX	XX
I	08/14/87	AM	XXI	XXI
I	08/15/87	AM	XXII	XXII
I	08/24/87	AM	XXIII	XXIII
I	08/25/87	AM	XXIV	XXIV
I	08/25/87	PM	XXV	XXVPOL
I	08/26/87	AM	XXVI	XXVI
I	08/27/87	AM	XXVII	XXVII
I	08/28/87	AM	XXVIII	XXVIII
I	09/08/87	AM	XXIX	XXIX
I	09/09/87	AM	XXX	XXX
I	09/14/87	AM	XXXI	XXXI
I	09/14/87	PM	XXXII	XXXIIPOL
I	09/15/87	AM	XXXIII	XXXIII
I	09/16/87	AM	XXXIV	XXXIV
I	09/21/87	AM	XXXV	XXXV
I	09/22/87	AM	XXXVI	XXXVI
I	09/23/87	AM	XXXVII	XXXVII
I	09/24/87	AM	XXXVIII	XXXVIII
I	09/29/87	AM	XXXIX	XXXIX
I	09/29/87	PM	XL	XLPOL
I	10/13/87	AM	XLI	XLI
I	10/14/87	AM	XLII	XLII
I	10/15/87	AM	XLIII	XLIII
I	10/26/87	AM	XLIV	XLIV
I	10/27/87	AM	XLV	XLV
I	10/28/87	AM	XLVI	XLVI
I	10/28/87	PM	XLVII	XLVIIPOL

APPENDIX G
TRANSCRIPT INDEX

HEARING PHASE	HEARING DATE	TIME	REPORTERS TRANSCRIPT VOLUME NUMBER	TRANSCRIPT SEQUENCE NUMBER
I	10/29/87	AM	XLVIII	XLVIII
I	11/09/87	AM	XLIX	XLIX
I	11/23/87	AM	L	L
I	11/24/87	AM	LI	LI
I	11/25/87	AM	LII	LII
I	11/30/87	AM	LIII	LIII
I	12/01/87	AM	LIV	LIV
I	12/08/87	AM	LV	LV
I	12/09/87	AM	LVI	LVI
I	12/10/87	AM	LVII	LVII
I	12/14/87	AM	LVIII	LVIII
I	12/15/87	AM	LIX	LIX
I	12/21/87	AM	LX	LX
I	12/22/87	AM	LXI	LXI
I	12/29/87	AM	LXII	LXII
II	01/09/89	AM		LXIII
II	02/27/89	AM		LXIV
II	06/06/89	AM		LXV
PPD	12/04/89	AM	I	LXVIA
PPD	12/11/89	AM	II	LXVIB
WQCP	02/20/90	AM	I	LXVII
WQCP	02/20/90	PM	II	LXVIIPOL
WQCP	02/21/90	AM	III	LXVIII
WQCP	02/22/90	AM	III	LXIX
WQCP	02/26/90	AM	V	LXX
WQCP	02/26/90	PM	VI	LXXPOL
WQCP	02/27/90	AM	VII	LXX
WQCP	08/07/90	AM	I	LXXI
WQCP	08/07/90	PM	II	LXXIPOL
WQCP	08/08/90	AM	III	LXXII
WQCP	08/13/90	AM	IV	LXXIII
WQCP	08/13/90	PM	V	LXXIIIPOL
WQCP	08/14/90	AM	VI	LXXIV
WQCP	08/20/90	AM	VII	LXXV
WQCP	08/20/90	PM	VIII	LXXVPOL
WQCP	08/22/90	AM	IX	LXXVI
WQCP	08/23/90	AM	X	LXXVII
WQCP	03/11/91	AM		LXXVIII
EIRSP	03/26/91	AM	I	LXXIX
WQCP	04/02/91	AM		LXXX
EIRSP	04/08/91	AM	II	LXXXI
EIRSP	04/09/91	AM	III	LXXXII
WQCP	05/01/91	AM		LXXXIII

STATE WATER RESOURCES CONTROL BOARD
P. O. Box 100, Sacramento, CA 95812-0100
(916)322-3132

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

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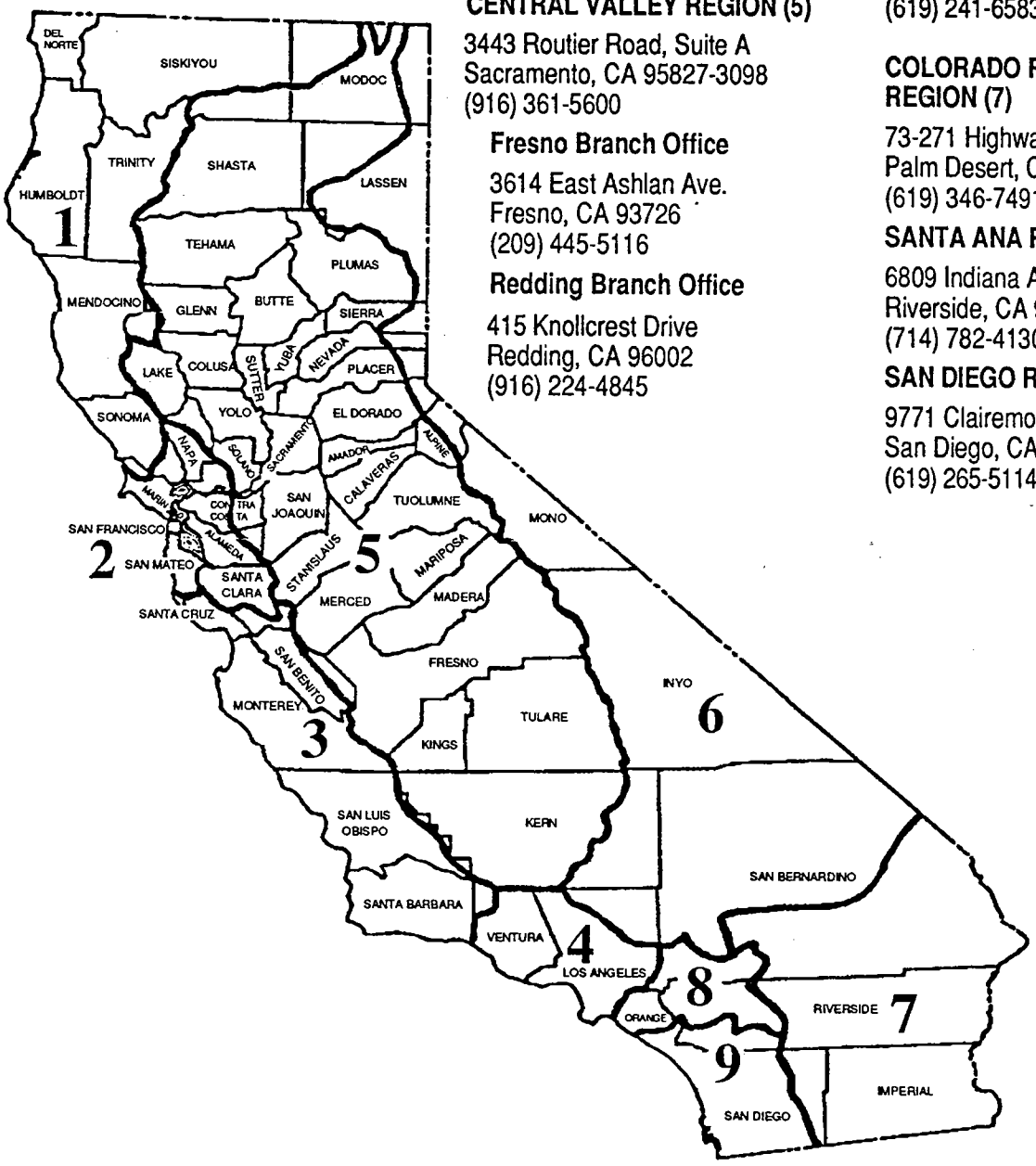
Santa Rosa, CA 95403
(707) 576-2220

SAN FRANCISCO BAY REGION (2)

2101 Webster Street, Ste. 500
Oakland, CA 94612
(415) 464-1255



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San Luis Obispo, CA 93401
(805) 549-3147

LOS ANGELES REGION (4)

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(213) 266-7500

CENTRAL VALLEY REGION (5)

3443 Routier Road, Suite A
Sacramento, CA 95827-3098
(916) 361-5600

Fresno Branch Office

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Fresno, CA 93726
(209) 445-5116

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415 Knollcrest Drive
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(916) 224-4845

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2092 Lake Tahoe Boulevard, Suite 2
South Lake Tahoe, CA 96150
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Victorville, CA 92392-2359
(619) 241-6583

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Palm Desert, CA 92260
(619) 346-7491

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Riverside, CA 92506
(714) 782-4130

SAN DIEGO REGION (9)

9771 Clairemont Mesa Blvd. Ste. B
San Diego, CA 92124
(619) 265-5114