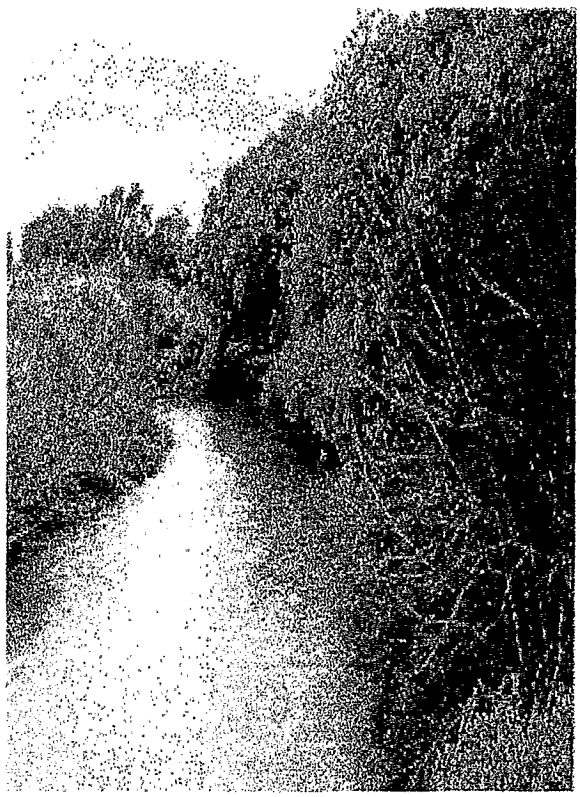
DRAFT
ENVIRONMENTAL IMPACT REPORT/ ENVIRONMENTAL IMPACT STATEMENT (EIR/EIS)

INTERIM SOUTH DELTA PROGRAM (ISDP)
Volume II



Prepared for:

Department of Water Resources (DWR)
State Lead Agency
Sacramento, California

Bureau of Reclamation (USBR)
Federal Lead Agency
Folsom, California

by: ENTRIX, Inc.
Sacramento, CA

and

Resource Insights
Sacramento, CA

July 1996

ENTRIX, Inc., 3416 American River Drive, Ste. A, Sacramento, CA 95864

Appendix 1

Draft

4/26/96

Section 404(b)(1)
Alternative Analysis Report

for

Interim
South Delta Project

DRAFT

6/26/96

Section 404(b)(1) Alternative Analysis Report

for

INTERIM SOUTH DELTA PROGRAM

State of California
The Resources Agency
Department of Water Resources

U. S. Dept. of the Interior
Bureau of Reclamation

CONTENTS

Literature Cited v

CHAPTER 1 - INTRODUCTION 1-1
Overview 1-1
Section 404(b)(1) Guidelines 1-2

CHAPTER 2 - PROJECT PURPOSES AND NEED 2-1
The South Delta 2-1
Project Purposes 2-1
Project Need 2-6

CHAPTER 3 - ALTERNATIVE SELECTION SCREENING METHODOLOGY 3-1
No-action Alternative 3-1
Alternative Selection 3-3
Screening Methodology 3-7

CHAPTER 4 - FIRST-STAGE EVALUATION 4-1
Screening Criteria 4-1
Alternative 4-5
No-Action Alternatives 4-5
Existing Conditions 4-5
Future Conditions 4-6
Level I Options Alternatives 4-9
Long-Term Delta Solution 4-9
Los Banos Grandes Reservoir 4-9
Level I Ground Water Reclamation 4-10
Level II Options Alternatives 4-11
Water Conservation 4-11
Land Retirement 4-12
Water Transfer 4-12
Reclamation 4-14
South Delta Water Agency Alternatives 4-15
South Delta Flow Control Structures 4-15
Roberts Island Canal Plan 4-18
Dredging South Delta Water Agency Channels 4-20
Pay for Agricultural Pump Damage in the South Delta 4-20
Treatment of Local Agricultural Drainage Water 4-20
Pumping Water from Clifton Court Forebay to a Portion of SDWA Users 4-22
Delta-Mendota Canal /Westley Wasteway Plan 4-23
Reduce San Joaquin River Agricultural Drainage 4-25
Reduce CVP/SWPExport 4-26
Increase San Joaquin River Flow 4-26
South Delta Water Management Alternatives 4-27
Northern Forebay Intake with Limited Channel Dredging 4-27

Northern Forebay Intake, Limited Channel Dredging, and South Delta Flow Control Structures 4-28
Channel Enlargement, South Delta Flow Control Structures, and Expanded Existing Intake 4-32
Enlarge Clifton Court Forebay with:
-Byron Tract 4-34
-North Victoria Island 4-36
-South Victoria Island 4-38
-Coney Island 4-39
-Union Island 4-42
Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at:
-Byron Tract 4-44
-North Victoria Island 4-45
-South Victoria Island 4-46
-Coney Island 4-47
-Union Island 4-48
Permanent Long-Range Alternatives 4-49
Isolated Water Transfer Facilities 4-49
Peripheral Canal 4-49
Dual Transfer System 4-51
Modified Folsom-South Canal 4-53
West or Central Delta Canal 4-53
Through-Delta Facilities 4-57
New Hope Cross Channel 4-57
Waterway Control Plan 4-59
North Stub Canal 4-61
South Stub Canal 4-61
Physical Barriers 4-64
Agency /Public Input Alternatives 4-67
Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water 4-67
Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP Pumping Capability 4-67
Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and Additional Clifton Court Forebay Intake at Italian Slough 4-71
South Delta Flow Control Structures, Limited Channel Dredging, and Intake at Italian Slough 4-73

CHAPTER 5 - SECOND-STAGE EVALUATION 5-1
Screening Criteria 5-1
Alternatives 5-3
South Delta Water Agency Alternatives 5-3
South Delta Flow Control Structures 5-3
Interim South Delta Water Management Alternatives 5-5
Northern Forebay Intake with Limited Channel Dredging 5-5

C—087143

C-087143

Northern Forebay Intake, Limited Channel Dredging, and South Delta Flow Control Structures 5-6
Channel Enlargement, South Delta Flow Control Structures, and Expanded Existing Intake 5-7
Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at:
-Byron Tract 5-8
-North Victoria Island 5-9
-South Victoria Island 5-11
-Coney Island 5-12
-Union Island 5-13
Agency/Public Input Alternatives 5-14
Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water 5-14
Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP Pumping Capability 5-14
Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and Additional Clifton Court Forebay Intake at Italian Slough 5-16
South Delta Flow Control Structures, Limited Channel Dredging, and Intake at Italian Slough 5-17
Summary 5-18
Regarding Third-Stage Evaluation 5-18

Tables

2-1 Level I Demand Management Options 2-12
2-2 Level I Water Supply Management Options 2-12
3-1 Alternatives for First-Stage Evaluation 3-10
4-1 First-Stage Evaluation of Alternatives 4-1
4-2 Water Supply and Demand Management Options Assumed for Inclusion in No-Action Future Alternative 4-7
4-3 State Water Project and State Water Project Service Area Water Balance Assumed for Inclusion in No-Action Future Alternative 4-8
4-4 Alternatives Retained for Second-Stage Evaluation 4-9
5-1 Second-Stage Evaluation of Alternatives 5-2
5-2 Alternatives Retained for Third-Stage Evaluation 5-19

Figures

2-1 South Delta Area 2-2
2-2 SWP and CVP Facilities in the South Delta 2-3
2-3 John E. Skinner Delta Fish Protection Facility 2-4
2-4 Harvey O. Banks Delta Pumping Plant 2-4
2-5 Tracy Pumping Plant 2-5
2-6 Aerial View Tracy Pumping Plant 2-5
2-7 Typical South Delta Channel 2-7
2-8 Agricultural Pump Diversion 2-7

C—087144

C-087144

2-9 Two Examples of How ISDP Can Shift Pumping to Divert Less Fish into Clifton Court Forebay 2-10
3-1 Alternative Selection Methodology 3-2
4-1 South Delta Flow Control Structures 4-16
4-2 Roberts Island Canal Plan 4-19
4-3 Delta-Mendota Canal/ Westley Wasteway Plan 4-24
4-4 Northern Forebay Intake Configuration 4-29
4-5 N. Intake/Control Structures/Dredging Plan 4-30
4-6 Control Structures/Dredging Plan with an Expanded Existing Intake 4-33
4-7 Byron Tract Forebay Configuration 4-35
4-8 North Victoria Forebay Configuration--Option A 3-37
4-8 North Victoria Forebay Configuration--Option B 4-38
4-9 South Victoria Forebay Configuration 4-40
4-10 Coney Island Forebay Configuration 4-41
4-11 Union Island Forebay Configuration 4-43
4-12 Peripheral Canal Plan 4-50
4-13 Dual Transfer System 4-52
4-14 Modified Folsom-South Canal Plan 4-54
4-15 West Delta Canal 4-55
4-16 Central Delta Canal 4-56
4-17 New Hope Cross Channel 4-58
4-18 Waterway Control Plan 4-60
4-19 North Stub Canal 4-62
4-20 South Stub Canal 4-63
4-21 Physical Barrier Alternatives 4-66
4-22 Consolidation of Diversions: Site Locations 4-69
4-23 Consolidation of Diversions: Cross Section 4-70
4-24 N. Intake/Control Structures/Dredging Plan with an Additional Clifton Court Forebay Intake at Italian Slough 4-72
4-25 Control Structures/Dredging Plan with an Intake at Italian Slough 4-74

Appendices

A State Water Project A-1
B Central Valley Project B-1
C South Delta Water Agency Lawsuit/Settlement C-1
D Supply/Demand Needs as Stated in DWR Bulletin 160-93 ..... D-1
E Water Demand and Supply Management E-1

C—087145

C-087145

Literature Cited

California Assembly Bill No. 3792 Authorizing Los Banos Grandes Reservoir. September 30, 1984.

California Department of Water Resources. 1994. *California Water Plan Update. Bulletin 160-93.*

_____. September 1990. *Los Banos Grandes Facilities, Alternatives Analysis Memorandum Report.*

_____. January 1986. *Final EIR on the Proposed Additional Pumping Units, Harvey O. Banks Delta Pumping Plant.*

_____. November 1983. *Alternatives for Delta Water Transfer (report presented California Water Commission).*

_____. July 1978. *Delta Water Facilities. Bulletin 76.*

_____. July 19, 1977. *Report in Response to Senate Concurrent Resolution No. 73, Relative to the Sacramento-San Joaquin Delta.*

_____. April 20, 1976. *Alternative Report on Southeast Delta Water Control Facilities.*

_____. April 1976. *Delta Alternatives Summaries.*

_____. August 1974. *DEIR for Peripheral Canal*

California Department of Water Resources, U.S. Bureau of Reclamation. June 1990. *Draft Environmental Impact Report/Environmental Impact Statement. South Delta Water Management Program. Phase I of Water Banking Program.*

CVP Improvement Act, Title 34 of HR 429 (PL 102-575). October 30, 1992.

Contra Costa Water District. May 1992. *Draft of Section 404(b)(1) Alternatives Analysis for Meeting Water Quality and Reliability Objectives.*

Framework Agreement between SDWA, USBR, and DWR, October 10, 1986.

Wilson, Pete. 1992. "Governor Pete Wilson's Water Policy Statement," April 6, 1992.

Interagency Delta Committee Task Force. September 1964. *Draft of Report on a Coordinated Plan for the Sacramento-San Joaquin Delta.*

State of California. 1986. *California Agriculture Water Management Planning Act of 1986.*

_____. 1983. *Urban Water Management Planning Act of 1983.*

State/federal Accord: Principles for Agreement on Bay-Delta Standards between the State of California and the Federal Government. December 15, 1994.

State Water Resources Control Board. December 1992. *Draft Water Rights Decision 1630.*

A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley. September 1990.

San Joaquin Valley Drainage Program. Report on Preliminary Planing Alternatives. 1989.

University of California, Davis. 1992. Survey of 23 Agricultural Agencies Affected by AB 1658.

U.S. Army Corps of Engineers. 1963. Technical Report on Barriers.

_____. Public Notice 5820A Amended.

U.S. Environmental Protection Agency. Section 404(b)(1) Guidelines.

WateRuse Association of California. 1993. *Future Water Recycling Potential.*

Water Rights Decision 1485.

C—087147

C-087147

CHAPTER 1 - INTRODUCTION

OVERVIEW

The California Department of Water Resources and the U.S. Bureau of Reclamation propose to implement the Interim South Delta Program (ISDP). The intent of this program is to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions and to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant. Clifton Court Forebay and Banks Pumping Plant are facilities of the State Water Project (SWP).

The purpose of this report is to provide the U.S. Army Corps of Engineers (Corps) and other decision makers with the information necessary to determine compliance with Section 404 of the Clean Water Act. A discussion of the guidelines for establishing compliance of the project with Section 404 is included below. The Corps is responsible for making the formal determination of compliance with the Section 404(b)(1) Guidelines. This analysis will provide the information necessary to determine such compliance.

In compliance with the Clean Water Act, California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA), numerous project alternatives are evaluated in a three-stage screening process. The first- and second-stage evaluations are presented in this report. The third-stage evaluation is conducted in the joint Environmental Impact Report / Environmental Impact Statement (EIR/EIS) for ISDP.

The development, selection and evaluation of alternatives is an integral part of the planning process. The alternative selection methodology depends on numerous factors, and has been done in conjunction with and in conformity with various statutes, policies, and published documents. These include the Clean Water Act, the Endangered Species Act, NEPA and CEQA, the Governor's Comprehensive Water Policy, DWR Bulletin 160-93 (The *California Water Plan Update)*, the December 15, 1994 State/federal Bay/Delta Accord, and the Central Valley Project Improvement Act (CVPIA).

By concurrently utilizing the above, the alternative screening mechanisms have incorporated the requirements of feasibility, least-environmentally damaging practicable alternative, and reasonable and prudent actions. These factors were incorporated in accordance with specific guidelines in the Public Resources Code and the Council of Environmental Quality guidelines, Clean Water Act, and Endangered Species Act.

SECTION 404(B)(1) GUIDELINES

The purpose of this report is to provide the Corps and other decision makers with the information necessary to determine compliance with Section 404 of the Clean Water Act. Section 404 provides the statutory mechanism for the Corps to permit discharge of dredged or fill material into waters of the United States. The Section 404 (b) (1) Guidelines promulgated by the U.S. Environmental Protection Agency (EPA) govern, in part, the issuance of permits by the Corps. Compliance with the guidelines is mandatory prior to permit issuance. Subpart B of the guidelines states:

> "No discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences."

The guidelines state, "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." Further, the guidelines qualify the requirements for discharges to special aquatic sites for uses that are not considered to be "water dependent" by the following regulatory presumption:

> "Where the activity associated with a discharge which is proposed for a special aquatic site (as defined in Subpart E) does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water dependent"), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise (40 CFR 230.10[a][3])."

Implementation of the ISDP may include activities occurring in special aquatic sites, which include wetlands and vegetated shallows. Where an activity associated with a discharge into waters of the United States, such as dredging, must be located within a special aquatic site to fulfill its basic purpose, such as improving channel hydraulics, the above presumption does not apply.

If an activity which normally does not require siting within a special aquatic site to fulfill the basic project purpose, such as improving water quality by treatment of local agricultural drainage waters, is proposed to be located within the special aquatic site, then the project applicant must demonstrate that a practicable alternative which does not involve the special aquatic site does not exist.

C—087149

C-087149

CHAPTER 2 - PROJECT PURPOSES AND NEED

THE SOUTH DELTA

The south Delta generally comprises the lands and channels of the Sacramento-San Joaquin Delta southwest of Stockton (Figure 2-1). The South Delta Water Agency, as defined in the Formation Act, California Statutes of 1973, is located in this area as are important features of the State Water Project and Central Valley Project (Figure 2-2).

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

Major channels and waterways in the south Delta include: the San Joaquin River, Old and Middle rivers, Woodward and North Victoria canals, Victoria and North canals, Grant Line Canal, Italian Slough, Indian Slough, Tom Paine Slough, and the adjoining SWP and CVP export facilities. SWP export facilities, operated by DWR, consist of Clifton Court Forebay, John E. Skinner Delta Fish Protective Facility (Figure 2-3), the intake channel, Harvey O. Banks Delta Pumping Plant (Figure 2-4), and the Governor Edmund G. Brown California Aqueduct. CVP export facilities, operated by USBR, consist of the Delta Mendota Canal, Tracy Fish Collecting Facility, and the Tracy Pumping Plant (Figures 2-5 and 2-6).

This area is faced with complex water rights, water supply, water quality, and environmental issues. These issues have been the subject of lawsuits, mitigation activities, agreements, and temporary actions over the last 20 years.

The Sacramento-San Joaquin Delta provides water supplies to about two-thirds of the State's population and millions of acres of irrigated lands. The State's two largest water projects, the State Water Project and the Central Valley Project, export water from the Delta. Increasing needs to protect endangered species have made it increasingly important to judiciously utilize proper windows of opportunity to export Delta water supplies. The operational flexibility which is provided by the ISDP will maximize the potential for SWP operations to achieve this objective.

PROJECT PURPOSES

The purposes of the Interim South Delta Program are as follows:

- To improve water levels and circulation in south Delta channels for local agricultural diversions, and
- To improve south Delta hydraulic conditions to increase diversion into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant.

These purpose purposes have been developed in coordination with the Bureau of Reclamation and the Corps of Engineers. In a letter dated July 29, 1993, the Corps confirmed that the statement provides clear definition of the project to be used in the alternative analysis required by Section 404(b)(1) of the Clean Water Act, and advised that (1) the purposes must be used

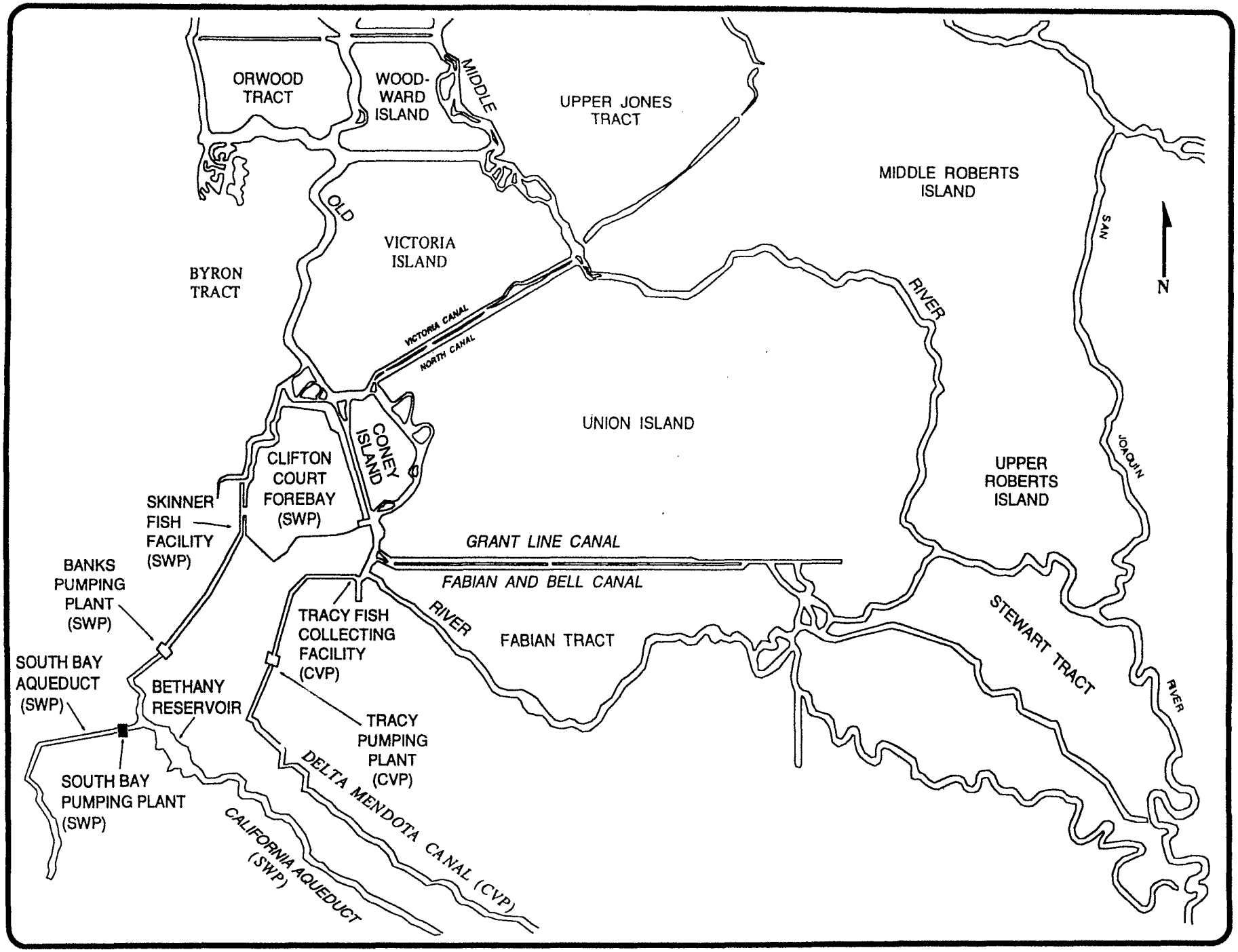
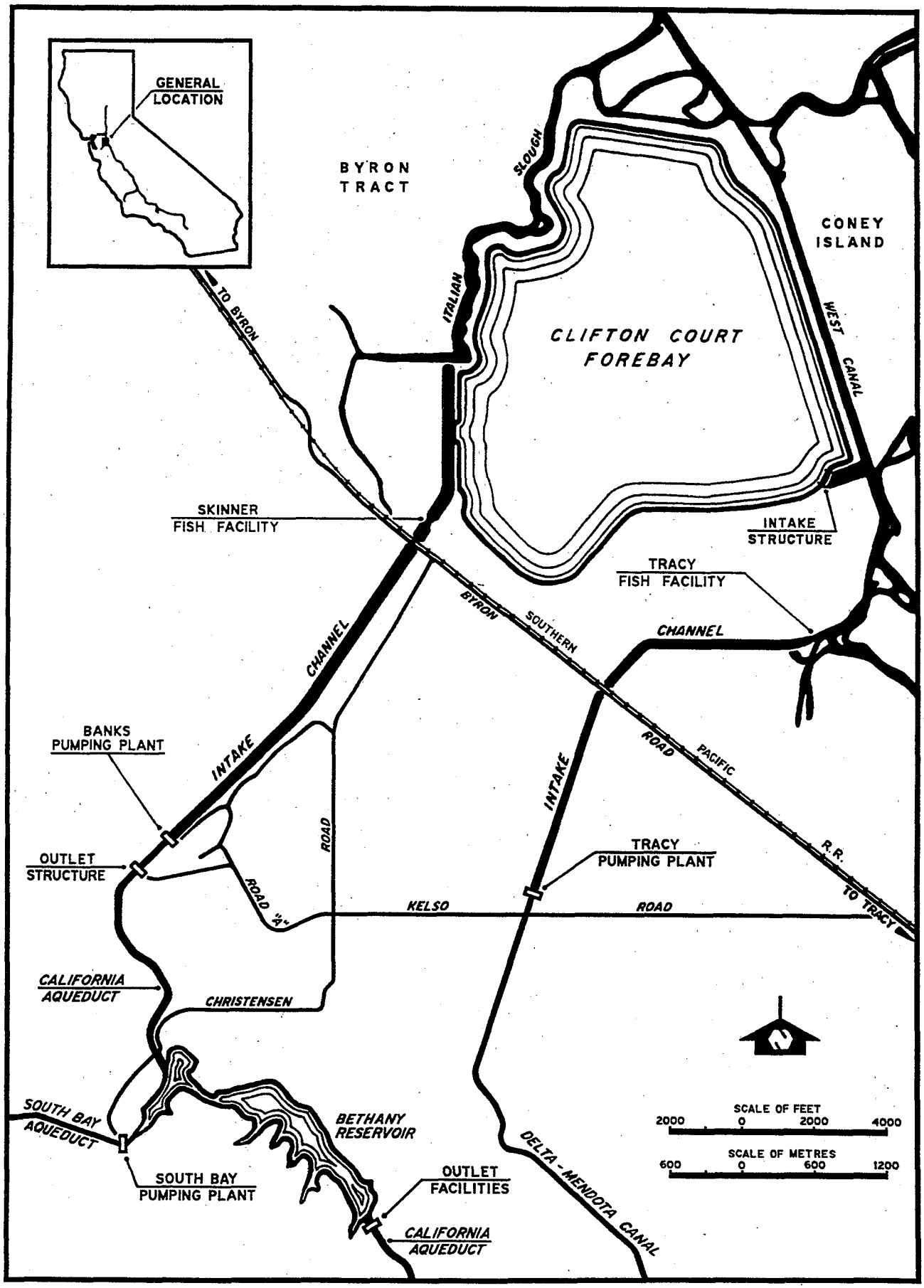


Figure 2-1. South Delta Area

C—087151

C-087151

Figure 2-2
SWP and CVP facilities in the south Delta



C—087152

C-087152

Figure 2-3.
John E. Skinner
Delta Fish
Protection Facility

Figure 2-4.
Harvey O. Banks
Delta Pumping Plant

C—087153

C-087153

D-M

GAP

NOTED

Figure 2-5.
Tracy Pumping Plant

Figure 2-6.
Aerial View Tracy Pumping Plant

Water is pumped by Tracy Pumping Plant through a covered conduit into the Delta Mendota Canal (lower right).

C—087155

C-087155

consistently throughout the Environmental Impact Statement and related documents, and (2) each project alternative proposed in the alternative analysis should be evaluated for its ability to meet each purpose individually and for its ability to meet both purposes.

PROJECT NEED

The following is a discussion of the need for the ISDP. A description of the water problems within the south Delta and the past and current actions taken to resolve them is provided. The need to maximize the frequency of full pumping at Banks Pumping Plant is also discussed.

1) South Delta Agricultural Diversion

SDWA Agreement

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

Through 1985, short-term actions to improve water conditions in the south Delta were taken in response to specific incidents of low water levels. Beginning in late 1985, several activities and agreements have been finalized to develop a permanent solution. These activities and documents are discussed in Appendix C.

Consistent with a joint agreement with SDWA, the ISDP should improve water levels and induce circulation in south Delta channels (See Figures 2-7 and 2-8).

State Water Policy

On April 4, 1992, California Governor Pete Wilson outlined a new Comprehensive Water Management Plan, which, among many things, called for action on both interim and long-term solutions to problems of the "broken Delta." Interim actions were defined as those which could be undertaken immediately and that would help restore the environment and improve the water supply. These actions are already in the advanced planning stage, require only a few years to complete, have no known permit constraints, and have excellent benefit-to-cost ratios. Governor Wilson's policy includes recommendations for enlargement of south Delta channels, channel dredging, construction and operation of flow control barriers, improving SWP water supply, and shifting pumping to winter months.

December 15 Accord

To provide ecosystem protection for the Bay-Delta Estuary, representatives of the State and Federal governments and urban, agricultural, and environmental interests agreed on December 15, 1994 to the implementation of a Bay-Delta protection plan through the California State Water Resources Control Board (SWRCB), consistent with certain principles. These principles are intended to be in force for three years, at which time they may be revised.

The key elements of the agreement are as follows:

- Estuarine Habitat Standard that adds more fresh water to the Delta in late winter and spring when smelt, bass and other fish most need it.
- Pumping controls that limit State and federal water project exports, but provide new management and operational flexibility.
- Requirement of certain base flows in the San Joaquin River.
- Barrier at the head of Old River to minimize fish losses to pumps and export operations.
- Restrictions on the take of endangered species.

Figure 2-7.
Typical South
Delta Channel

Figure 2-8.
Agricultural
Pump Diversion

• Program to address other non-flow related improvements (Category III).

The ISDP should be compatible with the December 15 Accord.

SWRCB WQCP

In May 1995, the State Water Resources Control Board adopted the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The plan, developed after numerous public workshops and hearings, sets forth beneficial uses, water quality objectives, and a program of implementation in relation to the Delta.

The ISDP should be compatible with the SWRCB WQCP.

2) SWP Exports at Banks Pumping Plant

Present south Delta hydraulics constrain SWP operations and at times raise concerns about water levels, quality, and circulation during the irrigation season. SWP water is pumped from Clifton Court Forebay instead of directly from south Delta channels in order to minimize drawdown effects to local agricultural diverters. Five radial gates at the southeastern corner of the forebay are open during high tides and closed during low tides. Inflows into the forebay are governed by the water levels inside and outside the forebay, and by the flow capacity of the forebay intake gates. Water levels inside the forebay are influenced by its storage volume, while water levels outside the forebay are influenced by San Joaquin River flows and tidal fluctuations. The flow capacity of the forebay intake gates is determined by the size and number of gates along with how the gates are operated to avoid high velocities and scouring in nearby channels. Hydraulic constraints limiting monthly maximum exports of the SWP are related to the:

- volume of Clifton Court Forebay
- forebay inlet gate size and location
- capacity of south Delta channels
- Delta inflow and outflow
- tidal fluctuations at the inlet gate
- storage availability south of pumps

The physical capability of Banks Pumping Plant is presently at its design capability of 10,300 cfs. However, the maximum monthly diversion into the forebay is controlled by the Corps Public Notice 5820A Amended, which establishes that diversions into Clifton Court Forebay bel limited to 13,870 AF for one day and 13,250 AF for a three-day average. The ISDP proposes to increase allowable diversions to 20,430 AF per day on a monthly average.

Implementing hydraulic improvements to the south Delta would allow Banks Pumping Plant to pump up to its maximum capacity of 10,300 cfs whenever applicable Delta standards, fish mitigation agreement requirements, and Endangered Species Act requirements allowed. The added pumping capability would provide needed SWP export flexibility and could increase SWP water supply delivery reliability.

Increased export flexibility will also improve fishery conditions in the Delta. Increased SWP pumping flexibility provides opportunities to shift exports away from critical periods for eggs, larvae, and juvenile striped bass. This would result in less fish being diverted into Clifton Court Forebay. As an example, consider a 3-month period with a goal of diverting a total of 1,160 TAF. With the existing forebay and Corps diversion constraint, this goal could only be achieved by pumping at a rate of 6,400 cfs continuously over the 3-month period. With the ISDP, the total of 1,160 TAF could be accomplished by pumping at rates at times higher and lower than 6,400 cfs, depending upon the density of fish in the Delta

channels near the forebay intake. Figure 2-9 illustrates this concept for two hypothetical fish density patterns. As shown, the flexibility in SWP pumping provided by the ISDP could result in substantially less fish being diverted into the forebay.

Shortages to SWP contractors are forecasted to become more frequent due to increasing urban, agricultural, and environmental demands. The SWP is one of the major water supply projects in the State. Recent studies in DWR Bulletin 160-93 (*The California Water Plan Update*) conclude that the State's present supplies are insufficient to meet present demands during drought, and by 2020, without improved water management and additional facilities, annual shortages of 3.7 to 5.7 MAF could occur in average water years and 7.0 to 9.0 MAF shortages could occur during drought years. Further discussion of the Bulletin 160-93 projections is contained in Appendix D.

SWP / Burns-Porter Act

The financing of the SWP was authorized by the State Water Resources Development Bond Act (also known as the Burns-Porter Act) ratified in 1960. The act not only describes the facilities to be constructed, but also requires that the pumping plant and aqueduct from the Delta to the initial offstream storage reservoir have a capacity of not less than 10,000 cfs.

The facilities and operation of the SWP are described in more detail in Appendix A. Briefly, surplus water from the Feather River watershed and the Sacramento-San Joaquin River Delta is captured and conveyed to areas of need in the San Francisco Bay area, the San Joaquin Valley, and Southern California.

Thirty agencies throughout the State have contracted to eventually receive 4.23 MAF of water a year, to be delivered as their needs develop. The existing facilities can supply about 2.3 MAF, enough to meet present needs. Additional facilities are need to increase the supply to meet projected needs. The ISDP is designed to be the first step in improving the ability of the SWP to meet is contractual demands.

The Burns-Porter Act also authorized unspecified additional future storage facilities, facilities to transfer water across the Delta, and facilities to remove drainage water from the San Joaquin Valley.

State Water Policy

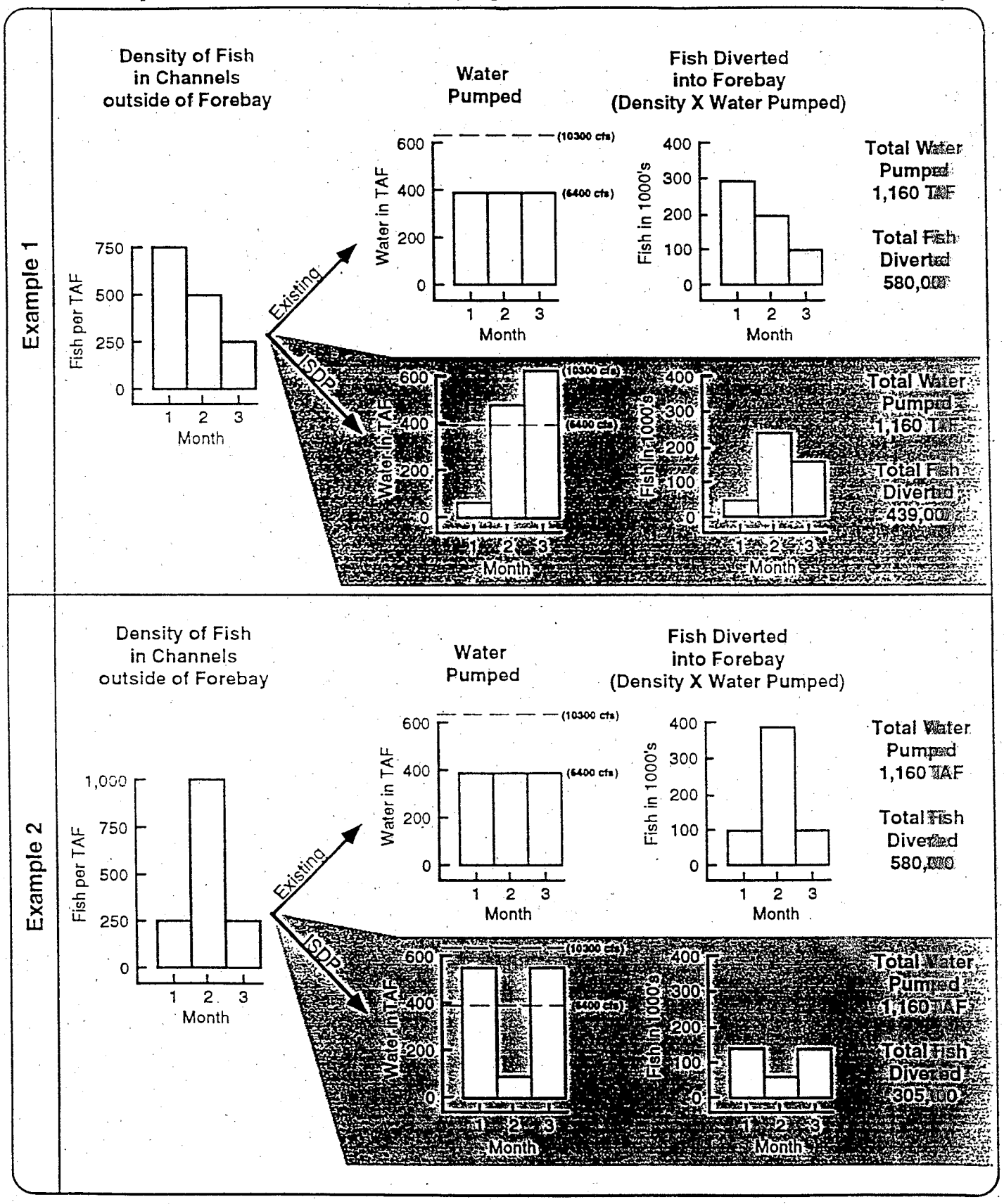
On April 4, 1992, California Governor Pete Wilson outlined a new Comprehensive Water Management Plan, which, among many things, called for action on both interim and long-term solutions to problems of the "broken Delta." Interim actions were defined as those which could be undertaken immediately and that would help restore the environment and improve the water supply. These actions are already in the advanced planning stage, require only a few years to complete, have no known permit constraints, and have excellent benefit-to-cost ratios. Governor Wilson's policy includes recommendations for enlargement of south Delta channels, channel dredging, construction and operation of flow control barriers, improving SWP water supply, and shifting pumping to winter months.

Article VII Agreement

In the mid 1980's, DWR proposed the installation of four additional pumps at Banks Pumping Plant to bring the plant ot its full design capability of 10,300 cfs. During the environmental review process, DFG and DWR negotiated an agreement for the preservation of fish potentially affected by the operation of the pumps. The agreement, signed by the two departments in December 1986, identifies the steps needed to offset adverse fishery impacts of the pumping, sets up a procedure to calculate direct fishery losses annually, and requires DWR to pay for mitigation projects that would offset the losses. Article VII of the agreement specifies the agencies' intent to mitigate for other fishery impacts related to the SWP, and requires that these measures, once determined, be included in any proposal by DWR to increase its diversions at Banks.

On August 1, 1995, an agreement was signed for concluding the Article VII negotiations. The agreement stipulated that: (1) the December 15, 1994 State-federal accord offsets indirect fish losses

Figure 2-9
Two Examples of How ISDP Can Shift Pumping to Divert Less Fish into Clifton Court Forebay



caused by the existing SWP and CVP operations, such that DWR and USBR have sufficiently met the requirements of their respective Delta and Tracy Pumping Plant agreements with DFG to proceed with the ISDP; (2) any incremental adverse environmental consequences which are attributed to the interim program will be dealt with through the CEQA/NEPA processes, the State and federal ESA, and Section 404 of the federal Clean Water Act; and, (3) other indirect fishery impacts caused by existing SWP and CVP operations which are not addressed by the new Bay-Delta standards will be dealt with through the joint State-federal process to develop long-term solutions for the problems affecting public values in the Bay-Delta estuary.

Supply/Demand Needs

DWR's Bulletin 160-93 examines the current and projected water needs and water supplies in California. The bulletin concludes that the State is expected to face chronic water shortages in the future; and that these shortages will occur even if reasonably foreseeable supply augmentation facilities are built, water conservation is practiced, and no additional endangered species requirements within the Sacramento-San Joaquin Delta are implemented. The projected shortages can be expected to increase, given the restrictions currently being placed upon water project operations in the Delta by endangered species requirements.

Two water balance scenarios of water supply and demand management programs are discussed in Bulletin 160-93.

- The Level I scenario includes programs that have undergone extensive investigation and environmental analyses and are judged to have a higher likelihood of being implemented by 2020.
- The Level II scenario includes programs that could fill the remaining gap shown in the balance between supply and urban, agricultural, and environmental water demands. These options require more extensive investigation and alternative analyses.

The Level I scenario includes programs which have been analyzed with respect to the quantity of water supply or demand reduction each could provide and have a good chance of being implemented. As shown in Tables 2-1 and 2-2, Level I programs and projects are grouped under demand management (long-term and short-term) and supply management (statewide and local). The ISDP is included in Level I options.

By design, Level II programs and projects are much more speculative in nature and include proposals such as additional water conservation, land retirement, and water transfers (under the heading of demand management); additional storage and conveyance projects (under the heading of statewide supply management); and additional water recycling, and water desalting, reuse of agricultural brackish water, and various other programs under the heading of local water management.

Recent studies contained in DWR Bulletin 160-93 (*The California Water Plan Update*) conclude

Table 2-1
Level I Demand Management Options

Program	Comments
Long-term Demand Management	
Urban Water Conservation	Urban Best Management Practices
Agricultural Water Conservation	Increased irrigation efficiency
Land Retirement	Retirement of land with drainage problems in west San Joaquin Valley
Short-term Demand Management	
Demand Reduction	Drought year supply (shortage)
Land Fallowing/Short-term Water Transfers	Drought year supply (shortage)

Table 2-2
Level I Water Supply Management Options

Program	Type	Comments
Statewide Water Management		
Long-term Delta Solution	Delta water management program	Considered under long-term planning process
ISDP	South Delta improvement	Subject of this report
Los Banos Grandes Reservoir	Offstream storage	Considered under long-term planning process
Kern Water Bank	Ground water storage	Considered under long-term planning process
Coastal Branch--Phase II	SWP conveyance facility	Under construction
Local Water Management		
Water Recycling	Reclamation	New water supply
Ground Water Reclamation	Reclamation	Primarily in South Coast
Los Vaqueros Reservoir--Contra Costa Water District	Offstream storage/ emergency supply/ water quality	Under construction
Domenigoni Valley Reservoir--MWDSC	Offstream storage of SWP and Colorado River water, drought year supply	Final EIR certified

C—087162

C-087162

that the State's present supplies are insufficient to meet present demands during drought, and by 2020, without improved water management and additional facilities, annual shortages of 3.7 to 5.7 MAF could occur in average water years and 7.0 to 9.0 MAF shortages could occur during drought years. A more detailed discussion on the State's water supply and demand is found in Appendix D of this report.

Los Banos Grandes Reservoir

South Delta improvements are also needed for offstream winter-banking storage projects. One such project is the Los Banos Grandes Reservoir, authorized by the Legislature in 1984 and included in Governor Pete Wilson's Water Policy. To operate LBG, it is necessaty to increase diversions into Clifton Court Forebay to maximize the full pumping capability of Banks Pumping Plant as proposed by the ISDP. Without this increase in Clifton Court diversion rates, LBG cannot be demonstrated to be feasible.

CHAPTER 3 - ALTERNATIVE SELECTION AND SCREENING METHODOLOGY

Figure 3-1 outlines the process of alternative selection. The first two steps shown, project purposes and project need, were discussed in Chapter 2 of this report. This chapter covers (1) selection of alternatives, including the no-action alternative, for the screening process, and (2) the methodology for screening or evaluating the alternatives. Chapters 4 and 5 present the first- and second- stage evaluations of the alternatives, and the EIR/EIS for the ISDP comprises the third-stage evaluation.

NO-ACTION ALTERNATIVE

CEQA and NEPA require "no-project" and "no-action" alternatives, respectively. CEQA's no-project alternative is a "snapshot" of existing conditions without the proposed project. It is a static condition. NEPA's no-action alternative, on the other hand, while it also assumes conditions without the proposed project, assumes that projects and programs and trends already set in motion will continue. It also accounts for events and trends that will likely take place *because* the project is not constructed. This analysis focuses on the NEPA-required no-action alternative.

Documents relating to the no-action alternative include the following.

State-Federal Framework Agreement

In June 1994, The Governor's Water Policy Council and the Federal Ecosystem Directorate (FED) reached an agreement called the "Framework Agreement." One of the issues addressed is the need for a long-term solution to environmental, water supply, and water quality problems in the Delta. By contrast, the ISDP is an interim, immediate solution to some of the problems.

December 15 Accord

The December 15, 1994 agreement between representatives of the State and federal government and urban, agricultural and environmental interests provides the standard for operating existing and new facilities in the Delta, including the ISDP.

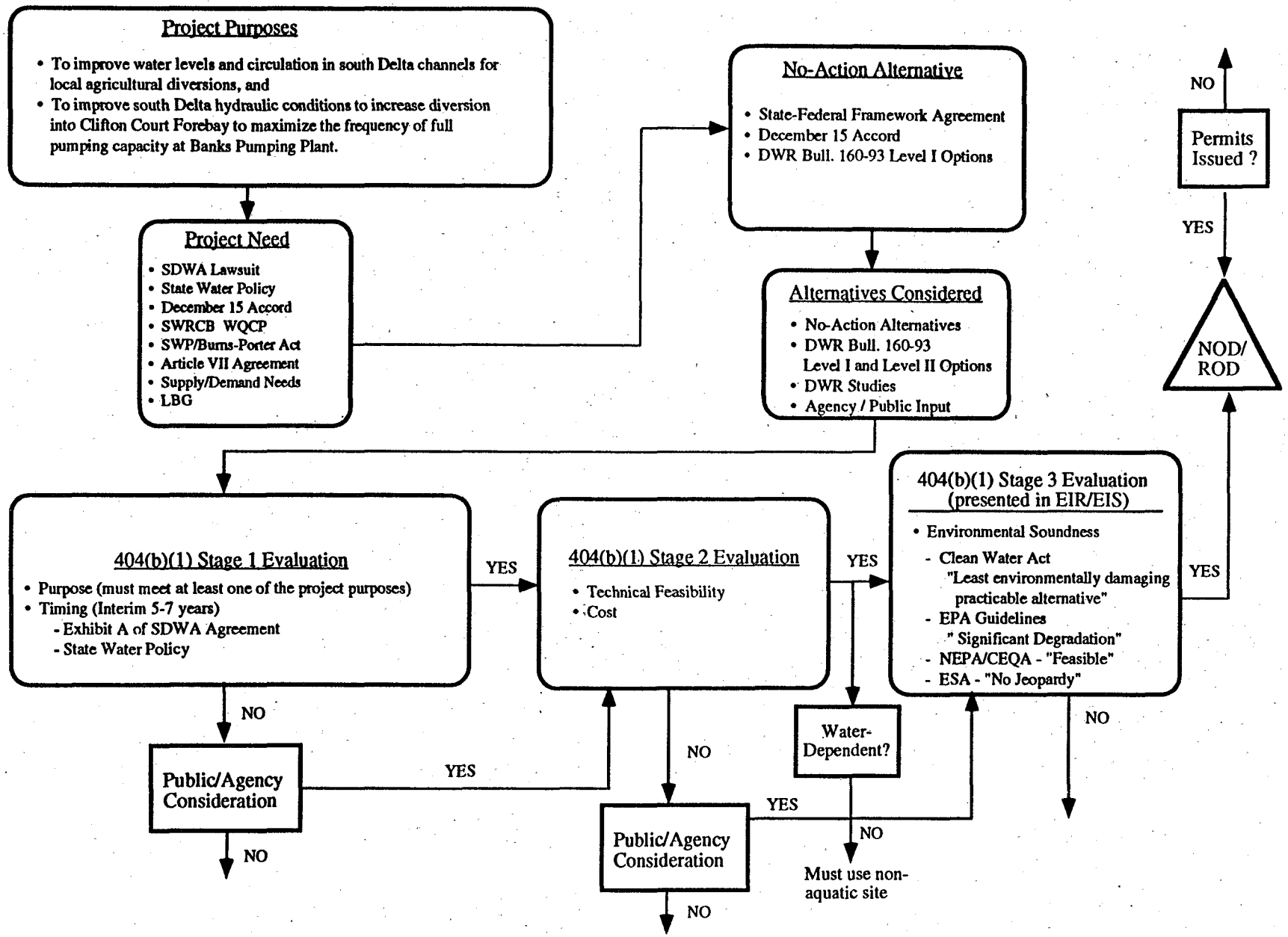
DWR Bulletin 160-93

This alternative selection effort incorporates findings of the ongoing public process conducted in the development of DWR Bulletin 160-93 *(The California Water Plan Update).* Bulletin 160-93 concluded that additional interim and long-term measures combining additional facilities and improved water management are needed to prevent current and future chronic water shortages in the State. The bulletin includes Level I and Level II options. Both Level I and II options are considered below for (1) inclusion in the no-action alternatives or (2) inclusion as alternatives to the ISDP.

C-087164

C-087164

Figure 3-1. Alternative Selection Methodology



C-087165

C-087165

ALTERNATIVE SELECTION

Table 3-1 lists the alternatives selected for consideration in this analysis. The sources of the alternatives are discussed below, in the same sequence as in the table.

No-Action Alternatives

As explained above, this analysis focuses on the NEPA-required no-action alternative. No-action includes existing programs and projects that are operational. No-action future programs and projects have permits to construct, are under construction or are ongoing programs.

DWR Bulletin 160-93 Level I Options

Level I options include those programs and projects that have undergone extensive investigation and environmental analysis and are judged to have a higher likelihood of being implemented by 2020. Level I options that are considered no-action have the following characteristics: (1) they are not in competition with the ISDP (do not have the potential of addressing one or both of the ISDP project purposes), and (2) they are relevant to the ISDP because they affect the general water supply/demand for the SWP or because they are in the Delta. Those Level I options that are not relevant in this way are not discussed here.

Level I Conservation

Following the statewide drought of 1976-77, DWR began an aggressive water conservation program to help local agencies achieve efficient use of California's limited water resources through promotion of water conservation policies and practices that would have the greatest public benefit consistent with sound resource conservation principles.

DWR administers several programs that encourage efficient use of water, and has focused on cost-effective urban and agricultural conservation programs carried out cooperatively with local agencies throughout the State. Legislation has also been adopted to encourage and improve water conservation in the State. The two most recent significant pieces of conservation legislation are: the Urban Water Management Planning Act of 1983, and the Agricultural Water Management Planning Act of 1986. Both require the larger water suppliers, under certain conditions, to prepare water management plans.

Water conservation effects on net water demand vary greatly, depending on the opportunity for water reuse in the area. Effective water conservation in a region is the reduction in depletion, which is defined as reduction of the evapotranspiration of applied water, irrecoverable losses from a distribution system, and outflow to a salt sink. For example, in the Sacramento River region, water is reused extensively, so the potential for effective conservation is limited. But a large water savings potential exists in the Colorado River and the coastal regions, where excess applied water generally enters saline sinks (Salton Sea or the ocean) or saline ground water basins and cannot be economically reused.

Reductions in applied water can often be beneficial because they reduce the pumping and treatment costs and could reduce diversions from streams and rivers to benefit fish and wildlife. However, care must be taken to look at impacts on downstream reuse, such as other farms or

wildlife refuges, that rely on excess applied water.

Because Level I conservation is underway independently of the ISDP, and is not in competition with the ISDP, it is considered part of the no-action alternatives, existing and future conditions.

Level I Land Retirement

Land retirement will take place in parts of the San Joaquin Valley where drainage has been a problem and where continued cultivation of some marginal lands will not be feasible. Forty-five thousand acres of land could be out of production by 2020 and about 70,000 acres by 2040. This is accounted for in agricultural acreage projections. The accompanying annual net water savings from this land retirement is about 0.13 MAF.

Because Level I land retirement is underway independently of the ISDP, and is not in competition with the ISDP, it is considered part of the no-action alternatives, existing and future conditions.

Demand Reduction

The Level I scenario uses a 15-percent reduction during a drought to determine the adequacy of urban water supplies through 2010. The 15-percent level reflects 1990 urban water use experiences, and was chosen as a management planning tool for drought periods rather than as an action which could impose more severe hardships on affected communities. Most of the urban areas which implemented special conservation programs achieved cutbacks at or above this level. DWR studies indicate that some individual sectors of local economies, such as the green industry, suffered substantial income and employment losses in 1991. (The "green industry" includes nurseries, self-employed gardeners, landscapers, and landscape-related businesses.) However, from a statewide perspective, a shortage of 15 percent, based on the 1990-91 drought experience, is considered manageable at the 1990 level for drought events which would occur about once every 20 years.

Because demand reduction is underway independently of the ISDP, and is not in competition with the ISDP, it is considered part of the no-action alternatives, existing and future conditions.

Level I Land Fallowing/Short-term Water Transfers

The State Drought Water Bank began in 1991. During the first year of operation, it purchased 0.82 MAF. About 50 percent of the water came from land fallowing (0.42 MAF), followed by ground water exchange (0.26 MAF), and stored water reserves (0.14 MAF). State Water Bank operations are included in this section because these actions were short-term (one-year drought supply) for areas with critical needs. Some of this purchased water could be considered supply management (ground water, reserved storage water) rather than demand management. However, since overall water service reliability was not improved for the long-term, ground water exchange and stored water reserves for the drought water bank are included as short-term demand management options.

Because land fallowing and Level I short-term water transfer is underway independently of the ISDP, and is not in competition with the ISDP, it is considered part of the no-action alternatives, existing and future conditions.

C—087167

C-087167

Kern Water Bank

In December 1994, DWR and the SWP contractors agreed on a set of principles now known as the Monterey Agreement. As part of the agreement, the Kern Fan Element of the Kern Water Bank will be turned over to the contractors, and is no longer a part of the SWP. Therefore, it is not an alternative to be considered for the ISDP but is considered part of the no-action alternatives.

Coastal Branch--Phase II (Santa Ynez Extension)

This project, which is under construction, is planned as a 102-mile buried pipeline and related facilities which will complete the Coastal Branch of the SWP. It will run from Devil's Den in northwestern Kern County, where Phase I ends, to Vandenburg Air Force Base in Santa Barbara County. It is designed to serve 4,830 AF per year of SWP water to San Luis Obispo County and 42,486 AF per year to Santa Barbara County.

Since this project is under construction and is not a competing alternative for the ISDP, it is considered part of the no-action alternative, future conditions.

Level I Water Recycling

Total annual Level I water recycling for 1990 was 0.4 MAF, projected to be about 1.3 MAF in 2020.

Because water recycling is underway independently of the ISDP, and is not in competition with the ISDP, it is considered part of the no-action alternatives, existing and future conditions.

Los Vaqueros Reservoir

This 100,000 AF Contra Costa County Water District water storage facility is under construction near Byron. Besides providing emergency storage, the reservoir will store high-quality Delta water during wet seasons for blending with lesser-quality Delta supplies in dry seasons.

Since this project is under construction and is not a competing alternative for the ISDP, it is considered part of the no-action alternative, future conditions.

Domenigoni Valley Reservoir

This reservoir is a project of Metropolitan Water District of Southern California. This 800,000 AF water storage facility is under construction in western Riverside County. It will provide emergency storage, drought year storage, carryover storage and seasonal storage, enhance the operational reliability of MWDSC's system, and assist with ground water recharge as part of a regional conjunctive use program.

Since this project is under construction and is not a competing alternative for the ISDP, it is considered part of the no-action alternatives.

DWR Bulletin 160-93 Level II Options

Level II options are demand management and supply augmentation concepts which could help fill the gap remaining between supply and demand or potentially provide water for SWP after

Level I programs are fulfilled. As with Level I options, to be considered no-action, Level II options would have the following characteristics: (1) they would not be in competition with the ISDP (would not have the potential of addressing one or both of the ISDP project purposes), and (2) they would be relevant to the ISDP because they would affect the general water supply/demand for the SWP or would be in the Delta.

Based on the above criteria, none of the Level II options are considered part of the no-action alternative.

Level I Options Alternatives

Those Level I options that are not considered part of the no-action alternatives and that have the potential of addressing one or both of the ISDP project purposes are listed in Table 3-1 and discussed in this section.

Long-term Delta Solution

Long-term Delta solutions are reviewed in this report as alternatives to the ISDP, because of their potential for meeting one or both of the ISDP project purposes.

South Delta Water Management Program

This reference in DWR Bulletin 160-93 is the previous name for the ISDP.

Los Banos Grandes Reservoir

This project, authorized by the Legislature in 1984 and included in Governor Pete Wilson's Water Policy, would work in conjunction with ISDP. It does not have permits and is not underway, and therefore is not considered part of the no-action alternatives.

Level I Ground Water Reclamation

Ground water reclamation programs are designed to recover degraded ground water. Currently, most of the ground water reclamation programs under consideration are in Southern California.

Because ground water reclamation is under consideration but not underway, it is not considered part of the no-action alternatives.

Level II Options Alternatives

Level II options are demand management and supply augmentation concepts which could help fill the gap remaining between supply and demand or potentially provide water for SWP after Level I programs are fulfilled. Because of their potential for addressing one or both of the ISDP project purposes, the following Level II options are included as alternatives for the ISDP and listed in Table 3-1: water conservation, land retirement, water transfer, and reclamation. Many of the remaining Level II options have been deferred, suspended, or put on hold. In any case, the

remaining Level II options are not considered to have the potential for addressing either of the ISDP project purposes.

DWR Studies Alternatives

Many of the alternatives evolved from past studies by DWR. These include the South Delta Water Agency Alternatives, the South Delta Water Management Alternatives, and the Permanent Long-range Alternatives, all as listed in Table 3-1.

Agency/Public Input Alternatives

These alternatives, which are listed in Table 3-1, were recommended by various agencies during development of the ISDP.

SCREENING METHODOLOGY

Once a list of alternatives is selected, as discussed above, a three-stage evaluation process is employed. The screening criteria used in the first-, second-, and third-stage evaluations are discussed in detail in Chapters 4, 5, and the EIR/EIS, respectively. Briefly, they are as follows (see Figure 3-1):

- Stage 1 Evaluation: project purpose, timing
- Stage 2 Evaluation: technical feasibility, cost
- Stage 3 Evaluation: environmental soundness

The above criteria arise from the institutional framework, the laws and guidelines, discussed below.

Generally, the alternative screening mechanisms have taken into account the requirements of *feasibility, least environmentally-damaging practicable alternative, and reasonable and prudent actions*. These factors were incorporated in accordance with specific guidelines in the Public Resources Code and the Council of Environmental Quality guidelines, Clean Water Act, and Endangered Species Act, respectively. These requirements are considered in light of the established project purposes (see Chapter 2).

State Water Policy

Relating to the Stage 1 evaluation, timing is an important screening factor in the delineation between interim and long-term measures, as defined by California Governor Pete Wilson's 1992 Comprehensive Water Policy. Long-term measures are being addressed in the long-term planning process, as established by the State-Federal Framework Agreement of June 1994.

Section 404 of the Clean Water Act and California Public Resources Code

Relating to the Stage 1 evaluation criteria of project purpose, according to Section 230.10 of the regulations implementing the Clean Water Act, Section 404(b)(1), "An alternative is *practicable* if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall *project purpose*." The Stage 1 evaluation looks at whether an alternative can meet at least one of the project purposes.

Relating to the Stage 2 evaluation criteria of technical feasibility and cost, the California Public Resources Code defines *"feasible"* to mean "capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social and technological factors."

The Stage 3 evaluation criteria of environmental soundness relates to EPA's 404(b)(1) Guidelines (40 CFR 230), where to receive a Department of Army permit to discharge dredged or fill material into "waters of the United States" a permit applicant may have to clearly demonstrate that the proposed discharge is unavoidable and the *least environmentally-damaging practicable alternative.*

EPA Guidelines

In relation to the Stage 3 evaluation, the EPA 404(b)(1) Guidelines do not allow permitting projects "which will cause or contribute to *significant degradation* of the waters of the United States."

NEPA and CEQA

Relating to the Stage 3 evaluation, under the California Environmental Quality Act, "public agencies should not approve projects as proposed if there are *feasible* alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects." (Public Resources Code Section 21002)

Under the National Environmental Policy Act, the evaluation of alternatives is governed by the "rule of reason" under which an EIS must consider a reasonable range of options that could accomplish the agency's objectives. Reasonable alternatives are those that may be feasibly carried out based on technical and economic factors (see Stage 2 evaluation criteria). An alternative may be considered reasonable even if it is outside the jurisdiction of the lead agency. 40 CFR 1502.14(c).

Endangered Species Act / Biological Assessments and Opinions

Endangered species considerations relate to the Stage 3 evaluation. To comply with the Endangered Species Act, biological opinions relating to the project must be rendered by the USFWS or NMFS. These biological opinions will be based on biological assessments for the ISDP prepared by DWR and USBR.

Based on the best scientific and commercial data available, the biological opinions must determine whether the project, combined with cumulative effects, is *likely to jeopardize* the continued existence of listed species, or result in the destruction or adverse modification of critical habitat. The USFWS or NMFS must include *reasonable and prudent* alternatives to the action that would *avoid jeopardy*. These alternatives must be consistent with the intended purposes of the action, must be able to be implemented by the agency, and must be technologically and economically feasible. (16 USC 1536, 50 CFR 402.14.) USFWS and NMFS will complete the biological opinion for the ISDP.

All alternatives selected for third-stage evaluation were assessed against mitigation measures to lessen or avoid impacts. The incremental impacts of the project on endangered species were not found to require additional restrictions beyond the December 15 requirements.

C—087172

C-087172

Table 3-1

Alternatives for First-Stage Evaluation

No-Action Alternatives

Existing Conditions
Future Conditions

Level I Options Alternatives

Long-term Delta Solution
Los Banos Grandes Reservoir
Level I Ground Water Reclamation

Level II Options Alternatives

Water Conservation
Land Retirement
Water Transfer
Reclamation

South Delta Water Agency Alternatives

South Delta Flow Control Structures
Roberts Island Canal Plan
Dredging South Delta Water Agency channels
Pay for Agricultural Pump Damage in the South Delta
Treatment of Local Agricultural Drainage Water
Pumping Water from Clifton Court Forebay to a Portion of SDWA Users
Delta-Mendota Canal /Westley Wasteway Plan
Reduce San Joaquin River Agricultural Drainage
Reduce CVP/SWP Export
Increase San Joaquin River Flow

South Delta Water Management Alternatives

Northern Forebay Intake with Limited Channel Dredging
Northern Forebay Intake, Limited Channel Dredging, and South Delta Flow Control Structures
Channel Enlargement, South Delta Flow Control Structures, and Expanded Existing Intake
Enlarge Clifton Court Forebay with:
- -Byron Tract
- -North Victoria Island
- -South Victoria Island
- -Coney Island
- -Union Island

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at:
- -Byron Tract

C—087173

C-087173

-North Victoria
-South Victoria
-Coney Island
-Union Island

Permanent Long-Range Alternatives

Isolated Water Transfer Facilities
- Peripheral Canal
- Dual Transfer System
- Modified Folsom-South Canal
- West or Central Delta Canal

Through-Delta Facilities
- New Hope Cross Channel
- Waterway Control Plan
- North Stub Canal
- South Stub Canal

Physical Barriers

Agency /Public Input Alternatives

Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water

Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP Pumping Capability

Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and Additional Clifton Court Forebay Intake at Italian Slough

Limited Channel Dredging, South Delta Flow Control Structures, and Intake at Italian Slough

C—087174

C-087174

CHAPTER 4 - FIRST-STAGE EVALUATION

This chapter presents the first-stage evaluation of numerous alternatives in seven categories, as listed in Table 3-1. Each alternative is reviewed to determine if either of the project purposes are met, as well as for reasonability of implementation time. Table 4-1 summarizes the information from the first-stage evaluation.

Screening Criteria

Screening criteria provide a comprehensive way to determine whether a project alternative is practicable and the least environmentally damaging. Important factors, such as meeting the project purposes, existing technology, environmental considerations, cost, and timing are included in the screening process. The specific screening criteria used in the second-stage evaluation are technology and cost, and in the third-stage the criterion is environmental constraints.

The criteria in the first-stage evaluation are project purpose and timing. These are presented in the following sections, along with supporting information used to develop each criterion.

First Project Purpose: To improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions

Water Levels

Water for lands within the SDWA boundary is supplied almost exclusively from Delta channels. Water conditions in the area are influenced by San Joaquin River inflow, tidal action, SWP, CVP and local pump diversions, agricultural return flows, channel capacity, and other upstream development. Historically, there have been complaints from SDWA that hydraulic capacity was insufficient to convey water to some points of diversion during peak agricultural demand periods. In response to SDWA's 1982 lawsuit, DWR, in a cooperative manner, implemented measures to partially relieve the problem in certain channels. Tom Paine Slough was dredged in response to a 1986 joint powers agreement and siphons were installed in 1989 to improve the water level and circulation in this dead-end channel. Also, starting in 1987, DWR has constructed a low rock weir in Middle River each irrigation season. The center portion is removed each fall for flood control and navigation purposes. This weir has improved the water level on Middle River upstream (east) of the weir.

To resolve the portion of SDWA's lawsuit relating to the effects of both the CVP and SWP export pumps and operations on water levels within SDWA channels, DWR and USBR have proposed, in a draft contract, to determine the most viable means which will afford SDWA an adequate agricultural water supply in terms of channel water levels to meet the reasonable and beneficial needs of SDWA water users. The selected alternative must show conceptual design capability to meet target net Delta depletion rates agreed upon by SDWA. These rates are presented in Exhibit A of the August 27, 1990 draft contract among DWR, USBR and SDWA.

Many studies have been conducted using hydrodynamic models to determine the most viable means of improving SDWA channel flows, levels, and circulation. Hydrodynamic simulation of the flow requirements of channels within SDWA under various hydrologic conditions provides an assessment of methods for alleviating water level and circulation problems.

TABLE 4-1

FIRST-STAGE EVALUATION OF ALTERNATIVES

ALTERNATIVES	SCREENING CRITERIA: Project Purposes Met ? — WATER LEVELS AND CIRCULATION IMPROVED ?	SCREENING CRITERIA: Project Purposes Met ? — SWP FLEXIBILITY IMPROVED ?	SCREENING CRITERIA: TIMING OK ? (5-7 Years)	RETAINED ?	COMMENTS
NO-ACTION ALTERNATIVES					
Existing Conditions	No	No	NA	No	No solution to existing problems
Future Conditions	No	Increased problems	NA	No	Conditions will worsen for water supply.
LEVEL I OPTIONS ALTERNATIVES					
Los Banos Grande Reservior	No	No	No	No	No improvement to situation.
Level I Ground Water Reclamation	No	No	Ongoing	No	No improvement to situation.
LEVEL II OPTIONS ALTERNATIVES					
Water Conservation	No	No	Ongoing	No	No improvement to situation.
Land Retirement	No	No	Ongoing	No	No improvement to situation.
Water Transfer	No	No	Ongoing	No	No improvement to situation.
Reclamation	No	No	Ongoing	No	No improvement to situation.

C-087176

C—087176

TABLE 4-1

FIRST-STAGE EVALUATION OF ALTERNATIVES

ALTERNATIVES	SCREENING CRITERIA: Project Purposes Met ? WATER LEVELS AND CIRCULATION IMPROVED ?	SWP FLEXIBILITY IMPROVED ?	TIMING OK ? (5-7 Years)	RETAINED	COMMENTS
SOUTH DELTA WATER AGENCY ALTERNATIVES					
South Delta Flow Control Structures	Yes	Small improvement	Yes	Yes (combined w/ other Alt.)	Solution to water level and circulation problems in SDWA channels.
Roberts Island Canal Plan	Yes	No	No (long term)	No	Needs some type of water transfer system to be effective.
Dredging South Delta Channels	Yes	Yes	Done incrementally over many years	No	Not retained as a whole, but portion combined with other alternatives.
Pay for Ag. Pump Damage-South Delta	Yes	No	No completion date with this project	No	
Treatment of Local Agricultural Drainage Water	No	No	Yes	No	Small improvement to water quality.
Pump Water from CCF to a portion of SDWA Users	Yes	No	Yes	No	Some improvement in water quality for agriculture wherever facilities can provide.
Delta Mendota-Westley Wasteway Plan	Yes	Some improvement	No (long term)	No	Needs some type of water transfer system to be effective.
Reduce San Joaquin River Ag. Drainage	No	No	No (long term)	No	Improved water quality.
Reduce CVP/SWP Exports	Small Improvement	No	Yes	No	Would reduce reverse flow.
Increase San Joaquin River Flow	Small improvement	Small improvement	No (many years)	No	Could have wide-ranging impacts

C-087177

C-087177

TABLE 4-1

FIRST-STAGE EVALUATION OF ALTERNATIVES

ALTERNATIVES	SCREENING CRITERIA: Project Purposes Met ? — WATER LEVELS AND CIRCULATION IMPROVED ?	SWP FLEXIBILITY IMPROVED ?	TIMING OK ? (5-7 Years)	RETAINED ?	COMMENTS
SOUTH DELTA WATER MANAGEMENT ALTERNATIVES					
Northern Forebay Intake with Limited Channel Dredging	No	Yes	Yes	Yes (Combined w/ other Alt.)	
Northern Forebay Intake, Limited Dredging, South Delta Flow Control Structures	Yes	Yes	Yes	Yes	
Channel Enlargement, South Delta Flow Control Structures, and Expanded Existing Intake	Yes	Yes	Yes	Yes	
Enlarge Clifton Court Forebay at:					
- Byron Tract	Small improvement	Yes	Yes	Yes (Combined w/ other Alt.)	
- North Victoria Island	Small improvement	Yes	Yes	Yes (Combined w/ other Alt.)	
- South Victoria Island	Small improvement	Yes	Yes	Yes (Combined w/ other Alt.)	
- Coney Island	Small improvement	Yes	Yes	Yes (Combined w/ other Alt.)	
- Union Island	Small improvement	Yes	Yes	Yes (Combined w/ other Alt.)	
Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at:					
- Byron Tract	Yes	Yes	Yes	Yes	
- North Victoria Island	Yes	Yes	Yes	Yes	
- South Victoria Island	Yes	Yes	Yes	Yes	

C-087178

C-087178

TABLE 4-1

FIRST-STAGE EVALUATION OF ALTERNATIVES

ALTERNATIVES	SCREENING CRITERIA: Project Purposes Met ? — WATER LEVELS AND CIRCULATION IMPROVED ?	SWP FLEXIBILITY IMPROVED ?	TIMING OK ? (5-7 Years)	RETAINED ?	COMMENTS
SOUTH DELTA WATER MANAGEMENT ALTERNATIVES cont.					
Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at:					
Coney Island	Yes	Yes	Yes	Yes	
Union Island	Yes	Yes	Yes	Yes	
PERMANENT LONG-RANGE ALTERNATIVES					
Isolated Water Transfer Facilities:					
Peripheral Canal	No	Yes	No	No	Consider for long-term solution.
Dual Transfer System	No	Yes	No	No	Consider for long-term solution.
Modified Folsom-South Canal	Yes	Small improvement	No	No	Consider for long-term solution.
West/Central Delta Canal	Yes	Yes	No	No	Consider for long-term solution.
Through-Delta Facilities:					
New Hope Cross Channel	No	Some improvement	No (over 10 years)	No	Consider for long-term solution.
Waterway Control Plan	Yes	Yes	No (over 10 years)	No	Consider for long-term solution.
North Stub Canal	No	No	No (over 8 years)	No	Consider for long-term solution, in combination with other alternatives.
South Stub Canal	Small improvement	Yes	No (8 years)	No	Consider for long-term solution, in combination with other alternatives.

C-087179
C-087179

TABLE 4-1

FIRST-STAGE EVALUATION OF ALTERNATIVES

ALTERNATIVES	SCREENING CRITERIA: Project Purposes Met ? — WATER LEVELS AND CIRCULATION IMPROVED ?	SCREENING CRITERIA: Project Purposes Met ? — SWP FLEXIBILITY IMPROVED ?	SCREENING CRITERIA: TIMING OK ? (5-7 Years)	RETAINED ?	COMMENTS
PERMANENT LONG-RANGE ALTERNATIVES					
Physical Barriers:					
Chippe Island Barrier	No	Yes	No (considerable time needed)	No	
AGENCY / PUBLIC INPUT ALTERNATIVES					
Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water	Small Improvement	No	Yes	Yes*	See earlier alternative, "Reduce CVP/SWP Exports"
Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP pumping Capability	No	Yes	Yes	Yes*	Water rights, other legal issues need to be resolved prior to consolidation of diversions.
Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and Additional Clifton Court Forebay Intake at Italian Slough	Yes	Some	Yes	Yes	The benefits for the second project purpose will be small when the Italian Slough intake is used.
South Delta Flow Control Structures, Limited Channel Dredging, and Intake at Italian Slough	Yes	No	Yes	Yes*	

* These alternatives are retained for further evaluation as determined by meetings held between DWR, USBR and several other State and federal agencies.

C-087180

C-087180

Other information to help this assessment is provided by the results of five years of monitoring for the Temporary Barriers Program.

The conceptual design of any facility is based upon analyses which include assumptions that simplify actual conditions. During actual operation of the selected alternatives, such factors as actual tide conditions, real-time output from monitoring stations, forecasted tides, and present channel depletions would come into play and would require operational adjustments.

The conceptual design objectives listed in the proposed agreement with SDWA are:

- provide sufficient volume of flow to provide water levels for uninterrupted operation by local SDWA diverters for certain specified hydrodynamic conditions;
- provide circulation in the controlled SDWA channels mentioned in the agreement; and
- provide compatibility with fishery needs.

The controlled channels are: (1) Middle River beginning about one-half mile upstream of the confluence with Trapper Slough and North Canal, and ending at Old River (12 miles upstream); (2) Grant Line Canal beginning one-half mile east of Old River and ending at its east end (8.7 miles upstream); and (3) Old River one–half mile upstream of Delta-Mendota Canal intake and ending at the head of Old River (18.9 miles upstream).

The water level screening criteria for use in the 404(b)(1) alternatives analysis is based on the local SDWA agricultural needs, and is sufficient to resolve the litigation. Information from 5 years of monitoring has provided added information for this assessment. An alternative, either individually or in combination with other possible alternatives, must be capable of 1) supplying enough water to satisfy the channel depletions, and 2) providing for uninterrupted operations by local diverters.

Water Circulation

Circulation in south Delta channels is controlled by tidal fluctuations, water supply, and channel capacities. The rate of pumping by local users and by project pumps can also influence circulation. Local agricultural drainage returns, aggravated by poor water circulation, have affected channel water quality. Irrigation practices concentrate the salts of the applied water, and disposal of the irrigation drainage in the channels degrades the channel water accordingly. Water circulation can be poor in dead-end channels, such as Tom Paine Slough and Paradise Cut, as well as reaches of Old River and Middle River where stagnant zones occur. During heavy irrigation periods, the agricultural drainage is recycled several times when flows are insufficient to flush the channel. Channel dredging and installation of siphons and a tidal pump helped water circulation in Tom Paine Slough, but that operation still depends on adequate water levels within the supply channel.

Other factors to consider, related to poor circulation, are high nutrient loading and impacts to dissolved oxygen. This can cause biostimulation for algal growth, a negative impact. One benefit that could result from improved circulation would be lower water temperatures which would increase dissolved oxygen levels and benefit resident fish.

The agreement and draft contract worked out with SDWA specifies that some means of providing circulation in the controlled channels (those reaches identified under "Water Levels"

C—087181

C-087181

above) will be developed. As noted earlier, modeling studies and monitoring programs have yielded results that indicate viable means for improving channel circulation.

An alternative, either individually or in combination with other alternatives, must be capable of improving conveyance to provide needed circulation while maintaining adequate water levels in spite of demands on the water.

Second Project Purpose: To improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant

DWR has long-term water supply contracts to deliver specified annual amounts of water to each of 29 contracting agencies. These contractors are in the Feather River Basin, San Francisco Bay area, San Joaquin Valley, Central Coastal area, and Southern California. The maximum annual entitlement for all contractors total about 4.2 million acre-feet (MAF). This represents the maximum water that would be delivered by the State to its contractors under full contract conditions (further discussion on this can be found in Appendix A). Delivering this maximum amount of water would require at times using the full pumping capacity of 10,300 cfs at Banks Pumping Plant, which in turn requires the implementation of the ISDP, as well as other water supply and demand management programs as discussed in Appendix D.

Water contracts establish annual entitlement and procedures for allocating deficiencies, surplus water deliveries, and payment. A temporary shortage of water supplies can occur in any year when a drought or other condition reduces available project water to less than the total requests for annual entitlement. In such an event, the SWP would reduce deliveries of that year's entitlement for agricultural purposes by a percentage not to exceed 50 percent in any one year, or a total of 100 percent of annual entitlement in any seven consecutive years. If necessary, further reductions will be made to all deliveries, regardless of use, and the deliveries will be reduced in proportion to the entitlement requests.

Operation of the SWP is governed by physical and institutional constraints. Physical factors limiting SWP operations include such things as California's geography and climate, available water supply, demands, and delivery capabilities; power operations; and hydraulic constraints and Banks Pumping Plant capacity. Institutional constraints include applicable water rights standards, fish mitigation agreements, and Endangered Species Act requirements.

The hydraulic constraints which can limit monthly maximum exports of the SWP are related to forebay inlet gate size and location, capacity of southern Delta channels leading to the intake, volume of Clifton Court Forebay, tidal fluctuations at the forebay intake, and San Joaquin River inflow.

Tidal fluctuations at the forebay intake average 3.7 feet daily. Five radial gates at the southeastern corner of the forebay are open during high tides and closed during low tides. Operational procedures for the inlet gates consist of minimizing the drawdown effects of the diversions at all tide levels. South Delta channels were not modified for SWP and CVP operations; therefore, they limit the amount of water that can be pumped from the south Delta without eroding the channels and levees. Banks Pumping Plant and Clifton Court Forebay play a key operational role because they are at the head of the aqueduct system. The pump capacity of the Banks Pumping Plant increased from 6,400 to approximately 10,300 cfs (20,430 AF/day) with the four additional pumps. However, the maximum monthly diversion into the Forebay is controlled by the US Corps of Engineers Public Notice 5820A Amended, and also by hydraulic constraints. The

C—087182

C-087182

Public Notice establishes the diversion constraint to be 13,870 AF for one day and 13,250 AF for a three-day average. Implementing hydraulic improvements to the south Delta would allow Banks Pumping Plant to pump up to its maximum capacity of approximately 10,300 cfs whenever the applicable water rights standards, fish mitigation agreement, and Endangered Species Act allowed. The added pumping capability would provide needed flexibility to offset some of the water supply lost to increased environmental protection.

An alternative, either individually or in combination with other alternatives, must be capable, to the extent allowed, of utilizing the 10,300 cfs pumping capacity, resulting in improved operational flexibility.

Timing

An alternative, either individually or in combination with other possible alternatives, should be completed in a reasonable time frame in accordance with Governor Wilson's policy and the draft settlement contract between SDWA, DWR, and USBR. Governor Wilson, in his 1992 water policy speech, called for "immediate interim actions in the South Delta." Some projects could take many years to formulate, move through the EIR/EIS process, design and construct. Five to seven years allows reasonable time to design and construct an interim project.

Temporary measures have been ongoing since 1985 in the south Delta to resolve the water level and circulation problems. Litigation by SDWA in 1982 pointed out the severity of the problems. Considerable work and coordination have gone into a draft settlement contract between SDWA, DWR, and USBR which settles the lawsuit. This contract has been approved by SDWA, DWR expects to obtain authority to sign, and USBR is seeking authorization from Congress to sign . The pace expressed in the draft contract for implementing a solution to the hydraulic problems in the south Delta (in Exhibit A of the contract it called for implementation within 5 years) is consistent with Governor Wilson's Comprehensive Water Policy, which calls for immediate interim actions to help restore the environment and improve water supply, and long-term solutions to the Delta to be developed. The Governor said, "We need to take immediate actions in the South Delta that will help restore the environment and improve the water supply."

Alternatives

NO- ACTION ALTERNATIVES

No- Action - Existing Conditions

The SWP operation in the south Delta and the present problems and needs are described in Chapter 2.

The existing hydrodynamic condition represents the annual water delivery schedule resulting from a 2.9 million acre-foot level of SWP demands. Under this alternative, no action would be taken. No flow control structures would be installed, nor would modifications to Clifton Court Forebay, intake, or channels be made. Therefore, water levels and circulation patterns in south Delta channels would remain the same, as would the present reliability of the SWP. Operations would continue under the present Corps constraints, and south Delta concerns would continue.

The no-action alternative would not comply with the agreement among DWR, USBR and SDWA to find a mutually acceptable solution to the SDWA water supply problems; therefore, the

C-087183

C-087183

litigation would continue. It also would not meet future water needs of the State.

The existing system does not meet the project purposes and is therefore eliminated from all further evaluations. However, it will be included in the EIR/EIS to provide a baseline for comparison of environmental effects.

No- Action - Future Conditions

The no-action alternative consists of a projection of future without-project conditions. The alternative involves conditions, policies, laws, ordinances, rules, regulations, programs and projects that exist or will likely be developed in the absence of the Interim South Delta Program.

By the year 2010, without additional actions, increased needs for urban water use will result in substantial shortages, and disagreements and potential litigation with SDWA will persist. According to the 1993 California Water Plan Update (DWR Bulletin 160-93), by 2020, without additional facilities and improved water management, an annual shortage of 3.7 to 5.7 MAF could occur in California during average years, depending on the outcome of the various actions. Similarly, by 2020, annual drought year shortages could amount to 7 to 9 MAF under D-1485 criteria.

With the inclusion of the projects and programs listed in Table 4-2, Water Supply and Demand Management Options Assumed for Inclusion in No-Action Future Alternative, the State will still experience shortages between 2.8 MAF to 4.8 MAF in average years, and 3.9 to 5.9 MAF in drought years.

Under the No-Action Future alternative, an adequate future water supply will also not be assured within the SWP service areas. Table 4-3, State Water Project & State Water Project Service Area Water Balance Assumed for Inclusion In No-Action Future Alternative, summarizes the supply and demand balances, assuming the same projects and programs as listed in Table 4-2. In the SWP service area, shortages are predicted in the year 2020, where a 1 MAF deficit will occur in average years, and a 2.9 MAF deficit will occur in drought years.

The SWP and CVP will continue to coordinate their operations under the following criteria:

- SWRCB Water Rights/ December 15, 1994 State-Federal Principles of Agreement
- Federal and State Endangered Species Acts
- Central Valley Project Improvement Act of 1992
- Safe Drinking Water Act
- Delta Flood Protection Act of 1988
- Delta Protection Act of 1992

Two new off-stream water supply facilities will be constructed in the upcoming years: the 800,000 acre-foot Domenigoni Valley Reservoir, and the 100,000 acre-foot Los Vaqueros Reservoir. In addition, reclamation programs, conjunctive use programs, and conveyance facilities will play key roles in managing California's future water supply. Other important water supply programs and projects include: urban and agricultural water conservation, land retirement, reclamation programs, conjunctive use programs and conveyance facilities.

This alternative does not meet the project purposes and is therefore eliminated from all further evaluations. However, it will be included in the EIR/EIS to provide a benchmark for comparison of environmental effects.

TABLE 4-2 WATER SUPPLY & DEMAND MANAGEMENT OPTIONS ASSUMED FOR INCLUSION IN NO-ACTION FUTURE ALTERNATIVE

WATER SUPPLY MANAGEMENT OPTIONS						
Program	**Type**	**Capacity (1,000 AF)**	**Annual Supply (1,000 AF)** *average*	*drought*	**Economic Unit Cost ($/AF)(1)**	**Comments**
Statewide Water Management						
Coastal Branch-Phase II (Santa Ynez Extension)	SWP Conveyance Facility	57	N/A	N/A	630-1,110	Notice of Determination was filed in July 1992; construction began in late 1993.
Local Water Management						
Water Recycling	Reclamation	1,321	923	923	125-840	New water supply
Ground Water Reclamation	Reclamation	200	100	100	350-900	Primarily in South Coast
Los Vaqueros Reservoir-Contra-Costa Water District	Offstream Storage Emergency Supply Water Quality	100	N/A	N/A	320-950	EIR certified in October 1993, 404 permit issued in April 1994.
EBMUD	Conjunctive Use and Other Options		N/A	43	370	Final EIR certified in October 1993.
Domenigoni Valley Reservoir-MWDSC	Offstream storage of SWP and Colorado River water, drought year supply	800	0	264	410	Final EIR certified
San Felipe Extension-PVWA	CVP Conveyance Facility		N/A	N/A(2)	140	Capital costs only; convey 18,000 AF annually
DEMAND MANAGEMENT OPTIONS						
Program		**Applied Water Reduction (1,000 AF)**	**Net Water Demand Reduction (1,000 AF)** *average*	*drought*	**Economic Unit Cost ($/AF)(1)**	**Comments**
Long-term Demand Management						
Urban Water Conservation		1,300	900	900	315-390(3)	Urban BMPs
Agricultural Water Conservation		1,700	300	300	Not Available	Increased irrigation efficiency
Land Retirement		130	130	130	60	Retirement of land with drainage problems in west San Joaquin Valley; cost is at the Delta.
All American Canal Lining		68	68	68	-	Water conservation project; increases supply to South Coast Region
Short-term Demand Management						
Demand Reduction		1,300	0	1,000	Not Available	Drought year supply
Land Fallowing/ Short-term Water Transfers		800	0	800	125	Drought year supply; cost is at the Delta.

(1) Economic costs include capital and OMP&R costs discounted over a 50-year period at 6 percent discount rate. These costs do not include applicable transportation and treatment costs.
(2) Yield of this project is in part or fully comes from the CVP.
(3) Costs are for the ultra-low-flush toilet retrofit and residential water audit programs.

Table 4-3. State Water Project and State Water Project Service Area Water Balance Assumed for Inclusion in No-Action Future Alternative

	1990 Average Year (maf)	1990 Drought Year (maf)	2020 Average Year (maf)	2020 Drought Year (maf)
SWP Entitlement	4.1	4.1	4.2	4.2
SWP Delivery Capability	2.8*	2.1*	3.3*	2.0*
SWP Balance	**-1.3**	**-2.0**	**-0.9**	**-2.2**
SWP Area Demand	10.1	9.3	10.9	11.2
SWP Area Supply Capability	10.1	10.3	9.9	8.3
SWP Area Balance	**0**	**-1.0**	**-1.0**	**-2.9**

* Bulletin 160-93, California Water Plan Update, Table 11-6

Note: Includes Programs/Projects listed in Table 4-2, Water Supply and Demand Management Options Assumed for Inclusion in the No-Action Future Alternative

Long-term Delta Solution

See Permanent Long-Range Alternatives later in this chapter.

Los Banos Grandes Reservoir

o Description

In 1983, DWR initiated a comprehensive investigation of alternative offstream storage reservoirs south of the Delta. In 1984, the State legislature authorized DWR to develop LBG (AB 3792, SEC. 11255 of State Water Code). After an initial examination of 18 sites, a DWR study recommended that Los Banos Grandes (LBG) be investigated to determine the most cost-effective reservoir size and its engineering, economic, and environmental feasibility. The proposed facilities would be located on Los Banos Creek in western Merced County, southwest of Los Banos and about 5 miles upstream from the existing Los Banos Detention Dam.

Based on the feasibility investigation, a 1.73-MAF reservoir was selected as a technically feasible and cost-effective solution to help offset projected future SWP water shortages and to provide the highest net benefits to the SWP. However, due to the recent endangered species actions in the Delta, the feasibility of the project is being reassessed. The actual sizing and schedule is highly dependent on the selection of a long-term solution for resolving fishery issues and facilitating efficient water transfer through the Delta.

o Benefits

Los Banos Grandes facilities could augment SWP supplies by about 186,000 AF in average years (under the December 15, 1995 Accord). Yield of LBG in drought years would be about 133,000 AF. The schedule for the investigation of this project has been slowed down in order to coincide with the Bay-Delta long-term planning process. It is likely that some of the SWP agricultural water contractors will not participate in financing or benefiting from the LBG program.

o Project Purposes

This project would not satisfy either project purpose.

o Timing

This project does not fit the interim category because it cannot be planned for, designed, and constructed in 5 to 7 years.

o Conclusion

Since this project would not satisfy either of the project purposes, and is not interim, it is not carried forward to second-stage screening.

C-087187

Level I Ground Water Reclamation

o **Description**

Ground water reclamation programs are designed to recover degraded ground water. High total dissolved solids and nitrate levels are the most common ground water quality problems. Currently, most of the ground water reclamation programs under consideration are in Southern California.

Ground water reclamation programs are designed to recover degraded ground water. High total dissolved solids and nitrate levels are the most common ground water quality problems. Currently, most of the ground water reclamation programs under consideration are located in Southern California (excluding ground water reclamation solely to remediate contamination at hazardous waste sites). Some of the polluted water must be treated, some can be blended with fresh water to meet water quality standards, and some can be applied untreated for landscape irrigation.

o **Benefits**

This program would add supply to the SWP service areas, thereby offsetting future local water supply demands. Total annual contribution of ground water reclamation is estimated to be 0.09 MAF by year 2000.

o **Project Purposes**

These ongoing programs do not satisfy either project purpose. They do add supply to the SWP service areas, thereby offsetting future local water supply demands. They do not compete with the ISDP.

o **Timing**

This program will be implemented over a long time frame.

o **Conclusion**

Since this alternative does not satisfy the project purposes, it is not retained for second-stage evaluation.

C—087188

C-087188

Water Conservation

o Description

DWR, through the Office of Water Conservation (OWC), administers several plans and programs that encourage efficient use of water and focus on cost-effective urban and agricultural conservation programs in cooperation with local agencies. DWR sponsored legislation to encourage and improve water conservation in the State. Two significant pieces of legislation are the Urban Water Management Planning Act of 1983 and the Agricultural Water Management Planning Act of 1986. Both require larger water suppliers to prepare water management plans that include Best Management Practices (BPM's).

More than 300 urban water suppliers prepared water management plans under the Urban Water Management Planning Act. These plans identify many current and future water conservation programs. California's agricultural sector has also been developing and implementing ways to reduce on-farm water use. This conservation effort was broad-based and involved various public institutions, private industries, and farmers.

o Benefits

Estimates made in DWR Bulletin 160-93 *(California Water Plan Update)* indicate that an additional 935,000 acre-feet per year of net urban water reduction will occur by 2020 due to Level I BMP's. The estimated savings in the agricultural sector due to reductions in the irrigated acreage, shifts in crops, and increased on-farm efficiency is about 1,400,000 acre-feet per year.

Bulletin 160-93 estimates that, upon implementation of the Level II BMP's, an additional 300 TAF/yr of agricultural applied water and an additional 220 TAF/yr of urban applied water can be saved through conservation measures. This alternative would decrease the need for new water supplies. However, even after implementation of the projected Level I water savings in both urban and agricultural sectors, there will still be a gap between SWP delivery capability and water demands in the service areas.

o Project Purposes

These ongoing programs do not satisfy either project purpose. They do add supply to the SWP service areas, thereby offsetting future local water supply demands. They do not compete with the ISDP.

o Timing

This is an ongoing program that DWR will continue to administer.

o Conclusion

Since this alternative does not satisfy the project purposes, it is not retained for second-stage evaluation.

C—087189

C-087189

Land Retirement

o Description

Land retirement will take place in parts of the San Joaquin Valley where drainage disposal has been a problem and where continued cultivation of some marginal lands will not be feasible. *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*, September 1990, evaluated the drainage problems in the San Joaquin Valley and recommended a plan of action to resolve the drainage problems on the west side of the valley through the year 2040. The recommendations included source control (water conservation), reuse of drainage water, and land retirement. For the Bulletin 160-93 update, and for the purpose of agricultural water demand calculations, it was assumed that source control and land retirement recommendations would be implemented. The 1990 report suggests 45,000 acres of land on the westside of the San Joaquin Valley could be out of production by 2020 and about 70,000 acres by 2040. These amounts are accounted for in agricultural acreage projections for DWR Bulletin 160-93.

o Benefits

The net water demand reduction resulting from land retirement could be about 130,000 MAF. To facilitate this option, the Central Valley Project Improvement Act provides federal authority and possible sources of funding for land retirement. At the State level, the San Joaquin Valley Drainage Relief Act provides DWR with authority to undertake a program of retiring lands with drainage problems.

o Project Purposes

These ongoing programs do not satisfy either project purpose. They do add supply to the SWP service areas, thereby offsetting future local water supply demands. They do not compete with the ISDP.

o Timing

This is an ongoing program that DWR will continue to explore.

o Conclusion

Federal and State funding has been provided for retiring lands with drainage problems. These programs will reduce water demand and have been accounted for in long-term planning. These programs will not meet the purposes or timing of an interim solution and therefore, are not considered for second-stage screening.

Water Transfer

o Description

Many water managers are seeking water transfers fo respond to water supply and allocation problems. Under existing law, holders of pre-1914 appropriative water rights can transfer water without seeking approval of the State Board, providing no other legal user is injured. Other holders of appropriative rights must obtain State Board approval.

o **Benefits**

Water transfers can augment a water agency's annual supplies to improve the water service reliability for the receiving area. Such transfers have been going on since early this century as evidenced by the construction of several major interstate transfer facilities. The 1987-92 drought caused some water agencies and individuals to begin looking at the potential of voluntary water transfers to augment short-term drought supplies. However, areas looking to the water transfer market for long-term supplies need an element of predictability. Uncertainties of Delta transfer capabilities, now and in the foreseeable future, make it difficult to predict transfer capability of the system.

The State Drought Water Bank experience was a good indication that obstacles to market-based water transfers can be overcome. However, as more and more willing buyers and sellers got together, legal problems in completing such transfers became more apparent. In response to such problems, the California Legislature has enacted, and the Governor has signed, several pieces of legislation that should facilitate market-based water transfers. Additional market-based water transfer legislation continues to be introduced with the hopes of further removing impediments to such transfers. The CVPIA is an example of federal legislation that will help facilitate water transfers in California by removing legal barriers, particularly those involving federal supplies.

Land fallowing and water bank operations are other options under short-term water transfers during periods of drought. During the first year of operation in 1991, the State Drought Water Bank purchased 0.82 MAF. About 50 percent of the water came from land fallowing (0.42 MAF), followed by ground water exchange (0.258 MAF) and stored water reserves (0.142 MAF). Operations were short-term (one-year drought supply) for areas with critical needs as determined by State Drought Water Bank criteria.

This is a program which operates well during drought periods, but does not improve SWP reliability. Water transfers can improve water service reliability if long-term supplies can be identified. Currently, transfer capability is difficult to forecast.

o **Project Purposes**

Since overall statewide water supply and water service reliability was not improved for the long-term, the drought water bank is considered a contingency or drought management supply option, and does not meet either of the project purposes.

o **Timing**

This is an ongoing program that DWR will continue to manage through the State Water Bank.

o **Conclusion**

This option cannot address short-term water needs and does not satisfy either of the project purposes. Therefore, this alternative is not considered for second-stage evaluation.

C—087191

C-087191

Reclamation

o **Description**

Water reclamation consists of gray water use, water recycling (discussed earlier under Level I options), water desalting, and reuse of agricultural brackish water. These options are getting increasing attention in California.

In 1992, the California Legislature approved, and the Governor signed Assembly Bill 3518 to permit statewide use of gray water for landscape irrigation. Many population centers in California are located in areas where the climate requires landscape irrigation at least 7 months of the year. This makes the use of gray water for landscape irrigation a major component of future water savings. Gray water would generally only be practical in larger lots where adequate side clearances can be maintained for subsurface irrigation fields. A substantial use of gray water in residential areas, however, would require major investments in plumbing and may not be practical for existing housing. Under Level II water management options, Bulletin 160-93 estimates 180 TAF/yr of gray water use by 2020.

According to Bulletin 160-93, there is the potential for 370 TAF/yr of additional recycled water (beyond Level I) by 2020.

Water desalting is becoming less expensive and is projected to grow in use.

The primary concern in the long-term use of brackish drainage water for irrigation is the impact of salt accumulation on the integrity and productivity of the soil.

o **Benefits**

This alternative would reduce the demand for potable water over the long term. Reduced demand would decrease the need for new supplies or extend the time until new supplies are needed.

o **Project Purposes**

These ongoing programs do not satisfy either project purpose. They do add supply to the SWP service areas, thereby offsetting future local water supply demands. They do not compete with the ISDP.

o **Timing**

This alternative is now being implemented on a small scale and is expected to expand over time. Most projects will depend on cost and availability of funds. Public acceptance will also be an important unknown factor in implementing these options.

o **Conclusion**

Since this alternative does not satisfy either of the project purposes, it is not retained for second-stage evaluation.

C—087192

C-087192

SOUTH DELTA WATER AGENCY ALTERNATIVES

The following alternatives focus on meeting all or part of the SDWA needs as stated in the first project purpose (to improve water levels and circulation in south Delta channels for local agricultural diversions) through physical changes or actions in south Delta channels, or actions at SWP/CVP facilities. Some of the alternatives, even though they would not satisfy the project purposes by themselves, could be combined with other alternatives to become viable plans.

South Delta Flow Control Structures

o Description

In response to litigation by SDWA, a contractual agreement was developed that affords SDWA an adequate agricultural water supply in terms of quantity, quality and channel water levels and circulation to meet the reasonable and beneficial needs of water users located along those portions of Old River, Middle River and Grant Line Canal that lie within SDWA lands.

One proposed plan to accomplish better water levels and circulation is a system of flow control structures installed at strategic locations in south Delta channels (Figure 4–1). By operating the gates to open and close during phases of the tide, they would take advantage of the natural tidal cycle of changing flow directions and water elevations to improve water levels and circulation.

Temporary low rock barriers have been installed at various locations during past years to improve water levels during the irrigation season. Those installations, along with numerous computer model simulations, have shown that flow control structures can alleviate the problem of low water levels and poor circulation.

Temporary agricultural barriers in Middle River and Old River were first installed in 1987 and 1991, respectively. DWR is seeking approval to install a temporary Grant Line Canal agricultural barrier. The agricultural barriers are operated in the spring and summer months each year.

A temporary fish barrier at the head of Old River was first installed in 1968. The barrier, which is being installed in the spring and fall each year, improves conditions for the San Joaquin River salmon migration and provides mitigation for the agricultural barriers by preventing salmon from being trapped behind them.

Information gained from tests and monitoring related to the temporary barriers will aid in verifying modeling studies. Additional monitoring studies will be conducted to assess operational performance and provide input to the development of permanent long-term features. Available information will be provided to the long-term planning process to provide guidance consistent with long-term planning.

Presently, four proposed flow control structure sites are being examined, three for the benefit of agricultural users and one for a fish barrier. The agricultural flow control structure locations would be:

- Middle River south of the confluence of Middle River, Trapper Slough and North

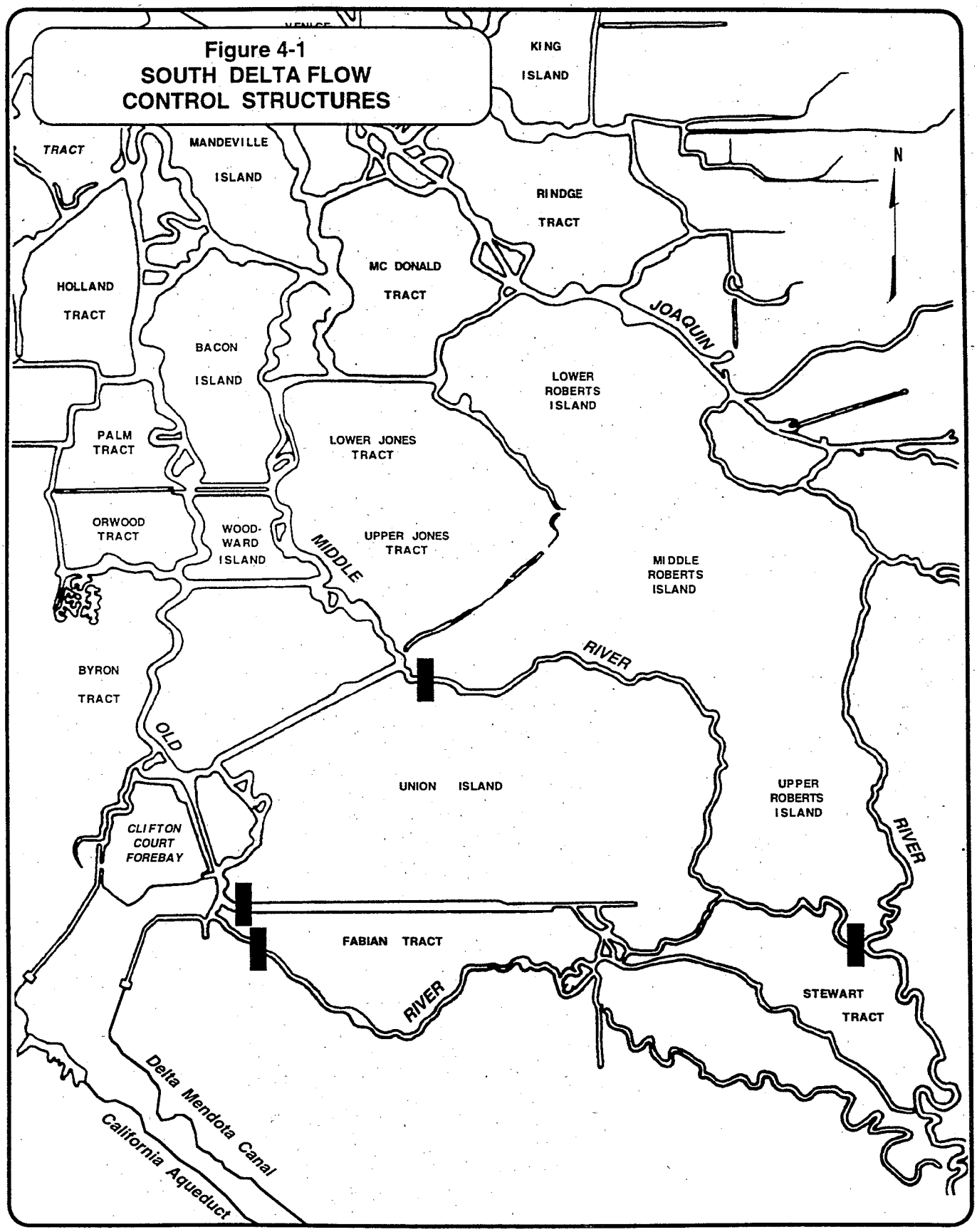


Figure 4-1
SOUTH DELTA FLOW
CONTROL STRUCTURES

C—087194

C-087194

Canal;

- Old River east of Delta-Mendota Canal intake; and
- Grant Line Canal east of the confluence with Old River.

The fish barrier control structure location would be:

- Old River west of the confluence with San Joaquin River.

The fish barrier control structure is mandated by PL 102-575, Title XXXIV of which is CVPIA, where it states that USBR, in conjunction with the State and in consultation with local interests, shall construct and operate a barrier at the head of Old River on a seasonal basis to increase the survival of young outmigrating salmon in a manner that does not significantly impair the ability of local entities to divert water. The ISDP should be fully compatible and complementary with the CVPIA.

When the agricultural and fish barriers are used together, they partly mitigate each other's adverse effects. The fish barrier prevents San Joaquin River salmon from being trapped behind the agricultural barriers; while the agricultural barriers prevent the fish barrier from adversely affecting water levels and water quality for Delta farmers and resident fish.

Different types of flow control facilities have been examined. Examples are: rock weir, inflatable rubber dam, or gated concrete structure. For operational control purposes, the most desirable facility is the gated concrete structure. A typical structure would be about 15 feet high with radial gates which could range from 15 to 45 feet wide.

o Benefits

Water for lands within the SDWA boundaries is supplied almost exclusively from Delta channels. Water conditions in this area are influenced by San Joaquin River inflow, water supply from the north Delta, tidal action, SWP and CVP pump diversions, local agricultural return flows, Tracy waste water outflow, channel capacities, and local geography. Flow-control type facilities could be constructed and operated to regulate flow during the irrigation season to improve water levels and circulation patterns. Increasing water levels would improve water circulation, especially in stagnant or dead-end channels, by putting more water into the system. A gate operation scheme can be developed that would take advantage of the two high and two low tides each day. It is possible to use this natural force to provide higher water levels during the low tide periods for improved pumping capability, and also use the outgoing tide to flush out the channels.

In addition, a flow control facility at the confluence of Old River and San Joaquin River would help migrating salmon in the San Joaquin River. This facility could be closed during the proper spring months to prevent salmon from moving down Old River toward the project pumps. These facilities could decrease the entrainment of various resident fish that inhabit south Delta channels upstream. SDWA and USBR are both supportive of this flow control structure plan.

o Project Purposes

The flow control structures satisfy the first project purpose (to improve water levels and circulation in the south Delta), and resolves the litigation by SDWA. They would also support the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant)) by decreasing entrainment of fish and enabling more flexibility in pumping. However, to

more fully satisfy the project purposes, additional features would be needed. The flow control structures would be complimentary to these other features and to any long-term Delta solutions.

o **Timing**

The flow control structures could be constructed within a reasonable time frame of 5 to 7 years, thus fitting into the "interim," rather than long-term, category.

o **Conclusion**

Since the flow control structure plan satisfies the first project purpose and helps to satisfy the second project purpose, and since it satisfies the timing for an interim project, this alternative is combined with others and retained for second-stage evaluation.

Roberts Island Canal Plan

o **Description**

This proposed plan (Figure 4-2) was one of several alternative water distribution plans that would work in conjunction with the Peripheral Canal (see later in Chapter 4). The Peripheral Canal would provide the water for distribution throughout the southern Delta to improve water supply and give a net downstream flow in the major channels used by migrating fish. The Roberts Island Canal Plan is discussed in DWR "Alternative Report Southeast Delta Water Control Facilities" April 20, 1976 report and November 8, 1977 supplement. The plan would consist of a 2,200 cfs pumping plant in Middle River, an earth-lined canal crossing Roberts Island between Middle River and San Joaquin River capable of carrying 1,100 cfs, and three flow control structures. The flow control structures would be located at the head of Middle River, on San Joaquin River below Old River bifurcation, and between Roberts Island Canal and San Joaquin River. They are needed for proper water distribution and to control flood flows.

The section of Middle River between Roberts Island Canal and Old River would convey the remaining 1,100 cfs for release down Old River. With the large flows in Middle River between the proposed Peripheral Canal crossing and Old River, there would need to be channel dredging and levee rework done.

o **Benefits**

This plan, *when coupled with the Peripheral Canal*, would improve the water level and circulation in Old River, Grant Line Canal and Middle River above the Peripheral Canal. Pumping directly from channels north of Highway 4 could provide an alternative operation method.

o **Project Purposes**

This plan, *when coupled with the Peripheral Canal*, would improve water levels and circulation patterns, thus furthering the first project purpose. It would also support the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant) by decreasing entrainment of fish.

C—087196

C-087196

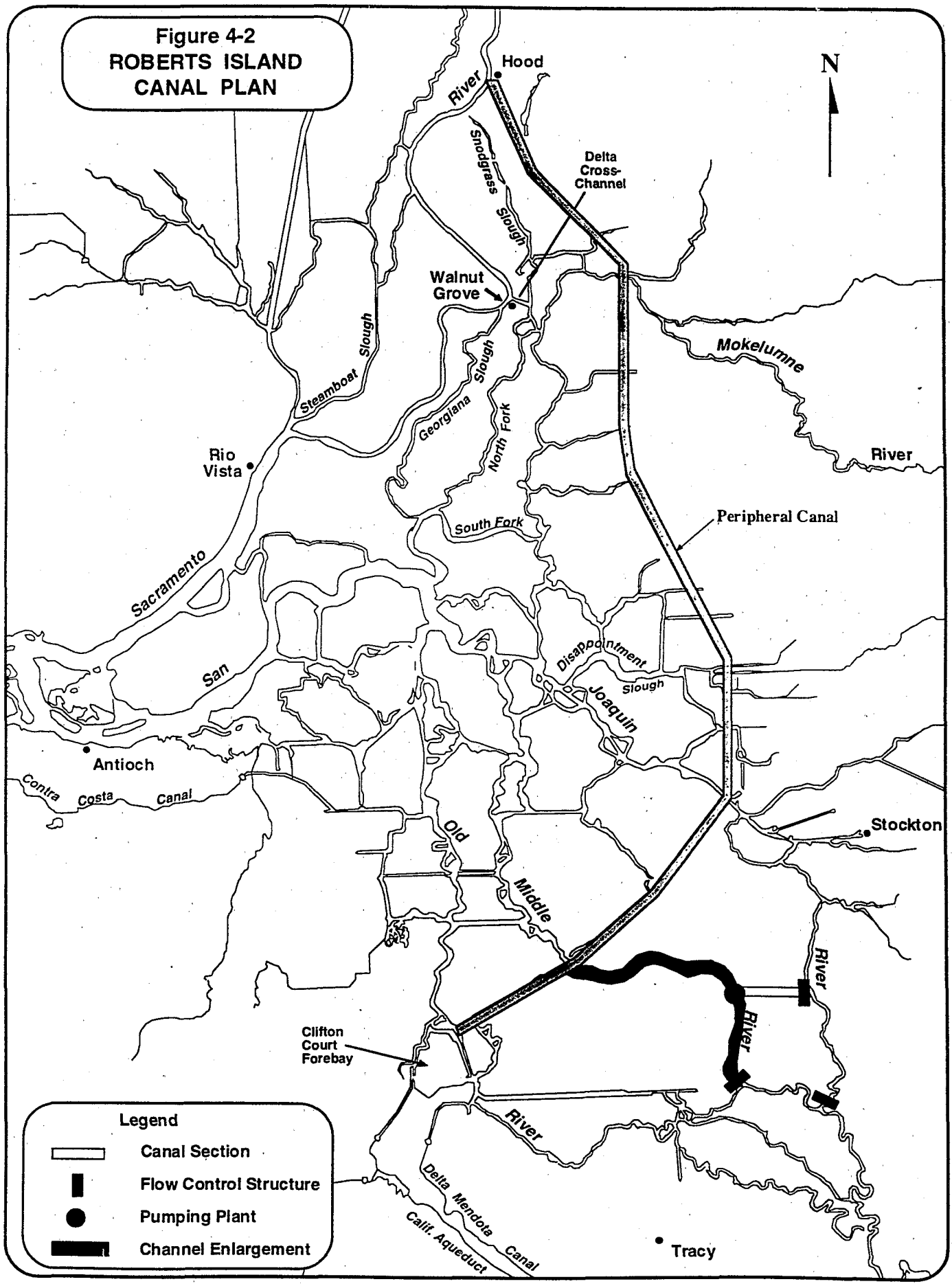


Figure 4-2
ROBERTS ISLAND
CANAL PLAN
N
Hood
River
Snodgrass
Slough
Delta
Cross-
Channel
Walnut
Grove
Steamboat
Slough
Georgiana
Slough
North Fork
Mokelumne
River
Rio
Vista
South Fork
Peripheral Canal
Sacramento
San
Disappointment
Slough
Joaquin
Antioch
Contra
Costa
Canal
Old
Middle
Stockton
River
River
Clifton
Court
Forebay
River
Delta
Mendota
Canal
Calif. Aqueduct
Tracy
Legend
Canal Section
Flow Control Structure
Pumping Plant
Channel Enlargement

o **Timing**

This plan, coupled with the Peripheral Canal, is a long-term, and not interim, alternative.

o **Conclusion**

Although this alternative supports the project purposes, it does not satisfy the timing for an interim project. Therefore, this alternative is not retained for second-stage evaluation.

Dredging South Delta Water Agency Channels

o **Description**

This proposed alternative would dredge all of the SDWA channels in an effort to (1) satisfy SWDA concerns regarding water levels and circulation in the channels, and (2) enable more water to reach Clifton Court Forebay.

o **Benefits**

Enlarging the channels would create the ability to transfer a larger volume of water in the channels, and the deeper channels would allow irrigators in the Delta that use siphons to lower their intakes, which would improve performance. For those farmers that use pumps, the deeper channels would decrease the chance of pump intakes becoming exposed, decreasing the chance of pump damage, because of increased conveyance and channel storage. The DWR Delta hydrodynamics model does not indicate an improvement in circulation resulting from the proposed dredging.

o **Project Purposes**

This alternative by itself does not meet either of the project purposes. It would have to be combined with other features, such as a water transfer system and channel flow control structures, to be considered further.

o **Timing**

Timing to perform extensive dredging under restrictive dredge windows impacts logistics for this alternative. It could take many years to complete dredging operations on the 75 miles of SDWA channels.

o **Conclusion**

Since this alternative does not meet either of the project purposes, and could take many years, it is not retained for second-stage evaluation.

Pay for Agricultural Pump Damage in the South Delta

o **Description**

The action is compensation. It is not a physical (engineering) solution. Damage to pumps caused by low water levels would be compensated by paying for repairs or replacement. Risk exists that during irrigation season, pumps could fail and crops be lost. Full impacts cannot be

C—087198

C-087198

calculated.

o **Benefits**

The only benefit from this plan would be monetary relief for damaged pumps. It still will disrupt agricultural operations in the SDWA area.

o **Project Purposes**

This alternative does nothing to satisfy the first project purpose of improving water levels and circulation, and only partially compensates for losses. It would also not resolve the present litigation action, nor satisfy the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant).

o **Timing**

Timing would not be a problem for this alternative.

o **Conclusion**

Since this alternative does not fulfill either project purpose, and would also not resolve the present litigation action, it is not a viable alternative, and is not retained for second-stage evaluation.

Treatment of Local Agricultural Drainage Water

o **Description**

This proposed alternative would entail constructing an agricultural drainage water collection and treatment system for the islands in the SDWA area. As noted in Chapter 2 of this report, about 120,000 acres in south Delta are in irrigated agriculture. The estimated annual drainage is 1.32 AF/acre of agricultural land. The treatment systems considered would be required to remove total dissolved solids (TDS), pesticides, organics and other contaminants from the agricultural drainage water. The treated water could then be reused for crop irrigation or discharged into the Delta channels.

The removal of these constituents could be accomplished by various treatment process options. The following options have been studied for this alternative analysis.

1. Sedimentation Ponds with Filtration

Under this option, the drainwater would be collected and discharged into sedimentation ponds for the removal of suspended solids and organics. Coagulants would be added to enhance removal. Following sedimentation, the drainwater would be processed through a filtration system to remove additional solids and organics.

2. Activated Carbon Filters

Under this option, the drainwater would be processed through filters which use granular and powdered activated carbon as the filter media. There is not enough information on the effectiveness of this process in treating agricultural drainage water, but this process has been found

C—087199

C-087199

to be most effective in removing organic compounds.

3. Desalination

Desalting can be accomplished by various methods, i.e., condensation and reverse osmosis. Desalination in the United States is accomplished by reverse osmosis simply because of the higher cost of the condensation process. In reverse osmosis, the drainwater would be processed through semi-permeable membranes, removing TDS and the other contaminants from the drainwater.

o Benefits

The removal of the referenced constituents would improve water quality and provide an additional source of irrigation water in the area. The treated effluent would be at an acceptable level for reuse on irrigated land and/or discharge back into the channel.

o Project Purposes

Although this project has the potential of providing benefits to agriculture, it does not fulfill either of the project purposes.

o Timing

This alternative could probably be accomplished within 5 to 7 years.

o Conclusion

This alternative is not retained for second-stage evaluation, because it does not fulfill either of the project purposes.

Pumping Water From Clifton Court Forebay to a Portion of SDWA Agricultural Users

o Description

This alternative proposes to pump water out of Clifton Court Forebay to the many SDWA agriculture users on the Delta islands. As a minimum, there would need to be a pipeline installed on both sides of Old River from Clifton Court Forebay to Upper Roberts Island. In addition, there would be many distribution service lines throughout the south Delta.

o Benefits

The delivery of water from Clifton Court Forebay to SDWA agricultural users would eliminate, or reduce, agricultural pumping from the channels, thereby eliminating or reducing problems of fish entrainment at individual agricultural pump intakes. However, there would be an increase in water drawn into Clifton Court Forebay and pumped back out to the local irrigators. This would increase fish predation at the forebay and cause fish entrainment at the new pump intakes.

o Project Purposes

This alternative would not satisfy either of the project purposes.

o **Timing**

This alternative could probably be accomplished within 5 to 7 years.

o **Conclusion**

Since this alternative would not satisfy either of the project purposes, it is not retained for second-stage evaluation.

Delta-Mendota Canal/Westley Wasteway Plan

o **Description**

This proposed project (Figure 4-3) was one of several alternative water distribution plans that would work in conjunction with the Peripheral Canal. The Peripheral Canal would provide the water for distribution throughout the southern Delta to improve water supply and circulation, and would give a net downstream flow in the major channels used by migrating fish. The plan is discussed in DWR "Alternative Report Southeast Delta Water Control Facilities", April 20, 1976 and its November 8, 1977 supplement.

The basic plan consists of a 700 cfs pumping plant in Middle River about three miles upstream of the Peripheral Canal to convey water up-river, channel enlargement downstream of the pumping plant, a San Joaquin River flow control structure, and some channelization below the end of Westley Wasteway to the San Joaquin River. A small steady flow of water would be pumped out of the Peripheral Canal to flow up the Middle River for distribution in the southeast Delta. This would be supplemented by releases from the Delta-Mendota Canal into the San Joaquin River via the Westley Wasteway, which would be in the order of 1,500 cfs.

o **Benefits**

This plan, *when coupled with the Peripheral Canal*, would improve the water level and circulation in the south Delta.

o **Project Purposes**

This plan, *when coupled with the Peripheral Canal*, would improve water levels and circulation patterns, thus furthering the first project purpose. It would also support the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant) by decreasing entrainment of fish.

o **Timing**

This plan must be coupled with the Peripheral Canal to be implemented. Since it is a long-term, and not an interim alternative, it cannot be completed within 5 to 7 years.

o **Conclusion**

Although this alternative supports the project purposes, it does not satisfy the timing for an interim project. Therefore, this alternative is not retained for second-stage evaluation.

C—087201

C-087201

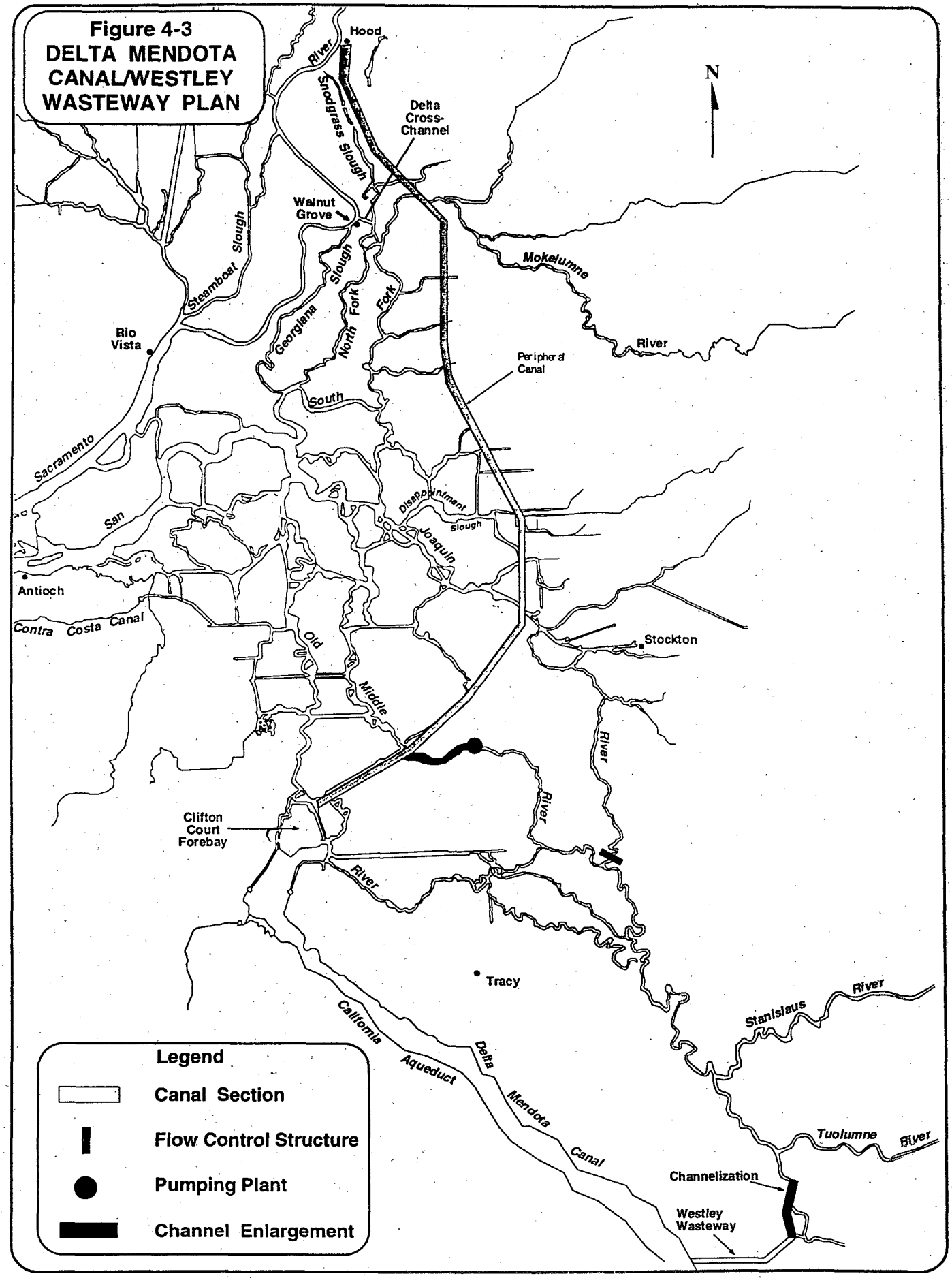


Figure 4-3
DELTA MENDOTA CANAL/WESTLEY WASTEWAY PLAN
N
Hood
Delta Cross-Channel
Snodgrass Slough
Walnut Grove
Steamboat Slough
Georgiana Slough
North Fork
South Fork
Mokelumne River
Rio Vista
Peripheral Canal
Sacramento
San Joaquin
Disappointment Slough
Antioch
Contra Costa Canal
Old
Middle
River
Stockton
Clifton Court Forebay
Tracy
California Aqueduct
Delta Mendota Canal
Stanislaus River
Tuolumne River
Channelization
Westley Wasteway
Legend
Canal Section
Flow Control Structure
Pumping Plant
Channel Enlargement

Reduce San Joaquin River Agricultural Drainage

o **Description**

Current agricultural drainage conditions on the west side of the San Joaquin Valley present three basic problems: (1) salt balance; (2) water balance; and (3) toxic, or potentially toxic, trace elements in subsurface agricultural drainage. In mid-1984, USBR, USF&WS, USGS and DFG formed the San Joaquin Valley Drainage Program (SJVDP) to investigate drainage problems and identify possible solutions. The four goals of the SJVDP are to: (1) minimize potential health risks associated with subsurface agricultural drainage water; (2) protect existing and future reasonable and beneficial uses of surface and ground water from impacts associated with drainage water; (3) protect, restore, and improve valley fish and wildlife resources; and (4) sustain the productivity of farm land on the west side of the San Joaquin Valley.

In 1987, the SJVDP narrowed its focus on planning alternatives for solving drainage problems to measures that could be taken within the valley itself. In 1989, the SJVDP published a report on preliminary planning alternatives, which would consist of combinations of drainage management strategies falling into seven categories: (1) source control to reduce drainage from individual farms; (2) management of shallow water tables by pumping; (3) treatment of drainage water; (4) reuse of drainage water; (5) disposal of drainage water in the valley; (6) fish and wildlife measures; and (7) institutional changes.

Drainage water reduction and disposal methods include irrigation improvements, reuse of drainage water for propagation of eucalyptus trees and saltbush, and limited drainage water storage in ground water and disposal in evaporation ponds. The alternative also involves actions to protect public health and to protect and restore fish and wildlife, including provision of fresh water supplies conserved from irrigation improvements for use on existing wetlands and wildlife areas.

DWR is collecting and preparing studies on reuse and disposal of agricultural drainage water in the SWP service area. Analyses emphasize trace elements, such as selenium and arsenic, because of their potential adverse effects on water supplies and the environment.

o **Benefits**

Benefits would be improved water quality and fisheries.

o **Project Purposes**

This alternative would not satisfy either of the project purposes.

o **Timing**

This alternative needs further development. However, it is likely that solutions to several of the planning alternatives listed above could be implemented in a 5- to 7-year period.

o **Conclusion**

Since this alternative would not satisfy either of the project purposes, and does not fit into the interim time frame, it is not retained for further evaluation.

C—087203

C-087203

Reduce CVP/SWP Export

o **Description**

This alternative would reduce the amount of water going to municipal, industrial, and agricultural users in the SWP service areas. Average pumping at the Banks Pumping Plant ranges from 3800 cfs to 5000 cfs from April through September. Average pumping at Tracy Pumping Plant ranges from 3200 cfs to 4000 cfs from July through September. Computer simulation analysis was done assuming 500 cfs at Banks and 1000 cfs at Tracy for April through September. Delta water levels increased 0.10 foot in April, 0.25-0.35 feet in July, and 0.10-0.20 feet in September. For all locations except one, salinity remains the same or increases when pumping is reduced.

o **Benefits**

This alternative would reduce fish losses, because of less pumping. Export reduction would reduce reverse flow.

o **Project Purposes**

Other programs to hold down demands for pumping, such as water transfers and better water use, are already in place or are being developed. This alternative does not meet the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant), and only goes a little way toward meeting the first (to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions).

o **Timing**

Timing is not a problem with this alternative.

o **Conclusion**

Since this alternative does not satisfactorily meet either of the project purposes, it is not retained for second-stage evaluation.

Increase San Joaquin River Flow

o **Description**

This alternative could consist of any one, or several, of a number of proposed programs. Programs that have been proposed include reallocating New Melones Reservoir water supplies, conjunctive use of Stanislaus and Calaveras River supplies, changing San Joaquin Valley land use, and purchasing Turlock and Modesto Irrigation District water. Each of these plans could improve the south Delta water situation and has been studied or is being studied in other programs. New Melones Reservoir water is presently being used, when available, on a temporary basis to improve water quality and fisheries in the lower San Joaquin River.

o **Benefits**

Any plan to increase water supply to the lower San Joaquin River and south Delta would be beneficial. The degree of benefit depends on the amount of water and time of availability, and the

reliability of the source. The area benefiting the most would be the lower San Joaquin and southeastern Delta.

o **Project Purposes**

Any of these programs related to increasing San Joaquin River flow could affect water levels and circulation in the south Delta, but the effects are not known at this time.

o **Timing**

The complexity of implementing any of these programs related to increasing San Joaquin River flow means implementation could take many years, which prevents the timely determination of impacts on the present Delta problems. The immediate needs of the south Delta would not be satisfied by this alternative.

o **Conclusion**

Many upstream water supply plans have merit and could provide emergency water supply in times of need. There are also complex issues that would need to be addressed, such as existing water commitments, CVPIA provisions, Endangered Species Act impacts, the December 15, 1994 Accord, and ongoing fishery negotiations. For this reason, investigations should continue on these programs, but the immediate needs of the south Delta would not be satisfied by this alternative and it is not retained for second-stage screening.

SOUTH DELTA WATER MANAGEMENT ALTERNATIVES

The following alternatives focus on satisfying the second project purpose through physical changes in the south Delta area: to improve South Delta hydraulic conditions to increase diversion into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant. In some cases, components have been combined in an effort to be complimentary and accomplish the project purposes. These alternatives are considered as interim solutions to meet the short-range goals of Governor Wilson's water policy. Permanent long-range alternatives are discussed in the next section.

Northern Forebay Intake with Limited Channel Dredging

o **Description**

This alternative uses the existing Clifton Court Forebay, but includes a new 6-gate intake structure of 30,000 cfs maximum capacity located in the northeast corner of the forebay (Figure 4-4). The existing intake would be retained for operational flexibility.

Some limited channel dredging would be required to assure greater flow capacity, therefore lower velocity of the water, so that channel scouring would not occur. This dredging would be in reaches of Old River north of the Forebay to Woodward Canal. The dredging would increase the average channel depth by around five feet and would not be done in sections that affect the stability of channel islands or levees. The dredging would only be done in areas of potential scour. An existing scour monitoring program would be expanded to protect against excessive scouring. A seepage monitoring plan would be implemented to check for seepage resulting from dredging exposing sand lenses near the channel.

o **Benefits**

The northern intake would increase intake capacity to the forebay and allow more water to be taken at more preferable high tide periods (when fishery impacts are less near the forebay). Channel dredging would increase channel capacity and improve conveyance, thus allowing more SWP operational flexibility.

o **Project Purposes**

This alternative would help satisfy the second project purpose, to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant.

o **Timing**

This alternative can be accomplished in a relatively short time (5 to 7 years), appropriate for an interim project.

o **Conclusion**

Since this alternative would help satisfy the second project purpose and would be timely, it is retained for further evaluation in combination with other alternatives.

Northern Forebay Intake, Limited Channel Dredging, and South Delta Flow Control Structures

o **Description**

With this alternative, Clifton Court Forebay would retain its present area of 2,100 acres (Figure 4-5). A multigate intake structure, with about 6 gates, is proposed for the northeastern corner of the existing Clifton Court Forebay near the confluence of Old River and Victoria and North Canals. This additional intake would be operated according to tidal water elevations to increase peak forebay diversions from 12,000 cfs to over 30,000 cfs for short periods. The existing gate structure, located at the southeastern corner of the Forebay, would be kept operable and used according to changing conditions. The pumping rate at Banks Pumping Plant would go up to 10,300 cfs. The limitations established by the Endangered Species Act would limit pumping rates to a great extent.

Some limited channel dredging would be required to assure greater flow capacity, therefore lower velocity of the water, so that channel scouring would not occur. This dredging would be in

C—087206

C-087206

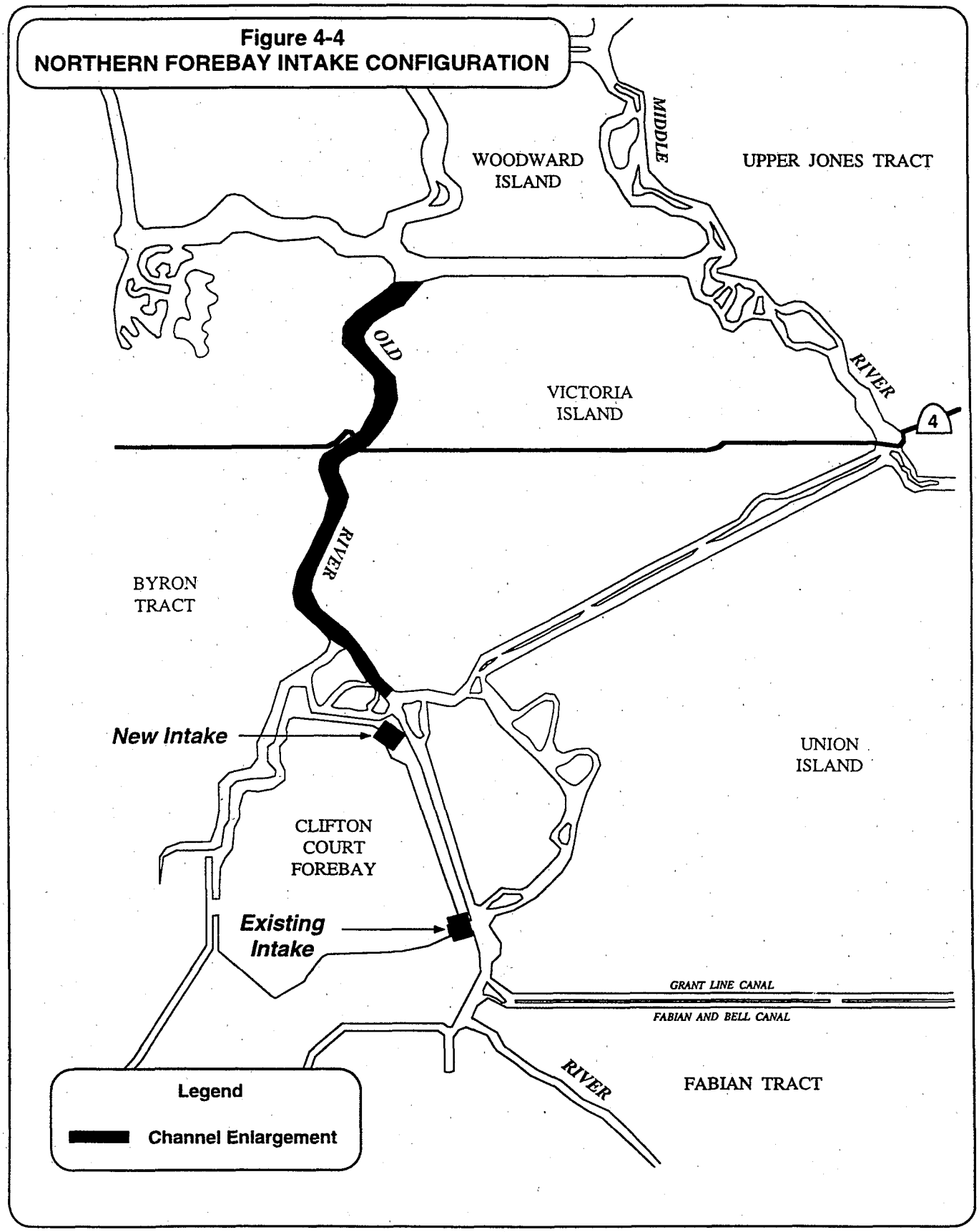


Figure 4-4
NORTHERN FOREBAY INTAKE CONFIGURATION
WOODWARD ISLAND
MIDDLE
UPPER JONES TRACT
OLD
RIVER
VICTORIA ISLAND
4
RIVER
BYRON TRACT
New Intake
UNION ISLAND
CLIFTON COURT FOREBAY
Existing Intake
GRANT LINE CANAL
FABIAN AND BELL CANAL
RIVER
FABIAN TRACT
Legend
Channel Enlargement

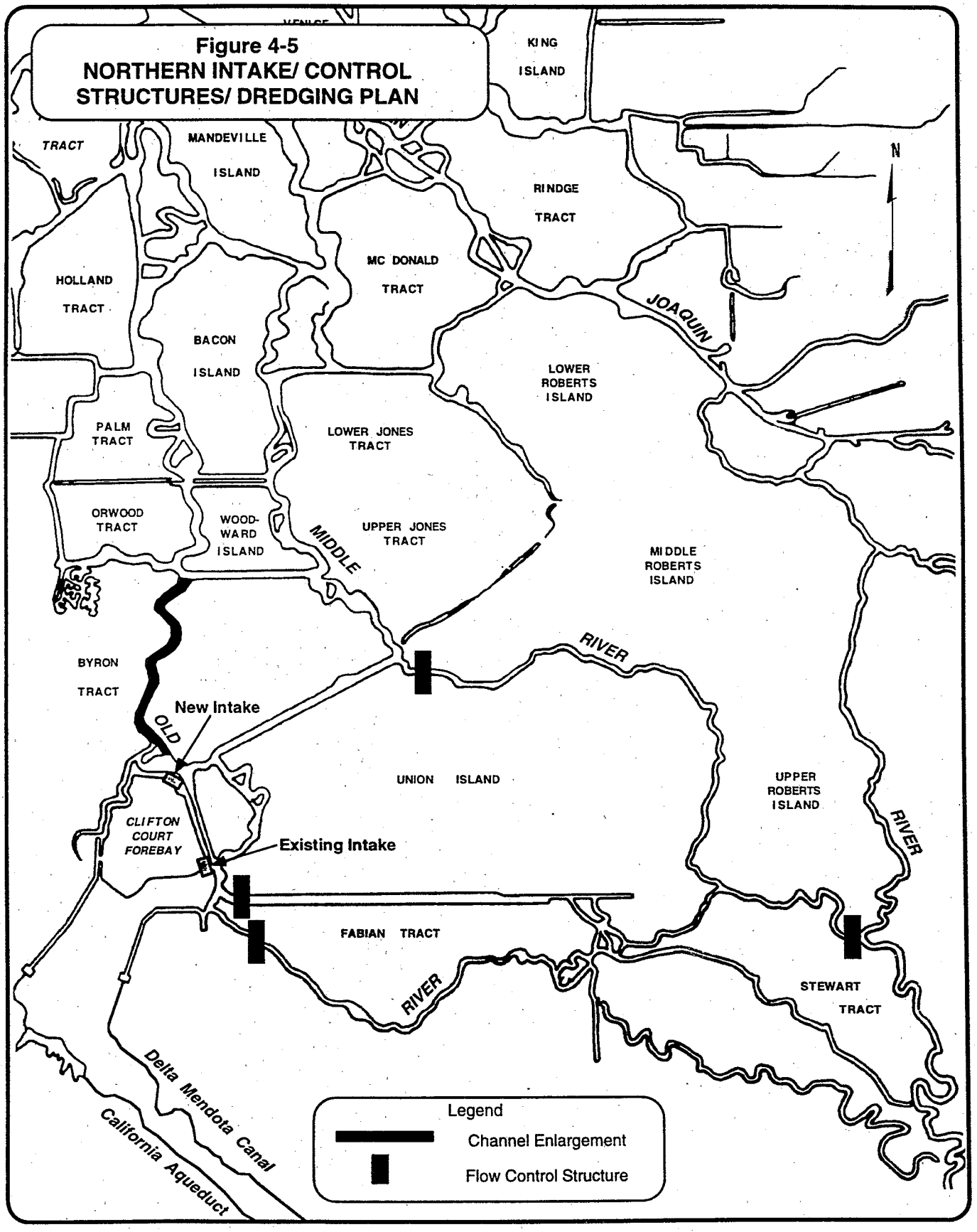


Figure 4-5
NORTHERN INTAKE/ CONTROL STRUCTURES/ DREDGING PLAN
KING ISLAND
TRACT
MANDEVILLE ISLAND
RINDGE TRACT
N
HOLLAND TRACT
MC DONALD TRACT
JOAQUIN
BACON ISLAND
LOWER ROBERTS ISLAND
PALM TRACT
LOWER JONES TRACT
ORWOOD TRACT
WOOD-WARD ISLAND
MIDDLE
UPPER JONES TRACT
MIDDLE ROBERTS ISLAND
RIVER
BYRON TRACT
New Intake
OLD
UNION ISLAND
UPPER ROBERTS ISLAND
CLIFTON COURT FOREBAY
Existing Intake
RIVER
FABIAN TRACT
RIVER
STEWART TRACT
Delta Mendota Canal
California Aqueduct
Legend
Channel Enlargement
Flow Control Structure

reaches of Old River north of the Forebay to Woodward Canal. The dredging would increase the average channel depth by around five feet and would not be done in sections that affect the stability of channel islands or levees. The dredging would only be done in areas of potential scour. An existing scour monitoring program would be expanded to protect against excessive scouring. A seepage monitoring plan would be implemented to check for seepage resulting from dredging exposing sand lenses near the channel.

Four flow control structures would be installed in south Delta channels to control water levels, circulation and San Joaquin River flow. A separate federal regulatory permit would be requested after final approval of the SDWA settlement agreement.

The locations are: (1) Old River east of Delta-Mendota Canal (DMC) intake; (2) Middle River south of the confluence with Trapper Slough and North Canal; (3) Grant Line Canal east of the Forebay; and (4) Old River just west of its confluence with the San Joaquin River. The control structures would have gates or flashboards which would be raised or removed to assure that channel flood capacity was maintained. Also, channel navigation would be provided by boat locks or portage systems.

The control structure on Old River near the San Joaquin would be operated in the fall and spring to help salmon migrating in the San Joaquin River. During other times of the year, this structure would not alter flows. The other three control structures would be tidally operated during the irrigation season. Operations would retain high tides in south Delta channels for a longer period of time to raise water levels. During other times of the year, these control structures would be open and not affect local hydrology.

- **Benefits**

This alternative would allow more flexibility in daily SWP diversion patterns because of the increased intake capacity and a more northerly location. By including the flow control structures, it would improve water levels and circulation patterns in the SDWA channels. The increased pump capacity would allow a shift in seasonal exports, to the benefit of the fishery. A flow control structure at the head of Old River could benefit the San Joaquin River fishery. Dredging of channels north of the new intake would increase water circulation and carrying capacity, and reduce impact of pumping on local water levels.

- **Project Purposes**

As noted above, this alternative combines features to satisfy both of the project purposes.

- **Timing**

This alternative can be accomplished in 5 to 7 years, appropriate for an interim project.

- **Conclusion**

Since it meets project purposes and timing criteria, this alternative is retained for evaluation in the second-stage screening.

C—087209

C-087209

Channel Enlargement, South Delta Flow Control Structures, and Expanded Existing Intake

o **Description**

With this alternative (see Figure 4-6), the existing Clifton Court Forebay intake would be expanded to accommodate the additional flow, instead of constructing a new intake either at Italian Slough or at the northeastern corner of Clifton Court Forebay. The maximum capacity of the expanded intake would be 30,000 cfs. The base width of the new channel would have to be increased from its present width of 300 feet to 560 feet, to maintain the average velocity below three feet per second. The south-east levee along the existing approach channel would have to be relocated approximately 260 feet inland. A 230 kV transmission line and a portion of the southern forebay embankment would also have to be relocated. A building housing the controls for the facility would be placed between the two gate structures. It is anticipated that enlargement of West Canal would be required to maximize the full pumping capacity at Banks Pumping Plant and avoid scouring the channel.

Some limited channel dredging would be required to assure greater flow capacity, therefore lower velocity of the water, so that channel scouring would not occur. This dredging would be in reaches of Old River north of the Forebay to Woodward Canal. The dredging would increase the average channel depth by around five feet and would not be done in sections that affect the stability of channel islands or levees. The dredging would only be done in areas of potential scour. An existing scour monitoring program would be expanded to protect against excessive scouring. A seepage monitoring plan would be implemented to check for seepage resulting from dredging exposing sand lenses near the channel.

o **Benefits**

The expanded intake would increase intake capacity to the forebay and reduce the impacts to south Delta water levels caused by the gate operation by allowing more water to be taken at more preferable high tide periods. Channel dredging would increase channel capacity and improve conveyance, thus allowing more SWP operational flexibility.

o **Project Purposes**

This alternative supports both of the project purposes.

o **Timing**

This alternative fits within an interim time frame.

o **Conclusion**

This alternative supports the project purposes and fits within an interim time frame, and it is therefore included in the second-stage evaluation.

Enlarge Clifton Court Forebay

Increasing the forebay size would add increased flexibility to SWP operations. Several forebay-enlargement single-component plans are being examined. A variety of combinations of expanding the forebay to various islands can be studied and compared. A few of the more obvious combinations that roughly double the forebay size are discussed below.

C—087210

C-087210

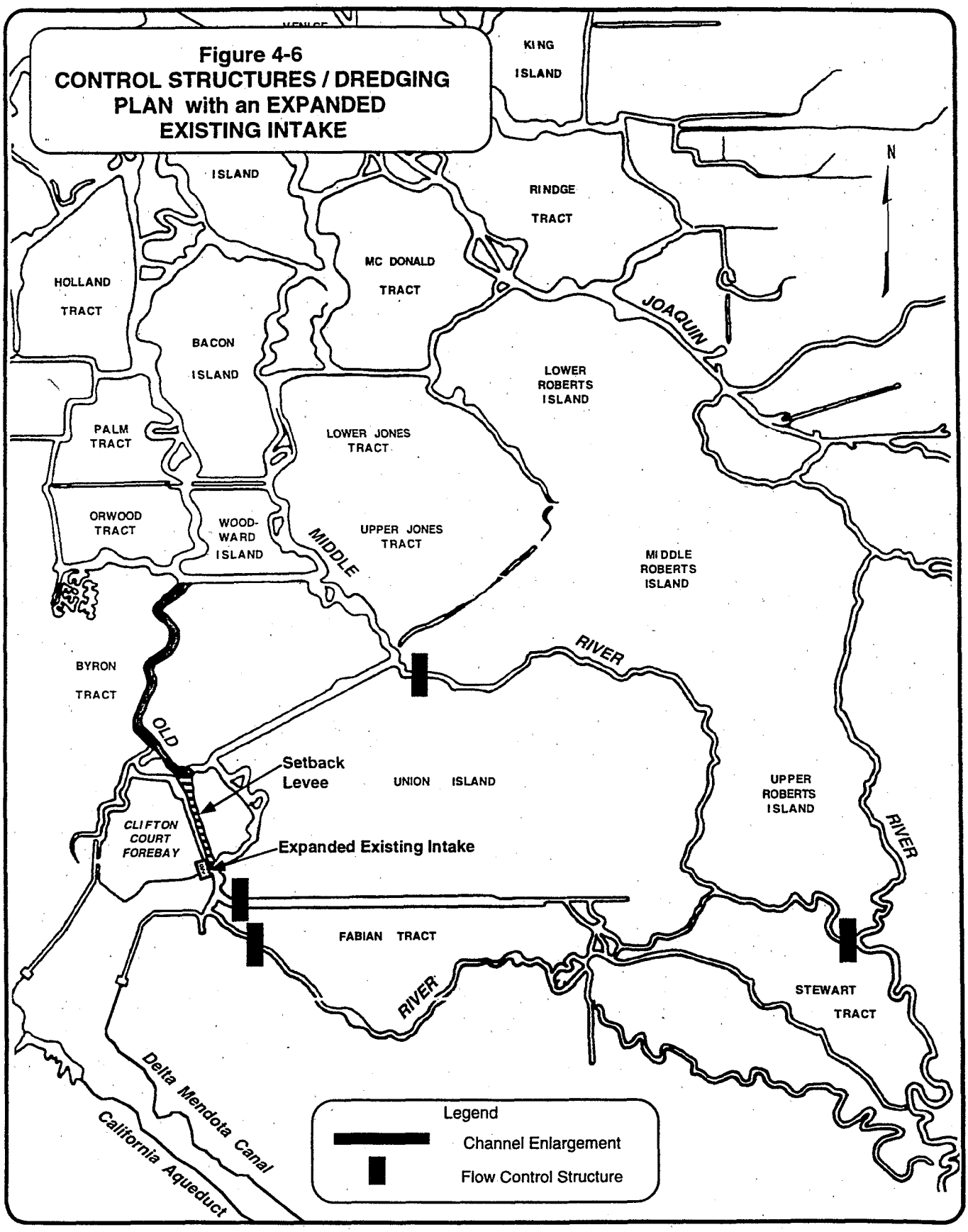


Figure 4-6
CONTROL STRUCTURES / DREDGING PLAN with an EXPANDED EXISTING INTAKE

Enlarge Clifton Court Forebay with Byron Tract

o **Description**

The Byron Tract forebay expansion would approximately double the forebay area and storage capacity for better pumping flexibility, and would have a larger and more northerly intake location to minimize the impact of gate operation on south Delta water levels and to access better quality water. The existing intake would be retained for operational flexibility. The hydraulic impacts of an enlarged forebay are based on the intake gate location and surface area of the forebay rather than on the configuration of lands used. Siphons would be used to hydraulically connect the existing forebay to the expanded forebay.

The Byron Tract forebay expansion would incorporate about 3,100 acres and would be along Highway 4 on the north, Old River and Italian Slough on the east, and an existing 500 KV power transmission line on the west. A new gated intake structure would be located in the northeast corner near Highway 4, and a siphon across Italian Slough would connect the forebay to the northwest corner of Clifton Court (Figure 4-7).

The new intake structure, with a capacity of 30,000 cfs, would require channel enlargement along the reach of Old River between Highway 4 and Woodward Canal for about 2.5 miles to enable the channel to transfer the flow without exceeding the desired maximum velocity.

o **Benefits**

There would be more flexibility in daily SWP diversion patterns, which would improve water levels somewhat in south Delta channels. Moving and enlarging the intake locations farther north, away from the southern Delta channels, would help raise average water levels slightly in Old River and Grant Line Canal, and improve the quality of the water going into Clifton Court Forebay.

o **Project Purposes**

Delta channels north of the existing intake gates have larger cross-sectional areas than those in the south Delta. Improving the forebay and increasing the capacity of the channels to the north would allow more water to be diverted at high tides and less at low tides. As a single component alternative, this plan, by itself, satisfies the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant), and could be combined with other alternatives to satisfy the first (to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions).

o **Timing**

This alternative can be accomplished in a relatively short time (5 to 7 years), appropriate for an interim project.

o **Conclusion**

This alternative is combined with other alternatives in subsequent alternative evaluations.

C—087212

C-087212

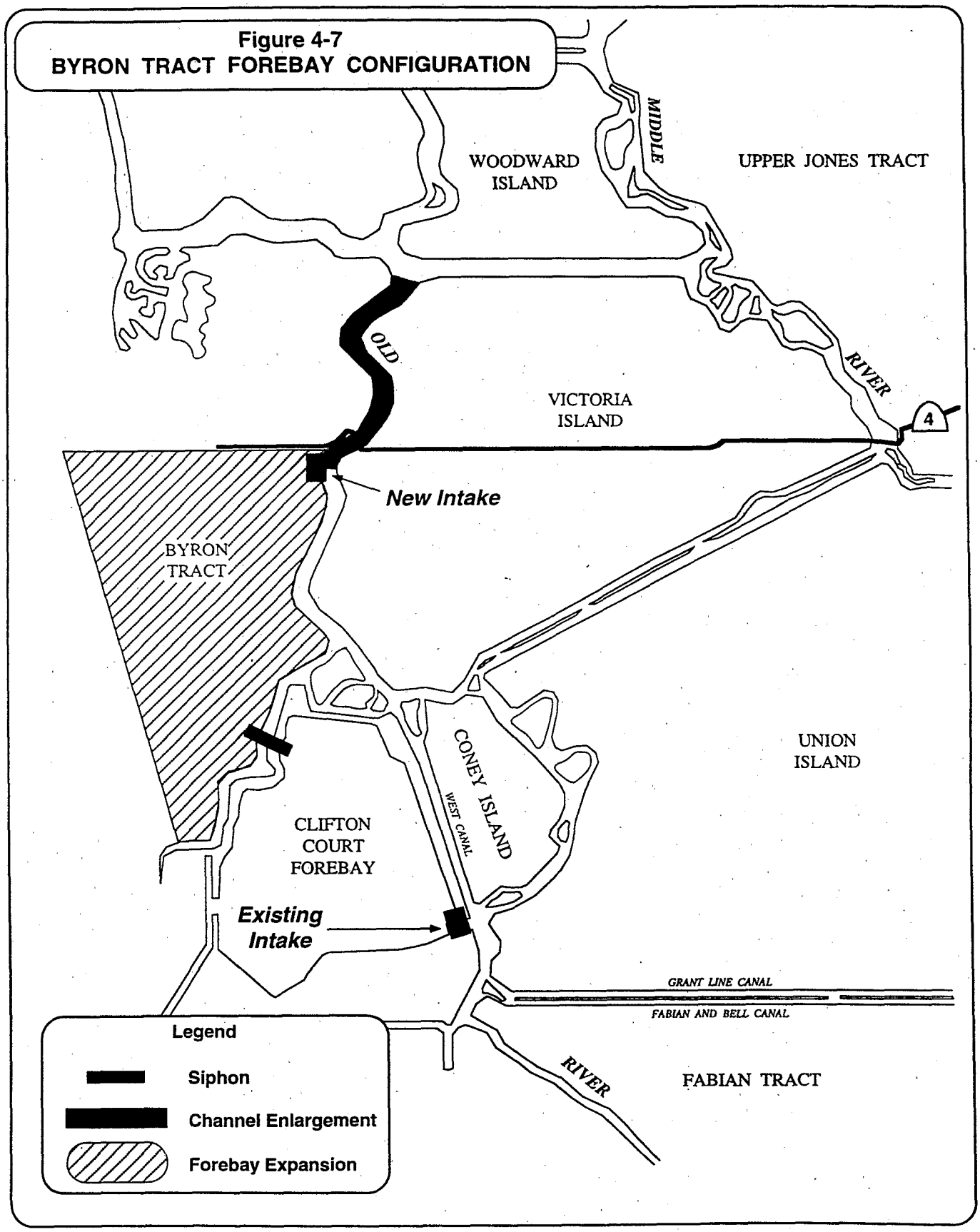


Figure 4-7
BYRON TRACT FOREBAY CONFIGURATION
WOODWARD ISLAND
MIDDLE
UPPER JONES TRACT
OLD
RIVER
VICTORIA ISLAND
4
New Intake
BYRON TRACT
CONEY ISLAND
WEST CANAL
UNION ISLAND
CLIFTON COURT FOREBAY
Existing Intake
GRANT LINE CANAL
FABIAN AND BELL CANAL
RIVER
FABIAN TRACT
Legend
Siphon
Channel Enlargement
Forebay Expansion

Enlarge Clifton Court Forebay With North Victoria Island

o **Description**

The objectives and conditions mentioned in the Byron Tract forebay expansion are also applicable for North Victoria Island forebay expansion. Clifton Court Forebay would be enlarged from 2,100 surface acres to more than 5,000 surface acres. The northwest portion of Victoria Island and the remaining area of Clifton Court Tract would be used to enlarge the forebay. The southeast portion of Byron Tract would be used to hydraulically connect the existing forebay to the new area. One siphon structure between Byron Tract and Victoria Island would be used to hydraulically connect the expanded forebay areas (Figure 4-8--Option A).

An option to the siphon would be a transfer channel crossing the southern part of the island, connecting the southwest corner of the new forebay to the northeast corner of Clifton Court Forebay. This canal would require a bridge on Highway 4 and a siphon under Old River before connecting to Clifton Court. The transfer canal would have a capacity of 18,000 cfs and would be about two miles in length (Figure 4-8--Option B).

Two intake structures would be needed for the new forebay; a 15,000 cfs capacity structure at the northwest corner at the Old River-North Victoria Canal juncture, and a 30,000 cfs structure at the northeast corner at Middle River-North Victoria Canal juncture. The existing intake would be retained for operational flexibility. Channel enlargement by levee setback might be required in Middle River between Woodward Canal and about one-half mile south of the AT&SF Railroad crossing.

o **Benefits**

This alternative would have the benefit of having intakes located farther north than the other forebay alternatives. This feature would allow access to better quality water; also, it would have somewhat less impact on south Delta water levels. As with any forebay, there would be more flexibility in daily SWP diversion patterns.

o **Project Purposes**

Delta channels north of the existing intake gates have larger cross-sectional areas than those in the south Delta. Improving the forebay and increasing the capacity of the channels to the north would allow more water to be diverted at high tides and less at low tides. As a single component alternative, this plan, by itself, satisfies the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant), and could be combined with other alternatives to satisfy the first (to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions).

o **Timing**

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o **Conclusion**

This alternative is combined with others in subsequent alternative evaluations.

C—087214

C-087214

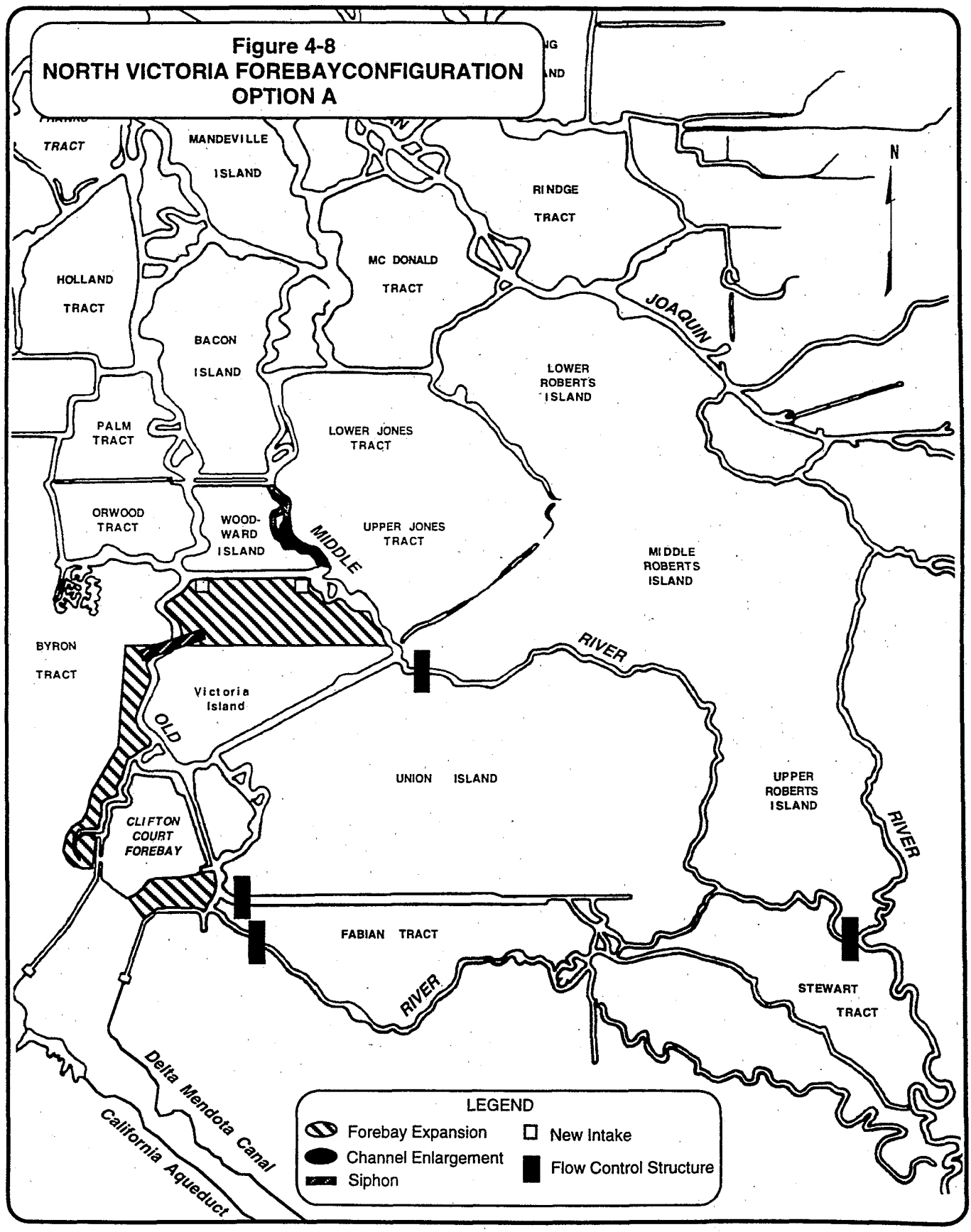


Figure 4-8
NORTH VICTORIA FOREBAYCONFIGURATION
OPTION A
TRACT
MANDEVILLE
ISLAND
RINDGE
TRACT
N
HOLLAND
TRACT
MC DONALD
TRACT
JOAQUIN
BACON
ISLAND
LOWER
ROBERTS
ISLAND
PALM
TRACT
LOWER JONES
TRACT
ORWOOD
TRACT
WOOD-
WARD
ISLAND
MIDDLE
UPPER JONES
TRACT
MIDDLE
ROBERTS
ISLAND
BYRON
TRACT
RIVER
Victoria
Island
OLD
UNION ISLAND
UPPER
ROBERTS
ISLAND
RIVER
CLIFTON
COURT
FOREBAY
FABIAN TRACT
RIVER
STEWART
TRACT
Delta Mendota Canal
California Aqueduct
LEGEND
Forebay Expansion
Channel Enlargement
Siphon
New Intake
Flow Control Structure

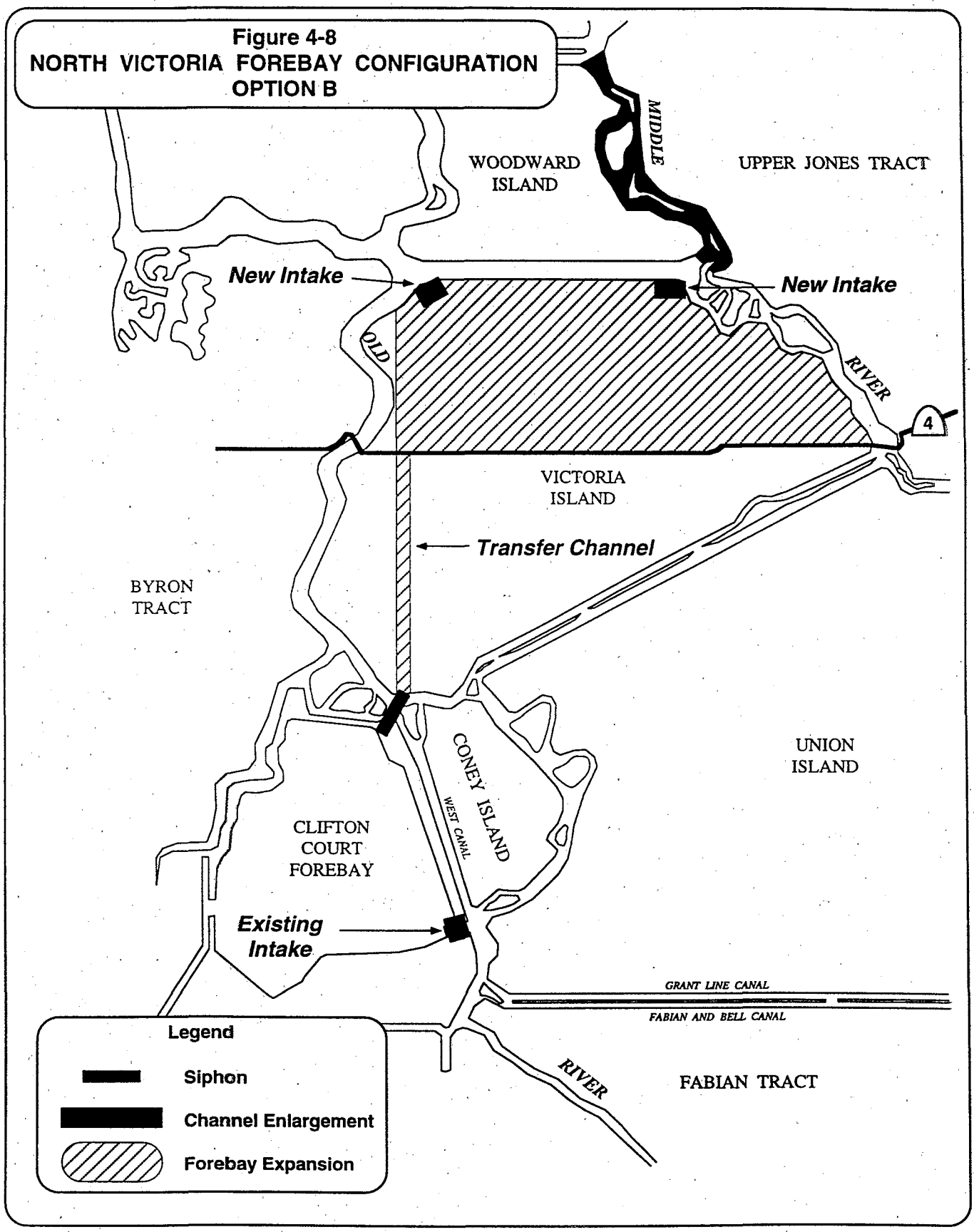


Figure 4-8
NORTH VICTORIA FOREBAY CONFIGURATION
OPTION B
MIDDLE
WOODWARD ISLAND
UPPER JONES TRACT
New Intake
New Intake
OLD
RIVER
4
VICTORIA ISLAND
Transfer Channel
BYRON TRACT
UNION ISLAND
CONEY ISLAND
WEST CANAL
CLIFTON COURT FOREBAY
Existing Intake
GRANT LINE CANAL
FABIAN AND BELL CANAL
RIVER
FABIAN TRACT
Legend
Siphon
Channel Enlargement
Forebay Expansion

Enlarge Clifton Court Forebay with South Victoria Island

o Description

The objectives and conditions mentioned in the Byron Tract forebay expansion are also applicable for a South Victoria Island forebay expansion. The forebay would cover about 3,700 acres of the southern part of Victoria Island, and would be about 30 percent larger than the northern alternative site. The limits of the new forebay would be Highway 4 on the north, Victoria Canal on the southeast side, and Old River on the west. A siphon under Old River would connect the new forebay with Clifton Court. Two intake structures would be needed for the new forebay; one on Old River at Highway 4, and another on Middle River near Highway 4. The existing intake would be retained for operational flexibility. Dredging might be required in Old River to satisfy the 15,000 cfs intake capacity. Levee setback would be required on Middle River for about two miles to increase the channel capacity to satisfy the 30,000 cfs intake capacity there. The Middle River channel work would be between Highway 4 and North Victoria Canal (Figure 4-9).

o Benefits

There would be more flexibility in daily SWP diversion patterns, which would improve water levels somewhat in south Delta channels. Moving and enlarging the forebay intakes farther north, away from the southern Delta channels, would help improve average water levels slightly in Old River and Grant Line Canal, but circulation would not improve much.

o Project Purposes

Delta channels north of the existing intake gates have larger cross-sectional areas than those in the south Delta. Improving the forebay and increasing the capacity of the channels to the north would allow more water to be diverted at high tides and less at low tides. As a single component alternative, this plan, by itself, satisfies the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant)), and could be combined with other alternatives to satisfy the first (water levels and circulation).

o Timing

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o Conclusion

By itself, this alternative does not satisfy both of the project purposes, but could be combined with some other alternative to do so. This is done in subsequent alternative evaluations.

Enlarge Clifton Court Forebay with Coney Island

o Description

The objectives and conditions mentioned in the Byron Tract forebay expansion are also applicable for the Coney Island forebay expansion. The forebay formed would be 900 acres. The Coney Island forebay expansion would connect to Clifton Court Forebay by a siphon. It would receive its water from Clifton Court. A little over five miles of embankment would be needed around the island (Figure 4-10).

C—087217

C-087217

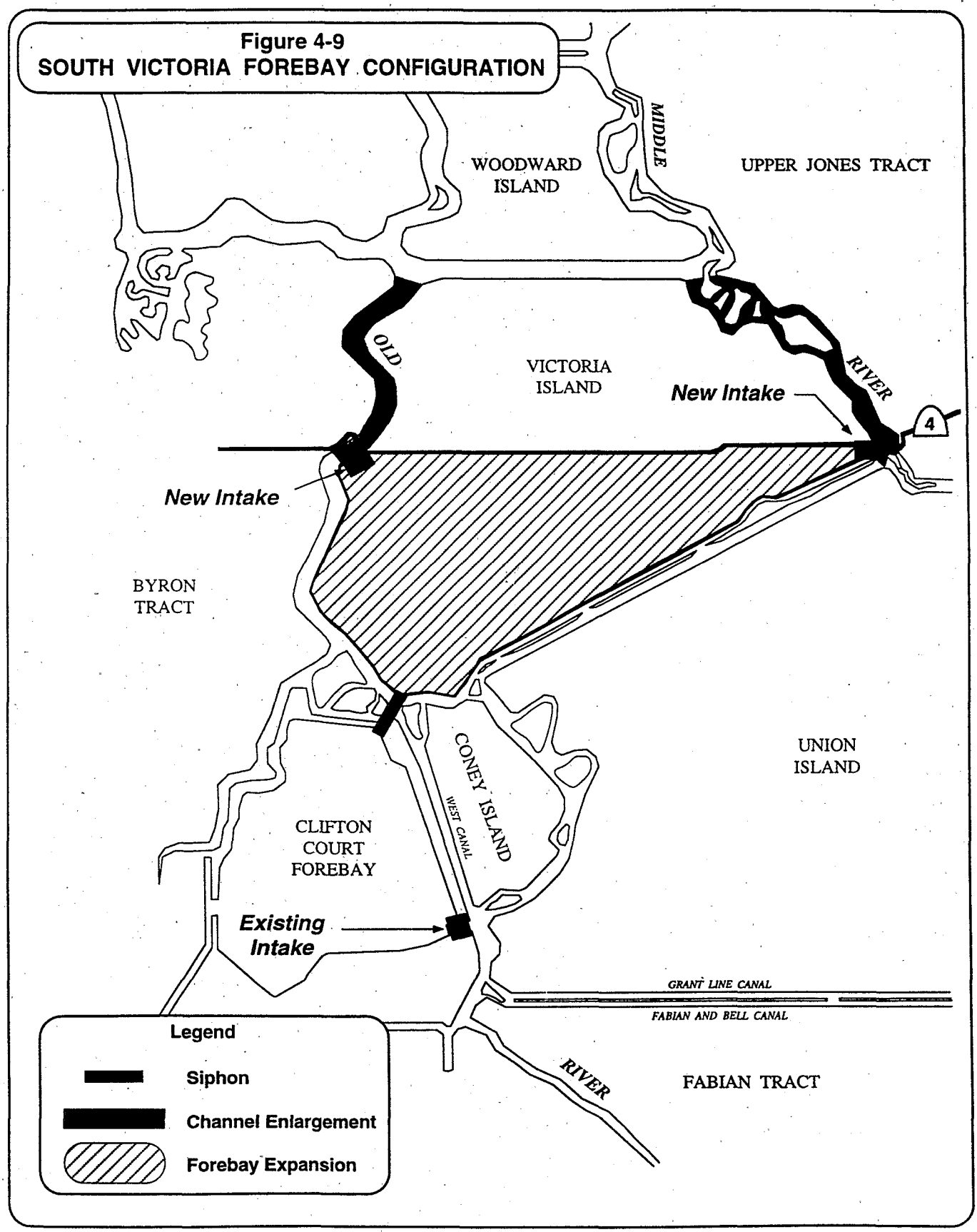


Figure 4-9
SOUTH VICTORIA FOREBAY CONFIGURATION

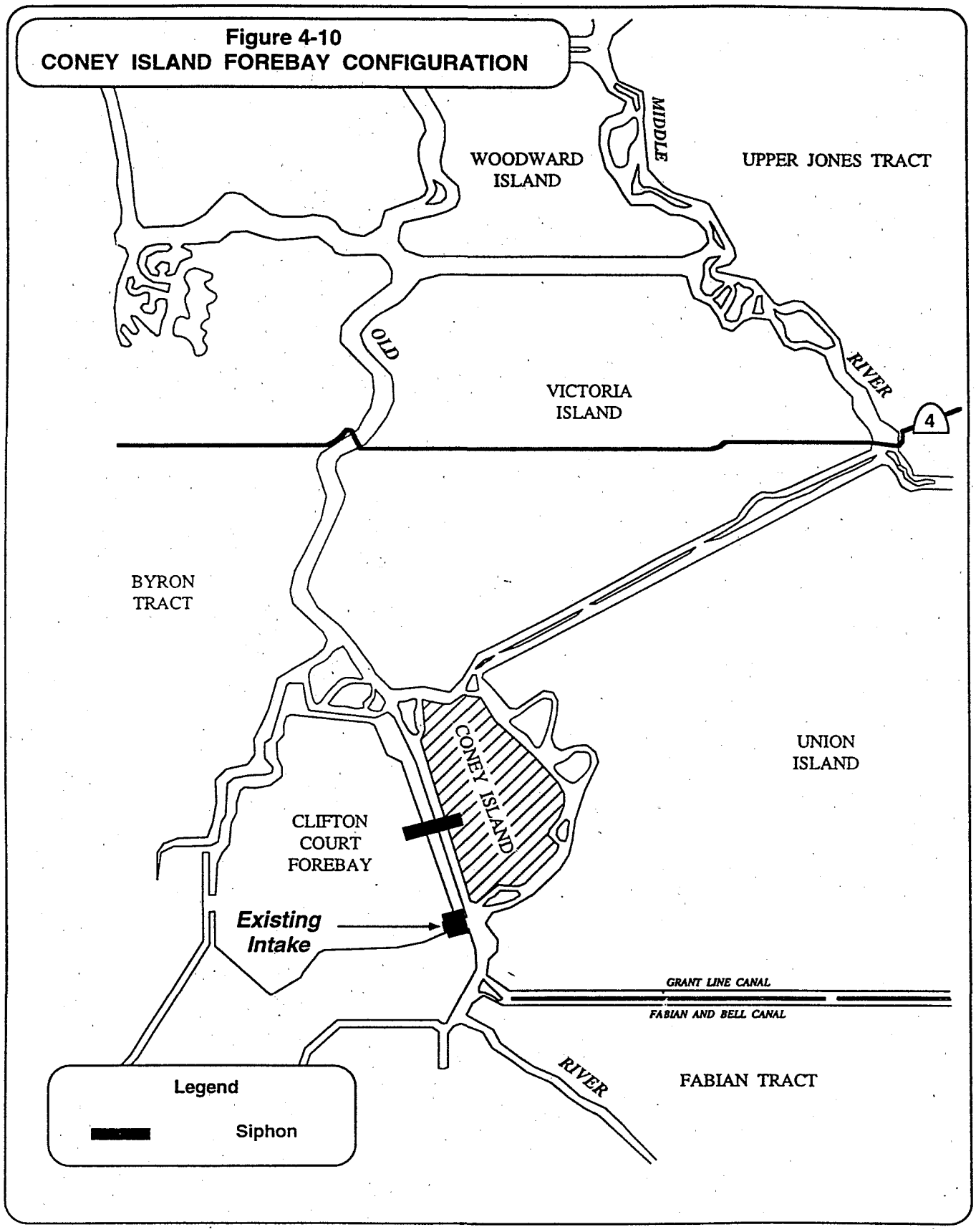


Figure 4-10
CONEY ISLAND FOREBAY CONFIGURATION
WOODWARD ISLAND
MIDDLE
UPPER JONES TRACT
OLD
RIVER
VICTORIA ISLAND
4
BYRON TRACT
CONEY ISLAND
UNION ISLAND
CLIFTON COURT FOREBAY
Existing Intake
GRANT LINE CANAL
FABIAN AND BELL CANAL
RIVER
FABIAN TRACT
Legend
Siphon

o **Benefits**

A relatively small amount of additional storage would be gained. No new intake would be needed since the expanded forebay would get water from Clifton Court.

o **Project Purposes**

Delta channels north of the existing intake gates have larger cross-sectional areas than those in the south Delta. Improving the forebay and increasing the capacity of the channels to the north would allow more water to be diverted at high tides and less at low tides. As a single component alternative, this plan, by itself, satisfies the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant), and could be combined with other alternatives to satisfy the first (to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions).

o **Timing**

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o **Conclusion**

Combining this alternative with other alternatives is explored in subsequent alternative evaluations.

Enlarge Clifton Court Forebay with Union Island

o **Description**

The objectives and conditions mentioned in the Byron Tract forebay expansion are also applicable for this alternative. The new forebay area would include Coney Island (900 acres) and a small portion, about 2,000 acres, of northwestern Union Island. A northern intake structure would be located near the juncture of North Canal and Old River, or about 1.5 miles east of that location. The existing intake would be retained for operational flexibility. Siphons would connect the Union Island forebay expansion with Coney Island, and Coney Island with Clifton Court Forebay. Channel dredging and/or levee setback would be required on Old River, Middle River, Victoria Canal, and possibly North Canal (Figure 4-11).

o **Benefits**

Additional forebay would provide more flexibility in the daily SWP diversion patterns. Water would be diverted only during high tide periods, which would improve water levels somewhat in south Delta channels. Moving the forebay intake farther north and enlarging it would also help improve average water levels slightly in Old River and Grant Line Canal, especially with a CVP tie-in to Clifton Court.

o **Project Purposes**

Delta channels north of the existing intake gates have larger cross-sectional areas than those

C—087220

C-087220

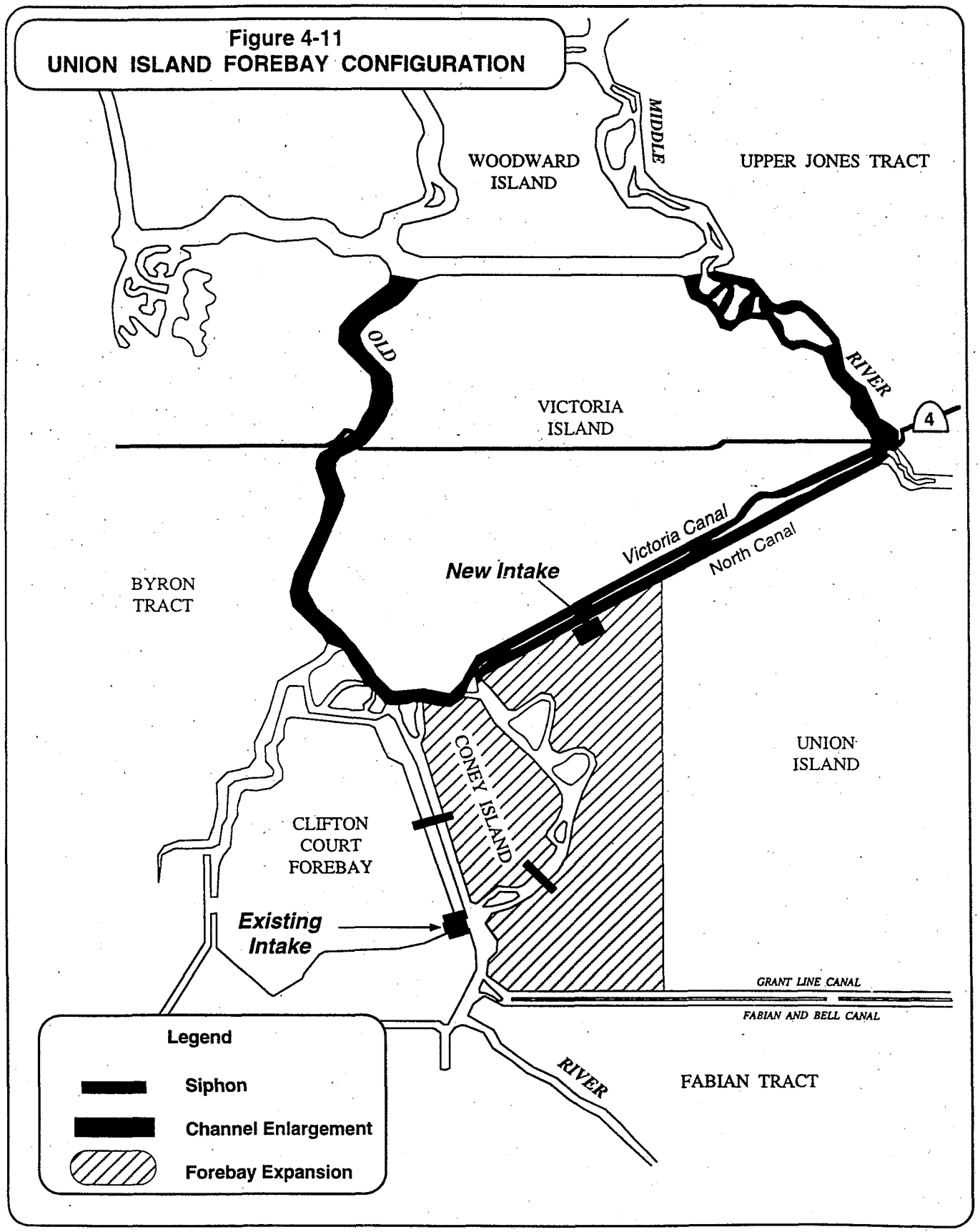


Figure 4-11
UNION ISLAND FOREBAY CONFIGURATION
WOODWARD ISLAND
MIDDLE
UPPER JONES TRACT
OLD
RIVER
VICTORIA ISLAND
4
Victoria Canal
North Canal
New Intake
BYRON TRACT
CONEY ISLAND
UNION ISLAND
CLIFTON COURT FOREBAY
Existing Intake
GRANT LINE CANAL
FABIAN AND BELL CANAL
RIVER
FABIAN TRACT
Legend
Siphon
Channel Enlargement
Forebay Expansion

in the south Delta. Improving the forebay and increasing the capacity of the channels to the north would allow more water to be diverted at high tides and less at low tides. As a single component alternative, this plan, by itself, satisfies the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant), and could be combined with other alternatives to satisfy the first (to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions).

o Timing

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o Conclusion

Additional improvement would result by combining this alternative with other alternatives, such as channel flow control structures, which is done in subsequent alternative evaluations.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at Byron Tract

o Description

Several forebay enlargement plans with flow control structures included are proposed in the following pages. The Byron Tract forebay expansion area is similar to that in the previous forebay enlargement description (see Figure 4-7). It would cover about 3,100 acres of farm land, have a new 30,000 cfs intake in the northeast corner of the new forebay, siphons to hydraulically connect the existing forebay to the expanded forebay, and require channel enlargement by levee setback for about 2.5 miles of Old River. It would also have up to four flow control structures installed in south Delta channels (see Figure 4-1), and would allow flexibility in export pumping times, with an increased maximum rate of 10,300 cfs.

o Benefits

There would be increased flexibility in pumping and opportunity for future water banking and also improved water quality in the forebay. Water could possibly be released from the old intake on Clifton Court for improvements in water levels and quality in the south Delta during emergencies. There would be opportunities to reduce fish loss by export flexibility, such as shifting of exports away from periods of high fish abundance, and possibly from a change in operation of the Delta Cross Channel to reduce entrapment of fish in the interior of the Delta. A direct SWP diversion from Italian Slough could be constructed to reduce predation losses, if this proves desirable. Improved intake gate operation, because of large capacity, would have less impact on local water levels by using the high tidal cycle to better advantage. In addition, at some later date, a connection to serve Contra Costa Water District could be constructed, if desired. Also, in case of a levee failure, a larger emergency water supply would be available to add to the existing forebay.

Fishery improvements could be derived in the San Joaquin River by using the control structure at the head of Old River. Improvement in water levels and circulation upstream of the structures would result from operating gates in conjunction with high tide periods.

C—087222

C-087222

o **Project Purposes**

This alternative supports both project purposes.

o **Timing**

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o **Conclusion**

All alternatives utilizing enlarged forebay plans have the greatest benefits when combined with control structures and operational improvements. As such, and since it meets both project purposes, this alternative is retained for second-stage screening.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at North Victoria Island

o **Description**

The North Victoria forebay expansion area is the same as described in the previous forebay enlargement description. Clifton Court Forebay would be enlarged from 2,100 surface acres to more than 5,000 surface acres. The northwest portion of Victoria Island and the remaining area of Clifton Court Tract would be used to enlarge the forebay. The southeast portion of Byron Tract would be used to hydraulically connect the existing forebay to the new area. One siphon structure between Byron Tract and Victoria Island would be used to hydraulically connect the expanded forebay areas (see Figure 4-8--Option A).

An option would be a transfer, or connection, channel to carry the water south to Clifton Court Forebay (see Figure 4-8--Option B). This canal would bisect the southern half of Victoria Island and connect to the northeast corner of Clifton Court and would require a bridge on Highway 4 and a siphon under Old River at Clifton Court. It would have a carrying capacity of 18,000 cfs and would be about two miles long.

Two intake structures would be needed at the north side of the new forebay; one with a capacity of 15,000 cfs and the other 30,000 cfs. About one mile of levee setback might be needed in Middle River between Woodward Canal and the AT&SF railroad crossing. Four flow control structures would be installed in south Delta channels (see Figure 4-1).

Pumping rates would be shifted and increased up to 10,300 cfs during periods that would not harm fish to help alleviate the water supply impacts from Endangered Species Act limitations. Exports would be lowered during fish migration periods to reduce impacts to the various species. The larger forebay would give greater operational freedom to store more water at high tide periods and result in less impact at low stages on local channel water levels. Greater intake capacity would permit more flexible operation around the high tidal cycle, and when combined with the northerly location, would help improve water levels in the south Delta channels. The structures installed in the south Delta channels would be operated to take full advantage of the tidal hydraulics to improve water levels and circulation.

Benefits

There would be more flexibility in pumping operations than with options without forebay

C—087223

C-087223

expansion, and this alternative would provide opportunity for later water banking at southern storage sites. There would be improved water quality in the forebay and south Delta channels, with potential for use of the old intake to release water to south Delta during critical low water periods. A connection to serve the Contra Costa Water District could also be constructed later if desired. Selective operation of the flow control structures and intake gates would improve water levels and circulation in the south Delta channels. This would improve recreation and fisheries, which would also be helped if the control structure on Old River just west of the confluence with the San Joaquin River was installed.

o **Project Purposes**

This alternative supports both project purposes.

o **Timing**

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o **Conclusion**

All alternatives utilizing enlarged forebay plans have the greatest benefits when combined with control structures and operational improvements. As such, and since it meets both project purposes, this alternative is retained for second-stage screening.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at South Victoria Island

o **Description**

The South Victoria forebay expansion area is described in the earlier South Victoria Island forebay enlargement discussion (see Figure 4-9). It would cover about 3,700 acres of the southern part of Victoria Island south of Highway 4. Two northern intake structures would be built on the new forebay; one on Old River at Highway 4, and another on Middle River near Highway 4. A siphon under Old River would connect the new forebay with Clifton Court. Dredging would be required in Old River to satisfy the intake capacity. Levee setback might be required on Middle River for about two miles to gain enough channel capacity for the large intake at the northeast corner of the new forebay. Four flow control structures would be built in south Delta channels (see Figure 4-1).

Pumping rates from the SWP pumps would increase up to a maximum of 10,300 cfs during high flow winter months to help alleviate the water supply impacts from Endangered Species Act limitations. Exports would be lowered during fish migration periods to reduce impacts to the various fish species. The larger forebay would give greater operational freedom to store more at high tide periods and result in less impact on local channel water levels. Greater intake capacity would permit more flexible operation around the high tide cycle, and when combined with the northerly location, would help improve water levels in the south Delta channels. The structures installed in the south Delta channels would be operated to take full advantage of the tidal hydraulics to further improve water levels and circulation.

o **Benefits**

There would be more flexibility in pumping operations and opportunity for later water banking during high flow periods. There would be improved water quality in the forebay and

C—087224

C-087224

south Delta channels, with potential to use the old intake to release water to the south Delta during critical low water periods. A connection to serve Contra Costa Water District could also be constructed later if desired. Selected operation of the flow control gates and intake gates would improve water levels and circulation in south Delta channels. Recreation and fisheries would also be helped by the flow control structure at the head of Old River.

o **Project Purposes**

This alternative supports both project purposes.

o **Timing**

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o **Conclusion**

All alternatives utilizing enlarged forebay plans have the greatest benefits when combined with control structures and operational improvements. As such, and since it meets both project purposes, this alternative is retained for second-stage screening.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at Coney Island

o **Description**

The Coney Island forebay expansion was described in the previous forebay enlargement description for Coney Island (see Figure 4-10). It would only cover 900 acres, would connect with Clifton Court by a siphon, and would not have an intake but would receive water from Clifton Court. A little over five miles of embankment would be needed around the island. With no new intake feature planned, it is doubtful that the additional area would have optimum utilization; also, drawdown in the local channels below the flow structures would be increased because of the additional volume of pumping during certain times of the year.

Four flow control structures would be built in south Delta channels (see Figure 4-1). These would be operated to take full advantage of the tidal hydraulics to improve water levels and circulation.

Pumping rates from Banks Pumping Plant would have the capability to pump 10,300 cfs during high flow winter months. The larger forebay would give a little better operational flexibility to store surplus flows.

o **Benefits**

Selective operation of the flow control structure gates would improve local water levels and circulation. Also, there would be an improvement in recreation and fishery with the structure at the head of Old River.

o **Project Purposes**

This alternative supports both project purposes.

o **Timing**

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o **Conclusion**

All alternatives utilizing enlarged forebay plans have the greatest benefits when combined with control structures and operational improvements. As such, and since it meets both project purposes, this alternative is retained for second-stage screening.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at Union Island

o **Description**

The Union Island forebay expansion was described in the previous Union Island forebay enlargement alternative description (see Figure 4-11). It would include Coney Island (900 acres) and a 2,000-acre portion of northwestern Union Island. A new northern intake structure would be constructed at the juncture of North Canal and Old River, or about 1.5 miles east of that location. Siphons would connect Union Island with Coney Island, and also Coney Island with Clifton Court Forebay. Channel dredging and/or levee setback would be required on Old River, Middle River, and possibly North Canal.

Up to four flow control structures would be built in south Delta channels (see Figure 4-1). These would be operated to take full advantage of the tidal hydraulics to improve local water levels and circulation.

Pumping rates from Banks Pumping Plant would increase up to a maximum of 10,300 cfs during high flow winter months to help alleviate the water supply impacts from Endangered Species Act limitations. Exports would be lowered during fish migration periods to reduce impacts to the various fish species. As planned, the larger forebay would allow greater operational freedom to store water at high tides and result in less impact at low tides to local channel water levels. Greater intake capacity would permit more flexible operation around the high tide cycle, and when combined with the northern location, would help improve water levels and circulation in the south Delta channels.

o **Benefits**

There would be more flexibility in pumping operations and opportunity for later water banking, if available, during high flow periods and periods where pumping would not impact fisheries. There would be improved water quality in the forebay and in south Delta channels, with potential for use of the old intake to release water to the south Delta during critical low water periods. A connection to serve Contra Costa Water District could also be constructed at a later time if desired. Selected operation of the flow control gates and forebay intake gates would improve water levels and circulation in south Delta channels. This would improve recreation and fisheries, which would also be improved by the flow control structure at the head of Old River.

o **Project Purposes**

This alternative supports both project purposes.

C—087226

C-087226

o **Timing**

This alternative can be accomplished in a relatively short time, appropriate for an interim project.

o **Conclusion**

All alternatives utilizing enlarged forebay plans have the greatest benefits when combined with control structures and operational improvements. As such, and since it meets both project purposes, this alternative is retained for second-stage screening.

PERMANENT LONG-RANGE ALTERNATIVES

These alternatives are large, long-term plans. As outlined in the Governor's April 6, 1992 Comprehensive Water Policy, a long-term solution must be developed for the protection of the Bay-Delta estuary. The long-term planning process will guide the planning and decision-making process for this long-term solution. The conclusions reached on each of these alternatives reflects their appropriateness to fill the short-range interim needs of the south Delta rather than the long-range needs of the entire estuary.

Isolated Water Transfer Facilities

Peripheral Canal

o **Description**

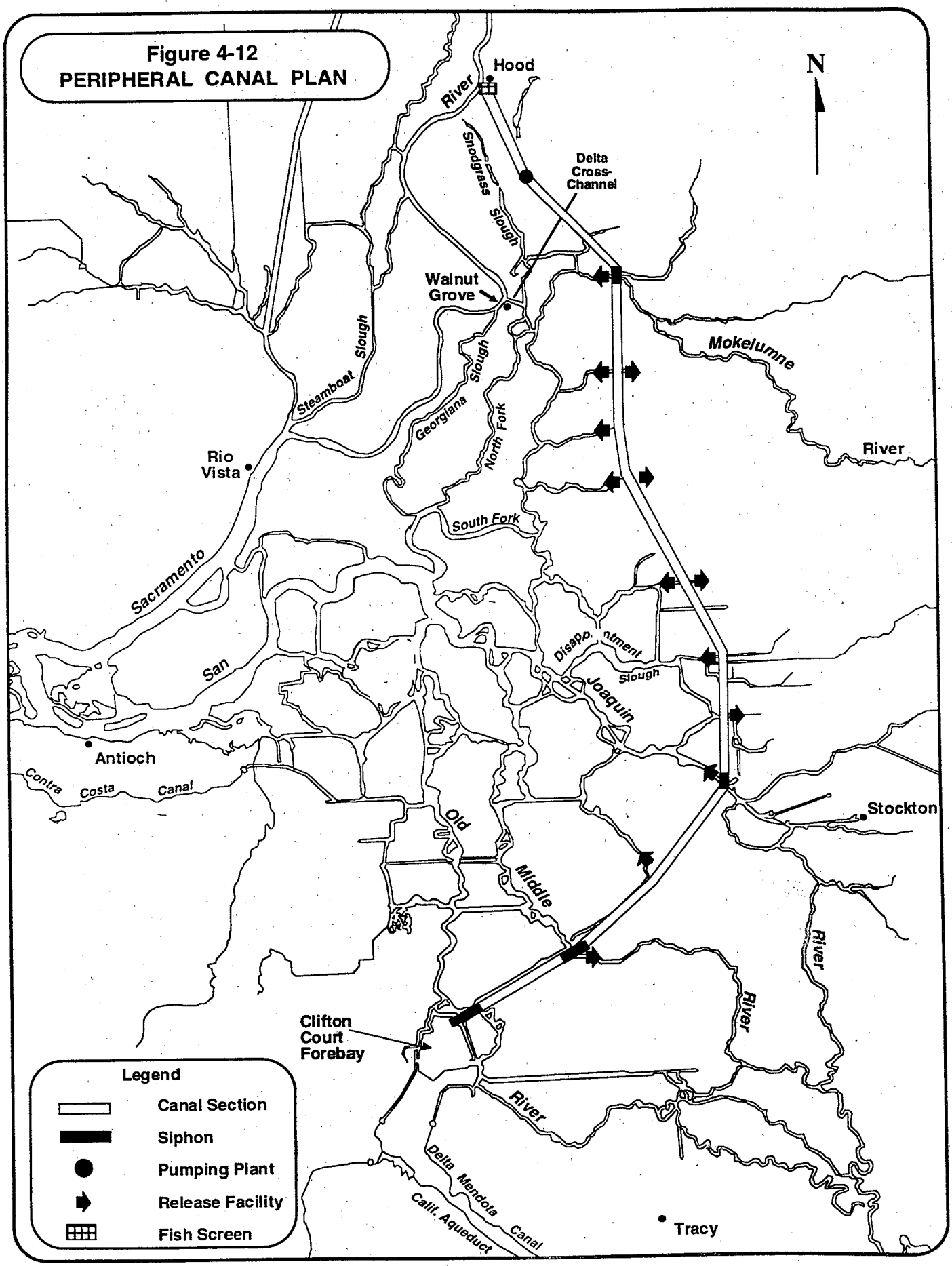
This water transfer concept, with various modifications, has been studied and presented for public acceptance numerous times in the past 30 years. The State-federal plan as described in the "Report in Response to Senate Concurrent Resolution No. 73," July 1, 1977, and also described in the DEIR for Peripheral Canal, published by DWR in August 1974, was composed of many physical features. These included: 42 miles of unlined channel from Hood, on the Sacramento River, to Clifton Court Forebay; an intake structure and fish screen at Hood; a pumping plant (21,800 cfs capacity); numerous siphons, bridges and access roads; water release structures located along the length of the canal at major rivers and sloughs; and a connection between Clifton Court Forebay and Tracy Pumping Plant (CVP). This large project would be built in three stages (Figure 4-12). The "State-only Gravity Canal" was a scaled-down version of the State-federal plan and would only carry enough water to meet SWP exports.

o **Benefits**

Releases from the canal for water quality control, Delta needs and fishery would be made at strategic locations along the east side of the Delta. Canal releases would provide positive downstream flows in Delta channels and would contribute to the outflow required to control salinity intrusion. By eliminating reverse flows in the western Delta, this alternative would reduce the amount of water needed for salinity control and thus conserve water for increased project yield. Provisions would be provided for passage of floodflows, migrating fish, and boats.

o **Project Purposes**

This alternative would support the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant), but would not by itself support the first project purpose of improving water levels and circulation in the south Delta.



C-087228

C-087228

o **Timing**

This is a long-term solution to the Delta, and not an interim solution.

o **Conclusion**

This alternative is not evaluated further because it is a long-term solution to the Delta, and will be addressed in the long-term planning process.

Dual Transfer System

o **Description**

This plan is comprised of an east Delta conveyance channel, very similar to the Peripheral Canal but only about one-third its size, and continued use of existing Delta channels as conveyance facilities. About 7,500 cfs of the SWP/CVP export water would flow through the new channel. Under the basic alternative, the new channel would operate by gravity and would only have about a 3-foot drop from the intake on the Sacramento River to Clifton Court Forebay. It would have five siphons at the major river crossings and would have several release structures at desired locations (Figure 4-13). To compliment the basic plan, there are several design options that would boost flow to improve water transfer (pumping plants and Sacramento River control structure), and provide additional protection for Delta fish. Also, there are a number of options to reduce or mitigate damage to fish, such as various fish screen and fish return designs, and hatcheries.

o **Benefits**

The new channel would improve water transfer efficiency across the Delta. Any needs of the SWP beyond the capacity of an east Delta conveyance channel would be met by existing project facilities, which for the most part would only be operated during high flow periods or when there is minimal impact to fish.

o **Project Purposes**

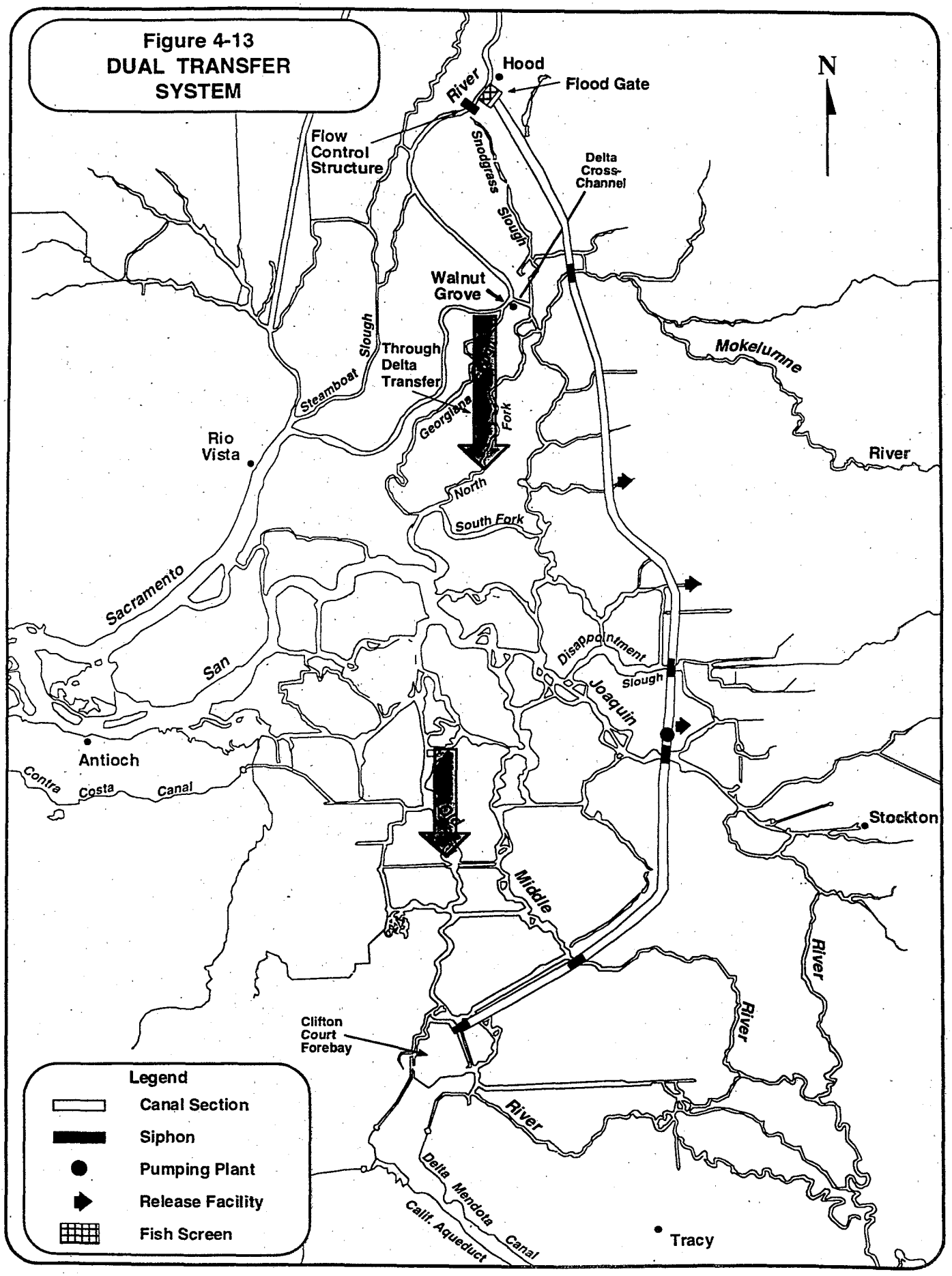
This alternative would support the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant), but would not by itself support the first project purpose of improving water levels and circulation in the south Delta.

o **Timing**

This alternative is a long-term, not an interim, solution.

o **Conclusion**

This alternative is not evaluated further because it is a long-term solution to the Delta, and will be addressed in the long-term planning process.



C-087230

C-087230

Modified Folsom-South Canal

o **Description**

This alternative plan would control water transfer through existing Delta channels and enlarged channels, install various new features to improve water levels and circulation in the central and southern Delta, and eliminate reverse flows in the San Joaquin River. The proposed Sacramento River Hood-Clay connection and the Folsom–South Canal would be enlarged to divert 3,800 cfs for release down the Mokelumne, Calaveras, and Stanislaus Rivers. However, the Folsom-South Canal was never completed south of the latitude of Hood. Other features would include channel closures, channel improvements, and a siphon for the Mokelumne River under the San Joaquin River to control water transfer through existing channels. A fish screen at Hood and boat passage facilities at the various channel closures would be needed (Figure 4-14). The modified Folsom-South Canal alternative is described briefly in DWR Delta Water Facilities Bulletin 76, July 1978.

o **Benefits**

Reverse flow problems and water level and circulation problems in the eastern Delta would be improved somewhat.

o **Project Purposes**

This alternative would support both of the project purposes.

o **Timing**

This alternative is a long-term, not an interim, solution.

o **Conclusion**

This alternative is not evaluated further because it is a long-term solution to the Delta, and will be addressed in the long-term planning process.

West or Central Delta Canal

o **Description**

The West Delta Canal and the Central Delta Canal are two separate projects with different alignments, but would have similar features and costs, and would have similar benefits and impacts. Each would have an 18,000 cfs unlined canal with headworks at Isleton. The alignments traverse through several Delta islands and terminate at Clifton Court Forebay. Physical features include fish screens, siphons, bridges, cross channel closures, and water release structures. Good quality water would be transported to Clifton Court Forebay with certain releases made at key locations along the alignment to provide positive downstream flows in Delta channels (Figures 4-15 and 4-16).

o **Benefits**

This type of alternative would eliminate cross-Delta flows and flow reversals, and would improve fishery conditions. Export pumping reliability would be improved.

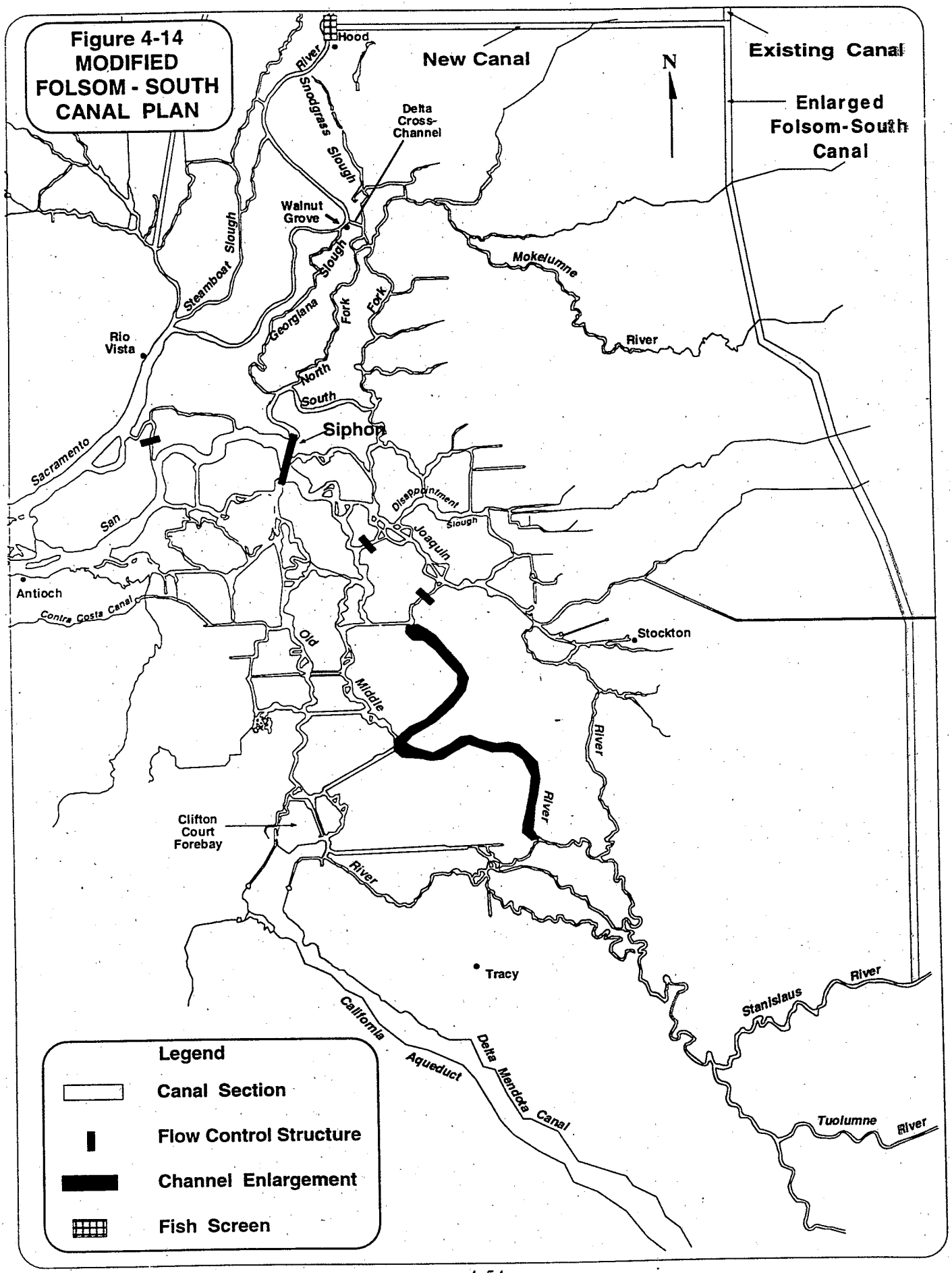
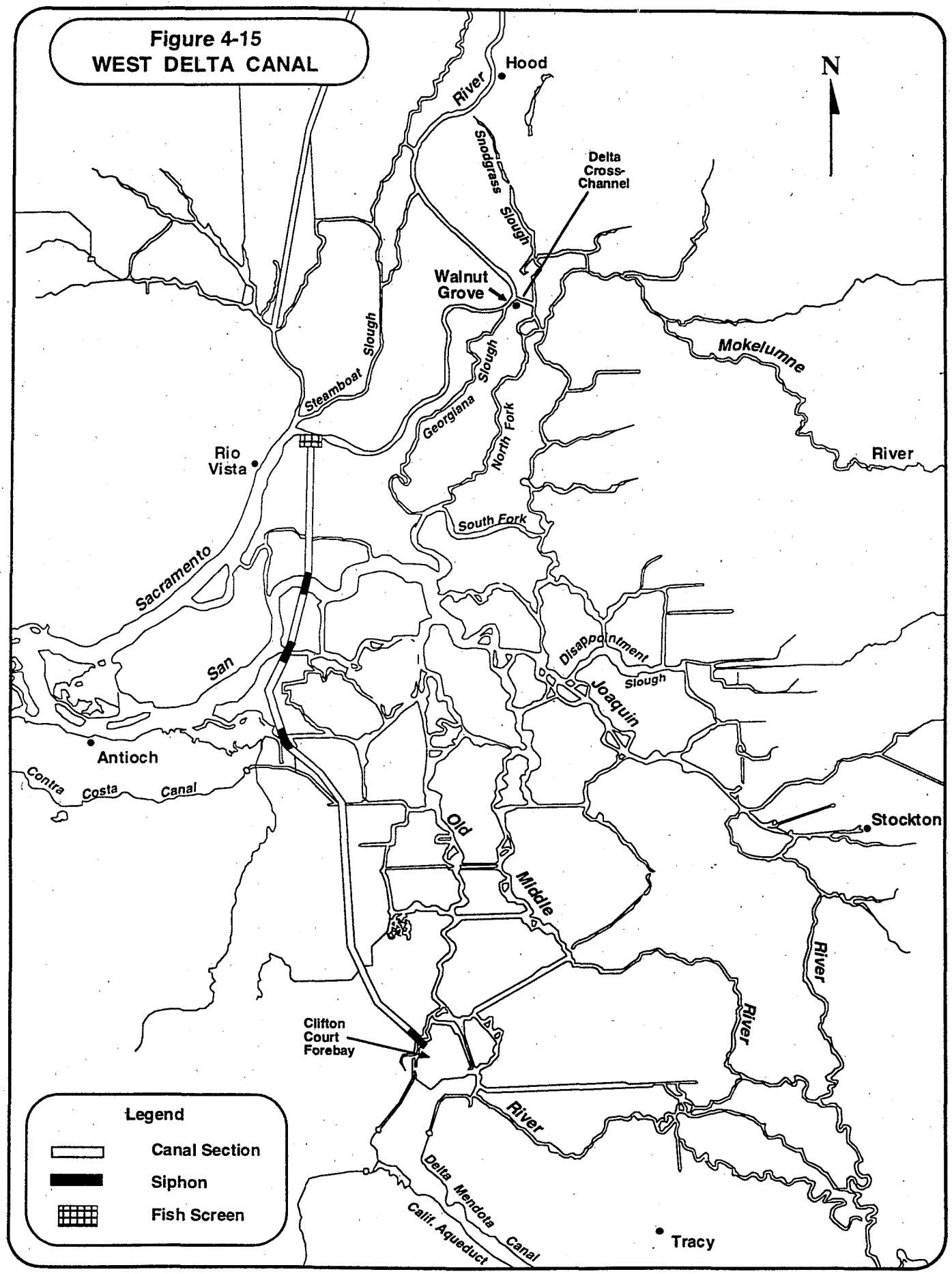


Figure 4-14
MODIFIED
FOLSOM - SOUTH
CANAL PLAN
Hood
New Canal
Existing Canal
N
Enlarged
Folsom-South
Canal
Delta
Cross-
Channel
Snodgrass Slough
Walnut
Grove
Steamboat Slough
Mokelumne
River
Georgiana Slough
North Fork
South Fork
Rio
Vista
Siphon
Sacramento
San
Disappointment Slough
Joaquin
Antioch
Contra Costa Canal
Stockton
Old
Middle
River
River
Clifton
Court
Forebay
River
Tracy
Stanislaus
River
California
Aqueduct
Delta Mendota Canal
Tuolumne
River
Legend
Canal Section
Flow Control Structure
Channel Enlargement
Fish Screen



C-087233

C-087233

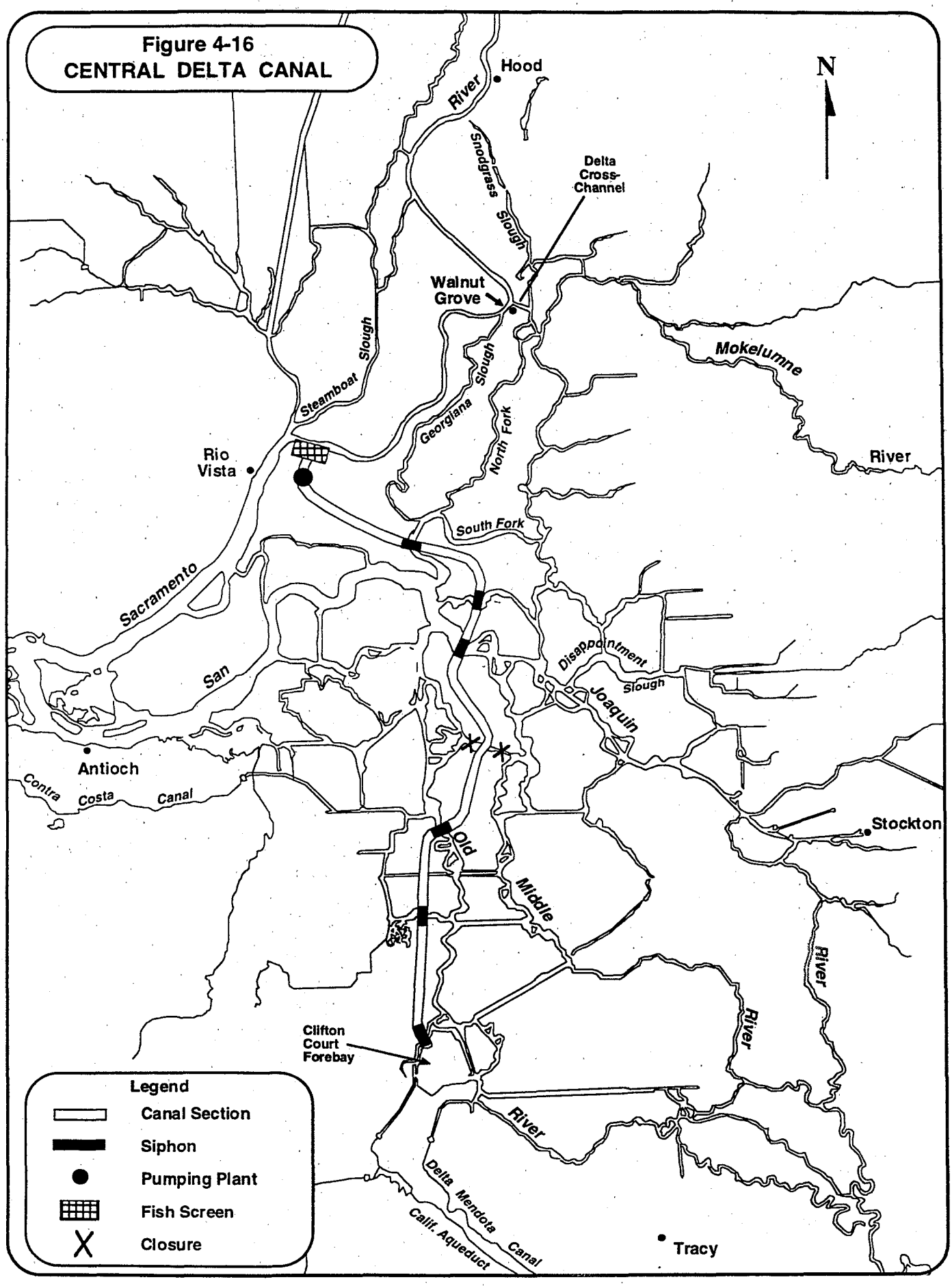


Figure 4-16
CENTRAL DELTA CANAL
N
Hood
River
Snodgrass Slough
Delta Cross-Channel
Walnut Grove
Steamboat Slough
Georgiana Slough
North Fork
Mokelumne
River
Rio Vista
South Fork
Sacramento
San
Disappointment Slough
Joaquin
Antioch
Contra Costa Canal
Stockton
Old
Middle
River
River
Clifton Court Forebay
River
Delta Mendota Canal
Calif. Aqueduct
Tracy
Legend
Canal Section
Siphon
Pumping Plant
Fish Screen
Closure

o **Project Purposes**

This alternative would support the project purposes.

o **Timing**

This alternative is a long-term solution to the Delta.

o **Conclusion**

This alternative is not evaluated further because it is a long-term solution to the Delta, and will be addressed in the long-term planning process.

Through-Delta Facilities

New Hope Cross Channel

o **Description**

This Delta water transfer proposal actually has two plans, both of which use interior Delta channels for part of the water transfer to the Delta Pumping Plant. New Hope Cross Channel was introduced in 1978 as a long-term Delta transfer solution. The canal portion of the New Hope alternative follows a portion of the Peripheral Canal alignment. Discussions of the New Hope Cross Channel project can be found in DWR Delta Water Facilities Bulletin 76, July 1978, and also in a DWR report entitled "Alternatives For Delta Water Transfer," November 1983.

One alternative plan is the New Hope Cross Channel and Enlarged Clifton Court Forebay (Alt. A on Figure 4-17). The north canal portion is a 12.3-mile reach from Hood to Beaver Slough. Water taken from the Sacramento River at Hood would be discharged into the Mokelumne River, Lost Slough, and enlarged Beaver Slough. The South Fork Mokelumne River would be enlarged, and an 8,000-foot channel constructed across Staten Island to convey water to the North Fork Mokelumne. The Delta Cross Channel would be closed and a boat lock provided for small boats. The initial canal capacity would be 16,500 cfs and would require pumping. About 4,500 cfs would be released into Lost Slough and 1,500 cfs into Mokelumne River. The remaining water would be conveyed on to Beaver Slough and South Fork Mokelumne. A short canal section across Staten Island would transfer 6,500 cfs from the South Fork to the North Fork Mokelumne. Additionally, flood flows from Stone Lake would pass over the canal into Snodgrass Slough through a gated weir. The canal reach between Lost Slough and Mokelumne River would be designed to be overtopped with floodwater. This would require flood gates in the canal at both ends of this reach. Clifton Court Forebay would be increased to twice its present capacity. There would be an additional intake on Old River near Indian Slough. New fish screens would be required at the New Hope Channel intake and at both intakes to the forebay, and a more efficient fish collector system installed at the Delta Mendota Intake Channel. The CVP would continue to pump exports from the Delta.

The other alternative is the New Hope Cross Channel and South Delta Intake Channel (Alt. B on Figure 4-17). This facility would combine the New Hope Cross Channel (as described) with a South Delta Intake Channel. There would be no enlarged forebay plan. The South Delta channel is a 12-mile canal which would be on the Peripheral Canal alignment between the San Joaquin River and Clifton Court Forebay. Water would be released into Middle River for water quality purposes.

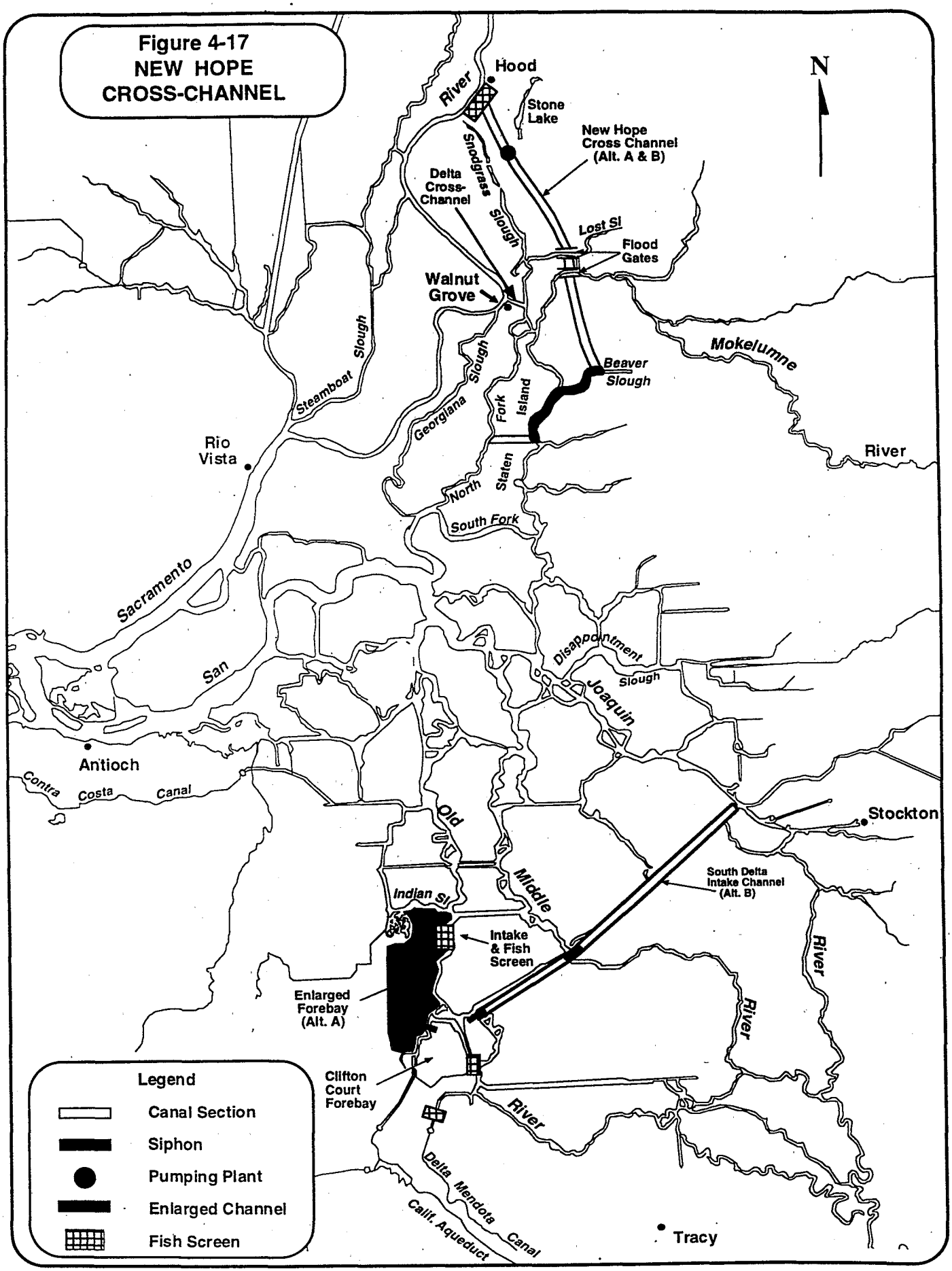


Figure 4-17
NEW HOPE
CROSS-CHANNEL
N
Hood
Stone Lake
New Hope Cross Channel (Alt. A & B)
Delta Cross-Channel
Snodgrass Slough
Lost Sl
Flood Gates
Walnut Grove
Steamboat Slough
Georgiana Slough
Beaver Slough
Mokelumne
River
Fork
Island
Staten
North
South Fork
Rio Vista
Sacramento
San
Disappointment
Slough
Joaquin
Antioch
Contra Costa Canal
Old
Middle
Stockton
South Delta Intake Channel (Alt. B)
Indian Sl
Intake & Fish Screen
Enlarged Forebay (Alt. A)
Clifton Court Forebay
River
Delta Mendota Canal
Calif. Aqueduct
Tracy
Legend
Canal Section
Siphon
Pumping Plant
Enlarged Channel
Fish Screen

o **Benefits**

With the Enlarged Clifton Court Forebay plan, reverse flows around Sherman Island would be eliminated, but some reverse flows in the central Delta would continue.

With the South Delta Intake Channel plan, reverse flows in Old and Middle Rivers would be eliminated but would continue in the western Delta and extend further into the eastern Delta. Fish in the south Delta would not be subject to the effects of the pumps, but adverse effects on anadromous fish in the San Joaquin River system would continue. This project has the effect of moving the Delta and Tracy Pumping Plant intakes to the San Joaquin River. The CVP would still pump exports from the Delta as is presently done.

o **Project Purposes**

This alternative would support the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant), to some degree, but would not by itself support the first project purpose of improving water levels and circulation in the south Delta.

o **Timing**

This alternative is a long-term solution to the Delta.

o **Conclusion**

This alternative is not retained for second-stage screening, because it is a long-term solution to the Delta, and will be addressed in the long-term planning process.

Waterway Control Plan

o **Description**

This alternative would use Delta channel control structures to hydraulically isolate about one-third of the Delta for conveying project water. Portions of levees upstream of the channel structures would be rehabilitated to handle water levels. Control structures or pumping plants would divert Sacramento River water into the Mokelumne River system through the Delta Cross Channel and Georgiana Slough. This diverted water, combined with the Mokelumne River flows, would be siphoned under the San Joaquin River. Middle River and Old Rivers, plus other channels, would be used for conveyance from the siphon to the export pumps. Construction features include enlarged Delta channels, a pumping plant, fish screens, navigation locks, fish passage facilities, control structures, a siphon, channel closures, and levees (Figure 4-18).

o **Benefits**

The project would eliminate reverse flows and co-mingling of transfer flows with saline water in the western Delta. It would provide positive downstream flows in major channels and improved water levels and circulation in central and south Delta. It would also improve some of the levees in the Delta.

o **Project Purposes**

This alternative would support the project purposes.

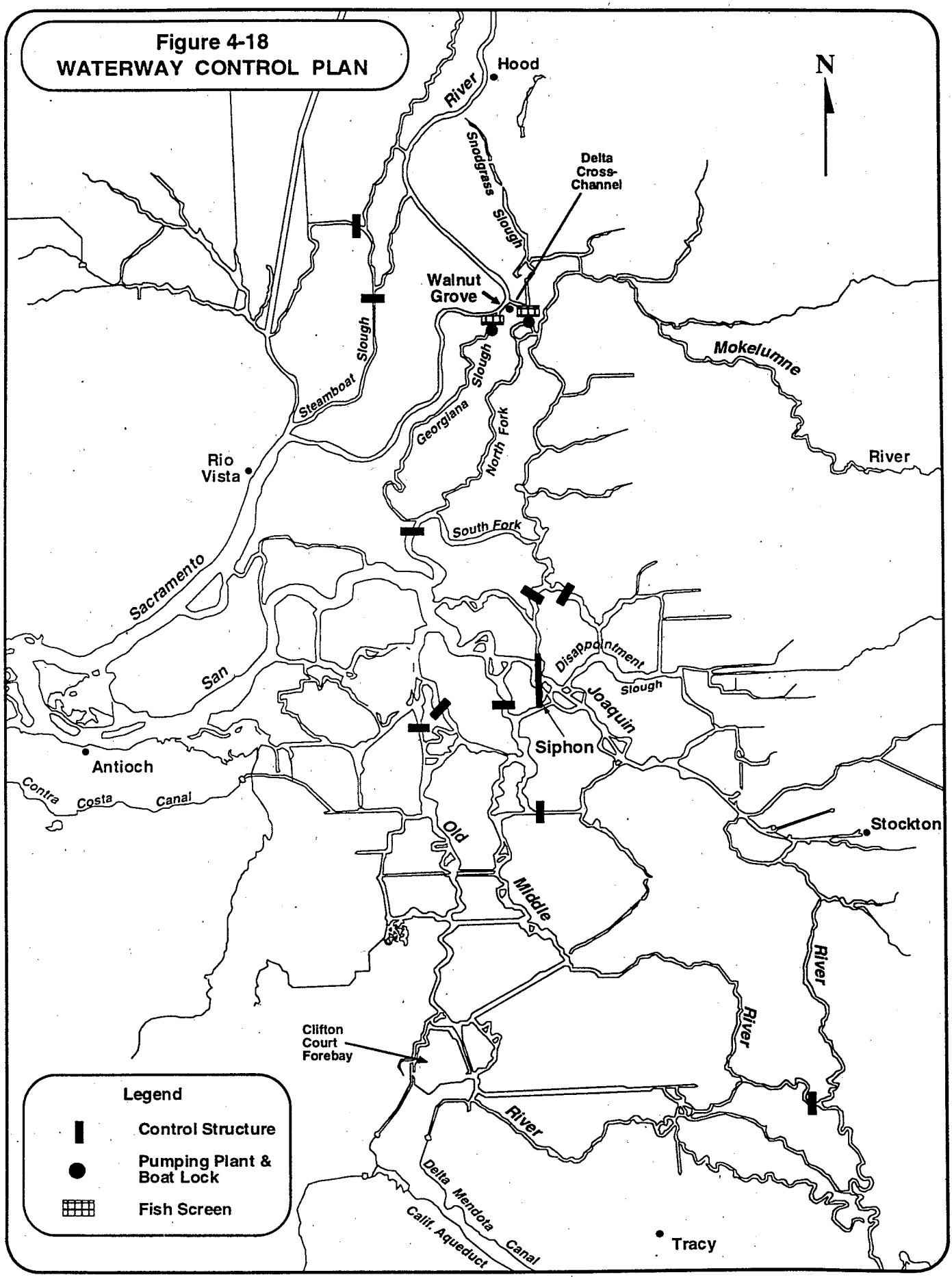


Figure 4-18
WATERWAY CONTROL PLAN
N
Hood
River
Snodgrass
Slough
Delta
Cross-
Channel
Walnut
Grove
Slough
Steamboat
Slough
Georgiana
North Fork
Mokelumne
River
Rio
Vista
South Fork
Sacramento
San
Disappointment
Slough
Joaquin
Siphon
Antioch
Contra
Costa
Canal
Old
Middle
Stockton
River
River
Clifton
Court
Forebay
River
Delta
Mendota
Canal
Calif. Aqueduct
Tracy
Legend
Control Structure
Pumping Plant &
Boat Lock
Fish Screen

o **Timing**

This alternative is a long-term solution to the Delta.

o **Conclusion**

This alternative is not evaluated further because it is a long-term solution to the Delta, and will be addressed in the long-term planning process.

North Stub Canal

o **Description**

This alternative is a full-sized canal, capacity about 23,000 cfs, following the Peripheral Canal alignment from Hood to the San Joaquin River. Water releases would be made into sloughs flowing into the Mokelumne River for water quality purposes. Good quality water would then be transported through Middle and Old Rivers to the export pumps. There would be about 24 miles of canal, a new intake and fish screen, and two siphons constructed (Figure 4-19).

o **Benefits**

Reverse flows would be reduced in the western Delta. Better water quality would be made available in the Mokelumne River and central Delta.

o **Project Purposes**

This alternative does not satisfy either of the project purposes, because no flexibility in pumping is gained, and nothing is done to increase water levels or circulation in SDWA channels.

o **Timing**

This alternative is a long-term solution.

o **Conclusion**

Since this alternative does not satisfy the project purposes, it is not carried forward to the second-stage evaluation. As a long-term solution to the Bay estuary problems, it would need to be combined with other features, or used as a first stage of a Peripheral Canal plan.

South Stub Canal

o **Description**

This alternative, like the North Stub Canal, is a segment of the Peripheral Canal. It has the effect of moving the pump intakes in the south Delta northward to the San Joaquin River west of Stockton. The alignment would be from the San Joaquin River to Clifton Court Forebay. The canal would be 12 miles long and would have a capacity of 18,500 cfs. Water releases would be made into Middle River for water quality purposes. It would eliminate reverse flow in Old and Middle Rivers, and reduce scour and tidal fluctuations in southern Delta (Figure 4-20).

C—087239

C-087239

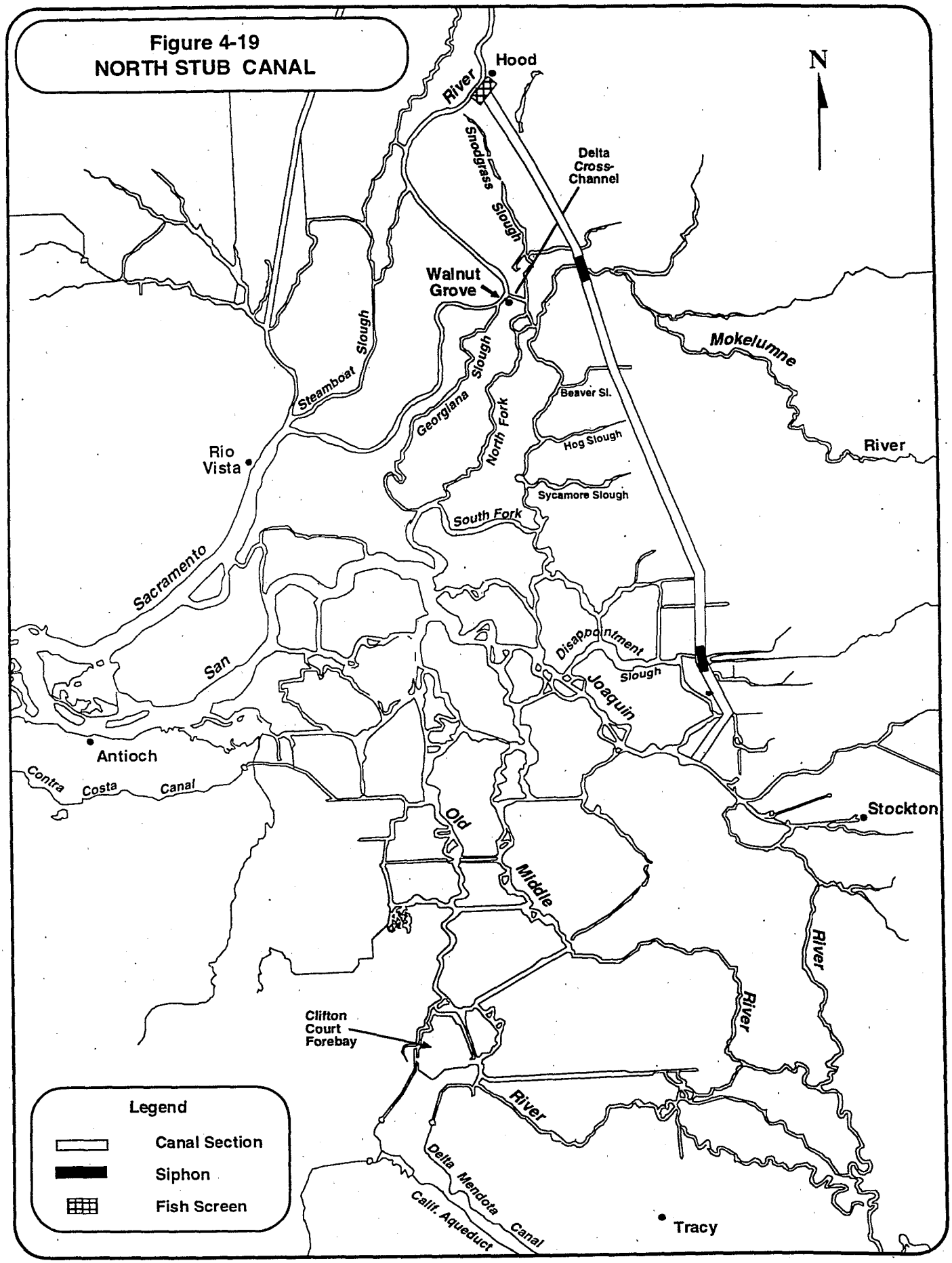
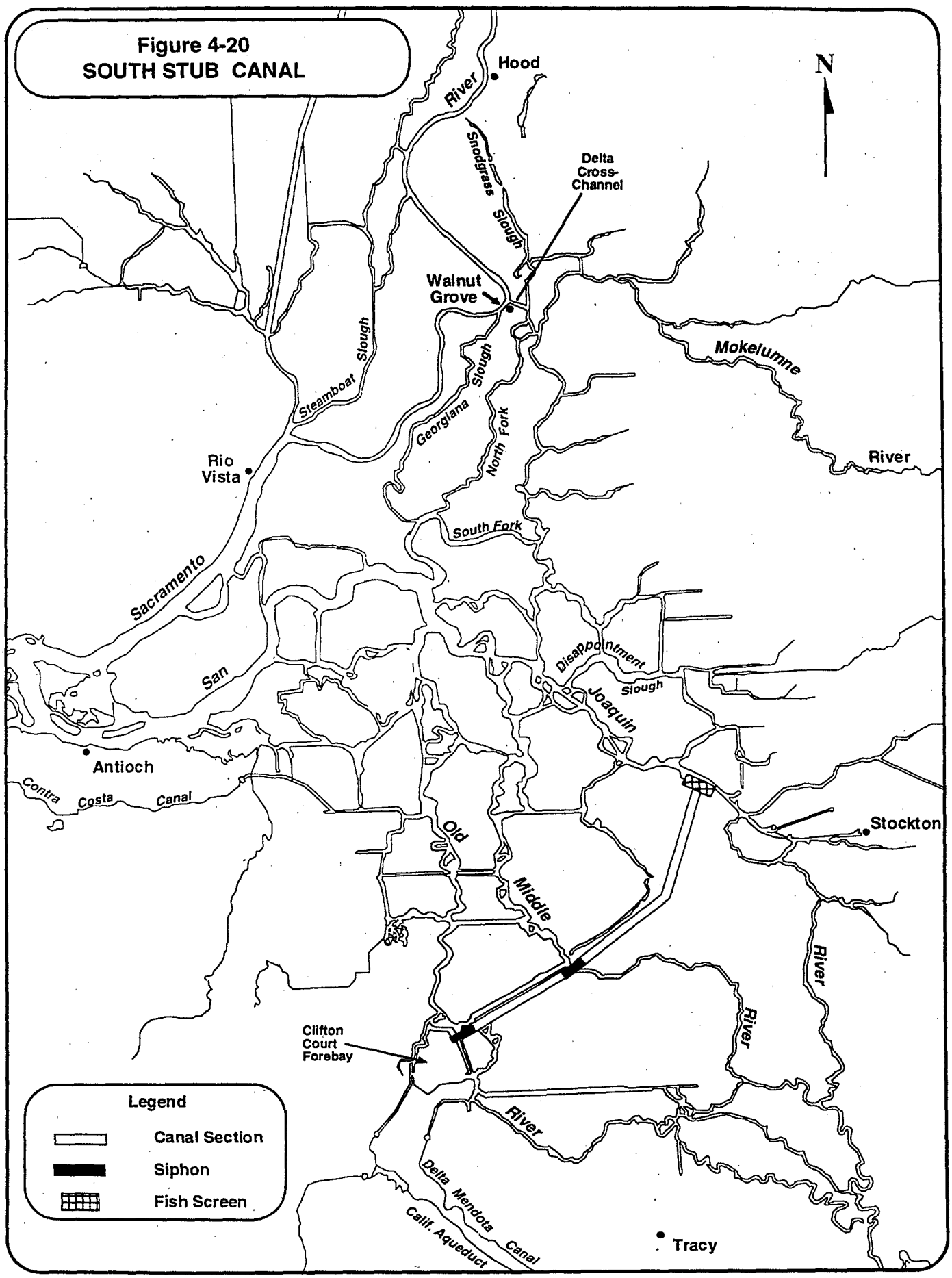


Figure 4-19
NORTH STUB CANAL
N
Hood
River
Snodgrass Slough
Delta Cross-Channel
Walnut Grove
Steamboat Slough
Georgiana Slough
North Fork
Beaver Sl.
Hog Slough
Sycamore Slough
South Fork
Mokelumne
River
Rio Vista
Sacramento
San
Antioch
Contra Costa Canal
Disappointment Slough
Joaquin
Stockton
Old
Middle
River
River
River
Clifton Court Forebay
Delta Mendota Canal
Calif. Aqueduct
Tracy
Legend
Canal Section
Siphon
Fish Screen

C-087240



C-087241

C-087241

o **Benefits**

Project would solve some of the reverse flow problems, mainly in south Delta. Fishery impacts at the SWP pumping plant would be reduced.

o **Project Purposes**

By reducing fishery impacts and facilitating the delivery of water to the forebay, this alternative would support the second project purpose, to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant.

o **Timing**

This alternative is a long-term solution.

o **Conclusion**

Since this alternative is a long-term, and not interim, solution, it is not carried forward to the second-stage evaluation. As a long-term solution to the Bay estuary problems, it would need to be combined with other features, or used as a first stage of a Peripheral Canal plan.

Physical Barriers

Various versions of physical barriers have been proposed and studied over the years. The basic purpose of these barriers have been to isolate different portions of the San Francisco Bay from the salinity and tidal effects of the Pacific Ocean and create large inland fresh water lakes for water supply. Opposition to this type of water supply alternative has mainly been due to its major interference with the natural interrelation between the Pacific Ocean and the Bay-Delta Estuary, and the potential adverse impacts on the anadromous fish and other aquatic species.

Physical barriers have been studied many times over the years, but have considerable environmental objections, and would be very costly to build.

Plans which involve a physical barrier concept in the Delta have been proposed in various reports by federal, State and local agencies since 1880. In 1963, the Corps of Engineers published a report entitled, "Technical Report on Barriers." It covered a multitude of proposals including Chipps Island, Dillon Point and Point San Pablo barriers. A physical barrier restricts commingling of fresh waters going downstream and saline waters of San Francisco Bay. In addition, it would permit pumping of the fresh water pool above the barrier for local water supplies and export requirements. The barrier would eliminate the influence of tidal action on Delta channels. The Delta area north of the San Joaquin River would have net flows as in present channel regimen, whereas the southern and western Delta would come under the influence of the export pumps, and reverse flows could be experienced in many channels. The barrier structure and associated works would have to be capable of passing anadromous fish and would need an acclimation system for their movement from saline to fresh water and vice versa. It would need both a large commercial navigation lock and a small craft lock for boat passages. Local water needs would be met directly from the channels.

Although the rising environmental concerns have made the likelihood of implementing this type of alternative more remote, a representative alternative is included here in the interest of a more comprehensive alternative analysis process.

C—087242

C-087242

Chipps Island Barrier

o **Description**

The Chipps Island Barrier site would be located in the Sacramento River, connecting Chipps Island with Mallard Island (Figure 4-21). There would also be dikes across Spoonbill Creek. The Sacramento River at the site is about 3,000 feet wide and has a maximum depth of 56 feet below mean sea level. The barrier would include an embankment, a gated floodway structure, four navigation locks, a salt scavenging system, a fish passage, a removable fuse plug, and other miscellaneous features. Mallard Island would be removed and replaced by the fuse plug. Channel excavation would be required for about two-thirds of the length of the barrier. The floodway structure would consist of 36 gated bays, with each bay 80 feet wide. The concrete base slab would be 15 feet thick and 90 feet wide with 125-foot piles as the foundation.

Four navigation locks would be constructed parallel to the northern shore between the floodway and Chipps Island. Approach channels would be excavated to a depth of 45 feet and a width of 600 feet. The locks themselves would range from 300 to 800 feet in length and from 45 to 96 feet in width.

Operation of the locks would result in salt water intrusion into the barrier pool. The denser salt water would displace the fresh water at the bottom of the pool, allowing the salt water to be collected in a sump. Removal of the salt water would be accomplished through a salt scavenging system. The salt water could be used in an adjacent fish ladder for fish attraction and acclimation.The fish ladder itself would be concrete and about 670 feet long and 30 feet wide.

To meet national defense requirements, a fuse plug with approach channels would be constructed near the southern shore. The plug would consist of four concrete cellular caissons, with three 100 feet long and one 75 feet long. Two center caissons would be removable. An approach channel would need to be dredged 200 feet wide with a bottom elevation of 44 feet. This would extend 6,000 feet both upstream and downstream.

The U.S. Public Health Service has recommended that, for any barrier of this type, all municipal and industrial effluent be diverted downstream of the barrier pool. A waste disposal conduit for Chipps Island Barrier would serve nine industrial and two municipal dischargers. Industrial cooling water facilities would also be needed.

Levees in Suisun Bay and in the Delta would require strengthening and raising under the new hydraulic conditions. Also, numerous reaches of channels in the Delta would need to be dredged to provide capacity for water transfer and navigation. It is estimated approximately six million cubic yards of material would be dredged.

o **Benefits**

This project would control salinity, as there would be no mixing of saline and fresh waters. This would conserve water for export.

o **Project Purposes**

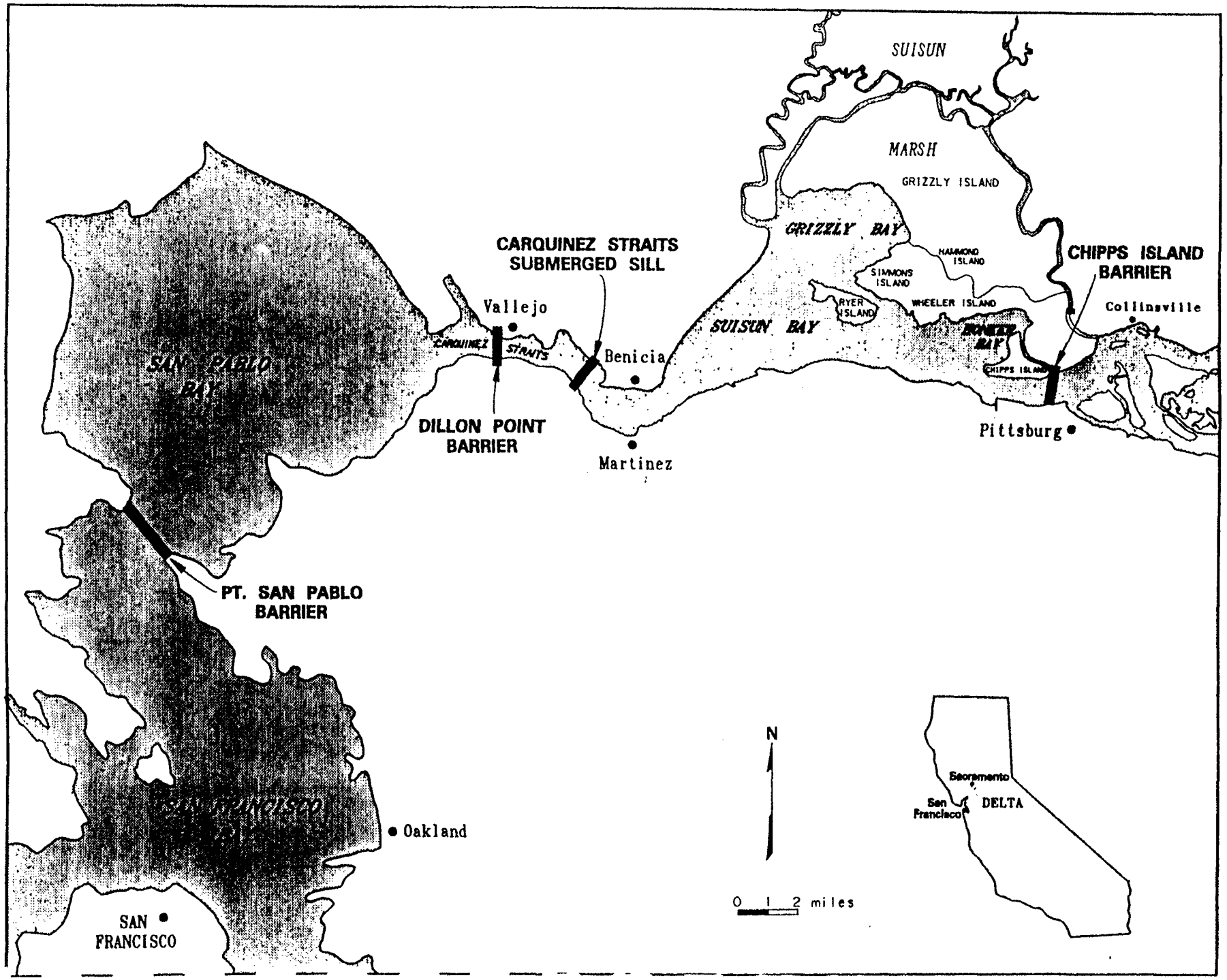
Although the barrier alternatives violate the institutional framework associated with the Delta, they would support the second project purpose, to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant

C—087243

C-087243

Figure 4-21

PHYSICAL BARRIER ALTERNATIVE



C-087244

C-087244

o **Timing**

This alternative is a long-term alternative, not an interim one.

o **Conclusion**

Because of the long-term time frame of the Chipps Island Barrier, it is not retained for second-stage screening.

AGENCY / PUBLIC INPUT ALTERNATIVES

Five of the alternatives in the EIR/EIS were developed through advanced review of the initial 404(b)(1) process. This review consisted of several interagency meetings with NMFS, USFWS, EPA, USACE, USBR, DFG and DWR. Many of the alternative components discussed in the review are included in this report, earlier in this chapter. The remaining alternative components are evaluated below, consistent with all other 404(b)(1) alternative screening.

Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water

o **Description**

The "Reduction of CVP/SWP Exports" component of this alternative is covered earlier in this chapter under the category, "South Delta Water Agency Alternatives." The "Management or Reduction of Demand for SWP Water" component is covered earlier in this chapter under the category, "Level II Options."

o **Project Purposes**

This alternative does not meet either project purpose.

o **Timing**

Timing is not a problem with this alternative.

o **Conclusion**

Since it does not satisfy either project purpose, this alternative would not normally be retained for further evaluation. However, in meetings held between DWR, USBR and several State and federal agencies, it was the consensus opinion that this alternative should be retained for further evaluation,and it is therefore included in the second-stage screening and in the EIR/EIS.

Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP Pumping Capability

o **Description**

(1) Head of Old River barrier (fall installation only)

This component would continue installation of a temporary rock barrier at the head of Old

River only in the fall of each year.

(2) Modification of CVP/SWP exports

This component would require operating under the CVP/SWP pumping limits per the December 15 Accord, except during the April 15 to May 15 period, when allowable project exports would be reduced to no greater than 50% of Vernalis flow, or 1,100 cfs, whichever was greater (see footnote 22 State Water Resources Control Board Water Quality Control Plan, May 1995). Current plan states 100% of Vernalis flows, or 1,500 cfs, whichever is greater.

(3) Consolidation of agricultural diversions, extension of diversions with dredging as needed

Agricultural diversions would be consolidated in reaches of Old and Middle Rivers, and Paradise Cut (Figure 4-22). Forty diversions would be consolidated to 10, with fish screens installed on the consolidated diversions. Approximately 250 acres of regulating reservoirs (Figure 4-23) would be required at the consolidated diversions, because of variable demand and pump rates, with the surface area of the largest reservoir being approximatily 90 acres. Channel dredging would be necessary in Middle River and North Paradise Cut, and pump platforms in these channels would need to be removed and rebuilt with longer intake pipes.

(4) Extension of agricultural diversions

Where consolidation is not feasible, the pump intakes at agricultural diversions would be extended. Fifty three pump intakes would require extensions averaging three feet in depth.

(5) Improve SWP pumping capability

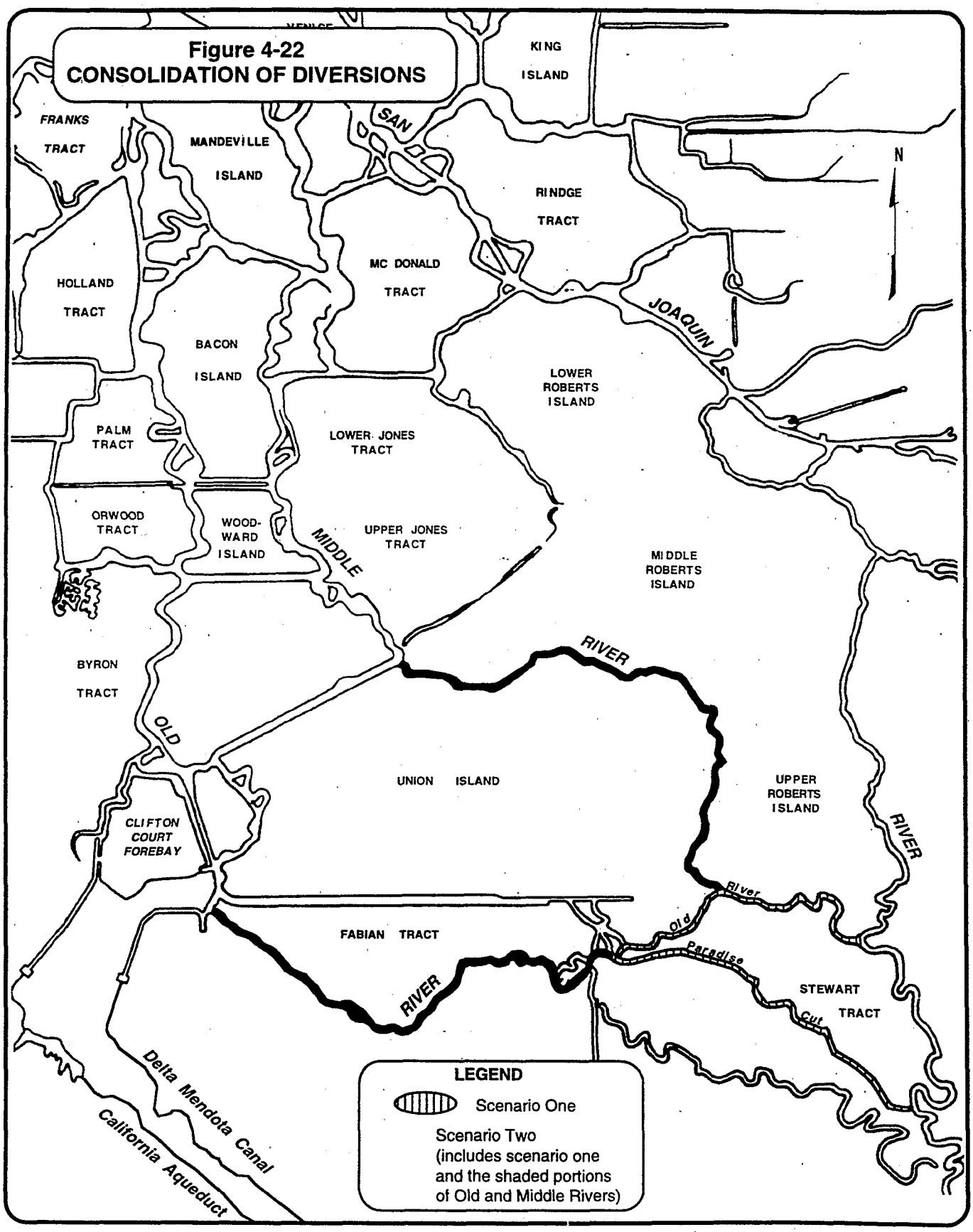
SWP pumping capability would be improved to 10,300 cfs by installing new Clifton Court Forebay intake gates and dredging.

o Benefits

(1) The barrier at the confluence of Old River and San Joaquin River would improve water quality near Stockton and help salmon migrating up the San Joaquin River.
(2) Modification of exports would reduce fish losses, because of less pumping. Export reduction would reduce reverse flow.
(3),(4) Consolidating diversions could reduce fish losses to salmon, but screening to protect eggs, larvae or delta smelt has been unsuccesful,
(5) Improving SWP pumping capability would reduce fish losses related to SWP pumping by enabling more pumping at times when fish loss would be less.

o Project Purposes

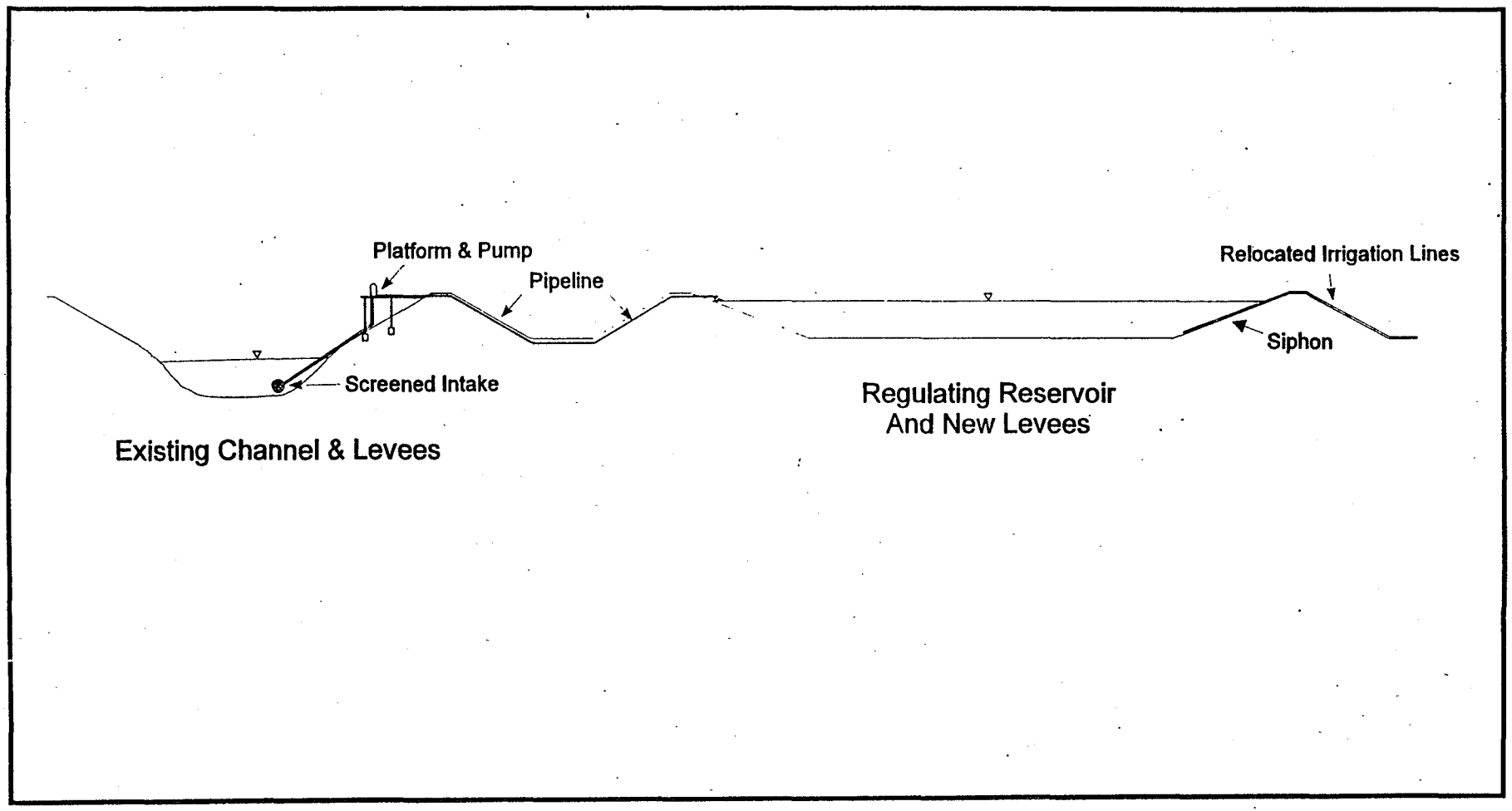
This alternative would support the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant. It would not support the first project purpose (to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions), because there would be no improvement in circulation in the channels. Attempts to find feasible solutions to the circulation problem have been unsuccessful. To solve the problem, agricultural drainage would have to be consolidated and transported far enough away from the south Delta so that flows in Delta channels will not bring the drainage back into the south Delta. This solution is not feasible.



C—087247

C-087247

C-087248



Cross Section of a Typical Installation

Not to Scale

Figure 4-23

C—087248

o **Timing**

It should not take longer than 5 to 7 years to implement the components of this alternative.

.o **Conclusion**

Since it does not satisfy the second project purpose, this alternative would not normally be retained for further evaluation. However, in meetings held between DWR, USBR and several State and federal agencies, it was the consensus opinion that this alternative should be retained for further evaluation, and it is therefore included in the second-stage screening and in the EIR/EIS.

Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and an Additional Clifton Court Forebay Intake at Italian Slough

o **Description**

The Italian Slough intake structure (see Figure 4-24) would be operated during periods of very low SWP exports, when Clifton Court Forebay was not in use. The intake facility would include a four-bay flashboard structure which would allow water from Italian Slough to be diverted into the intake channel of the California Aqueduct. The 630-foot opening that connects the forebay to the intake channel would be blocked with a rock dam. This breach would be filled either using a barge that would be located in Italian Slough or using trucks. The time required to place or remove the rock dam would be from 4 to 6 weeks. Once the temporary rock dam was in place, the flashboards would be removed from the intake structure. The intake would remain open and water would be pumped as allowed by tide levels.

Because of the limited hydraulic capacity of Italian Slough, Delta diversions would be physically limited to approximately 2,300 cfs or 4,560 acre-feet per day. When the tides prevented pumping, the structure would remain open. When higher export pumping rates were needed, the flashboards would be reinserted and the rock dam would be removed, allowing access to the forebay.

Some limited channel dredging would be required to assure greater flow capacity, therefore lower velocity of the water, so that channel scouring would not occur. This dredging would be in reaches of Old River north of the Forebay to Woodward Canal. The dredging would increase the average channel depth by around five feet and would not be done in sections that affect the stability of channel islands or levees. The dredging would only be done in areas of potential scour. An existing scour monitoring program would be expanded to protect against excessive scouring. A seepage monitoring plan would be implemented to check for seepage resulting from dredging exposing sand lenses near the channel.

o **Benefits**

This alternative would lower fish loss per unit of water by diverting from a natural channel, thereby avoiding forebay predation losses. If exports are limited by other restrictions, then this alternative could be useful. Channel dredging would increase channel capacity and improve conveyance, thus allowing more SWP operational flexibility.

o **Project Purposes**

The maximum pumping capacity of this alternative is probably between 1,000 cfs and 3,000 cfs, which would support but not fully meet the second project purpose (to improve south

C—087249

C-087249

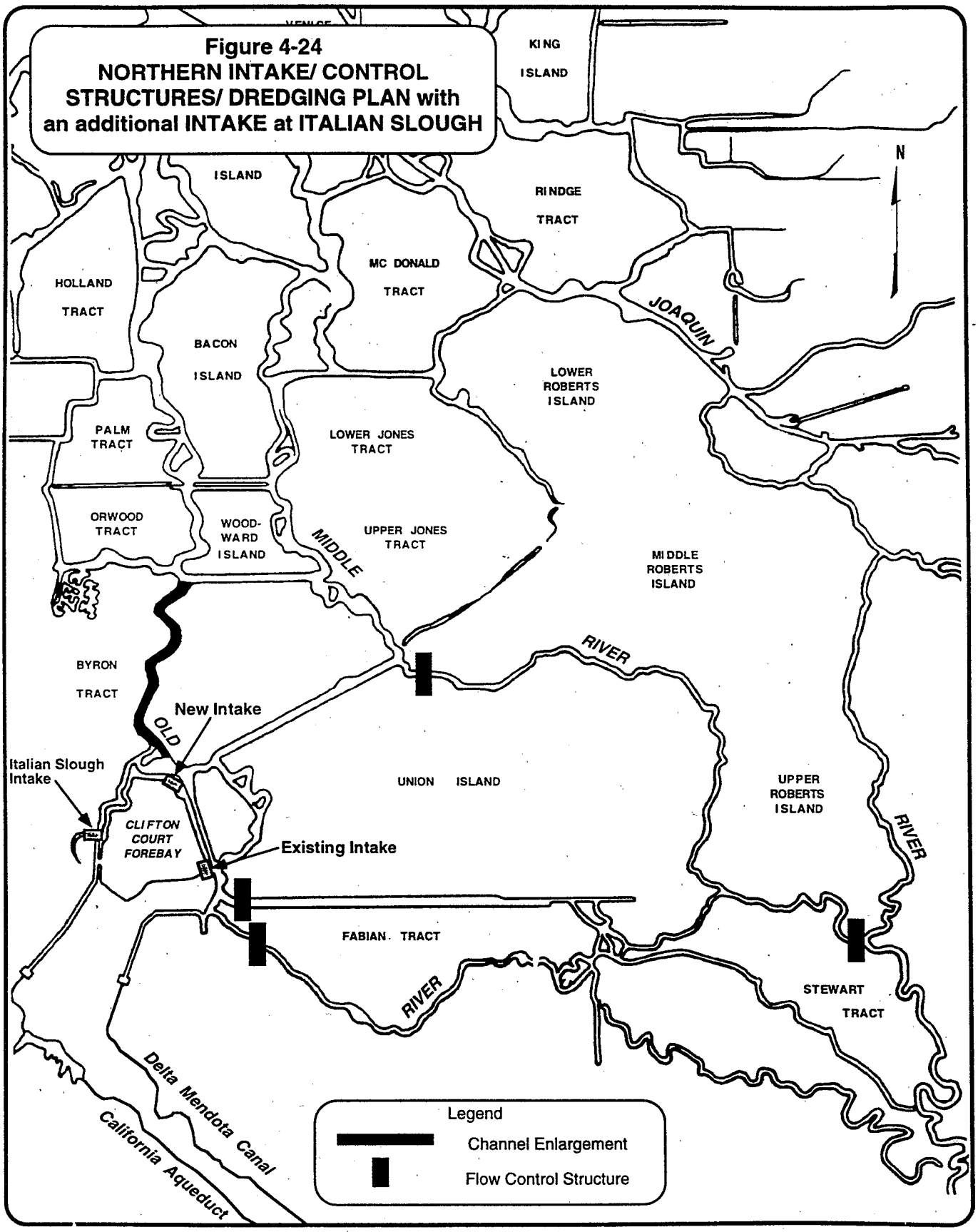


Figure 4-24
NORTHERN INTAKE/ CONTROL STRUCTURES/ DREDGING PLAN with an additional INTAKE at ITALIAN SLOUGH

Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant). The flow control structures support the first project purpose (to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions).

o **Timing**

This alternative fits in the interim time frame.

o **Conclusion**

This alternative supports the project purposes and fits in the interim time frame. Also, in meetings held between DWR, USBR and several State and federal agencies, it was the consensus opinion that this alternative should be retained for further evaluation, and it is included in the second-stage evaluation.

Limited Channel Dredging, South Delta Flow Control Structures, and Intake at Italian Slough

o **Description**

With this alternative (see Figure 4-25), the new intake would be constructed at Italian Slough instead of at the northeastern corner of Clifton Court Forebay. The intake would provide insufficient capacity to support the development of ISDP objectives. The limited hydraulic capacity of Italian Slough would limit diversions to 2,300 cfs or 4,560 AF per day. With this intake, ISDP operations would be limited to periods of very low SWP Delta imports.

Some limited channel dredging would be required to assure greater flow capacity, therefore lower velocity of the water, so that channel scouring would not occur. This dredging would be in reaches of Old River north of the Forebay to Woodward Canal. The dredging would increase the average channel depth by around five feet and would not be done in sections that affect the stability of channel islands or levees. The dredging would only be done in areas of potential scour. An existing scour monitoring program would be expanded to protect against excessive scouring. A seepage monitoring plan would be implemented to check for seepage resulting from dredging exposing sand lenses near the channel.

o **Benefits**

This alternative would lower fish loss per unit of water by diverting from a natural channel, thereby avoiding forebay predation losses. If exports are limited by other restrictions, then this alternative could be useful. Channel dredging would increase channel capacity and improve conveyance, thus allowing more SWP operational flexibility.

o **Project Purposes**

This alternative would not support the second project purpose (to improve south Delta hydraulic conditions to increase diversions into Clifton Court Forebay to maximize the frequency of full pumping capacity at Banks Pumping Plant). The flow control structures support the first project purpose (to improve water levels and circulation in the southern Sacramento-San Joaquin Delta channels for local agricultural diversions).

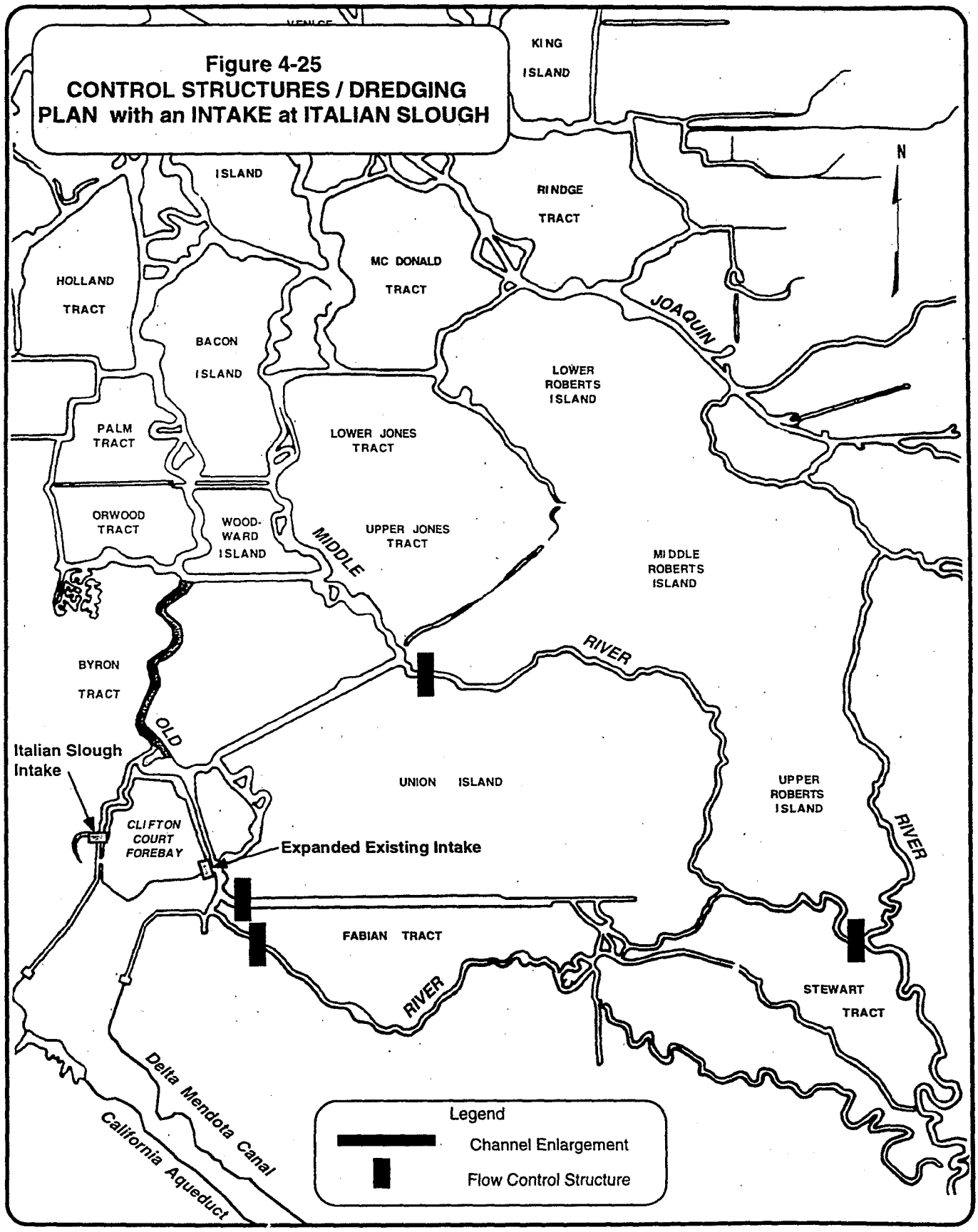


Figure 4-25
CONTROL STRUCTURES / DREDGING PLAN with an INTAKE at ITALIAN SLOUGH

C-087252

C-087252

o **Timing**

This alternative fits in the interim time frame.

o **Conclusion**

The maximum pumping capacity of this alternative is probably between 1,000 cfs and 3,000 cfs, which would not meet the second project purpose. However, in meetings held between DWR, USBR and several State and federal agencies, it was the consensus opinion that this alternative should be retained for further evaluation, and it is therefore included in the second-stage screening and in the EIR/EIS.

Those projects retained for second-stage evaluation are listed in Table 4-4.

Table 4-4

Alternatives Retained for Second-Stage Evaluation

South Delta Flow Control Structures

Northern Forebay Intake with Limited Channel Dredging

Northern Forebay Intake, Limited Channel Dredging, and South Delta Flow Control Structures

Channel Enlargement, South Delta Flow Control Structures, and Expanded Existing Intake

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at:
- -Byron Tract
- -North Victoria Island
- -South Victoria Island
- -Coney Island
- -Union Island

Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water

Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP Pumping Capability

Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and Additional Clifton Court Forebay Intake at Italian Slough

Limited Channel Dredging, South Delta Flow Control Structures, and Intake at Italian Slough

C—087254

C-087254

CHAPTER 5 - SECOND -STAGE EVALUATION

This chapter presents the second-stage evaluation of those alternatives that passed the first-stage screening criteria (see Table 4-1). Second-stage evaluation is a further investigation of the alternatives or combination of alternatives that appear practicable for meeting at least one of the project purposes, as well as implementation time. In the second-stage evaluation, each alternative is briefly reviewed for technical feasibility, as well as cost. Table 5-1 summarizes the information from the second-stage evaluation. Alternatives carried forward to third-stage evaluation are addressed in detail in the EIR/EIS.

Screening Criteria

As noted in Chapter 4, screening criteria provide a comprehensive way to determine whether a project alternative is practicable and the least environmentally damaging. Important factors, such as meeting the project purposes, technical constraints, environmental considerations, cost, and timing are included in the screening process.

The specific screening criteria used in the second-stage evaluation are technical feasibility and cost. These are presented in the following sections, along with supporting information used to develop each criterion.

Technical Feasibility

An alternative, either individually or in combination with other possible alternatives, must not have any significant geotechnical or engineering site problems, questionable or untested technology, or unreliable availability of site or resources. Construction must be feasible, and earthquake risk and safety risk must be considered.

Existing technology must be adequate to ensure that the basic project purposes can be reasonably met. Reliance on any questionable or untested technology could put the project at risk and may not allow the fulfillment of the project purposes. Meeting the improved-hydraulics components of the project purpose will be expensive with any alternative, and using unsound, untested, or questionable technology presents a high risk of nonachievement of the purpose. In some instances, technology may exist but may not be advanced enough to make a particular alternative cost effective.

Cost

The proposed project is in response to the SDWA lawsuit and Governor Wilson's Water Policy. Whether or not to do the project is not entirely a financial decision. However, economic considerations are important in deciding which alternatives, either individually or in combination with other alternatives, are competitive with other alternatives that meet the criteria of project purpose, timing and technical feasibility.

Where the cost and yield of an alternative can be reasonably estimated, the "break even point," or number of years in which the project would pay for itself, will be determined for that alternative, based on a water value of $125/AF.

Cost estimates associated with the various ISDP alternatives discussed in the first-stage evaluation vary widely and do not include associated costs of delivering water to the customer. When relevant to the screening process, unit costs and benefits to the various urban and agriculture

C—087255

C-087255

Table 5-1

SECOND-STAGE EVALUATION OF ALTERNATIVES

ALTERNATIVES	SCREENING CRITERIA: TECHNICALLY FEASIBLE?	COST: CAPITAL COST (millions)*	COST: BREAK-EVEN POINT (years)	RETAINED?	COMMENTS
South Delta Flow Control Structures	Yes	$33	NA	Yes (combined w/ other alt.)	Solution to water level and circulation problems in SDWA channels. Should be combined with other features for complete project.
Northern Forebay Intake with Limited Channel Dredging	Yes	$23	NA	Yes (combined w/ other alt.)	Should be combined with other features for complete project.
Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures	Yes	$56	6.8	Yes	Relatively low-cost solution.
Channel Enlargement, South Delta flow Control Structures, and Expanded Existing Intake	Yes	$72	8.7	Yes	
Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at: - Byron Tract	Yes	$200	24.2	No	Unwilling property seller.
- North Victoria Island	Yes	$280	33.9	Yes	Less impact on SD water levels. Land available.
- South Victoria Island	Yes	$220	26.7	No	More impact on SD water levels.
- Coney Island	Yes	$125	15.2	No	Too small additional storage.
- Union Island	Yes	$300	36.4	No	Relatively costly solution.
Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water	Yes	--	NA	Yes	Retained per agencies
Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP Pumping Capabilities	Yes	$79	9.6	Yes	Retained per agencies
Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and Additional Clifton Court Forebay Intake at Italian Slough	Yes	$59	7.2	Yes	Limited hydraulic capacity at Italian Slough.
South Delta Flow Control Structures, Limited Channel Dredging and Intake at Italian Slough	Yes	$40	NA	Yes	Retained per agencies

* Not including land cost

C-087256

C-087256

users will be examined in detail for those alternatives referred to the third-stage screening. The EIR/EIS for the ISDP describes the economic risk model developed to evaluate the economic benefits of additional development of the SWP. The model operates by comparing the urban and agriculture supply and demand, and simulating expected local response.

The Department's ability to finance construction of these alternatives, along with the SWP contractors' ability to repay the incurred financial obligation, is of concern. Financing would be through the sale of water revenue bonds, backed by the contractors' bond credit rating and repayment ability. Revenues collected from the contractors would be used to pay the principal and interest on the bonds.

The level of revenue bond financing which the Department could obtain is based on the investment community's perception of the financial strength and operating integrity of the SWP. To a great extent, the SWP's financial strength is directly related to the contractors' ability to repay the operating and capital costs of SWP facilities constructed. The Department's bond rating, which is an indicator of SWP financial strength, is even more directly related to the credit rating of the Metropolitan Water District of Southern California, the largest of the contractors. The amount of revenue bond financing that could be raised is directly related to the contractors' ability to repay the operating and capital costs over the life of the bonds sold, usually about 35 years. The repayment ability of the contractors is determined by consumer water rates, taxing authority, and commodity prices. The Department would collect revenues for the repayment of water supply-associated costs from the 29 SWP contractors. With the implementation of some of the more expensive alternatives, the current SWP conservation water charge would double (and this does not include additional off-stream storage costs or delivery costs).

Alternatives

SOUTH DELTA WATER AGENCY ALTERNATIVES

South Delta Flow Control Structures

Introduction

The alternative of flow control structures at four locations in the south Delta (see Figure 4-1) has the least environmental impact of alternatives that meet the project purpose of improving water levels and circulation patterns. An indication of this is the fact that flow control structures have been included in the settlement contract with SDWA, CVPIA, and historic mitigation actions. The flow control structures could be combined with many other alternatives to meet both of the project purposes. These combined alternatives will be discussed later in this chapter.

One proposed plan, as described in the first-stage evaluation, would be several gated channel flow control structures installed at strategic locations in south Delta channels. These would take advantage of the natural tidal cycle of changing flow directions and water elevations to create desired hydraulic conditions. The structure gates would be operated to open and close during phases of the tide, using the natural forces to improve water levels and circulation.

Temporary low rock weirs have been installed at three specific locations during past irrigation seasons. These installations, along with numerous hydrodynamic model runs, have shown that the barrier concept does relieve problems caused by low water levels and poor circulation. Monitoring of these temporary barriers has been ongoing and will continue to assess operational performance and provide input to the development of the permanent flow control

C—087257

C-087257

structures. Available information will be provided to the long-term planning process to provide guidance for a long-term Delta solution.

Conceptual Alternative Description

As presently proposed, the features of this alternative would include three agricultural flow control structures and a flow control structure serving as a fish barrier at the head of Old River. The agricultural flow control structures would consist of moderate-sized gated concrete structures on Middle River, south of the confluence of Middle River, Trapper Slough and North Canal; and on Old River east of the Delta-Mendota Canal intake; and, a large gated concrete structure across Grant Line Canal and Fabian-Bell Canal just above the confluence with Old River. This latter structure would either be a full barrier with a large boat lock, or a partial barrier with an open or flashboarded section large enough (approximately 60 feet wide) to accommodate maintenance barges. A typical structure would be about 15 feet high with radial gates, which could range from 20 to 60 feet wide.

The agricultural flow control structures would use the natural tidal hydraulics to provide higher water levels upstream during low tide periods, for improved agricultural pumping conditions; and would use the outgoing tide during selected periods to more thoroughly flush out the channels. If necessary, they would have electronic controls to control the gates in response to upstream needs.

The flow control structure serving as a fish barrier is mandated by PL 102-575, where it states that the USBR, in cooperation with the State and in consultation with local interests, shall construct and operate a barrier at the head of Old River on a seasonal basis to increase the survival of young outmigrating salmon in a manner that does not significantly impair the ability of local entities to divert water. This structure would help improve water quality in the San Joaquin River, as well as helping fish.

Technical Feasibility

No known technical or engineering constraints exist.

Cost

Channel flow control structures are relatively inexpensive and fairly easily constructed, compared to other types of structures in the Delta. Costs can run between $3.6 and $14.4 million each, depending on the size and type of structure and features such as boat portage facilities and number of gates. The cost of the four barriers is estimated to be $33 million. In addition, there would be annual maintenance and operation costs.

Conclusion

Since there are neither known technical nor relative cost problems with this alternative, it is combined with other alternatives below.

C—087258

C-087258

INTERIM SOUTH DELTA WATER MANAGEMENT ALTERNATIVES

Introduction

This section presents several alternatives that are combinations of various features which were evaluated separately. These alternatives satisfy one or both project purposes and the interim water management goals specified in the Governor's water policy.

Northern Forebay Intake with Limited Channel Dredging

Conceptual Alternative Description

With this alternative (see Figure 4-4), Clifton Court Forebay would retain its present area of 2,100 acres. A multigate (possibly 10 gates) intake structure would be built in the northeast corner of Clifton Court near the confluence of Old River and Victoria and North Canals. This intake structure would be operated to utilize high tide elevations for increased inflow to the forebay, with flows of 12,000 cfs to 30,000 cfs for short periods. The existing intake structure would remain operable for special needs. The pumping rate at Banks Pumping Plant would be allowed to go to 10,300 cfs when fish impacts would be low, but would be less during fish migration periods. The limitations established by the Endangered Species Act will determine pumping rates to a great extent.

Some limited channel dredging would be required to assure greater flow capacity, therefore lower velocity of the water, so that channel scouring would not occur. This dredging would be in reaches of Old River north of the Forebay to Woodward Canal. The dredging would increase the average channel depth by around five feet and would not be done in sections that affect the stability of channel islands or levees. The dredging would only be done in areas of potential scour. An existing scour monitoring program would be expanded to protect against excessive scouring. A seepage monitoring plan would be implemented to check for seepage resulting from dredging exposing sand lenses near the channel.

Technical Feasibility

No known technical or engineering constraints exist. In 1992, DWR sampled dredge sediment in the vicinity of Old River and Middle River, adjacent to proposed flow control sites, and around Victoria Island. Thirteen sediment samples, thirteen water quality samples, and eleven soil samples from the backsides of levees were taken between October and December 1992. This sampling program included two water and two sediment sample sites within the proposed dredging area of ISDP. One set of samples were taken at the confluence of Old River and North Victoria Canal and another set from just north of Highway 4. In September 1994, six additional sites were sampled for sediment and four for water. The sample sites were located in Old River between North Victoria Canal and Clifton Court Forebay. All samples were analyzed using EPA approved tests for a variety of constituents including metals, tributyltin, PCBs and pesticides. As in most environmental investigations, it is impossible to adequately extrapolate the results from a relatively small investigation to the actual project. However, from the results of the investigation, it appears likely that significant impacts due to contamination in the dredged material will not occur.

Cost

The cost of this alternative would be about $23 million. This cost does not include dredge

C—087259

C-087259

disposal costs.

Conclusion

Since there are neither known technical nor relative cost problems with this alternative, it is combined with other alternatives below.

Northern Forebay Intake, Limited Channel Dredging, and South Delta Flow Control Structures

Conceptual Alternatives Description

With this alternative (see Figure 4-5), Clifton Court Forebay would retain its present area of 2,100 acres. A multigate (possibly 10 gates) intake structure would be built in the northeast corner of Clifton Court near the confluence of Old River and Victoria and North Canals. This intake structure would be operated to utilize high tide elevations for increased inflow to the forebay, with flows of 12,000 cfs to 30,000 cfs for short periods. The existing intake structure would remain operable for special needs. The pumping rate at Banks Pumping Plant would be allowed to go to 10,300 cfs when high flows occur, but would be less during fish migration periods. The limitations established by the Endangered Species Act will determine pumping rates to a great extent.

Some limited channel dredging would be required to assure greater flow capacity, therefore lower velocity of the water, so that channel scouring would not occur. This dredging would be in reaches of Old River north of the Forebay to Woodward Canal. The dredging would increase the average channel depth by around five feet and would not be done in sections that affect the stability of channel islands or levees. The dredging would only be done in areas of potential scour. An existing scour monitoring program would be expanded to protect against excessive scouring. A seepage monitoring plan would be implemented to check for seepage resulting from dredging exposing sand lenses near the channel.

Four channel flow control structures would be installed in south Delta channels to control water levels, circulation and San Joaquin River flow. A separate federal regulatory permit would probably be requested after final approval of the SDWA settlement agreement.

Locations of the structure sites are: (1) Old River east of the Delta-Mendota Canal intake; (2) Middle River south of the confluence with Trapper Slough and North Canal; (3) Grant Line Canal east of the Forebay; and (4) Old River just west of its confluence with the San Joaquin River.

The control structure on Old River near the San Joaquin would be operated in the fall and spring to help salmon migrating in the San Joaquin River. During other times of the year, it would not alter flows. The gates on the other three control structures would be operated during the irrigation season to fulfill their purpose, but would be raised the rest of the year to maintain channel carrying capacity.

Technical Feasibility

No known technical problems exist. Channel sediment and levee soil samples have been taken in the past, and additional sampling will be done. Also, see write-up under "Northern Forebay Intake with Limited Channel Dredging," earlier in this chapter, for sediment sampling

C—087260

C-087260

program.

Cost

The combination of all these features in this alternative would cost about $56 million. This could vary depending on what type of flow control structures are constructed, what type of boat passage facilities are needed, and technical problems encountered. This cost does not include dredge disposal costs. It is presently estimated that the average yield from this alternative would be 66,000 AF/year. Assuming the value of the water is $125/AF, this alternative would break even after 6.8 years.

Conclusion

Since there are neither technical nor relative cost problems with this alternative, it is carried forward to third-stage evaluation, in the EIR/EIS.

Channel Enlargement, South Delta Flow Control Structures, and Expanded Existing Intake

Conceptual Alternative Description

As explained in Chapter 4 (see Figure 4-6), this alternative would include all of the proposed components of the ISDP, except that the existing Clifton Court Forebay intake would be expanded to accommodate the additional flow, instead of constructing a new intake either at Italian Slough or at the northeastern corner of Clifton Court Forebay. The maximum capacity of the expanded intake would be 30,000 cfs. The base width of the new channel would have to be increased from its present width of 300 feet to 560 feet, to maintain the average velocity below three feet per second. The south-east levee along the existing approach channel would have to be relocated approximately 260 feet inland. A 230 kV transmission line and a portion of the southern forebay embankment would also have to be relocated. A building housing the controls for the facility would be placed between the two gate structures. It is anticipated that enlargement of West Canal would be required to maximize the full pumping capacity at Banks Pumping Plant and avoid scouring the channel.

The expanded intake would increase intake capacity to the forebay and reduce the impacts to south Delta water levels caused by the gate operation by allowing more water to be taken at more preferable high tide periods.

Technical Feasibility

No known technical problems exist. Channel sediment and levee soil samples have been taken in the past, and additional sampling will be done. Also, see write-up under "Northern Forebay Intake with Limited Channel Dredging," earlier in this chapter, for sediment sampling program.

Cost

The capital cost for this alternative is estimated to be $72 million. The final cost would depend on the type of flow control structures constructed, and the amount of channel enlargement needed. It is presently estimated that the average yield from this alternative would be 66,000

AF/year. Assuming the value of the water is $125/AF, this alternative would break even after 8.7 years.

Conclusion

Since there are neither technical nor relative cost problems with this alternative, it is carried forward to third-stage evaluation, in the EIR/EIS.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay

Introduction

Several enlarged forebay alternatives with combined features are presented here to cover all possible combinations that have merit. Each alternative has the same general features: channel flow control structures (four structures as described earlier); enlarged forebay area (three sites, as discussed below); new intakes; and channel enlargement. Pumping rates would be increased during periods of time when fish are not impacted, to help alleviate impacts on endangered species and take advantage of water storage facilities.

Greater forebay intake capacity would permit a more flexible operation around the high tide cycle, and when combined with the more northerly intake location where channels are larger, would help to improve the low tide water levels in the southern channels. The larger forebay capacity would give greater pumping flexibility and have less impact on local channels.

A necessary part of the larger intakes would be the need to improve local channel capacities so that scour would not occur. Channel dredging and/or levee setbacks would be needed downstream of the intakes.

Flow control structures would improve the low water levels and circulation in the south Delta. A flow control structure at Old River near the San Joaquin River could be operated during salmon spawning season and during migration of smolt to prevent entrance to Old River from the San Joaquin River.

The following evaluations are for the forebay expansion areas presented in Chapter 4.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at Byron Tract

Conceptual Alternative Description

The forebay expansion feature of this alternative would be a portion of Byron Tract, west of Clifton Court Forebay (see Figure 4-7). The present area being considered is about 3,100 acres. Project levees similar to those at Clifton Court would be built around this proposed area. An 18,000 cfs siphon structure under Italian Slough would connect the two forebays. Both forebays would be served by a new 30,000 cfs gated intake structure located in the northeast corner of the new forebay near Highway 4 (see Figure 4-5). This intake location is about 4.5 miles downstream (north) of the existing Clifton Court intake. The existing Old River channel below the new intake location would need to be enlarged to accommodate the proposed diversion rate. The amount of

C—087262

C-087262

enlargement is based on a need to keep channel velocities below a maximum of about three feet per second to minimize scour. It is estimated that possibly 2.5 miles of levee setback and new channel would be needed between Highway 4 and Woodward Canal.

The flow control structures, which have been discussed earlier in this report (see Figure 4-1), would be located on Middle River, Old River, Grant Line Canal, and at the head of Old River. All of the structures would only be operated a portion of the year when needed, and all of the structures except the one at the head of Old River would provide better water levels and circulation in south Delta channels.

Technical Feasibility

No known technical (engineering) problems exist. Channel sediment and levee soil samples have been taken in the past, and additional sampling will be done. Also, see write-up under "Northern Forebay Intake with Limited Channel Dredging," earlier in this chapter, for sediment sampling program. To date, no testing has been on the lands that could be converted to forebay.

Cost

The capital cost for this water management alternative is estimated to be approximately $200 million. The final cost would depend on the type of flow control structures constructed, and the amount of channel enlargement needed. Land costs are not included in any of the forebay enlargement alternatives, but the Byron owners are not willing sellers.

It is presently estimated that the average yield from this alternative would be 66,000 AF/year. Assuming the value of the water is $125/AF, and without land costs, this alternative would break even after 24.2 years.

Conclusion

Undoubtedly, it would be more expensive to include a forebay expansion in the ISDP. However, for more thorough evaluation, including environmental impacts, an alternative including a forebay expansion is included in the third-stage evaluation in the EIR/EIS. Because other expansions would have more northerly intakes leading to better quality for the SWP and less impact on south Delta water levels, and because land would be difficult to obtain and very expensive for a Byron Tract expansion, this alternative is not the forebay expansion alternative carried forward to third-stage evaluation.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at North Victoria Island

Conceptual Alternative Description

The forebay expansion feature of this alternative would consist of enlarging Clifton Court Forebay from about 2,100 surface acres to about 5,000 acres using the northern portion of Victoria Island, the southeast portion of Byron Tract, and the remainder of Clifton Court Tract (see Figure 4-8 Option A).

A siphon structure between Byron Tract and Victoria Island would be used to hydraulically connect the two expanded forebay areas. The siphon would be capable of conveying flows of 15,300 cfs at a velocity of about 6 feet per second. A portion of the west channel embankment of the intake channel to Banks Pumping Plant would be removed to connect the expanded forebay on Byron Tract to Clifton Court Forebay.

An option would be a transfer, or connection, channel to carry the water south to Clifton Court Forebay (see Figure 4-8 Option B). This canal would bisect the southern half of Victoria Island and connect to the northeast corner of Clifton Court and would require a bridge on Highway 4 and a siphon under Old River at Clifton Court. It would have a carrying capacity of 18,000 cfs and would be about two miles long.

Two new intake structures would be constructed on the north end of the expanded forebay on Victoria Island. One intake structure would be located at the confluence of North Victoria Canal and Middle River; the other at the confluence of North Victoria Canal and Old River. The intake at Middle River would have a capacity of 30,000 cfs, and the facility at Old River would have a capacity of 15,000 cfs. Intakes could be operated singly, or in combinations of two or three. The configuration of the Delta channels, however, would limit the total flow into the forebay to a maximum of about 30,000 cfs, regardless of how many of the intakes were open.

To increase the channel capacity north of the new intakes, a 2.3-mile reach of Middle River adjacent to Woodward Island would be enlarged by constructing a levee setback. After a new levee is placed, the existing levee would be breached to connect the old and new channels.

The flow control structures, which have been discussed earlier in this report, would be located on Middle River, Old River, Grant Line Canal, and at the head of Old River. All of the structures would provide better water levels and circulation in south Delta channels, and would only be operated a portion of the year when needed.

Technical Feasibility

No known technical problems exist. Channel sediment and levee soil samples have been taken in the past, and additional sampling will be done. Also, see write-up under "Northern Forebay Intake with Limited Channel Dredging," earlier in this chapter, for sediment sampling program. To date, no testing has been on the lands that could be converted to forebay.

Cost

The capital cost for this alternative is estimated to be about $280 million. The final cost would depend on the type of flow control structures constructed, and the amount of channel enlargement needed. Land costs are not included in any of the forebay enlargement alternatives, but would be relatively low for this alternative.

It is presently estimated that the average yield from this alternative would be 66,000 AF/year. Assuming the value of the water is $125/AF, and without land costs, this alternative would break even after 33.9 years.

Conclusion

Undoubtedly, it would be more expensive to include a forebay expansion in the ISDP.

C—087264

C-087264

However, for more thorough evaluation, including environmental impacts, an alternative including a forebay expansion is included in the third-stage evaluation in the EIR/EIS. Because this expansion has the most northerly intakes, leading to better quality for the SWP and less impact on south Delta water levels, and because land would be available, this alternative is the forebay expansion alternative carried forward to third-stage evaluation.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at South Victoria Island

Conceptual Alternative Description

The forebay expansion feature of this alternative would consist of about 3,700 acres of the southern half of Victoria Island, which is about 30 percent larger than the North Victoria alternative (see Figure 4-9). It would be bounded on the north by Highway 4 and would have two new intakes at the northwest and northeast corners. These would have capacities of 15,000 cfs and 30,000 cfs respectively. A siphon structure under Old River would connect to Clifton Court. To accommodate the new intake capacities, dredging may be required on Old River, and possibly levee setback with new channel would be required on Middle River for about two miles.

The flow control structures, which have been discussed earlier in this report, would be located on Middle River, Old River, Grant Line Canal, and at the head of Old River. All of the structures would provide better water levels and circulation in south Delta channels, and would only be operated a portion of the year when needed.

Technical Feasibility

No known technical problems exist. Channel sediment and levee soil samples have been taken in the past, and additional sampling will be done. Also, see write-up under "Northern Forebay Intake with Limited Channel Dredging," earlier in this chapter, for sediment sampling program. To date, no testing has been on the lands that could be converted to forebay.

Cost

The capital cost for this alternative is estimated to be about $220 million, not including land costs. Final cost will depend on the type of flow control structures constructed, and on the amount of channel enlargement needed. Land costs are not included in any of the forebay enlargement alternatives, but would be relatively high for this alternative.

It is presently estimated that the average yield from this alternative would be 66,000 AF/year. Assuming the value of the water is $125/AF, and without land costs, this alternative would break even after 26.7 years.

Conclusion

Undoubtedly, it would be more expensive to include a forebay expansion in the ISDP. However, for more thorough evaluation, including environmental impacts, an alternative including a forebay expansion is included in the third-stage evaluation in the EIR/EIS. Because the North Victoria expansion would have more northerly intakes leading to better quality for the SWP and less impact on south Delta water levels, this more southern alternative is not the forebay expansion alternative carried forward to third-stage evaluation.

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at Coney Island

Conceptual Alternative Description

As discussed in Chapter 4 (see Figure 4-10), the Coney Island forebay expansion would only cover 900 acres, which is much smaller than desired. It would connect with Clifton Court by a siphon structure, and would not have an intake but would receive water from Clifton Court. A little over five miles of embankment would be needed around the island. With no new intake feature planned, it is doubtful that the additional area would have optimum utilization; also, drawdown in the local channels below the flow structures would be increased because of the additional volume of pumping during certain times of the year.

Pumping rates from Banks Pumping Plant would have the capability to pump 10,300 cfs during high flow winter months. The larger forebay would give better operational flexibility to store surplus flows.

Selective operation of the flow control structure gates would improve local water levels and circulation. Also, there would be an improvement in recreation and fishery with the structure at the head of Old River.

The flow control structures, which have been discussed earlier in this report, would be located on Middle River, Old River, Grant Line Canal, and at the head of Old River. All of the structures would provide better water levels and circulation in south Delta channels, and would only be operated a portion of the year when needed.

Technical Feasibility

No known technical problems exist. Channel sediment and levee soil samples have been taken in the past, and additional sampling will be done. Also, see write-up under "Northern Forebay Intake with Limited Channel Dredging," earlier in this chapter, for sediment sampling program. To date, no testing has been on the lands that could be converted to forebay.

Cost

The capital cost for this alternative is estimated to be about $125 million. The final cost would depend on the type of flow control structures constructed, and the amount of channel enlargement needed. Land costs are not included in any of the forebay enlargement alternatives.

It is presently estimated that the average yield from this alternative would be 66,000 AF/year. Assuming the value of the water is $125/AF, and without land costs, this alternative would break even after 15.2 years.

Conclusion

Because of the small amount of additional storage, this alternative, by itself, is not carried forward. It is combined with Union Island below.

C—087266

C-087266

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay at Union Island

Conceptual Alternative Description

As discussed in Chapter 4 (see Figure 4-11), the Union Island forebay expansion would include Coney Island (900 acres) and a 2,000-acre portion of northwestern Union Island. A new northern intake structure would be constructed at the juncture of North Canal and Old River, or about 1.5 miles east of that location. A siphon structure would connect Union Island with Coney Island, and also Coney Island with Clifton Court Forebay. Channel dredging and/or levee setback would be required on Old River, Middle River, and possibly North Canal.

Pumping rates from Banks Pumping Plant would increase up to a maximum of 10,300 cfs during high flow winter months to help alleviate the water supply impacts from Endangered Species Act limitations. Exports would be lowered during fish migration periods to reduce impacts to the various fish species. As planned, the larger forebay would allow greater operational freedom to store water at high tides and result in less impact at low tides to local channel water levels. Greater intake capacity would permit more flexible operation around the high tide cycle, and when combined with the northern location, would help improve water levels and circulation in the south Delta channels.

There would be more flexibility in pumping operations and opportunity for later water banking, if available, during high flow periods. There would be improved water quality in the forebay and in south Delta channels, with potential for use of the old intake to release water to the south Delta during critical low water periods. A connection to serve Contra Costa Water District could also be constructed at a later time if desired. Selected operation of the flow control gates and forebay intake gates would improve water levels and circulation in south Delta channels. This would improve recreation and fisheries, which would also be improved by the flow control structure at the head of Old River.

The flow control structures, which have been discussed earlier in this report, would be located on Middle River, Old River, Grant Line Canal, and at the head of Old River. All of the structures would provide better water levels and circulation in south Delta channels, and would only be operated a portion of the year when needed.

Technical Feasibility

No known technical problems exist. Channel sediment and levee soil samples have been taken in the past, and additional sampling will be done. Also, see write-up under "Northern Forebay Intake with Limited Channel Dredging," earlier in this chapter, for sediment sampling program. To date, no testing has been on the lands that could be converted to forebay.

Cost

The capital cost for this alternative is estimated to be about $300 million. The final cost would depend on the type of flow control structures constructed, and the amount of channel enlargement needed. Land costs are not included in any of the forebay enlargement alternatives.

It is presently estimated that the average yield from this alternative would be 66,000 AF/year. Assuming the value of the water is $125/AF, this alternative would break even after 36.4 years.

C—087267

C-087267

Conclusion

Because of the relatively high cost of this alternative, it is not carried forward.

AGENCY / PUBLIC INPUT ALTERNATIVES

As stated in Chapter 4, five of the alternatives in the EIR/EIS were developed through advanced review of the initial 404(b)(1) process. This review consisted of several interagency meetings with NMFS, USFWS, EPA, USACE, USBR, DFG and DWR. The alternatives were evaluated in Chapter 4 and are evaluated below, consistent with all other 404(b)(1) alternative screening.

Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water

Conceptual Alternative Description

The "Reduction of CVP/SWP Exports" component of this alternative is covered earlier in this chapter under the category, "South Delta Water Agency Alternatives." The "Management or Reduction of Demand for SWP Water" component is covered earlier in this chapter under the category, "Level II Options."

Technical Feasibility

There is no technical feasibility problem with this alternative.

Cost

There is no construction cost associated with this alternative.

Conclusion

Although technical feasibility and cost are not problems, since in the first stage screening this alternative did not satisfy either project purpose, it would not normally be retained for further evaluation. However, in meetings held between DWR, USBR and several State and federal agencies, it was the consensus opinion that this alternative should be retained for further evaluation,and it is therefore included in the EIR/EIS.

Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP Pumping Capability

Conceptual Alternative Description

(1) Head of Old River barrier (fall installation only)

This component would continue installation of a temporary rock barrier at the head of Old River only in the fall of each year.

(2) Modification of CVP/SWP exports

This component would require operating under the CVP/SWP pumping limits per the December 15 Accord, except during the April 15 to May 15 period, when allowable project exports would be reduced to no greater than 50% of Vernalis flow, or 1,100 cfs, whichever was greater (see footnote 22 State Water Resources Control Board Water Quality Control Plan, May 1995). Current plan states 100% of Vernalis flows, or 1,500 cfs, whichever is greater.

(3) Consolidation of agricultural diversions, extension of diversions with dredging as needed

Agricultural diversions would be consolidated in reaches of Old and Middle Rivers, and Paradise Cut (Figure 4-22). Forty diversions would be consolidated to 10, with fish screens installed on the consolidated diversions. Approximately 250 acres of regulating reservoirs (Figure 4-23) would be required at the consolidated diversions, because of variable demand and pump rates, with the surface area of the largest reservoir being approximatily 90 acres. Channel dredging would be necessary in Middle River and North Paradise Cut, and pump platforms in these channels would need to be removed and rebuilt with longer intake pipes.

(4) Extension of agricultural diversions

Where consolidation is not feasible, the pump intakes at agricultural diversions would be extended. Fifty three pump intakes would require extensions averaging three feet in depth.

(5) Improve SWP pumping capability

SWP pumping capability would be improved to 10,300 cfs by installing a new Clifton Court Forebay northerly intake structure and dredging.

Technical Feasibility

This alternative is assumed to be technically feasible. However, feasibility and jurisdictional issues include the following:

(1) negotiations with landowners would be required for implementation;
(2) there would be water rights issues to be resolved;
(3) appropriate screen technology would have to be available;
(4) the Williamson Act restricts use of designated lands to agriculture and related uses during a 10-year period. Much of the regulating reservoir land is protected by the Williamson Act. Consultation would be needed to determine if reseervoirs violate this act;
(5) seepage from the regulating reservoirs could cause problems for farmers by raising the ground water table into crop root zones and damaging the crops;
(6) reservoirs would need to be under the jurisdiction of the State Division of Safety of Dams;
(7) reserevoirs may be subject ot land subsidence, common in the Delta;
(8) Operation and maintenance of new facilities would need to be negotiatied between the State and agricultural business owners; and
(9) power costs for pumping will likely increase due to the consolidation of diversions.

Cost

The estimated (1) annual cost of installing and removing the head of Old River barrier (fall installation only) is $0.5 million. The present worth cost (based on 50 years of installation and removal and an interest rate of 6%) is $8 million. There is no construction cost associated with (2)

modification of exports. The estimated cost of (3) the consolidation and extension of agricultural diversions is $34 million, related dredging $13 million, and (4) extension of agricultural diversions including rebuilding platforms $2 million. The estimated cost of (5) a new intake structure and related dredging is $22 million. Altogether, the estimated cost of this alternative is $79 million.

It is presently estimated that the average yield from this alternative would be 66,000 AF/year. Assuming the value of the water is $125/AF, this alternative would break even after 9.6 years.

Conclusion

Since, in the first-stage screening, it did not satisfy the second project purpose, this alternative would not normally be retained for further evaluation. However, in meetings held between DWR, USBR and several State and federal agencies, it was the consensus opinion that this alternative should be retained for further evaluation, and it is therefore included in the EIR/EIS.

Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and Additional Clifton Court Forebay Intake at Italian Slough

Conceptual Alternative Description

As detailed in Chapter 4 (see Figure 4-23), the Italian Slough intake structure would be operated during periods of very low SWP exports, when Clifton Court Forebay was not in use. The intake facility would include a four-bay flashboard structure which would allow water from Italian Slough to be diverted into the intake channel of the California Aqueduct. The 630-foot opening that connects the forebay to the intake channel would be blocked with a rock dam. This breach would be filled either using a barge that would be located in Italian Slough or using trucks. The time required to place or remove the rock dam would be from 4 to 6 weeks. Once the temporary rock dam was in place, the flashboards would be removed from the intake structure. The intake would remain open and water would be pumped as allowed by tide levels.

Because of the limited hydraulic capacity of Italian Slough, Delta diversions would be physically limited to approximately 2,300 cfs or 4,560 acre-feet per day. When the tides prevented pumping, the structure would remain open. When higher export pumping rates were needed, the flashboards would be reinserted and the rock dam would be removed, allowing access to the forebay.

This alternative would lower fish loss per unit of water by diverting from a natural channel, thereby avoiding forebay predation losses. If exports are limited by other restrictions, then this alternative could be useful.

Technical Feasibility

No known technical problems exist. Channel sediment and levee soil samples have been taken in the past, and additional sampling will be done. Also, see write-up under "Northern Forebay Intake with Limited Channel Dredging," earlier in this chapter, for sediment sampling program. To date, no testing has been on the lands that could be converted to forebay.

Cost

The capital cost for this alternative is estimated to be $59 million, including $3.3 million for the Italian Slough intake. The final cost would depend on the type of flow control structures constructed, and the amount of channel enlargement needed.

It is presently estimated that the average yield from this alternative would be 66,000 AF/year. Assuming the value of the water is $125/AF, this alternative would break even after 7.2 years.

Conclusion

Since there are neither technical nor relative cost problems with this alternative, it is carried forward to third-stage evaluation, in the EIR/EIS.

Limited Channel Dredging, South Delta Flow Control Structures, and Intake at Italian Slough

Conceptual Alternative Description

With this alternative (see Figure 4-24), the new intake would be constructed at Italian Slough instead of at the northeastern corner of Clifton Court Forebay. The intake would provide insufficient capacity to support the development of ISDP objectives. The limited hydraulic capacity of Italian Slough would limit diversions to 2,300 cfs or 4,560 AF per day. With this intake, ISDP operations would be limited to periods of very low SWP Delta imports.

Some limited channel dredging would be required to assure greater flow capacity, therefore lower velocity of the water, so that channel scouring would not occur. This dredging would be in reaches of Old River north of the Forebay to Woodward Canal. The dredging would increase the average channel depth by around five feet and would not be done in sections that affect the stability of channel islands or levees. The dredging would only be done in areas of potential scour. An existing scour monitoring program would be expanded to protect against excessive scouring. A seepage monitoring plan would be implemented to check for seepage resulting from dredging exposing sand lenses near the channel.

This alternative would lower fish loss per unit of water by diverting from a natural channel, thereby avoiding forebay predation losses. If exports are limited by other restrictions, then this alternative could be useful. Channel dredging would increase channel capacity and improve conveyance, thus allowing more SWP operational flexibility.

Technical Feasibility

No known technical prolems exist.

Cost

The capital cost for this alternative is estimated to be $40 million, including $3.3 million for the Italian Slough intake. The final cost would depend on the type of flow control structures constructed, and the amount of channel enlargement needed.

Conclusion

In the first-stage screening, it was shown that this alternative would not meet the second project purpose. However, in meetings held between DWR, USBR and several State and federal agencies, it was the consensus opinion that this alternative should be retained for further evaluation, and it is therefore included in the EIR/EIS.

Summary

Table 5-2 lists the alternatives that are carried forward to third-stage evaluation. Two alternatives discussed in the preceding section ("South Delta Flow Control Structures," and "Northern Forebay Intake with Limited Channel Dredging") were combined to form the first alternative listed in Table 5-2 ("Northern Forebay Intake, Limited Channel Dredging, and South Delta Flow Control Structures"). The second alternative listed in Table 5-2 includes as expanded existing intake instead of a northern forebay intake. The third alternative is based on forebay enlargement, which also includes the flow control structures feature in order to meet both project purposes. The other alternatives are the agency/public input alternatives, where in meetings held between DWR, USBR and several State and federal agencies, it was the consensus opinion that these alternatives should be retained for further evaluation.

As stated earlier, operational flexibility would be incorporated in all of the final alternatives carried forward.

These alternatives meet the CEQA and NEPA requirements for evaluating a reasonable range of alternatives. They will be discussed in more detail in the EIR/EIS. Selection of the least environmentally damaging practicable alternative will then be made according to Section 230.10 of the regulations implementing the Clean Water Act, Section 404(b)(1):

> "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."

The alternatives passed on to third-stage evaluation are all water-dependent, i.e., they must be located within special aquatic sites to fulfill the basic project purposes. Therefore, it is not necessary to demonstrate that a practicable alternative that does not involve the special aquatic sites exists. See the "Section 404 (b) (1) Guidelines" section of Chapter 1.

Regarding Third-Stage Evaluation

Third-stage evaluation of the remaining alternatives and the alternatives requested by other agencies takes place in the ISDP EIR/EIS document. As quoted in Chapter 1, the Section 404 (b) (1) Guidelines state in Subpart B:

> "No discharge of dredged or fill material shall be permitted if there is a <u>practicable alternative</u> to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences."

The above criteria are the principle focus of the third-stage evaluation. The least adverse impact to the aquatic ecosystem will be determined using the ESA Biological Opinion which will determine if the project will jeopardize the environment. NMFS and USFWS must provide reasonable and prudent alternatives to the action that avoids jeopardy.

Table 5-2

Alternatives Retained for Third-Stage Evaluation

Northern Forebay Intake, Limited Channel Dredging, and South Delta Flow Control Structures

Channel Enlargement, South Delta Flow Control Structures, and Expanded Existing Intake

Channel Enlargement, South Delta Flow Control Structures, and Enlarged Forebay Expansion at North Victoria Island

Reduction of CVP/SWP Exports and Management or Reduction of Demand for SWP Water

Head of Old River Barrier, Modification of CVP/SWP Exports, Consolidation of Agricultural Diversions, Extension of Agricultural Diversions, Improvement of SWP Pumping Capability

Northern Forebay Intake, Limited Channel Dredging, South Delta Flow Control Structures, and Additional Clifton Court Forebay Intake at Italian Slough

Limited Channel Dredging, South Delta Flow Control Structures, and Intake at Italian Slough

C—087273

C-087273

APPENDIX A--STATE WATER PROJECT

Voters authorized construction of the State Water Project (SWP) in 1960 by ratifying the Burns-Porter Act. At that time, the plans recognized that there would be a gradual increase in water demand and that some of the supply facilities could be deferred until later. The SWP's major components include the multipurpose Oroville Dam and Reservoir on the Feather River, the Edmund G. Brown California Aqueduct, South Bay Aqueduct, North Bay Aqueduct, and a portion of San Luis Reservoir. Delta water transfer facilities were part of the original plan, and additional Sacramento and North Coast basin supply reservoirs were envisioned. Contracts were signed for an eventual delivery of 4.23 MAF. Of this amount, about 2.50 MAF of water is destined for south of the Tehachapis, nearly 1.36 MAF to the San Joaquin Valley, and the remaining 0.37 MAF to the San Francisco Bay and Central Coast regions and the Feather River area. Service areas of the present 29 contracting agencies are shown in Figure A-1. Generally, use of SWP supply in the San Joaquin Valley has been near full contract amounts since 1980 (except during very wet years and deficient-supply years), whereas Southern California use has built up to about 60 percent of full entitlement.

The initial features of the SWP begin with three small reservoirs in the upper Feather River basin in Plumas County: Lake Davis, and Frenchman and Antelope Lakes. Farther downstream in the foothills of the Sierra Nevada is the 3.5-MAF Lake Oroville, the second largest reservoir in California, where winter and spring flows of the Feather River are stored (see Figure A-2). The 444-mile California Aqueduct is the state's largest and longest water conveyance system, beginning in the southwest Delta at Banks Pumping Plant and extending to Lake Perris south of Riverside, in Southern California.

Delta water is taken into Clifton Court Forebay via intake gates which are operated in coordination with the tide and to avoid any contribution to low water levels in the south Delta during the irrigation season. Generally, the gates are open during periods of high tide and closed during low tides. Water which has flowed into the forebay is then pumped by Banks Pumping Plant into the aqueduct. This water continues to be pumped southward and westward, with amounts exceeding immediate needs temporarily stored in the 2.0-MAF San Luis Reservoir (which is shared with the CVP). At the southern end of the San Joaquin Valley, pumps at Edmonston Pumping Plant lift water 1,926 feet, sending flows through the Tehachapi Mountains by tunnels and into Southern California. Slightly over 1.5 MAF was pumped at Edmonston Pumping Plant in 1990.

The estimated seven-year average dry-period yield of the SWP with its current facilities operating to the requirements of Water Right Decision 1485 is about 2.4 MAF per year. Entitlement demand of SWP contractors for the year 2010 is an estimated 4.1 MAF. To augment project supply, additions to the SWP are proposed and include: Delta facilities; interim south Delta facilities; groundwater recharge facilities; additional offstream storage facilities; and possible conjunctive use of surface storage and ground water in the Sacramento and San Joaquin valleys; and short- and long-term water purchases.

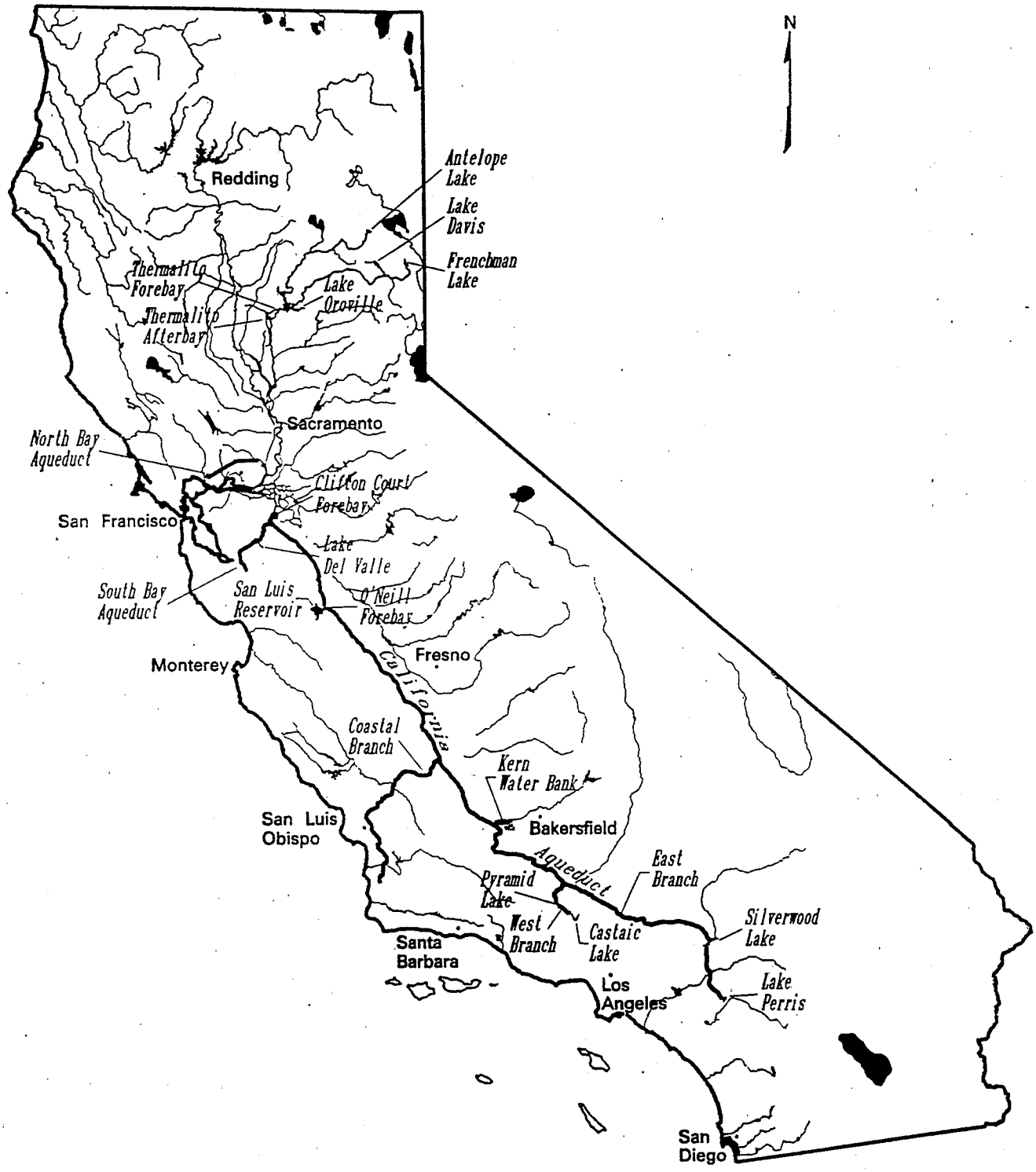
In the short-term, SWP contractors relying on the Delta for all or a portion of their supplies face great uncertainty in terms of water supply reliability due to the uncertain outcome of a number of actions currently being undertaken to protect aquatic species in the Delta. Until solutions to complex Delta problems are identified and put into place, many will experience more frequent and severe water supply shortages (see Tables 4-2 and 4-3 in Chapter 4).

C—087274

C-087274

Figure A-1. State Water Project Service Areas

Figure A-2. Major State Water Project Facilities



APPENDIX B--Central Valley Project

The U.S. Bureau of Reclamation's Central Valley Project is the largest water storage and delivery system in California, covering 29 of the State's 58 counties. The project's features include 18 federal reservoirs, plus 4 additional reservoirs jointly owned with the State Water Project (primarily San Luis Reservoir). The keystone of the CVP is the 4.6-MAF Lake Shasta, the largest reservoir in California. The reservoirs in this system provide a total storage capacity of slightly over 12 MAF, nearly 30 percent of the total surface storage in California, and deliver about 7.3 MAF annually to agricultural, urban, and wildlife uses.

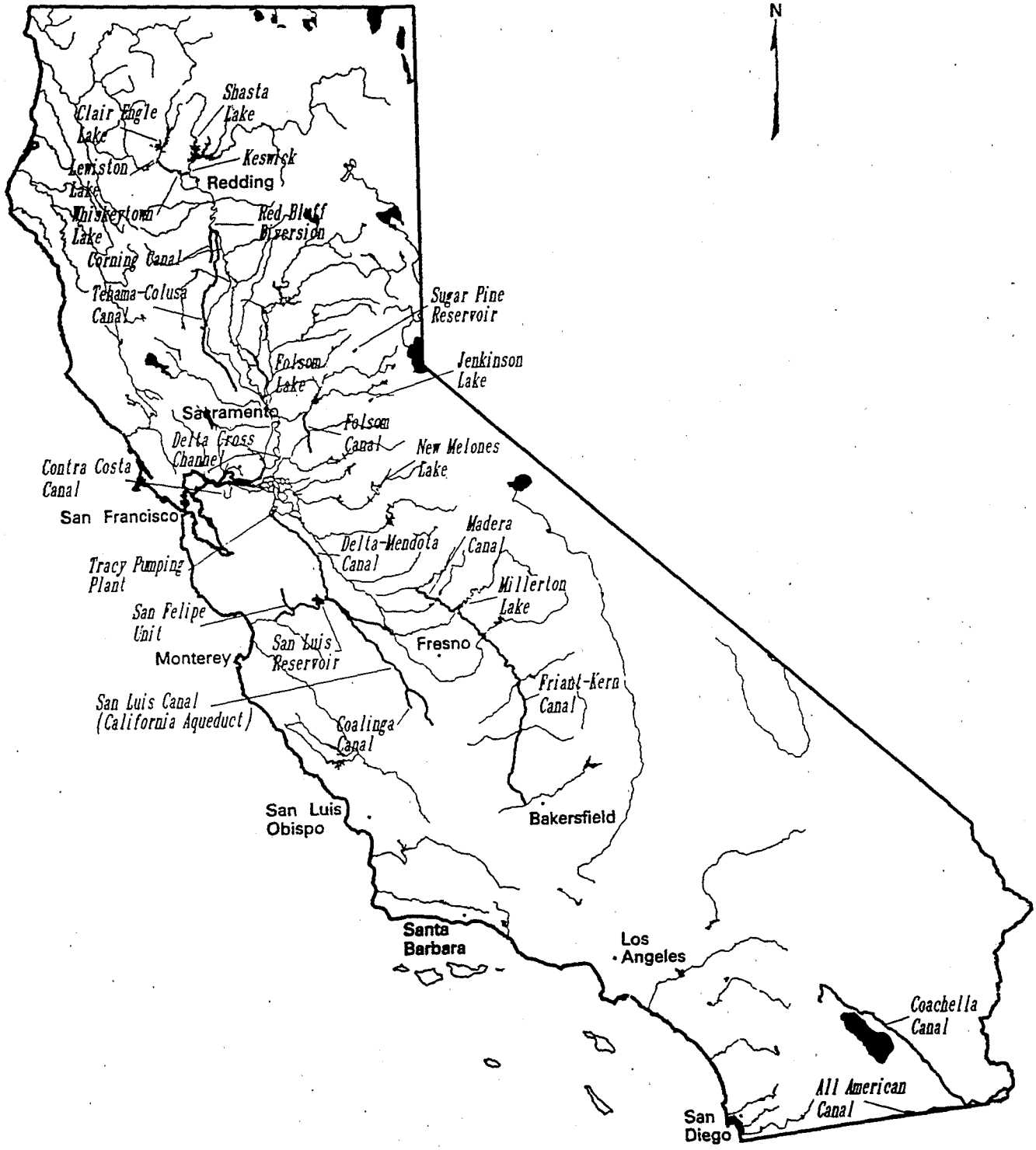
The federal government began construction of the CVP in the 1930s, as authorized under the Rivers and Harbors Act of 1937. CVP purposes expanded to include river regulation, flood control, and navigation; later reauthorization included recreation and fish and wildlife purposes. Initial authorization covered facilities such as Shasta and Friant Dams, Tracy Pumping Plant, and the Contra Costa, Delta-Mendota, and Friant-Kern Canals. Later authorizations continued to add additional facilities such as Folsom Dam (authorized in 1949), San Luis Unit (authorized in 1960), and New Melones Dam (authorized in 1962).

The CVP supplies water to over 250 long-term water contractors in the service areas shown in Figure B-1, whose contracts total 9.3 MAF including 1.4 MAF of Friant Division Class 2 supply available in wet years. Of the 9.3 MAF, 6.2 MAF is project water and 3.1 MAF is water right settlement water. Average-year deliveries in the past decade have been around 7 MAF. Water right settlement water is water covered in agreements with water rights holders whose diversions were in existence before the project was constructed. Since construction of project reservoirs altered the rivers' natural flow upon which these diverters had relied, contracts were negotiated to serve the users stored water to supplement river flows available under their rights. CVP water right settlement contractors (called prior right holders) on the upper Sacramento River receive their supply from natural flow and storage regulated at Shasta Dam; settlement contractors on the San Joaquin River (called exchange contractors) receive Delta water via the Delta-Mendota Canal as explained below.

Water stored in CVP northern reservoirs is gradually released down the Sacramento River into the Sacramento-San Joaquin Delta, where it helps meet demand along the river and quality and flow requirements in the Delta (see Figure B-2). The remainder is exported via the Contra Costa Canal and the Delta-Mendota Canal. Excess water during the winter is conveyed to off-stream San Luis Reservoir on the west side of the valley for subsequent delivery to the San Luis and San Felipe units. A portion of the Delta-Mendota exports are placed back into the San Joaquin River at Mendota Pool to serve, by exchange, water users who have long-standing historical rights to use of San Joaquin River flow. This exchange enabled the CVP to build Friant Dam, northeast of Fresno, and divert a major portion of the flow farther south in the Friant-Kern Canal (and some water northward in the Madera Canal). The Corning and Tehama-Colusa Canals serve an area on the west side of the Sacramento Valley. Other water supplies are furnished to districts and water rights holders in the Sacramento Valley. American River water stored in Folsom Reservoir is used mainly for stream flow and Delta requirements, inc'uding CVP exports. More recently, the San Felipe Unit was added to serve coastal counties west of San Luis Reservoir. New Melones Reservoir serves an area on the eastern side of the San Joaquin Valley. The CVP is required to release water from New Melones Reservoir as a temporary solution to the lawsuit filed by SDWA against the USBR and DWR. The releases are to maintain adequate San Joaquin River flows and water quality as measured at Vernalis.

Figure B-1. Central Valley Project Service Areas

Figure B-2. Major Central Valley Project Facilities



Operations in the Delta are coordinated with the SWP to meet water quality and other standards set by the State Water Resources Control Board, and more recently by federal fisheries agencies. CVP contractors relying on the Delta for their supplies also face more frequent and severe water supply shortages until solutions to Delta problems are put into place.

C—087280

C-087280

APPENDIX C--SDWA LAWSUIT/SETTLEMENT

South Delta Agricultural Diversion

Water for lands within the South Delta Water Agency boundary is supplied almost exclusively from the Delta channels. Water conditions in the area are influenced in varying degrees by:

- natural tidal fluctuation,
- San Joaquin River flow and quality,
- local agricultural drainage water,
- CVP, SWP and local diversions, and
- channel capacity.

These factors affect water levels and water availability at some local diversion points. Local agricultural drainage water, aggravated by poor circulation, has affected channel water quality, particularly in shallow, stagnant, or dead-end channels. Channels that are too shallow and narrow also restrict flow and the volume of water available for SWP and CVP pumping.

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

- CVP operations on the San Joaquin River, primarily at Friant Dam, unlawfully reduce the quantity and degrade the quality of water flowing in the San Joaquin River to the south Delta,
- operations of SWP and CVP pumps violate SDWA rights by lowering water levels, reversing flows, and diminishing the influence of the tides, and
- the Secretary of the Interior's designation of the Stanislaus River basin for allocation of water from New Melones Reservoir violates SDWA rights by not including the south Delta in the basin.

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

Through 1985, actions to improve water conditions in the south Delta were taken in response to specific incidents of low water levels. Beginning in late 1985 with a letter of intent to develop a permanent solution, several agreements have been finalized, a draft contract developed, and the Temporary Barriers Project implemented to obtain this objective. These activities and documents are discussed in the following text and are listed in Table C-1, a chronology of events associated with activities in the south Delta.

Table C-1 CHRONOLOGY OF EVENTS	
October 1973	SDWA created by act of Legislature
July 9, 1982	SDWA filed suit against U.S. Department of Interior (USBR) and the State (DWR).
March 1985	DWR modified Clifton Court Forebay gate operation to help relieve the impacts of SWP diversions on water levels. Modified gate operation continues currently to lessen the impact upon south Delta water levels.
July 1985	SDWA claimed farmers were losing crops due to hot weather and insufficient water supply. DWR took emergency action to alleviate the problem in Tom Paine Slough.
September 1985	DWR and SDWA signed a letter of intent on actions to improve water levels in the south Delta.
November 1985	Workplan issued for an interim program for the mitigation of south Delta water level problems.
December 1985	Permit applications filed with the Corps of Engineers.
April 3, 1986	Corps issued Permit No. 9201 to dredge Tom Paine Slough.
April 17, 1986	DFG Streambed Alteration Agreement for Tom Paine Slough dredging.
May 6, 1986	Corps issued Permit No. 9204 to install siphons in Tom Paine Slough.
May 7, 1986	Notice of Determination filed for Tom Paine Slough dredging and siphons.
June 1986	DWR-SDWA Joint Powers Agreement regarding mitigation for the south Delta signed and approved.
June 1986	Joint Powers Agreement for Tom Paine Slough between DWR, SDWA, and Pescadero Reclamation District signed and approved.
August 18, 1986	Pescadero Reclamation District signed construction contract to dredge Tom Paine Slough.
October 1986	Framework agreement (South Delta Agreement) for settling SDWA litigation signed by USBR, DWR, and SDWA.
October 28, 1986	Dredging of Tom Paine Slough completed (100,000 cubic yards).
November 4, 1986	Corps issued Permit No. 9205 to construct Middle River weir.
January 1987	South Delta agricultural water supply project 3-agency workplan published.
February 6, 1987	DFG Streambed Alteration Agreement for new Middle River Weir.
February 9, 1987	Filed Notice of Determination for the barrier on Middle River.
May 15, 1987	Weir completed on Middle River.
September 1987	Temporary barrier at Head of Old River installed.
September 30, 1987	Center portion of Middle River weir removed in accordance with DFG Stream Alternation Agreement.
November 1987	Temporary barrier at Head of Old River removed.

(Continued)

Table C-1 (cont.)

May 1988	Temporary barrier at Middle River installed.
September 1988	Temporary barrier at Middle River removed.
September 1988	Temporary barrier at Head of Old Riverr installed.
November 1988	Temporary barrier at Head of Old River removed.
August 1, 1989	Construction of Tom Paine Slough siphons completed.
April 1990	Temporary barrier at Middle River installed.
September 1990	Temporary barrier at Middle River removed.
September 1990	Temporary barrier at Head of Old River installed.
October 1990	Framework agreement for Article VII of the Fish Mitigation Agreement was signed between DWR, USBR and DFG.
November 1990	Temporary barrier at Head of Old River removed.
April 1991	Temporary barrier at Middle River installed.
August 1991	Temporary barrier in Old River near DMC installed.
September 1991	Temporary barrier at Head of Old River installed.
September 1991	Temporary barrier at Middle River removed.
September 1991	Draft South Delta Contract was finalized by DWR, USBR, and SDWA. Local voters approved agreement.
October 1991	Temporary barrier in Old River near DMC installed.
October 1991	SWRCB report on Delta Water Quality (SCR 55) was released.
November 1991	Agreement to use Twitchell and Sherman Islands as mitigation for forebay expansion was signed by DWR and DFG
November 1991	Temporary barrier at Head of Old River removed.
April 1992	Temporary barriers installed, two on Old River and one on Middle River.
April 6, 1992	Governor's Water Policy was announced in April 1992 and proposed appointment of an Oversight Task Force, called for establishing interim Delta water quality standards, and listed South Delta facilities as an immediate interim action.
June 1992	Temporary barrier at Head of Old River removed.
September 1992	Temporary barrier in Old River near DMC and Middle River barrier removed.
September 1992	Temporary barrier at Head of Old River installed.
October 30, 1992	CVP Improvement Act, Title 34 of HR 429 (PL 102-575).
December 1992	Temporary barrier at Head of Old River removed.

(Continued)

Table C-1 (cont.)

December 9, 1992	Governor signed Executive Order creating a 22-member Bay-Delta Oversight Council (BDOC) to assist and advise the new Water Policy Council.
December 10, 1992	Draft of Water Right Decision 1630 (interim Delta water quality standards) available for public review.
December 1992	Draft of Temporary barriers monitoring report completed.
February 12, 1993	Winter-Run Salmon Biological Opinion for the Operation of CVP/SWP.
March 5, 1993	Delta Smelt listed as Federal Threatened Species.
March 1993	Temporary barriers project monitoring report finalized.
April 1, 1993	Governor announced that requirements established by the Endangered Species Acts, coupled with existing water quality standards (D1485), will give interim protection to Delta. He redirected State efforts to establishing long-term Delta standards.
June 1993	Temporary barriers installed at Middle River and Old River.
September 1993	Temporary barriers removed from Middle River and Old River.
November 1993	Temporary barrier at Head of Old Riverr installed.
December 1993	Temporary barrier at Head of Old River removed.
April 1994	Temporary barriers installed at Middle River and Old River. Fish Barrier installed at the head of Old River.
May 1994	Fish Barrier at the head of Old River removed.
September 1994	Temporary barriers removed from Middle River and Old River.
September 1994	Temporary barrier at Head of Old River installed.
November 1994	Temporary barrier at Head of Old River removed.
December 1994	State/federal Bay/Delta Accord.

Early Actions (1976-1985)

The installation of a rock barrier in Old River near Delta Mendota Canal during the 1976-77 drought was the first action taken to improve water conditions in the south Delta. Later, in May 1984, SDWA complained of low water levels in Tom Paine Slough and DWR responded by installing three stage recorders on the slough: one below the tidal control structure, one above the structure, and another near the southern end of the slough.

In March 1985, SDWA again complained about low water making it difficult to get sufficient water into Tom Paine Slough to meet irrigation needs. DWR made "soundings" along the slough, to determine channel bottom contours, and found high sections in the channel bottom both above and below the tidal control structure. DWR also found the gates functioning improperly, and subsequently fixed the gates and removed a small amount of sediment from around the control structure. However, in July 1985, SDWA claimed that water levels in both Tom Paine Slough and southern Middle River were so low that adequate irrigation was impossible and crops were being lost. Emergency efforts concentrated on Tom Paine Slough where three portable pumps were installed to augment the water supply. Also, Clifton Court Forebay gate operation was modified to improve water levels in channels.

In September 1985, DWR signed a letter of intent with SDWA which describes the responsibilities of these agencies to develop a permanent solution for the water level and water circulation concerns in the south Delta channels affecting SDWA.

Joint Powers Agreement

In June 1986, DWR signed a joint powers agreement with SDWA regarding interim mitigation in SDWA channels. This agreement provided for dredging Tom Paine Slough (completed in October 1986), constructing a seasonal rock weir in Middle River (completed in May 1987) (see Figure C-1), constructing siphons in Tom Paine Slough (completed in June 1989)(see Figure C-2), and developing an intake gate operation criteria for Clifton Court Forebay which eliminates diversions during the low-low tide. All appropriate permits and certifications required under current regulatory and legislative acts were acquired.

SDWA Framework Agreement

In October 1986, DWR, USBR and SDWA entered into an agreement to provide a framework to settle SDWA's lawsuit. All three parties agreed to work together to develop mutually acceptable, permanent solutions to the water supply concerns of water users within SDWA. To facilitate negotiations, the parties agreed to a stay of all actions in the litigation. USBR agreed to provide releases of water from New Melones Reservoir for an interim period during the negotiation process.

Draft South Delta Contract

DWR, USBR and SDWA have developed a draft contract that settles the 1982 lawsuit by SDWA against DWR and USBR. SDWA held an election on September 17, 1991 to vote on the contract. The contract was approved by 97 percent of the voters in SDWA service area. The USBR requires Congressional authorization to sign and is seeking this authorization under the Central Valley Project Improvement Act (PL 102-575). DWR is also pursuing authority to sign.

Figure C-1.
Temporary Barrier
in Middle River

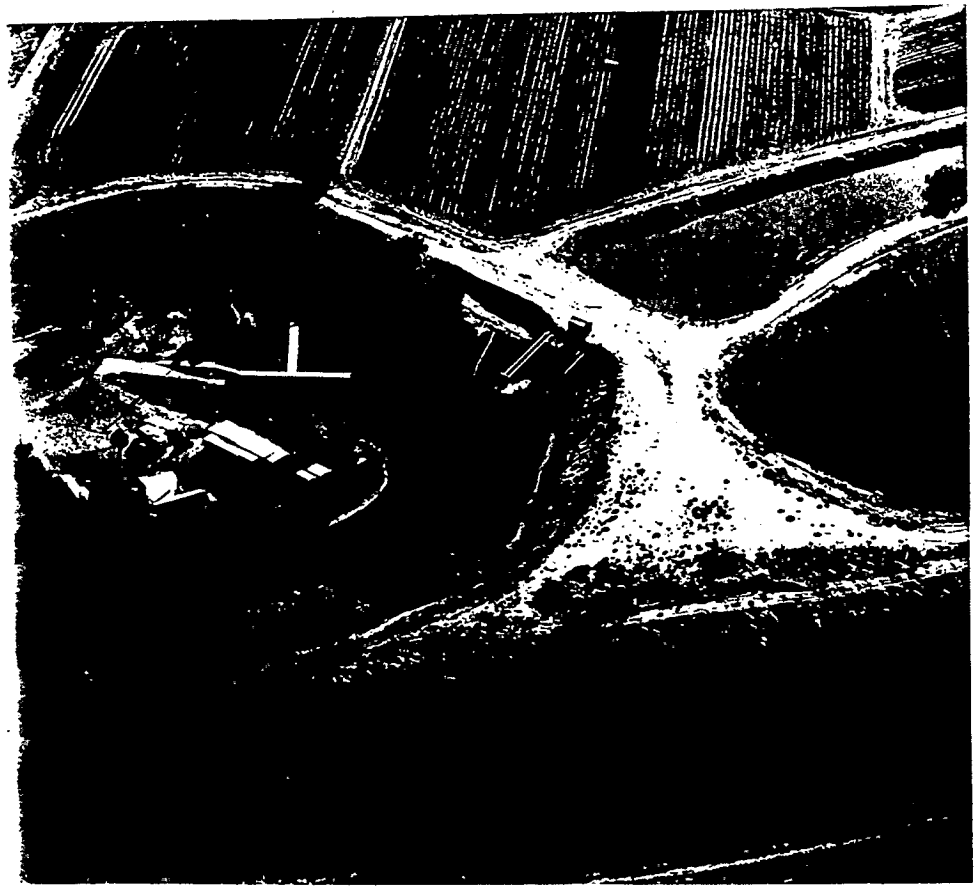


Figure C-2.
Tom Paine
Slough Siphons

The draft contract includes provisions to test and construct barrier facilities in certain south Delta channels to provide SDWA with an adequate agricultural water supply in terms of quantity, quality, and channel water levels to meet the reasonable and beneficial needs of those water users located along those portions of Old River, Middle River, and Grant Line Canal that lie within SDWA boundaries. It also provides for interim releases by USBR from New Melones to resolve the portion of the litigation relating to San Joaquin River flows and provides the framework for USBR and SDWA to negotiate an amendment to the contract to provide a permanent resolution of those issues.

Temporary Barriers Project

To begin implementing the Draft South Delta Contract, DWR is proceeding with the planning and construction of temporary rock barriers in the SDWA channels at locations specified by the draft contract (see Figure C-3). DWR released an Initial Study/Negative Declaration for the Temporary Barriers Project, and filed a Notice of Determination for one barrier on Old River. DWR installed the temporary barrier in Old River near Tracy, east of Delta Mendota Canal, in late August 1991 (see Table C-2). DWR had installed a temporary barrier in Middle River each year from May 15, 1987 through 1990. In 1991, it was installed and incorporated into the Temporary Barriers Project.

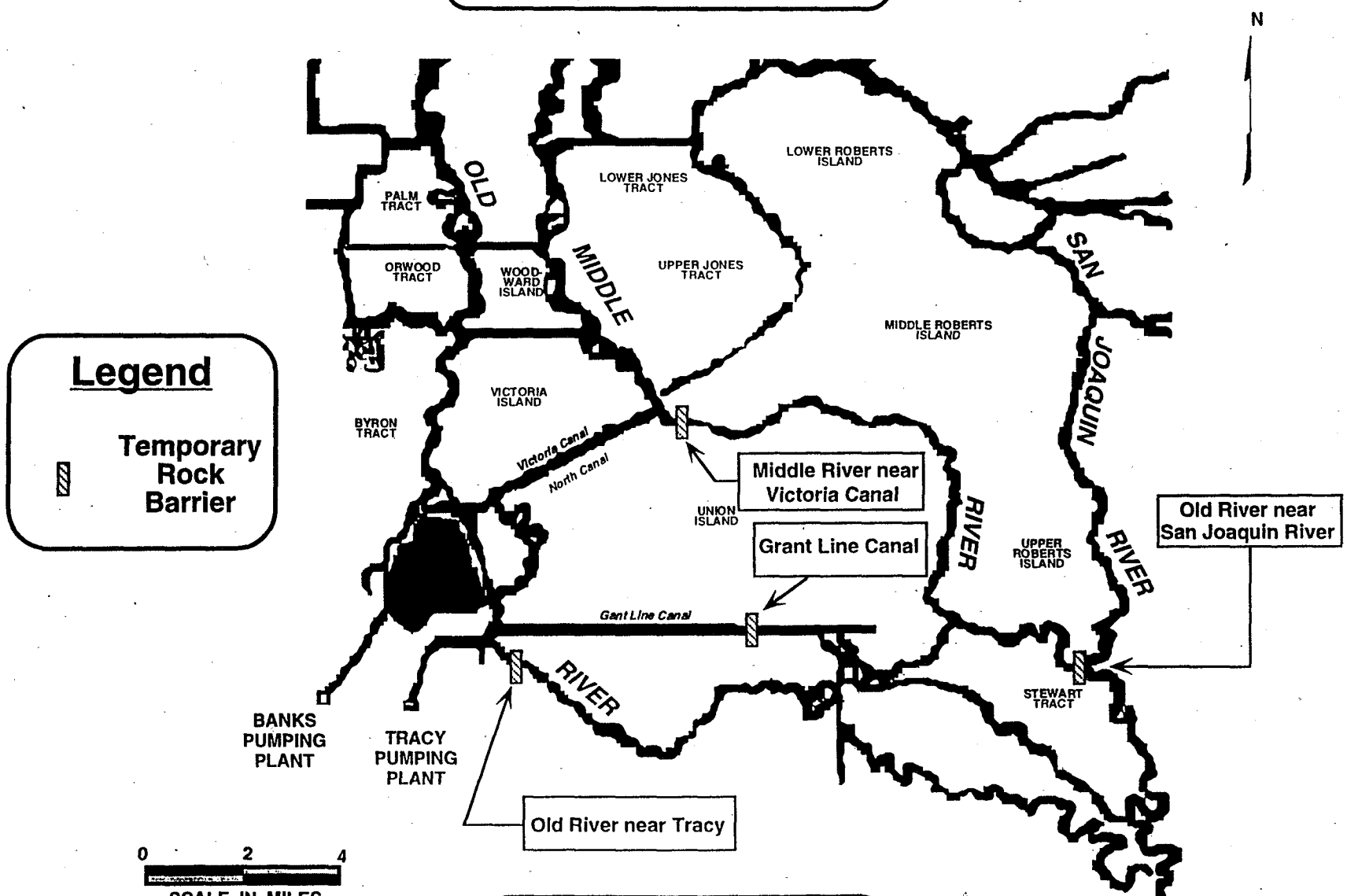
In March 1992, the Corps issued a permit to install two temporary barriers on Old River, the agricultural barrier near Delta Mendota Canal and the fish barrier at the head of Old River (See Figures C-4 and C-5). The fish barrier improves conditions for spawning salmon and outmigrating smolts by partially closing off Old River during the spring salmon migration season. These barriers and the Middle River barrier were installed in April 1992. The fish barrier was removed in June 1992 and reinstalled for the period September-December.

In 1993, DWR applied for a three-year permit that would allow up to four barriers---one in Middle River, two in Old River, and one in Grant Line Canal to be constructed every year. The agricultural barriers in Old River and Middle River were installed in 1993 and 1994. The fish barrier at the head of Old River was installed in the spring of 1994 but was not installed in the spring of 1993 because of the possibility of high San Joaquin River flows and concerns about Delta smelt. DWR is pursuing approval to install the Grant Line Canal Barrier in 1996.

In addition to the installing the fish barrier at the head of Old River in the spring, DWR has been installing the fish barrier at the head of Old River in the fall on a regular basis in accordance with a 1969 MOU with California Department of Fish and Game, U. S. Bureau of Reclamation, and U. S. Fish and Wildlife Service in order to address dissolved oxygen and fishery problems in the lower San Joaquin River.

The Temporary Barriers Project is being regularly monitored to document and analyze any adverse effects on fish such as chinook salmon, striped bass, Delta smelt, white catfish, American shad, Sacramento splittail, longfin smelt, and green sturgeon. Vegetation monitoring is being conducted for sensitive plants, and riparian and emergent vegetation to determine whether the project will have adverse effects on vegetation. This monitoring will also help verify computer modeling studies. A summary of this monitoring program is listed below:

Figure C-3
Temporary Barrier Locations



SOUTH DELTA

C—087288

C-087289

Table C-2

Dates of Installations and Removals of Temporary Barriers

Year	Middle River				Old River near Tracy (DMC)				Old River @ Head			
	Installation		Removal		Installation		Removal		Installation		Removal	
	Started	Completed	Started	Completed	Started	Completed	Started	Completed	Started	Completed	Started	Completed
1987		May-15	Sep-30	Sep-30						Sep-11		Nov-28
1988	May-26	May-28	Sep-23	Sep-23					Sep-21	Sep-28		Dec-02
1989		Apr-12	Sep-26	Sep-26					Sep-27	Sep-29	Nov-27	Nov-30
1990		Apr-16	Sep-29	Sep-29					Sep-10	Sep-11		Nov-27
1991	Apr-04	Apr-05	Sep-27	Sep-27	Aug-14	Aug-30	Sep-28	Oct-13 (I)	Sep-09	Sep-13 Closure	Nov-27	Nov-27
1992	Apr-08	Apr-10	Sep-28	Sep-29	Apr-15 boat-port	May-01 May-09	Sep-30	Oct-09 (II)	Apr-15 boat-port Sep-08	Apr-23@4ft Apr-28@6ft May-01 Sep-11	Jun-02 Dec-01	Jun-08 Dec-4
1993	Jun-14	Jun-17	Sep-23	Sep-24	May-12	Jun-1	Sep-27	Oct-6	Nov-8	Nov-11	Dec-3	Dec-7
1994	Apr-23	Apr-25	Sep-29	Oct-5	Apr-22 boat-port All culverts tied open (5/18-6/1)	Apr-24 May-1	Sep-26	Oct-10	Apr-21 boat-port Sep-6	Apr-23@10ft May-1 Sep-8	May-18 Nov-28	May-20 Nov-30

(I) Barrier notched on Sept. 28, 1991. Construction resumed on Oct. 10 and finished on Oct. 13.

(II) Barrier notched on Sept. 30, 1992. Construction resumed on Oct. 2 and finished on Oct. 9.

C—087289

Figure C-4.
Temporary Barrier in Old River near DMC

Figure C-5.
Temporary Barrier at Head of Old River

Fishery resources and water quality monitoring includes the elements described below. The Fishery Resources and Water Quality Monitoring Plan is implemented for the duration of the five-year Temporary Barriers Project which was initiated in 1991. The results of the sampling may indicate the need for changes in the program.

- Studying loss effects
- Fish community sampling
- Adult salmon migration monitoring
- Monitoring of juvenile salmon migration into the southern Delta at Mossdale
- Studying salmon smolt survival through the southern Delta
- Obtaining water circulation field data
- Southern Delta water quality monitoring
- Studying possible fish screening of south Delta agricultural diversions
- Hydrologic modeling of various barrier installations
- Water quality monitoring by the Central Valley Regional Water Quality Control Board

The *vegetation monitoring* program has been developed in coordination with the Department of Fish and Game to monitor the South Delta Temporary Barriers Project's effects on riparian vegetation, emergent wetland vegetation, and sensitive plant species in Old River, Grant Line Canal, and Victoria and North Canals. This monitoring program is being conducted for a period of five years beginning in April 1992. Sensitive plant species and control sites were located and monitored in 1992 and include:

- California hibiscus
- Mason's Lilaeopsis
- Delta Tule Pea
- Riparian and emergent vegetation communities

Annual monitoring reports are prepared which provide all population data analyses. A descriptive assessment of qualitative and quantitative data is discussed in the annual report in addition to an assessment of how well the performance criteria were met. Reports were published for the Middle River temporary barrier for 1988 through 1992. Reports for the overall program have been published for 1992 and 1993. The annual report for 1994 will be submitted to the Corps, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. National Marine Fishery Services, and DFG in 1995. The final report will be submitted to the agencies by February 21, 1995.

The ISDP will improve conditions for agriculture through the installation and operation of tidal flow control structures. These structures will improve water levels and induce circulation in south Delta channels.

APPENDIX D

WATER USE AND SUPPLY IN CALIFORNIA

Overview

This appendix looks at the current and projected water needs and water supplies in California. The discussion notes that the State is expected to face chronic water shortages in the future; and that these shortages will occur even if reasonably foreseeable supply augmentation facilities were built, water conservation was practiced, and no endangered species requirements within the Sacramento-San Joaquin Delta were implemented. These projected shortages can be expected to increase, given the restrictions currently being placed upon water project operations in the Delta by endangered species requirements.

California's water use and supply have been described in detail in past years in a series of comprehensive long-range planning documents periodically published by DWR. The most recent document was published in October 1994 as Bulletin 160-93, *California Water Plan Update.* The bulletin compares urban, agricultural, and environmental water needs for the 1990 level of development with forecasts for years 2000, 2010 and 2020. Information presented in this appendix is taken from Bulletin 160-93.

Two water balance scenarios of water supply and demand management programs are discussed in Bulletin 160-93.

- The Level I scenario includes those programs that have undergone extensive investigation and environmental analyses and are judged to have a higher likelihood of being implemented by 2020.
- The Level II scenario includes those programs that could fill the remaining gap shown in the balance between supply and urban, agricultural, and environmental water demands. These options require more extensive investigation and alternative analyses.

The Level I scenario is the focus of this discussion because it includes programs which have been analyzed with respect to the quantity of water supply or demand reduction each could provide and have a good chance of being implemented. As shown in Tables 2-1 and 2-2 in Chapter 2, Level I programs and projects are grouped under demand management (long-term and short-term) and supply management (statewide and local).

By design, Level II programs and projects are much more speculative and include additional water conservation, land retirement, and water transfers (under the heading of demand management); additional storage and conveyance projects (under the heading of statewide supply management); and additional water recycling, and water desalting, reuse of agricultural brackish water, and various other programs under the heading of local water management.

Descriptions of the State's water supply and demand and a summary of the Level I water balance components follow.

Water Supply

The State's water supply is comprised of surface water, ground water, and reclaimed water. The total, developed water supply for 1990-level facilities and environmental requirements

is estimated to be 63.5 MAF in average years and 53.2 MAF in drought years.

Significant surface water supply components are the Sacramento and San Joaquin rivers, averaging nearly 15.5 MAF, and the Colorado River, which has provided 5 MAF, annually, including about 600,000 AF of surplus water. The amount of supply available from these sources is projected to decline due to recent and future actions to protect aquatic species and the environment in the Sacramento - San Joaquin Delta and valleys and because of increasing demand within the Upper Colorado River Basin. Mono Lake water supply will also decrease due to a 1991 Superior Court ruling.

Ground water is a valuable adjunct to surface supplies, adding reliability in meeting seasonal needs. In some areas, ground water is the only available water supply. Californians rely heavily on ground water when surface supplies dwindle. Ground water overdraft results when long-term ground water depletion exceeds recharge. Overdraft has been reduced to about 65 percent of the 1980 level. Between 1980 and 1990, annual ground water overdraft has been reduced by about 0.7 MAF from the 1980 level of 2 MAF. The reduction is mostly in the San Joaquin Valley and is due primarily to the benefits of imported supplies to the southern end of the valley, construction and operation of new reservoirs in the central area of the valley during the 1960s and 1970s, and prudent management of surface and ground water resources, including conjunctive use of those supplies. Current average annual net ground water use is about 8.4 MAF, including about 1.3 MAF of overdraft. Conjunctive-use operations (using a ground water basin in combination with a surface water storage and conveyance system) are currently being planned by DWR and other water agencies in the Central Valley. Most of these programs, however, are in the early planning stages.

Water reclamation programs include water recycling of urban waste water, ground water reclamation, desalting agricultural brackish water, and sea water desalting. These sources currently provide 0.2 MAF of supply annually. Projected new supply due to water recycling for the year 2020 is estimated to be 2.4 times present amounts. Ground water reclamation programs will be implemented to recover degraded ground water with about one-half of the reclaimed amount being new supply. Their additional net contribution to the water supply is expected to be about 0.9 MAF, bringing the total to 1.1 MAF. Because of its high cost and the uncertain future, sea water desalting and reuse of agricultural drainage are not expected to contribute significantly to water supply in the near future.

The water supply estimate of the Level I scenario includes the expected increase from reclaimed water (0.9 MAF). It does not include the 1.3 MAF/yr of ground water overdraft because overdraft is not sustainable. The estimate does include water supply increases resulting from a long-term Delta solution, the Interim South Delta Program, Kern Water Bank, Los Banos Grandes Reservoir, the Coastal Branch (Phase II), Los Vaqueros Reservoir, Domenigoni Reservoir, and miscellaneous local facilities. The impact to surface water supply due to recent and proposed actions to protect aquatic species and the environment is included as an increase in the water use projections. Water use is discussed in the following section. Given these assumptions, water supply in 2020 is expected to be 64.5 MAF under average conditions and 51.6 MAF under drought conditions.

Water Use

California water is used to meet three basic areas of demand: urban, agricultural, and environmental. Bulletin 160-93 presents a detailed discussion of these uses and the assumptions included in calculating California's current and projected water use. The following three sections summarize this information.

Population and Urban Water Use:

The population projection by the Department of Finance for the year 2020 is 49 million, which is an increase of 19 million over 1990. As population increases, so does urban water use. Although California's communities have instituted effective water conservation programs -- and are expected to continue refining and expanding them -- the magnitude of the State's projected urban growth will continue to increase the need for additional water.

Urban annual net water demand could increase from 6.8 MAF in 1990 to 10.5 MAF by 2020 after accounting for implementation of conservation measures that are expected to reduce urban annual net water demand by about 0.9 MAF. These conservation measures are referred to as Best Management Practices and are listed in Table D-4. Level I demand projections include the use of Best Management Practices. The demand projections also assume that urban net water demand during drought will be reduced by mandatory reductions. In spite of the mandatory reductions, demand during drought is estimated to be 11.0 MAF by 2020.

Agricultural Water Use:

Since 1980, there has been an overall reduction in irrigated lands. Urbanization will assure this trend continues in the future. Also, crop shift is expected to happen as growers move from low-value/high-water-use crops. A decrease in unit-applied water has occurred due to Efficient Water Management Practices and increased emphasis on water conservation. These factors are expected to reduce agricultural net water demand by about 2 MAF during the period 1990-2020. Efficient Water Management Practices are listed in Table D-5. The projected net agricultural water demand is expected to be 24.9 MAF by 2020 for average conditions. Use during drought is projected to be 26.1 MAF by 2020. These estimates include land fallowing and water marketing and transfers, and are part of the Level I demand projections.

Environmental Needs:

Environmental water use is projected to increase as a result of actions currently underway by the various regulatory agencies. The 1990-level study and future projections of the Level I scenario include water needs of managed fresh water wetlands, instream flows (including the San Francisco Bay and Delta), and wild and scenic rivers. Proposed instream flow needs for future years are expected to increase use by 1 to 3 MAF.

Net environmental water requirements during average conditions are estimated to be 28.8 MAF by 2020. When the proposed instream flows are included, the total volume increases to 30 to 32 MAF. During drought conditions, the amount (including proposed instream flows) decreases to about 18 to 21 MAF primarily due to the variability of natural flows in the North Coast wild and scenic rivers.

Water Balance Shortages

Table D-1 summarizes the water balances for 1990, 2000, 2010, and 2020 for the Level I scenario. The shortages for 2020 under the Level I scenario are projected to be 2.1 to 4.1 MAF for average conditions and 2.9 to 4.9 MAF during drought conditions. The shortages shown for the years 2000, 2010, and 2020 are presented as ranges to incorporate the proposed additional instream needs and actions underway by regulatory agencies, both of which benefit fisheries). These needs are estimated to be between 1 and 3 MAF.

Table D-1
California Water Balance
(millions of acre-feet)

	1990		2000		2010		2020	
DEMAND	Average	Drought	Average	Drought	Average	Drought	Average	Drought
Net Demand*	63.5	53.2	64.3	53.9	64.9	54.5	65.7	55.3
Proposed Additional Environmental Demands								
Case I	-	-	1.0	1.0	1.0	1.0	1.0	1.0
Case II	-	-	2.0	2.0	2.0	2.0	2.0	2.0
Case III	-	-	3.0	3.0	3.0	3.0	3.0	3.0
SUPPLY								
Water Supplies w/existing facilities under D-1485	63.5	50.5	62.3	48.9	62.7	49.1	63.0	49.3
Additional Supply from Level I Water Management Programs	0.0	1.8	0.7	2.5	1.4	4.0	1.6	4.1
BALANCE	0.0	-0.9	-	-	-	-	-	-
Case I	-	-	2.3	-0.9	-1.8	-2.4	-2.1	-2.9
Case II	-	-	3.3	-4.5	-2.8	-3.4	-3.1	-3.9
Case III	-	-	4.3	-5.5	-3.8	-4.4	-4.1	-4.9

* Includes Level I demand-reduction measures

C—087296

C-087296

As indicated above, California's total annual water supply will need to increase by 2 to 5 MAF between now and 2020 to provide enough water to meet average and drought-condition water demands of urban, agricultural, and environmental uses. These amounts would be even greater if the assumptions of the balance did not include major conservation and reclamation efforts and the construction of water supply projects such as Los Banos Grandes Reservoir, the Kern Water Bank, and Domenigoni Valley Reservoir.

Given these forecasted chronic shortages and the fact that the Level I scenario includes the ISDP and other facilities which are dependent upon the ISDP, DWR is actively pursuing finalizing the ISDP EIR/EIS and related environmental documentation in order to receive permit approval for this program.

APPENDIX E

WATER DEMAND AND SUPPLY MANAGEMENT

This chapter presents a more detailed look at some of the components analyzed in the water balances discussed in Appendix D. These components are consistent with Governor Wilson's water policy, which has provided general direction in developing demand management and water supply management programs. Bulletin 160-93 data is the primary source for the information presented here.

Level I Demand Management

As noted in Table 2-1 of Chapter 2, Level I demand management consists of long-term and short-term demand management. Water conservation and level retirement comprise the long-term measures; and demand reduction, land fallowing and short-term water transfers comprise the short-term measures.

Long-Term Demand Management

- **Water Conservation**

Following the statewide drought of 1976-77, DWR began an aggressive water conservation program to help local agencies achieve efficient use of California's limited water resources through promotion of water conservation policies and practices that would have the greatest public benefit consistent with sound resource conservation principles.

DWR administers several programs that encourage efficient use of water, and has focused on cost-effective urban and agricultural conservation programs carried out cooperatively with local agencies throughout the State. Legislation has also been adopted to encourage and improve water conservation in the State. The two most recent significant pieces of conservation legislation are: the Urban Water Management Planning Act of 1983, and the Agricultural Water Management Planning Act of 1986. Both require the larger water suppliers, under certain conditions, to prepare water management plans.

Water conservation effects on net water demand vary greatly, depending on the opportunity for water reuse in the area. Effective water conservation in a region is the reduction in depletion, which is defined as reduction of the evapotranspiration of applied water, irrecoverable losses from a distribution system, and outflow to a salt sink. For example, in the Sacramento River region, water is reused extensively, so the potential for effective conservation is limited. But a large water savings potential exists in the Colorado River and the coastal regions, where excess applied water generally enters saline sinks (Salton Sea or the ocean) or saline ground water basins and cannot be economically reused.

Reductions in applied water can often be beneficial because they reduce the pumping and treatment costs and could reduce diversions from streams and rivers to benefit fish and wildlife. However, care must be taken to look at impacts on downstream reuse, such as other farms or wildlife refuges, that rely on excess applied water.

Urban Water Conservation - These efforts have been expanding since the 1970's. Unlike in the case of agriculture, there were no institutions such as the University of California Cooperative

C-087298

C-087298

Extension and local Resource Conservation Districts to provide conservation expertise to urban water users. Urban water agencies have now filled that void and have dramatically increased water conservation programs.

With the passage of the Urban Management Planning Act in 1983, the California Legislature acknowledged the importance of water conservation and demand management as essential components of water planning. The Act requires the 300 medium- and large-sized urban water agencies to prepare and adopt plans for the efficient use of their water supplies, and update these plans every five years. The first plans were due in 1985. Over 95 percent of the agencies affected by the law submitted a plan. DWR's Water Conservation Office works cooperatively with local water agencies on many conservation efforts such as water education, leak detection, plumbing code changes, conservation planning, efficient landscape ordinances, and Best Management Practices.

Efforts by the State Water Resources Control Board to protect public trust resources in the Sacramento-San Joaquin Delta have led directly to the establishment of BMPs. In 1988, interested parties gave the SWRCB widely divergent opinions on appropriate levels for implementing urban conservation measures. To resolve these differences, urban water agencies, environmental groups, and State agencies actively participated in a three-year effort which resulted in identifying BMPs. These are conservation measures that meet either of the following criteria:

- An established and generally accepted practice among water suppliers that results in more efficient use or conservation of water.

- Practice for which sufficient data are available from existing water conservation projects to indicate significant conservation or conservation related benefits can be achieved; the practice is technically and economically reasonable; the practice is not environmentally or socially unacceptable; the practice is not otherwise unreasonable for most water suppliers to carry out.

Sixteen initial BMPs that meet at least one of these criteria have been identified. Table E-1 lists the practices and indicates those that have been quantified and are included in the Level I demand projection. Table E-2 summarizes potential BMPs that have not yet been approved and analyzed and are therefore not included in the Level I demand projections.

As of December 1992, over 100 water agencies, plus over 50 public advocacy groups and other interested parties, had signed a Memorandum of Understanding Regarding Urban Water Conservation in California. This MOU commits signatories to implement these BMPs at specified levels of effort over the period 1991 to 2001. The water industry and others are working toward the implementation of BMPs through the Urban Water Conservation Council, established under the MOU. Full descriptions of BMPs, including estimates of reliable savings and implementation schedules, are contained in the MOU.

The widespread acceptance of BMPs in California virtually assures that their implementation will become the industry standard for water conservation programs through 2001 and probably beyond. The BMP process offers great advantages for water agencies. Since many agencies will be implementing similar programs on similar schedules, there are significant opportunities for combining programs regionally to reduce implementation costs and increase effectiveness. In addition to the programs described above, many of the cooperative efforts to help local agencies with urban water conservation programs will focus on implementing BMPs.

Water conservation will undoubtedly continue to play a significant role in managing

C—087299

C-087299

Table E-1

Best Management Practices for Urban Water Use

Management Practices	Estimate of Water Savings	
	Quantified	Not Quantified
1. Interior and Exterior Water Audits and Incentive Programs for Single Family Residential, Multi-Family Residential and Governmental/Institutional Customers	X	
2. New and Retrofit Plumbing	X	
3. Distribution System Water Audits, Leak Detection and Repair	X	
4. Metering with Commodity Rates for All New Connections and Retrofit of Existing Conditions	X	
5. Large Landscape Water Audits and Incentives	X	
6. Landscape Water Conservation Requirements for New and Existing Commercial, Industrial, Institutional, Governmental, and Multi-Family Developments	X	
7. Public Information		X
8. School Education		X
9. Commercial and Industrial Water Conservation	X	
10. New Commercial and Industrial Water Use Review		X
11. Conservation Pricing		X
12. Landscape Water Conservation for New and Existing Single Family Homes		X
13. Water Waste Prohibition		X
14. Water Conservation Coordinator		X
15. Financial Incentives		X
16. Ultra-Low Flush Toilet Replacement Programs	X	

Table E-2

Potential Best Management Practices

1. Rate Structure and other economic incentives and disincentives to encourage water conservation.
2. Efficiency standards for water using appliances and irrigation devices.
3. Replacement of existing water using appliances (except toilets and showerheads whose replacements are incorporated as Best Management Practices) and irrigation devices.
4. Retrofit of existing car washes.
5. Gray water use.
6. Distribution system pressure regulation.
7. Water supplier billing records broken down by customer class (e.g., residential, commercial, industrial).
8. Swimming pool and spa conservation including covers to reduce evaporation.
9. Restrictions or prohibitions on devices that use evaporation to cool exterior spaces.
10. Point-of-use water heaters, recirculating hot water systems and hot water pipe insulation.
11. Efficiency standards for new industrial and commercial processes.

California's urban water needs. Proven conservation measures will be implemented by more agencies, and new measures will gain greater acceptance. More sophisticated economic analyses will shape the ways that water needs are met or modified. However, as water use continues to become more efficient, agencies are losing some flexibility in dealing with shortages.

Agricultural Water Conservation - Agricultural water conservation has taken a different path than that of the urban sector. Agriculture has had the University of California, California State Universities, local Resource Conservation Districts and U.S. Department of Agriculture programs to provide management assistance over many decades. These efforts have often included improved and better crop varieties, high-yielding food and fiber crops, disease- resistant crops, frost-resistant crops, and irrigation and farming methods that help preserve soil structure and fertility, as well as maintaining favorable soil salinity and long-term productivity. These collective efforts have resulted in better use of resources for agricultural production and significant increases in yield per acre for almost all crops grown in California. Irrigation efficiencies have been increased and applied water requirements reduced over time as a result of these efforts.

Even though irrigation management continued to improve in the 1970s and 1980s, using the existing technological transfer mechanisms, agricultural water agencies now fill an active role paralleling urban water conservation efforts. The two pieces of legislation that initiated this effort are the California Agricultural Water Management Planning Act of 1986 (AB 1658) and the federal Reclamation Reform Act of 1982.

AB 1658 required all agricultural water suppliers delivering over 50,000 AF of water per year to prepare an "Information Report" and identify whether the district has a significant opportunity to conserve water or reduce the quality of saline or toxic drainage water through improved irrigation water management. The legislation affected the 80 largest agricultural water purveyors in California. The districts that have a significant opportunity to conserve water or reduce drainage are required to prepare Water Management Plans.

The Reclamation Reform Act of 1982 required federal water contractors to prepare "Water Conservation Plans." In California, the U.S. Bureau of Reclamation's Mid-Pacific Region developed a set of "Guidelines to Prepare Water Conservation Plans" and required all federal water contractors serving over 2,000 acres to submit water conservation plans. In 1990, USBR requested assistance from DWR to upgrade the guidelines on how to prepare water conservation plans. New guidelines for USBR's Mid-Pacific Region were prepared and DWR is providing assistance to USBR contractors to develop, update, and implement water conservation plans. The 1992 Strategic Plan for the USBR has identified water conservation as a key element for improving the use and management of the Nation's water resources. Close cooperation with DWR avoids duplication of these activities.

Enactment of AB 3616 in 1991 charged DWR to establish an Advisory Committee consisting of members of the agricultural community, University of California, California Department of Food and Agriculture, environmental and public interest groups, and other interested parties to develop a list of Efficient Water Management Practices for agricultural water supplies. The proposed list of EWMPs is shown in Table E-3, and estimated water demand reduction from these practices is included in the Level I demand projection.

The AB 3616 Advisory Committee is working to develop a mechanism for implementation of EWMPs. Water suppliers implementing EWMPs will identify water conservation opportunities and set a schedule for implementation. It is difficult to assess the impact of EWMPs at the present time. Calculation of water savings resulting from EWMP implementation will require a detailed planning process by each individual district, including analysis of the economic and environmental costs and benefits. The University of California at Davis surveyed 23 of the 79 agricultural water agencies affected by AB 1658 to assess what practices similar to EWMPs are currently in place. The results of that survey are displayed as percentages in Table E-3.

DWR continues to cooperate with many local agencies to implement measures that may be included on the list of EWMPs in the future. These include providing real-time irrigation scheduling data through the California Irrigation Management Information System; providing on-farm irrigation system evaluations through the Mobile Irrigation Management Laboratory program; offering advice on redesigning fee structures; and offering loans for installation of water measurement devices and construction of regulating reservoirs. A cooperative effort, along with Pacific Gas and Electric and others, has helped develop the Irrigation Training and Research Center at California Polytechnic State University, in San Luis Obispo.

The definition of water conservation assumes that reducing applied water only results in additional water supply when the water would otherwise be lost to evapotranspiration or a saline water body such as the Pacific Ocean. In the agricultural sector, this condition only applies to a few specific areas, primarily the Colorado River Region which drains to the Salton Sea, and the west side of the San Joaquin Valley. In the Sacramento River and the San Joaquin River hydrologic basins, excess applied irrigation water is either reused or ultimately percolates to ground water or drains back into rivers that flow to the Delta. Any reduction in return flow from applied irrigation water must be made up by increased reservoir releases to maintain specified

Table E-3
Agricultural Efficient Water Management Practices

Practice	Currently in Place[1] (percentage)
Irrigation Management	
1. Improve water measurement and accounting	70
2. Conduct irrigation efficiency studies	43
3. Provide farmers with "normal-year" and real-time" irrigation, scheduling and crop evapotranspiration ET information	52
4. Monitor surface water qualities and quantities	52 & 100 respectively
5. Monitor soil moisture	13
6. Promote efficient pre-irrigation techniques	17
7. Monitor soil salinity	26
8. Provide on-farm irrigation system evaluations	35
9. Monitor quantity and quality of drainage waters	39 & 52 respectively
10. Monitor ground water elevations and qualities	83 & 43 respectively
11. Evaluate and improve water user pump efficiencies	39
12. Designate a water conservation coordinator	48
Physical Improvement	
13. Improve the condition and type of flow measuring devices	61
14. Automatic canal structures	35
15. Line or pipe ditches and canals	22
16. Modify distribution facilities to increase the flexibility of water deliveries	43
17. Construct or line regulatory reservoirs	26
18. Construct District tailwater reuse systems	39
19. Develop recharge basins	35
20. Improve on-farm irrigation and drainage systems	43
21. Evaluate efficiencies of District pumps	57
22. Provide educational seminars	57
Institutional Adjustments	
23. Improve communication and cooperative work among districts, farmers, and other agencies	65
24. Change the water fee structure in order to provide incentives for more efficient use of water and drainage reduction	43
25. Increase flexibility in water ordering and delivery	65
26. Conduct public information programs	48
27. Facilitate financing capital improvements for District and on-farm irrigation systems	43
28. Increase conjunctive use of ground water and surface water	22
29. Facilitate, were appropriate, alternative land uses	4

[1] *Based on a 1992 survey of 23 agricultural water suppliers delivering over 50,000 AF of irrigation water.*

outflows through the Delta.

- **Land Retirement**

Land retirement will take place in parts of the San Joaquin Valley where drainage has been a problem and where continued cultivation of some marginal lands will not be feasible. In September 1990, a report titled *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley* was published. This report evaluated the drainage problems in the San Joaquin Valley and recommended a plan of action to resolve the drainage problems on the west side of the valley through the year 2040. The recommendations included source control (conservation), reuse of drainage water, and land retirement. For the purpose of the Level I agricultural water demand calculations, it was assumed that source control and land retirement recommendations would be implemented. Forty-five thousand acres of land could be out of production by 2020 and about 70,000 acres by 2040. This is accounted for in agricultural acreage projections. The accompanying net water savings from this land retirement is about 0.13 MAF.

Short-Term Demand Management

Short-term demand management options are actions taken by water managers to reduce water demand during drought. This is an intrinsically local issue, and decisions must be made on the basis of very site-specific reliability needs. Trying to establish a universal basis for an acceptable level of short-term demand reduction is difficult, especially when approaching it from a broad, statewide perspective.

- **Demand Reduction**

The Level I scenario uses a 15-percent reduction during a drought to determine the adequacy of urban water supplies through 2010. The 15-percent level reflects 1990 urban water use experiences, and was chosen as a management planning tool for drought periods rather than as an action which could impose more severe hardships on affected communities. Most of the urban areas which implemented special conservation programs achieved cutbacks at or above this level. DWR studies indicate that some individual sectors of local economies, such as the green industry, suffered substantial income and employment losses in 1991. (The "green industry" includes nurseries, self-employed gardeners, landscapers, and landscape-related businesses.) However, from a statewide perspective, a shortage of 15 percent, based on the 1990-91 drought experience, is considered manageable at the 1990 level for drought events which would occur about once every 20 years.

As more conservation measures are developed and implemented in the future, a 15-percent shortage criteria will become more difficult to implement because of the increased efficiency in overall urban water use. These increases in efficiency mean that current drought contingency measures will be less productive in the future because opportunities to eliminate low-valued water uses or reduce waste in remaining uses have, for the large part, already been taken. Consequently, smaller water supply shortages can result in greater adverse impacts because there is little else to conserve.

By 2020, the Level I scenario assumes that the 1990 level of 15 percent is reduced to a 10-percent voluntary or mandatory shortage criterion for urban applied water use, while urban BMPs are implemented to reduce water demand by an additional 10 percent for a total demand reduction of 20 percent in 2020 during drought years. Potential measures, such as urban rationing programs

and changing water price rate structures, while not mandated by the State, are assumed to be implemented during drought periods to attain the overall 10-percent cutback.

- **Land Fallowing and Water Bank Operations**

The State Drought Water Bank began in 1991. During the first year of operation, it purchased 0.82 MAF. About 50 percent of the water came from land fallowing (0.42 MAF), followed by ground water exchange (0.26 MAF), and stored water reserves (0.14 MAF). State Water Bank operations are included in this section because these actions were short-term (one-year drought supply) for areas with critical needs. Some of this purchased water could be considered supply management (ground water, reserved storage water) rather than demand management. However, since overall water service reliability was not improved for the long-term, ground water exchange and stored water reserves for the drought water bank are included as short-term demand management options..

DWR is considering making the State Drought Water Bank a permanent water transfer program available for future drought management. A draft program EIR was published in January 1993 and, after public review, a final EIR was released in November 1993. The report reflects the experiences of DWR in running the 1991 and 1992 Drought Water Banks and evaluates potential environmental impacts associated with different categories of transfers. The program EIR only discusses a State-run drought water bank involving short-term transfers during drought periods over the next 5 to 10 years. Based on the 1991 and 1992 experience, the operation of a Drought Water Bank in the future could provide 0.6 MAF of supplies during droughts.

Level I Water Supply Management

This section discusses the various water supply management options included in the Level I scenario that could be implemented to reduce short- and long-term water shortages, and thus improve overall reliability of developed supplies. They are listed in Table 2-2.

Statewide Water Management

Water augmentation programs included in the Level I scenario are a long-term Delta solution, the ISDP, Los Banos Grandes Reservoir, the Coastal Aqueduct (Phase II), the Kern Water Bank, the Eastside Reservoir Project (Domenigoni Reservoir), Los Vaqueros Reservoir, and miscellaneous local projects.

This report discusses various interim south Delta measures and potential long-term solutions to the Delta. Further discussion of Los Vaqueros Reservoir and the miscellaneous local projects can be found in Bulletin 160-93.

Los Banos Grandes Reservoir, Kern Water Bank, and Domenigoni Reservoir will increase the water supply of the SWP and/or improve its water supply reliability. Their potential yield is included in future water supply estimates for the SWP in the water balance for the Level I scenario. Further discussion of the SWP water supply is contained in Appendix D.

As shown in the water balances in Appendix D, California's total average annual water supply will need to increase between 2.1 and 4.1 MAF between now and 2020 to provide enough water to meet average demands of urban, agricultural, and environmental uses. This is over and above the previously discussed demand and supply management options, and water supply

augmentation measures discussed in this chapter.

- **Los Banos Grandes Facilities**

In 1983, DWR initiated a comprehensive investigation of offstream storage reservoir sites south of the Delta. In 1984, after an initial examination of 18 sites, a DWR study recommended that Los Banos Grandes be investigated to determine the most cost-effective reservoir size and associated environmental impacts.

Based on the feasibility investigations, the proposed Los Banos Grandes project was found to be a technically feasible and cost-effective solution to help offset projected future SWP water shortages. Under D-1485 criteria, the Los Banos Grandes reservoir could augment SWP supplies by about 0.30 MAF in average years and about 0.26 MAF in drought years. However, recent endangered species actions in the Delta have reduced the potential water supply available for the project, and the feasibility of the project must be reassessed. During this reassessment, alternative offstream reservoir sites will also be re-evaluated. The outcome of this investigation is highly dependent on the selection of the long-term Delta solution for resolving fishery issues and facilitating efficient water transfers through the Delta.

- **Kern Water Bank**

The Kern Water Bank, established under an agreement between DWR and the Kern County Water Agency, would take advantage of available opportunities to store and extract SWP water in the Kern County ground water basin. There are eight potential elements, or separate components, to the Kern Water Bank; seven will be sponsored by local water districts and the eighth element is DWR's Kern Fan Element.

The Kern Fan Element Programmatic EIR was completed in 1986. The EIR proposed acquiring up to 46,000 acres for recharging, extracting, and storing SWP water in the Kern River Fan area. DWR acquired 20,000 acres for the bank in 1988. Initial studies indicate that the Kern Fan Element could be developed to store as much as 1 MAF and contribute as much as 0.14 MAF per year to the SWP in drought years.

The actual size of the Kern Water Bank, along with its implementation schedule, is highly dependent on resolution of endangered species issues in the Sacramento-San Joaquin Delta. The planning program is focused on completion of a Habitat Conservation Plan, incidental-take permits for terrestrial aspects of the Kern Fan Element, analysis of delayed implementation on the economic viability of the Kern Fan Element, and analysis of reduced levels of water supply on project economics. Once the supply impacts are identified and it appears that adequate water is available, the Kern Fan Element will be reassessed, final environmental documentation will be issued, and a program for further evaluation of local elements will be considered.

The seven locally-sponsored elements are in various stages of investigation. They have the potential of providing over 2 MAF of ground water storage and could contribute as much as 0.29 MAF per year to the SWP in drought years.

Local Water Management

Local water supply Level I management actions include water recycling, ground water reclamation, and Domenigoni Valley Reservoir.

- **Water Recycling**

Projected water recycling is based on the July 1993 survey, *Future Water Recycling Potential*, by the WateReuse Association of California and input from local water and sanitation districts. The survey indicates that there is potential for accelerating the pace of water recycling in the future. However, current budgetary problems and the economic recession have had a negative impact on water recycling project development in the State.

Additional water supply would by generated by water recycling where the outflow of water treatment plants would otherwise enter a salt sink or the Pacific Ocean. To estimate how much additional supply would be generated by Level I and Level II water recycling, a set criteria was established. The criteria for determining Level I and Level II water recycling is located in DWR Bulletin 160-93. Total annual Level I water recycling for 2020 is projected to be about 1.32 MAF. This would contribute about 0.92 MAF of new water to the State Water Project supply. The total annual Level II water recycling for 2020 is projected to be about 0.37 MAF, which would contribute about 0.37 MAF of new water to the State Water Project supply.

- **Ground Water Reclamation**

High total dissolved solids and nitrate levels are the most common ground water quality problems. Ground water reclamation programs are designed to recover degraded ground water. Currently, most of the ground water reclamation programs under consideration are in Southern California (excluding ground water reclamation solely to remediate contamination at hazardous waste sites). Some of the degraded water must be treated, some can be blended with fresh water to meet water quality standards, and some can be applied untreated for landscape irrigation. Total annual ground water reclaimed by year 2000 is estimated at 0.09 MAF in the Level I scenario.

- **Eastside Reservoir Project (Domenigoni)**

The Metropolitan Water District of Southern California began preliminary studies in 1988 to expand reservoir storage capacity to meet projected water demands. Their Eastside Reservoir Study was undertaken to:

- determine the amount of storage needed in the future,
- identify alternative sites for the storage,
- narrow the list of potential sites, and
- evaluate the potential for a reservoir at one or more of these sites.

Reservoir storage requirements were evaluated in a two-step process designed to establish the combined ground and surface storage and to determine the minimum surface storage needed. Based on the minimum reservoir storage need and a comparison of several sites three alternative sites were selected, including Domenigoni Valley in the western Riverside County.

The Domenigoni Valley Reservoir alternative involves constructing two main embankments as well as a large roller-compacted concrete saddle dam. The site is near the junction of the Colorado River Aqueduct, the San Diego Pipeline, and the terminus of the East Branch of the California Aqueduct. The reservoir, which could receive water from both the Colorado River and California aqueducts, will have a capacity of 0.80 MAF.

The reservoir will provide emergency service, carryover storage, and seasonal storage and enhance operational reliability of MWD's system. It would also assist with ground water basin recharge as part of a conjunctive use program. The reservoir will be used primarily for seasonal

and carryover storage, of which 50 percent will be allocated to emergency storage and the remainder will augment MWD supplies by 0.26 MAF per year during drought years.

In October 1991, MWD certified the final EIR for the Eastside Reservoir Project. Construction began May 17, 1995. The current MWD schedule indicates that the Eastside Project will be operational by the end of this decade. However, it will take about five years to fill the reservoir and the full benefit of the reservoir may not be realized until the year 2004.

Level II Water Management

Following is a brief discussion of two of the demand management and supply augmentation concepts which could help fill the gap remaining between supply and demand after Level I programs are fulfilled.

- **Ocean Water Desalting**

Engineers and scientists have been working on economical ways to desalt agricultural brackish water and sea water for the last 50 years. While environmental impacts are important in planning for desalting, the major limitation to desalting is its high cost, directly related to high energy requirements. Desalting costs range from $900 to $2,000 per acre-foot, and are generally far greater than obtaining water from most other sources. The largest post-2000 desalination projects are currently in the conceptual stages. The Metropolitan Water District of Southern California and the San Diego County Water Authority are currently planning for these projects. Future desalting programs depend on several factors, including the success of initial pilot projects (including determination of environmental requirements), and the availability and cost of other sources of supply. Because of its high cost and the uncertain future, desalting is considered as a possible option for future water supply, but is not included in the water supply projections and water balances presented in Chapter 3 and Appendix D.

- **Reuse of Brackish Agricultural Drainage Water**

Agricultural drainage is reused extensively throughout the State. As drainage water is reused, salinity of drain water eventually is increased to a level that prohibits water reuse for most crops. Some salt-tolerant crops can be grown with a portion of its applied water having a relatively high concentration of dissolved solids. Fresh-water use might be reduced by substituting brackish agricultural drainage water or brackish shallow ground water for irrigation during the mid- to late-growing season. Using drainage water for irrigation of some salt-tolerant crops was studied and discussed in *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*, September 1990.

The primary concern in long-term use of brackish drainage water for irrigation is the impact of salt accumulation on the integrity and productivity of the soil. Before a decision can be made about large scale reuse of agricultural brackish drainage water for irrigation, field-sized pilot experiments need to be conducted to examine the impact of salt accumulation on soil and the feasibility of commercial farming with brackish water. Any savings associated with this action is, therefore, not included in the water balances in Chapter 3 and Appendix D.

Appendix 2

Interim South Delta Program

Economic Analysis

Interim South Delta Program
Economic Analysis Appendix
May 29, 1996

The purpose of this appendix is to show how the proposed ISDP fits into overall SWP service area water management from an economic perspective. The core of this investigation involved developing and comparing two economically preferred service area water management plans. The plans forecast development of federal, State, and local long-term water supply augmentation and demand management programs that are considered reasonably feasible to implement by 2000, 2010, and 2020, respectively. These plans include both the Level 1 and the Level 2 water management options described in DWR Bulletin 160-93. In addition, the plans consider the expected availability of local shortage management contingency options.

The plans differ in that one plan assumed that SWP supply reliability was enhanced by the ISDP during the period of analysis, whereas the other assumed that this enhancement was not available (i.e., the baseline or no-project condition). Costs of SWP supplies to the State Water Project contractors were assumed to be unchanged in order to compute gross benefits of the ISDP. The plans were developed by assuming that local long-term water management options would be implemented within service areas strictly on the basis of economic efficiency. For this purpose, the point of greatest economic efficiency is defined as the least cost point when the costs and losses associated with water service shortages are combined with the costs of managing the likelihood of those shortages. This is the least-cost planning criterion described below.

Comparing the two plans identifies the effects of ISDP supply reliability enhancement both on the costs associated with service area water management and on the level of shortage-related costs and losses. The result is a measure of the relative economic merit of ISDP for meeting increasing water demands in the context of other feasible local water management options. This approach is a broader one than is traditionally used, since it employs a comprehensive analysis of all available local water management options in the determination of the economic benefits of ISDP for water supply enhancement.

Least-Cost Planning Criterion. The least-cost planning criterion is designed to give all available options an equal chance in the plan selection process. If any options, either demand management *or* supply augmentation, are arbitrarily excluded, it becomes more unlikely that the selected plan will be truly least-cost. The plan will probably not provide the greatest "value for the dollar", where the "value" is meeting the needs of water users and the "dollar" includes social and environmental, as well as economic, costs.

Use of the least-cost planning criterion does not mean that planning decisions must be limited to evaluations that translate all costs into dollar amounts. The LCP concept can be incorporated into evaluations that rank plans according to their relative social and environmental impacts. However, whenever social and environmental consequences of alternatives can be reasonably expressed in dollars, identifying the preferred plan will be less subjective. The appropriate evaluation method might include a mix of economically quantifiable and non-quantifiable environmental and social impacts based on the relative confidence that can be placed in the

specific approach to measuring those impacts. Thus, a plan which is not least-cost in quantifiable economic terms may be judged to be least-cost from a total welfare perspective when non-quantifiable social and environmental impacts are considered.

With least-cost planning, the water manager's objective becomes one of meeting all water-related needs of customers, not one restricted to looking for ways of providing additional supply. If a growing service area's need for sanitation can be met with ultra-low-flush toilets rather than additional water supplies, then this option should be considered on its merits and compared with all other options when putting together a water management plan. Making such comparisons is entirely consistent with the objective of enhancing reliability. With the LCP criterion, how the service area enhances reliability relates only to the relative costs of the alternatives.

This viewpoint has its origin in the energy industry, where it is called "value-based" planning. In the energy industry context, providing new customers with warm houses becomes the goal, for example. Whether this goal is achieved by adding generation capacity (supply management) or by "freeing up" existing capacity by insulating houses (demand management) is a concern only with respect to the relative costs of these options.

In addition to considering all feasible options for meeting customers' needs, the LCP process requires systematic and comprehensive evaluation of all costs associated with each option when devising alternative plans. This includes evaluating the costs of not fully meeting the customers' needs at all times (planning for some probability of shortages); this option must be as carefully evaluated as any other. Plans which would result in extreme shortages jeopardizing life or health would be unreasonable and extremely costly.

Analytical Approach. Identification of the economically preferred (i.e., least-cost) water management plan can be done once sufficient information is collected from existing studies or new research on the following: all costs and losses expected with the local water management options available to manage unreliability, including supply augmentation and demand management costs; shortage-related costs and losses; and any quantifiable social or environmental costs and losses. The preferred plan will be that combination of water management options which is likely to produce the lowest total of these costs and losses. The most useful way of identifying this plan is with a water system simulation model which uses either historical or synthetic (computer generated) hydrology. In this way, shortage events can be given their relative probabilities and their associated costs and losses weighted accordingly.

C—087311

C-087311

Figure 1 depicts the primary planning relationships important for evaluating, from a least-cost perspective, the cost of alternative plans to increase the reliability of a hypothetical water service system. The link between the investment in long-term water management options and the size and frequency of shortages is shown, as is the link between expenditures to make contingency options available on the costs and losses associated with those shortages. As indicated, simulation studies (hydrologic and shortage impact) are required to best approximate the actual nature of these links. In general, the larger the investment in long-term water management the less frequent and less severe will be the shortages experienced. Similarly, greater investment in making contingency measures available for future shortage events will lessen the economic, environmental, or social costs of these shortages when they occur.

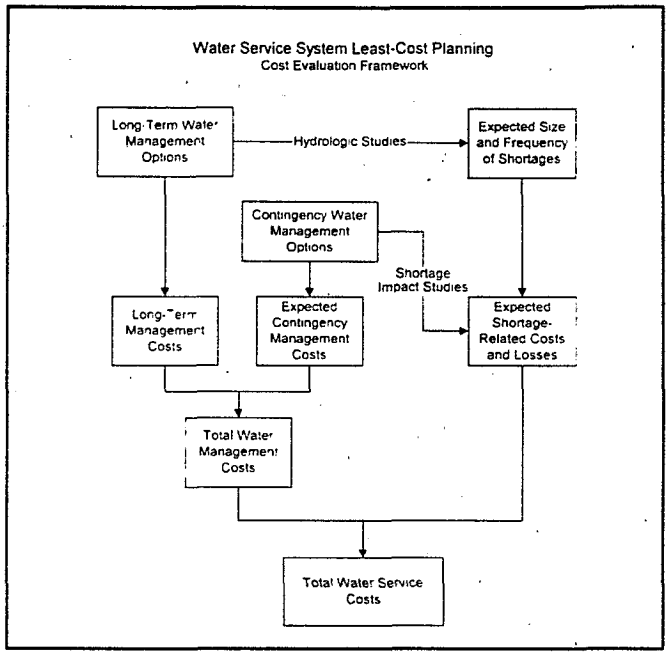


Figure 1 - Reliability Planning Relationships

The capital and operations and maintenance costs of both the long-term and contingency water management scenarios are shown as components of the total water service system costs, the remaining component being the expected costs and losses associated with shortages under those scenarios. Use of different long-term and contingency water management options affects water service costs not only directly but also indirectly through their influence on the size and frequency of shortages as well as the costs and losses associated with those shortages. They can also affect costs because of their influence on the quality of water provided to users and/or water agency treatment processes. Some options, for example, may require substantial capital investment to convert existing treatment processes to those which will be required to meet existing or expected standards if those options are to be used.

Figure 2 depicts an analysis to identify an economically optimal plan for increasing water service reliability. The process involves looking at the additional water management expenditures called for by alternative water management plans (each alternative water management plan is made up of both long-term and contingency water management options) vis-a-vis the shortage-related

C-087312

C-087312

costs and losses associated with those plans. (Plans which impose water quality-related costs on water agencies or directly on users should have these cost included in their cost of implementation.) In Figure 2, the alternative plans are arrayed in terms of increasing water management expenditures. Alternative plan number one represents existing conditions (no additional water management actions.) In this example, the least-cost plan in terms of total costs and losses is alternative plan number eight. Water management expenditures lower than those represented by this plan (plans one through seven) expose the local area to higher shortage-related costs and losses than necessary. Water management expenditures higher than those associated with this plan (plans nine through fifteen) do not "pay for themselves" in terms of additional reductions shortage-related costs and losses.

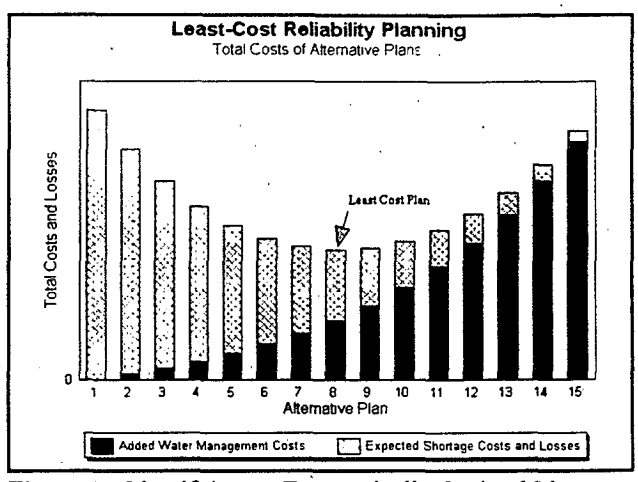


Figure 2 - Identifying an Economically Optimal Plan

Water Supply Augmentation and Demand Reduction Options

The analyses that follow were prepared by the DWR hydrologic regions as defined in Bulletin 160-93. Because of the detailed information available for the South Coast and San Francisco Bay Regions, an economic risk management analysis of these regions was used and is described in detail. The approaches used for the other regions served by the State Water Project were less comprehensive and are therefore less detailed.

The water supply augmentation and demand reduction options examined in this analysis are nonstructural and structural measures that are in addition to the demand reduction due to conservation assumed in the calculation of water supply needs with existing facilities made for Bulletin 160-93 (DWR, 1994). These measures are those identified as either Level I or Level II options in the Bulletin.

South Coast and San Francisco Bay Regions. Water supply benefits in these regions were evaluated by predicting what an economically efficient (least cost) mix of local water management measures would look like both with and without the availability of the proposed facilities and noting the impact on the local management options used and the costs and losses associated with shortages.

The approach used in this analysis takes a comprehensive view of water supply reliability, incorporating key information on the frequency, size, and impacts of shortages. Local water managers (and users) must respond primarily to actual year-to-year fluctuations in demand level and water supply availability rather than to average levels of demand and supply. As shortages

C—087313

C-087313

increase in magnitude and regularity, shortage management becomes increasingly important for the local water manager. Shortage management contingency options such as water transfers, emergency conservation measures, and allocation of shortages among different classes of users (rationing) have been incorporated in the economic risk management analysis prepared for the ISDP Facilities.

The analysis also incorporates a means to account for the value of avoiding extreme shortage events. Summary statistics, such as firm and average yield, do not reflect that one event of a specified shortage amount can be much more damaging than two events of half that magnitude, for example. This is particularly true when there are intervening years of no shortfall in the latter situation and when shortage management can mitigate some of the impacts of the two smaller shortages.

Looking at year-to-year water demand level and supply availability in the context of what local shortage management contingency options can and cannot do to mitigate adverse impacts is critical to assessing the value of enhanced reliability. This includes relating the effectiveness of impact mitigation measures to shortages of specific sizes. In light of the increasing environmental and economic costs of reliability enhancement, this effort can be very valuable. The economic risk analysis evaluates the economic feasibility of the level of reliability enhancement provided by any combination of facilities in light of the shortage management measures locally available.

Local water management program options were divided into three categories:

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

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

The availability of each of these options depends upon the specific circumstances faced by the study area. For example, the South Coast Region is assumed to have the option of using banked ground water through an exchange program based upon the MWDSC and Arvin-Edison WSD agreement. The capacities of other carryover storage facilities for CVP and SWP deliveries not needed for current consumptive use were estimated by accounting for the local storage

reservation capacities needed for the development of the local supply quantities used in Bulletin 160-93. The remaining capacities were used in the Economic Risk Model.

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

The following is a list of shortage management contingency options, the limit of their effect on demand, and their expected order of use. These options are assumed to be available throughout the study period. These options are listed in their expected order of use:

1. Institute public relations campaign to heighten conservation awareness, use alternate day watering, gutter flooder patrols, etc.

   Region Available: South Coast, San Francisco Bay Regions

   Maximum Potential Effect: 7 percent of demand.

   Use Constraints: Conservation program not implemented if the availability of carryover storage is excellent, compared to shortage.

   Associated Cost or Loss: Economic losses to consumers arising from the need to undertake conservation efforts is quantified with shortage loss function and based on extent of conservation needed. Costs of running conservation programs to local water agencies are also included. Above cutbacks of 5 percent, commercial and governmental cutbacks are assumed to occur at a rate of one-half the residential user cutback; industrial cutbacks are assumed to occur at a rate of one-quarter the residential user cutback.

2. Reduce deliveries for reservoir carryover storage.

   Region Available: South Coast

   Maximum Potential Effect: 205,000 acre feet.

   Use Constraints: Size of cutback dependent on size of shortage.

   Associated Cost or Loss: No cost in current year, potential for increased costs and losses in future years because of reduced carryover storage supply available for shortage mitigation.

C—087315

C-087315

3. Reduce deliveries for local in-lieu ground water recharge.

Region Available: South Coast

Maximum Potential Effect: 30,000 acre feet.

Use Constraints: Size of cutback dependent on size of shortage.

Associated Cost or Loss: No cost in current year, potential for increased costs and losses in future years because of reduced ground water supply available for shortage mitigation.

4. Reduce deliveries for local ground water recharge through spreading.

Region Available: South Coast, San Francisco Bay

Maximum Potential Effect: South Coast: 165,000 acre feet.

San Francisco Bay: 1,100 acre feet.

Use Constraints: Size of cutback dependent on size of shortage.

Associated Cost or Loss: No cost in current year, potential for increased costs and losses in future years because of reduced ground water supply available for shortage mitigation.

5. Reduce deliveries made under interruptible agricultural delivery program.

Region Available: South Coast

Maximum Potential Effect: 116,000 acre feet.

Use Constraints: Cut back related to size of shortage through 1995 MWDSC Incremental Interruption and Conservation Plan.

Associated Cost or Loss: Loss valued as equivalent to the cost of water which would have been purchased from MWDSC.

6. Use local reservoir carryover supply made available by storage in previous years.

Region Available: South Coast, San Francisco Bay

Maximum Potential Effect: South Coast: As available -- up to 658 TAF capacity for

carryover storage of imported supplies.

San Francisco Bay: As available -- up to 245 TAF capacity for carryover storage of imported supplies.

Use Constraints: Operational rules limit use.

Associated Cost or Loss: Local treatment and distribution costs.

7. Use imported supplies stored within the service area ground water basins in previous years.

Region Available: South Coast, San Francisco Bay

Maximum Potential Effect: South Coast: As available -- up to 572 TAF capacity for carryover storage of imported supplies.

San Francisco Bay: As available -- up to 20 TAF capacity for carryover storage of imported supplies.

Use Constraints: South Coast: Operational rules and annual extraction capacity of 240 TAF annually limit use.

San Francisco Bay: Operational rules and annual extraction capacity of 18 TAF annually limit use.

Associated Cost or Loss: Cost of pumping ground water plus local treatment and distribution costs.

8. Use ground water banked in a previous year through an exchange agreement with another agency.

Region Available: South Coast

Maximum Potential Effect: As available -- up to 830 TAF capacity for carryover storage of imported supplies.

Use Constraints: Operational rules and annual extraction capacity of 128 TAF annually limit use.

Associated Cost or Loss: Cost of pumping ground water plus conveyance and local treatment and distribution costs.

9. Purchase emergency imported supply through local long-term water marketing agreement.

C-087317

C-087317

Region Available: South Coast, San Francisco Bay

Maximum Potential Effect: South Coast: 90,000 acre feet, based on Palo Verde Test Land Fallowing Program.

San Francisco Bay: 35,000 acre feet, based on 1991 purchases.

Use Constraints: Availability dependent on conveyance capacity available. Frequency of availability is assumed to be limited by third-party impacts to a maximum of five years in any ten-year period and no more than two years in a row.

Associated Cost or Loss: South Coast: Cost of purchase assumed to be $138/AF plus conveyance costs, based on Palo Verde Test Land Fallowing Program. Cost of any additional treatment required by poor quality of purchased supply not taken into account.

San Francisco Bay: Cost of purchase assumed to be $100/AF plus conveyance costs. Cost of any additional treatment required by poor quality of purchased supply not taken into account.

10. Purchase emergency imported supply through State Water Bank.

Region Available: South Coast, San Francisco Bay

Maximum Potential Effect: South Coast: 250,000 acre feet, based on 1991 State Water Bank purchase.

San Francisco Bay: 92,000 acre feet, based on 1991 State Water Bank purchase.

Use Constraints: Availability dependent on conveyance capacity available and on critical shortage criteria established by the State Water Bank: presently triggered by 50 percent shortfall in SWP entitlement delivery and assumed to require at least an 20 percent shortage in the service area after all the above actions.

Associated Cost or Loss: Cost of purchase assumed to be the same as that during the 1991 State Water Bank: $175 /AF plus cost of conveyance from the Delta.

11. Institute a rationing program designed to minimize adverse economic impacts (provide for

business exemptions based on economic hardship or have an specific plan for differential cutbacks for different customer classes).

Region Available: South Coast, San Francisco Bay

Maximum Potential Effect: Amount of remaining shortage after all local contingency options are exhausted.

Use Constraints: Not imposed unless 20 percent shortfall remains after foregoing measures.

Associated Cost or Loss: Losses associated with rationing program computed using loss function in conjunction with a function which varies the size of shortages based on the type of user: Industrial, Commercial and Governmental, and Residential, in order of decreasing protection from shortages. Costs to local water agencies of running the rationing programs are included.

Shown in Table 1 is a summary of the options discussed above:

C—087319

C-087319

Table 1
Annual Availability of Contingency Options

Option (In Order of Use)	Maximum Potential Effect	
	South Coast Region	San Francisco Bay Region
Contingency Conservation Program	7% of Demand	7% of Demand
Reduced Deliveries for Surface Carryover Storage	205 TAF	NA
Reduced Deliveries for In-Lieu Ground Water Recharge	30 TAF	NA
Reduced Spreading for Ground Water Recharge	165 TAF	1.1 TAF
Reduced Interruptible Program Agricultural Deliveries	116 TAF	NA
Deliveries from Local Reservoir Carryover Storage	658 TAF	245 TAF
Deliveries from Previously Stored Local Ground Water	572 TAF	20 TAF
Deliveries from Previously Stored Ground Water Bank Supply	128 TAF	NA
Locally Negotiated Water Market Purchase	90 TAF	35 TAF
State Water Bank Purchase	250 TAF	92 TAF
Rationing Program	As Required	As Required

Long-Term Options. Local long-term water management options to increase reliability that were considered include: (1) local waste water reclamation, (2) local desalination of brackish drainage and ground water, (3) local desalination of sea water, and (4) the development of water by importation, using long-term measures in other geographic areas, including land fallowing. Also included was the retrofit with ultra-low-flush toilets and leak detection programs in the service area. All these programs are beyond those assumed for the base case water supply forecasts in DWR Bulletin 160-93 (i.e., they are Level I and Level II options).

Another long-term management option "automatically" evaluated as part of the least-cost planning approach is the acceptance of risk with regard to the level of use of the other long-term

C—087320

C-087320

management options. This strategy calls for explicitly evaluating the economic cost of shortages based on their expected frequency and magnitude and in the light of available contingency shortage management measures. The results of that evaluation were used in conjunction with an analysis of the cost and effectiveness of available long-term water management measures to determine which of these measures were reasonable from an economic standpoint. The results of this final analysis is the best overall risk management strategy for the study area.

South Coast Region Long-Term Options

Table 2 is a summary list of local long-term options assumed to be available in the South Coast Region. These are listed in Bulletin 160-93 as Level I and Level II options. The options are ranked in the assumed order of implementation (based on using those with the lowest unit cost first, irrespective of whether they are Level I or II). The water reclamation options were grouped into categories based on unit cost (the cost criteria for the categories are described below). With the exception of the last category, the midpoint of the cost range is shown in Table 1 (and used for the ERM evaluation) for each reclamation category. To be conservative, the start of the range is used for the last category.

Unit cost, water produced or conserved by each option, and cumulative quantities are also shown in Table 2. Costs shown are in 1992 dollars and are computed using noninflated dollars and a 6 percent discount rate. The energy cost component of each alternative is assumed not to escalate during the study period. These criteria are consistent with those used for developing the costs of the proposed SWP action. Additional details on each option are given below:

1. Water Reclamation (Category I). For year 2000, projects producing a total of 224 TAF are assumed available in this group. For 2010, projects producing a total of 261 TAF are assumed available in this group. For 2020, projects producing a total of 270 TAF are assumed available in this group. The cost of these projects is in the $100/AF to $249/AF range.

2. Extraordinary Conservation. Residential water audits would be conducted by water agency representatives as a result of aggressive promotional campaigns by the water agency. The audits are free to the property owner but they are voluntary; the number of households benefiting from the audit was estimated at 50 percent. Under the program: 1) water uses are identified and discussed with householders, 2) low-flow shower heads, toilet tank displacement dams, and faucet aerators are offered for installation by the agency, 3) toilet leaks are repaired, and 4) advice on reducing landscape and other exterior water uses is provided. Ultra-low-flush toilets use 1.6 gallons per flush (gpf), compared to about 5.5 gpf for conventional toilets installed before 1978 and 3.5 gpf (low-flush) toilets installed beginning in 1978. (State legislation required the installation of 3.5 gpf toilets after 1977.) Water savings from conservation programs combining both measures are estimated to be 277 TAF annually in 2000, 470 TAF annually in 2010, and 609 TAF annually in 2020. The average cost of these efforts is estimated to be $350/AF.

3. Water Reclamation (Category II). For year 2000, projects producing a total of 201 TAF are

assumed available in this group. For 2010, projects producing a total of 321 TAF are assumed available in this group. For 2020, projects producing a total of 336 TAF are assumed available in this group. The cost of these projects is in the $250/AF to $499/AF range.

4. Ground Water Reclamation. For years 2000, 2010, and 2020, projects producing a total of 80 TAF are assumed available in this group. The average cost of these projects is $400/AF.

5. Water Reclamation (Category III). For year 2000, projects producing a total of 104 TAF are assumed available in this group. For 2010, projects producing a total of 147 TAF are assumed available in this group. For 2020, projects producing a total of 149 TAF are assumed available in this group. The cost of these projects is in the $500/AF to $749/AF range.

6. Ground water desalting and treatment. Facilities to desalt brackish ground water and treat to drinking water standards are expected to be able to produce 30 TAF in years 2000, 2010, and 2020. The average cost of these projects is $810/AF.

7. Water Reclamation (Category IV). For year 2000, projects producing a total of 26 TAF are assumed available in this group. For 2010, projects producing a total of 37 TAF are assumed available in this group. For 2020, projects producing a total of 156 TAF are assumed available in this group. The cost of these projects is in the $750/AF to $999/AF range.

8. Sea Water Desalting. This option is dual-purpose project involving both power production and a desalting distillation process using waste heat from the power plant. For the years 2000, 2010, and 2020, 33 TAF is expected to be available from cogeneration RO at about $900/AF.

9. Gray Water Use. Residential gray water systems are expected to be able to reduce water use by 85 TAF in years 2000, 2010, and 2020. Most households produce between 24 and 36 gallons of gray water per person per day. Many population centers in the State are located in areas where the climate requires landscape irrigation at least seven months of the year. Gray water could replace potable water during that period of time. The cost is extimated to be $1,000/AF.

10. Water Reclamation (Category IV). For year 2000, projects producing a total of 36 TAF are assumed available in this group. For 2010, projects producing a total of 60 TAF are assumed available in this group. For 2020, projects producing a total of 72 TAF are assumed available in this group. The cost of these projects is $1000/AF or greater.

11. Sea Water Desalting. Reverse Osmosis (RO) desalting using primary energy is expected to make available about 309 TAF in years 2000, 2010, and 2020. This is expected to cost about $2000/AF.

Table 2
Local Long-Term Options - South Coast Region

	Product (TAF)			Cumulative Product (TAF)			
Local Option	Year 2000	Year 2010	Year 2020	Year 2000	Year 2010	Year 2020	Cost ($/AF)
Water Reclamation (Category I)	224	261	270	224	261	270	175
Extraordinary Conservation	277	470	609	501	731	879	350
Water Reclamation (Category II)	201	321	336	702	1052	1215	375
Ground Water Reclamation	80	80	80	782	1132	1295	400
Water Reclamation (Category III)	104	147	149	886	1279	1444	625
Groundwater Desalting and Treatment	30	30	30	916	1309	1474	810
Water Reclamation (Category IV)	26	37	156	942	1346	1630	875
Sea Water Desalting (Cogeneration)	33	33	33	975	1379	1663	900
Gray Water Use	36	60	72	1011	1439	1735	1000
Water Reclamation (Category V)	85	85	85	1096	1524	1820	1000
Sea Water Desalting (Reverse Osmosis)	309	309	309	1405	1833	2129	2000

San Francisco Bay Region Long-Term Options. Table 3 is a summary list of comparable long-term options for the San Francisco Bay Region.

C—087323

C-087323

Table 3
Local Long-Term Options - San Francisco Bay Region

	Product (TAF)			Cumulative Product (TAF)			
Local Option	Year 2000	Year 2010	Year 2020	Year 2000	Year 2010	Year 2020	Cost ($/AF)
Water Reclamation (Category I)	19	53	64	19	53	64	175
Extraordinary Conservation	142	240	312	161	293	376	375
Water Reclamation (Category II)	29	35	42	190	328	418	375
Ground Water Reclamation	10	10	10	200	338	428	400
Water Reclamation (Category III)	4	4	5	204	342	433	625
Groundwater Desalting and Treatment	0	0	0	204	342	433	810
Water Reclamation (Category IV)	23	26	30	227	368	463	875
Sea Water Desalting (Cogeneration)	35	35	35	262	403	498	900
Gray Water Use	13	13	13	275	416	511	1000
Water Reclamation (Category V)	16	33	37	291	449	548	1000
Sea Water Desalting (Reverse Osmosis)	325	325	325	616	774	873	2000

Central Coast Region. This region is characterized by costly water management options in the face of increasing urban use due to population growth. Management options in this region were extensively evaluated during the decision/regulatory process for subscribing to SWP deliveries through the Coastal Aqueduct. On this basis, alternatives to the reliability added by the ISDP were assumed to be at least as costly as the SWP supply.

C-087324

C-087324

Tulare Lake Region. Management options for this region were examined for two classes of users: (1) agricultural and (2) municipal and industrial.

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

- Pumping ground water (if farms overlie a ground water basin).

- Increasing on-farm water application efficiency

- Exchanging supplies within the local water agency from areas with alternative supplies to those without.

- Stressing crops by not meeting full evapotranspiration requirements.

- Reducing planted acreage of annual crops.

Based on the 1976-77 and the 1989-92 drought experiences, which included the drilling of many additional wells and the more than doubling of annual pumping in the Tulare Lake Basin in the most recent drought, it is reasonable to expect that any additional increment to SWP delivery curtailments due to the absence of the ISDP facilities will be substantially compensated by local ground water pumping. In 1991, additional ground water pumping was used to compensate almost totally for about a 60 percent shortfall in surface water availability. For areas that do not overlie ground water, the 1976-77 and 1989-92 experiences demonstrated local water agency flexibility in setting up contingency exchanges with those nearby areas with available local ground water supplies.

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

The cost of using ground water as an alternative in the Tulare Lake Region includes the cost of additional pumping in the year of curtailment related to the absence of the ISDP facilities and the cost of managing any exchange programs necessary to get additional water to areas without ground water pumping capability. The results of a study by Northwest Economic Associates, *Economic Impacts of the 1991 California Drought on San Joaquin Valley Agriculture and Related Industries,* March 16, 1991, was used for the unit cost of pumping additional quantities from added depths during times of surface water shortage. In addition, because the Tulare Lake Region is in a condition of long-term ground water overdraft, the additional pumping in any single year will cause an increase in pumping depth, which will result in a long-term increase in all pumping costs. This is an additional cost not taken into account. The estimate of the single-year pumping costs impacts used for the ISDP study was $34/AF in the Fresno/Kings area and

C-087325

C-087325

$58/AF in the Kern area.

The Northwest Economic Associates study was also used to estimate the farm-level income impacts of that portion of surface water shortage not made up by ground water pumping. The overall impact due to crop fallowing and yield reductions used for the ISDP study was $43/AF. Because conditions both with and without the ISDP result in large expected surface water deficiencies for the Tulare Lake Region, the 1991 study was considered to be appropriate to estimate the benefits of the ISDP for both the added pumping costs and the farm losses.

This assumption of a linear relationship between the level of agricultural deficiency and the economic impact of that deficiency could bias the results of this study. The direction of bias is indeterminant because of the higher frequency of conditions of less severe shortage compared with those of more severe shortage. Thus, overestimates of the impact of smaller shortages will tend to be counterbalanced by the much larger, but less frequent, underestimates of the impact of more severe shortages. Also, the coincidence of shortages in adjoining agricultural areas and in supplies from alternative water surface water sources can influence the ability of affected areas to trade water to reduce shortage-related costs and losses. The 1991 drought event created surface water shortages in all areas in the San Joaquin Valley to some extent.

Because of the long-term overdraft, the absence of the ISDP will accelerate the point at which agricultural ground water pumping becomes uneconomical, or water quality becomes unacceptable for crop production. The net economic cost of the future loss of irrigated acreage was assumed to be at least as costly as the ground water pumping alternative described above.

Municipal and Industrial Users - SWP M&I users in the Tulare Lake Region were assumed to have the same capability for ground water pumping and/or contingency exchange as the agricultural users in the region. The cost of these alternatives to the M&I users was assumed to be at least as high as the current cost of the M&I supply minus the cost of local treatment and delivery. This value was estimated to be $165/AF, based on a DWR water price survey.

Sacramento River Region. The M&I water users in this region are assumed to have access to local surface water as a supply management option. Using the weighted average SWP equivalent unit water cost of $20/AF as a conservative alternative cost, DWR assumes that the cost of using the alternative supplies is at least as great as the cost of the current SWP supply. Bulletin 132, *Management of the California State Water Project* (DWR 1989), was the source of the equivalent unit cost.

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

would be worse.

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

Analytical Approach for South Coast and San Francisco Bay Regions

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

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

Table 4 shows the relationship between potential water shortages to households as a percentage of normal use and the median willingness to pay to avoid such shortages. These values were used in the simulation model in functional form to estimate losses. An adjustment to the economic cost of shortages was made to account for the disbenefit of enduring substantial shortages (equal to or greater than 20 percent) occurring consecutively or with only one or two intervening years. Two consecutive years of such a shortage is assumed to produce an added disbenefit equal to a 20 percent upward adjustment to the second year's losses. With one intervening year, this adjustment is 7 percent . With two intervening years, the adjustment is 4 percent. Beyond two intervening years, there is no adjustment.

C—087327

C-087327

Table 4
Annual Willingness to Pay to Avoid Shortages

	Annual Use per Household		
Deficiency	0.75 AF	0.65 AF	0.55 AF
0%	$0	$0	$0
5%	$30	$26	$22
10%	$91	$79	$67
15%	$181	$157	$133
20%	$298	$258	$219
25%	$439	$381	$322
30%	$602	$522	$441
35%	$784	$680	$575

These values were derived by extrapolating from the results of a contingent valuation study done for the Metropolitan Water District of Southern California for the Bay-Delta Hearings held in 1987-88. The results were entered as State Water Contractors Exhibit 51, *Economic Value of Reliable Water Supplies*, dated June 1987. The credibility of the extrapolated values was strengthened by using (as part of the extrapolation process) the existing unit cost of water at the no shortage point and, at the moderate- to high-shortage points, the cost of contingency supply augmentation measures under serious consideration during the 1990-91 drought period, and the cost of emergency punitive water rates for high water users during that period.

More recent studies have shown evidence of an even more severe "threshold" effect than can be inferred from the 1987 study, which means that the estimates of losses produced by using the values presented in Table 3 might be seriously understated for the smaller deficiency levels. The resulting bias would be to undervalue the benefits of the ISDP program.

The simulation program accounts for the existence of strategies by local water agencies to manage the most severe economic impacts of shortages either by official rationing programs which allocate the shortages differentially or ad hoc exemption programs based on economic hardship. The program uses a shortage allocation formula above a set threshold (5 percent) to adjust the size of the overall shortage to be equivalent to the shortage that would have to be borne by the residential sector in order to allocate proportionately smaller shortages to the commercial and governmental sector and the industrial sector. This "economically equivalent" shortage is calculated by estimating the allocation which would be needed to equalize the incremental costs

C—087328

C-087328

of shortage in each sector, the economically "least cost" way of shortage allocation. The assumption used is that the shortage in the commercial and governmental sector should be held to one-half the size of the shortage in the residential sector and the shortage in the industrial sector should be held to one-quarter the size of the shortage in the residential sector.

Figure 3 is a flow chart of the Economic Risk Model. In brief, the model was run yearly on the 71-year hydrologic record for the SWP contractor-requested entitlement demand levels and projected local use levels for the years 2000, 2010, and 2020. Two sets of runs were made at each year level; the only difference was the existence of the ISDP: one set assumed its existence, whereas the other set did not. Within each set, runs differed only by the amount of additional water made available by the use of local extraordinary long-term water supply enhancement and demand management options. For each of the South Coast and San Francisco Bay Regions, fifty simulation runs were made, each run adding a specified fixed increment of local supply, depending upon the demand and use levels being evaluated.

Average M&I consumptive use for the South Coast and San Francisco Bay Regions were based on numbers produced for DWR Bulletin 160-93. Variation in the year-to-year level of M&I consumptive use was simulated within the economic risk model based on historic climatic conditions in each region during the 71-year period of hydrologic record. The variance in consumptive use driving the simulation was based on an estimate made in a study done for the Metropolitan Water District (Chesnutt and McSpadden, January 1989). Each run (at a specified increment of local supply) was made thirty times for each of the 71 years of hydrologic record. This allowed for the resimulation of

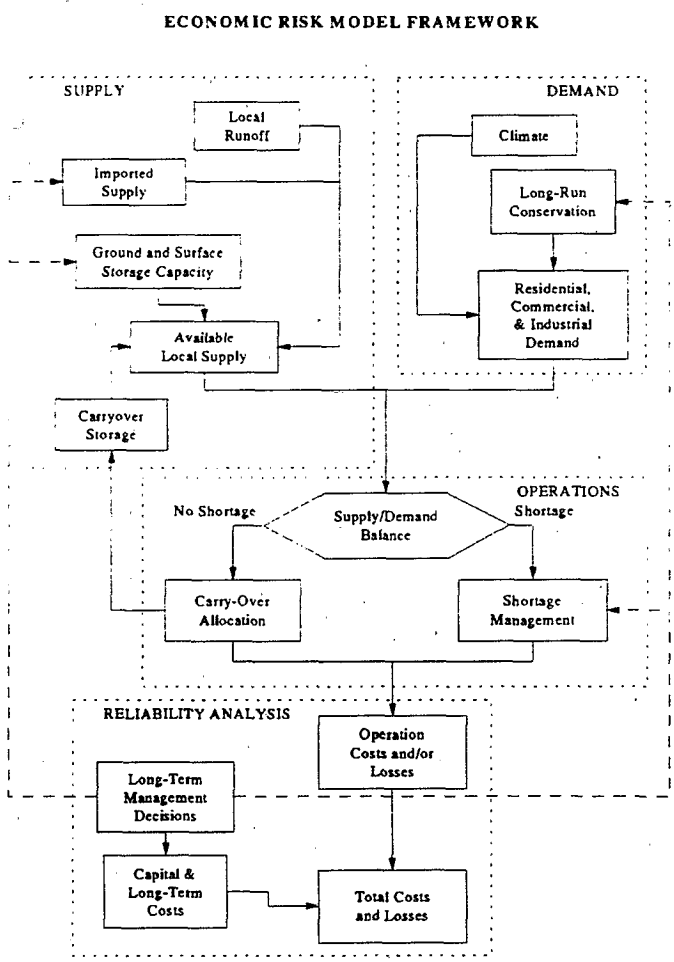


Figure 3 - Economic Risk Model

consumptive use each time to get a sufficiently reliable estimate of the expected value of the economic losses.

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

An additional criterion must be considered if risk management mandates a higher level of use of local options for an earlier year compared with a subsequent year. In this case, "extra capacity" can appear on the local system after a period of time. This may come about if, for example, the combined effect of downward-trending local agricultural demands in an M&I service area and increased risk acceptance for SWP operations (i.e., higher average deliveries to the local area) more than counterbalances the additional use associated with a growing population.

The local decision-makers must decide how much additional risk should be accepted on the local system in the early years to avoid paying for at least some portion of the excess capacity in the later years. Factors to be considered are the size of the option costs which could be avoided compared to the size and duration of the additional risk which would have to be accepted and the confidence which can be placed in assumptions about future supply/use conditions.

Identification of South Coast Region Alternatives

Table 5 shows the water balance assumptions used for the Economic Risk Model runs for the South Coast Region. This balance does not include the supplies provided by the State Water Project, the Los Angeles Aqueduct, or the Colorado River Aqueduct. Yearly time-step delivery files produced by water supply system simulation models are used to add supplies from these sources for the 71-year period of hydrologic record.

Table 5
Average Year Local Water Balance - South Coast Region

LOCAL SUPPLY [1]	Year 2000		Year 2010		Year 2020	
Local Surface		254		254		254
Ground Water		1,100		1,125		1,150
Other Federal		22		22		22
Reclamation [2]		82		82		82
TOTAL LOCAL SUPPLY		1,458		1,483		1,508
Non-Interruptible Ag. Net Use		453		342		240
Total Ag Net Use	569		458		356	
<Interruptible Ag Net Use>	116		116		116	
Other Non-Interruptible Net Use		233		238		238
Environmental	6		6		6	
Other	227		232		232	
NET URBAN & INTERRUPTIBLE AG SUPPLY		772		903		1,030
NET URBAN & NET INTERRUPTIBLE DEMAND						
Urban Net Use [3]		4,228		5,004		5,779
Interruptible Ag Net Use		116		116		116
Intr. Ag Applied Use	155		155		155	
<In-Lieu Applied GW Avail.> [4]	35		35		35	
Basin Efficiency	0.97		0.97		0.97	
TOTAL LOCAL NET DEMAND		4,344		5,120		5,915
NET ADDL NEED FOR IMPORTED SUPPLIES		3,572		4,217		4,885

[1] No additional local storage assumed

[2] Net of 50 TAF for Salinity Barrier Injection

[3] Net of 50 TAF consumptive use to keep GW supply useable

[4] GW available to replace interruptible program surface water cutback

C—087331

C-087331

At the Year 2000 level and without the ISDP, a decision based on risk management calls for implementing local options up to and including 3 TAF from Category II water recycling facilities, producing a total of 504 TAF from the use of local options. With the ISDP in place, a total of 444 TAF from local options would be needed. No Category II water recycling facilities supply would be used and only 220 TAF from extraordinary water conservation would be used. On this basis, the appropriate local option alternative is the 3 TAF from the Category II water recycling facilities and 57 TAF from the extraordinary water conservation program, the difference in option use. Figure 4 is a graphic depiction of this result. For the 2000 level, lower economic risk with the ISDP is also part of the alternative. The least-cost management strategy allows a reduction in the cost of risk as well as a reduction of the cost of local option use with ISDP.

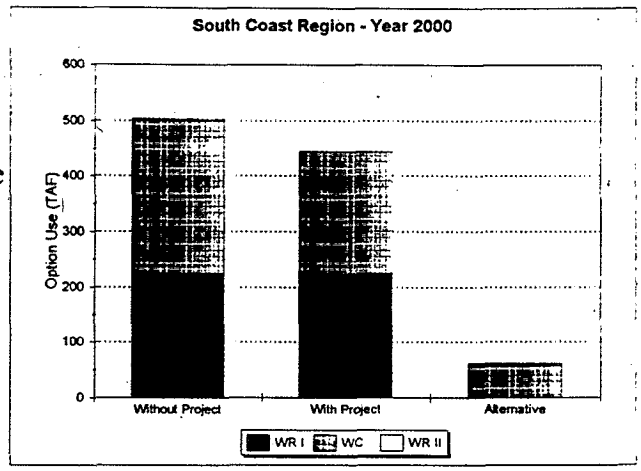


Figure 4 - Identification of Year 2000 Alternative

Without the ISDP in 2010, risk management dictates the use of local options up to and including 243 TAF from Category II water recycling facilities for a total of 974 TAF from the use of local options. With the ISDP in place, a total of 980 TAF from local options would be needed. Options up to and including 249 TAF from Category II water recycling facilities would be used. On this basis, the appropriate alternative is a 6 TAF *decrease* in the use of Category II water recycling facilities, a reduction in use of local options. Figure 5 is a graphic depiction of this result. For the 2010 level, the benefit of economic risk with the ISDP is part of the alternative. The least-cost management strategy requires the trade-off of a small increase in the cost of local option use for the benefit of this reduced risk for with the ISDP.

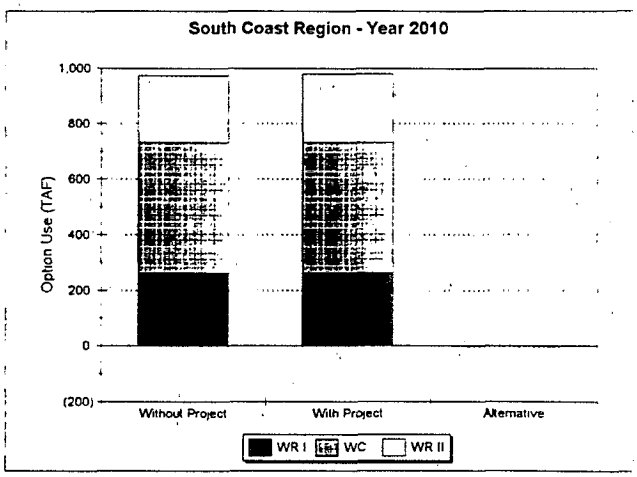


Figure 5 - Identification of Year 2010 Alternative

C-087332

C-087332

At the 2020 level of requested entitlement deliveries and without the ISDP, local options producing a total of 1,484 TAF would be needed to meet the "least cost" economic efficiency criterion. This would be provided by those options up to and including 10 TAF from the Category IV water recycling facilities. With the ISDP in place, a total of 1,451 TAF from local options would be needed. Only the options up to and including 7 TAF from ground water desalting and treatment facilities would be used. The 23 TAF from the Category IV water recycling facilities and the 10 TAF from ground water desalting and treatment, which are no longer needed with the proposed SWP facilities in place, are properly designated as comprising the alternative. Figure 6 is a graphic depiction of this result. As in the case of the 2000 level analysis, the least-cost management strategy allows a reduction in the cost of risk as well as a reduction in the cost of local option use with ISDP.

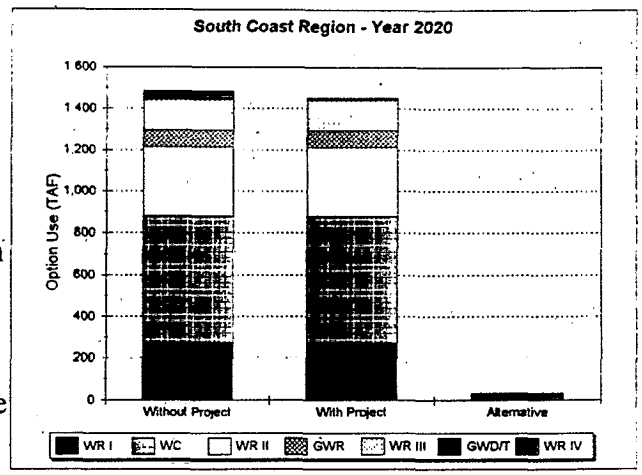


Figure 6 - Identification of Year 2020 Alternative

Shown in Figures 7 through 9 are the results of the least-cost optimum analyses for the South Coast Region for the Years 2000, 2010, and 2020, respectively. Each result identifies the cost of local option use and the associated level of economic risk. These values correspond to the alternative identification results described in detail above.

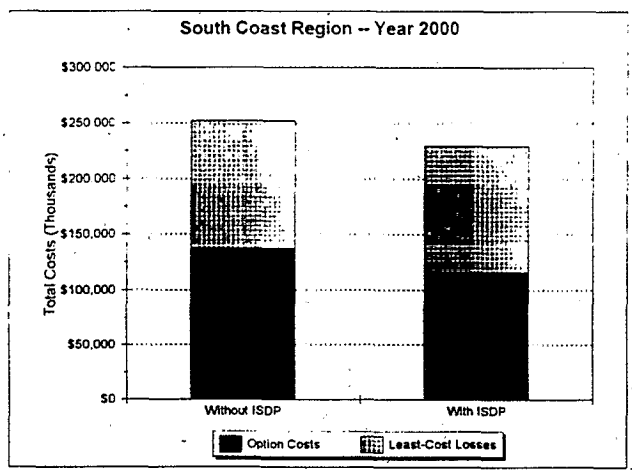


Figure 7 - Least-Cost Solution for Year 2000

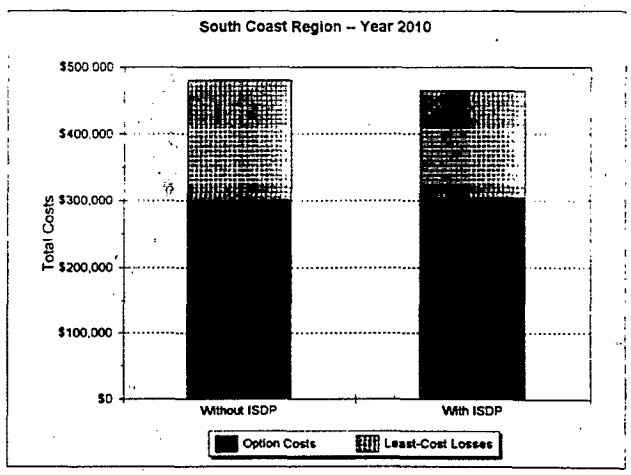


Figure 8 - Least-Cost Solution for Year 2010

C—087333

C-087333

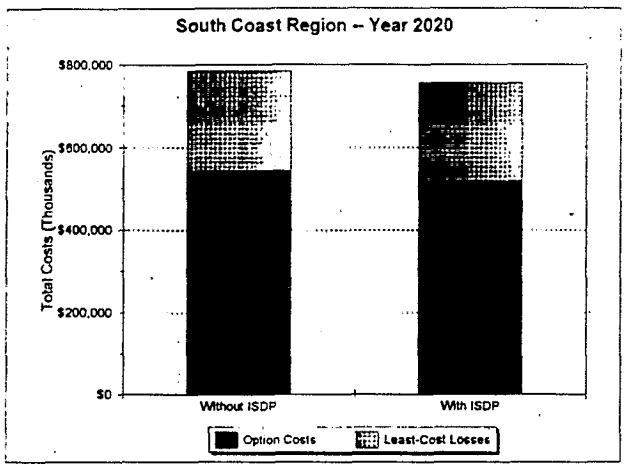


Figure 9 - Least-Cost Solution for Year 2020

Identification of San Francisco Bay Region Alternatives

Table 6 shows the water balance assumptions used for the Economic Risk Model runs for the San Francisco Bay Region. This balance does not include the supplies provided by the Mokelumne or the Hetch Hetchy Aqueducts, the State Water Project, or the Central Valley Project. The model uses yearly time-step delivery files to add these supplies for the 71-year period of

C—087334

C-087334

Table 6
Average Year Local Water Balance - San Francisco Bay Region

LOCAL SUPPLY [1]	Year	2000	Year	2010	Year	2020
Local Surface		365		365		365
Local Imports		32		39		43
Ground Water		126		160		165
Other Federal		54		54		54
Reclamation		36		36		36
TOTAL LOCAL SUPPLY		613		654		663
Non-Interruptible Ag. Net Use		90		90		90
Total Ag Net Use	90		90		90	
<Interruptible Ag Net Use>	0		0		0	
Other Non-Interruptible Net Use		182		183		185
Environmental	160		160		160	
Other	22		23		25	
NET URBAN & INTERRUPTIBLE AG SUPPLY		341		381		388
NET URBAN & NET INTERRUPTIBLE DEMAND						
Urban Net Use		1,409		1,559		1,656
Interruptible Ag Net Use		0		0		0
Intr. Ag Applied Use	0		0		0	
<In-Lieu Applied GW Avail.> [2]	0		0		0	
Basin Efficiency	0.97		0.97		0.97	
TOTAL LOCAL NET DEMAND		1,409		1,559		1,656
NET ADDL NEED FOR IMPORTED SUPPLIES		1,068		1,178		1,268

[1] No additional local storage assumed

[2] GW available to replace interruptible program surface water cutback

hydrologic record.

The analysis of alternatives for the San Francisco Bay Region resulted in the identification of the use of extraordinary water conservation as the only long-term local option which was affected by the availability of the added reliability supplied by the ISDP. In Year 2000, the level of long-

C-087335

C-087335

term option use was reduced from 39 TAF to 36 TAF by the ISDP. For Year 2010, use was reduced from 68 TAF to 65 TAF and, for Year 2020, from 100 TAF to 97 TAF. The local option alternative was 3 TAF of extraordinary water conservation for all three year levels. For each of these year levels, Category I water recycling was used to the extent it was assumed to be available: 19 TAF, 53 TAF, and 64 TAF, respectively (see Table 3).

Shown in Figures 10 through 12 are the results of the least-cost optimum analyses for the San Francisco Bay Region for the Years 2000, 2010, and 2020, respectively. Each result identifies the cost of local option use and the associated level of economic risk. These values correspond to the alternative identification results described above.

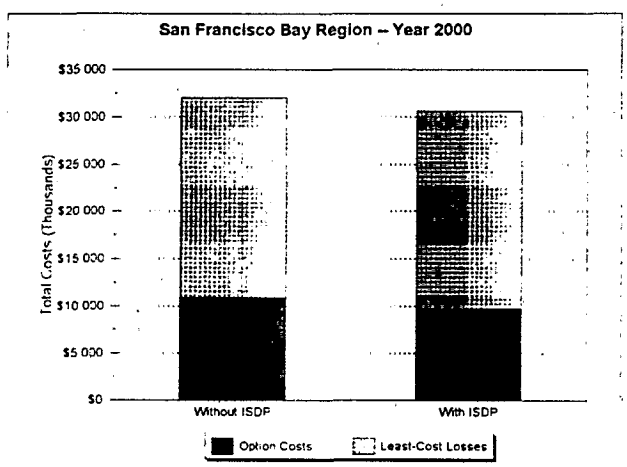


Figure 10 - Least-Cost Solution for Year 2000

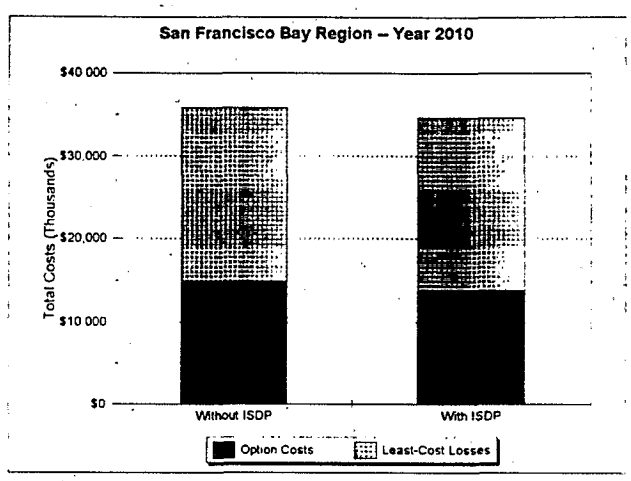


Figure 11 - Least-Cost Solution for Year 2010

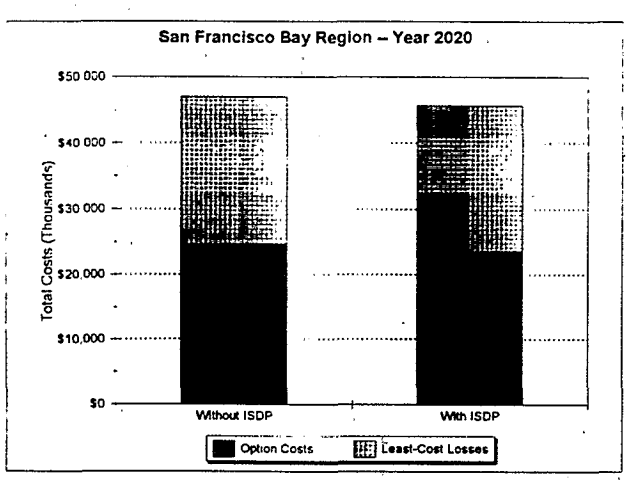


Figure 12 - Least-Cost Solution for Year 2020

Economic Benefits

C—087336

C-087336

Economic benefits of the proposed ISDP project were estimated using the Economic Risk Model for the South Coast and San Francisco Bay Regions. The benefits of the ISDP for these regions depend on the extraordinary local water supply and demand management options that would be employed under conditions with and without the proposed ISDP. Either the costs of the options that could be displaced by the existence of the proposed ISDP, the expected economic losses that would be avoided with the proposed ISDP, or both (if appropriate), could then be properly attributed to the ISDP facilities as benefits. The lower level of total costs of water management at the least cost point with the ISDP supply enhancement available is the economic benefit of the ISDP. Tables 6 and 7 were developed by using the procedure described in the previous section for determining the optimal employment of local options and noting the expected total water management costs associated with each level of use of the options. This was done by calculating the increase in expected losses due to the reduction in use of the local options (a cost) and adjusting it by the avoided cost of the options no longer needed (a benefit).

The lower the use of the local options, the higher the value of the ISDP for reducing risk. The avoided economic loss benefit of the ISDP would be more than proportionally greater to the degree that the local options are not available to the extent assumed or are more costly than assumed, an important observation because of the uncertainty about the environmental, legal, and health problems associated with some of the options. While the technical feasibility of the local options has been established, the reclamation and desalting options require additional study to assess their environmental and health impacts and to determine legal obstacles to their implementation.

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

Benefits for SWP agricultural contractors in Kings and Kern counties were computed by using estimated avoided pumping costs and crop revenue losses. These costs were developed (and generalized) from the results of a study done by Northwest Economic Associates, *Economic Impacts of the 1991 California Drought on San Joaquin Valley Agriculture and Related Industries*, March 1992. Current water costs were used to estimate willingness to pay for M&I water in the Central Coast, Tulare Lake, and Sacramento River Regions.

South Coast Region M&I Benefits. For 2000, 2010, and 2020, the corresponding benefit values were calculated to be $22.5 million, $15.3 million, and $29.3 million annually. Shown in

C—087337

C-087337

Table 7 are the details of the derivation of these numbers. The drop in benefits in the year 2010 was due to assuming a greater availability of the lower-cost options in that year compared to the year 2000. The equivalent annual benefit over the 21-year study period is $20.3 million.

Table 7
Analysis of Annual Benefits - South Coast Region

Variable		Demand Level		
		Year 2000	Year 2010	Year 2020
Water Use (TAF)				
Use of Local Options	Without ISDP	504	974	1,484
	With ISDP	444	980	1,451
Avoided Option Use		60	(6)	33
Benefits ($ Thousands)				
Cost of Local Options	Without ISDP	137,275	301,300	544,575
	With ISDP	116,200	303,550	517,195
Reduction in Local Option Costs		21,075	(2,250)	27,380
Expected Economic Costs and Losses Due to Shortage	Without ISDP	114,632	179,354	238,982
	With ISDP	113,272	161,776	237,097
Reduction in Economic Costs and Losses		1,360	17,578	1,885
ISDP Benefits (Reduction in Option Costs Plus Reduction in Expected Costs and Losses)		22,435	15,328	29,265

San Francisco Bay Region M&I Benefits. For 2000, 2010, and 2020, the benefit values were calculated to be $0.7 million annually. Shown in Table 8 are the details of the derivation of these numbers. The equivalent annual benefit over the 21-year study period is $0.7 million.

C—087338

C-087338

Table 8
Analysis of Annual Benefits - Francisco Bay Region

Variable		Demand Level		
		Year 2000	Year 2010	Year 2020
Water Use (TAF)				
Use of Local Options	Without ISDP	39	68	100
	With ISDP	36	65	97
Avoided Option Use		3	3	3
Benefits ($ Thousands)				
Cost of Local Options	Without ISDP	10,825	14,855	24,628
	With ISDP	9,700	13,739	23,509
Reduction in Local Option Costs		1,125	1,116	1,119
Expected Economic Costs and Losses Due to Shortage	Without ISDP	21,163	20,876	22,353
	With ISDP	20,918	20,839	22,244
Reduction in Economic Costs and Losses		245	37	109
ISDP Benefits (Reduction in Option Costs Plus Reduction in Expected Costs and Losses)		1,370	1,153	1,228

Agricultural Benefits for SWP Service Areas in Tulare Lake Region. The estimate of the single-year pumping costs impacts used for the ISDP study was $34/AF in the Fresno/Kings area and $58/AF in the Kern area. The impact due to crop fallowing and yield reductions used for the ISDP study was $6/AF in the Fresno/Kings area and $50/AF in the Kern area. The average impact from the proposed facilities on SWP deliveries to the Fresno/Kings area is about 7,300 AF. The average impact from the proposed facilities on SWP deliveries to the Kern area is about 40,600 AF. Annual benefits were estimated to be $4.1 million. The results are shown in Table 9.

C—087339

C-087339

Table 9
Agricultural Benefit Analysis -- Tulare Lake Region

Annual Benefits ($ Thousands)

Expected agricultural losses	Year 2000	2010	2020
without ISDP			
Pumping Costs	12,561	12,561	12,561
Income Loss	12,936	12,936	12,936
with ISDP			
Pumping Costs	10,551	10,551	10,551
Income Loss	10,866	10,866	10,866
Avoided losses			
Pumping Costs	2,010	2,010	2,010
Income Loss	2,070	2,070	2,070
Total	4,080	4,080	4,080

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

Central Coast Region - The cost of water supplied by the Coastal Aqueduct is $645/AF. Adjusting this for SWP conveyance cost and local treatment and distribution results in a net value of $575/AF. This value was assumed to remain constant throughout the study period. The average impact from the proposed facilities on SWP deliveries to this area is about 2 TAF. Based on this, an estimated equivalent annual benefit of $1.2 million was obtained.

Tulare Lake Region - The average urban water rate presently being paid for urban water in this area is $190/AF. Adjusting this for SWP conveyance cost and local treatment and distribution results in a net value of $165/AF. This value was assumed to remain constant throughout the study period. The average impact from the proposed facilities on SWP deliveries to this area is about 4 TAF. Based on this, an estimated equivalent annual benefit of $0.7 million was obtained.

C-087340

C-087340

Sacramento Valley Region - SWP operations studies for the ISDP revealed no effect on deliveries to this region. No benefits were ascribed to the existence of the ISDP.

Table 10
ISDP Annual Economic Benefits by Region

Type of Use	Region	Benefit (Million $)
Municipal and Industrial	South Coast	20.3
	Central Coast	1.2
	San Francisco Bay	1.2
	Tulare Lake	0.7
	Subtotal	23.4
Agricultural	Tulare Lake	4.1
Total		27.5

Summary of Annual Benefits. Table 10 shows a summary of the benefits derived with the procedures described above. Total benefits or "cost savings" for the SWP service areas due to the implementation of the ISDP were estimated to be about $28 million annually.

The benefit values presented in this table should be used advisedly for the determination of economic justification for the proposed project for the following reasons:

- Economic benefits were computed for the period 2000 to 2020 only. Because the economic life of the project exceeds this substantially, this is a very conservative method of benefit estimation, particularly in light of expected increases in urban demand beyond the year 2020.

- Local water supply sources that are not modeled on a year-to-year basis in the Economic Risk Model are assumed to be continually at their average year values. This simplifying assumption can bias the results by not capturing the large costs and losses which can arise when shortages occur on these local supply and the explicitly modeled imported supply systems concurrently. This bias is most likely to be present when the local area has limited carryover storage capacity compared with the size of current-year use. Similarly, the benefits of the coincidence of "surpluses" on both systems is not correctly taken into account, although this bias is reduced in areas with limited carryover storage capacity. Both situations will tend to show less benefits from increased SWP reliability than would otherwise be the case.

C—087341

C-087341

- Some local imported water supply sources which are modeled on a year-to-year basis are modeled at the current level of demand and do not reflect the benefits which might be gained by reoperation for higher levels of demand, if that opportunity exists. The modeled sources also do not reflect the benefits which might be gained by coordinating their operations based on regional rather than individual water agency benefits, if that option is feasible.

- The determination of local project alternatives is done in the model on the basis of a risk-neutral view of risk management. Risk-averse management (risk minimization) by local agencies--which has been the predominant mode--would result in the proposed project displacing more costly water management options than under the risk-neutral assumption.

- The costs developed for the local water management options must be considered very preliminary in comparison to the costs developed for the proposed project. In the preponderance of cases, when a detailed study is made of an option and commensurate refinements are made to cost estimates, the costs increase substantially.

- Local options which require the disposal of materials covered by hazardous waste regulations, such as desalting plants and some waste water reclamation plants, may have higher than anticipated costs.

- Some of the local options assumed to be available may not be politically, financially, and/or technically feasible as soon as the model expects or not feasible at all. For example, the reclaimed waste water options were based on liberal assumptions regarding the acceptable uses for this source of supply in light of current regional Water Quality Control Boards and Health Department regulations.

- The model assumes that both the South Coast, Central Coast, San Francisco Bay and the Tulare Lake Regions have the facilities and institutional agreements in place to move water as needed to minimize the impact of shortages. Because this is more or less unlikely to be the situation the model tends to undervalue the benefits of the proposed project for this reason.

- The long-term consequences of added surface water deficiencies on ground water levels in overdrafted basins in the San Joaquin Valley for future agricultural pumping costs were not calculated. Also, because of the growing market for California's high-income crops, plantings of these crops are expected to increase significantly, creating a higher exposure to risk from water supply unreliability.

In light of the foregoing, the economic benefit numbers must be considered, on balance, to underestimate the actual benefits of the proposed project.

Appendix 3

Project-Related Hydrodynamics

3 *Project-Related Hydrodynamics*

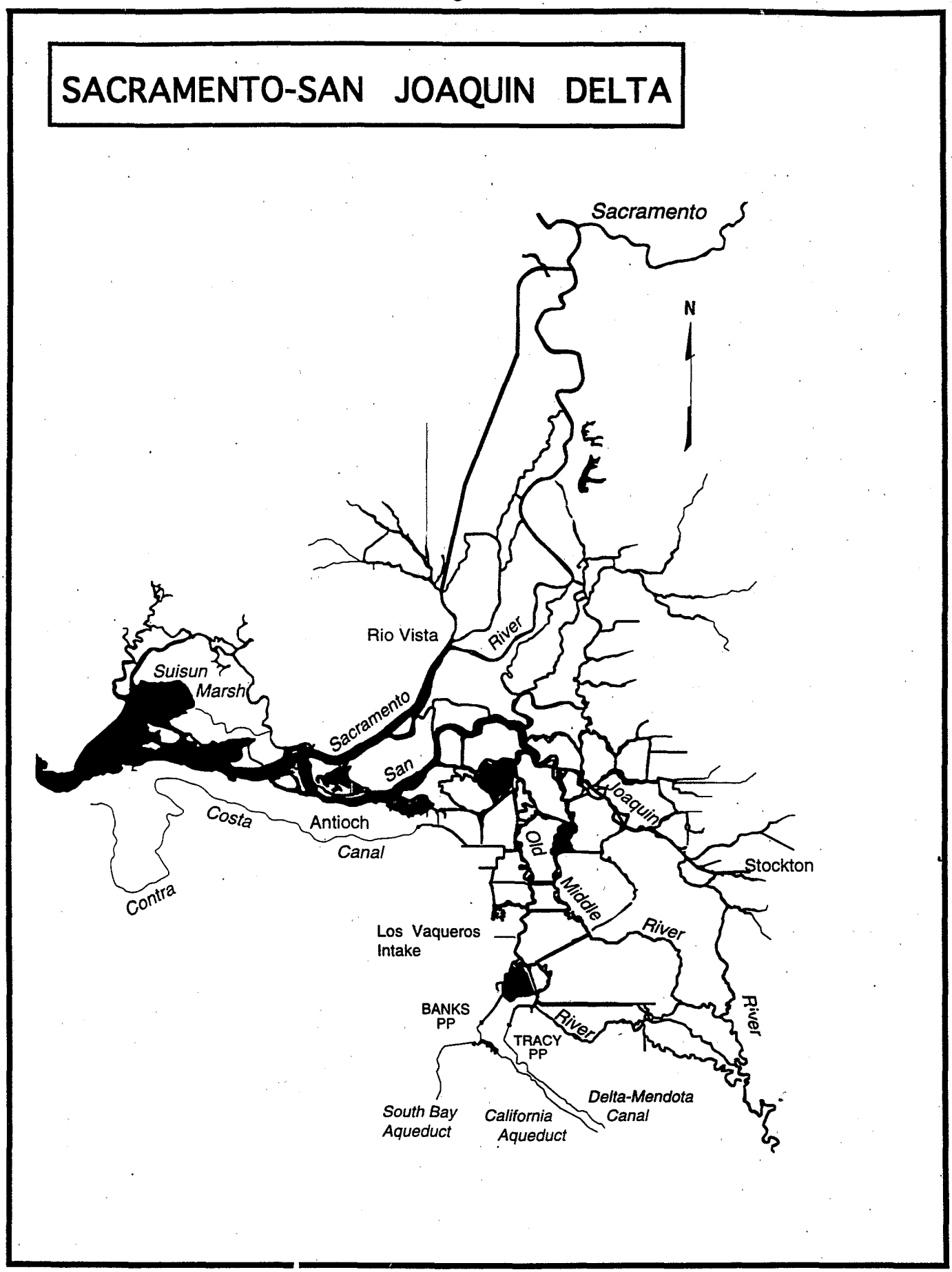
Delta hydrodynamics are influenced by changes in stream inflow, watershed modifications, Pacific Ocean tides, CVP and SWP exports, municipal and industrial users, agricultural diversions and returns, channel modifications within the Delta, and regulatory constraints. This section first provides a general description of the environmental setting, followed by a discussion of the methodology used to evaluate alternatives. Next, there is a discussion of base conditions under both existing and future SWP demand levels, followed by a discussion of changes as a result of the preferred alternative. Finally, a discussion of changes as a result of the Fisheries Alternative.

3.1 *General Setting*

The Sacramento-San Joaquin Delta is a roughly triangular area of about 738,000 acres (1,150 square miles) extending from Chipps Island near Pittsburg on the west to Sacramento on the north and to the Vernalis gaging station on the south (Figure A3-1). In addition to the Sacramento River entering the Delta from the north and the San Joaquin River entering from the south, minor tributaries to the Delta include the Cosumnes, Mokelumne, and Calaveras rivers (Eastside Streams). The rivers flowing to the Delta receive a combined runoff from approximately 40 percent of California's land area. The Delta discharges to Suisun Bay and San Francisco Bay, forming an interconnected estuary system. The Delta comprises over 700 miles of interconnected waterways which flow around 57 major islands. The total surface area of the Delta waterways is over 48,000 acres. Approximately 1,100 miles of levees protect 700,000 acres of reclaimed marshlands and uplands.

The Delta serves as a source of fresh water for agricultural and municipal consumption in central and southern California. The principal diversions are through the State Water Project (SWP), operated by the Department of Water Resources (DWR), and the Central Valley Project (CVP), operated by the U.S. Bureau of Reclamation (Reclamation). The Contra Costa Water District also exports water to a lesser extent. The state and federal agencies built dams, reservoirs, and canals to increase storage capacity and annual export

Figure A3-1


SACRAMENTO-SAN JOAQUIN DELTA
Sacramento
N
Rio Vista
River
Suisun
Marsh
Sacramento
San
Joaquin
Costa
Antioch
Canal
Contra
Old
Middle
River
Stockton
Los Vaqueros
Intake
BANKS
PP
River
TRACY
PP
River
Delta-Mendota
Canal
South Bay
Aqueduct
California
Aqueduct

rates. These facilities represent one of the world's largest man-made water systems, with a water-storage capacity of about 16.5 million acre-feet (MAF). At present nearly 10 MAF of fresh water is removed from the Sacramento-San Joaquin river system for local consumption upstream and within the Delta. An additional 6 MAF is pumped from the Delta and exported in aqueducts for municipal and agricultural use in the state (DWR 1993b). There are approximately 1,800 local water diversions in the Delta (DWR 1993a).

Water from the Delta flows west into the San Francisco Bay and is in turn influenced by tidal input from the ocean. The hydrodynamics of the Delta are greatly influenced by the operations of the SWP and the CVP. Together, these two projects divert approximately 18 percent of the inflows to the Delta, based on an average from 1980 to 1991. Important parameters to consider when evaluating hydrodynamics of the Delta include Delta inflow, Delta outflow, Delta exports, flow reversals, null zones, tidal influence, water levels, and cross-delta flow. Each of these parameters is discussed in the following sections.

3.1.1 Delta Inflow

Runoff from Central Valley rivers and streams accounts for approximately 95 percent of the inflow to the Delta. Approximately 70 percent of the inflow comes from the Sacramento River basin, 15 percent comes from the San Joaquin River basin, and 5 percent comes from the Central Sierra Basin through the Eastside Streams (State Board 1991b). Precipitation throughout the state has a great impact on the hydrodynamics of the Delta. This section characterizes the variations in precipitation and flows reaching the Delta from the three river basins.

Precipitation

Generally, precipitation in northern California is much more important to water supply than precipitation in southern California. For the most part, water supply systems throughout California rely on water that comes from northern California. The water supply infrastructure favors the import of water from the north to the south. Most contracts for

C—087346

C-087346

water supplies in southern California are through DWR, which derives its supplies from the northern and central areas of California.

Availability of water supplies at the Delta varies with natural conditions and upstream development. Natural hydrologic variations cause extreme fluctuations in monthly and yearly inflows. Winter storms produce Delta flow rates of several hundred thousand cfs, while drier summer conditions can decrease flow rates to a few thousand cfs. Unimpaired annual volumes range from less than 7 MAF in critical years to more than 70 million in wet years. Most Delta inflow is provided from the Sacramento River basin and the San Joaquin River basin. The annual rainfall within the Delta varies from approximately 18 inches in the east and central portions to approximately 12 inches in the southern area.

Sacramento River Basin

The Sacramento River basin includes the watersheds of the following major tributaries: McCloud, Pit, Sacramento, Feather, Yuba, Bear, and American rivers and Cottonwood, Stony, Cache, and Putah creeks. Water from the Sacramento River basin enters the Delta from the Sacramento River near Sacramento and during high flow conditions from the Yolo Bypass just west of Sacramento. Sacramento River flows are highest in winter and early spring, since the watershed receives more precipitation as rain than as snow.

Flows on the Sacramento River just south of Sacramento can approach maximum channel capacity of 110,000 cfs during high flow conditions (February and March of wet years). Diversions to the Yolo Bypass begin at Sacramento River flows between 40,000 and 80,000 cfs (Jones and Stokes 1993). Minimum flows, during late summer, are normally between 10,000 and 20,000 cfs. However, during summer months of drier years flows often fall below 10,000 cfs. These summer month flows are dependent on releases from reservoirs upstream of the Delta.

San Joaquin River Basin

The San Joaquin River basin includes the watersheds of three major tributaries: the Merced, Tuolumne, and Stanislaus rivers. Smaller tributaries, consisting of runoff from the Coast Range or agricultural drainage, include Salt and Mud sloughs, Panoche, Little Panoche, Los Banos, Horsewoman, and Del Puerto creeks, and the Fresno and Chowchilla rivers. Water is imported into the San Joaquin River basin from the Delta via the Delta-Mendota Canal (DMC) of the CVP and the California Aqueduct of the SWP.

Peak streamflows in the San Joaquin River generally occur later in spring than the Sacramento River basin. These peak streamflows contribute runoff in the form of snowmelt and occur in the spring. Peak flows during winter and spring range from 15,000 to 40,000 cfs. During summer months flows are typically 1,000 cfs, but can drop below 1,000 cfs. These summer month flows are dependent on releases from reservoirs upstream of the Delta.

3.1.2 Delta Outflow

Delta outflow is the water that flows through the Delta and past Chipps Island to San Francisco Bay. Delta outflow is composed of two components: minimum amounts required by existing standards, and "surplus" Delta outflow. Delta outflows vary greatly according to month and hydrologic year type. It is highly seasonal and generally is characterized by large winter outflows from runoff generated by Pacific storms, and small, relatively steady outflows from reservoir releases during the summers. Delta outflow averages about 13.0 MAF per year. The magnitude of this flow depends on Delta inflow, export, and depletions of channel water within the Delta. During normal water years, Delta outflow is higher in winter and spring and decreases during summer and fall. Delta outflow commonly exceeds 35,000 cfs from December through April, but is usually less than 14,000 cfs from July though October. During summer months of critically dry years, Delta outflow can be as low as 3,000 cfs.

Freshwater Delta outflow establishes a hydraulic barrier to prevent ocean water from intruding deep into the Delta and affecting municipal and agricultural supplies. The

hydraulic barrier, where fresh water gradually mixes with ocean water, is located near Chipps Island during moderate Delta outflow periods. During flood flows, the hydraulic barrier moves out into the Bay. Delta flows provide a nutrient-rich environment for the multitude of organisms that are an integral part of the Bay-Delta food chain.

3.1.3 Delta Exports

State Water Project

The SWP, operated by the DWR, includes a series of dams, reservoirs, pumping plants, channels and aqueducts, and hydroelectric dams. Lake Oroville, located on the Feather River in Butte County, is the SWP's main storage facility. Water releases from Lake Oroville enter the Delta through the Feather and Sacramento rivers and contribute to the flows in those rivers as well as the channels within the Delta for Delta users, Delta salinity control, and export needs.

According to the current U.S. Army Corps of Engineers permit, the maximum allowable pumping from the SWP's Banks Pumping Plant is 6,400 cfs, unless flows in the San Joaquin River at Vernalis are above 1,000 cfs during mid-December through mid-March. If the river flows are greater, then the SWP can divert 33 percent of the amount of the San Joaquin River flow in addition to the 6,400 cfs. At a maximum, daily diversions into Clifton Court Forebay cannot exceed 13,870 AF. The historical average annual diversion of the SWP is 1,872,000 AF between 1968 and 1991. SWP recent entitlements and other deliveries have ranged from 2.0 to 3.1 MAF annually. Entitlement demand of SWP contractors for the year 2010 is an estimated 4.1 MAF annually.

Central Valley Project

The CVP, operated by Reclamation, consists of dams, reservoirs, and conveyance facilities in northern and central California. CVP reservoir systems providing Delta export supplies

and augmenting low summer and fall flows to the Delta are: the Shasta Division, the Trinity River Division, and the Folsom Unit of the American River Division.

The CVP exports about 3.4 MAF of water annually from the southern Delta via the Tracy Pumping Plant to the Delta-Mendota Canal, 2 miles east of Banks Pumping Plant. The capacity of Tracy Pumping Plant is 4,600 cfs. Tracy Pumping Plant averaged 802,000 AF annually during the first decade of operation (1950s) increasing to 1,539,000 and 2,141,000 AF during the 1960s and 1970s and reaching an average of 2,519,000 AF during the 1980s. Within its current contracts, the CVP is meeting a 1985 demand of 7.0 MAF. With no new contracts or facilities, these contracts will build up to a demand of 7.8 MAF by year 2010. In addition to current contracts, a needs analysis conducted by Reclamation for the CVP service areas has identified a further need for 3 to 4 MAF. Estimates of uncommitted CVP water supplies are less than half this need for water.

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

3.1.4 Delta Flow Reversal

The expression "reverse flow" characterizes a Delta flow problem that stems from the lack of capacity in certain channels leading to the export pumps. CVP and SWP water supply exports are obtained from uncontrolled Delta inflows (when available) and from upstream reservoir releases when Delta inflow is low. Most of these uncontrolled flows and releases enter the Delta via the Sacramento River and then flow by various routes to the export

pumps in the southern Delta. Some of these flows are drawn to the SWP and CVP pumps through interior Delta channels, facilitated by the CVP's Delta Cross Channel and a natural connection through Georgiana Slough. In some situations, these interior channels do not have enough capacity to meet Delta demands for agricultural, the export pumps, and other users in the southern Delta.

The remaining water from the Sacramento River needed to meet pumping demand flows down the Sacramento River to Threemile Slough and the western end of Sherman Island and up the San Joaquin River toward the pumps. When freshwater outflow is relatively low, water in the western Delta is brackish because fresh water from the Sacramento River mixes with saltier ocean water entering as tidal inflow from the San Francisco Bay. This water can be drawn upstream (reverse flow) into the San Joaquin River and other channels by pumping plant operations when San Joaquin River flow is low and pumping is high. The massive amount of water driven in and out of the Delta by tidal action dwarfs the actual freshwater outflow and considerably complicates the reverse flow issue. Prolonged reverse flow can deteriorate water quality in the interior Delta and at the export pumps and can harm fisheries.

Currently, during operational periods of reverse flow, more water than is needed for export must be released from project reservoirs to help repel intruding sea water, maintain required water quality in the Delta, and meet export quality standards. This incremental release of water from the reservoirs is a function of Delta export, south Delta inflow, tidal cycle, and operation of the Delta Cross Channel gates. If the Delta Cross Channel gates are closed when pumping rates are high and the Delta is under controlled conditions, more water must be released to repel salinity intrusion.

Portions of the southern Delta are also affected by reverse flow. San Joaquin River water naturally flowing downstream past the head of Old River toward Stockton can reverse and flow upstream during periods of low San Joaquin River flows and high export rates. During these times San Joaquin River water from downstream of Stockton reverses and flows into the head of Old River toward the export pumps. Middle River between Victoria

Canal and Old River will reverse during the latter portion of the irrigation season (July through September). When San Joaquin River flow is below 2,000 cfs at Vernalis, local diversions in this reach of Middle River are usually greater than the flow from Old River into Middle River, causing flows to reverse and flow from the north. These flows can be further aggravated during high export periods or during low tides.

3.1.5 Null Zones

Local diversions can and do affect the pattern of water circulation in narrow south Delta channels, so that, at times, local saline discharges do not move downstream and out of the area but instead become trapped and concentrated in the "null zones" of zero flow. This in turn results in water quality degradation irrespective of how fresh the water flowing into the Delta may be.

In shallow, low capacity channels, diversions from the channel can begin to approximate the flow leaving the channel. When this happens, water can cease flowing from the channel or even begin to flow into it from its downstream end just as it is flowing into it from the upstream end. This results in no flow out of the channel, creating what is called a "null zone". In this situation, there is no way to carry away the saline return flows that continue to accumulate and concentrate along the channel. This lack of circulation prevents better quality water otherwise available from the main channels from freshening the degraded supplies available to users along the channel.

Within the south Delta, null zones exist in three predominant areas: in Old River between Sugar Cut and the CVP intake, in Middle River between Victoria Canal and Old River,and in the San Joaquin River between the head of Old River and the city of Stockton. At both the Middle River and the San Joaquin River locations, the reverse flow conditions due to project diversions can improve the null zone condition. In each case the quality of water coming from the reversal of flow is better than the water quality coming from the upstream direction.

At both Middle River and the San Joaquin River locations, the reverse flow conditions due to project diversions can improve the null zone condition. In each case, the quality of water coming from the reversal of flow is better than the water quality coming from the upstream direction. Improvements to water circulation in south Delta channels can be evaluated in terms of two factors: increases in reverse flows due to project diversions, and elimination of null zones.

3.1.5 Tidal Influence and Water Levels

The river systems of the Delta are open to the Pacific Ocean via the Golden Gate and are influenced by tides: two high tides and two low tides each day. Each high-water stage raises water elevations and produces a flood tide that flows landward through Delta channels. As the tidal cycle continues, it reverses to a low-water stage and produces an ebb tide that flows to the ocean and lowers water levels. Near the western edge of the Delta, near the city of Pittsburg, tidal flood flows can be as much as 330,000 cfs (upstream) and tidal ebb flows can be as much as 340,000 cfs (downstream) during summer conditions. The tidal influence decreases as the distance from the ocean increases. Near the south-eastern boundary of the Delta, at the San Joaquin River just downstream of the head of Old River, summer flood flows are approximately 2,000 cfs and ebb flows are approximately 1,000 cfs. The average incoming and outgoing Delta tidal flow is about 170,000 cfs.

The tidal currents also carry a large volume of ocean water back and forth through the San Francisco Bay-Delta Estuary with the tide cycle. The mixing of salt and fresh water can shift two to six miles depending on the tides and outflow, and may reach into the Delta during periods of low inflow. The point at which fresh water flowing seaward from the Delta meets saline water flowing landward at depth is called the entrapment zone, an important biological entity of the Delta food web. The location of the entrapment zone is estimated from electrical conductivity data. The Environmental Protection Agency has designated the position of the mean daily 2 ppt isohaline, measured in kilometers from the

Golden Gate Bridge, as X_2. The location of X_2 is dependent on tidal flows and Delta outflow.

Tides affect the water elevations throughout the Delta, with increasing influence as the distance to the ocean decreases. Water elevations can vary within the Delta from 1.5 feet above mean sea level at the San Joaquin River just downstream of the head of Old River to over five feet at the outlet of the Delta, near the city of Pittsburg. The tidal range of water levels within the south Delta is affected by the magnitude of export pumping. If water in the south Delta is diverted by the SWP and CVP during the rising tide, the incoming volume of water and its corresponding momentum would be diminished, attenuating the subsequent high tide upstream. Water conditions in the area are also influenced by San Joaquin River inflow, local pump diversions, agricultural diversions and returns, and channel capacity. Historically, there have been various complaints from South Delta Water Agency that hydraulic capacity is insufficient to convey water to some points of diversion during the months of peak agricultural demand.

3.2 Methodology

Mathematical modeling of statewide operations, water levels, flows, velocities, and salinities in the Delta channels has greatly aided water resources planning for the Delta. However, some care is required when interpreting the results of such modeling. The mathematical modeling conducted to aid in the evaluation of change caused by the ISDP was generally not intended to provide absolute predictions of future Delta hydrodynamic conditions. Results of mathematical modeling of Delta conditions under alternative actions planned are often interpreted in terms of direction and relative magnitude of changes. For this reason, the analysis of how the ISDP may affect hydrodynamics was based on the values changed under the preferred alternative with respect to the base no-action alternative. The figures and tables, which show the modeling results, are located at the end of this section.

C—087354

C-087354

Two different types of engineering studies were used to evaluate changes as a result of the proposed project: (1) water supply studies using the DWRSIM model, based on 71-year historic hydrology from 1922 to 1992, in which two levels of SWP demand were analyzed; and (2) Delta hydrodynamic and water quality studies using the DWRDSM model. Mathematical modeling of Delta hydrodynamics and water quality was used to evaluate potential changes to Delta flows, stages, velocities, and salinities. The following sections will include a description of both models, a brief listing of major assumptions and operating criteria of the models, and a description of the locations of reported data from the models.

3.2.1 Operation Studies

Monthly operational studies of the SWP and the CVP systems were performed with DWR's statewide water simulation model (DWRSIM) to evaluate the changes to SWP operation as a result of the ISDP. DWRSIM simulates operation of CVP/SWP system reservoirs and conveyance facilities. It operates to meet various operation objectives for purposes of water supply, instream flow objectives, flood control and recreation objectives, as well as various physical, institutional, and legal constraints.

These water supply studies account for the total availability, storage, release, and use of water in the Sacramento and San Joaquin river systems, the Delta, and the aqueduct systems out of the Delta. These studies represent a superimposition of existing and future water demands and development on the historical water supply for the 71-year period from water years 1922 through 1992. DWRSIM uses a monthly time step, and thus the operation studies provide monthly average data on reservoir storage and releases, and Delta inflows, exports, and outflows. The model optimizes this water supply system to provide the maximum water export from the Delta system allowed by regulatory constraints, up to the total water demand.

Three water supply operation studies were simulated assuming an existing (1995) level of demand. This is a variable demand from 2.2 to 3.6 MAF that changes depending on the

hydrologic conditions in the years prior to the current year. The first study is a base case to be used for the existing demand no-action alternative. The second study is to be used for the preferred alternative. The third study is to be used for the Fisheries Alternative. The base study (study 420.F) assumed existing facilities without other south Delta improvements, thus limiting SWP allowable diversion capacity to 6,680 cfs (7,300 cfs in some winter months if there is sufficient San Joaquin River flow at Vernalis). The second study (study 413.F) assumed south Delta facilities to allow a maximum SWP diversion at Banks Pumping Plant of 10,300 cfs. The third study (study 454.F) assumed the Fisheries Alternative components which would also allow a maximum SWP diversion at Banks Pumping Plant of 10,300 cfs.

Three additional water supply operation studies were simulated assuming a future (2020) fixed level of demand of 4.1 MAF. Each water year the demand will be 4.1 MAF regardless of the previous or current water year type. The first study is a base case to be used for the future demand, no-action alternative. The second study is to be used for the preferred alternative. The third study is to be used for the Fisheries Alternative. The base study (study 411.F) assumed existing facilities without other south Delta improvements, thus limiting SWP allowable diversion capacity to 6,680 cfs (7,300 cfs in some winter months if there is sufficient San Joaquin River flow at Vernalis). The second study (study 414.F) assumed south Delta facilities to allow a maximum SWP diversion at Banks Pumping Plant of 10,300 cfs. The third study (study 455.F) assumed the Fisheries Alternative components which would also allow a maximum SWP diversion at Banks Pumping Plant of 10,300 cfs.

The six studies operated SWP facilities in accordance with the December 15, 1994 Bay Delta Accord, the Coordinated Operation Agreement, and agreements and contracts with local Delta interests. The operation studies used delivery-carryover storage relationships that were designed to simulate the concept and philosophy of criteria adopted by DWR's Division of Operation and Maintenance in 1987. The monthly Delta inflows, exports, and outflows simulated with these operation studies provided the hydrologic conditions for the subsequent Delta studies conducted in support of the ISDP.

The operation studies provided data to analyze the amount of change resulting from the ISDP alternative actions. To determine how the ISDP may affect the operation of the SWP, these operation study data for the alternative actions were compared with the no-action alternatives. In general, the data for the no-action alternatives is discussed first, and a percentage change relative to the analyses of the no-action alternatives follows. The mathematical modeling data are not intended to provide absolute predictions of future conditions; rather, it is meant to be used as a tool to compare conditions under various alternative actions. The absolute data for the no-action alternatives are provided only as a reference for the comparative analyses. The parameters analyzed are (1) Shasta Lake storage, (2) Lake Oroville storage, (3) San Luis Reservoir storage, (4) total pumping at Harvey O. Banks Delta Pumping Plant, (5) total pumping at Tracy Pumping Plant, (6) Qwest, (7) San Joaquin River at Vernalis flow, (8) Sacramento River at Freeport flow, (9) Feather River flow, (10) total inflow to the Delta, (11) total outflow from the Delta, (12) X2 position, and (13) Delta export ratio. The hydrodynamic analyses are discussed later in this chapter.

3.2.2 Delta Modeling Studies

Mathematical model studies of flows and salinity in the Sacramento-San Joaquin Delta were conducted in support of this EIR/EIS. DWRDSM, an enhanced version of the Fisher Delta Model, was used to simulate hydrology and conservative constituent transport to evaluate the performance of existing and/or future facilities in view of diverse hydrologic conditions and operation criteria. Within DWRDSM there are two modules, DWRFLO and DWRSAL. DWRFLO, a modified version of DELFLO, simulates Delta flows, velocities, and stages based on principles of momentum, continuity, and energy. DWRSAL, a modified version of DELSAL, simulates Delta conservative constituents through mass balance with a direction, dispersion, source, and sink relation. This chapter discusses the results from DWRFLO and changes in hydrodynamics. The water quality chapter, Chapter 4, discusses the results from DWRSAL and the changes in water quality.

The DWRFLO module was selected to simulate the water surface elevations and flow/velocity patterns in the Delta. The Delta as characterized by the model is bounded by the communities of Sacramento on the North, Vernalis on the south, and Martinez on the west. The model includes approximately 400 nodes, 500 channels, and 13 open reservoirs or lakes. Figure A3-2 shows a network representation of the Sacramento-San Joaquin Delta as used in DWRDSM. The following attributes of this model are of particular importance:

- DWRDSM uses the most current descriptions of Delta channel bathymetry;
- Timed operations of forebay gates are simulated;
- Existing and proposed hydraulic structures, such as flow control barriers, the Delta Cross Channel, and intake culverts to Tom Paine Slough are simulated; and
- The most current descriptions of diversion and drainage return flows in the Delta, both in magnitude and spatial distribution, are used.

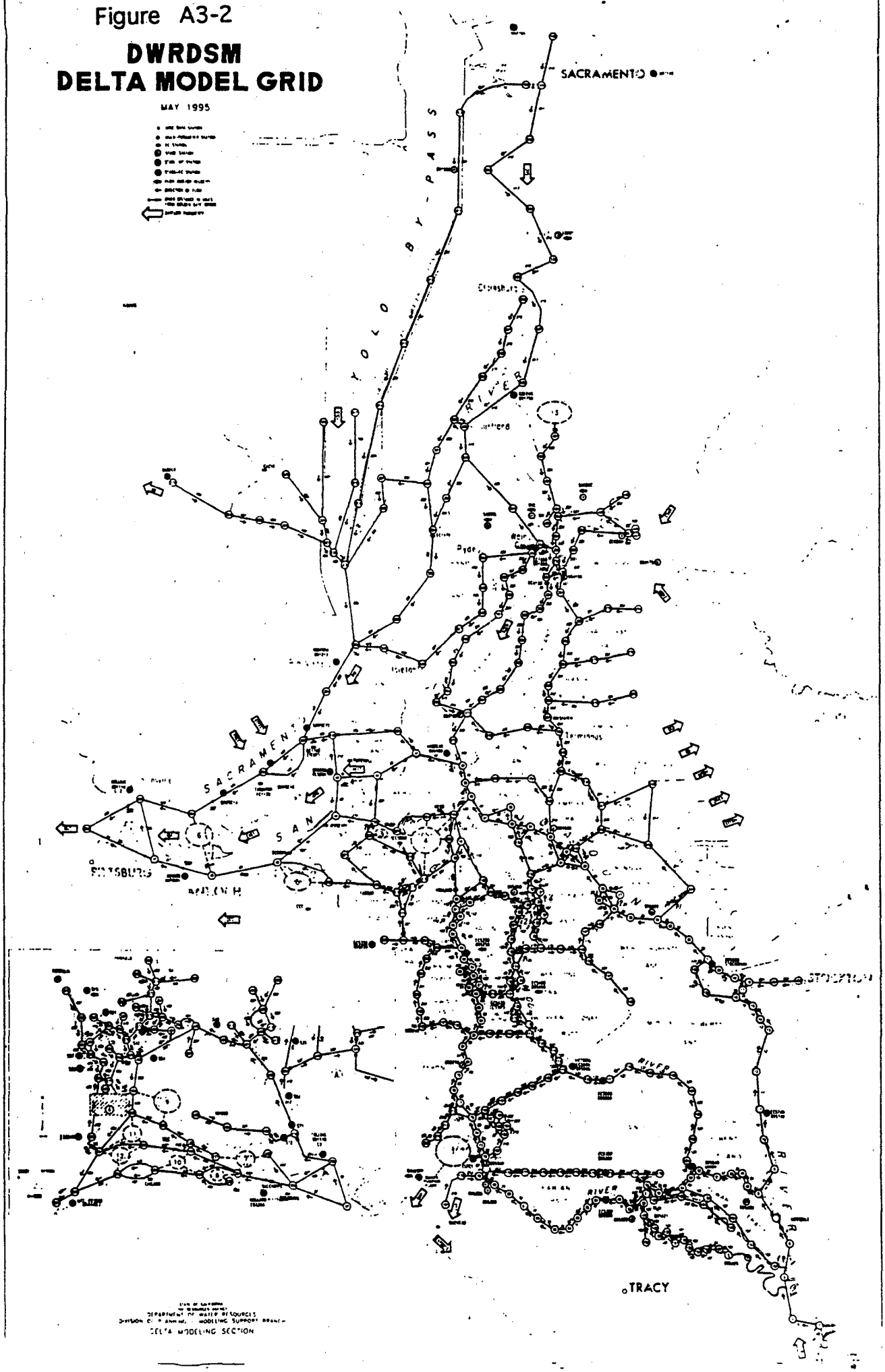
DWRDSM is a one-dimensional model that simulates changes in water levels, flows, and velocities on a 60-second time step (changes in salinities are calculated on a 5-minute time step). To generate the information needed to evaluate the environmental impacts, a number of decisions had to be made. These included (1) selecting and preparing an appropriate tide and a wide range of Delta net channel depletions and hydrologic conditions, (2) evaluating the mean monthly hydrodynamic responses of the no-action and alternative configurations, and (3) evaluating the mean tidal daily salinity responses of the alternatives with DWRSAL. For additional information on Delta modeling and the assumptions incorporated in the modeling studies, contact DWR's Hearing Support and South Delta Management Section Chief, Stephen Roberts at (916) 653-2118.

Monthly average Delta hydrodynamic conditions were simulated by running the DWRFLO model for one tidal cycle (25 hours) for each month. This was considered reasonable for the evaluation and comparison of various alternatives based on monthly average minimum water levels, monthly net flow, and net velocity patterns in the Delta. The 19-year mean, 25-hour tide at Martinez/Benicia was used to simulate mean monthly conditions (boundary tide). The boundary salinity, daily average salinity at Eckly in Carquinez Strait, was

Figure A3-2

DWRDSM DELTA MODEL GRID

MAY 1995



C—087359

generated by SALDIF. This model predicts the salinity at Benicia given the Net Delta Outflow Index. Estimates of monthly internal delta channel diversions and drainage returns are based on the DWR Delta island consumptive use study (1987). These flows were allocated to appropriate nodes and then are varied monthly.

Delta hydrology data were derived from the statewide operation model (DWRSIM) studies discussed in the section 3.2.1 - Operation Studies. These studies provided monthly Delta inflows, exports, and net Delta outflows over a 71-year period. Delta hydrology was changed once per month to evaluate and compare various alternative configurations. Five different water year types were selected from each operation study to represent each of the five water year types defined in the May 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary by the State Water Resources Control Board. This water year classification, known as 40-30-30 water year classification, is based on channel hydrology in the Sacramento Valley (Table A3-1). Since most precipitation occurs in the winter, the water year begins in October of the previous calendar year and ends in the September of the stated water year. The five representative water years were selected by consultation with DWR and the Department of Fish and Game. They are: 1991 as the representative critical year, 1981 as the representative dry year, 1966 as the representative below normal year, 1957 as the representative above normal year, and 1982 as the representative wet year. The Delta hydrologies defined for these water years represent the historic hydrology adjusted to a future level of water demand and development. Thus, the results from the modeling do not represent what occurred historically, but rather show how the Delta system would react to various hydrologies given existing and future SWP facilities. By selecting the five representative water years, a range of the magnitude of change as a result of the ISDP can be displayed. The model was not used to determine how the system would react in a particular water year type, but to bracket the varying hydrologies resulting from these different water year types.

Mathematical modeling of water levels, flows, and velocities in the Delta channels has greatly aided water resources planning for the Delta. However, some care is required when interpreting the results of such modeling. The mathematical modeling conducted to aid in

Table A3-1
40-30-30 Water Year Classification
Sacramento Valley Hydrology

Year Classification is based on the INDEX value, which is determined by:

INDEX = 0.4X + 0.3Y + 0.3Z

where:

X = Current year's April - July Sacramento Valley unimpaired runoff

Y = Current October - March Sacramento Valley unimpaired runoff

Z = Previous year's index[1]

Year Classification[2]	Index [Millions of Acre-Feet, MAF]
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

Reference: *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, May 1995*, Page 23. State Water Resources Control Board

---

[1]A cap of 10.0 MAF is put on the Previous Year's Index (Z) to account for required flood control reservoir releases during wet years.

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

the evaluation of potential environmental impacts as a result of the ISDP was generally not intended to provide absolute predictions of future Delta hydrodynamic and salinity conditions. Results of mathematical modeling of Delta conditions under various alternative actions planned are often interpreted in terms of direction and relative magnitude of changes in such variables as water levels and salinities. For this reason, the analysis of how the ISDP may affect Delta water levels, flows, velocities, and salinities was based primarily on how the values of these parameters changed under the preferred alternative and the Fisheries Alternative with respect to the base no-action alternative. Much of the Delta modeling results in this chapter and in the water quality chapter are therefore provided in terms of change or improvements when compared to the no-action alternative.

The hydrodynamic modeling results are displayed at the end of this section. Since the model incorporates the requirements of the December 1994 Bay-Delta Accord, the preferred alternative and the Fisheries Alternative were operated to meet these regulatory constraints. Therefore, although a change in hydrodynamics may occur, these regulatory constraints will continue to be met, and the ISDP will not have a significant impact on the environment related to hydrodynamics. Thus, only the changes in hydrodynamics will be discussed in this chapter. In general, the data for the no-action alternatives is discussed first, and a percentage change relative to the no-action alternatives analysis follows. Since the mathematical modeling data are not intended to provide absolute predictions of future conditions, the absolute data for the no-action alternatives are provided only as a reference for the comparative analyses.

The parameters analyzed are minimum water surface elevations, monthly average flow, and maximum and minimum velocities. The minimum water surface elevation was chosen to demonstrate the operation of the barriers and the improvement in water levels. By design, the barriers will hold water for a longer period of time during the low-low portion of the tide with little change in the maximum water levels. Therefore, the discussion focuses on the change in minimum water levels. Since the tidal influence often causes many Delta channels to flow in both upstream and downstream directions, the average flow is discussed. The threshold of concern for velocity is three feet per second. It has been

determined that velocities above three feet per second have the potential of causing channel scour. Tidal and reverse flows can create potential scour in both the downstream and the upstream directions. The model interprets a positive flow or velocity as moving in the downstream direction, and likewise a negative flow or velocity as moving in the upstream direction. Since upstream and downstream velocities above three feet per second have the potential of causing scour, both the maximum positive and negative velocities are discussed. Nineteen locations in the southern and central Delta (Figure A3-3) were selected to determine the changes resulting from the various alternative actions.

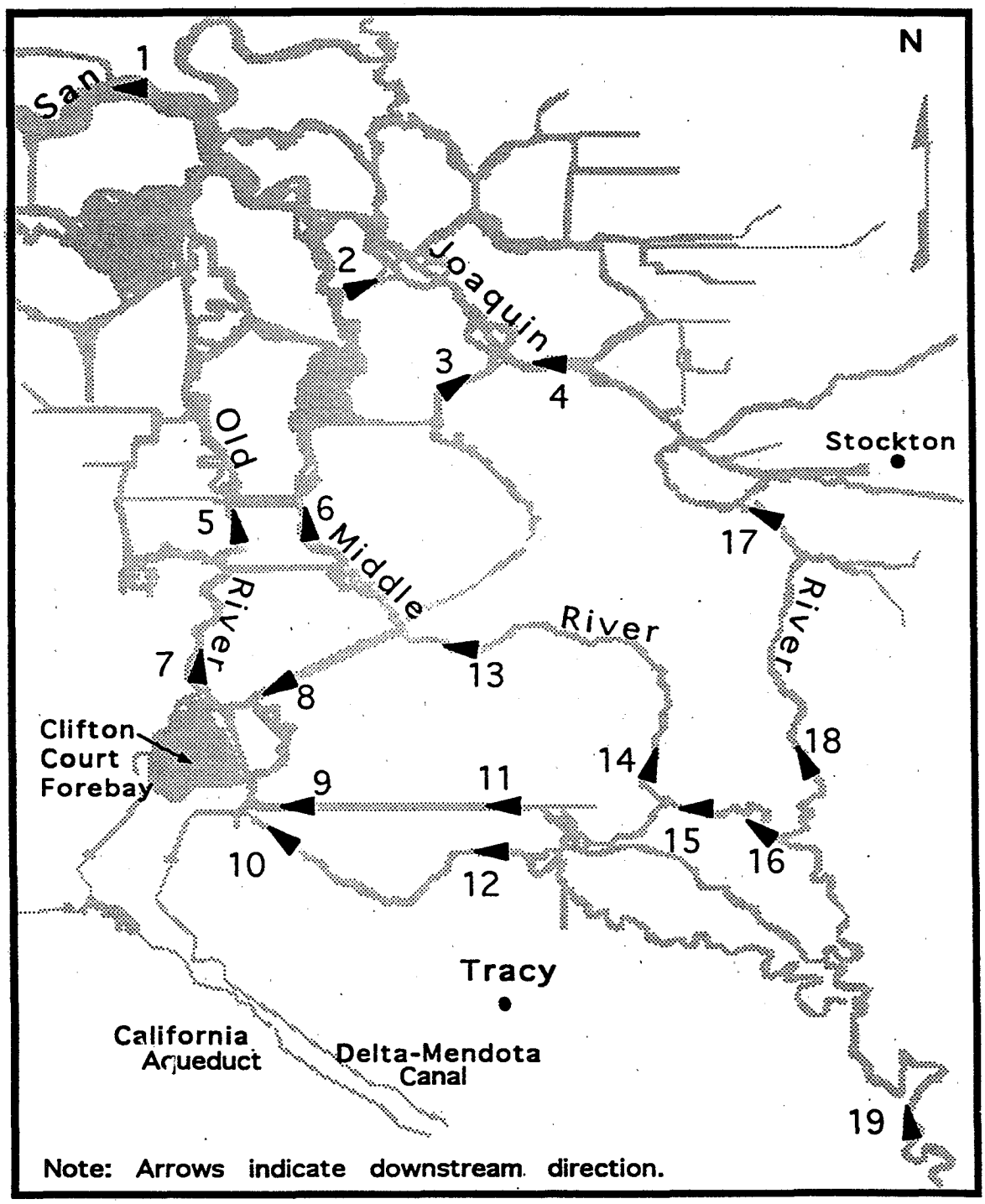
3.3 Evaluation of Alternatives

The following section discusses the changes in hydrodynamics as a result of the proposed project and other alternative actions. Although direct changes to hydrodynamics may be slight, subtle changes in water quality and the hydrodynamics in the Delta can trigger impacts to fish, wildlife, and other biotic resources. For this reason, the discussion of hydrodynamic change illustrates the magnitude and timing of changes. Further interpretation of these effects is discussed in the appropriate chapter for each resource category affected by hydrodynamics or water quality.

This section begins with a discussion of the no-action alternatives at both the existing and future levels of SWP demand. Data from DWRSIM is first discussed, followed by a discussion of in-Delta changes. The absolute data for the no-action alternatives are provided only as a reference for the comparative analyses with the preferred alternative and other alternative actions. This is followed by the comparative analyses of the preferred alternative with the no-action alternative at both levels of SWP demand. Finally, the Fisheries Alternative comparative analyses with the no-action alternative at both levels of SWP demand is presented.

3.3.1 No Action (Maintain Existing Conditions)

Figure A3-3
South Delta Map
Corresponding Reference Number to Data



This alternative differs from the preferred alternative by maintaining conditions as they exist at present. In addition, this alternative maintains current pumping constraints and does not require construction of barriers or dredging within the south Delta. Mathematical simulations of water project operations and the Delta environment were made to augment the description of the existing environment in evaluating the consequences of the no action alternative. These simulation runs were used as a baseline in evaluating the impacts of the ISDP (Existing Demand Case Study). Both statewide operation study and Delta modeling results are discussed in the following text. Since the mathematical modeling data are not intended to provide absolute predictions of future conditions, the absolute data for the no-action alternatives are provided only as a reference for the comparative analyses.

3.3.1.1 Statewide Operation Study Output

Monthly operational studies of the SWP and the CVP systems were performed with DWR's statewide water simulation model (DWRSIM) to evaluate the changes on SWP operation as a result of the ISDP. These studies are described in section 3.2.1. Within this section the modeling output for the existing demand base case is displayed.

Reservoir Storage

Figure A3-4 depicts the monthly average storage of Shasta Lake (a CVP reservoir), Lake Oroville, and the SWP portion of San Luis Reservoir for the 71-year historic hydrology. Typically, these reservoirs fill in the winter and releases are made in spring, summer, and fall to augment inflow to the Delta for export. Maximum storage occurs during the late winter to early spring. Shasta Lake average storage ranges from 2.8 million acre-feet (MAF) in October and November to above 4.0 MAF during April and May. Lake Oroville average storage ranges from 2.2 MAF in September, October, and November to above 3.0 MAF during May. The SWP portion of San Luis Reservoir average storage ranges from 0.3 MAF in August, September, October, and November to 0.9 MAF during March. Shasta Lake and Lake Oroville facilities provide both flood control and additional flows for

deliveries. Since San Luis Reservoir is downstream of the Delta export pumps, the SWP portion of San Luis Reservoir increases as pumping increases during high flows in the winter.

Flows Downstream of Reservoirs

Reservoir releases provide downstream flows throughout the year and augment low summer flows. Without these releases the downstream flows would be almost nonexistent. The monthly average seasonal pattern of flows for the 71-year historical hydrology is shown in Figure A3-5 for the San Joaquin River at Vernalis, Sacramento River at Freeport, and the Feather River below Lake Oroville. Typically, these flows increase as precipitation, runoff, and releases increase during winter and early spring. Throughout the summer the reservoir releases provide sustained flows for fishery and export purposes and to meet Delta standards. The monthly average San Joaquin River at Vernalis flows range from approximately 1,500 cubic feet per second (cfs) in August to more than 5,200 cfs in April. Sacramento River at Freeport flows range from about 12,000 cfs in September to almost 40,000 cfs in February. Feather River flows, which contribute to the Sacramento River flows, range from 1,600 cfs in September to over 6,600 cfs in March. Feather River flows increase from April through July due to releases from Lake Oroville for fishery purposes.

Delta Exports

Delta exports affect Delta outflows and within-Delta flows throughout the Delta. Typically, exports are highest during high flow conditions. Generally, exports increase in the winter and decrease in the spring and summer to protect fish during the lower flow conditions. From February through June, the combined export rate of the inflow at Clifton Court Forebay and pumping at Tracy Pumping Plant is limited to 35 percent of Delta inflow and from July through January the combined export is limited to a maximum of 65 percent of Delta inflow. From April 15 through May 15 the combined export rate is further limited to 1,500 cfs or 100 percent of the 3-day running average of San Joaquin River flow at

Vernalis, whichever is greater. The monthly average exports for the 71-year historical hydrology is shown in Figure A3-6 for pumping at Banks Pumping Plant and at Tracy Pumping Plant. Also shown on the figure is the Delta Export Ratio, the percentage of the Delta Inflow that is exported from the Delta. Exports at Banks Pumping Plant range from a monthly average minimum of 2,600 cfs during August to a monthly average maximum of over 6,000 cfs during January. As shown, during the winter months exports increase due to higher Delta inflows, and during the spring the exports decrease as inflow to the Delta decreases. Banks Pumping Plant exports are further limited during April and May to meet the more restrictive constraints. These exports during April and May average between 2,800 and 2,900 cfs over the 71-year record. At Tracy Pumping Plant exports follow a similar pattern. However, due to limited capacity, the Tracy Pumping Plant exports are not increased during the winter months. The Delta Export Ratio, the ratio of Delta exports to total Delta inflow, is highest during September and October at 0.52 and falls to 0.23 during the month of April. Generally, combined pumping is most restricted by the Delta Export Ratio from February through June. This is especially true during dry and critical years when inflows are lower.

Delta Inflow and Outflow

Delta inflow and outflow follow the typical pattern of California hydrology. Both inflow and outflow peak during the winter months and decrease during the summer and fall (Figure A3-7). These plots are similar to the reservoir storage presented earlier. The inflow and outflow are augmented by reservoir releases throughout the summer and fall. Monthly average Delta inflow for the 71-year historical hydrology peaks at over 59,000 cfs during February and decreases to approximately 15,000 cfs during the months of August and September. Monthly average Delta outflow for the 71-year historical hydrology follows a similar pattern, peaking at over 48,000 cfs during February and decreasing to just over 5,000 cfs during August and September. X_2 position, which is related to Delta inflow, outflow, and exports, ranges from 85 kilometers during the low outflow period of September to 66 kilometers during the high outflow months of February and March. QWEST, the measurement of San Joaquin River reverse flows and related to Delta inflow, outflow, and exports, ranges from 5,000 cfs during February to approximately -1,400 cfs

C—087367

C-087367

during the months of November and July. This pattern is similar to those of Delta inflow and outflow.

3.3.1.2 Delta Modeling Study Output

Monthly average Delta hydrodynamic studies of the existing demand base case were performed with DWR's Delta Simulation Model (DWRDSM) to evaluate the changes to within Delta flows, water levels, and velocities as a result of the ISDP. These studies are described in section 3.2.2. Within this section the modeling output for the existing demand base case is discussed. Average flow, minimum water surface elevations, and minimum and maximum velocities at nineteen locations throughout the central and southern Delta are displayed by water-year type.

Representative Critical Year

Table A3-2 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative critical year. Throughout the representative critical year, flows within the Delta are low. In the central Delta and along Old River, reverse flows (shown as negative flows) are prevalent due to the exports in the southern Delta. The closer to the exports pumps, the greater these reverse flows become. The reverse flows also increase during months of high exports, such as January, February, and March, or during high exports and low inflow conditions, such as July. Middle River reverses throughout the time period shown. This reversing action creates a null zone in this reach during February and April through the end of the summer. A null zone also exists along the San Joaquin River during the month of February and in Old River upstream of Clifton Court Forebay during the month of July and during the summer. The San Joaquin River, between the city of Stockton and the head of Old River, reverses flow from January through March, and from July and through the summer due to low inflow conditions.

Throughout the southern Delta the minimum water surface elevations decrease during the irrigation season and into the summer. As shown, the months of June and July typically

have the lowest water surface elevation. Velocities throughout the central and southern Delta remain below the three feet per second (fps) threshold that would cause scour. The highest velocities of 2.6 to -2.2 fps occur in Old River downstream of Clifton Court Forebay. Typically, velocities are approximately 1.5 fps or below at other locations.

Representative Dry Year

The average flow, minimum water surface elevations, and minimum and maximum velocities for the representative dry year are displayed in Table A3-3. The flow patterns throughout the central and southern Delta follow the same pattern as the critical year. Reverse flows are prevalent along the path from the central Delta to the export facilities. A null zone is created in Middle River during May, June, July, and through the summer. Flows along Old River just upstream of Clifton Court Forebay are low, approximately 50 cfs during June and July. Most of the San Joaquin River is diverted down Old River from May and into the summer. During July and through the summer, the San Joaquin River reverses near the city of Stockton.

Minimum water surface elevations and velocities follow the same pattern as that seen during the representative critical year. Minimum water surface elevations range 1.3 to 1.8 feet close to Clifton Court Forebay, and 1.5 to 3.4 feet at other locations in the southern Delta. Velocities are generally below 1.5 fps throughout the central and southern Delta.

Representative Below Normal Year

Table A3-4 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative below normal year. The flow patterns throughout the central and southern Delta follow the same pattern as the critical year. Reverse flows are prevalent along the path from the central Delta to the export facilities. A null zone is created in Middle River during March, May, June, July, and through the summer. Flows along Old River just upstream of Clifton Court Forebay are low, approximately 50 cfs during June and July. Most of the San Joaquin River is diverted down Old River from May through the summer. During July and through the summer, the San Joaquin River reverses near the city of Stockton.

Minimum water surface elevations and velocities follow the same pattern as those seen during the representative critical year. Minimum water surface elevations range 1.5 to 1.8 feet close to Clifton Court Forebay, and 1.5 to 3.0 feet at other locations in the southern Delta. The highest velocities of -2.5 and 2.0 fps occur in Old River downstream of Clifton Court Forebay and in Old River just downstream of the head Old River, respectively.Velocities are generally below 1.5 fps throughout the central and southern Delta.

Representative Above Normal Year

Table A3-5 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative above normal year. During the representative above normal year, flows within the Delta are generally higher but follow the same pattern as that seen in the critical year. In the central Delta and along Old River, reverse flows exist but typically occur less often or are lower due to higher inflows. The closer to the export pumps, the greater these reverse flows become. The reverse flows also increase during months of high exports, such as January and February, or during high exports and low inflow conditions, such as July. Middle River continues to reverses during January, March, June and through the summer. This reversing action creates a null zone in this reach during March, June and throughout the summer. The San Joaquin River, between the city of Stockton and the head of Old River, reverses flow during June and through the summer due to low inflow conditions. From June through the summer, the majority of the San Joaquin River flow is diverted down Old River.

Throughout the southern Delta the minimum water surface elevations decrease during the irrigation season and into the summer. As shown, the months of June and July typically have the lowest water surface elevation. Velocities throughout the central and southern Delta remain below the three feet per second (fps) threshold. The highest velocities of -2.6 and 2.1 fps occur in Old River downstream of Clifton Court Forebay and in Old River just downstream of the head Old River, respectively. Typically, velocities are approximately 1.5 fps or below at other locations.

Representative Wet Year

Table A3-6 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative wet year. Flows throughout the central and southern Delta increase as a result of higher inflows. The reverse flows that commonly occurred in the representative critical year occur less frequently. Most channels in the southern Delta have positive downstream flow. Null zones are less prevalent, but still occur in Middle River during July and the summer. A positive downstream San Joaquin River flow also occurs at the city of Stockton.

Water surface elevations throughout the Delta are higher than those of the drier water years. Minimum water surface elevations range from 1.5 to 4.2 feet close to Clifton Court Forebay, and 1.6 to 12.6 feet at other locations in the southern Delta. Typically, these minimum water surface elevations are much higher than those of the drier years. Velocities are typically less than 1.5 fps, but are greatest on Old River near Clifton Court Forebay and jut downstream of the head of Old River. Velocities greater than three fps occur on Old River downstream of the head of Old River.

3.3.2 No Action Future (Maintain conditions as they would exist in the future)

This no-action, future case alternative involves conditions, policies, laws, ordinances, rules, regulations, programs and projects that exist or would likely be developed in the absence of the ISDP, leading to a determination of the likelihood that California's future water requirements would be met without the ISDP. Implementation of this alternative would not accomplish the project objectives of improved water levels and circulation in the south Delta for local agricultural diversions. Improved hydrologic conditions that allow for increase of diversion into the Clifton Court Forebay to allow full pumping capacity would not be developed.

C—087371

C-087371

This alternative differs from the no-action, existing demand alternative by assuming SWP demand would be increased to the full entitlement of 4.1 MAF. This alternative maintains current pumping constraints and does not require construction of barriers or dredging within the south Delta. Mathematical simulations of water project operations and the Delta environment were made to augment the description of the existing environment in evaluating the consequences of the no-action alternative. These simulation runs were used as a baseline in evaluating the impacts of the ISDP (Future Demand Case Study). Both statewide operation and Delta modeling results are discussed in the following text. Since the mathematical modeling data are not intended to provide absolute predictions of future conditions, the absolute data for the no-action alternatives are provided only as a reference for the comparative analyses.

3.3.2.1 Statewide Operation Study Output

Monthly operational studies of the SWP and the CVP systems were performed with DWR's statewide water simulation model (DWRSIM) to evaluate the changes on SWP operation as a result of the ISDP. These studies are described in section 3.2.1. Within this section the modeling output for the future demand base case is displayed.

Reservoir Storage

Figure A3-8 depicts the monthly average storage of Shasta Lake (a CVP reservoir), Lake Oroville, and the SWP portion of San Luis Reservoir for the 71-year historical hydrology. Typically, these reservoirs fill in the winter, and releases are made in spring, summer, and fall to augment inflow to the Delta for export purposes. The reservoirs follow the same fill and release pattern as that shown in the existing demand base case study. Monthly average Lake Shasta storage ranges from 2.7 MAF in November to over 4.0 MAF in April and May. Storage at Lake Oroville averages from slightly below 2.0 MAF from August through October to nearly 3.0 MAF in May. The SWP portion of San Luis Reservoir storage ranges from 0.3 MAF in September and October to 0.9 MAF in March. Typically,

the SWP portion of San Luis Reservoir is slightly higher than that of the existing demand base case study. This is due to slightly higher exports in the future demand base case studies.

Flows Downstream of Reservoirs

The monthly average seasonal pattern of flows for the 71-year historical hydrology is shown in Figure A3-9 for the San Joaquin River at Vernalis, the Sacramento River at Freeport, and the Feather River below Lake Oroville. These flow patterns follow the same trends as those found in the existing demand base case study. Typically, these flows increase as precipitation, runoff, and releases increase during winter and early spring. Throughout the summer the reservoir releases provide sustained flows for fishery and export purposes and to meet Delta standards. The monthly average San Joaquin River at Vernalis flows range from approximately 1,500 cubic feet per second (cfs) in August to more than 5,200 cfs in April. Sacramento River at Freeport flows range from about 12,000 cfs in September to almost 38,000 cfs in February. Feather River flows, which contribute to the Sacramento River flows, range from 1,200 cfs in September to over 6,900 cfs in July. Feather River flows increase from April through July due to releases from Lake Oroville for fishery purposes. The monthly average Feather River flows for May, June, and July are significantly increased over the existing demand base case study to meet increased export demands.

Delta Exports

Delta exports affect Delta outflows and within-Delta flows throughout the Delta. Typically, exports are highest during high flow conditions. Generally, exports increase in the winter and decrease in the spring and summer to protect fish during the lower flow conditions. The monthly average exports for the 71-year historical hydrology is shown in Figure A3-10 for pumping at Banks Pumping Plant and at the Tracy Pumping Plant. Also shown on the figure is the Delta Export Ratio, the percentage of the Delta Inflow that is exported from the Delta. Exports at Banks Pumping Plant range from a monthly average minimum of

C—087373

C-087373

2,900 cfs during May to approximately 7,000 cfs during December and January. As shown, Banks Pumping Plant exports are limited during April and May to meet the more restrictive pumping constraints. These exports during April and May average between 2,900 and 3,100 cfs over the 71-year record. At Tracy Pumping Plant exports follow a similar pattern. However, due to limited capacity, the exports are not increased during the winter months. The Delta Export Ratio is highest during October at 0.53 and falls to 0.23 during the month of April. Generally, combined pumping is most restricted by the Delta Export Ratio from February through June. This is especially true during dry and critical years when inflows are lower.

Delta Inflow and Outflow

Delta inflow and outflow follow the typical pattern of California hydrology. Both inflow and outflow peak during the winter months and decrease during the summer and fall (Figure A3-11). These plots are similar to the reservoir storage presented earlier. The inflow and outflow are augmented by reservoir releases throughout the summer and fall. Monthly average Delta inflow for the 71-year historical hydrology peaks at 56,000 cfs during February and decreases to approximately 14,000 cfs during September. Monthly average Delta outflow for the 71-year historical hydrology follows a similar pattern, peaking at over 47,000 cfs during February and decreasing to just over 5,000 cfs during September. X2 position, which is related to Delta inflow, outflow, and exports, ranges from 85 kilometers during the low outflow period of September to 66 kilometers during the high outflow month of March. QWEST, also related to Delta inflow, outflow, and exports, ranges from 4,600 cfs during February to approximately -2,500 cfs during July. This pattern is similar to those of Delta inflow and outflow.

3.3.2.2 Delta Modeling Study Output

Monthly average Delta hydrodynamic studies of the future demand base case were performed with DWR's Delta Simulation Model (DWRDSM) to evaluate the changes to

within Delta flows, water levels, and velocities as a result of the ISDP. These studies are described in section 3.2.2. Within this section the modeling output for the future demand base case is discussed. Average flow, minimum water surface elevations, and minimum and maximum velocities at nineteen locations throughout the central and southern Delta are displayed by water year type.

Representative Critical Year

Table A3-7 shows the monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative critical year. Throughout the representative critical year, flows within the Delta are low. Minimum water surface elevations and velocities for the representative critical year are only slightly different than those listed in the existing demand base case study within section 3.3.1.2. However, as a result of the increased demand and increased pumping, reverse flows are more frequent and of a higher magnitude. Middle River always reverses and creates a null zone most months. The San Joaquin River between the city of Stockton and the head of Old River reverses January through March and through the summer.

Other Representative Year Types

The average flow, minimum water surface elevations, and minimum and maximum velocities for the representative dry, below normal, above normal, and wet year are displayed in Tables A3-8 through A3-11. The flow patterns throughout the central and southern Delta follow the same pattern as those of the existing demand base case. Reverse flows are prevalent along the path from the central Delta to the export facilities. Middle River commonly reverses and creates null zones from March through the summer. Flows along Old River just upstream of Clifton Court Forebay are typically low, during June and July. Most of the San Joaquin River flow is diverted down Old River from May and into the summer. During July and through the summer, the San Joaquin River often reverses near the city of Stockton. Flows typically become more positive with the higher Delta inflow in the wetter year types.

Minimum water surface elevations and velocities follow the same patterns as those seen in the existing demand base case. The magnitude of the minimum water surface elevations and the velocities for the representative critical year are only slightly different than those listed in the existing demand base case study within section 3.3.1.2. Minimum water surface elevations range from 1.4 to above 4.2 feet close to Clifton Court Forebay, and 1.5 to 3.4 feet at other locations in the southern Delta. Velocities are generally below 1.5 fps throughout the central and southern Delta. The two areas of greatest concern are Old River just downstream of Clifton Court Forebay and just downstream of the head of Old River. Velocities in Old River just downstream of Clifton Court Forebay can approach 2.5 fps in January through March, but remain below the three fps threshold. Velocities in Old River just downstream of the head of Old River increase in April and May and as the Delta inflows increase with the wetter water year types. Velocities in this channel are typically below 2.5 fps, but can exceed the three fps threshold during the representative wet year. From March through June of the representative wet year, velocities have the potential of exceeding 3.0 fps.

3.3.3 Interim South Delta Program, Existing Demand

This section describes the changes in hydrodynamics resulting from the implementation of the proposed ISDP operating under the current demand of the SWP. The preferred alternative includes (1) the construction and operation of a new intake structure at the SWP Clifton Court Forebay, (2) channel dredging along Old River just north of Clifton Court Forebay, (3) the construction and operation of a barrier seasonally in both the spring and fall to improve fishery conditions for salmon migrating along the San Joaquin River, (4) the construction and operation of three flow control structures to improve existing water level and circulation patterns for agricultural users in the south Delta, and (5) increasing the allowable exports from Harvey O. Banks Delta Pumping Plant to a maximum of 10,300 cfs.

Mathematical simulations of water project operations and the Delta environment with the proposed project were made to augment the description of the changes resulting from the proposed action. Since the mathematical modeling data is not intended to provide absolute predictions of future conditions, the results of these simulations were compared to the no-action, existing demand base case study and the incremental changes resulting from the proposed action were presented. Although the magnitude of the changes resulting from the ISDP may , at times, appear large or significant, the operation of the SWP facilities was modeled to meet all existing regulatory constraints. No attempt was made to optimize the operation of the components of the ISDP, but rather to make the operation consistent for comparison purposes.

With the ISDP, flows and water surface elevations in the south Delta would be changed as a result of barrier operation and timing of exports. As modeled, the timing of operation of each barrier varies from month to month over the course of a water year (Figure A3-12). Water surface elevations and circulation patterns are improved upstream of the barriers by tidal pumping. Tidal pumping allows upstream flow during the flood tide and blocks downstream flow during the ebb tide. This operation retains flood tide flows in south Delta channels to raise minimum water levels. As modeled, the Grant Line Canal Barrier was operated to open for a portion of the ebb tide to increase circulation by providing a downstream outlet. The increase in water levels routes the San Joaquin River downstream toward the central Delta, rather then through the south Delta towards the export pumps. Both statewide operation and Delta modeling results are discussed in the following text.

3.3.3.1 Statewide Operation Study Output

Monthly operational studies of the SWP and the CVP systems were performed with DWR's statewide water simulation model (DWRSIM) to evaluate the changes on SWP operation as a result of the ISDP. These studies are described in section 3.2.1. This section compares the modeling output of the ISDP, existing demand case with the no-action, existing demand base case. The percentage difference over base is shown to

C—087377

C-087377

provide a relative scale of the magnitude of change. However, some parameters such as QWEST have small values and a slight increase or decrease could result in a large percentage difference. The no-action existing demand base case study data found in Section 3.3.1.1 can be used as a reference to further determine the magnitude of change.

Reservoir Storage

Figure A3-12 depicts the percentage difference over the base case for the monthly average storage of Shasta Lake (a CVP reservoir), Lake Oroville, and the SWP portion of San Luis Reservoir for the 71-year historical hydrology. Since Shasta Lake is part of the CVP and is operated to meet the demands of the CVP, the CVP operation was frozen to prevent changes in the CVP operation and to illustrate the changes as a result of the ISDP facilities on SWP facilities. This is depicted in Figure XX by a 0.0 percent change between base and project cases. Lake Oroville monthly average storage over the 71-year record also does not change significantly. These changes equate to increases and decreases of less than 1 percent. However, since the ISDP will increase SWP exports from the Delta, the SWP portion of San Luis Reservoir, located downstream of the exports, will increase throughout the year. The greatest increases in monthly average storage occur in the fall and early winter, peaking at an increase of 16 percent during the months of November and December. Increases throughout the rest of the year remain at less than 10 percent.

Flows Downstream of Reservoirs

The monthly percentage difference over the base case of flows downstream of reservoirs for the 71-year historical hydrology is shown in Figure A3-13. The San Joaquin River at Vernalis, Sacramento River at Freeport, and the Feather River below Lake Oroville flows are depicted. Since San Joaquin River at Vernalis flows are dependent on upstream CVP reservoir releases, they do not change as a result of a frozen CVP operation. The Feather River below Oroville and the Sacramento River at Freeport flows follow similar trends. Feather River flows increase or decrease less than 5 percent except during August and September. In August, Feather River flows decrease 10 percent and in September they

decrease approximately 6 percent. Generally, this pattern occurs in Sacramento River at Freeport flows, but to a smaller degree, 3 percent and 1 percent respectively. This decrease is caused by a decrease in SWP exports during August, thus requiring smaller releases from the upstream reservoirs.

Delta Exports

Effects of the project alternative are most clearly represented in the operation of Harvey O. Banks Delta Pumping Plant. The project as defined increases exports in some months and decreases exports in others. The percentage difference over the base case for monthly average exports for the 71-year historical hydrology is shown in Figure A3-14 for pumping at Banks Pumping Plant and at the Tracy Pumping Plant. Also shown on the figure is the Delta Export Ratio, the percentage of the Delta Inflow that is exported from the Delta. Exports at the Tracy Pumping Plant do not change, since CVP operations are frozen. As shown, the greatest monthly average increase in Banks Pumping Plant exports are 12 percent, during October and November. SWP exports decrease from January through June. However, the largest monthly average decrease of 10 percent occurs in August. This is further shown on the Delta export ratio plot. The Delta export ratio increase correlates with the increase in pumping at SWP facilities from October through December. From March through May and in August the Delta export ratio is the controlling factor and does not change between the base and the project cases. During all months increases and decreases are below 5 percent.

Delta Inflow and Outflow

Delta inflow and outflow are changed as a result of the ISDP (Figure A3-15). Inflow is closely related to the operation of Lake Oroville, and outflow is related to amount and timing of Delta exports. Generally, impacts to Delta inflow are slight since this portion of the SWP is already operated to optimize exports. As shown, there is relatively no change in Delta inflow, with the greatest change occurring in August at just over a 2 percent decrease. However, Delta outflow past Chipps Island shows more of a decrease as a result

of timing and increased export of water from the Delta associated with the project. The months of September through November, which have the greatest increase in SWP pumping, show the largest decreases in Delta outflow. The largest decrease of 7 percent occurs in September. Generally, Delta outflow shows a slight increase in January and February, then remains steady from March through August. Since Delta outflow remains relatively unchanged, X_2 position does not change significantly. The only change occurs in October and November with an increase in X_2 position of just over 1 percent. QWEST, also related to Delta inflow, outflow, and exports, changes as a result of the proposed project. The greatest negative changes in QWEST occur between October and January. The most dramatic changes are in October and December, 91 percent and 97 percent respectively. These changes are large due to the low values of QWEST in the base study. Any small change would represent a large percentage in comparison with the base study. From February through June the change in QWEST is typically small. The month of August shows a 15 percent increase in positive QWEST flows, with a decrease of 31 percent in September.

3.3.3.2 Delta Modeling Study Output

Monthly average Delta hydrodynamic studies of the existing demand base case were performed with DWR's Delta Simulation Model (DWRDSM) to evaluate the changes to within-Delta flows, water levels, and velocities as a result of the ISDP. These studies are described in section 3.2.2. This section compares the modeling output of the ISDP, existing demand case with the no-action, existing demand base case. The difference over base is shown to provide a relative scale of the magnitude of change. The no-action, existing demand base case study data in Section 3.3.1.2 can be used as a reference to further determine the magnitude of change. Average flow, minimum water surface elevations, and minimum and maximum velocities at nineteen locations throughout the central and southern Delta are displayed by water year type.

Representative Critical Year

Table A3-12 shows the difference between the existing demand project and base for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative critical year. The proposed project increases monthly average channel flows in some months and decreases channel flows in others. The barrier operation and the shift in pumping affect the flow patterns in the southern Delta.

From January through March, the greatest changes in flows occur in Old River just downstream of Clifton Court Forebay. Old River reverse flows (7) increase by as much as 600 cfs during March as a result of a shift in pumping. Also, positive flows along Victoria Canal (8) decrease by as much as 460 cfs. San Joaquin River flows downstream of the head of Old River (17 and 18) increase by as much as 150 cfs in March, and flows into Old River (15 and 16) decrease by the same amount. Middle River flows in the south Delta (13 and 14) remain approximately the same, but during March become more positive by 250 cfs north of Woodward Canal (6).

From April through November, flows change dramatically as a result of barrier operation. As a result of the head of Old River barrier operation from April 15 through May, reverse flows increase by approximately 600 cfs and by 400 cfs in Columbia Cut (2) and Turner Cut (3), respectively. San Joaquin River flows downstream of the head of Old River (4, 17, and 18) do not reverse and increase by approximately 1,400 cfs. Likewise, Old River flows downstream of the head of Old River (15 and 16) decrease by the same amount. Reverse flows downstream of Clifton Court Forebay (7) increase by approximately 1,000 cfs. Flow is directed upstream through the flow control barriers on Middle (13) and Old River (10), and is prevented from flowing downstream. The change in flow for these two rivers is 150 cfs and over 500 cfs, respectively. Even without a Grant Line barrier in operation, positive flow in the channel (9) is reduced by over 700 cfs. Null zones in Middle, Old, and San Joaquin rivers, which existed in the base case, no longer exist in the project case.

Without the head of Old River barrier operating and the three flow control barriers operating during June through September, the results follow a similar pattern. Reverse

C—087381

C-087381

flows in Columbia and Turner Cut increase by approximately 190 cfs and 100 cfs, respectively. San Joaquin River flow increases over 400 cfs downstream of the head of Old River rather than being diverted down Old River. Reverse Old River flows downstream of Clifton Court Forebay (7) increase 600 cfs in June and 900 cfs in July, but decrease in comparison to the flows with the head of Old River barrier operating. With the Grant Line barrier operating, flows in that channel (9) are reduced by 170 cfs in June and 150 cfs in July. Null zones no longer exist in Middle, Old, and San Joaquin rivers.

Minimum water surface elevations improve as a result of the operation of the barriers. The most significant improvements are shown when the Grant Line barrier is operating. With no barriers operating during January through March, there is no significant change between base and project conditions. When the Middle River and Old River near Tracy barriers are operating during the first part of April, the only significant improvements in minimum water surface elevation occur immediately upstream of the barriers. Middle River minimum water surface elevations improve by 2.3 feet immediately upstream of the barrier (13) and 1.6 feet further upstream (14). Immediately upstream of the Old River near Tracy barrier (10) minimum water surface elevations improve by 1.3 feet and further upstream (12) by 0.8 feet. These improvements remain when the head of Old River barrier is operating during the latter part of April and in May. However, when this barrier is operating, minimum water surface elevations on Old River immediately downstream of the head of Old River barrier (15 and 16) degrade by less than 1.0 feet.

The true benefit of the barriers is best depicted when the Grant Line Barrier and the other two flow control barriers are operating during June and July and through the summer. As a result of these three barriers operating, all minimum water surface elevations in the south Delta are improved throughout the irrigation season. Middle River elevations (13 and 14) increase by approximately 2 feet, Old River elevations just upstream of Clifton Court Forebay (10 and 12) increase between 1.6 to 2.0 feet, Grant Line Canal elevations (9 and 11) increase approximately 1.6 feet, and Old River elevations just downstream of the head of Old River (15 and 16) increase between 1.4 and 1.6 feet.

Generally, velocities in the south Delta change very little as a result of the proposed project. Typically, the change in velocity is less than 0.2 fps. The most significant change in velocity occurs in the San Joaquin River downstream of the head of Old River barrier. With the head of Old River barrier operating, San Joaquin River velocities can increase by 1.3 fps, but will remain less than the 3.0 fps threshold. Likewise, Old River velocities decrease during the same time period. In the channels upstream of the barriers, the velocities typically decrease, but the change is relatively minor.

Representative Dry Year

Table A3-13 shows the difference between the existing demand project and base for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative dry year. The change in these parameters in the representative dry year are similar to those found in the representative critical year. The barrier operation and the shift in pumping affect the flow patterns in the southern Delta. The proposed project increases monthly average channel flows in some months and decreases channel flows in others.

As shown in the representative critical year, the head of Old River barrier affects the flows in Old River and in the San Joaquin River. When the head of Old River is operating in the latter part of April and in May, more flow, 2,400 cfs and 1,900 cfs, continues down the San Joaquin River (17 and 18) rather than being diverted down Old River (15 and 16). With the three flow control barriers operating in June, July and through September, a hydraulic barrier is created at the head of Old River. San Joaquin River flow, approximately 500 cfs, continues past the head of Old River (17 and 18). Again, the flow into Old River (15 and 16) is reduced by the same amount. More flow reverses in Columbia (2) and Turner Cut (3), and in Middle (6) and Old River (7). This increase over the base conditions varies from 200 to 1,000 cfs in Columbia Cut, from 50 to 600 cfs in Turner Cut, from 100 to 900 cfs in Middle River, and from 500 to 1,900 cfs in Old River. This is a result of San Joaquin River flow bypassing the south Delta, entering the central Delta, and being drawn south to the export facilities. The null zones that existed in the base case study no longer exist as a result of the proposed project operations.

C—087383

C-087383

Minimum water surface elevations improve as a result of barrier operation as was shown in the representative critical year. The Middle River and the Old River near Tracy barriers improve minimum water surface elevations upstream of the barrier approximately 2 feet. The Grant Line Canal conditions are improved by about 1.6 feet while the barrier is operating. All water levels upstream of the barriers are improved, with the improvements decreasing as the distance from the barrier increases. Changes in velocities in the south Delta are similar to those shown in the representative critical year.

Representative Below Normal Year

Channel flow, minimum water surface elevations, and velocities change in the representative below normal year as a result of the proposed project. Table A3-14 shows the difference between the existing demand project and base for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative below normal year. Typically, the changes follow the same pattern as those shown in the other water year types. The major difference between this water year type and the representative critical year is that there is more inflow to the Delta and the magnitude of the change in flow is slightly higher.

As a result of the head of Old River barrier, San Joaquin River flow increases by approximately 2,600 cfs rather than being diverted down Old River. With the three flow control structures operating, the hydraulic barrier created results in an additional 500 cfs continuing down the San Joaquin River and the flow into Old River reduced by the same amount. In June and July (three flow control barriers operating) reverse flows in Columbia Cut (2) increase by 180 and 300 cfs, Turner Cut (3) increases by 70 and 60 cfs, Middle River (6) increases by 100 cfs in June and reduces by 90 cfs in July, and Old River (7) increases by 600 and 1,000 cfs.

Improvement in minimum water surface elevations are shown in the representative below normal year as a result of barrier operation. Middle River and Old River near Tracy barriers improve upstream water levels by approximately 2 feet, and the Grant Line Canal

barrier improves water levels by 1.6 feet. Changes in velocities are small and follow the same pattern as shown in the representative critical year.

Representative Above Normal Year

The change in flows, minimum water surface elevations, and velocities as a result of the proposed project are similar to that seen in the other water year types. Table A3-15 shows the difference between the existing demand base and project for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative above normal year.

The head of Old River barrier continues to change the flow patterns of the San Joaquin. When the barrier is installed in the latter part of April and in May, San Joaquin River flow downstream of the barrier increases by approximately 2600 cfs, and Old River flow is reduced by the same amount. The San Joaquin River flow increases by approximately 500 cfs when the three flow control structures are operating during the summer. As a result of the operation of these three barriers in June and July, reverse flows increase in Columbia Cut (2)by 190 and 300 cfs, in Turner Cut (3) by 60 cfs, in Old River (7) by 600 and 900 cfs, respectively. Null zones existing in the base case are minimized under the operation of the proposed project.

Minimum water surface elevation improvements are similar to those shown in the other water year types. Middle River and Old River near Tracy barriers improve water levels upstream of the barriers (13 and 10) by approximately 2 feet, and the Grant Line Canal barrier improves water surface elevations by 1.6 feet (9). Without the Grant Line Canal barrier operating, the improvements in Old River water levels upstream of the Old River near Tracy barrier (10) are about 50 percent less than those with the Grant Line Canal barrier operating. Old River water surface elevations downstream of the head of Old River barrier (16) decrease by 1.6 feet while the head of Old River barrier is operating. Changes in minimum and maximum velocities are similar to those of the representative critical year.

Representative Wet Year

The barrier operation during representative wet year is significantly different than the operation during the other water year types. During this water year, San Joaquin River flows were much larger. Due to flood control concerns, when San Joaquin River at Vernalis flows are greater than 5000 cfs, barriers in the south Delta were not operated. Therefore, while the exports were increased and timing of pumping continued to be shifted, the typical barrier operation did not occur. From April through June, no barriers were operating in the south Delta. Beginning in July, after the flows dropped below the 5000 cfs threshold, the three flow control barriers were operated as they had previously in other water years. Table A3-16 shows the difference between the existing demand project and base for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative above normal year.

Prior to the operation of the barrier, flows changes are similar to those seen in other water year types. Beginning in July, the changes in flow are a result of the operation of the three flow control barriers. The San Joaquin River flow downstream of the head of Old River (18 and 17) increases by approximately 650 cfs, and Old River flow decreases by the same amount. As a result of the operation of these three barriers in July, reverse flows increase in Columbia Cut (2) by 290 cfs, in Turner Cut (3) by 85 cfs, in Old River (7) by 850 cfs, respectively. Flows upstream of the barriers decrease by controlling the downstream flow. Null zones existing in the base case are minimized under the operation of the proposed project.

Before the barriers are operating in the south Delta, the changes in water levels is insignificant. With the barriers in operation, the changes in minimum water surface elevations follows the same patterns as other water year types. Beginning in July, Middle River and Old River near Tracy barriers improve water levels upstream of the barriers (13 and 10) by approximately 3 feet, and the Grant Line Canal barrier improves water surface elevations by 2.0 feet (9). Changes in minimum and maximum velocities are similar to those of the other representative years.

3.3.4 Interim South Delta Program (ISDP), Future Demand

This section describes the changes in hydrodynamics resulting from the implementation of the proposed Interim South Delta Program (ISDP) operating under the future demand of the SWP. The future demand of 4.1 MAF is considered the ultimate demand level that the SWP would be able to supply to existing contractors. The preferred alternative includes (1) the construction and operation of a new intake structure at the SWP Clifton Court Forebay, (2) channel dredging along Old River just north of Clifton Court Forebay, (3) the construction and operation of a barrier seasonally in both the spring and fall to improve fishery conditions for salmon migrating along the San Joaquin River, (4) the construction and operation of three flow control structures to improve existing water level and circulation patterns for agricultural users in the south Delta, and (5) increasing the allowable exports from Harvey O. Banks Pumping Plant to a maximum of 10,300 cfs.

Mathematical simulations of water project operations and the Delta environment with the proposed project were made to augment the description of the changes resulting from the proposed action. Since the mathematical modeling data is not intended to provide absolute predictions of future conditions, the results of these simulations were compared to the no-action, existing demand base case study and the incremental changes resulting from the proposed action were presented. Although the magnitude of the changes resulting from ISDP may , at times, appear large or significant, the operation of the SWP facilities were modified to meet all existing regulatory constraints. No attempt was made to optimize the operation of the components of the ISDP, but rather to make the operation consistent for comparison purposes.

With ISDP flows and water surface elevations in the south Delta would be changed as a result of barrier operation and timing of exports. As modeled, the timing of operation of each barrier varies (Figure A3-12), but is consistent with that shown in the existing demand case. Water surface elevations and circulation patterns are improved upstream of the barriers by tidal pumping. Tidal pumping allows upstream flow during the flood tide and

C—087387

C-087387

impedes downstream flood flow during the ebb tide. This operation retains flood tide flows in south Delta channels to raise minimum water levels. As modeled, the Grant Line Canal Barrier was operated to open for a portion of the ebb tide to increase circulation by providing a downstream outlet. The increase in water levels routes San Joaquin River downstream towards the central Delta, rather then through the south Delta towards the export pumps. Both statewide operation study and Delta modeling results are discussed in the following text.

3.3.4.1 Statewide Operation Study Output

Monthly operational studies of the SWP and the CVP systems were performed with DWR's statewide water simulation model (DWRSIM) to evaluate the changes on SWP operation as a result of ISDP. These studies are described in section 3.2.1. Within this section the modeling output of the ISDP, future demand case compared with the no-action, future demand base case is presented. The percent difference over base is shown to provide a relative scale of the magnitude of change. However, some parameters such as QWEST have small values and slight increase or decrease could result in a large percent difference. The no-action future demand base case study data found in Section 3.3.2.1 can be used as a reference to further determine the magnitude of change.

Reservoir Storage

Figure A3-17 depicts the percentage difference over the base case for the monthly average storage of Shasta Lake (a CVP reservoir), Lake Oroville, and the SWP portion of San Luis Reservoir for the 71-year historic hydrology. Similar to the existing demand case, the CVP operation was frozen to prevent changes in CVP operation and to illustrate the changes as a result of the ISDP facilities on SWP facilities. This is depicted in Shasta Lake in Figure XX by a 0.0 percent change between base and project cases. Lake Oroville monthly average storage over the 71-year record also does not change significantly. These changes equate to increases and decreases of less than 4 percent. The largest change is an increase

of 3.3 percent in August. However, since the ISDP will increase SWP exports and deliveries from the Delta, the SWP portion of San Luis Reservoir, located downstream of the exports, will change throughout the year. Storage decreases from July through October with the largest decrease of 21 percent occurring in September. The greatest increases in monthly average storage occur in the early winter, peaking at an increase of 10.5 percent during December. Storage increases throughout the rest of the year, but are typically less than 5 percent from March through June.

Flows Downstream of Reservoirs

The monthly percentage difference over the base case of flows downstream of reservoirs for the 71-year historical hydrology is shown in Figure A3-18. The San Joaquin River at Vernalis, Sacramento River at Freeport, and the Feather River below Lake Oroville flows are depicted. Since San Joaquin River at Vernalis flows are dependent on upstream CVP reservoir releases, they do not change as a result of a frozen CVP operation. The Feather River below Oroville and the Sacramento River at Freeport flows follow similar trends. Feather River flows increase or decrease less than 5 percent except during December and July through September. In December, Feather River flows increase 10.9 percent and from July and August decrease 8 and 9 percent, respectively. In September they increase approximately 27 percent. Generally, this occurs in Sacramento River at Freeport flows, but to a smaller degree, increasing 2 percent in December and decreasing 3 percent in July and August. This decrease is caused by a decrease in SWP exports during July August, thus requiring smaller releases from the upstream reservoirs and increasing exports in the fall, requiring larger releases.

Delta Exports

Effects of the project alternative are most clearly represented in the operation of Harvey O. Banks Pumping Plant. The project, as defined, increases exports in some months and decreases exports in others. The percentage difference over the base case for monthly average exports for the 71-year historical hydrology is shown in Figure A3-19 for pumping

at Harvey O. Banks Pumping Plant and at the Tracy Pumping Plant. Also shown on the figure is the Delta Export Ratio, the percentage of the Delta Inflow that is exported from the Delta. Exports at the Tracy Pumping Plant do not change since CVP operations are frozen. As shown, the greatest monthly average increase in Harvey O. Banks Pumping Plant exports are 17 percent and 19 percent, during the months of October and November. SWP exports decrease from February through May. However, the largest monthly average decreases of 7.8 percent and 7.3 occurs in July and August. This is further shown on the Delta export ratio plot. The Delta export ratio increase correlates with the increase in pumping at SWP facilities from October through January. During the months of February through June and August the Delta export ratio is the controlling factor and does not change between the base and the project cases. With the exception of a 8 percent November increase, increases and decreases are below 5 percent during all months.

Delta Inflow and Outflow

Delta inflow and outflow are changed as a result of the ISDP (Figure A3-20). Inflow is closely related to the operation of Lake Oroville and outflow is related to amount and timing of Delta exports. Generally, impacts to Delta inflow are slight since this portion of the SWP is already operated to optimize exports. As shown there is relatively no change in Delta inflow, with the greatest change being a 2.6 percent decrease during in August. However, Delta outflow past Chipps Island shows more of a decrease as a result of timing and increased export of water from the Delta associated with the project. The months of October through December, which have the greatest increase in SWP pumping, show the largest decreases in Delta outflow. The largest decrease of 9.3 percent occurs in the month of October. Generally, Delta outflow remains steady from January through September. Since Delta outflow remains relatively unchanged, X2 position does not change significantly. The only slight change occurs in October through December, and July with ar. increase in X2 position of just over 1 percent. QWEST, also related to Delta inflow, outflow, and exports, changes as a result of the proposed project. The greatest negative changes in Qwest occur between October and December. The most dramatic changes are in October and December, 131 percent and 86 percent respectively. These changes are large

due to the low values of Qwest in the base run. Any small change would represent a large percentage in comparison with the base run. In January and June increases of 16 and 18 percent in more positive Qwest flows occur. From February through May the change in Qwest is typically small. The month of August shows a 10 percent increase in more positive Qwest flows and then shows a decrease of 28 percent in September.

3.3.4.2 Delta Modeling Study Output

Monthly average Delta hydrodynamic studies of the existing demand base case were performed with DWR's Delta Simulation Model (DWRDSM) to evaluate the changes to within Delta flows, water levels, and velocities as a result of ISDP. These studies are described in section 3.2.2. Within this section the modeling output of the ISDP, future demand case compared with the no-action, future demand base case and is presented. The difference over base is shown to provide a relative scale of the magnitude of change. The no-action future demand base case study data found in Section 3.3.2.2 can be used as a reference to further determine the magnitude of change. Average flow, minimum water surface elevations, and minimum and maximum velocities at nineteen locations throughout the central and southern Delta are displayed by water year type. The Delta reacts to the ISDP in the future demand case in the same way it reacted in the existing demand case. The changes between these two demand levels are minor and often are close to being exactly the same.

Representative Critical Year

Table A3-17 shows the difference between the future demand project and base for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative critical year. The proposed project increases monthly average channel flows in some months and decreases channel flows in others. The barrier operation and the shift in pumping affect the flow patterns in the southern Delta.

C-087391

C-087391

As shown in the existing demand case, from January through March the greatest changes in flows occur in Old River just downstream of Clifton Court Forebay. Old River reverse flows (7) increase by as much as 650 cfs during March as a result of a shift in pumping. Also, positive flows along Victoria Canal (8) decrease by as much as 470 cfs. San Joaquin River flows downstream of the head of Old River (17 and 18) increase by as much as 150 cfs in March and flows into Old River (15 and 16) decrease by the same amount. Middle River flows in the south Delta (13 and 14) remain approximately the same, but become more positive by 250 cfs during March north of Woodward Canal (6).

From April through November flows change dramatically as a result of barrier operation and the results are similar to the existing demand case. As a result of the head of Old River barrier operation from April 15 through May, reverse flows increase by approximately 600 cfs in Columbia Cut (2) and by 400 cfs in Turner Cut (3). San Joaquin River flows downstream of the head of Old River (4, 17, and 18) do not reverse and increase by approximately 1500 cfs. Likewise, Old River flows downstream of the head of Old River (15 and 16) decrease by the same amount. Reverse flows downstream of Clifton Court Forebay (7) increase by approximately 1100 cfs. Flow is directed upstream through the flow control barriers on Middle (13) and Old River (10), and prevented from flowing downstream. The change in flow for these two rivers is 150 cfs and over 500 cfs, respectively. Even without a Grant Line barrier in operation, positive flow in the channel (9) is reduced by over 800 cfs. Null zones in Middle, Old and San Joaquin rivers, that existed in the base case no longer exist in the project case.

Without the head of Old River barrier operating and the three flow control barriers operating during June through September the results follow a similar pattern. Reverse flows in Columbia and Turner Cut increase by approximately 150 cfs and 70 cfs respectively. San Joaquin River flow increases over 450 cfs downstream of the head of Old River, rather than being diverted down Old River. Reverse Old River flows downstream of Clifton Court Forebay (7) increase 550 cfs in June and 200 cfs in July, but decrease in comparison to the flows with the head of Old River barrier operating. With the

Grant Line barrier operating flows in that channel (9) are reduced by 170 cfs in June and 160 cfs in July. Null zones no longer exist in Middle, Old, and San Joaquin rivers.

Following the same pattern as seen in the existing demand case, minimum water surface elevations improve as a result of the operation of the barriers. The most significant improvements are shown when the Grant Line barrier is operating. With no barriers operating during January through March there is no significant change between base and project conditions. When the Middle River and Old River near Tracy barriers are operating during the first part of April the only significant improvements in minimum water surface elevation occur upstream of the barriers. Middle River minimum water surface elevations improve by 2.3 feet immediately upstream of the barrier (13) and 1.6 feet further upstream (14). Immediately upstream of the Old River near Tracy barrier (10) minimum water surface elevations improve by 1.3 feet and further upstream (12) by 0.7 feet. These improvements remain when the head of Old River barrier is operating during the latter part of April and in May. However, when this barrier is operating minimum water surface elevations on Old River immediately downstream of the head of Old River barrier (15 and 16) decrease by less than 1.0 feet.

The true benefit of the barriers is best depicted when the Grant Line Barrier along with the other two flow control barriers are operating during the months of June and July and throughout the rest of the summer. As a result of these three barriers operating, all minimum water surface elevations in the south Delta are improved throughout the irrigation season. Middle River elevations (13 and 14) increase by approximately 2 feet, Old River elevations just upstream of Clifton Court Forebay (10 and 12) increase between 1.9 to 2.0 feet, Grant Line Canal elevations (9 and 11) increase approximately 1.6 feet, and Old River elevations just downstream of the head of Old River (15 and 16) increase between 1.4 and 1.6 feet.

Generally, velocities in the south Delta change very little as a result of the proposed project. Typically, the change in velocity is less than 0.2 fps. The most significant change in velocity occurs in the San Joaquin River downstream of the head of Old River barrier.

C-087393

C-087393

With the head of Old River barrier operating, San Joaquin River velocities can increase by 1.3 fps, but will remain less the 3.0 fps threshold. Likewise, Old River velocities decrease during the same time period. In the channels upstream of the barriers, the velocities typically decrease, but the change is relatively minor.

Other Representative Year Types

The average flow, minimum water surface elevations, and minimum and maximum velocities for the representative dry, below normal, above normal, and wet year are displayed in Tables A3-18 through A3-21. The flow patterns throughout the central and southern Delta follow the same pattern as those of the representative critical year for the future demand project case. Reverse flows are prevalent along the path from the central Delta to the export facilities. The most significant changes, compared with the existing demand, project case occurs in January, February, and July in Old and San Joaquin rivers. Due to increased exports in the future demand case, reverse flows can increase 1,000 cfs or more over the existing demand case during these months. Flows in Grant Line Canal, Middle River, and Old River upstream of Clifton Court Forebay, follow the same patterns and trends shown above in the representative critical year. San Joaquin River flows downstream of the head of Old River, with and without the barriers, also follow the same trend as shown in the representative critical year. Flows typically become more positive with the higher inflow in the wetter year types.

Minimum water surface elevations and velocities follow the same patterns as that seen in the existing demand case and representative critical year of the future demand case. Following the same pattern, minimum water surface elevations improve as a result of the operation of the barriers. The most significant improvements are shown when the Grant Line barrier is operating. With no barriers operating during January through March there is no significant change between base and project conditions. When the Middle River and Old River near Tracy barriers are operating during the first part of April, the only significant improvements in minimum water surface elevation occur upstream of the barriers. Middle River minimum water surface elevations improve by 2.4 feet immediately

upstream of the barrier (13) and 1.5 to 1.6 feet further upstream (14). Immediately upstream of the Old River near Tracy barrier (10) minimum water surface elevations improve by 1.3 to 1.5 feet and further upstream (12) by 0.7 to 1.8 feet. These improvements remain when the head of Old River barrier is operating during the latter part of April and in May. However, when this barrier is operating minimum water surface elevations on Old River immediately downstream of the head of Old River barrier (15 and 16) decrease by 1.0 to 1.6 feet.

The true benefit of the barriers is best depicted when the Grant Line Barrier along with the other two flow control barriers are operating during the months of June and July and throughout the rest of the summer. As a result of these three barriers operating, all minimum water surface elevations in the south Delta are improved throughout the irrigation season. Middle River elevations (13 and 14) increase by approximately 2 feet, Old River elevations just upstream of Clifton Court Forebay (10 and 12) increase between 1.9 to 2.0 feet, Grant Line Canal elevations (9 and 11) increase approximately 1.6 feet, and Old River elevations just downstream of the head of Old River (15 and 16) increase between 1.4 and 1.6 feet. As seen in the representative wet year of the existing demand case, high San Joaquin River flows prevented the operation of barriers until July.

Generally, velocities in the south Delta change very little as a result of the proposed project and follow the same pattern as shown in the representative critical year and in the existing demand case.. Typically, the change in velocity is less than 0.2 fps. The most significant change in velocity occurs in the San Joaquin River downstream of the head of Old River barrier. With the head of Old River barrier operating, San Joaquin River velocities can increase by 1.3 fps, but will typically remain less the 3.0 fps threshold. Likewise, Old River velocities decrease during the same time period. In the channels upstream of the barriers, the velocities typically decrease, but the change is relatively minor.

3.3.4 Fisheries Alternative, Existing Demand

C—087395

C-087395

This section describes the changes in hydrodynamics resulting from the implementation of the Fisheries Alternative under the current demand of the SWP. The Fisheries Alternative includes (1) modification of CVP and SWP exports, (2) consolidation of agricultural diversions, (3) extensions for existing agricultural diversions, (4) dredge 5 miles of Old River north of Clifton Court Forebay, and install a new intake structure at the northeast corner of Clifton Court Forebay, and (5) increase pumping at Harvey O. Banks Pumping Plant to 10,300 cfs.

Mathematical simulations of water project operations and the Delta environment with the Fisheries Alternative were made to augment the description of the changes resulting from the proposed action. Since the mathematical modeling data is not intended to provide absolute predictions of future conditions, the results of these simulations were compared to the no-action, existing demand base case study and the incremental changes resulting from the proposed action were presented. Although the magnitude of the changes resulting from the Fisheries Alternative may , at times, appear large or significant, the operation of the SWP facilities was modeled to meet all existing regulatory constraints. No attempt was made to optimize the operation of the components of the Fisheries Alternative, but rather to make the operation consistent for comparison purposes.

3.3.4.1 Statewide Operation Study Output

Monthly operational studies of the SWP and the CVP systems were performed with DWR's statewide water simulation model (DWRSIM) to evaluate the changes in SWP operation as a result of the Fisheries Alternative. These studies are described in section 3.2.1. This section compares the modeling output of the Fisheries Alternative and the no-action, existing demand base condition. The percentage difference over base is shown to provide a relative scale of the magnitude of change. However, some parameters such as QWEST have small values and a slight increase or decrease could result in a large percentage difference. The no-action existing demand base case study data found in section 3.3.1.1 can be used as a reference to further determine the magnitude of change.

Reservoir Storage

Figure A3-21 depicts the percentage difference over the base case for the monthly average storage of Shasta Lake (a CVP reservoir), Lake Oroville, and the SWP portion of the San Luis Reservoir for the 71-year historical record. Since Shasta Lake is part of the CVP and is operated to meet the demands of the CVP, the CVP operation was frozen to prevent changes in the CVP operation and to illustrate the changes as a result of the Fisheries Alternative on the SWP. This is depicted by a 0.0 percent change between base and project cases. Lake Oroville monthly average storage over the 71-year record does not change significantly. A slight decrease of less than 2 percent occurs during every month except May and June where there is no change. The SWP portion of the San Luis Reservoir will increase throughout the year except during May and June. The greatest increases in monthly average storage occur in the fall and early winter, peaking at an increase of 16 percent during the months of November and December. The decrease, during May and June, of 2 percent is caused by the decrease in pumping, below base conditions as defined by the modification of CVP/SWP exports from April 15 through May 15.

Flows Downstream of Reservoirs

The monthly average seasonal pattern of flows for the 71-year historical hydrology is shown in Figure A3-22 for the San Joaquin River at Vernalis, Sacramento River at Freeport and the Feather River below Lake Oroville. Since San Joaquin River at Vernalis flows are dependent on upstream CVP reservoir releases, there is no change as a result of the frozen CVP operations. The Feather River below Oroville and the Sacramento River flows follow similar trends. Sacramento River flows increase or decrease less than 5 percent. The largest increase of 5 percent occurs in July. Feather River flows increase or decrease less than 5 percent except during May and also from July through September. The decrease in flow of 6 percent during May is caused by the pumping restrictions from April 15 to May 15. The increase of 17 percent in July is caused by increased releases from Oroville, which make up for the April 15 through May 15 diversion reductions.

C—087397

C-087397

Delta Exports

The percentage difference over the base condition from monthly average exports for the 71-year historical hydrology is shown in Figure A3-23 for pumping at Harvey O. Banks Pumping Plant and Tracy Pumping Plant. Also shown is the Delta Export Ratio, the percentage of the Delta inflow that is exported from the Delta. The effects of the Fisheries Alternative are represented in the operation of Banks Pumping Plant. This alternative increases exports in some months and decreases exports in others. The greatest increase in exports, 12 percent, occurs in November. From January through May, a decrease in exports from 5 percent to 18 percent occurs, with the greatest decrease occurring in April and May. This is consistent with the specified decrease in pumping from April 15 to May 15. A decrease of 14 percent occurs in August due to low inflow. Exports at the Tracy Pumping Plant change as a result of this Alternative. Tracy Pumping Plant has an increase and decrease of exports less than 3 percent except during April and May. This follows the same trend as Banks Pumping Plant during April and May. The Delta Export Ratio increases and decreases less than 5 percent except in April and May. A 17 percent decrease in April and a 16 percent decrease in May occurs which is a result of the pumping restrictions on exports during April and May.

Delta Inflow and Outflow

Delta inflow, outflow, QWEST and X_2 change as a result of the Fisheries Alternative (Figure A3-24). Inflow is closely related to the operation of Lake Oroville and outflow is related to amount and timing of Delta exports. Delta inflow decreases from January through May with the largest decrease of 8 percent occurring in November. This is similar to what occurs at Lake Oroville. From January through September the increases or decreases are less than 4 percent. Delta outflow past Chipps Island shows a decrease, from September through November, as a result of timing and increased exports from the Delta associated with the Fisheries Alternative. The largest decrease of 7 percent occurs in

September. From December through August, the outflow increases or decreases by less than 3 percent. X_2 position does not change significantly. The only change occurs in November and April, with an increase and decrease of just over 1 percent respectively. QWEST, also related to Delta inflow, outflow, and exports, changes as a result of the Fisheries Alternative. The greatest negative change in QWEST occurs between October and December. The most dramatic changes are in October and December, 116 percent and 94 percent respectively. These changes are largely due to the low values of QWEST in the base condition. Any small change would represent a large percentage in comparison with the base condition. From February through June the change in QWEST is typically small. The month of July and September shows a 41 percent and 30 percent increase in negative QWEST flows.

3.3.4.2 Delta Modeling Study Output

Monthly average Delta hydrodynamic studies of the existing demand base condition were performed with DWR's Delta Simulation Model (DWRDSM) to evaluate the changes to within-Delta flows, water levels, and velocities as a result of the Fisheries Alternative. These studies are described in section 3.2.2. This section compares the modeling output of the Fisheries Alternative, existing demand case with the existing demand base condition. The difference over the base is shown to provide a relative scale of the magnitude of change. The existing demand base condition study data in Section 3.3.1.2 can be used as a reference to further determine the magnitude of change. Average flow, minimum water surface elevations, and minimum and maximum velocities at nineteen locations throughout the central and southern Delta are displayed by water year type.

Representative Critical Year

C—087399

C-087399

The difference between the Fisheries Alternative, existing demand and base condition, existing demand for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative critical year is shown in Table A3-22. The Fisheries Alternative decreases monthly channel flows during most months. The flow patterns are affected by increased pumping, San Joaquin River flows and the irrigation season.

From January through March, small changes in flow occur in Old River just downstream of Clifton Court Forebay and also in Middle River. In Old River (5,7) the largest increase in reverse flow is 199 cfs which occurred in January. Reverse flows also increase in Middle River (6) by 100 cfs, which is similar to what occurs in the base condition, existing demand. Victoria Canal's (8) positive flows increase by 82 cfs. No changes occur in flows near the head of Old River (15,16) nor along the San Joaquin River (17,18).

From April through June, the change in flows are also small. A null zone occurs in Middle River (13,14) between the head of Old River and Victoria Canal, which is also similar to what occurs in the base condition existing demand critical year. Reverse flows decrease in Old River downstream of Clifton Court Forebay. This is due to a combination of CVP pumping, agricultural channel depletions and lower inflow to the south Delta from the San Joaquin River. In July, the changes in flow along Old River (5,7) and Middle River (6) increase due to the irrigation season increased demands and an increase in pumping at SWP. Also in July through the summer, a null zone occurs along Old River (10,12) upstream of Clifton Court Forebay. There is no improvement of the reverse flows and null zones for this alternative, which also appear in the base condition, existing demand representative critical year.

In the southern Delta, there is no improvement in the minimum water surface elevations. The minimum and maximum velocities do not change as a result of this alternative. The conditions, which are the same as in the base condition, existing demand representative critical year, include decreased minimum water surface elevation during the irrigation

season and the highest velocities occurring in Old River downstream of Clifton Court Forebay of 2.6 to -2.2 fps.

Representative Dry Year

Table A3-23 shows the difference between the existing demand Fisheries Alternative and base condition for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative dry year. Changes in flow occur in Old and Middle Rivers. In Old River (5,7) the reverse flows that occur from January through March increase by 300 cfs. This is caused by an increase in pumping. This increase, which is higher than in the representative critical year, should be expected because of the increased amount of water available for pumping. Reverse flows in Middle River (6) decrease 150 cfs when compared to the base condition, existing demand. Positive flows along Grant Line (9,11) and Victoria Canals (8) decrease by 150 cfs.

Reverse flows decrease, from April through May, in Old and Middle Rivers as a result of a decrease in pumping. In June and July, the reverse flows increase along Old River (5,7) downstream of Clifton Court Forebay and along Victoria Canal (8). Null zone occurs in Middle River (13,14) during June and July, which is similar to what occurs in the representative critical year. Null zone and reverse flow occurs, during July, in the San Joaquin River. Null zones that existed in the representative critical year are still prevalent.

Minimum water surface elevation and velocities follow the same pattern as seen during the representative critical year. As a result of this alternative, no changes or improvements occur when compared to the base condition.

Representative Below Normal Year

Channel flow, minimum water surface elevations, and velocities do not improve in the representative below normal year as a result of the Fisheries Alternative. Table A3-24

shows the difference between the existing demand Fisheries Alternative and base for monthly average flow, minimum water surface elevation, and minimum and maximum velocities for the representative below normal year.

Reverse flows along Old and Middle Rivers decrease in January and February. Old River (5,7) reverse flows decrease by 2400 cfs and 2150 cfs respectively in January. The reverse flow in Middle River (6) is decreased by 1600 cfs. A null zone occurs in Middle River (13,14) during March, which is the result of lower San Joaquin River flows entering the south Delta. Also during March, the reverse flows along Old (5,7) and Middle (6) Rivers increase.

From April to May, pumping is less than the base condition because of modifications in CVP/SWP exports. This results in a decrease in reverse flows along Old and Middle Rivers (5,6,7). Flows increase along the San Joaquin River (1,4) near Jersey Island and Turner Cut. A null zone exists in Middle River (13,14) in June and July. In the San Joaquin River, reverse flow occurs near Stockton and a null zone occurs from July through the summer. Higher pumping and the irrigation season causes increased reverse flows along Columbia Cut (2) and Old River (5,7). Problems with reverse flows and null zones along the San Joaquin River and null zones along Middle River are still present in the representative below normal year.

Minimum water surface elevation and velocities follow the same pattern as seen during the representative critical year. As a result of this alternative, no changes or improvements occur when compared to the base condition.

Representative Above Normal Year

Table A3-25 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative above normal year. During the representative above normal year, flows within the Delta are generally higher but follow the

same pattern as that seen in the below normal year. In the central Delta and along Old River, reverse flows exist but typically occur less or are lower due to higher inflows and less pumping. The closer to the export pumps, the greater these reverse flows become. Reverse flows increase during months of high pumping and during the irrigation season. Middle River continues to reverse from June through the summer. This reversing action creates a null zone in this reach from June through the summer. The San Joaquin River, between Stockton and the head of Old River, reverse flow during June through the summer due to low inflow conditions.

Minimum water surface elevation and velocities follow the same pattern as seen during the representative critical year. As a result of this alternative, no changes or improvements occur when compared to the base condition.

Representative Wet Year

Table A3-26 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative wet year. During the representative wet year, flows within the Delta are higher but follow the same pattern as that seen in the below normal year. The San Joaquin River does not reverse because of higher inflows. Most channels have a positive downstream flow. Old (5,7) and Middle (6) Rivers continue to have reverse flow during high pumping, specifically January, February, March and June through the summer. Null zones are less prevalent, but still occur in Middle River from July through the summer.

Minimum water surface elevation and velocities follow the same pattern as seen during the representative critical year. As a result of this alternative, no changes or improvements occur when compared to the base condition.

3.3.5 Fisheries Alternative, Future Demand

C—087403

C-087403

This section describes the changes in hydrodynamics resulting from the implementation of the fisheries alternative operating under the future demand of the SWP. The Fisheries Alternative includes (1) modification of CVP and SWP exports, (2) consolidation of agricultural diversions, (3) extensions for existing agricultural diversions, (4) dredge 5 miles of Old River north of Clifton Court Forebay, and install a new intake structure at the northeast corner of Clifton Court Forebay, and (5) increase pumping at Harvey O. Banks Pumping Plant to 10,300 cfs. The future demand of 4.1 MAF is considered the ultimate demand level that the SWP would be able to supply to existing contractors.

Numerical simulations of water project operations and the Delta environment with the proposed fisheries alternative were done to understand trends and changes resulting from implementing this alternative. The numerical modeling data is not intended to provide absolute prediction of future conditions, but comparative results. The results of these simulations, including this alternative, are compared to the no-action future demand base condition study, and the incremental changes resulting from the proposed alternative are presented.

3.3.5.1 Future Demand Statewide Operation Study Output

Monthly operational studies of SWP and CVP systems were performed with DWR's state water simulation model (DWRSIM) to evaluate the changes on SWP operation as a result of implementation of the fisheries alternative. These studies are described in section 3.2.1. Within the modeling output of the fisheries alternative, the fisheries alternative future demand condition is compared with the future demand no-action base condition. The percentage difference is shown to provide a relative scale of the magnitude of change. However, some parameters such as QWEST have small values, and a slight increase or decrease could result in a large percentage difference. The no-action future demand base condition study data found in Section 3.3.2.1 can be used as a reference to further determine the magnitude of change.

Reservoir Storage

Figure A3-25 depicts the percentage difference over the base condition for the monthly average storage of Shasta Lake (a CVP reservoir), Lake Oroville, and the SWP portion of San Luis Reservoir for the 71-year historic hydrology. The fisheries alternative is similar to the existing demand case and the future demand case. The Shasta Reservoir releases were frozen during fisheries alternative simulation to prevent changes in CVP operation, and to illustrate the changes resulting from the fisheries alternative implementation on the SWP. Shasta Reservoir was also frozen in all other DWRSIM analyses. This is depicted in Figure A3-25 by a 0.0 percent change between the fisheries alternative and the base condition. Lake Oroville monthly average storage over the 71-year record also does not change significantly. These changes represent increases from 0 to 5 percent. The largest change is an increase of 4.8 percent in July. However, since the fisheries alternative will decrease the exports from the Delta in April and May, the SWP portion of San Luis Reservoir, located downstream of the exports, will change throughout the year. Storage decreases from April through October, with the largest decrease of 30 percent in August. The greatest increase in monthly average storage occurs in early winter, peaking at an increase of 8.5 percent during January. Storage increases throughout the rest of the year, but are typically about 5 percent in February and March.

Flows Downstream of Reservoirs

The monthly percentage differences between the fisheries alternative and the base condition flows downstream of reservoirs for the 71-year historical hydrology are shown in Figure A3-26. The Feather River flow and the Sacramento River at Freeport flows follow similar trends except between March and May. Feather River flows increase or decrease less than 6.5 percent except during April through October. The highest increase of 68.9 percent occurred in the month of June. Feather River flows in February decrease approximately 6 percent. In comparing the preferred alternative to the base condition, Feather River flow patterns and Sacramento River at Freeport flow patterns are similar, but

increases and decreases are less. In the alternative, there was a deviation from the flow pattern because of reduction in Delta exports between April 15 and May 15. Under the alternative, between April 15 through May 15, SWP exports are limited to 50 percent of Vernalis flows, or 1,100 cfs, whichever is greater. In the base condition, exports are limited to 100 percent of Vernalis, or 1,500 cfs, whichever is greater. This decrease in flow causes a reduction in SWP exports and CVP exports and requires an additional release after May from upstream reservoirs to meet future demand. Sacramento River flows at Freeport fluctuate from -5.36% in July to 9% in September.

Delta Exports

Effects of the alternative are most clearly represented in the operation of Harvey O. Banks Delta Pumping Plant and Tracy Pumping Plant. The alternative allows for increasing exports at the Harvey O. Banks Pumping Plant up to 10,300 cfs. However, from April 15 to May 15 there are reductions in Delta exports at both CVP and SWP pumps. The percentage difference between the alternative and the base condition for monthly average exports for the 71-year historical hydrology is shown in Figure A3-27 for pumping at Banks Pumping Plant and at the Tracy Pumping Plant. Also shown on the figure is the Delta Export Ratio, the percentage of the Delta inflow that is exported from the Delta. Exports at the Tracy Pumping Plant decrease April and May due to the reduction in Delta exports required by the alternative. The greatest monthly average increases in Banks Pumping Plant exports are 13 and 18 percent, during October and November. SWP exports decrease from mid-January through the end of May and from early June through mid-August. However, the largest monthly average decrease of 24 percent occurs in July. The Tracy Pumping Plant exports decrease from mid-February through June, with the greatest decrease of 15 percent occurring in April and in May. This is also shown on the Delta Export Ratio plot. The Delta Export Ratio increase correlates with the increase in pumping at SWP facilities from October through February. From February to March, the Delta Export Ratio does not change between the ISDP base and cases. In April and May, the Delta Export Ratio decreases, with the greatest decrease of 17 percent occurring in April. Between June and September, the Delta Export Ratio varies from 5 to -5 percent.

Delta Inflow and Outflow

Delta inflow and outflow are changed as a result of the Alternative (Figure A3-28). Inflow is closely related to the operation of Lake Oroville, and outflow is related to amount and timing of Delta exports. Generally, impacts to Delta inflow are slight since this portion of the SWP is operated to optimize exports. As shown, there is relatively no change in Delta inflow, with the greatest decrease occurring in August at about 5 percent and the greatest increase of 9 percent occurring in September. However, Delta outflow past Chipps Island shows more of a decrease as a result of timing and increased export of water from the Delta associated with the alternative. September, October and November have the greatest increases in SWP pumping and the largest decreases in Delta outflow. The largest decrease of 9.6 percent occurs in November. Generally, Delta outflow shows a slight increase in January and February, then remains steady from March through August. More positive Delta outflow occurs from March through mid-May and from mid-August through September. From mid-June through mid-August, Delta outflows decrease due to increased Delta exports.

The X_2 position does not change significantly. The only increases in the X_2 position, just over 1 percent, occur in November, December, and July. Decreases in the X_2 position by the same amount occur in April and September.

QWEST, also related to Delta inflow, outflow, and exports, changes as a result of the alternative. The greatest negative changes in QWEST occur between October and February. The most dramatic changes are in October and December, 140 percent and 99 percent, respectively. These changes are large due to the low values of QWEST in the ISDP base study. Any small change would represent a large percentage in comparison with the base study. From February through March, the change in QWEST is small. May shows a 29 percent increase in positive QWEST flows, with a decrease of 29 and 55 percent in June and September, respectively.

C—087407

C-087407

3.3.5.2 Delta Modeling Study Output

Monthly average Delta hydrodynamic studies of the alternative were performed with DWR's Delta Simulation Model (DWRDSM) to evaluate the changes to within-Delta flows, water levels, and velocities as a result of the alternative implementation. This section compares the modeling output of the alternative future demand condition and the future demand base condition. The difference is shown to provide a relative scale of the magnitude of change. The future demand base condition data found in Section 3.3.2.2 can be used as a reference to further determine the magnitude of change. Average flow, minimum water surface elevations, and minimum and maximum velocities at nineteen locations throughout the central and southern Delta are displayed by water year type. The changes are small when comparing the alternative future demand case to the future demand base condition.

Representative Critical Year

Table A3-27 shows the difference between the future demand alternative and future demand base condition for monthly average flow, minimum water surface elevations, and minimum and maximum velocities for the representative critical year. The alternative increases monthly average channel flows in some months and decreases channel flows in others. Because this alternative does not have barriers (or other provisions) to improve water circulation, null zones continue to appear in modeling results.

in the critical year, there is little difference between the alternative and base condition. Old River reverse flow downstream of Clifton Court Forebay (7) increases in January through March, and in June, with the greatest increase of 628 cfs occurring in March. In April, May, and July, more positive flow occurs. The greatest flow, noted in April, is 227 cfs. Positive flows along Victoria Canal (8) decrease by as much as 487 cfs. San Joaquin River

flows downstream of the head of Old River (17 and 18) slightly reverse the reverse flow during the months of January and February. The difference between the alternative and the base condition is slightly under 100 cfs. From April through June, there is an increase in positive flow of a little above 50 cfs. In March and in July, there is a little above 100 cfs reduction in reverse flow. Flow into Old River (15 and 16) ranges from 50 cfs to a little above 100 cfs. The greatest reduction,132 cfs, occurs in March. Middle River flows in the south Delta (13 and 14) under the alternative are slightly increased from May through July. However, null zones and circulation problems remain approximately the same as with the base condition, since there are no barriers (or other provisions) installed to improve circulation. From January through March, the difference between the alternative and base condition is approximately a 10 cfs reduction in reverse flow. Woodward Canal (6) experiences a reduction in reverse flow ranging from 92 cfs to 393 cfs, with the greatest reduction occurring in July.

More reverse flow occurs under the alternative in Columbia Cut (2) from January through April. In Turner Cut (3) and throughout the entire period, reverse flow decreases. In the San Joaquin River (4), there is an increase in positive flow from January through June. In July, less reverse flow occurs. The greatest increase,135 cfs positive flow, occurs in March. Null zones exist in the San Joaquin River when comparing flow directions between (4) and (11). Old River (10) and (12) experiences an increase in positive flow from January through June. In July, however, null zones are evident. Positive flow in Grant Line (9) and (11) decreased by roughly 100 cfs, with the greatest reduction,192 cfs, during the month of March, with no null zones occurring in this reach.

Following the same pattern as seen in the base condition, minimum water surface elevations do not change. With no barriers operating during January through March there is no significant change between base and conditions, nor is there any improvement during irrigation season. Middle River elevations (13 and 14) either remain constant or decrease 0.1 feet. Old River elevations just upstream of Clifton Court Forebay (10 and 12), Grant Line Canal elevations (9 and 11), and Old River elevations just downstream of the head of Old River (15 and 16) all follow the same pattern.

Generally, velocities in the south Delta change very little as a result of implementation of the alternative. Typically, the change in velocity is less than 0.2 fps. The most significant change in velocity occurs in Middle River (16), with the greatest change of -0.4 fps occurring in February and March. San Joaquin River and Old River velocities remain constant.

Representative Dry Year

The average flow, minimum water surface elevations, and minimum and maximum velocities for the representative dry year are displayed in Table A3-28. The flow patterns throughout the central and southern Delta follow a pattern similar to the critical year. Reverse flows are prevalent along the path from the central Delta to the export facilities. A null zone is created in Middle River during June, July, and through the summer. Reverse flows along Old River just upstream of Clifton Court Forebay (5) increase during January, February, June and July. In March they decrease by approximately 65 cfs. In April and May they decrease by 500 and 375 cfs, respectively. San Joaquin River flows increase from January through May by an average of 68 cfs, with the greatest increase being 106 cfs. During July and through the summer, the San Joaquin River reverses near the city of Stockton (4, 17, and 18).

Minimum water surface elevations and velocities follow the same pattern as that seen during the representative critical year. Minimum water surface elevations range from 1.6 to 1.8 feet close to Clifton Court Forebay (7), and 1.5 to 3.4 feet at other locations in the southern Delta, but there is no difference in water surface elevation noted between the alternative and the base condition. The change in velocity between the alternative and the base condition is less than 0.2 fps. The most significant change in velocity occurs in reach (5), with a value of 0.4 fps.

Representative Below Normal Year

Table A3-29 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative below normal year. The flow patterns throughout the central and southern Delta follow a pattern similar to the critical year. Reverse flows are prevalent along the path from the central Delta to the export facilities. A null zone is created in Middle River during June, July, and through the summer. Reverse flows along Old River just upstream of Clifton Court Forebay (5) increase under the alternative during January, March,June, and July. In February, and April through May, they decrease. The greatest reduction, 1,148 cfs, occurs in February. The reduction in reverse flow in April and May is 537 and 400 cfs, respectively. San Joaquin River flows increase from January through May by an average of 68 cfs, with the greatest increase, 104 cfs, occurring in March. During July and through the summer, the San Joaquin River reverses near Stockton.

Minimum water surface elevations and velocities follow the same pattern as that seen during the representative critical year. The difference in water surface elevation between and base is negligible. Typically, the change in velocity between and base is less than 0.2 fps. The most significant change in velocity occurs in reach (6) and (9) with a value of 0.4 fps.

Representative Above Normal Year

Table A3-30 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative above normal year. During the representative above normal year, flows within the Delta are generally higher but follow a pattern similar to the critical year in the central Delta and along Old River. Reverse flow occurs near the export pumps, increasing during months of high exports, such as January and February. High exports also cause reverse flows to increase in July. Reverse flows along Middle River continue during June, July, and through the summer. This reversing action creates a null zone in this reach during these months. The San Joaquin River, between Stockton and the head of Old River, reverses flow during July and through the

C—087411

C-087411

summer due to low inflow conditions. From July through the summer, the majority of the San Joaquin River flow is diverted down Old River.

Throughout the southern Delta, the minimum water surface elevations decrease during the irrigation season and into the summer. As shown, the months of June and July typically have the lowest water surface elevation; the difference between the alternative and base condition was negligible. Velocities throughout the central and southern Delta remain unchanged when comparing the alternative to base conditions. The highest velocity change of 0.4 fps occurs in Old River downstream of Clifton Court Forebay and in Old River just downstream of the head of Old River. Typically, velocities are 1.7 fps or less at other locations.

Representative Wet Year

Table A3-31 shows the average flow, minimum water surface elevations, and minimum and maximum velocities for the representative wet year. Flows throughout the central and southern Delta increase as a result of higher inflows. The reverse flows that commonly occur in the representative critical year occur less frequently. Less pumping is required in wet years in February , March and April. Export losses due to reducing April 15 to May 15 exports are made up in June and July. Most channels in the southern Delta have positive downstream flow. Null zones are less prevalent, but still occur in Middle River during July and the summer. A positive downstream San Joaquin River flow also occurs at Stockton.

Water surface elevations throughout the Delta are higher than those of the drier water years. Minimum water surface elevation changes between the alternative and base condition range from -0.8 to 0.2 foot in the southern Delta. Typically, these minimum water surface elevations are much higher than those of the drier years. For example, reach (16) reaches an elevation of 12.1 feet during the month of April under the alternative; and around Clifton Court Forebay, water surface elevations range between 1.6 and 3.1 feet. Velocities are typically less than 1.7 fps under the alternative, but are greatest on Old River at head (15)

and (16). The difference in velocities between the alternative and base is as high as 0.5 fps, and as low as -0.4 fps.

Flows and water surface elevations in the south Delta will experience little change as a result of implementation of the alternative. Water surface elevation and circulation patterns are similar to the base condition with a slight reduction in flow, substantial increase in Oroville releases, and reduction in SWP exports.

3.4 Delta Modeling Studies for Endangered Species Consultation

The CVP/SWP operations and Delta modeling analyses used to analyze the potential effects of the ISDP contained herein are wholly representative of and encompass the range of reasonably foreseeable potential impacts due to ISDP operations.

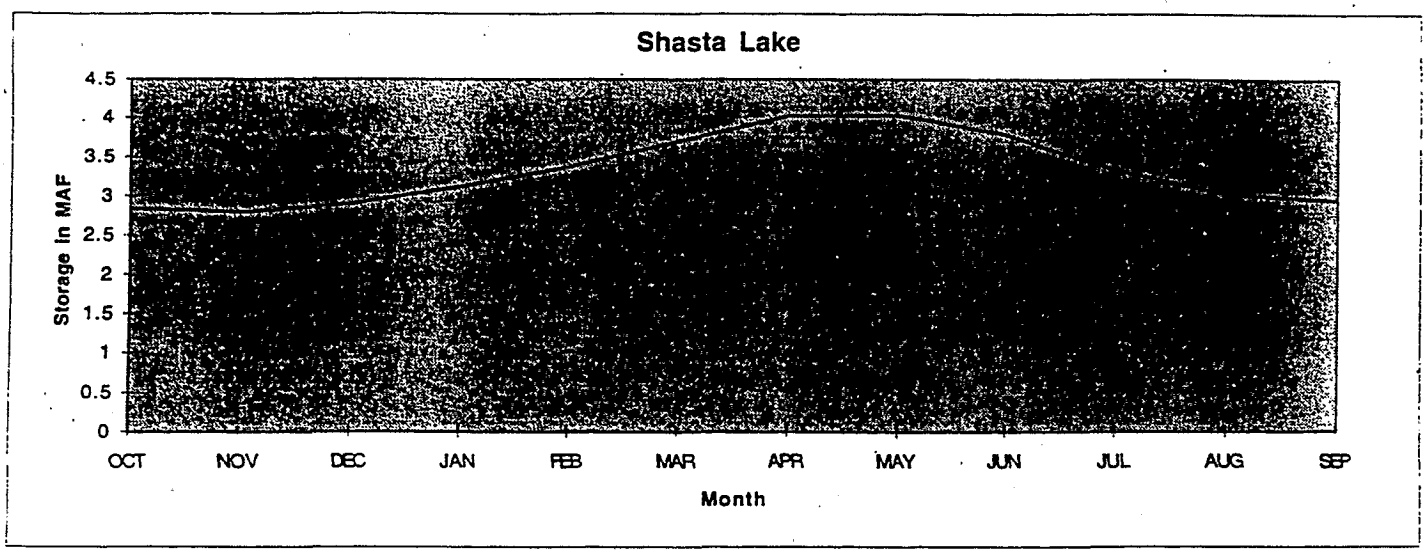
Additional Delta modeling analyses are presently being conducted to investigate the potential for modifying the presently identified operational criteria for the ISDP. These studies were reqested by regulatory agencies for formal endangered species consultation. Any further refinements of the ISDP operations will be made to reduce and minimize the potential for adverse impacts to Delta fisheries, terrestrial plant and animal species, and water quality for other Delta users.

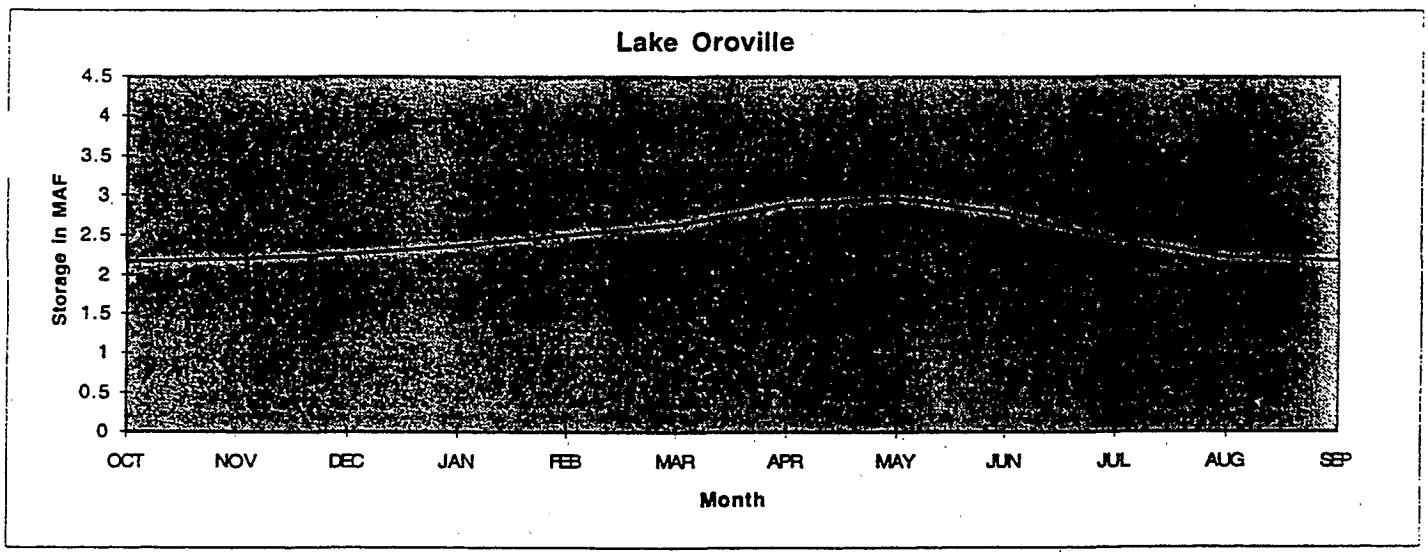
Therefore, the analyses in the EIR/EIS have been conducted with the full intent and expectation that all applicable NEPA and CEQA requirements have been complied with and that the information presented in this document provides the appropriate level of information for decision-makers and the general public to determine the full range of impacts that may be associated with ISDP.

C—087413

C-087413

Figure A3-4
Existing Demand Case - Base Condition
End of Month Storage





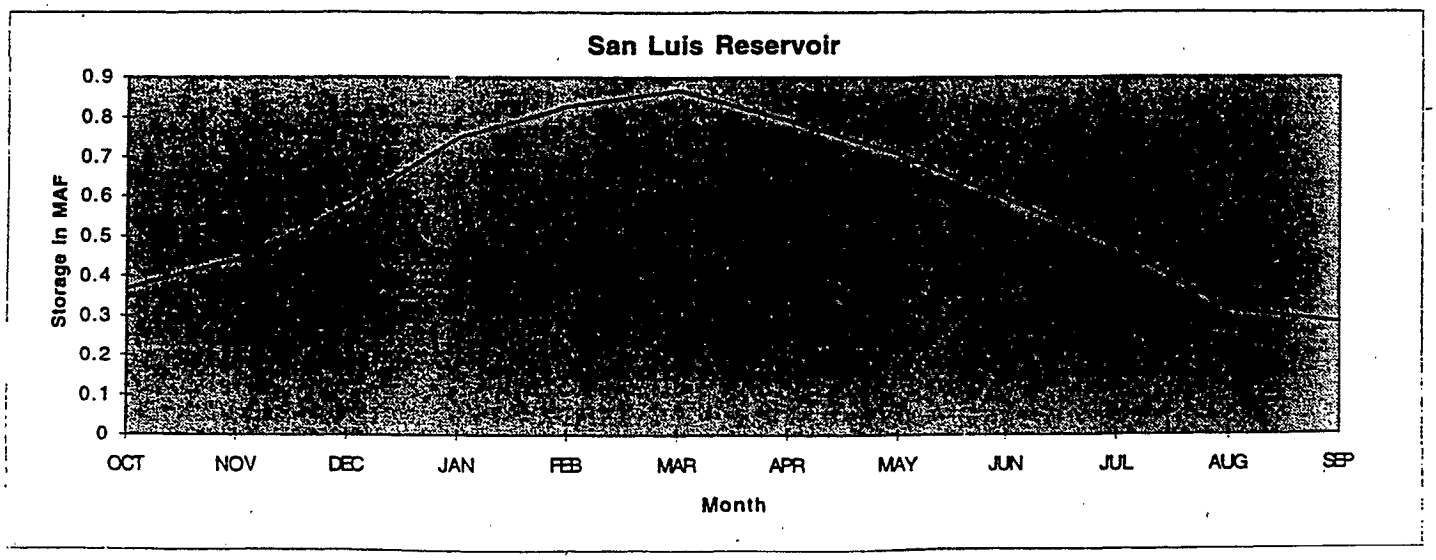
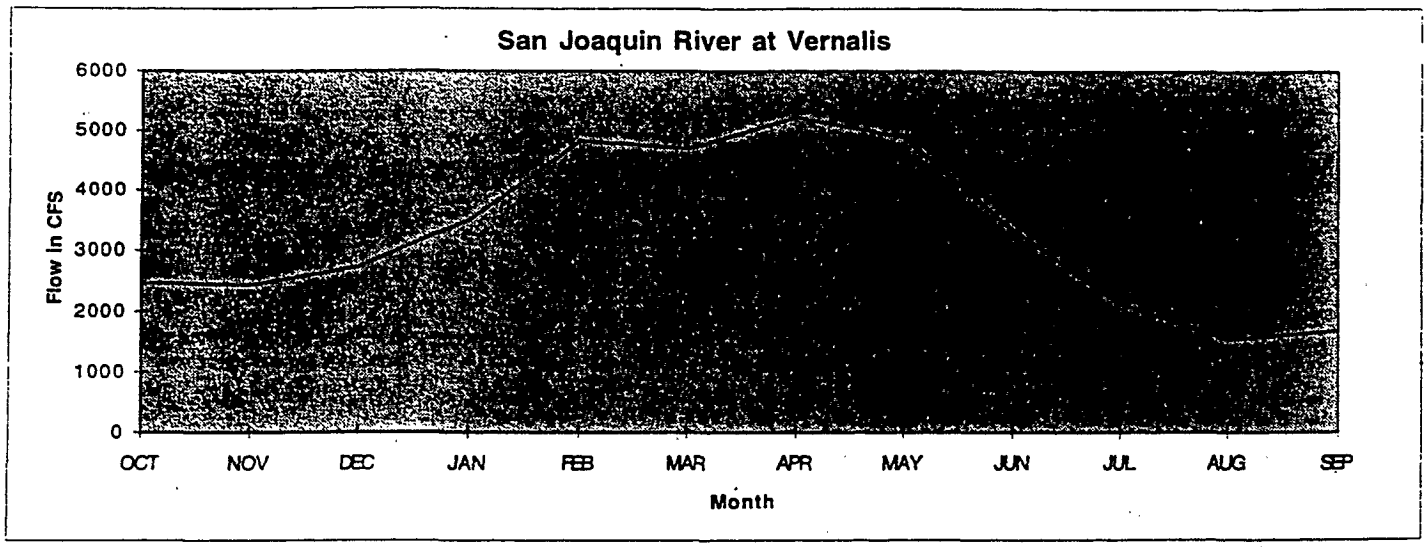
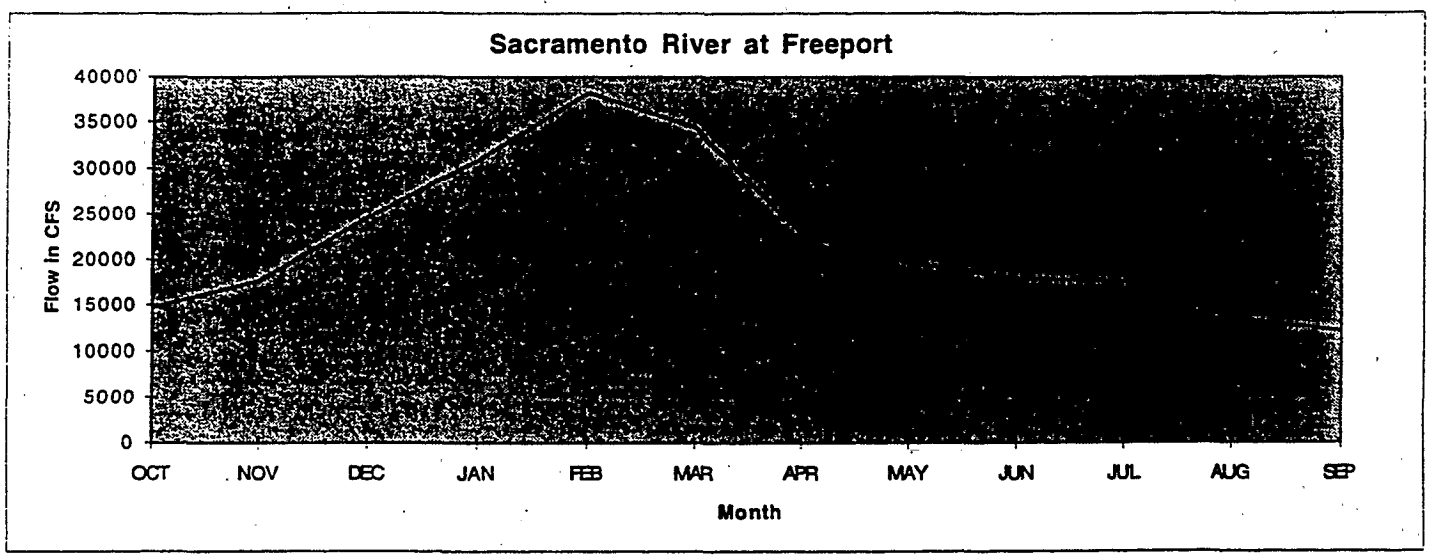


Figure A3-5
Existing Demand Case - Base Condition
River Flows





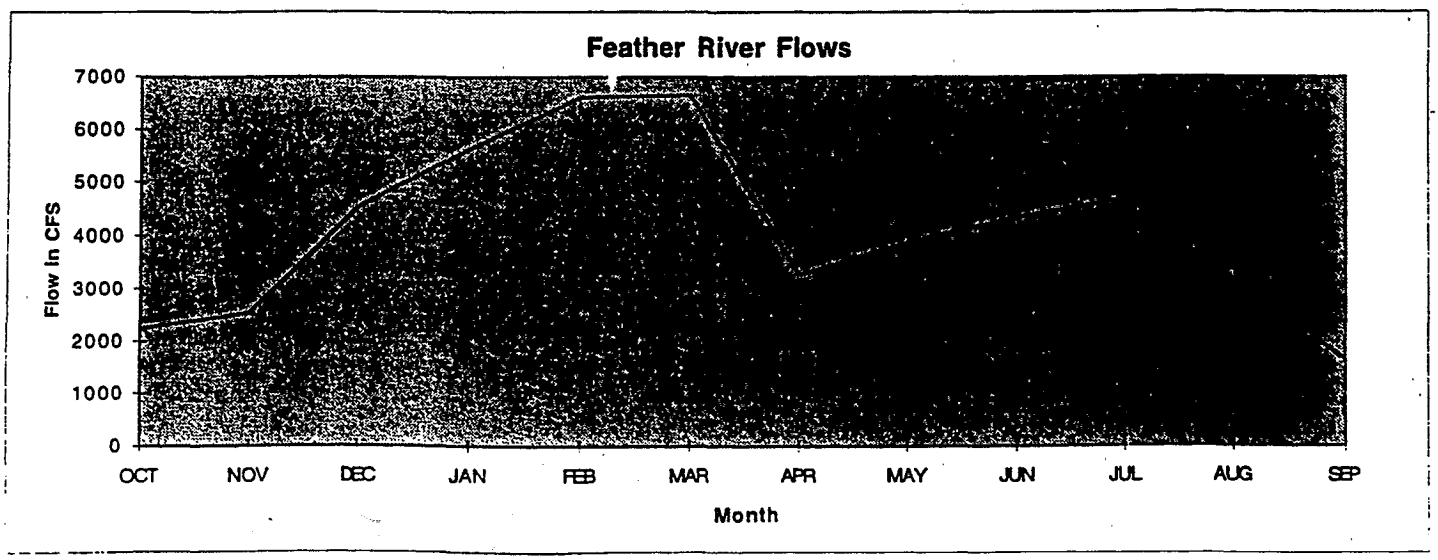
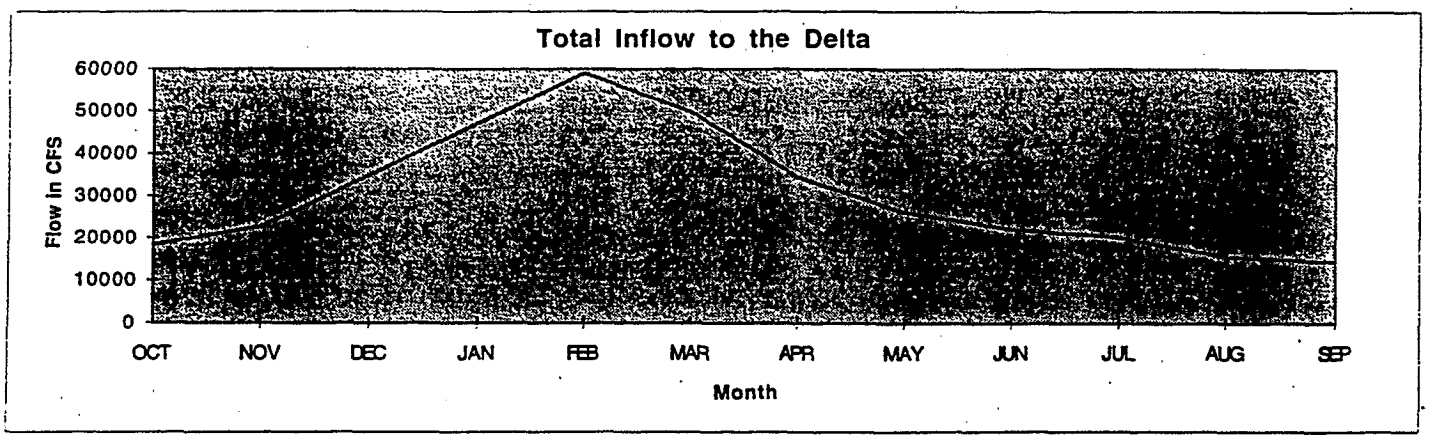
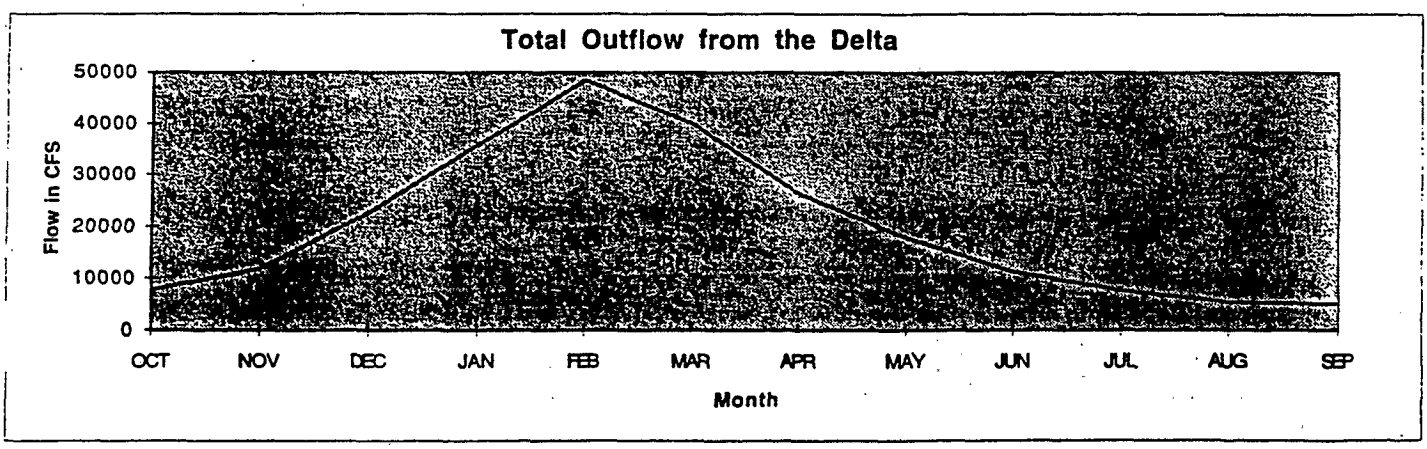
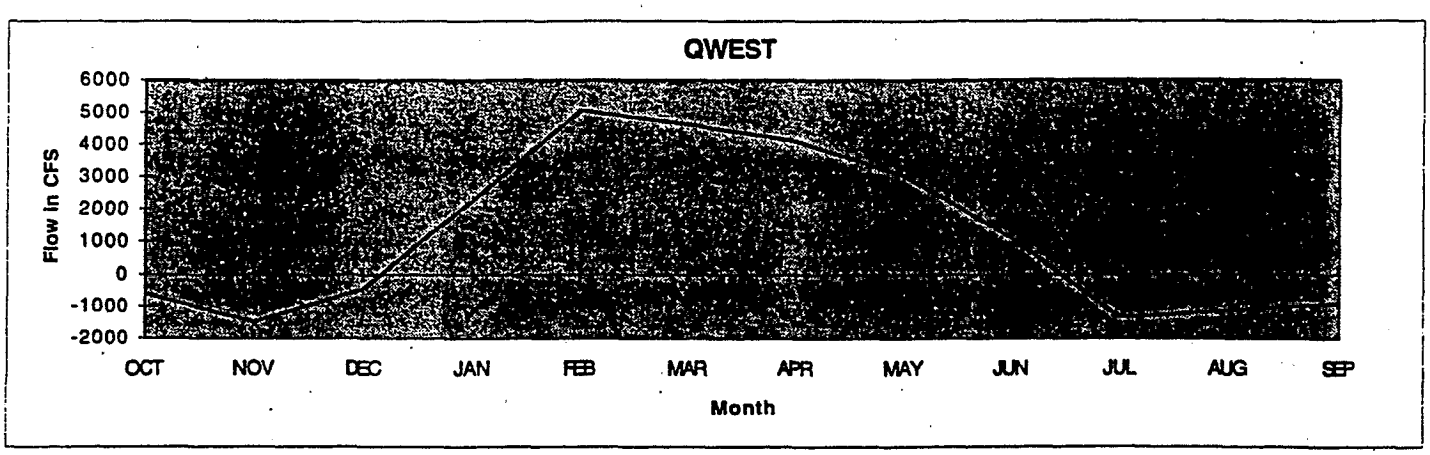


Figure A3-6
Existing Demand Case - Base Condition
Delta Exports







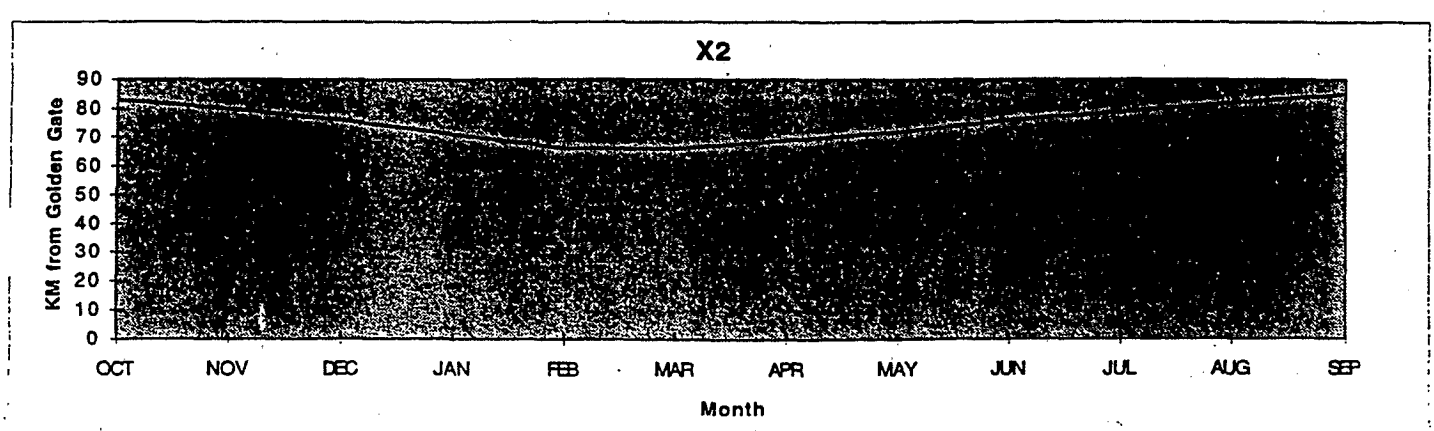
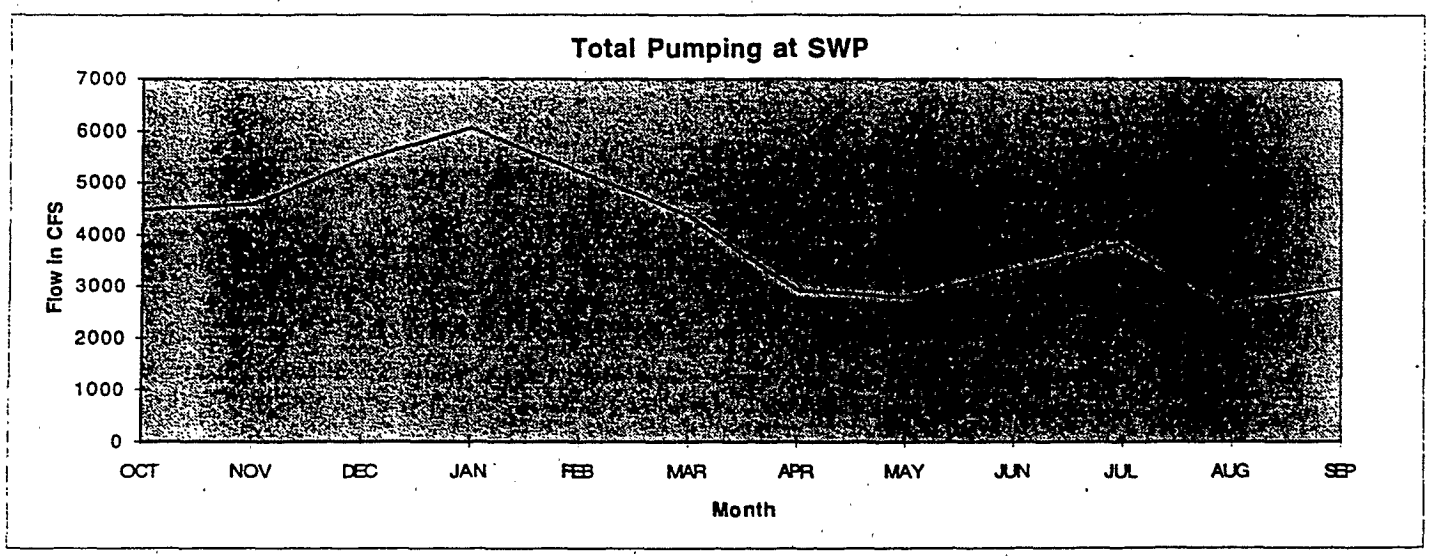
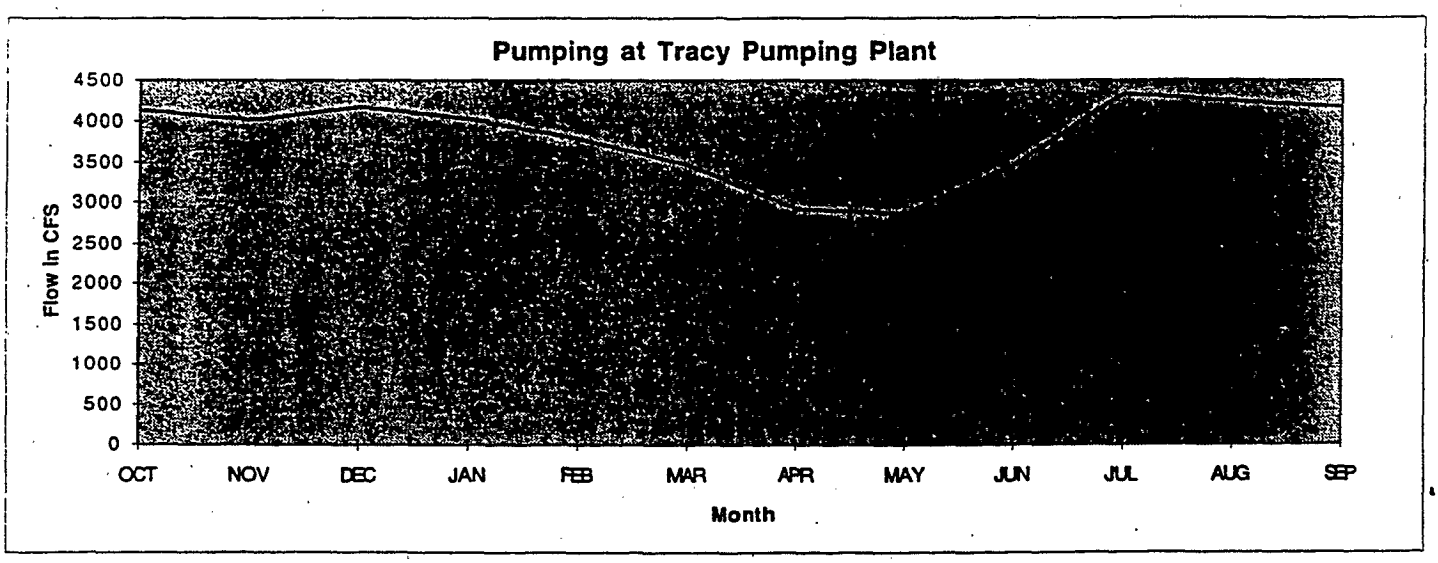


Figure A3-7
Existing Demand Case - Base Condition
Delta Inflow and Outflow





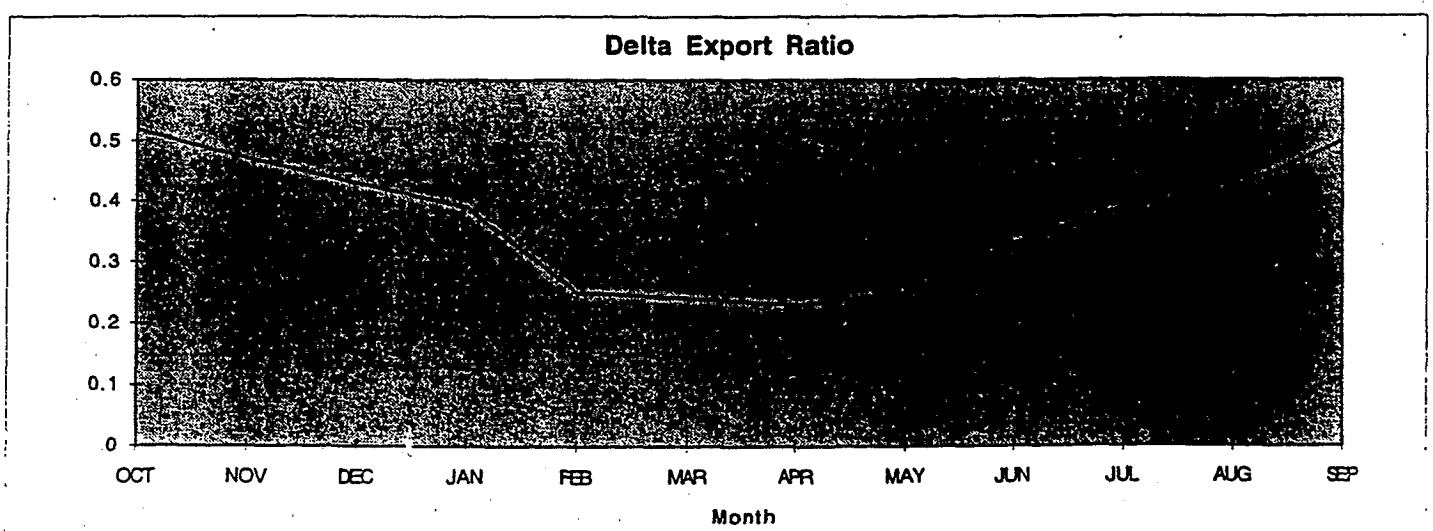
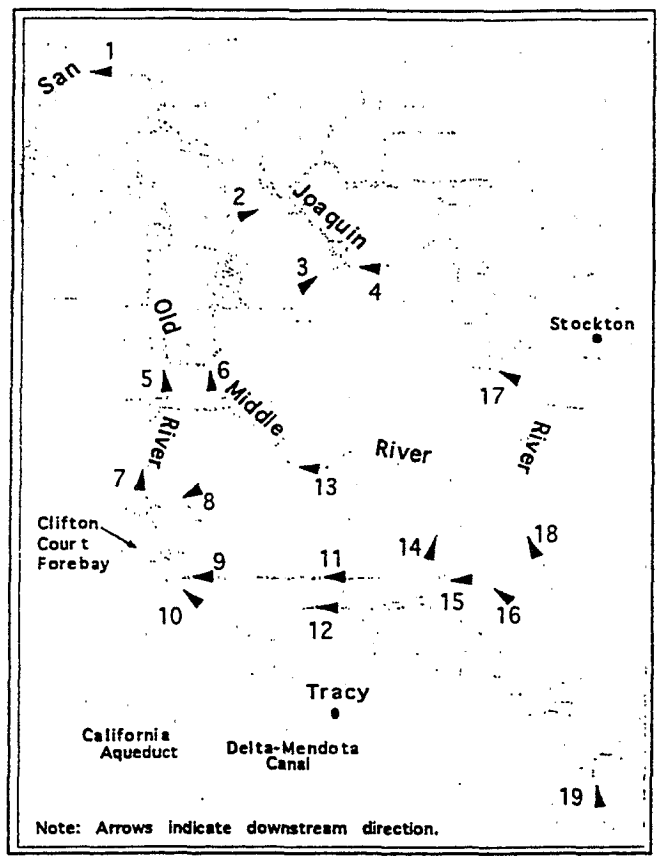


TABLE A3-2

Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Critical Year



Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-117	-2012	-1775	-2545	198	-85	1269	254	-1112
2	-351	-91	-147	-677	-186	-79	-258	-368	-337
3	-607	-554	-583	-1015	-427	-351	-391	-669	-810
4	35	11	63	171	437	407	421	111	-195
5	-3061	-3089	-3139	-5768	-1532	-1166	-1141	-2976	-4242
6	-2222	-2192	-2236	-3935	-1162	-912	-934	-2226	-3035
7	-3678	-3686	-3735	-6871	-1771	-1273	-1265	-3416	-4862
8	1688	1680	1695	3037	843	610	614	1511	2092
9	699	700	832	1117	1114	988	990	779	442
10	111	111	129	138	143	107	108	40	-16
11	702	702	839	1123	1125	1005	1008	814	482
12	121	121	143	166	214	211	212	205	160
13	-24	-24	93	-37	-5	-31	-31	-103	-136
14	-5	-5	2	-35	38	52	52	41	18
15	820	820	1005	1310	1476	1402	1406	1277	895
16	822	823	1008	1312	1480	1411	1414	1291	910
17	-42	-43	-10	-189	358	349	345	65	-223
18	-37	-37	2	-191	394	396	393	131	-154
19	791	791	1021	1153	1925	1872	1872	1519	862

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9
2	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.8	1.8
3	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7
4	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7
5	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.6
6	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.6
7	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.6	1.5
8	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.5	1.4
9	1.6	1.6	1.6	1.5	1.8	1.8	1.8	1.6	1.5
10	1.5	1.4	1.5	1.4	1.7	1.7	1.7	1.5	1.4
11	1.9	1.8	1.9	1.8	2.1	2.1	2.1	1.9	1.7
12	1.9	1.8	1.9	1.8	2.1	2.1	2.1	1.8	1.7
13	1.6	1.6	1.6	1.6	1.8	1.7	1.7	1.6	1.5
14	2.0	2.0	2.0	2.0	2.2	2.1	2.2	1.8	1.7
15	2.1	2.0	2.1	2.0	2.4	2.4	2.4	2.1	1.9
16	2.2	2.2	2.3	2.2	2.7	2.7	2.7	2.4	2.1
17	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.8	1.7
18	2.4	2.4	2.4	2.4	2.8	2.7	2.7	2.5	2.3
19	4.0	4.0	4.5	4.6	6.1	6.0	6.1	5.4	4.0

Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.4
2	0.4	-0.5	0.5	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.4	0.1	-0.3
4	0.4	-0.4	0.3	-0.4	0.3	-0.4	0.4	-0.4	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.3	-0.4
5	0.8	-1.3	0.8	-1.3	0.8	-1.3	0.6	-1.5	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	0.7	-1.3
6	0.8	-1.4	0.8	-1.3	0.8	-1.4	0.6	-1.6	0.9	-1.2	0.9	-1.1	0.9	-1.2	0.8	-1.3	0.7	-1.4
7	0.9	-2.2	0.9	-2.2	0.9	-2.2	0.7	-2.6	1.1	-1.6	1.2	-1.5	1.2	-1.6	0.9	-1.8	0.7	-2.1
8	0.9	-0.2	0.9	-0.2	0.9	-0.2	1.1	-0.1	0.9	-0.3	0.8	-0.3	0.8	-0.3	1.0	-0.2	1.1	-0.1
9	1.0	-0.7	1.0	-0.7	1.0	-0.7	0.9	-0.4	1.0	-0.8	1.0	-0.8	1.0	-0.8	1.0	-0.8	1.0	-0.9
10	0.7	-0.6	0.7	-0.6	0.7	-0.6	0.7	-0.5	0.7	-0.7	0.7	-0.8	0.7	-0.8	0.7	-0.8	0.7	-0.8
11	0.9	-0.6	0.9	-0.5	0.9	-0.5	0.8	-0.3	0.9	-0.6	0.9	-0.7	0.9	-0.7	0.9	-0.7	0.8	-0.8
12	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	0.0	0.3	-0.1	0.3	-0.1	0.3	-0.2	0.3	-0.1	0.3	-0.2
13	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.8	0.6	-0.8
14	0.4	-0.6	0.4	-0.6	0.4	-0.6	0.3	-0.7	0.4	-0.5	0.5	-0.4	0.5	-0.4	0.5	-0.5	0.4	-0.6
15	1.0	-0.1	1.0	-0.1	1.1	-0.1	1.0	0.5	1.3	0.1	1.2	0.1	1.2	0.0	1.2	0.0	1.0	-0.5
16	1.1	-0.1	1.1	-0.1	1.2	0.2	1.3	0.7	1.4	0.3	1.4	0.2	1.4	0.2	1.3	0.1	1.1	-0.4
17	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.0	-1.1	1.2	-1.0	1.2	-1.0	1.2	-1.0	1.1	-1.1	1.0	-1.2
18	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.9	-1.2	1.0	-0.8	1.0	-0.8	1.1	-0.8	1.0	-1.0	0.9	-1.2
19	0.7	0.5	0.7	0.5	0.8	0.7	0.9	0.8	1.2	1.1	1.2	1.1	1.2	1.1	1.1	0.9	0.8	0.5

TABLE A3-2 CONT.

Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct.	Nov. 1-15	Nov. 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	206	472	-971	-6	-1979	362	-180
2	-204	-214	-19	-350	-79	-70	-208
3	-450	-435	-392	-612	-557	-367	-509
4	366	212	193	81	57	69	97
5	-1852	-1787	-1810	-2940	-2971	-1472	-2303
6	-1278	-1375	-1351	-2163	-2132	-1170	-1718
7	-1939	-2124	-2130	-3508	-3516	-1621	-2681
8	918	1009	1004	1601	1594	751	1223
9	1120	840	839	835	835	347	670
10	161	123	123	131	129	-26	73
11	1134	851	851	848	848	371	685
12	202	146	146	146	145	99	147
13	-13	-18	-18	-38	-38	-67	-44
14	42	25	25	9	9	34	21
15	1443	1062	1061	1039	1038	668	953
16	1449	1066	1065	1044	1043	679	961
17	346	178	178	25	26	48	49
18	373	195	196	41	42	102	85
19	1854	1278	1278	1098	1098	859	1093

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.99	1.99	1.98	1.98	1.98	1.99	1.97
2	1.81	1.82	1.81	1.81	1.78	1.82	1.8
3	1.75	1.76	1.75	1.74	1.72	1.76	1.73
4	1.75	1.76	1.75	1.74	1.72	1.76	1.73
5	1.71	1.71	1.7	1.68	1.68	1.71	1.69
6	1.7	1.71	1.7	1.69	1.67	1.71	1.69
7	1.63	1.63	1.62	1.58	1.55	1.64	1.61
8	1.59	1.58	1.57	1.52	1.49	1.6	1.56
9	1.67	1.66	1.64	1.57	1.55	1.66	1.62
10	1.55	1.54	1.53	1.45	1.43	1.56	1.52
11	2.02	1.97	1.96	1.88	1.86	1.93	1.91
12	2.02	1.97	1.96	1.88	1.85	1.9	1.89
13	1.67	1.67	1.66	1.62	1.6	1.66	1.64
14	2.14	2.09	2.07	1.98	1.98	1.94	1.98
15	2.33	2.22	2.2	2.1	2.08	2.12	2.12
16	2.61	2.44	2.42	2.3	2.28	2.3	2.32
17	1.85	1.84	1.83	1.81	1.78	1.82	1.8
18	2.71	2.57	2.56	2.46	2.43	2.46	2.47
19	6.02	4.99	4.99	4.62	4.61	4.19	4.62

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.3
2	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3
4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.3	-0.4	0.3	-0.4	0.4	-0.4
5	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.3	0.8	-1.3	0.9	-1.1	0.8	-1.1
6	0.9	-1.2	0.9	-1.2	0.9	-1.2	0.8	-1.3	0.8	-1.3	0.9	-1.2	0.9	-1.2
7	1.1	-1.7	1.1	-1.9	1.0	-1.9	0.9	-2.2	0.9	-2.1	1.1	-1.7	1.0	-1.7
8	0.8	-0.3	0.8	-0.3	0.8	-0.3	0.9	-0.2	0.9	-0.2	0.7	-0.2	0.9	-0.2
9	1.0	-0.8	1.0	-0.7	1.0	-0.7	1.0	-0.7	1.0	-0.7	1.0	-0.9	1.0	-0.9
10	0.8	-0.7	0.8	-0.7	0.8	-0.7	0.8	-0.6	0.8	-0.8	0.7	-0.8	0.7	-0.8
11	0.9	-0.6	0.9	-0.6	0.9	-0.6	0.9	-0.5	0.9	-0.5	0.9	-0.8	0.9	-0.8
12	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	0.0	0.3	-0.3	0.3	-0.3
13	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.7
14	0.5	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.6	0.4	-0.6	0.5	-0.5	0.4	-0.6
15	1.3	0.1	1.1	0.0	1.1	0.0	1.1	0.1	1.1	0.1	1.1	-0.6	1.1	-0.5
16	1.4	0.3	1.3	0.0	1.3	0.0	1.2	0.2	1.2	0.2	1.2	-0.6	1.2	-0.4
17	1.2	-1.0	1.2	-1.1	1.1	-1.0	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.1	-1.1
18	1.0	-0.9	1.0	-1.0	1.0	-1.0	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.9	-1.0
19	1.2	1.1	1.0	0.8	1.0	0.8	0.9	0.7	0.9	0.7	0.8	0.5	0.9	0.6

TABLE A3-3

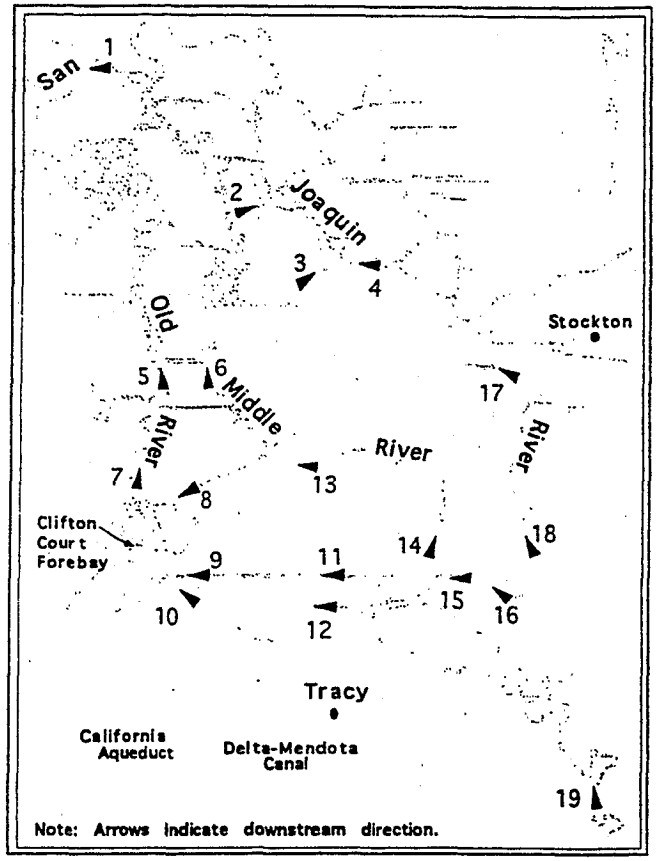
Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Dry Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	225	-143	1203	517	-109	1712	81	-2001
2	-631	-592	-803	-458	-213	-455	-354	-575
3	-745	-782	-788	-600	-469	-519	-663	-1062
4	895	892	911	1120	663	677	146	-80
5	-2895	-3118	-2945	-1676	-1509	-1475	-2966	-5829
6	-2114	-2257	-2174	-1267	-1157	-1184	-2185	-4037
7	-3518	-3762	-3573	-1962	-1671	-1659	-3359	-6729
8	1652	1740	1873	945	787	790	1464	2883
9	1879	2024	1766	1959	1396	1402	868	991
10	271	270	247	258	158	161	48	45
11	1880	2029	1771	1970	1419	1424	911	1034
12	271	286	262	321	269	272	209	206
13	28	12	18	36	21	-21	-112	-146
14	27	35	24	66	62	63	47	17
15	2165	2362	2071	2441	1906	1914	1403	1498
16	2165	2363	2072	2444	1914	1923	1417	1511
17	696	812	590	1074	635	627	115	-125
18	689	827	588	1108	885	677	184	-54
19	2863	3209	2678	3601	2674	2674	1701	1559

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	1.9
2	1.9	1.9	2.0	1.9	1.9	1.9	1.8	1.7
3	1.8	1.8	1.9	1.8	1.8	1.8	1.7	1.7
4	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.7
5	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6
6	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6
7	1.7	1.7	1.8	1.7	1.7	1.7	1.6	1.5
8	1.7	1.6	1.7	1.7	1.7	1.7	1.6	1.4
9	1.8	1.8	1.8	1.8	1.8	1.8	1.6	1.5
10	1.6	1.6	1.7	1.7	1.7	1.7	1.5	1.3
11	2.2	2.2	2.2	2.3	2.2	2.2	1.9	1.7
12	2.2	2.2	2.2	2.3	2.1	2.2	1.9	1.7
13	1.8	1.7	1.8	1.8	1.7	1.8	1.6	1.5
14	2.4	2.4	2.4	2.5	2.2	2.3	1.8	1.7
15	2.7	2.7	2.6	2.9	2.8	2.6	2.2	2.0
16	3.1	3.2	3.0	3.4	2.9	3.0	2.4	2.2
17	2.0	2.0	2.0	2.0	1.9	1.9	1.8	1.7
18	3.1	3.2	3.0	3.3	3.0	3.0	2.8	2.4
19	7.6	8.1	7.4	8.7	7.3	7.3	5.7	5.4



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.4
2	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.3	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.8	-1.3	0.8	-1.3	0.8	-1.3	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	0.5	-1.4
6	0.8	-1.4	0.8	-1.4	0.8	-1.4	0.9	-1.2	0.9	-1.1	0.9	-1.2	0.8	-1.3	0.5	-1.5
7	0.9	-2.2	0.9	-2.3	1.0	-2.3	1.1	-1.7	1.1	-1.6	1.2	-1.6	1.0	-1.9	0.6	-2.5
8	0.9	-0.2	0.9	-0.2	0.9	-0.2	0.9	-0.3	0.8	-0.3	0.8	-0.3	1.0	-0.2	1.2	-0.1
9	1.1	-0.5	1.1	-0.3	1.1	-0.4	1.1	-0.7	1.1	-0.7	1.1	-0.8	1.0	-0.9	0.9	-0.9
10	0.8	-0.5	0.8	-0.5	0.8	-0.5	0.8	-0.7	0.7	-0.7	0.7	-0.8	0.7	-0.8	0.6	-0.9
11	1.0	-0.3	1.0	-0.2	1.0	-0.3	1.0	-0.5	0.9	-0.6	0.9	-0.6	0.9	-0.7	0.8	-0.8
12	0.4	0.0	0.4	0.1	0.4	0.0	0.4	0.0	0.4	0.0	0.4	0.0	0.3	-0.1	0.3	-0.1
13	0.7	-0.7	0.7	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.8
14	0.5	-0.5	0.5	-0.5	0.6	-0.5	0.6	-0.4	0.5	-0.4	0.5	-0.4	0.5	-0.5	0.4	-0.6
15	1.5	1.0	1.6	1.1	1.5	0.9	1.7	0.8	1.5	0.5	1.5	0.5	1.2	0.0	1.1	0.1
16	1.8	1.2	1.9	1.3	1.7	1.1	2.0	1.2	1.7	0.8	1.7	0.8	1.4	0.11	1.4	0.3
17	1.3	-0.8	1.3	-0.8	1.2	-0.9	1.4	-0.6	1.2	-0.8	1.3	-0.9	1.1	-1.1	1.0	-1.1
18	1.2	-0.7	1.2	-0.6	1.1	-0.8	1.3	-0.3	1.2	-0.6	1.2	-0.7	1.0	-1.0	0.9	-1.1
19	1.6	1.5	1.7	1.6	1.5	1.4	1.8	1.7	1.5	1.4	1.5	1.4	1.2	1.0	1.1	1.0

TABLE A3-3 CONT.

Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-62	-585	-3019	423	-2246	-918	-534
2	-1092	-989	-652	-829	-459	-383	-305
3	-1184	-1098	-1041	-928	-862	-772	-645
4	1178	1002	990	730	710	-63	57
5	-4931	-4875	-4913	-4025	-4071	-3952	-3094
6	-3451	-3400	-3368	-2857	-2821	-2829	-2269
7	-5867	-5802	-5816	-4810	-4829	-4577	-3640
8	2573	2571	2565	2148	2141	2006	1641
9	2366	2338	2334	1994	1987	662	736
10	299	280	276	252	246	50	90
11	2378	2346	2341	2008	2001	689	752
12	340	298	293	267	262	168	160
13	-5	-14	-14	-20	-20	-92	-48
14	49	29	28	26	25	13	13
15	2811	2690	2678	2337	2325	1039	1017
16	2816	2690	2678	2339	2327	1049	1024
17	1088	909	924	657	668	-119	-1
18	1119	928	943	677	689	-67	30
19	3970	3637	3637	3036	3036	1053	1094

Minimum Water Surface Elevation

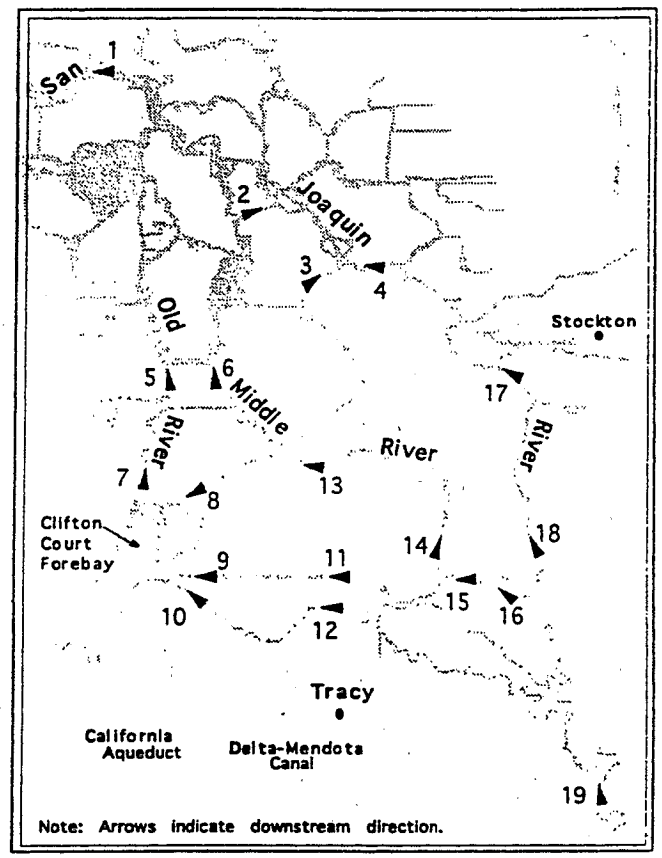
Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.95	1.95	1.92	2	1.98	1.95	1.98
2	1.79	1.8	1.76	1.84	1.8	1.77	1.78
3	1.73	1.73	1.7	1.77	1.73	1.7	1.71
4	1.73	1.74	1.7	1.77	1.73	1.7	1.72
5	1.71	1.67	1.64	1.71	1.67	1.63	1.65
6	1.71	1.68	1.64	1.72	1.68	1.64	1.66
7	1.62	1.58	1.54	1.62	1.58	1.51	1.54
8	1.56	1.52	1.49	1.56	1.52	1.44	1.47
9	1.68	1.64	1.61	1.66	1.62	1.49	1.53
10	1.51	1.47	1.44	1.51	1.47	1.37	1.4
11	2.2	2.16	2.12	2.1	2.07	1.77	1.83
12	2.2	2.16	2.13	2.11	2.08	1.73	1.81
13	1.65	1.63	1.59	1.66	1.62	1.54	1.58
14	2.44	2.4	2.38	2.31	2.27	1.79	1.92
15	2.84	2.75	2.72	2.6	2.58	1.96	2.05
16	3.44	3.29	3.26	3.04	3.01	2.16	2.25
17	1.93	1.91	1.88	1.91	1.87	1.75	1.78
18	3.4	3.27	3.24	3.05	3.02	2.34	2.42
19	9.14	8.69	8.69	7.85	7.85	4.45	4.58

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.3
2	0.3	-0.6	0.3	-0.5	0.4	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.3	0.2	-0.3
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.3	0.3	-0.4	0.4	-0.4
5	0.6	-1.3	0.7	-1.4	0.7	-1.4	0.8	-1.4	0.8	-1.4	0.7	-1.3	0.7	-1.2
6	0.5	-1.4	0.7	-1.5	0.7	-1.5	0.8	-1.5	0.8	-1.5	0.7	-1.4	0.8	-1.3
7	0.7	-2.3	0.9	-2.5	0.9	-2.5	0.9	-2.4	0.9	-2.4	0.8	-2.0	0.8	-1.9
8	1.0	-0.1	1.1	-0.2	1.0	-0.2	1.0	-0.2	1.0	-0.2	1.1	-0.1	1.0	-0.1
9	1.1	-0.7	1.2	-0.2	1.1	-0.2	1.1	-0.3	1.1	-0.3	1.0	-0.9	1.0	-0.8
10	0.8	-0.8	0.7	-0.4	0.7	-0.4	0.8	-0.4	0.8	-0.4	0.7	-0.8	0.7	-0.7
11	1.0	-0.5	1.0	0.0	1.0	0.0	1.0	-0.1	1.0	-0.1	0.9	-0.8	0.9	-0.7
12	0.5	0.0	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.3	-0.2	0.3	-0.2
13	0.7	-0.8	0.6	-0.7	0.6	-0.6	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.7
14	0.6	-0.4	0.5	-0.5	0.5	-0.5	0.5	-0.5	0.5	-0.5	0.4	-0.6	0.4	-0.6
15	1.8	1.1	1.7	1.3	1.7	1.3	1.6	1.1	1.6	1.1	1.1	-0.4	1.1	-0.3
16	2.1	1.5	2.0	1.6	2.0	1.6	1.8	1.3	1.8	1.3	1.2	-0.3	1.2	-0.3
17	1.4	-0.6	1.3	-0.7	1.3	-0.7	1.3	-0.8	1.3	-0.8	1.0	-1.1	1.1	-1.1
18	1.3	-0.3	1.3	-0.6	1.3	-0.5	1.2	-0.7	1.2	-0.7	0.9	-1.1	0.9	-1.1
19	1.9	1.8	1.8	1.7	1.8	1.7	1.6	1.6	1.6	1.6	0.9	0.6	0.9	0.7

TABLE A3-4

Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Below Normal Year



Average Net Flow

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	-1823	-964	-856	746	-236	2189	54	-2244
2	-990	-848	-449	-543	-307	-633	-387	-619
3	-1175	-1004	-751	-634	-575	-640	-698	-1117
4	1189	1107	477	1304	769	787	140	-100
5	-5445	-4349	-3477	-1607	-1968	-1923	-3170	-6282
6	-3738	-3028	-2464	-1233	-1472	-1508	-2317	-4321
7	-6520	-5217	-4138	-1879	-2224	-2208	-3603	-7273
8	2910	2348	1868	908	1025	1029	1568	3111
9	2505	2293	1553	2104	1578	1585	892	1038
10	300	283	202	265	178	183	49	51
11	2505	2297	1585	2118	1600	1606	932	1078
12	313	299	232	344	289	293	213	207
13	21	21	-25	30	-22	-21	-110	-144
14	17	21	19	78	63	64	43	10
15	2813	2603	1859	2623	2106	2118	1425	1527
16	2821	2606	1863	2629	2114	2125	1438	1539
17	1000	900	356	1225	740	730	105	-148
18	1007	905	376	1265	791	780	174	-79
19	3860	3533	2268	3947	2980	2980	1713	1560

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.1	2.0	2.1	2.0	1.9
2	1.8	1.9	1.9	1.9	1.9	1.9	1.8	1.7
3	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6
4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.6
5	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.6
6	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.6
7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.5
8	1.6	1.6	1.6	1.7	1.7	1.7	1.6	1.5
9	1.7	1.7	1.7	1.9	1.8	1.8	1.6	1.5
10	1.6	1.6	1.6	1.7	1.7	1.7	1.5	1.4
11	2.2	2.2	2.1	2.4	2.2	2.2	1.9	1.7
12	2.2	2.2	2.1	2.3	2.1	2.2	1.9	1.7
13	1.7	1.7	1.7	1.8	1.7	1.8	1.6	1.5
14	2.6	2.5	2.2	2.6	2.3	2.3	1.9	1.7
15	2.8	2.8	2.4	3.0	2.6	2.7	2.2	2.0
16	3.4	3.3	2.8	3.6	3.0	3.1	2.4	2.2
17	2.0	2.0	1.9	2.0	1.8	2.0	1.8	1.7
18	3.4	3.3	2.8	3.5	3.1	3.1	2.6	2.3
19	9.0	8.6	6.7	9.1	7.8	7.8	5.7	5.3

Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.4
2	0.4	-0.6	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.6
3	0.0	-0.4	0.1	-0.4	0.1	-0.3	0.1	-0.3	0.2	-0.3	0.2	-0.4	0.1	-0.3	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.8	-1.4	0.8	-1.4	0.8	-1.4	0.9	-1.1	0.8	-1.1	0.9	-1.1	0.8	-1.2	0.4	-1.4
6	0.8	-1.5	0.8	-1.5	0.8	-1.4	0.9	-1.2	0.9	-1.2	0.9	-1.2	0.8	-1.3	0.4	-1.5
7	0.8	-2.6	0.9	-2.4	1.0	-2.3	1.1	-1.7	1.1	-1.7	1.1	-1.7	1.0	-2.0	0.4	-2.5
8	1.1	-0.1	1.0	-0.2	1.0	-0.2	0.8	-0.3	0.9	-0.3	0.9	-0.3	1.0	-0.2	1.2	-0.1
9	1.1	-0.1	1.2	-0.2	1.1	0.4	1.2	-0.6	1.1	-0.7	1.1	-0.7	1.4	-0.9	0.9	-1.0
10	0.7	-0.4	0.8	-0.4	0.7	-0.5	0.8	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.8	0.6	-0.9
11	1.0	0.1	1.0	0.0	0.9	-0.2	1.1	-0.4	1.0	-0.5	1.0	-0.5	0.9	-0.7	0.8	-0.8
12	0.4	0.1	0.4	0.1	0.3	0.0	0.5	0.1	0.4	0.0	0.4	0.0	0.3	0.1	0.3	-0.1
13	0.6	-0.8	0.7	-0.7	0.8	-0.7	0.6	-0.7	0.8	-0.7	0.6	-0.8	0.6	-0.8	0.6	-0.8
14	0.5	-0.6	0.5	-0.5	0.5	-0.5	0.6	-0.3	0.5	-0.4	0.6	-0.4	0.5	-0.5	0.4	-0.6
15	1.8	1.4	1.7	1.3	1.3	0.8	1.8	0.9	1.5	0.7	1.5	0.6	1.2	0.0	1.1	0.1
16	2.1	1.7	2.0	1.5	1.5	1.0	2.1	1.3	1.8	1.0	1.8	1.0	1.4	0.2	1.5	0.3
17	1.4	-0.6	1.3	-0.7	1.2	-1.0	1.4	-0.5	1.3	-0.8	1.3	-0.8	1.1	-1.1	1.0	-1.2
18	1.3	-0.5	1.3	-0.6	1.1	-0.9	1.3	-0.1	1.2	-0.6	1.2	-0.6	1.0	-1.0	0.9	-1.1
19	1.8	1.8	1.7	1.7	1.4	1.3	1.9	1.8	1.8	1.5	1.6	1.5	1.2	1.0	1.1	1.0

TABLE A3-4 CONT.

Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	-1075	-1967	-2767	-215	-1590	-709
2	-841	-793	-783	-1137	-495	-346
3	-1110	-1072	-1098	-1157	-925	-698
4	588	1103	1070	1082	-192	-9
5	-5305	-4823	-5188	-5148	-5149	-3503
6	-3664	-3337	-3542	-3576	-3570	-2524
7	-6295	-5741	-6174	-6160	-5977	-4116
8	2737	2548	2734	2741	2579	1835
9	1834	2393	2393	2396	656	686
10	228	287	291	295	40	81
11	1849	2406	2395	2399	682	702
12	265	307	295	300	158	152
13	-35	-4	4	5	-109	-55
14	20	30	20	21	-4	4
15	2195	2759	2704	2716	1005	953
16	2199	2768	2703	2716	1014	960
17	489	1000	930	914	-261	-73
18	497	1018	936	921	-210	-42
19	2728	3827	3652	3652	876	957

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	1.92	1.99	1.93	1.96	1.91	1.95
2	1.75	1.83	1.77	1.81	1.75	1.78
3	1.69	1.77	1.71	1.75	1.69	1.71
4	1.69	1.77	1.72	1.75	1.69	1.71
5	1.68	1.71	1.66	1.69	1.6	1.64
6	1.67	1.71	1.66	1.7	1.62	1.65
7	1.57	1.62	1.57	1.6	1.47	1.53
8	1.51	1.56	1.51	1.55	1.4	1.46
9	1.59	1.68	1.63	1.67	1.44	1.51
10	1.45	1.51	1.46	1.5	1.32	1.39
11	1.98	2.21	2.14	2.18	1.7	1.81
12	1.98	2.21	2.13	2.16	1.67	1.78
13	1.6	1.66	1.62	1.66	1.51	1.57
14	2.15	2.48	2.43	2.46	1.72	1.89
15	2.41	2.82	2.72	2.75	1.87	2
16	2.83	3.38	3.27	3.3	2.05	2.19
17	1.82	1.95	1.89	1.93	1.73	1.77
18	2.86	3.36	3.26	3.29	2.24	2.37
19	7.38	8.95	8.71	8.72	4.04	4.3

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3
2	0.4	-0.8	0.4	-0.5	0.4	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5
3	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.2	-0.3
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.3	-0.4	0.3	-0.4
5	0.5	-1.4	0.7	-1.4	0.7	-1.4	0.7	-1.4	0.6	-1.4	0.7	-1.2
6	0.5	-1.5	0.7	-1.5	0.7	-1.5	0.7	-1.5	0.7	-1.5	0.8	-1.3
7	0.6	-2.4	0.9	-2.5	0.8	-2.5	0.8	-2.5	0.7	-2.3	0.8	-1.9
8	1.1	-0.1	1.0	-0.2	1.1	-0.2	1.1	-0.2	1.2	-0.1	1.0	-0.1
9	1.0	-0.8	1.2	-0.2	1.1	-0.2	1.1	-0.2	1.0	-1.0	1.0	-0.9
10	0.7	-0.6	0.7	-0.4	0.7	-0.4	0.7	-0.4	0.6	-0.6	0.7	-0.7
11	0.9	-0.6	1.1	0.0	1.0	0.0	1.0	0.0	0.8	-0.9	0.9	-0.8
12	0.4	0.0	0.4	0.1	0.4	0.1	0.4	0.1	0.3	-0.2	0.3	-0.2
13	0.6	-0.8	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.7
14	0.6	-0.5	0.5	-0.5	0.5	-0.5	0.5	-0.5	0.4	-0.7	0.4	-0.6
15	1.6	0.7	1.8	1.4	1.7	1.4	1.7	1.3	1.0	-0.6	1.1	-0.4
16	1.8	1.0	2.1	1.6	2.0	1.6	2.0	1.6	1.1	-0.4	1.2	-0.4
17	1.2	-0.9	1.4	-0.6	1.3	-0.7	1.4	-0.7	1.0	-1.2	1.1	-1.1
18	1.1	-0.8	1.3	-0.5	1.3	-0.5	1.3	-0.6	0.8	-1.2	0.9	-1.1
19	1.5	1.4	1.8	1.8	1.8	1.7	1.8	1.7	0.8	0.5	0.8	0.6

TABLE A3-5

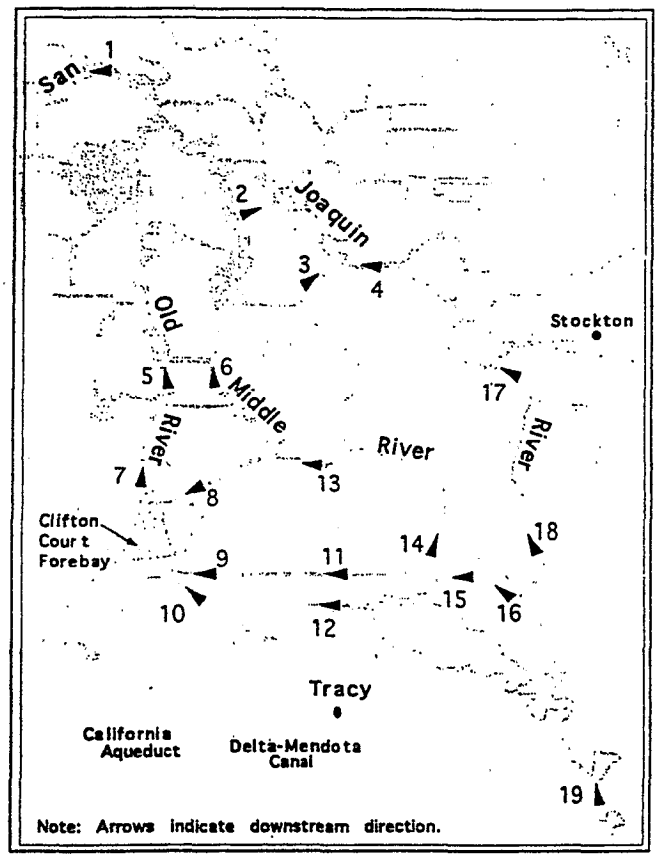
Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Above Normal Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-915	-3553	-326	1510	647	446	2812	144	-1977
2	-873	-506	-809	-812	-592	-573	-895	-508	-658
3	-1061	-997	-989	-844	-695	-695	-757	-784	-1129
4	485	462	852	697	1284	1252	1269	140	-98
5	-5397	-5439	-4414	-3364	-1981	-2000	-1956	-3646	-6302
6	-3707	-3673	-3090	-2460	-1481	-1502	-1538	-2629	-4346
7	-6458	-6475	-5312	-4053	-2341	-2309	-2292	-4175	-7294
8	2856	2849	2385	1860	1117	1092	1096	1813	3120
9	1865	1861	2076	1575	2151	2061	2066	920	1033
10	233	228	260	218	275	259	264	48	47
11	1867	1863	2081	1581	2182	2073	2078	960	1075
12	236	232	277	238	341	336	342	216	208
13	-19	-19	4	-11	44	29	30	-109	-149
14	-5	-5	15	16	58	69	70	37	12
15	2091	2083	2388	1862	2834	2589	2601	1455	1537
16	2091	2083	2373	1864	2640	2592	2603	1468	1550
17	338	346	666	357	1205	1157	1146	70	-148
18	340	348	672	372	1236	1198	1188	139	-78
19	2439	2439	3069	2254	3922	3851	3851	1710	1574

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	1.9	1.9	2.1	2.2	2.1	2.1	2.1	2.0	1.9
2	1.8	1.8	1.9	2.0	1.9	1.9	1.9	1.8	1.7
3	1.7	1.7	1.9	1.9	1.8	1.8	1.9	1.8	1.7
4	1.7	1.7	1.9	1.9	1.8	1.8	1.9	1.8	1.7
5	1.7	1.6	1.8	1.9	1.8	1.8	1.8	1.7	1.6
6	1.7	1.6	1.8	1.9	1.8	1.8	1.8	1.7	1.6
7	1.6	1.5	1.7	1.8	1.7	1.7	1.8	1.6	1.5
8	1.5	1.5	1.7	1.8	1.7	1.7	1.7	1.5	1.5
9	1.6	1.6	1.8	1.8	1.9	1.8	1.9	1.6	1.5
10	1.5	1.4	1.6	1.7	1.7	1.7	1.7	1.5	1.4
11	2.0	1.9	2.2	2.2	2.4	2.3	2.3	1.9	1.7
12	2.0	1.9	2.2	2.2	2.3	2.3	2.3	1.8	1.7
13	1.6	1.6	1.8	1.8	1.8	1.8	1.8	1.6	1.5
14	2.2	2.2	2.5	2.4	2.6	2.6	2.6	1.8	1.7
15	2.4	2.3	2.7	2.5	3.0	2.9	3.0	2.1	2.0
16	2.7	2.7	3.1	2.9	3.6	3.5	3.5	2.4	2.2
17	1.8	1.8	2.0	2.0	2.0	2.0	2.0	1.8	1.7
18	2.8	2.8	3.2	2.9	3.5	3.4	3.4	2.5	2.3
19	6.9	6.9	7.9	6.7	9.1	9.0	9.0	5.7	5.4



Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.4
2	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.6
3	0.1	-0.4	0.1	-0.3	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.3	0.1	-0.4
4	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.7	-1.5	0.7	-1.5	0.7	-1.4	0.8	-1.4	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.7	-1.2	0.4	-1.4
6	0.7	-1.5	0.7	-1.5	0.8	-1.5	0.8	-1.5	0.9	-1.2	0.9	-1.1	0.9	-1.2	0.8	-1.3	0.3	-1.5
7	0.8	-2.6	0.8	-2.6	0.9	-2.5	1.0	-2.4	1.1	-1.8	1.1	-1.8	1.1	-1.8	0.9	-2.1	0.4	-2.5
8	1.1	-0.1	1.1	-0.1	1.0	-0.2	1.0	-0.2	0.9	-0.3	0.9	-0.3	0.9	-0.3	1.0	-0.2	1.2	-0.1
9	1.1	-0.3	1.0	-0.3	1.1	-0.2	1.0	-0.4	1.2	-0.7	1.2	-0.6	1.2	-0.6	1.0	-0.9	0.9	-1.0
10	0.7	-0.4	0.7	-0.4	0.7	-0.4	0.7	-0.5	0.8	-0.7	0.8	-0.7	0.8	-0.7	0.7	-0.8	0.6	-0.9
11	0.9	-0.1	0.9	-0.1	1.0	-0.1	0.9	-0.2	1.1	-0.4	1.0	-0.4	1.1	-0.5	0.9	-0.7	0.8	-0.8
12	0.3	0.1	0.3	0.1	0.4	0.1	0.3	0.0	0.5	0.1	0.4	0.1	0.5	0.1	0.3	-0.1	0.4	-0.1
13	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.6	-0.7	0.7	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.8
14	0.4	-0.6	0.4	-0.6	0.5	-0.6	0.4	-0.6	0.6	-0.4	0.6	-0.4	0.6	-0.4	0.5	-0.5	0.4	-0.6
15	1.4	-1.0	1.4	1.0	1.6	1.1	1.3	0.8	1.8	0.9	1.8	0.9	1.8	0.9	1.2	0.1	1.1	0.1
16	1.7	1.2	1.7	1.2	1.8	1.3	1.5	0.9	2.1	1.3	2.1	1.3	2.1	1.3	1.4	0.2	1.5	0.3
17	1.2	-1.0	1.2	-0.9	1.3	-0.8	1.2	-1.0	1.4	-0.5	1.4	-0.6	1.4	-0.6	1.1	-1.1	1.0	-1.2
18	1.1	-0.9	1.1	-0.9	1.2	-0.7	1.1	-0.9	1.3	-0.2	1.3	-0.2	1.3	-0.3	1.0	-1.0	0.9	-1.1
19	1.4	1.4	1.4	1.4	1.6	1.6	1.4	1.3	1.8	1.8	1.8	1.8	1.8	1.8	1.2	1.0	1.1	1.0

TABLE A3-5 CONT.

Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	966	-1186	-3943	-185	-2277	-1749	-680
2	-1227	-725	-343	-491	-201	-579	-347
3	-1211	-1006	-938	-729	-674	-1009	-689
4	1195	262	236	287	266	-148	39
5	-4905	-5258	-5300	-3442	-3476	-5613	-3398
6	-3467	-3627	-3590	-2469	-2439	-3877	-2456
7	-5867	-6245	-6261	-4098	-4111	-6527	-3992
8	2585	2742	2734	1845	1838	2821	1786
9	2340	1625	1622	1362	1359	840	778
10	301	200	195	190	187	57	99
11	2354	1638	1635	1376	1373	867	792
12	339	216	212	207	204	175	163
13	0	-46	-46	-34	-34	-109	-48
14	-46	-2	-3	15	15	-4	7
15	2781	1887	1880	1637	1631	1206	1048
16	2788	1890	1883	1641	1636	1215	1054
17	1053	193	199	228	233	-221	-24
18	1081	210	216	246	251	-170	5
19	3909	2119	2119	1904	1904	1118	1096

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	2	1.94	1.9	1.98	1.95	1.9	1.95
2	1.84	1.78	1.74	1.8	1.78	1.74	1.78
3	1.78	1.72	1.67	1.74	1.71	1.68	1.71
4	1.78	1.72	1.68	1.74	1.71	1.68	1.71
5	1.76	1.65	1.61	1.69	1.66	1.61	1.65
6	1.76	1.66	1.61	1.69	1.66	1.62	1.65
7	1.67	1.54	1.5	1.59	1.56	1.48	1.53
8	1.61	1.48	1.44	1.53	1.51	1.41	1.47
9	1.72	1.55	1.51	1.61	1.58	1.45	1.52
10	1.56	1.42	1.37	1.48	1.45	1.33	1.4
11	2.24	1.92	1.87	1.96	1.93	1.72	1.82
12	2.24	1.92	1.88	1.96	1.94	1.68	1.8
13	1.7	1.59	1.55	1.63	1.61	1.52	1.57
14	2.48	2.08	2.04	2.09	2.07	1.74	1.92
15	2.86	2.26	2.22	2.27	2.25	1.91	2.04
16	3.44	2.57	2.53	2.56	2.53	2.11	2.24
17	1.97	1.81	1.77	1.83	1.8	1.73	1.77
18	3.41	2.66	2.62	2.66	2.63	2.28	2.41
19	9.06	6.4	6.39	6.07	6.06	4.52	4.58

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3
2	0.3	-0.6	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.1	-0.4	0.1	-0.4	0.1	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.4	0.2	-0.3
4	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.3	-0.4	0.4	-0.4
5	0.6	-1.3	0.7	-1.5	0.7	-1.4	0.8	-1.4	0.8	-1.3	0.6	-1.4	0.7	-1.2
6	0.5	-1.5	0.7	-1.5	0.7	-1.5	0.8	-1.4	0.8	-1.4	0.6	-1.5	0.8	-1.3
7	0.7	-2.3	0.8	-2.6	0.8	-2.5	0.9	-2.3	0.9	-2.3	0.6	-2.4	0.8	-1.8
8	1.0	-0.1	1.1	-0.1	1.1	-0.1	1.0	-0.2	1.0	-0.2	1.2	-0.1	1.0	0.1
9	1.1	-0.7	1.0	-0.3	1.0	-0.3	1.1	-0.5	1.1	-0.5	0.9	-1.0	1.0	-0.8
10	0.8	-0.6	0.7	-0.4	0.7	-0.4	0.8	-0.5	0.7	-0.5	0.6	-0.8	0.7	-0.7
11	1.0	-0.5	0.9	-0.2	0.9	-0.1	0.9	-0.4	0.9	-0.4	0.8	-0.8	0.9	-0.7
12	0.5	0.0	0.3	0.1	0.3	0.1	0.3	0.0	0.3	0.0	0.3	-0.2	0.3	-0.2
13	0.7	-0.8	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.7
14	0.6	-0.4	0.4	-0.6	0.4	-0.6	0.4	-0.6	0.4	-0.5	0.4	-0.6	0.4	-0.6
15	1.8	1.0	1.3	0.9	1.3	0.9	1.3	0.7	1.3	0.7	1.0	-0.3	1.1	-0.3
16	2.1	1.5	1.6	1.0	1.6	1.1	1.4	0.8	1.4	0.8	1.3	-0.3	1.2	-0.3
17	1.4	-0.7	1.1	-1.0	1.1	-1.0	1.1	-1.0	1.1	-1.0	1.0	-1.2	1.1	1.1
18	1.3	-0.4	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	-0.9	0.9	-1.2	0.9	1.1
19	1.8	1.8	1.3	1.2	1.3	1.2	1.2	1.1	1.2	1.2	0.9	0.7	0.9	0.7

TABLE A3-6

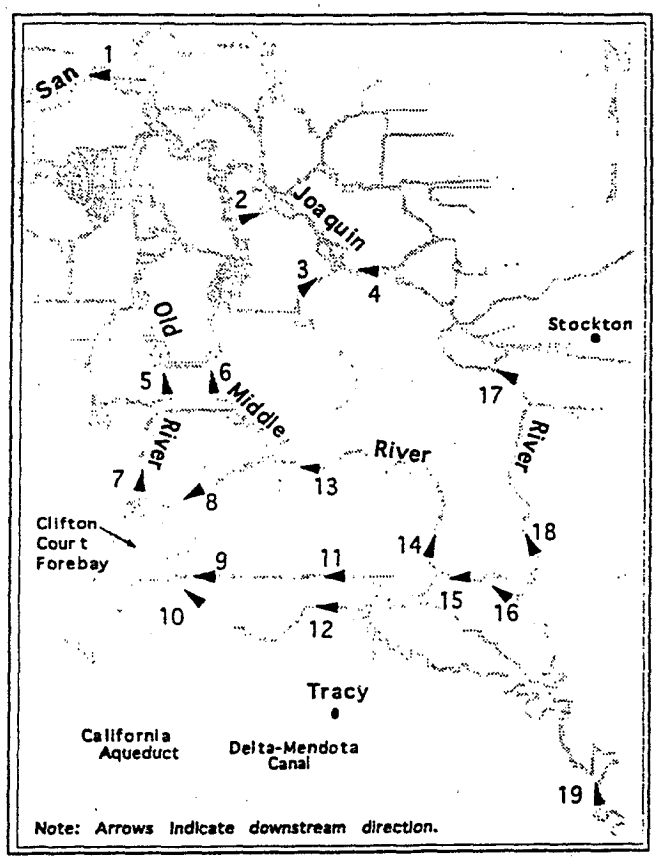
Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	6290	7724	14415	24701	11431	2568	597
2	-2414	-2905	-3681	-5581	-3458	-1792	-1022
3	-1477	-1692	-1541	-2073	-1654	-1421	-1082
4	2261	3302	6054	10471	7573	2697	1419
5	-5036	-4941	-84	3367	805	-4401	-3805
6	-3769	-3792	-617	1503	115	-3201	-2783
7	-6349	-6122	-574	3282	677	-5184	-4384
8	2936	2873	596	-1029	13	2266	1921
9	2337	3392	6476	10713	8924	3638	2287
10	347	459	1168	2235	1614	392	209
11	2331	3399	6482	10757	8973	3681	2325
12	307	477	1145	2294	1751	568	376
13	36	80	407	817	542	12	-70
14	6	75	371	823	619	156	87
15	2582	3941	7010	13869	11451	4629	3009
16	2584	3962	7968	13976	11646	4665	3021
17	742	1942	4724	8651	6933	2409	1268
18	718	1950	4795	9027	7245	2499	1345
19	3309	5976	12888	23235	19046	7340	4478

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	2.4	2.5	2.6	3.1	2.4	2.0	2.0
2	2.3	2.3	2.5	3.0	2.3	1.9	1.8
3	2.2	2.3	2.5	3.0	2.2	1.8	1.8
4	2.2	2.3	2.5	3.0	2.2	1.8	1.8
5	2.1	2.2	2.4	3.0	2.2	1.8	1.7
6	2.2	2.3	2.4	2.9	2.2	1.8	1.7
7	2.1	2.2	2.4	3.1	2.3	1.8	1.6
8	2.0	2.1	2.4	3.3	2.4	1.7	1.5
9	2.1	2.2	2.9	4.2	3.2	1.9	1.7
10	2.0	2.0	2.5	3.7	2.7	1.7	1.5
11	2.5	2.9	4.2	6.3	5.1	2.7	2.2
12	2.5	2.8	4.2	6.2	5.0	2.6	2.2
13	2.1	2.2	2.5	3.2	2.4	1.8	1.6
14	2.8	3.3	5.2	7.9	6.5	3.0	2.3
15	3.0	3.8	6.5	10.0	8.4	4.0	3.0
16	3.4	4.7	8.2	12.6	10.7	5.1	3.6
17	2.4	2.6	3.3	4.8	3.8	2.2	2.0
18	3.5	4.5	7.5	11.4	9.8	4.8	3.6
19	8.3	11.6	17.8	24.7	22.1	12.9	9.8



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.25	-1.3	1.26	-1.28	1.34	-1.21	1.4	-1.06	1.33	-1.24	1.24	-1.31	1.21	-1.33
2	0.23	-0.64	0.17	-0.68	0.03	-0.58	-0.17	-0.81	0.11	-0.72	0.29	-0.65	0.31	-0.55
3	0	-0.42	-0.02	-0.47	0.01	-0.48	0.01	-0.53	0.06	-0.46	0.04	-0.43	0.08	-0.39
4	0.42	-0.3	0.48	-0.26	0.57	-0.14	0.69	0.05	0.6	-0.08	0.46	-0.28	0.44	-0.32
5	0.83	-1.44	0.58	-1.42	0.97	-1.1	1.12	-0.79	0.92	-0.95	0.45	-1.33	0.73	-1.27
6	0.59	-1.54	0.52	-1.53	0.94	-1.23	1.04	-1.02	0.85	-1.07	0.38	-1.41	0.74	-1.4
7	0.75	-2.57	0.74	-2.49	1.33	-1.83	1.76	-0.99	1.45	-1.43	0.69	-2.28	0.87	-2.09
8	1.1	-0.13	1.07	-0.15	0.75	-0.34	0.43	-0.6	0.61	-0.48	0.95	-0.21	1.02	-0.16
9	1.08	-0.19	1.21	0.04	1.76	0.64	2.28	1.22	2.1	0.98	1.34	-0.32	1.2	-0.68
10	0.71	-0.41	0.78	-0.38	1.1	-0.02	1.46	0.21	1.33	0.07	0.94	-0.64	0.73	-0.77
11	0.98	0	1.15	0.25	1.68	0.87	2.19	1.49	2.02	1.22	1.26	-0.09	1.09	-0.44
12	0.4	0.1	0.56	0.2	0.94	0.61	1.42	1.12	1.26	0.89	0.67	0.21	0.5	0.08
13	0.6	-0.81	0.6	-0.59	0.73	-0.58	0.99	-0.57	0.86	-0.51	0.71	-0.69	0.61	-0.79
14	0.47	-0.63	0.7	-0.5	1.25	0.84	1.93	1.75	1.7	1.49	0.88	0.19	0.69	-0.33
15	1.59	1.2	2.27	1.83	3.64	3.24	5.08	4.78	4.61	4.27	2.63	1.84	1.95	1.18
16	1.94	1.44	2.67	2.26	4.24	3.89	5.87	5.63	5.3	5.04	3.07	2.39	2.26	1.84
17	1.27	-0.85	1.61	-0.08	2.63	1.49	3.88	3	3.44	2.48	1.84	0.32	1.42	-0.49
18	1.2	-0.76	1.61	0.41	2.53	2.08	3.54	3.31	3.18	2.81	1.82	1.02	1.4	-0.08
19	1.67	1.62	2.3	2.27	3.39	3.37	4.53	4.52	4.11	4.1	2.56	2.54	1.99	1.94

TABLE A3-6 CONT.

Existing Demand Case Study (Run 420)
Base Condition Without ISDP
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	-892	-2324	2007	-393	1573
2	-476	-593	-1216	-643	-1434
3	-824	-1006	-1188	-904	-1274
4	92	204	482	470	1722
5	-4179	-5482	-5565	-4006	-4665
6	-2920	-3766	-3995	-2868	-3327
7	-4964	-6510	-6667	-4656	-5596
8	2174	2868	3004	2043	2487
9	1135	1400	1395	1435	2860
10	158	186	195	140	374
11	1148	1409	1410	1463	2873
12	179	191	209	259	419
13	-41	-47	-48	-69	38
14	1	-17	-19	35	74
15	1371	1603	1622	1927	3406
16	1375	1606	1627	1936	3420
17	36	-4	-27	341	1615
18	54	6	-20	395	1646
19	1448	1625	1622	2409	5123

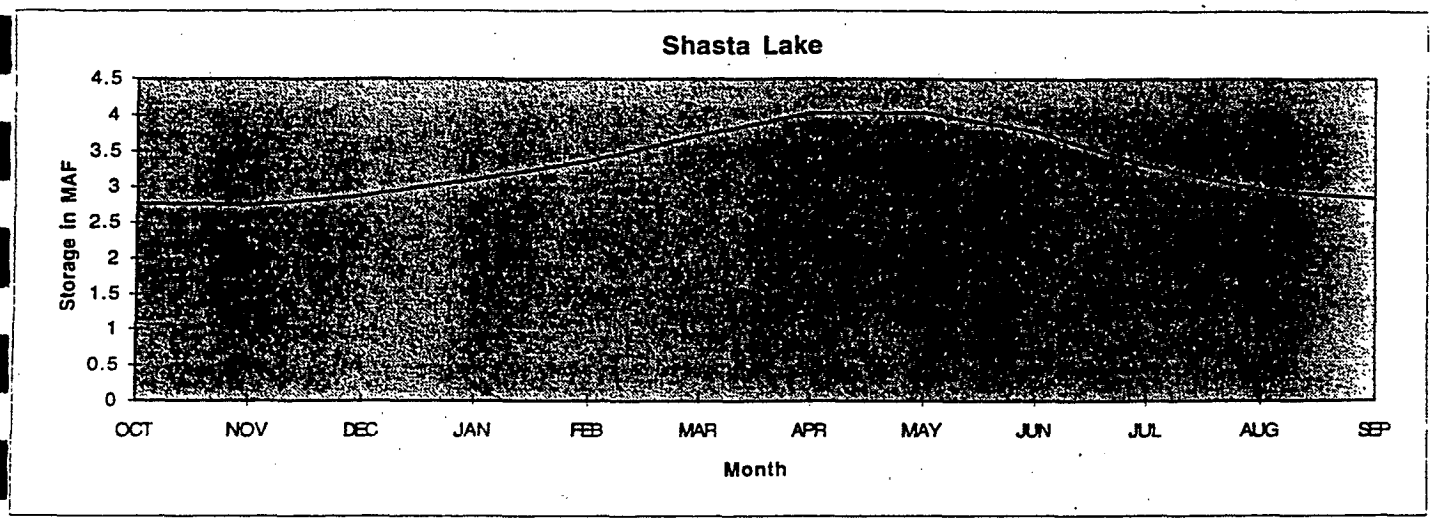
Minimum Water Surface Elevation

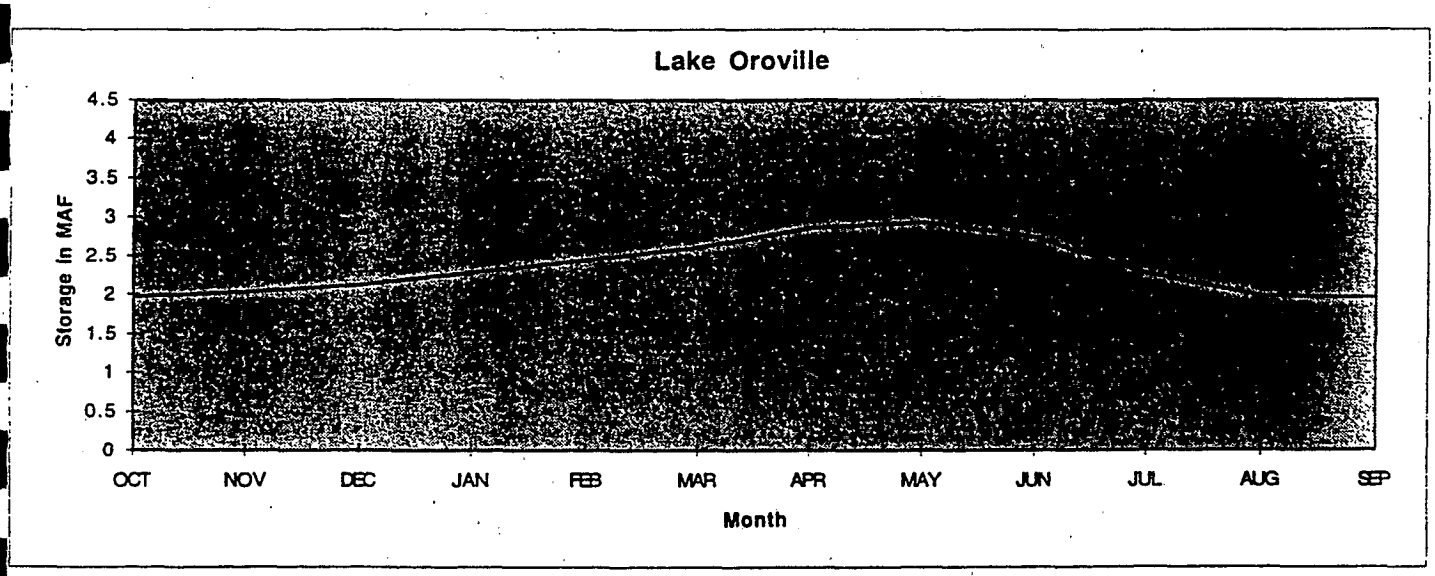
Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	1.94	2	2.31	1.96	2.02
2	1.78	1.85	2.18	1.79	1.86
3	1.71	1.79	2.12	1.72	1.8
4	1.72	1.79	2.12	1.73	1.8
5	1.64	1.72	2.04	1.65	1.78
6	1.65	1.73	2.05	1.66	1.77
7	1.53	1.61	1.93	1.53	1.69
8	1.46	1.55	1.88	1.47	1.63
9	1.53	1.6	1.92	1.54	1.78
10	1.4	1.48	1.81	1.4	1.59
11	1.86	1.92	2.2	1.92	2.42
12	1.86	1.92	2.18	1.89	2.41
13	1.58	1.65	1.98	1.57	1.73
14	1.99	2.06	2.31	2	2.77
15	2.12	2.18	2.43	2.3	3.27
16	2.35	2.42	2.67	2.66	4.04
17	1.79	1.86	2.18	1.83	2.07
18	2.49	2.54	2.8	2.75	3.93
19	5.25	5.55	5.63	6.87	10.57

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec.		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3
2	0.4	-0.5	0.4	-0.5	0.4	-0.6	0.4	-0.5	0.3	-0.6
3	0.1	-0.3	0.1	-0.3	0.0	-0.4	0.1	-0.4	0.0	-0.4
4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.3
5	0.7	-1.3	0.7	-1.5	0.6	-1.5	0.7	-1.3	0.6	-1.3
6	0.7	-1.4	0.7	-1.5	0.6	-1.6	0.7	-1.4	0.6	-1.4
7	0.8	-2.2	0.7	-2.6	0.7	-2.6	0.8	-2.1	0.7	-2.3
8	1.1	-0.1	1.1	-0.1	1.1	-0.1	1.1	-0.1	1.0	-0.2
9	1.0	-0.9	1.0	-0.4	0.9	-0.4	1.1	-0.8	1.2	-0.6
10	0.7	-0.8	0.7	-0.4	0.7	-0.5	0.7	-0.8	0.8	-0.8
11	0.9	-0.7	0.9	-0.2	0.8	-0.2	1.0	-0.6	1.1	-0.4
12	0.3	-0.1	0.3	0.0	0.3	0.0	0.4	0.0	0.5	0.1
13	0.6	-0.8	0.6	-0.7	0.5	-0.7	0.6	-0.8	0.7	-0.8
14	0.4	-0.6	0.3	-0.7	0.4	-0.7	0.5	-0.5	0.6	-0.4
15	1.2	-0.1	1.2	0.7	1.1	0.7	1.4	0.6	2.1	1.3
16	1.3	0.0	1.4	0.8	1.5	0.8	1.6	0.9	2.5	1.8
17	1.1	-1.1	1.1	-1.1	1.0	-1.1	1.2	-1.0	1.6	-0.3
18	0.9	-1.0	0.9	-1.1	0.9	-1.1	1.1	-0.8	1.5	0.2
19	1.1	0.9	1.1	1.0	1.1	1.0	1.4	1.3	2.1	2.1

Figure A3-8
Future Demand Case - Base Condition
End of Month Storage





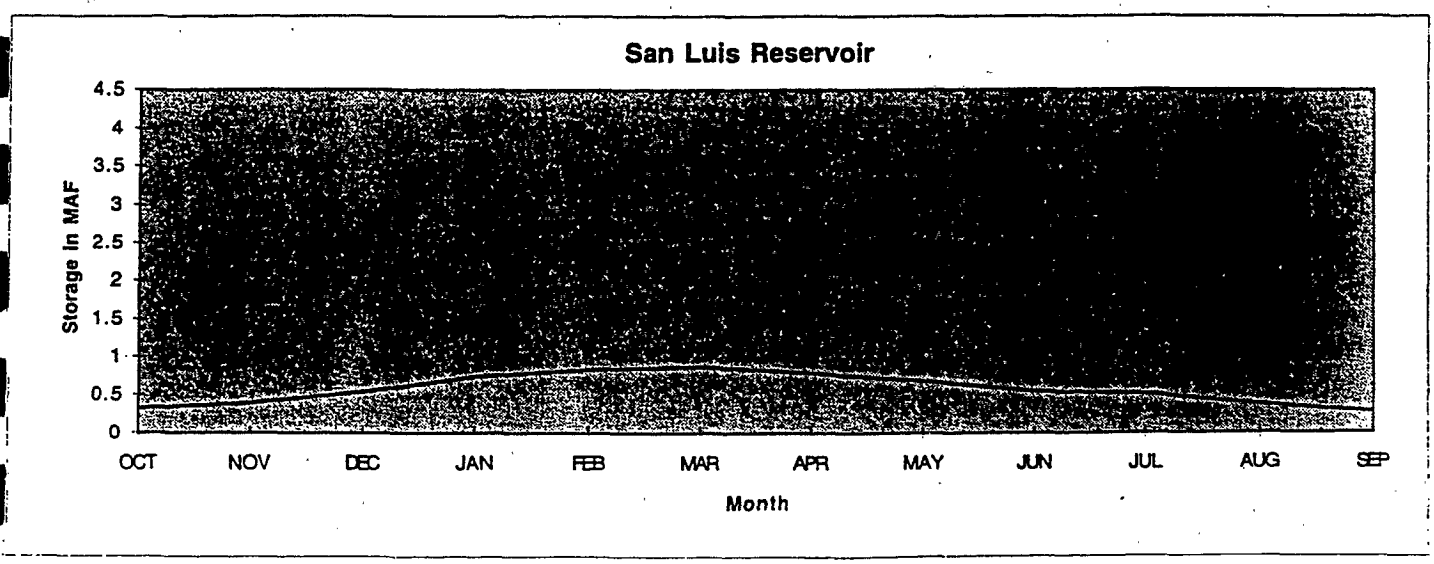
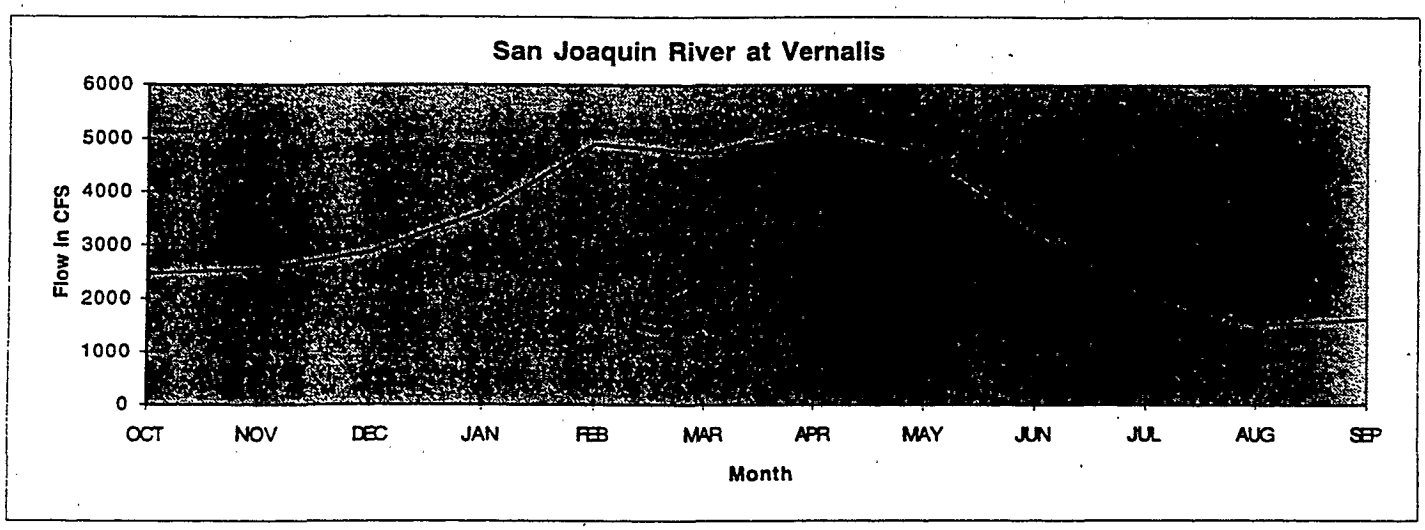
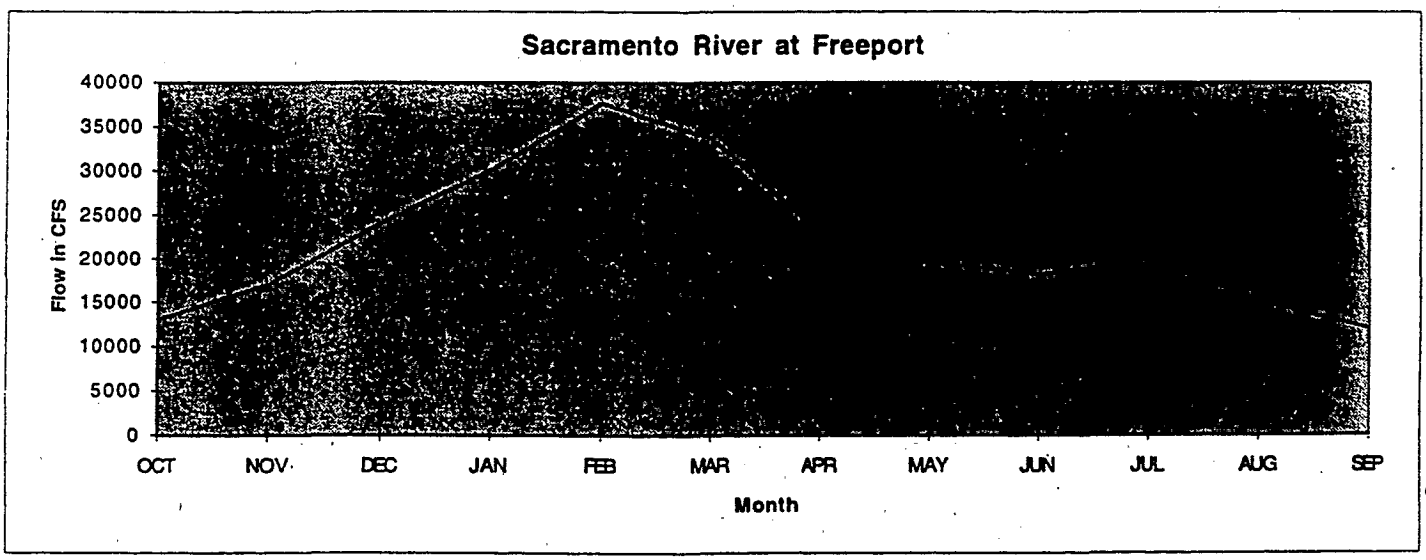


Figure A3-9
Future Demand Case - Base Condition
River Flows





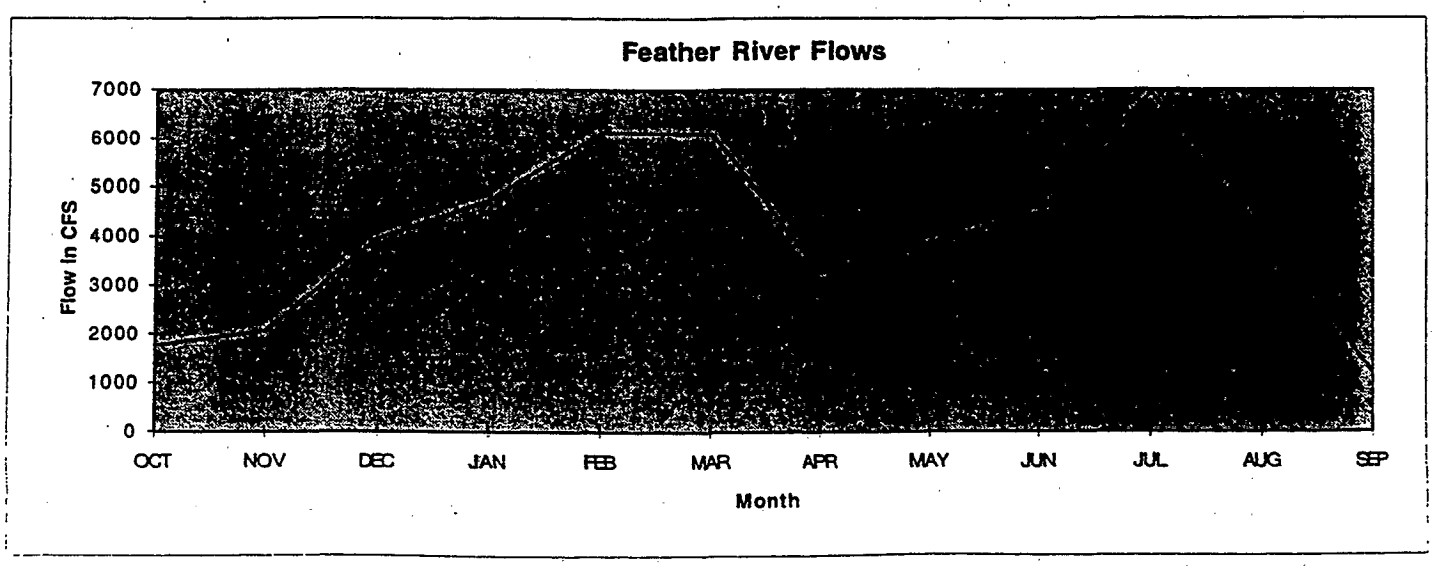
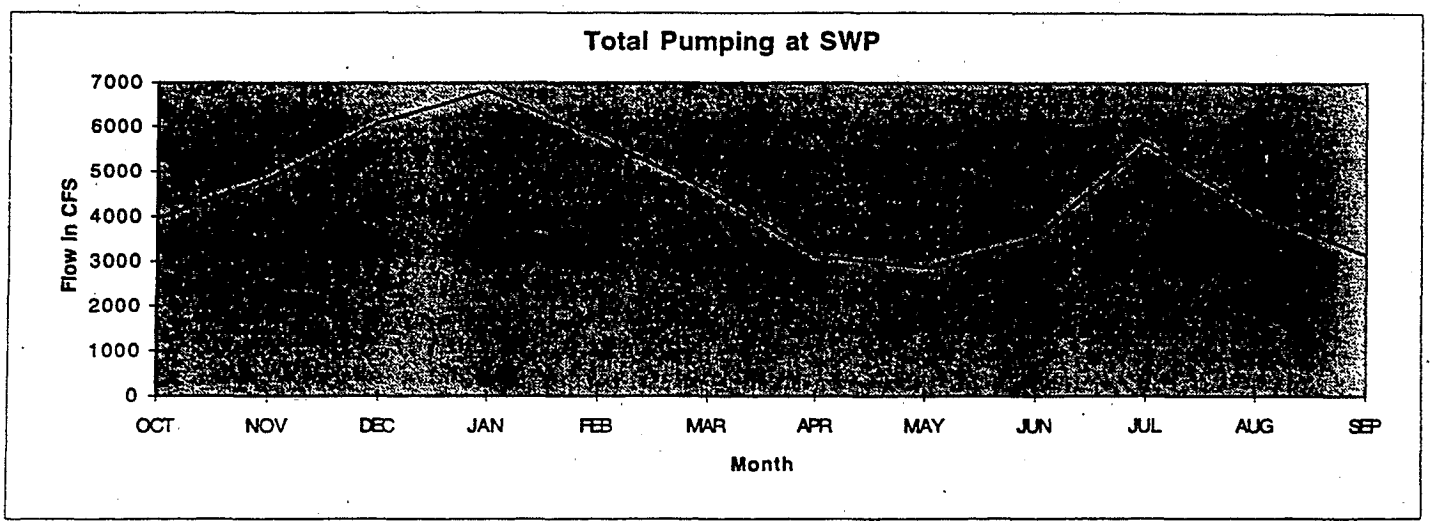
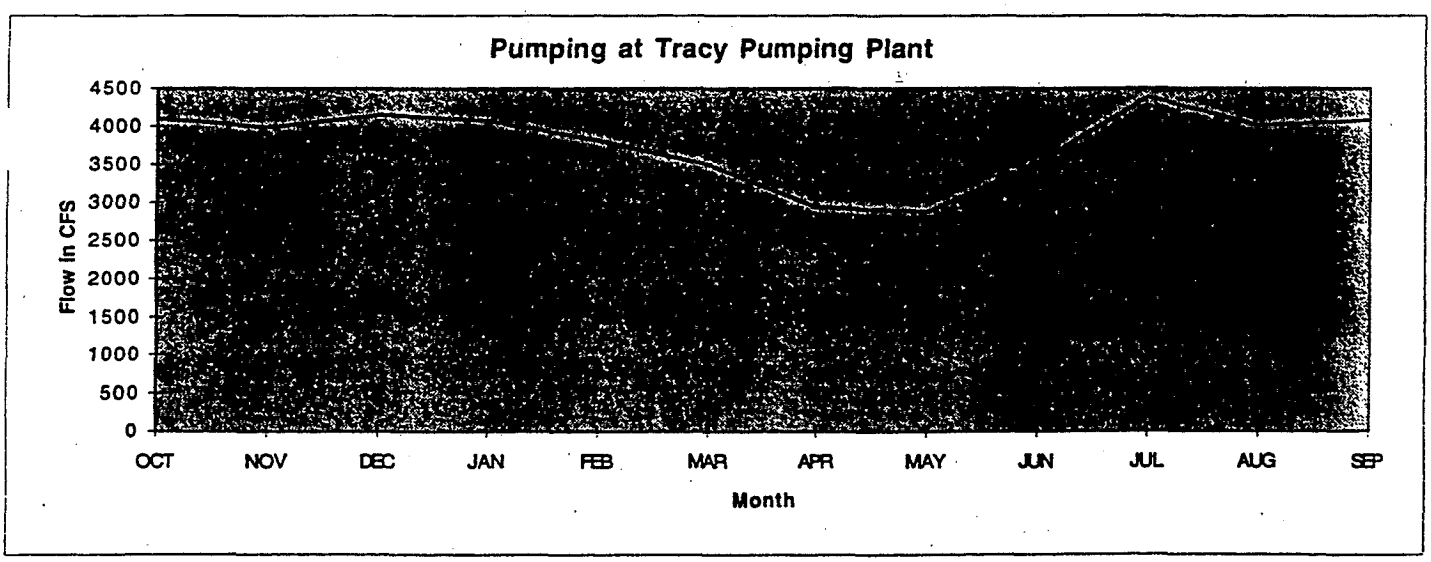


Figure A3-10
Future Demand Case - Base Condition
Delta Exports





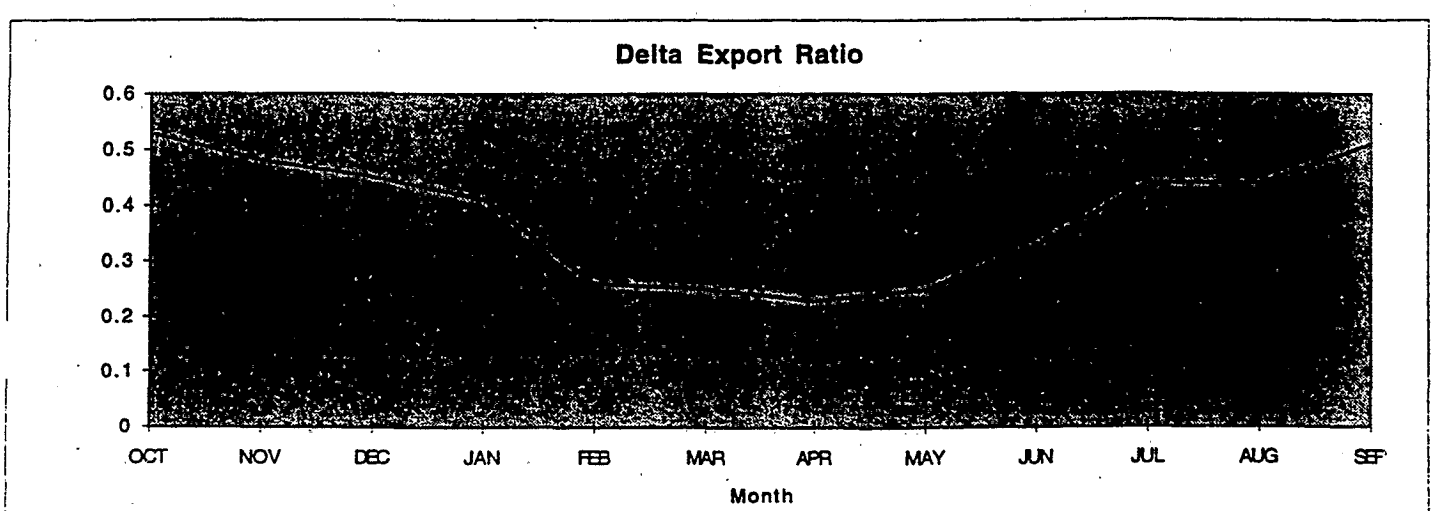
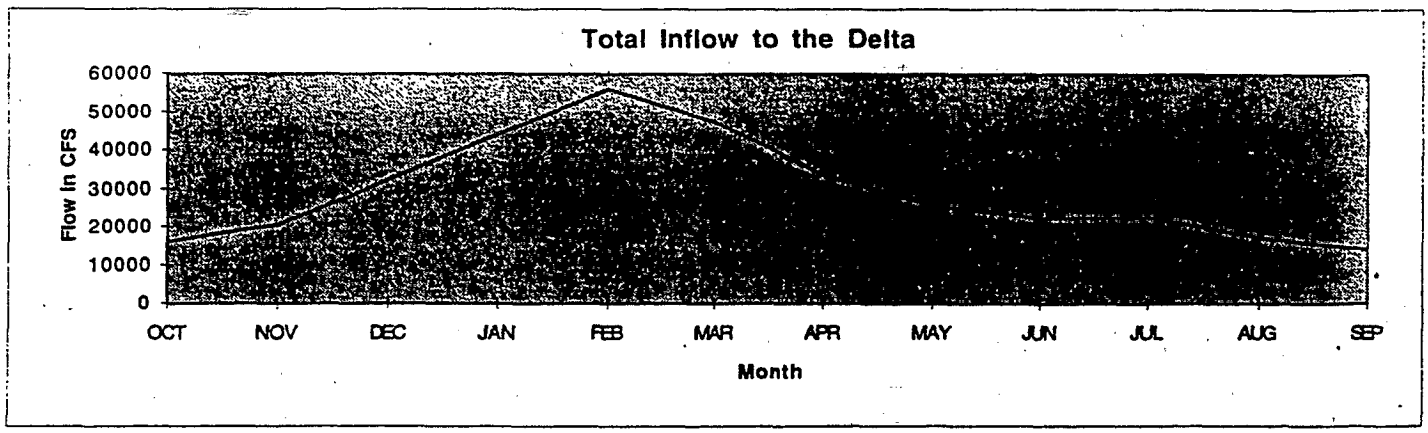
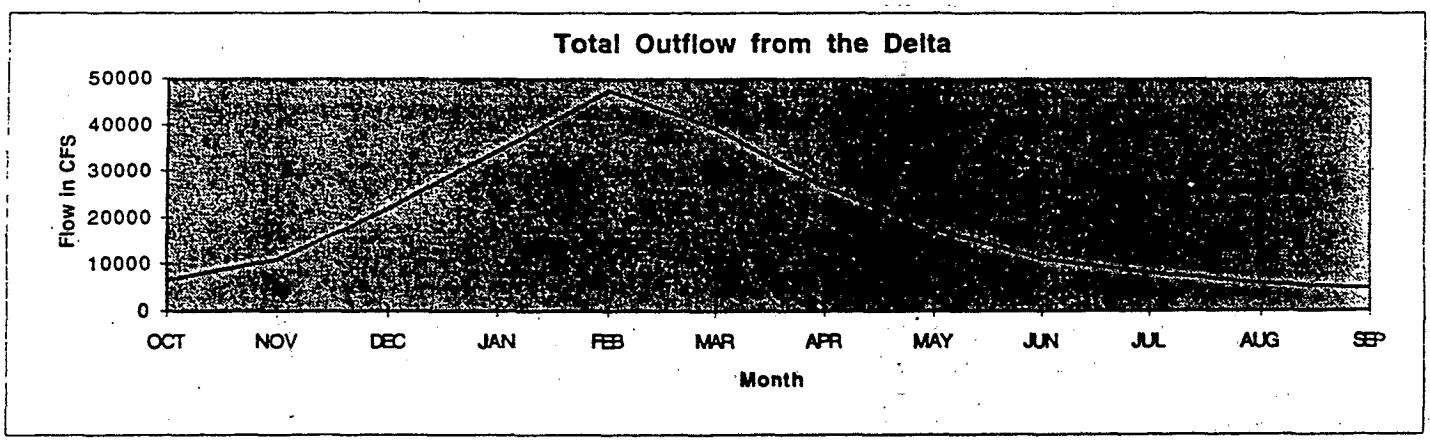
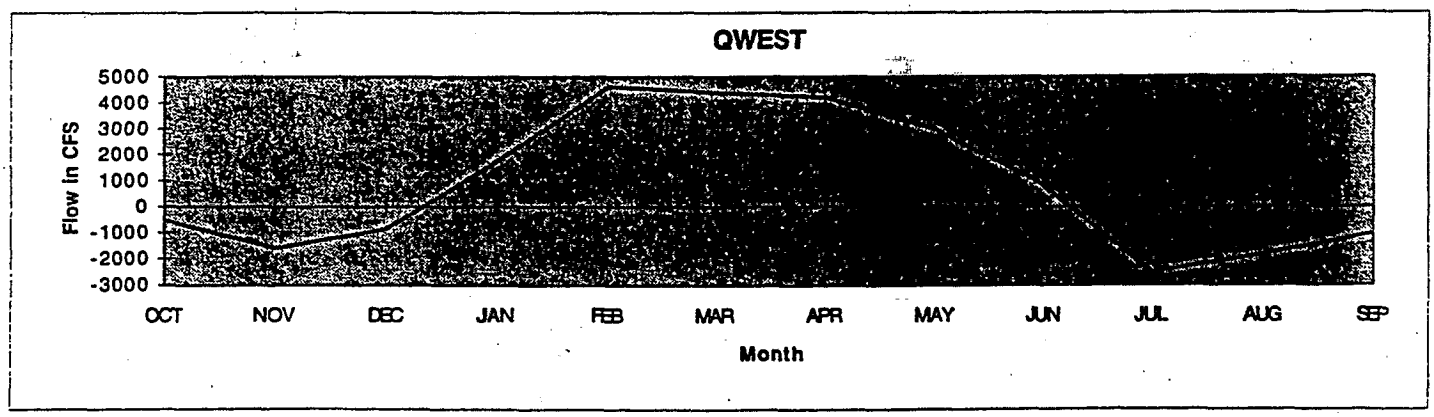


Figure A3-11
Future Demand Case - Base Condition
Delta Inflow and Outflow







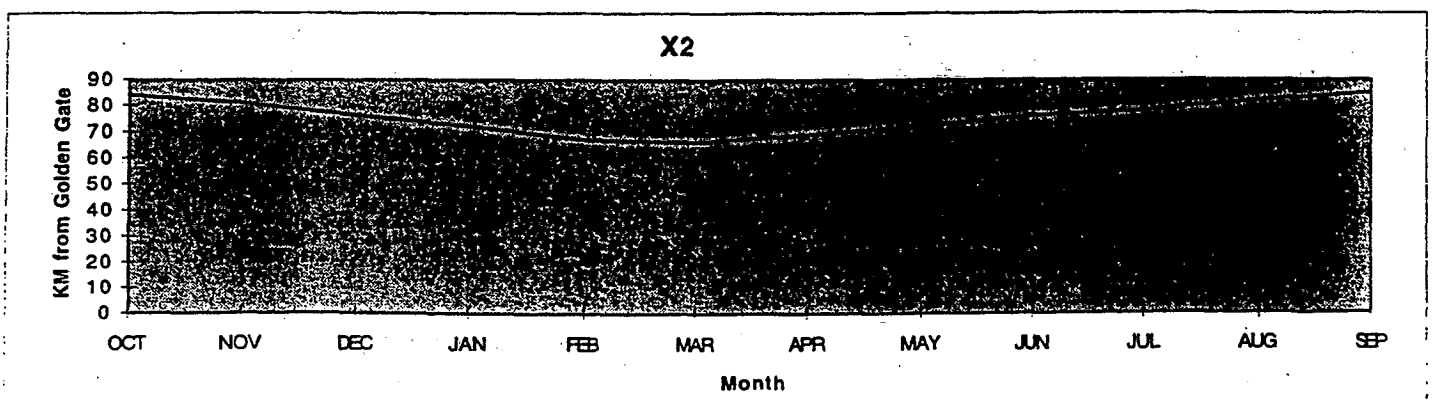
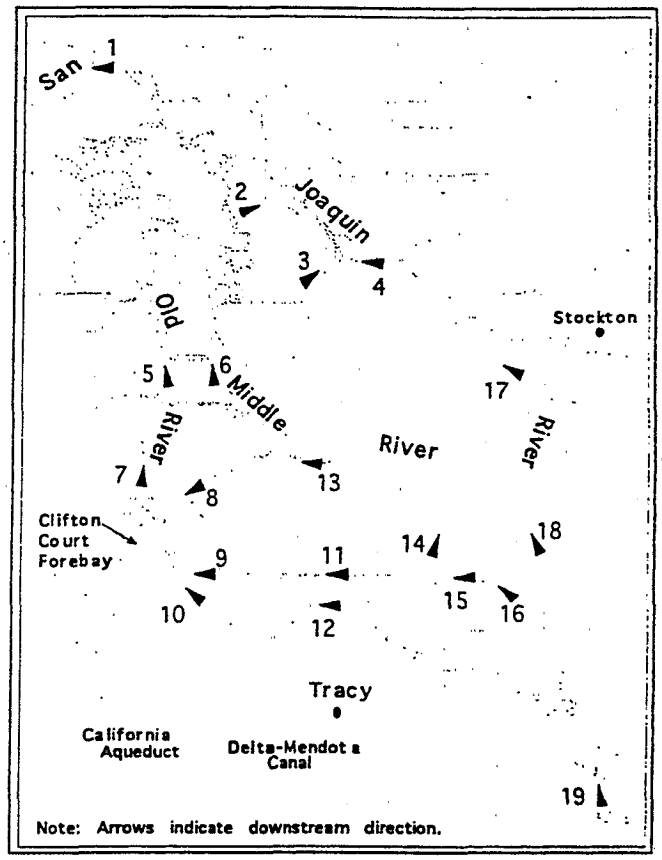


TABLE A3-7

Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Critical Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-193	-2157	-1863	-2503	237	-113	1244	210	-843
2	-371	-101	-168	-718	-196	-74	-253	-365	-287
3	-630	-575	-605	-1038	-430	-349	-390	-665	-738
4	14	-11	62	194	455	389	404	78	-161
5	-3229	-3259	-3281	-5873	-1520	-1183	-1159	-3049	-3752
6	-2329	-2298	-2324	-4008	-1155	-923	-946	-2235	-2721
7	-3877	-3885	-3902	-6997	-1756	-1293	-1286	-3485	-4283
8	1769	1762	1763	3092	637	619	622	1521	1850
9	696	696	849	1116	1132	962	965	746	392
10	111	110	130	138	146	103	104	29	-24
11	699	699	856	1122	1143	980	982	782	433
12	120	120	144	165	216	207	208	193	151
13	-27	-27	-36	-39	-4	-32	-32	-107	-131
14	-7	-7	-0	-37	39	51	51	37	23
15	814	814	1020	1307	1496	1372	1376	1228	842
16	816	816	1024	1309	1501	1380	1384	1242	857
17	-68	-68	-25	-203	371	331	328	30	-186
18	-63	-63	-13	-205	407	379	375	96	-117
19	758	758	1021	1136	1859	1824	1824	1435	846



Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
2	1.8	1.8	1.8	1.8	1.9	1.8	1.9	1.8	1.8
3	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7
4	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7
5	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.6
6	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.7
7	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.6	1.5
8	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.6	1.5
9	1.6	1.5	1.5	1.5	1.8	1.8	1.8	1.6	1.5
10	1.5	1.4	1.5	1.4	1.7	1.7	1.7	1.5	1.4
11	1.9	1.8	1.9	1.8	2.1	2.1	2.1	1.9	1.8
12	1.9	1.8	1.9	1.8	2.1	2.1	2.1	1.9	1.7
13	1.6	1.6	1.6	1.6	1.8	1.7	1.7	1.6	1.6
14	2.0	2.0	2.0	2.0	2.2	2.1	2.2	1.9	1.7
15	2.1	2.0	2.1	2.0	2.4	2.4	2.4	2.1	1.9
16	2.2	2.2	2.3	2.2	2.7	2.6	2.7	2.4	2.1
17	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.8	1.8
18	2.4	2.4	2.4	2.4	2.8	2.7	2.7	2.5	2.3
19	4.0	3.9	4.5	4.6	6.2	6.0	6.0	5.2	4.0

Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.3
2	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.3	0.1	-0.3
4	0.4	-0.4	0.3	-0.4	0.3	-0.4	0.4	-0.4	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.3	-0.4
5	0.8	-1.3	0.8	-1.3	0.8	-1.3	0.6	-1.5	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	0.7	-1.3
6	0.8	-1.4	0.8	-1.4	0.8	-1.4	0.6	-1.6	0.9	-1.2	0.9	-1.1	0.9	-1.2	0.8	-1.3	0.8	-1.4
7	0.9	-2.2	0.9	-2.2	0.9	-2.2	0.7	-2.6	1.1	-1.6	1.2	-1.5	1.2	-1.6	1.0	-1.9	0.8	-2.0
8	0.9	-0.2	0.9	-0.2	0.9	-0.2	1.1	-0.1	0.9	-0.3	0.8	-0.3	0.8	-0.3	1.0	-0.2	1.0	-0.1
9	1.0	-0.7	1.0	-0.7	1.0	-0.7	0.9	-0.4	1.0	-0.8	1.0	-0.8	1.0	-0.8	1.0	-0.9	1.0	-0.9
10	0.7	-0.8	0.7	-0.6	0.7	-0.8	0.6	-0.5	0.7	-0.7	0.7	-0.8	0.7	-0.8	0.7	-0.8	0.7	-0.8
11	0.9	-0.5	0.9	-0.5	0.9	-0.5	0.8	-0.3	0.9	-0.6	0.9	-0.7	0.9	-0.7	0.9	-0.8	0.8	-0.8
12	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	0.0	0.3	-0.1	0.3	-0.2	0.3	-0.2	0.3	-0.2	0.3	-0.2
13	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.6	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.8	0.6	-0.8
14	0.4	-0.6	0.3	-0.6	0.4	-0.6	0.3	-0.7	0.5	-0.5	0.5	-0.4	0.5	-0.4	0.5	-0.5	0.4	-0.6
15	1.0	-0.1	1.0	-0.1	1.1	0.1	1.0	0.5	1.3	0.1	1.2	0.0	1.2	0.0	1.1	-0.2	1.0	-0.5
16	1.1	-0.1	1.1	-0.1	1.2	0.2	1.3	0.7	1.5	0.3	1.4	0.1	1.4	0.1	1.3	-0.2	1.1	-0.5
17	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.0	-1.1	1.2	-1.0	1.2	-1.0	1.2	-1.0	1.1	-1.1	1.0	-1.2
18	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	1.1	-0.8	1.0	-0.8	1.0	-0.9	1.0	-1.0	0.9	-1.1
19	0.7	0.5	0.7	0.5	0.8	0.7	0.9	0.8	1.3	1.1	1.2	1.1	1.2	1.1	1.1	0.9	0.8	0.5

TABLE A3-7 CONT.

Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	202	568	704	-4	2002	477	81
2	216	-165	55	-366	32	-43	186
3	482	-373	394	-623	567	-329	486
4	383	225	209	81	57	76	309
5	1744	-1454	1476	-3003	3034	-1254	2130
6	1332	-1136	1115	-2204	2172	-1017	1809
7	2048	-1719	1724	-3582	3591	-1359	2476
8	964	830	926	1632	1126	634	1351
9	1127	808	1027	843	1313	315	1000
10	162	117	117	132	130	-32	41
11	1143	820	1101	856	1356	339	1135
12	201	140	130	146	118	92	130
13	14	-15	51	-39	51	-66	42
14	41	26	21	8	53	35	21
15	1450	1027	1082	1046	1045	629	1007
16	1456	1031	1130	1051	1050	640	1015
17	339	196	196	17	181	54	62
18	368	213	214	33	34	108	98
19	1864	1261	1261	1098	1098	826	1060

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.99	2	1.99	1.98	1.98	2	1.97
2	1.81	1.83	1.82	1.81	1.78	1.83	1.8
3	1.75	1.76	1.76	1.74	1.72	1.76	1.73
4	1.75	1.76	1.76	1.74	1.72	1.76	1.74
5	1.7	1.73	1.72	1.68	1.66	1.72	1.69
6	1.7	1.72	1.72	1.69	1.67	1.72	1.69
7	1.63	1.66	1.66	1.58	1.55	1.66	1.6
8	1.58	1.63	1.62	1.52	1.51	1.62	1.55
9	1.67	1.71	1.7	1.57	1.56	1.69	1.62
10	1.55	1.6	1.61	1.45	1.43	1.6	1.51
11	2.01	2.02	2.01	1.88	1.86	1.96	1.91
12	2.01	2.01	2	1.88	1.86	1.92	1.89
13	1.67	1.7	1.69	1.62	1.6	1.68	1.64
14	2.15	2.12	2.08	1.98	1.98	1.96	1.98
15	2.39	2.26	2.24	2.1	2.07	2.13	2.12
16	2.51	2.47	2.46	2.3	2.27	2.31	2.32
17	1.85	1.85	1.84	1.81	1.78	1.83	1.8
18	2.7	2.59	2.60	2.46	2.43	2.47	2.47
19	5.02	4.99	4.98	4.62	4.6	4.14	4.56

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3
2	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3
4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.3	-0.4	0.3	-0.4
5	1.0	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.3	0.9	-1.3	0.9	-1.1	0.9	-1.1
6	0.9	-1.2	0.9	-1.2	0.9	-1.2	0.8	-1.4	0.9	-1.3	0.9	-1.2	0.9	-1.2
7	1.1	-1.7	1.1	-1.9	1.1	-1.9	0.9	-2.2	1.0	-2.2	1.1	-1.6	1.0	-1.7
8	0.7	-0.3	0.7	-0.3	0.7	-0.3	0.9	-0.2	0.8	-0.2	0.6	-0.3	0.7	-0.2
9	1.0	-0.8	1.0	-0.8	1.0	-0.7	1.0	-0.7	1.0	-0.7	1.0	-0.9	1.0	-0.7
10	0.8	-0.7	0.8	-0.7	0.8	-0.7	0.8	-0.6	0.7	-0.6	0.7	-0.8	0.7	-0.7
11	0.9	-0.6	0.9	-0.6	0.9	-0.6	0.9	-0.5	1.0	-0.5	0.9	-0.8	0.9	-0.5
12	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	-0.3	0.3	-0.1
13	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.7
14	0.5	-0.6	0.5	-0.5	0.5	-0.5	0.4	-0.6	0.4	-0.6	0.5	-0.5	0.4	-0.5
15	1.3	0.1	1.1	0.0	1.1	0.0	1.1	0.1	1.1	0.1	1.1	-0.6	1.1	0.0
16	1.4	0.3	1.3	0.0	1.3	0.0	1.2	0.2	1.2	0.2	1.2	-0.6	1.2	0.4
17	1.2	-1.0	1.2	-1.1	1.2	-1.0	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.1	-1.1
18	1.0	-0.9	1.0	-1.0	1.0	-1.0	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.9	-1.0
19	1.2	1.1	1.0	0.8	1.0	0.8	0.9	0.7	0.9	0.7	0.7	0.5	0.8	0.6

TABLE A3-8

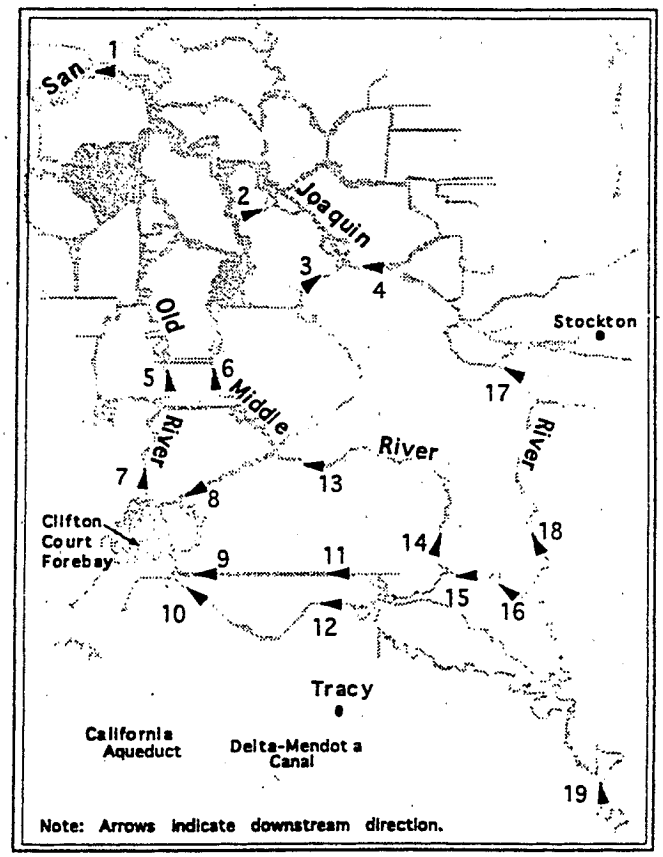
Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Dry Year

Average Net Flow

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	287	-2784	-2088	65	676	-136	1893	2	-2320
2	-1206	-784	-655	-798	-453	-200	-444	-372	-818
3	-1172	-1101	-996	-876	-578	-462	-513	-681	-1122
4	874	854	780	846	1139	628	643	143	-104
5	-5474	-5521	-4811	-3700	-1587	-1517	-1463	-3017	-6315
6	-3796	-3752	-3305	-2633	-1177	-1161	-1189	-2240	-4345
7	-6569	-6586	-5736	-4453	-1828	-1680	-1667	-3424	-7305
8	2933	2922	2549	2029	885	789	793	1494	3121
9	2168	2166	2128	1793	1950	1358	1363	873	1024
10	268	264	254	237	258	153	156	48	45
11	2168	2165	2133	1798	1961	1380	1385	915	1066
12	272	266	277	252	321	264	267	209	208
13	4	4	-7	7	37	-23	-22	-113	-150
14	2	2	15	13	67	61	61	46	12
15	2415	2405	2425	2078	2434	1860	1869	1408	1527
16	2416	2405	2430	2079	2437	1869	1877	1421	1540
17	604	617	686	502	1081	600	592	111	-154
18	597	609	701	500	1115	650	642	180	-84
19	3024	3024	3155	2597	3601	2593	2593	1701	1559

Minimum Water Surface Elevation

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	1.9	2.0	2.1	2.1	2.0	2.0	2.0	1.9
2	1.8	1.8	1.8	1.9	1.9	1.9	1.9	1.8	1.7
3	1.8	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.6
4	1.8	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.6
5	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.7	1.6
6	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.7	1.6
7	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.5
8	1.6	1.5	1.6	1.7	1.7	1.7	1.7	1.6	1.5
9	1.7	1.6	1.7	1.7	1.9	1.8	1.8	1.6	1.5
10	1.5	1.5	1.5	1.6	1.7	1.7	1.7	1.5	1.4
11	2.1	2.1	2.1	2.1	2.3	2.2	2.2	1.9	1.7
12	2.1	2.0	2.1	2.1	2.3	2.1	2.1	1.9	1.7
13	1.7	1.6	1.7	1.7	1.8	1.7	1.8	1.6	1.6
14	2.4	2.3	2.4	2.4	2.5	2.2	2.3	1.8	1.6
15	2.6	2.5	2.6	2.5	2.9	2.5	2.6	2.2	2.0
16	3.0	3.0	3.1	2.9	3.4	2.9	2.9	2.4	2.2
17	1.9	1.9	1.9	2.0	2.0	1.9	1.9	1.8	1.7
18	3.1	3.0	3.1	3.0	3.3	2.9	3.0	2.6	2.3
19	7.8	7.8	8.0	7.2	8.7	7.2	7.2	5.7	5.3



Note: Arrows indicate downstream direction.

Minimum and Maximum Velocity

Ref. No.	Jan 1-15		Jan 16-31		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.4
2	0.3	-0.6	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.6
3	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.3	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.6	-1.5	0.6	-1.5	0.7	-1.4	0.8	-1.4	0.8	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	0.9	-1.4
6	0.6	-1.6	0.6	-1.5	0.7	-1.5	0.8	-1.5	0.9	-1.2	0.9	-1.1	0.9	-1.2	0.8	-1.3	0.9	-1.5
7	0.8	-2.6	0.8	-2.6	0.8	-2.5	0.9	-2.4	1.1	-1.6	1.1	-1.6	1.1	-1.6	1.0	-1.9	0.9	-2.5
8	1.1	-0.1	1.1	-0.1	1.0	-0.2	1.0	-0.2	0.9	-0.3	0.8	-0.3	0.8	-0.3	1.0	-0.2	1.0	-0.1
9	1.1	-0.2	1.1	-0.2	1.1	-0.2	1.1	-0.3	1.1	-0.7	1.1	-0.7	1.1	-0.8	1.0	-0.9	0.9	-1.0
10	0.7	-0.4	0.7	-0.4	0.7	-0.4	0.8	-0.4	0.8	-0.7	0.7	-0.7	0.7	-0.8	0.7	-0.8	0.6	-0.9
11	1.0	0.0	1.0	0.0	1.0	0.0	1.0	-0.1	1.0	-0.5	0.9	-0.6	0.9	-0.8	0.9	-0.7	0.8	-0.8
12	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.0	0.4	0.0	0.4	-0.1	0.3	-0.1	0.3	-0.1
13	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.8
14	0.4	-0.6	0.4	-0.6	0.5	-0.6	0.4	-0.6	0.6	-0.4	0.5	-0.4	0.5	-0.4	0.5	-0.5	0.4	-0.6
15	1.5	1.2	1.5	1.2	1.6	1.2	1.4	1.0	1.7	0.8	1.4	0.5	1.4	0.5	1.2	0.0	1.1	0.1
16	1.9	1.4	1.9	1.4	1.9	1.4	1.7	1.1	2.0	1.2	1.7	0.8	1.7	0.7	1.4	0.2	1.5	0.3
17	1.3	-0.9	1.3	-0.8	1.3	-0.8	1.2	-0.9	1.4	-0.6	1.2	-0.9	1.2	-0.9	1.1	-1.1	1.0	-1.2
18	1.2	0.8	1.2	-0.8	1.2	-0.7	1.1	-0.8	1.3	-0.3	1.1	-0.7	1.1	-0.7	1.0	-1.0	0.9	-1.1
19	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.8	1.7	1.5	1.4	1.5	1.4	1.2	1.0	1.1	1.0

TABLE A3-8 CONT.

Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	286	-473	2810	-1044	3677	-2387	830
2	1083	-947	1023	-914	1649	-600	404
3	1178	-1057	1002	-1106	1044	-1081	781
4	1144	988	1076	686	669	-209	7
5	4957	-4630	4167	-5349	5389	-6264	3885
6	3465	-3239	3209	-3696	3861	-4284	2759
7	5884	-5513	5527	-6349	6383	-7293	4569
8	2583	2446	2110	2799	2791	3137	2016
9	2334	2300	2205	2099	2098	838	792
10	295	277	273	250	245	52	51
11	2316	2308	2103	2108	2105	865	807
12	305	295	290	265	290	169	162
13	57	-13	41	-31	31	-117	38
14	17	30	23	14	13	-12	5
15	2772	2652	2410	2407	2397	1191	1041
16	2776	2653	2410	2408	2397	1201	1070
17	1050	897	912	596	809	-287	79
18	1079	916	931	615	827	-236	48
19	3889	3587	3567	3036	3036	1037	1061

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.94	1.96	1.93	1.94	1.9	1.87	1.85
2	1.78	1.8	1.77	1.78	1.74	1.7	1.78
3	1.72	1.74	1.71	1.72	1.68	1.64	1.71
4	1.72	1.74	1.71	1.72	1.68	1.64	1.71
5	1.7	1.67	1.64	1.66	1.62	1.62	1.64
6	1.72	1.68	1.65	1.66	1.63	1.62	1.65
7	1.61	1.58	1.55	1.56	1.52	1.51	1.52
8	1.55	1.53	1.5	1.5	1.46	1.43	1.46
9	1.67	1.65	1.61	1.6	1.58	1.46	1.51
10	1.5	1.48	1.44	1.45	1.41	1.35	1.38
11	2.21	2.16	2.13	2.05	2.02	1.69	1.8
12	2.18	2.17	2.14	2.04	2.01	1.65	1.78
13	1.64	1.63	1.6	1.61	1.57	1.53	1.58
14	2.42	2.4	2.37	2.26	2.23	1.7	1.89
15	2.81	2.75	2.72	2.52	2.49	1.87	2.01
16	3.3	3.28	3.25	2.98	2.96	2.05	2.21
17	1.91	1.91	1.88	1.86	1.82	1.67	1.76
18	3.26	3.25	3.22	3.01	2.98	2.21	2.38
19	9.03	8.63	8.62	7.84	7.83	4.32	4.5

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4
2	0.4	-0.8	0.3	-0.5	0.4	-0.5	0.3	-0.5	0.3	-0.5	0.4	-0.6	0.3	-0.3
3	0.1	-0.1	0.1	-0.4	0.1	-0.1	0.1	-0.4	0.1	-0.1	0.1	-0.4	0.1	-0.1
4	0.3	-0.3	0.4	-0.3	0.3	-0.1	0.4	-0.3	0.2	-0.1	0.3	-0.4	0.4	-0.4
5	0.7	-1.3	0.7	-1.4	0.7	-1.4	0.7	-1.5	0.7	-1.1	0.4	-1.4	0.7	-1.3
6	0.8	-1.5	0.8	-1.5	0.8	-1.5	0.7	-1.5	0.8	-1.3	0.4	-1.5	0.8	-1.4
7	0.9	-2.1	0.9	-2.5	0.9	-2.4	0.8	-2.6	0.9	-2.5	0.4	-2.5	0.9	-2.3
8	1.0	-0.1	1.0	-0.2	1.0	-0.1	1.1	-0.1	1.1	-0.1	1.2	-0.1	1.1	-0.1
9	1.1	-0.2	1.2	-0.2	1.2	-0.2	1.1	-0.2	1.1	-0.2	0.9	-1.0	1.2	-0.2
10	0.8	-0.6	0.8	-0.4	0.7	-0.4	0.7	-0.4	0.7	-0.4	0.6	-0.9	0.7	-0.3
11	1.0	-0.5	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	0.8	-0.9	0.9	-0.9
12	0.5	0.0	0.4	0.1	0.3	0.1	0.4	0.1	0.3	0.1	0.3	-0.2	0.3	-0.2
13	0.7	-0.8	0.6	-0.7	0.3	-0.7	0.6	-0.6	0.4	-0.6	0.6	-0.8	0.3	-0.7
14	0.3	-0.1	0.5	-0.5	0.3	-0.7	0.5	-0.6	0.2	-0.3	0.3	-0.7	0.1	-0.6
15	1.8	-1.1	1.7	1.3	1.7	1.3	1.6	1.2	1.6	1.2	1.0	-0.4	1.1	-0.1
16	2.1	-1.5	2.0	1.6	2.0	1.6	1.9	1.4	1.9	1.4	1.3	-0.3	1.2	-0.3
17	1.4	-0.8	1.3	-0.7	1.3	-0.7	1.3	-0.9	1.3	-0.9	1.0	-1.2	1.0	-1.1
18	1.3	-0.4	1.3	-0.6	1.3	-0.5	1.2	-0.8	1.2	-0.7	0.8	-1.2	0.9	-1.1
19	1.6	-1.8	1.8	1.7	1.8	1.7	1.6	1.6	1.6	1.6	0.9	0.7	0.9	0.6

TABLE A3-9

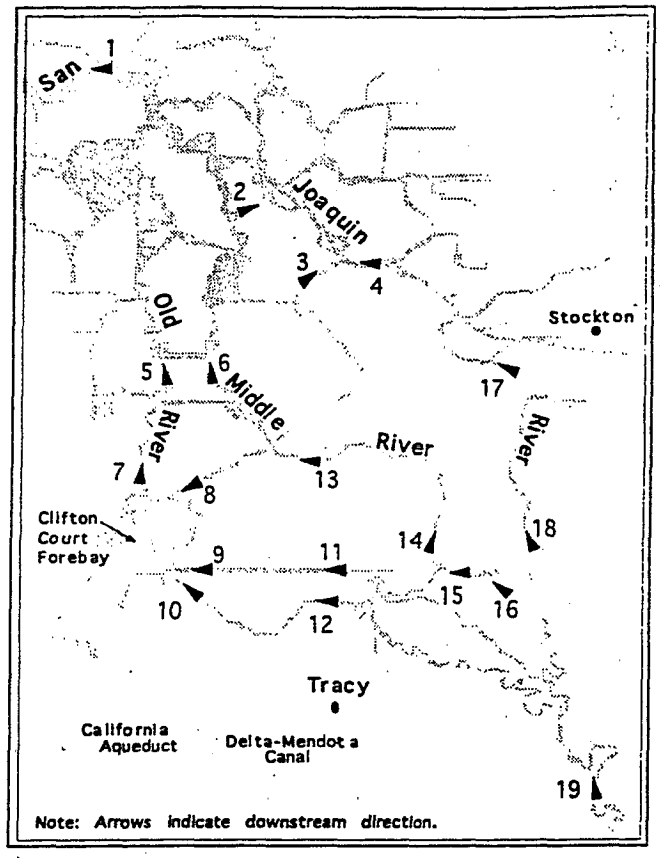
Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Below Normal Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	-1839	-1651	-1770	878	-250	2183	-22	-2233
2	-996	-884	-453	-557	-293	-621	-408	-622
3	-1177	-1087	-832	-636	-568	-632	-716	-1119
4	1210	1064	429	1309	729	747	137	-104
5	-5436	-4999	-4154	-1638	-1870	-1925	-3222	-6297
6	-3728	-3442	-2880	-1240	-1473	-1509	-2372	-4331
7	-6509	-5977	-4932	-1915	-2226	-2209	-3668	-7290
8	2906	2670	2189	921	1025	1029	1599	3118
9	2519	2304	1598	2089	1533	1539	898	1030
10	302	277	199	263	172	177	49	50
11	2519	2309	1610	2103	1554	1561	937	1069
12	315	295	229	342	283	287	213	206
13	22	14	-33	29	-24	-23	-110	-145
14	17	15	11	77	62	62	43	10
15	2829	2610	1893	2606	2053	2065	1430	1518
16	2838	2617	1897	2612	2061	2072	1442	1530
17	1017	846	305	1208	697	686	101	-154
18	1024	853	327	1248	747	737	170	-85
19	3892	3498	2252	3913	2883	2883	1713	1544

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.1	2.0	2.1	2.0	1.9
2	1.8	1.9	1.8	1.9	1.9	1.9	1.8	1.7
3	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6
4	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6
5	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.6
6	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.6
7	1.7	1.6	1.6	1.8	1.7	1.7	1.6	1.5
8	1.6	1.6	1.6	1.7	1.7	1.7	1.6	1.5
9	1.7	1.7	1.6	1.9	1.8	1.8	1.6	1.5
10	1.6	1.5	1.5	1.7	1.7	1.7	1.5	1.4
11	2.2	2.2	2.0	2.4	2.2	2.2	1.9	1.7
12	2.2	2.2	2.0	2.3	2.1	2.2	1.9	1.7
13	1.7	1.7	1.7	1.8	1.7	1.8	1.8	1.5
14	2.6	2.5	2.2	2.6	2.3	2.3	1.9	1.7
15	2.8	2.7	2.4	3.0	2.6	2.6	2.2	2.0
16	3.4	3.3	2.7	3.5	3.0	3.0	2.4	2.2
17	2.0	2.0	1.9	2.0	1.9	2.0	1.8	1.7
18	3.4	3.3	2.8	3.5	3.0	3.1	2.5	2.3
19	9.0	8.5	6.6	9.1	7.6	7.6	5.7	5.3



Note: Arrows indicate downstream direction.

Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.4
2	0.4	-0.6	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.6
3	0.0	-0.4	0.1	-0.4	0.1	-0.3	0.1	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.3	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.8	-1.4	0.7	-1.4	0.8	-1.4	0.9	-1.1	0.8	-1.1	0.9	-1.1	0.8	-1.2	0.4	-1.4
6	0.8	-1.5	0.7	-1.5	0.8	-1.5	0.9	-1.2	0.9	-1.2	0.9	-1.2	0.8	-1.3	0.4	-1.5
7	0.8	-2.6	0.8	-2.5	0.9	-2.4	1.1	-1.7	1.1	-1.7	1.1	-1.7	0.9	-2.0	0.4	-2.5
8	1.1	-0.1	1.1	-0.1	1.0	-0.2	0.8	-0.3	0.9	-0.3	0.9	-0.3	1.0	-0.2	1.2	-0.1
9	1.1	-0.1	1.1	-0.2	1.1	-0.3	1.2	-0.6	1.1	-0.7	1.1	-0.7	1.0	-0.9	0.9	-1.0
10	0.7	-0.4	0.7	-0.4	0.7	-0.4	0.8	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.8	0.6	-0.9
11	1.0	0.1	1.0	0.0	0.9	-0.2	1.1	-0.4	1.0	-0.5	1.0	-0.6	0.9	-0.7	0.8	-0.8
12	0.4	0.2	0.4	0.1	0.3	0.1	0.5	0.1	0.4	0.0	0.4	0.0	0.3	-0.1	0.3	-0.1
13	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.8	0.6	-0.8
14	0.5	-0.5	0.5	-0.6	0.4	-0.6	0.6	-0.3	0.5	-0.4	0.5	-0.4	0.5	-0.5	0.4	-0.6
15	1.8	1.4	1.7	1.3	1.3	0.9	1.8	0.9	1.5	0.8	1.5	0.6	1.2	0.0	1.1	0.1
16	2.1	1.7	2.0	1.5	1.6	1.0	2.1	1.3	1.7	0.9	1.8	0.9	1.4	0.2	1.5	0.3
17	1.4	-0.6	1.3	-0.7	1.2	-1.0	1.4	-0.5	1.3	-0.8	1.3	-0.8	1.1	-1.1	1.0	-1.2
18	1.3	-0.5	1.2	-0.6	1.1	-0.9	1.3	-0.2	1.2	-0.6	1.2	-0.6	1.0	-1.0	0.9	-1.1
19	1.8	1.8	1.7	1.7	1.4	1.3	1.8	1.8	1.6	1.5	1.6	1.5	1.2	1.0	1.1	1.0

TABLE A3-9 CONT.

Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug	Sep.
1	-945	-1708	-2651	-94	-2387	-849
2	-758	-861	-818	-1170	-596	-378
3	-1023	-1090	-1108	-1167	-1080	-739
4	579	1250	1124	1136	-273	-41
5	-4753	-4739	-5171	-5132	-6340	-3793
6	-3302	-3290	-3535	-3569	-4332	-2704
7	-5640	-5649	-6158	-6143	-7380	-4457
8	2455	2512	2729	2736	3174	1972
9	1766	2506	2427	2430	729	683
10	222	302	296	299	38	79
11	1782	2519	2429	2433	755	699
12	259	322	299	304	156	150
13	-33	2	6	6	-121	-59
14	23	36	22	22	-16	0
15	2123	2892	2744	2756	1064	943
16	2128	2902	2743	2756	1073	949
17	460	1129	969	953	-353	-112
18	486	1149	976	961	-302	-82
19	2647	4094	3733	3733	844	907

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	1.93	1.99	1.93	1.97	1.87	1.95
2	1.77	1.84	1.78	1.82	1.7	1.77
3	1.71	1.78	1.72	1.75	1.64	1.71
4	1.71	1.78	1.72	1.76	1.64	1.71
5	1.65	1.72	1.66	1.7	1.62	1.64
6	1.65	1.72	1.67	1.7	1.62	1.65
7	1.54	1.63	1.57	1.61	1.51	1.52
8	1.48	1.58	1.52	1.55	1.44	1.46
9	1.57	1.7	1.64	1.67	1.46	1.5
10	1.42	1.53	1.47	1.51	1.36	1.38
11	1.97	2.26	2.16	2.19	1.68	1.79
12	1.98	2.26	2.14	2.18	1.64	1.77
13	1.59	1.68	1.63	1.66	1.53	1.56
14	2.15	2.54	2.45	2.48	1.68	1.87
15	2.41	2.92	2.75	2.78	1.83	1.98
16	2.8	3.52	3.31	3.34	1.99	2.17
17	1.83	1.98	1.9	1.94	1.67	1.76
18	2.85	3.47	3.29	3.32	2.16	2.34
19	7.28	9.3	8.82	8.83	3.91	4.19

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3
2	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5	0.4	-0.6	0.4	-0.5
3	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.3
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.3	-0.4	0.3	-0.4
5	0.7	-1.3	0.7	-1.4	0.7	-1.4	0.7	-1.4	0.4	-1.4	0.7	-1.3
6	0.7	-1.4	0.7	-1.5	0.7	-1.5	0.7	-1.5	0.4	-1.5	0.8	-1.4
7	0.8	-2.3	0.9	-2.5	0.8	-2.5	0.8	-2.5	0.4	-2.5	0.8	-2.0
8	1.1	-0.1	1.0	-0.2	1.1	-0.2	1.1	-0.2	1.2	-0.1	1.1	-0.1
9	1.1	-0.8	1.2	-0.1	1.1	-0.1	1.1	-0.2	0.8	-1.0	1.0	-0.9
10	0.7	-0.8	0.8	-0.4	0.7	-0.4	0.7	-0.4	0.5	-0.9	0.7	-0.8
11	1.0	-0.6	1.1	0.1	1.0	0.1	1.0	0.0	0.7	-0.9	0.9	-0.8
12	0.4	0.0	0.4	0.1	0.4	0.1	0.4	0.1	0.3	-0.2	0.3	-0.2
13	0.6	-0.8	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.8	0.6	-0.7
14	0.5	-0.5	0.6	-0.5	0.5	-0.5	0.5	-0.5	0.3	-0.7	0.4	-0.6
15	1.5	0.7	1.8	1.4	1.7	1.4	1.7	1.4	1.0	-0.5	1.0	-0.5
16	1.7	1.0	2.1	1.7	2.0	1.6	2.1	1.6	1.2	-0.4	1.2	-0.4
17	1.2	-0.9	1.4	-0.6	1.4	-0.6	1.4	-0.7	1.0	-1.2	1.0	-1.1
18	1.1	-0.8	1.3	-0.4	1.3	-0.5	1.3	-0.6	0.8	-1.2	0.9	-1.1
19	1.5	1.4	1.9	1.9	1.8	1.8	1.8	1.8	0.8	0.5	0.8	0.5

TABLE A3-10

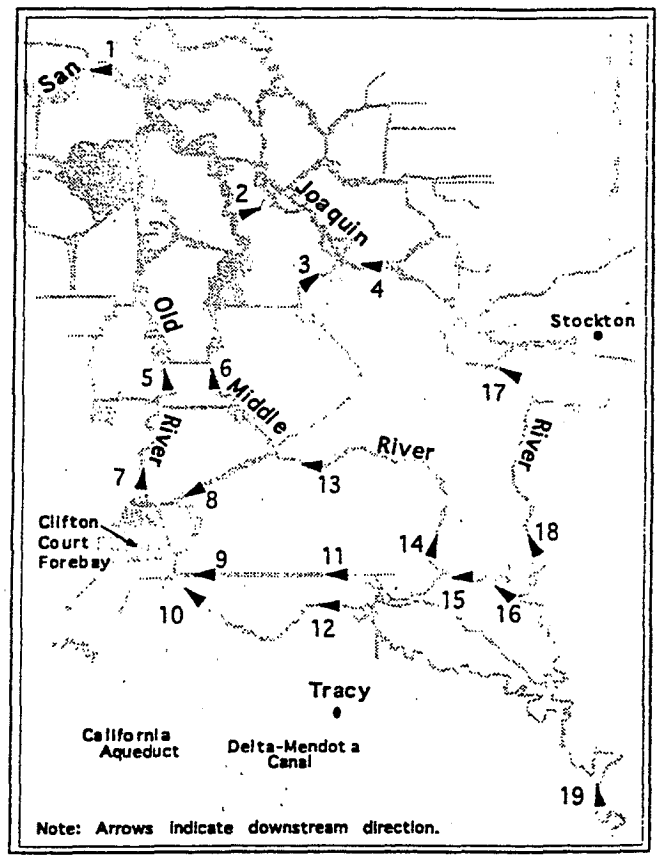
Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Above Normal Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-422	-2762	-1575	-226	711	455	2823	57	-1950
2	-809	-484	-885	-901	-594	-569	-890	-524	-664
3	-961	-905	-1145	-1062	-696	-692	-754	-801	-1131
4	575	555	826	614	1284	1215	1232	133	-96
5	-4631	-4669	-5575	-5019	-2024	-2016	-1971	-3705	-6301
6	-3210	-3180	-3836	-3512	-1493	-1513	-1547	-2686	-4348
7	-5558	-5573	-6673	-5990	-2390	-2327	-2310	-4247	-7293
8	2469	2463	2986	2671	1135	1099	1103	1847	3121
9	1861	1856	2164	1680	2153	2009	2015	915	1033
10	238	233	258	204	275	253	258	47	47
11	1863	1858	2170	1691	2164	2021	2027	956	1075
12	242	238	277	237	341	330	335	215	208
13	-10	-10	-7	-28	43	27	28	-110	-149
14	4	4	5	-2	67	67	67	36	12
15	2102	2093	2451	1951	2638	2529	2540	1448	1537
16	2102	2093	2459	1957	2642	2531	2543	1461	1550
17	423	432	623	253	1202	1105	1094	60	-148
18	426	435	630	270	1234	1146	1135	128	-78
19	2536	2536	3123	2254	3922	3738	3738	1693	1574

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	1.9	2.0	2.1	2.1	2.1	2.1	2.0	1.9
2	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.8	1.7
3	1.7	1.7	1.8	1.9	1.8	1.8	1.9	1.8	1.7
4	1.8	1.7	1.8	1.9	1.8	1.8	1.9	1.8	1.7
5	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.7
6	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.6
7	1.8	1.6	1.7	1.7	1.7	1.7	1.8	1.6	1.5
8	1.5	1.5	1.6	1.7	1.7	1.7	1.7	1.5	1.5
9	1.6	1.6	1.7	1.7	1.9	1.8	1.9	1.6	1.5
10	1.5	1.4	1.6	1.6	1.7	1.7	1.7	1.5	1.4
11	2.0	2.0	2.1	2.1	2.4	2.3	2.3	1.9	1.7
12	2.0	2.0	2.1	2.1	2.3	2.3	2.3	1.8	1.7
13	1.6	1.6	1.7	1.8	1.8	1.8	1.8	1.6	1.5
14	2.3	2.2	2.4	2.3	2.6	2.5	2.6	1.8	1.7
15	2.4	2.4	2.8	2.4	3.0	2.9	2.9	2.1	2.0
16	2.8	2.8	3.1	2.8	3.6	3.4	3.5	2.4	2.2
17	1.9	1.8	2.0	2.0	2.0	2.0	2.0	1.8	1.7
18	2.9	2.8	3.1	2.8	3.5	3.4	3.4	2.5	2.3
19	7.1	7.1	6.0	6.7	9.1	8.8	8.8	5.7	5.4



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.4
2	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.6
3	0.1	-0.4	0.1	-0.3	0.0	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4
4	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.7	-1.4	0.7	-1.4	0.6	-1.5	0.7	-1.5	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.7	-1.2	0.4	-1.4
6	0.8	-1.5	0.8	-1.5	0.6	-1.5	0.7	-1.5	0.9	-1.2	0.9	-1.2	0.9	-1.2	0.8	-1.3	0.3	-1.5
7	0.9	-2.5	0.8	-2.5	0.7	-2.6	0.8	-2.5	1.1	-1.8	1.1	-1.8	1.1	-1.8	0.9	-2.1	0.4	-2.5
8	1.0	-0.2	1.0	-0.2	1.1	-0.1	1.1	-0.1	0.9	-0.3	0.9	-0.3	0.9	-0.3	1.1	-0.2	1.2	-0.1
9	1.1	-0.3	1.1	-0.3	1.1	-0.2	1.0	-0.3	1.2	-0.7	1.1	-0.6	1.1	-0.7	1.0	-0.9	0.8	-1.0
10	0.7	-0.4	0.7	-0.4	0.7	-0.4	0.7	-0.5	0.8	-0.7	0.8	-0.7	0.8	-0.7	0.7	-0.8	0.6	-0.9
11	1.0	-0.1	1.0	-0.1	1.0	0.0	0.9	-0.2	1.1	-0.4	1.0	-0.5	1.0	-0.5	0.9	-0.7	0.8	-0.8
12	0.3	0.1	0.3	0.1	0.4	0.1	0.3	0.1	0.5	-0.1	0.4	0.1	0.4	0.1	0.3	-0.1	0.4	-0.1
13	0.6	-0.7	0.6	-0.7	0.6	-0.6	0.6	-0.7	0.8	-0.7	0.6	-0.7	0.8	-0.7	0.6	-0.8	0.6	-0.8
14	0.4	-0.6	0.4	-0.6	0.5	-0.6	0.4	-0.6	0.8	-0.4	0.6	-0.4	0.6	-0.4	0.5	-0.5	0.4	-0.6
15	1.4	1.0	1.4	1.0	1.6	1.2	1.3	0.9	1.8	0.9	1.7	0.9	1.7	0.9	1.2	0.1	1.1	0.1
16	1.7	1.2	1.6	1.2	1.9	1.4	1.6	1.1	2.1	1.3	2.0	1.3	2.0	1.3	1.4	0.2	1.6	0.3
17	1.2	-0.9	1.2	-0.9	1.3	-0.8	1.1	-1.0	1.4	-0.5	1.4	-0.6	1.4	-0.6	1.1	-1.1	1.0	-1.2
18	1.1	-0.9	1.1	-0.8	1.2	-0.8	1.0	-1.0	1.3	-0.2	1.3	-0.3	1.3	-0.3	1.0	-1.0	0.9	-1.1
19	1.5	1.4	1.5	1.4	1.6	1.6	1.4	1.3	1.8	1.8	1.8	1.7	1.8	1.7	1.2	1.0	1.1	1.0

TABLE A3-10 CONT.

Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	420	-1138	3884	12	1879	-2155	1440
2	1150	-714	383	-432	172	-630	514
3	1197	-994	3026	-660	610	-1087	903
4	170	253	227	311	282	-192	77
5	4932	-5192	5256	-2981	3013	-6241	4928
6	3169	-3584	3648	-2183	2156	-4276	3401
7	5880	-6167	6183	-3557	3568	-7268	5786
8	2690	2708	2700	1625	1619	3130	2613
9	2319	1603	600	1294	1291	866	882
10	297	198	124	190	190	55	59
11	2331	1615	1613	1308	1305	893	896
12	334	214	210	208	205	172	162
13	71	-46	46	-27	28	-116	67
14	44	-2	3	21	20	-11	12
15	2750	1863	1856	1575	1570	1223	1132
16	2756	1866	1859	1580	1575	1233	1137
17	1026	183	190	256	261	-271	157
18	1053	200	206	275	279	-220	129
19	3845	2085	2085	1871	1871	1086	1048

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.98	1.94	1.9	1.98	1.98	1.88	1.92
2	1.92	1.78	1.74	1.81	1.78	1.71	1.78
3	1.75	1.72	1.67	1.74	1.72	1.65	1.69
4	1.76	1.72	1.68	1.74	1.72	1.65	1.7
5	1.73	1.65	1.61	1.69	1.67	1.63	1.61
6	1.73	1.66	1.62	1.69	1.67	1.63	1.62
7	1.64	1.54	1.5	1.59	1.57	1.52	1.49
8	1.58	1.48	1.44	1.53	1.51	1.45	1.42
9	1.72	1.55	1.51	1.6	1.58	1.47	1.47
10	1.53	1.42	1.38	1.47	1.45	1.37	1.34
11	2.21	1.91	1.87	1.96	1.93	1.71	1.78
12	2.21	1.92	1.88	1.96	1.94	1.67	1.74
13	1.67	1.59	1.55	1.63	1.61	1.54	1.54
14	2.45	2.08	2.04	2.09	2.07	1.72	1.88
15	2.82	2.25	2.21	2.27	2.25	1.89	1.97
16	3.4	2.56	2.52	2.56	2.53	2.08	2.18
17	1.84	1.81	1.77	1.83	1.87	1.69	1.75
18	2.37	2.65	2.61	2.66	2.64	2.23	2.33
19	6.98	6.35	6.33	6.03	6.02	4.42	4.43

Minimum and Maximum Velocity

Ref. No.	Oct. MAX.	Oct. MIN.	Nov. 1-15 MAX.	Nov. 1-15 MIN.	Nov. 16-30 MAX.	Nov. 16-30 MIN.	Dec. 1-16 MAX.	Dec. 1-16 MIN.	Dec. 17-31 MAX.	Dec. 17-31 MIN.	Aug. MAX.	Aug. MIN.	Sep. MAX.	Sep. MIN.
1	1.2	1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4
2	0.3	-0.8	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.6	0.4	-0.5
3	0.1	-0.4	0.1	-0.4	0.1	-0.5	0.2	-0.3	0.2	-0.3	0.1	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.3	-0.4	0.0	-0.1
5	0.0	-1.3	0.7	-1.5	0.7	-1.5	0.8	-1.3	0.8	-1.3	0.4	-1.4	0.0	-1.3
6	0.5	-1.6	0.7	-1.5	0.7	-1.5	0.8	-1.4	0.8	-1.4	0.4	-1.5	0.0	-1.5
7	0.7	-2.3	0.8	-2.6	0.8	-2.6	0.9	-2.2	0.9	-2.2	0.4	-2.5	0.7	-2.3
8	1.0	-0.1	1.1	-0.1	1.1	-0.1	0.9	-0.2	0.9	-0.2	1.2	-0.1	1.1	-0.1
9	1.1	-0.7	1.0	-0.3	1.0	-0.3	1.1	-0.6	1.1	-0.6	0.9	-1.0	0.9	-0.9
10	0.3	-0.8	0.7	-0.4	0.7	-0.4	0.8	-0.6	0.8	-0.6	0.6	-0.9	0.7	-0.8
11	1.0	-0.6	0.9	-0.2	0.9	-0.4	0.9	-0.4	0.9	-0.4	0.8	-0.9	0.9	-0.9
12	0.6	0.0	0.3	0.1	0.3	0.1	0.3	0.0	0.3	0.0	0.3	-0.2	0.3	-0.2
13	0.7	-0.8	0.6	-0.7	0.5	-0.7	0.6	-0.7	0.7	-0.7	0.6	-0.8	0.6	-0.8
14	0.6	-0.4	0.4	-0.6	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.3	-0.7	0.3	-0.7
15	1.8	1.03	1.3	0.9	1.3	0.9	1.3	0.7	1.3	0.7	1.0	-0.3	1.0	-0.4
16	2.1	1.5	1.5	1.0	1.5	1.0	1.4	0.7	1.4	0.7	1.3	-0.3	1.2	-0.3
17	1.4	-0.7	1.1	-1.0	1.1	-1.0	1.2	-1.0	1.2	-1.0	1.0	-1.2	1.0	-1.2
18	1.3	-0.4	1.0	-1.0	1.0	-1.0	1.0	-0.9	1.0	-0.9	0.8	-1.2	0.9	-1.1
19	1.8	1.8	1.3	1.2	1.3	1.2	1.2	1.1	1.2	1.1	0.9	0.7	0.9	0.6

TABLE A3-11

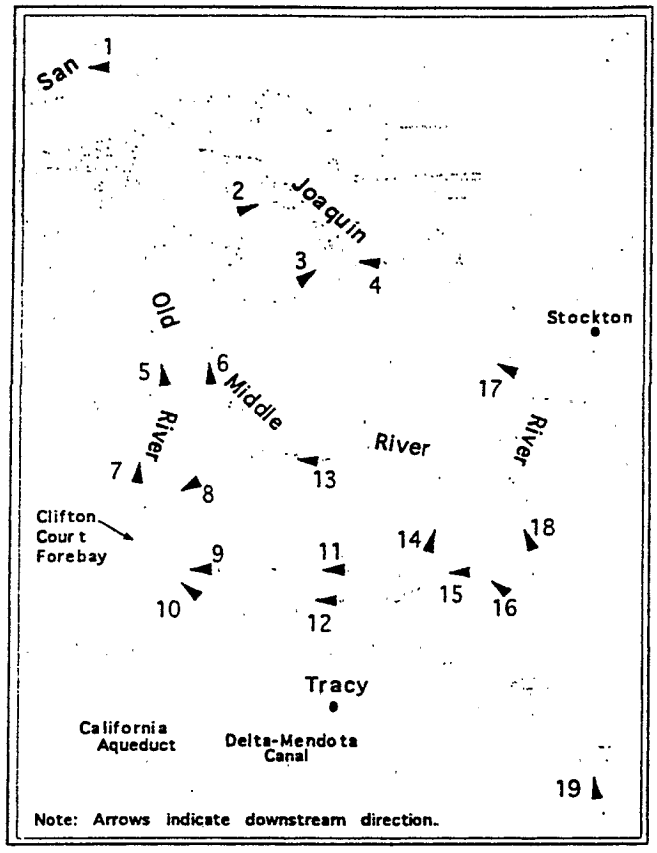
Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	6558	7258	14254	24679	11068	2429	558
2	-2486	-2738	-3817	-5606	-3474	-1798	-1057
3	-1498	-1651	-1631	-2090	-1688	-1426	-1108
4	2356	2842	6228	10458	7539	2666	1432
5	-5018	-5179	-542	3170	461	-4408	-3951
6	-3770	-3937	-921	1375	-124	-3233	-2879
7	-6336	-6381	-1121	3048	266	-5191	-4556
8	2933	2974	851	-926	193	2275	1992
9	2379	2911	6664	10675	8873	3567	2287
10	353	385	1204	2222	1594	381	209
11	2374	2917	6671	10719	8922	3610	2326
12	313	401	1181	2280	1732	557	374
13	39	47	419	812	535	7	-72
14	8	42	383	818	611	151	85
15	2632	3349	8145	13813	11372	4542	3007
16	2634	3362	8205	13919	11464	4576	3019
17	788	1438	4882	8613	6878	2350	1255
18	765	1440	4941	8985	7184	2440	1331
19	3406	4847	13275	23135	18901	7189	4462

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	2.4	2.5	2.6	3.1	2.4	2.0	2.0
2	2.3	2.3	2.5	3.0	2.3	1.9	1.8
3	2.2	2.3	2.5	3.0	2.2	1.8	1.8
4	2.2	2.3	2.5	3.0	2.2	1.8	1.8
5	2.2	2.2	2.4	3.0	2.2	1.8	1.7
6	2.2	2.2	2.4	3.0	2.2	1.8	1.7
7	2.1	2.1	2.4	3.1	2.3	1.8	1.6
8	2.0	2.1	2.5	3.3	2.4	1.7	1.5
9	2.1	2.2	2.9	4.2	3.2	1.9	1.7
10	2.0	2.0	2.6	3.7	2.7	1.7	1.5
11	2.5	2.7	4.3	6.3	5.1	2.7	2.2
12	2.5	2.7	4.3	6.2	5.0	2.6	2.2
13	2.1	2.2	2.5	3.2	2.4	1.8	1.6
14	2.8	3.1	5.3	7.8	6.5	3.0	2.3
15	3.0	3.4	6.6	10.0	8.4	3.9	2.9
16	3.5	4.1	8.3	12.5	10.7	5.0	3.6
17	2.4	2.5	3.4	4.8	3.8	2.2	2.0
18	3.5	4.1	7.7	11.4	9.7	4.7	3.5
19	8.4	10.3	18.1	24.7	22.0	12.8	9.7



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.3	-1.3	1.3	-1.3	1.3	-1.2	1.4	-1.1	1.3	-1.2	1.2	-1.3	1.2	-1.3
2	0.2	-0.6	0.2	-0.7	0.0	-0.7	-0.2	-0.8	0.1	-0.7	0.3	-0.7	0.3	-0.6
3	0.0	-0.4	0.0	-0.5	0.0	-0.5	0.0	-0.5	0.1	-0.5	0.0	-0.4	0.1	-0.4
4	0.4	-0.3	0.5	-0.3	0.6	-0.1	0.7	0.1	0.6	-0.1	0.5	-0.3	0.4	-0.3
5	0.6	-1.4	0.6	-1.4	1.0	-1.2	1.1	-0.8	0.9	-1.0	0.5	-1.3	0.7	-1.3
6	0.6	-1.5	0.5	-1.6	0.9	-1.3	1.0	-1.0	0.8	-1.1	0.4	-1.4	0.7	-1.4
7	0.8	-2.6	0.7	-2.6	1.4	-1.9	1.7	-1.0	1.4	-1.5	0.7	-2.3	0.9	-2.1
8	1.1	-0.1	1.1	-0.1	0.8	-0.4	0.4	-0.6	0.6	-0.5	1.0	-0.2	1.0	-0.2
9	1.1	-0.2	1.1	-0.1	1.8	0.7	2.3	1.2	2.1	1.0	1.3	-0.3	1.2	-0.7
10	0.7	-0.4	0.7	-0.4	1.1	0.0	1.5	0.2	1.4	0.1	0.9	-0.6	0.7	-0.8
11	1.0	0.0	1.1	0.1	1.7	0.9	2.2	1.5	2.0	1.2	1.3	-0.1	1.1	-0.5
12	0.4	0.1	0.5	0.2	1.0	0.6	1.4	1.1	1.3	0.9	0.7	0.2	0.5	0.1
13	0.6	-0.6	0.6	-0.6	0.7	-0.6	1.0	-0.6	0.9	-0.5	0.7	-0.7	0.6	-0.8
14	0.5	-0.8	0.6	-0.6	1.3	0.9	1.9	1.7	1.7	1.5	0.9	0.2	0.7	-0.3
15	1.6	1.2	2.0	1.6	3.7	3.3	5.1	4.8	4.6	4.3	2.6	1.8	1.9	1.2
16	2.0	1.5	2.4	1.9	4.3	4.0	5.9	5.6	5.3	5.0	3.0	2.3	2.3	1.6
17	1.3	-0.8	1.5	-0.5	2.7	1.6	3.9	3.0	3.4	2.5	1.8	0.3	1.4	-0.5
18	1.2	-0.7	1.4	-0.2	2.6	2.1	3.5	3.3	3.2	2.9	1.8	1.0	1.4	-0.1
19	1.7	1.6	2.1	2.0	3.4	3.4	4.5	4.5	4.1	4.1	2.5	2.5	2.0	1.9

TABLE A3-11 CONT.

Future Demand Case Study (Run 411)
Base Condition Without ISDP
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	644	-2507	1928	-315	1212
2	399	-604	1219	-640	1367
3	728	-1011	1190	-892	1264
4	140	294	512	481	1558
5	3503	-5428	5550	-3899	4765
6	2505	-3723	3982	-2802	3382
7	4169	-6445	6848	-4531	5702
8	1955	2838	2994	1992	2528
9	1077	1487	1420	1419	2688
10	158	194	198	139	351
11	1090	1497	1435	1446	2698
12	179	199	212	258	390
13	233	-43	17	-68	26
14	35	-13	7	36	69
15	1521	1703	1651	1911	3182
16	1325	1705	1657	1920	3189
17	185	62	70	340	1432
18	103	72	111	395	1458
19	1448	1792	1671	2392	4688

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	1.96	1.98	2.31	1.96	2.01
2	1.78	1.83	2.17	1.79	1.85
3	1.72	1.77	2.11	1.73	1.79
4	1.72	1.77	2.11	1.73	1.79
5	1.65	1.7	2.03	1.65	1.76
6	1.66	1.71	2.05	1.67	1.78
7	1.54	1.59	1.93	1.54	1.67
8	1.48	1.53	1.87	1.48	1.62
9	1.55	1.59	1.91	1.55	1.75
10	1.42	1.46	1.8	1.41	1.66
11	1.88	1.92	2.2	1.93	2.35
12	1.88	1.92	2.18	1.9	2.35
13	1.59	1.63	1.95	1.58	1.71
14	2.01	2.07	2.31	2.01	2.67
15	2.14	2.2	2.43	2.3	3.12
16	2.38	2.47	2.68	2.66	3.82
17	1.79	1.85	2.17	1.83	2.03
18	2.52	2.58	2.61	2.75	3.74
19	5.26	5.85	5.72	6.84	10.05

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec.		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	[illegible]	[illegible]	1.2	-1.4	[illegible]	-1.4	1.2	-1.3	[illegible]	[illegible]
2	0.1	[illegible]	0.4	-0.5	0.4	-0.6	0.4	-0.5	[illegible]	[illegible]
3	0.1	-0.3	0.1	-0.3	0.0	-0.4	0.1	-0.4	0.1	[illegible]
4	0.1	[illegible]	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.0	0.0
5	0.7	-1.2	0.7	-1.5	0.6	-1.5	0.7	-1.3	[illegible]	[illegible]
6	0.8	-1.3	0.7	-1.5	0.6	-1.6	0.7	-1.4	[illegible]	[illegible]
7	0.8	-2.0	0.8	-2.6	0.7	-2.6	0.8	-2.1	0.7	-2.3
8	1.0	[illegible]	1.1	-0.1	1.1	-0.1	1.0	-0.1	[illegible]	[illegible]
9	1.0	0.0	1.0	-0.3	1.0	-0.4	1.1	-0.8	[illegible]	[illegible]
10	0.7	-0.2	0.7	-0.4	0.7	-0.5	0.7	-0.8	[illegible]	[illegible]
11	1.0	-0.7	0.9	-0.2	0.9	-0.2	1.0	-0.6	[illegible]	[illegible]
12	[illegible]	-0.1	0.3	0.1	0.3	0.0	0.4	0.0	[illegible]	[illegible]
13	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.7	-0.8
14	0.4	-0.6	0.4	-0.6	0.4	-0.7	0.5	-0.5	[illegible]	[illegible]
15	1.2	-0.1	1.2	0.8	1.2	-0.7	1.4	0.6	[illegible]	-1.2
16	1.3	-0.0	1.5	0.9	1.5	-0.9	1.6	0.9	[illegible]	[illegible]
17	[illegible]	-1.1	1.1	-1.1	1.0	-1.1	1.2	-1.0	[illegible]	-0.4
18	1.0	-1.0	1.0	-1.1	0.9	-1.1	1.1	-0.8	1.4	0.0
19	1.1	-0.9	1.2	1.1	1.1	1.0	1.4	1.3	2.0	2.0

Figure A3-12

PROPOSED BARRIER OPERATION FOR FINAL ISDP EIR/EIS

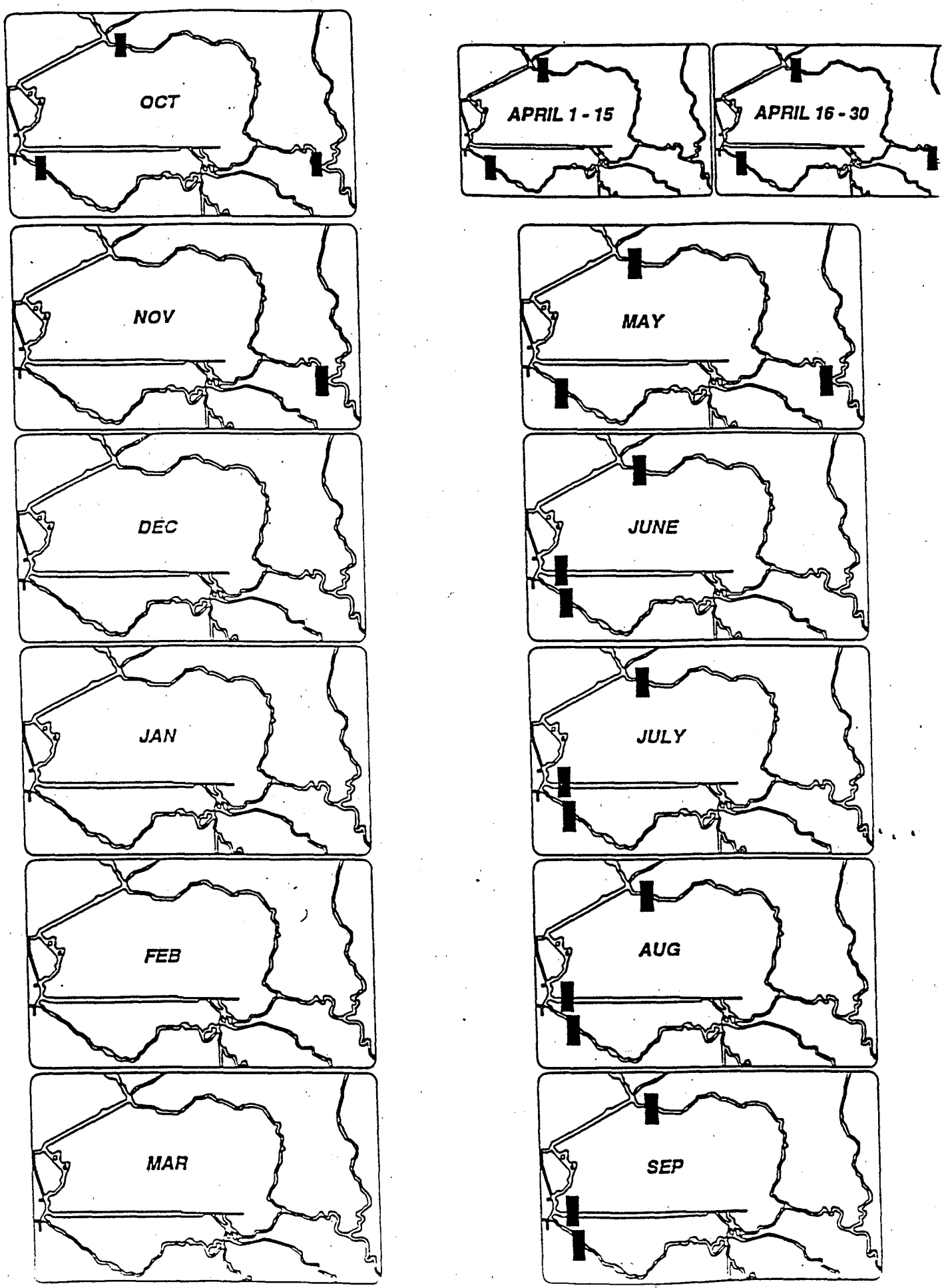
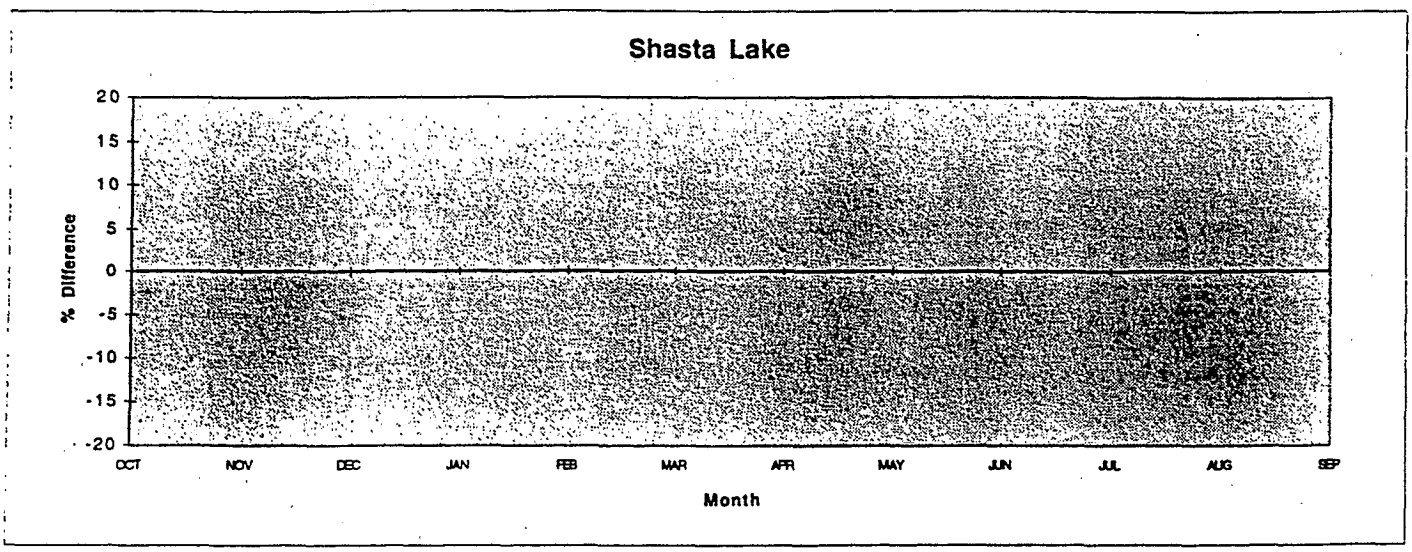
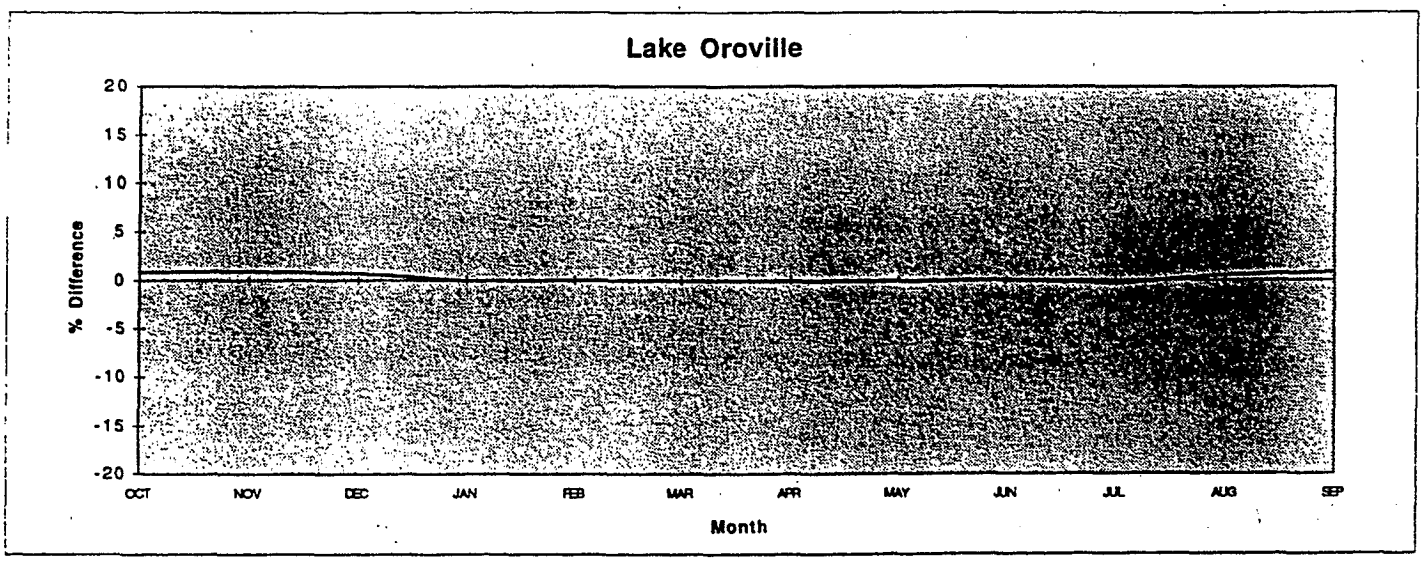


Figure A3-13
Existing Demand Case - Percent Difference
between ISDP and Base Condition
End of Month Storage





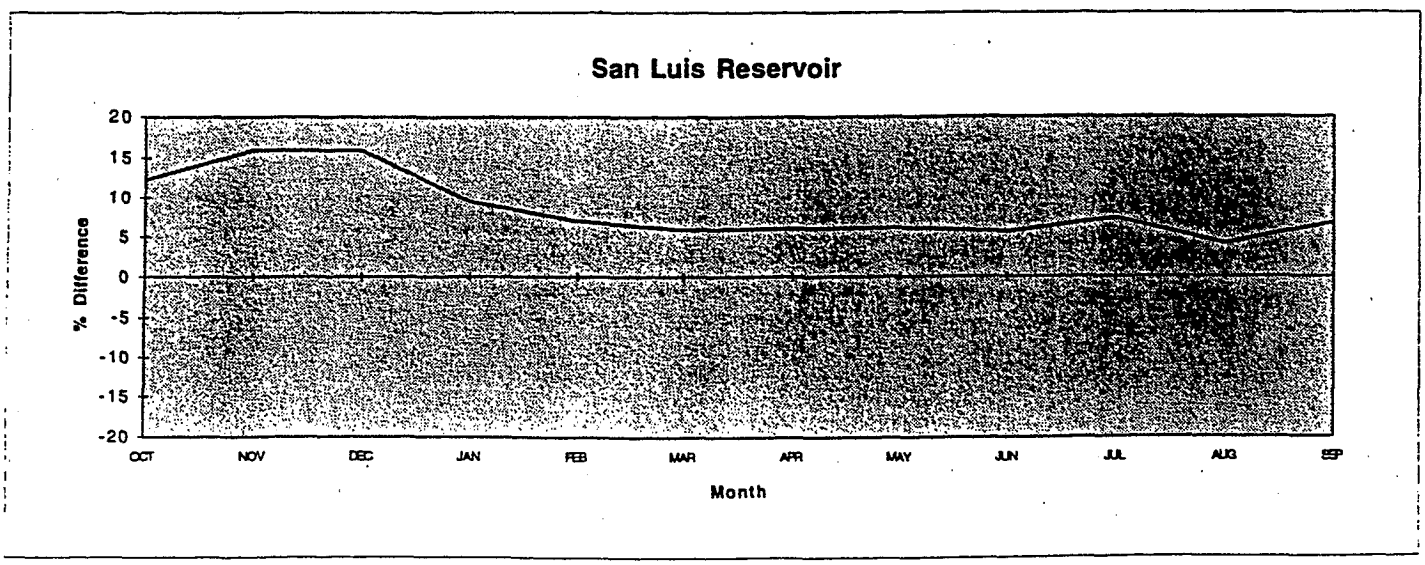
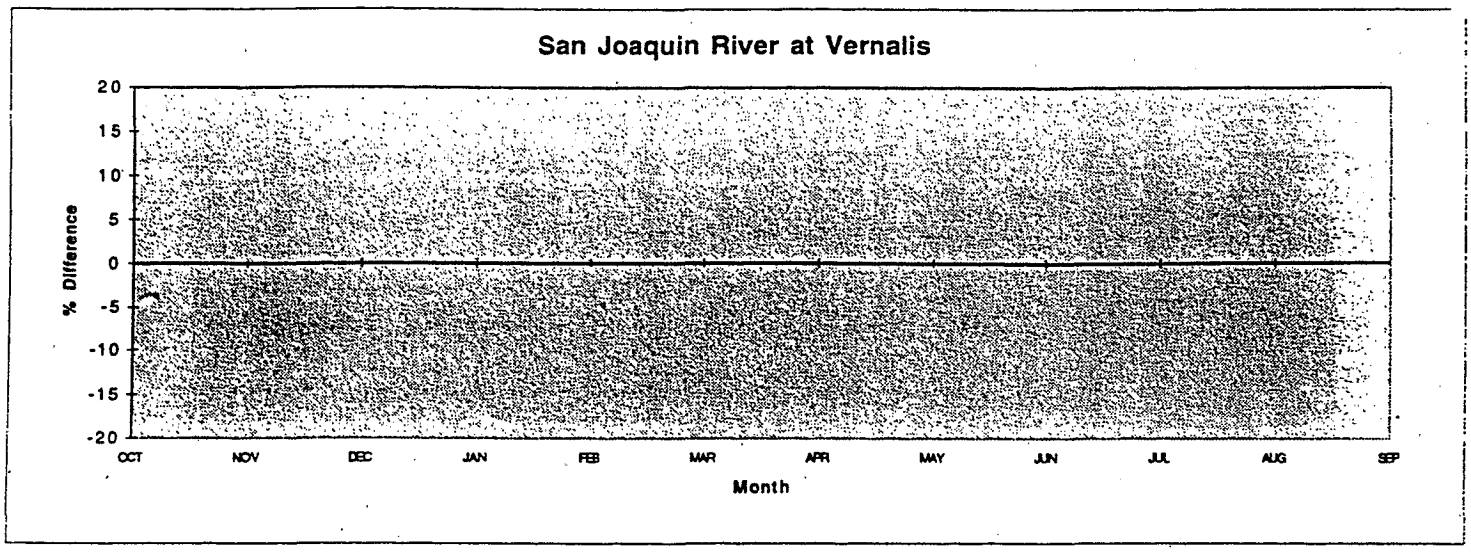
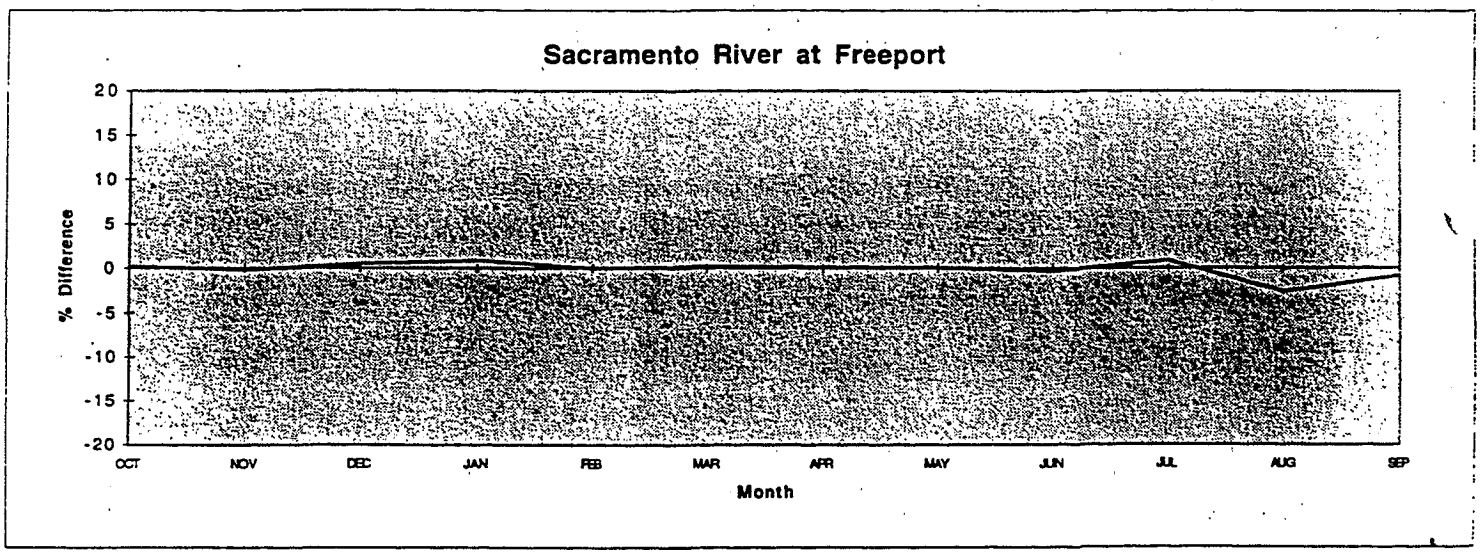


Figure A3-14
Existing Demand Case - Percentage Difference
between ISDP and Base Condition
River Flows





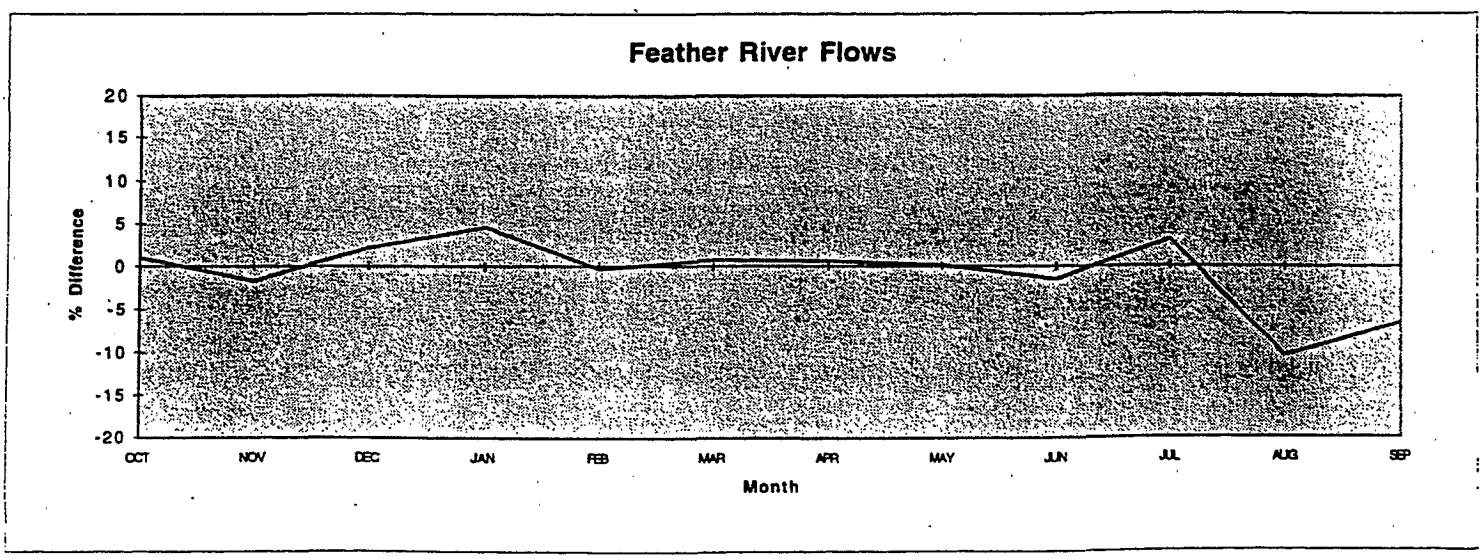
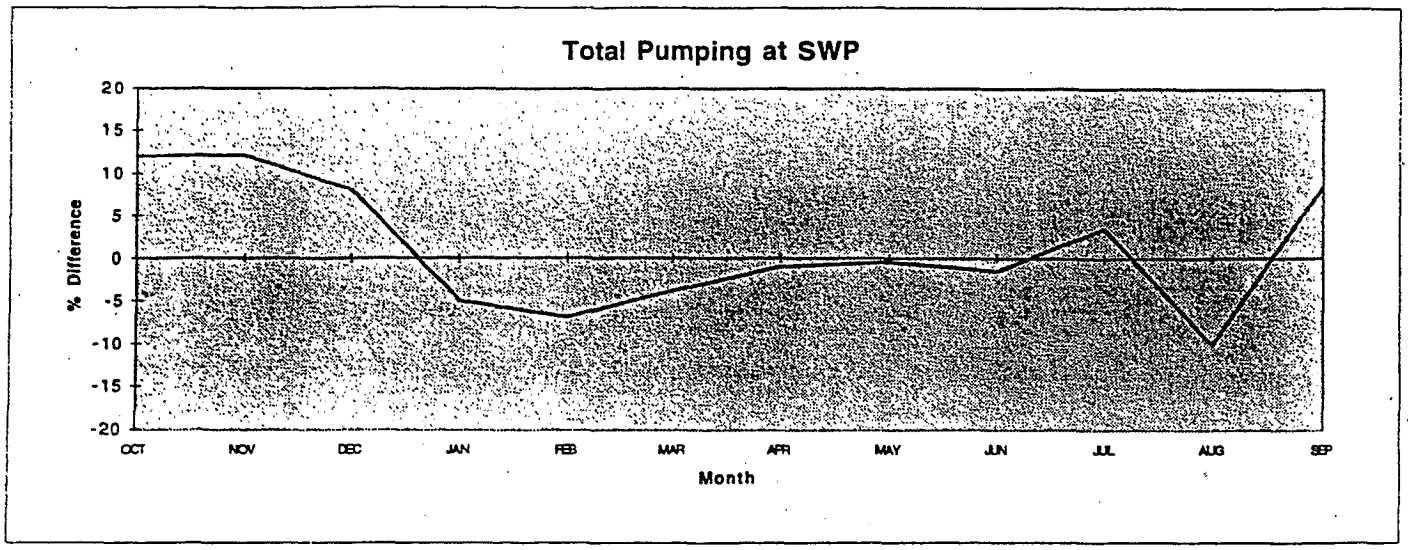
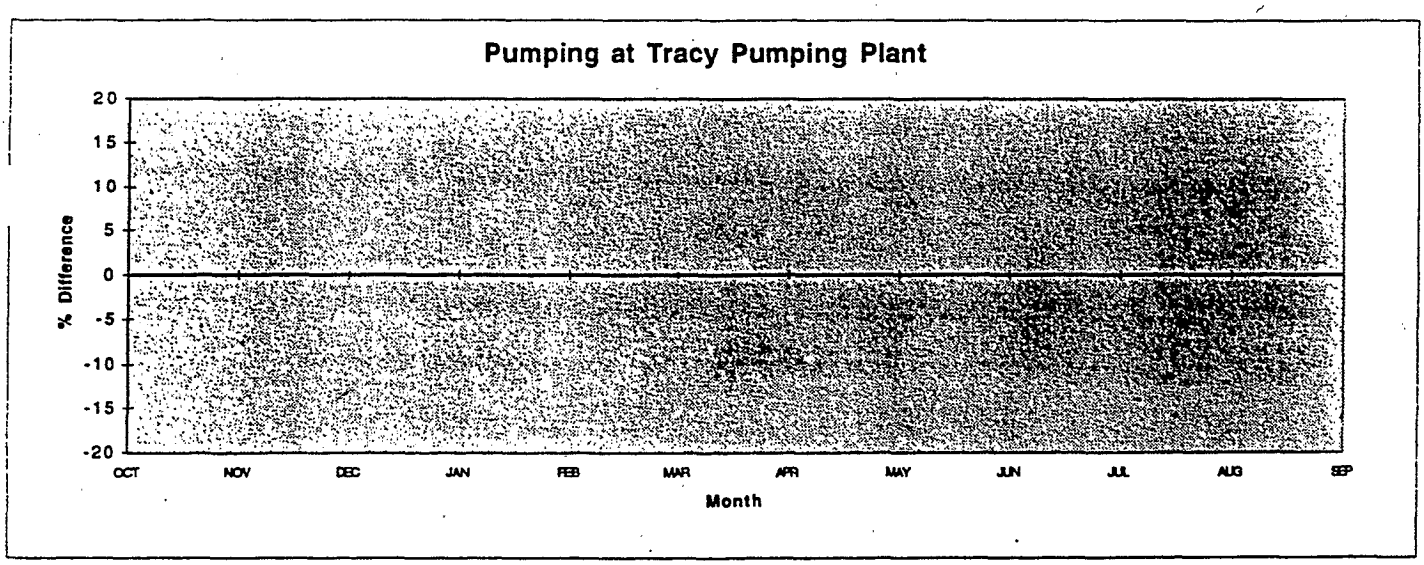


Figure A3-15
Existing Demand Case - Percent Difference
between ISDP and Base Condition
Delta Exports





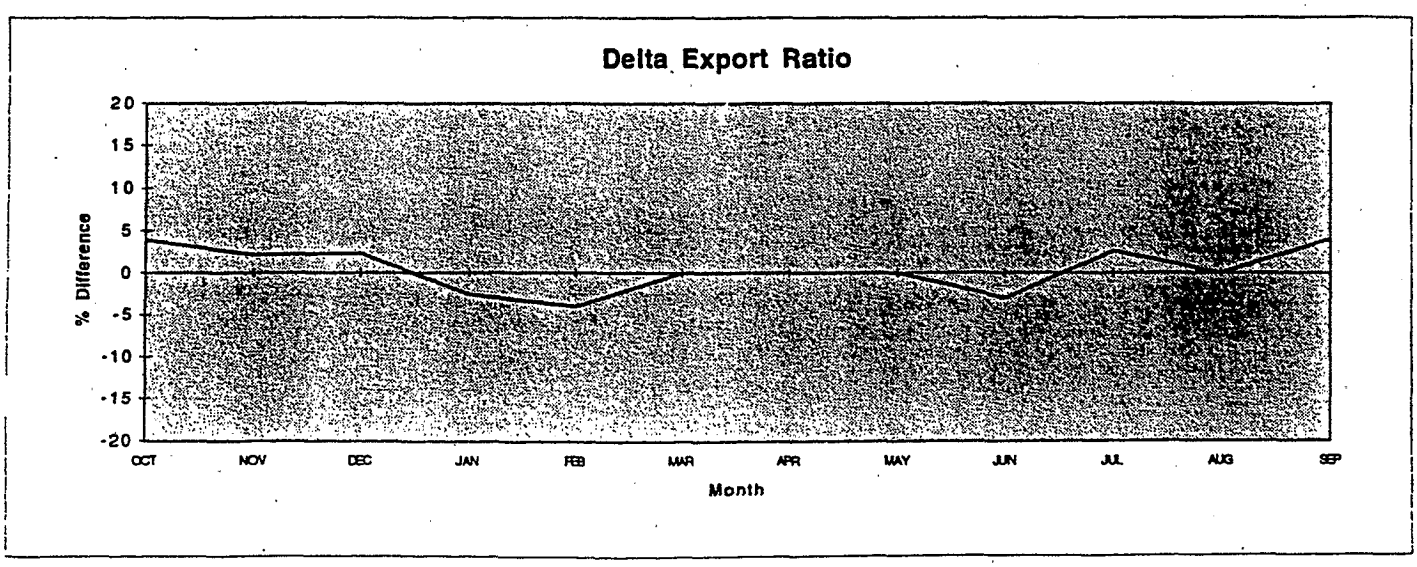
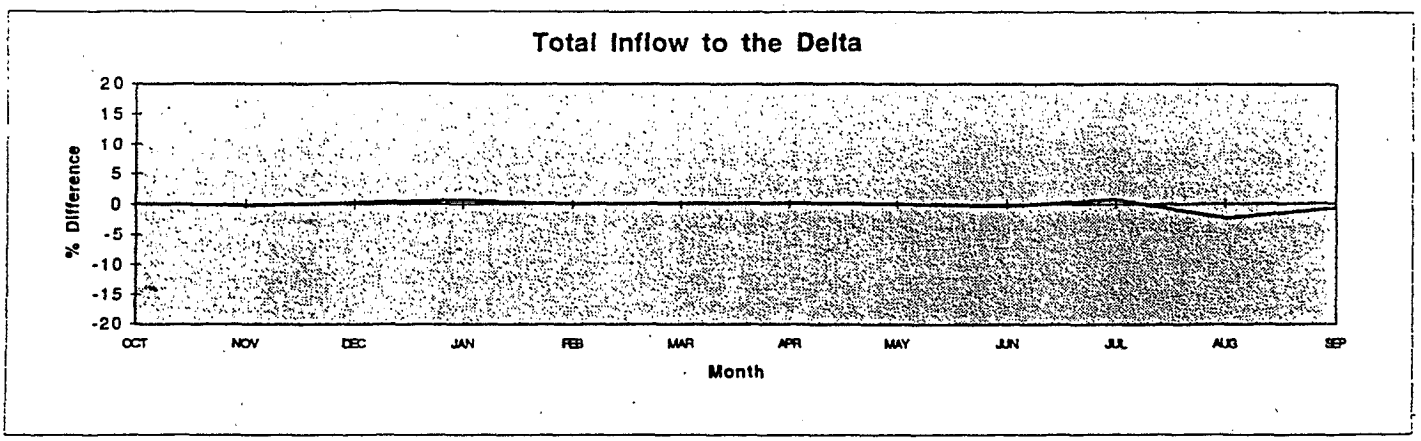
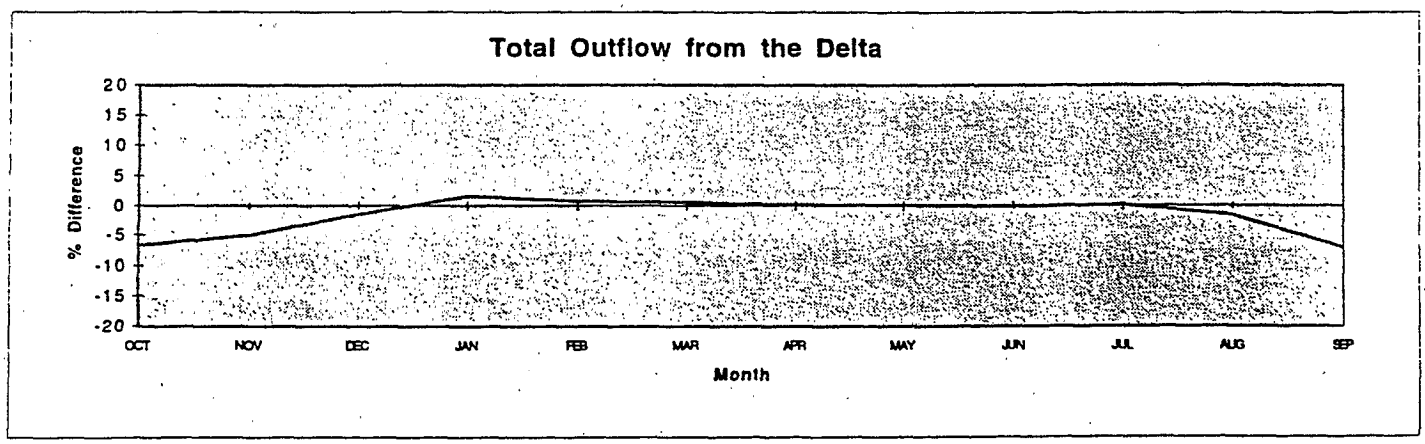
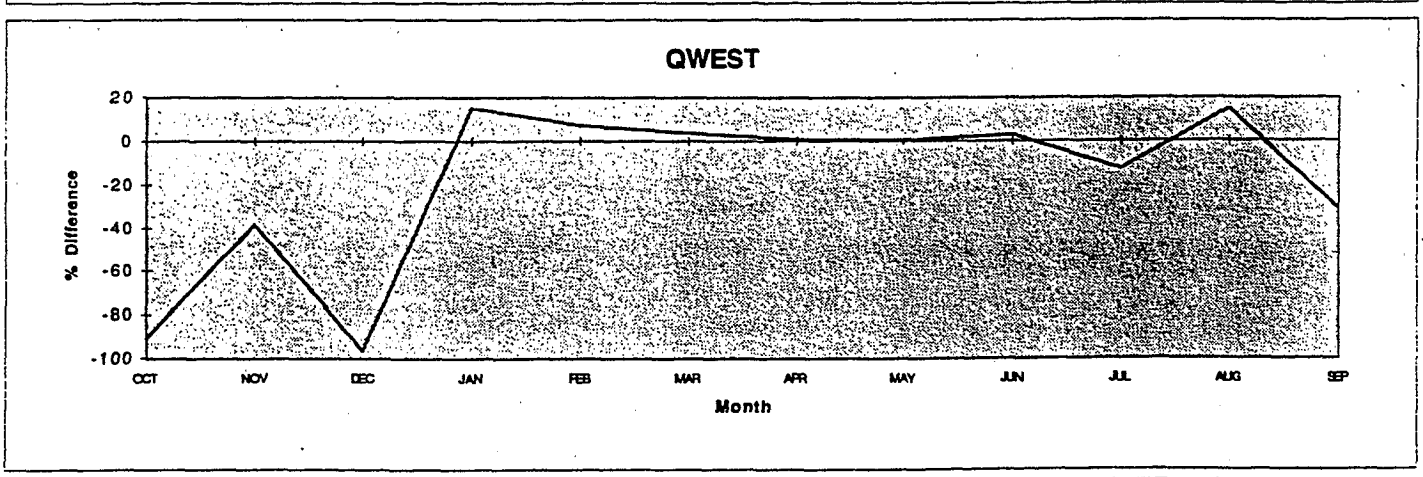


Figure A3-16
Existing Demand Case - Percent Difference between ISDP and Base Condition Delta Inflow and Outflow







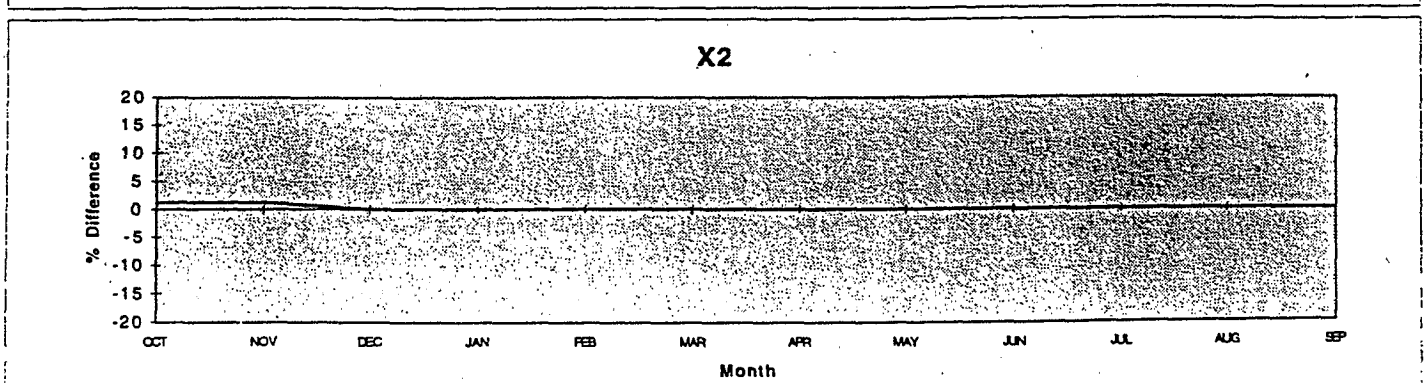


TABLE A3-12

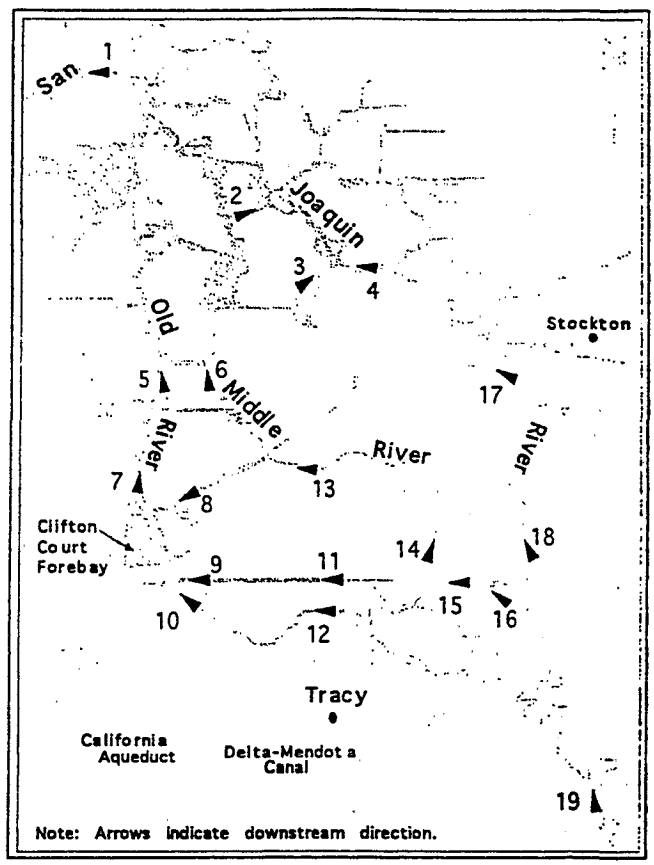
Existing Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 413 - Run 420)
Representative Critical Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	-5	-27	-27	72	9	69	52	51	12	-93
2	-59	-53	-61	-148	-51	-631	-593	-601	-157	-187
3	4	2	5	58	-18	-403	-402	-398	-97	-80
4	90	90	97	153	141	1445	1377	1378	440	393
5	-235	-234	-249	-368	-106	-883	-828	-833	-335	-578
6	68	65	66	260	-33	-553	-555	-555	-105	-144
7	-398	-401	-417	-633	-176	-1157	-1081	-1080	-576	-903
8	-197	-199	-197	-460	-160	168	194	196	-199	-217
9	-87	-89	-102	-176	439	-791	-736	-728	-174	-152
10	-18	-18	-13	-2	-454	-533	-522	-530	-207	-180
11	-87	-88	-101	-175	440	-791	-738	-728	-174	-153
12	-17	-17	-12	-2	-457	-537	-525	-534	-210	-183
13	12	12	14	27	-134	-160	-155	-158	-71	-68
14	13	13	14	27	-133	-159	-155	-158	-72	-68
15	-91	-92	-100	-150	-148	-1480	-1409	-1413	-456	-404
16	-91	-92	-99	-150	-147	-1480	-1410	-1413	-456	-404
17	90	91	99	149	147	1476	1406	1410	457	404
18	91	91	100	150	148	1484	1414	1417	459	406
19	0	0	-1	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
7	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1
8	0.0	0.0	0.0	0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1
9	0.1	0.1	0.1	0.1	0.1	-0.1	-0.1	-0.1	1.6	1.5
10	0.0	0.0	0.0	0.1	1.3	1.0	0.9	0.9	2.2	2.0
11	0.1	0.1	0.1	0.1	0.3	-0.2	-0.2	-0.2	1.7	1.6
12	0.1	0.1	0.1	0.1	0.8	0.3	0.3	0.3	2.0	1.8
13	0.0	0.0	0.0	0.0	2.3	2.1	2.1	2.1	2.2	2.0
14	0.1	0.1	0.1	0.1	1.8	1.3	1.3	1.3	2.0	1.8
15	0.1	0.1	0.1	0.1	0.4	-0.5	-0.5	-0.5	1.6	1.5
16	0.1	0.1	0.1	0.1	0.3	-0.9	-0.8	-0.8	1.4	1.4
17	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0
18	0.1	0.1	0.1	0.1	0.1	1.4	1.4	1.4	0.5	0.4
19	0.0	0.0	0.0	0.1	0.1	0.9	0.9	0.9	0.3	0.4



Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.2	-0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.2	-0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
7	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.1	-0.2	-0.2	-0.1	-0.2	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	-0.2	-0.1
8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.1	0.3	0.1	0.3	0.1	0.2	0.1	0.2	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.1	0.0	-0.2	0.0	-0.1	0.0	-0.1	0.0	0.3	0.0	0.3
10	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	-0.7	0.1	-0.7	-0.1	-0.7	-0.1	-0.7	0.0	-0.7	0.1	-0.7	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.2	0.0	-0.1	-0.2	0.0	-0.2	-0.1	-0.2	0.0	0.2	0.0	0.3
12	0.1	-0.1	0.1	-0.1	0.1	0.0	0.0	-0.1	-0.1	-0.4	-0.2	-0.5	-0.2	-0.4	-0.2	-0.4	0.0	-0.3	0.0	-0.2
13	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.6	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.2	-0.6	0.2	-0.6	0.1
14	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	-0.2	-0.3	-0.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	0.0	-0.2	0.1
15	0.0	-0.2	0.0	-0.2	0.0	-0.2	0.0	-0.2	-0.1	0.0	-1.0	-0.5	-0.9	-0.5	-0.9	-0.5	-0.3	0.2	-0.3	0.2
16	0.0	-0.3	0.0	-0.3	0.0	-0.4	-0.1	-0.4	-0.1	0.0	-1.3	-0.5	-1.3	-0.4	-1.3	-0.4	-0.4	0.1	-0.4	0.2
17	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.4	1.0	0.4	0.9	0.4	0.9	0.1	0.2	0.1	0.1
18	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.6	1.3	0.6	1.3	0.5	1.2	0.2	0.2	0.2	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.0

TABLE A3-12 CONT.

Existing Demand Case Study (Run 413-Run 420)
Project-Base (Difference) Demand Condition
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct.	Nov. 1-15	Nov. 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	59	-15	-125	-27	-69	-38	-14
2	-618	-543	-513	-64	-55	-145	-164
3	-405	-312	-318	-3	-5	-122	-108
4	1413	1045	1045	85	84	390	440
5	-871	-940	-938	-279	-276	-314	-352
6	-536	-490	-491	37	35	-192	-162
7	-1153	-1235	-1238	-443	-446	-466	-550
8	142	215	212	-167	-170	-72	-131
9	-750	-883	-883	-87	-87	-55	-114
10	-544	-149	-149	-12	-11	-241	-241
11	-750	-883	-884	-87	-87	-55	-113
12	-547	-151	-151	-12	-11	-244	-244
13	-180	-30	-30	13	12	-104	-99
14	-159	-31	-30	12	12	-104	-99
15	-1449	-1066	-1065	-86	-86	-403	-456
16	-1449	-1067	-1066	-87	-86	-403	-457
17	1445	1065	1065	85	85	404	457
18	1454	1070	1069	86	85	405	459
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.02	0	0	0	0	-0.02	-0.02
2	-0.02	0	0	0	0.01	-0.03	-0.03
3	-0.02	0	-0.01	0	0	-0.05	-0.04
4	-0.02	0	0	0	0	-0.04	-0.03
5	-0.05	-0.01	-0.02	0	0	-0.17	-0.17
6	-0.03	-0.01	-0.01	0	0	-0.13	-0.12
7	-0.08	-0.05	-0.05	-0.01	0	-0.22	-0.2
8	-0.09	-0.05	-0.05	0	0.01	-0.22	-0.18
9	-0.05	-0.08	-0.07	0.1	0.09	1.63	1.81
10	1.09	-0.06	-0.07	0.02	0.01	2.13	2.22
11	-0.18	-0.29	-0.29	0.08	0.07	1.62	1.85
12	0.4	-0.32	-0.33	0.07	0.07	1.88	1.93
13	2.2	-0.05	-0.05	0	0	2.29	2.34
14	1.36	-0.41	-0.4	0.06	0.05	1.92	1.95
15	-0.52	-0.63	-0.62	0.08	0.07	1.55	1.57
16	-0.84	-0.88	-0.88	0.08	0.07	1.4	1.41
17	0.18	0.14	0.13	0.01	0.02	0	0.01
18	1.42	1.1	1.08	0.06	0.08	0.46	0.47
19	0.92	0.78	0.76	0.05	0.04	0.42	0.36

Minimum and Maximum Velocity

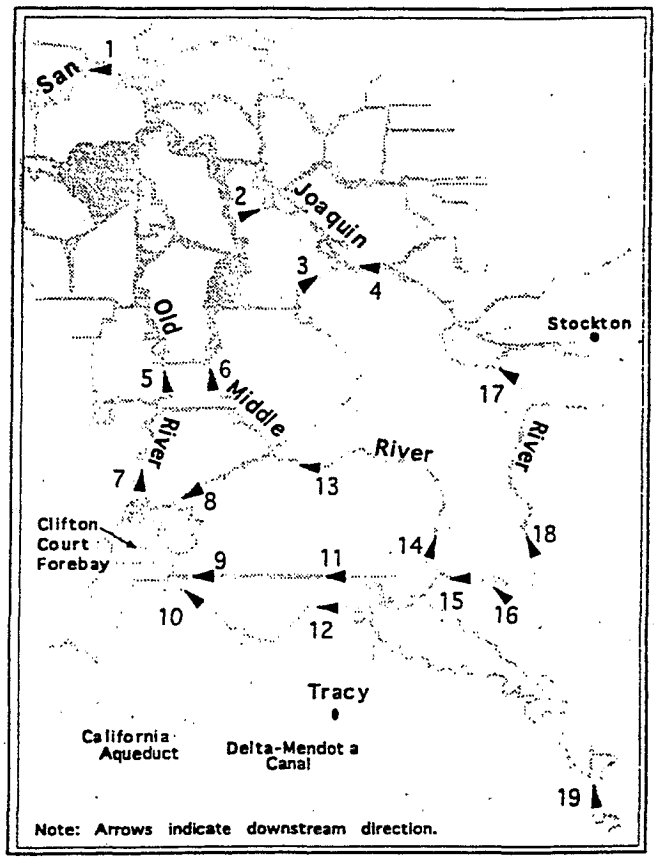
Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	-0.3	0.0	-0.3	0.1	-0.2	0.0	-0.2	-0.1	0.0	0.0	0.0
6	0.0	0.0	0.0	-0.2	0.0	-0.2	0.1	-0.1	0.1	-0.1	-0.1	0.1	0.0	0.1
7	-0.2	-0.2	-0.1	-0.3	-0.1	-0.3	-0.1	-0.1	-0.1	-0.1	-0.4	0.4	-0.3	-0.1
8	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.2	0.1
9	0.0	-0.2	-0.1	-0.2	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
10	-0.8	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	-0.7	0.1	-0.7	0.1
11	0.0	-0.2	-0.1	-0.3	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
12	-0.1	-0.5	0.0	-0.2	0.0	-0.2	0.1	0.0	-0.1	0.0	-0.1	-0.1	0.0	-0.2
13	-0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	0.2	-0.6	0.2
14	-0.4	-0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	-0.4	-0.1	-0.3	0.1
15	1.0	-0.6	-0.8	-0.4	-0.8	-0.4	0.0	-0.2	0.0	-0.2	-0.3	0.2	-0.3	0.3
16	-1.3	-0.5	-1.1	-0.1	-1.1	-0.2	0.0	-0.4	0.0	-0.4	-0.4	0.2	-0.4	0.3
17	0.4	1.0	0.3	0.6	0.3	0.6	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2
18	0.6	1.3	0.5	0.6	0.5	0.6	0.0	0.0	0.0	0.0	0.2	0.1	0.2	0.1
19	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0

TABLE A3-13

Existing Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 413 - Run 420)
Representative Dry Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	88	97	203	20	124	92	97	32	59
2	-64	-72	-66	-49	-1096	-826	-841	-172	-273
3	36	45	55	-5	-813	-507	-502	-75	-53
4	100	103	108	137	2388	1872	1876	451	510
5	-137	-143	-40	-110	-1464	-1134	-1140	-343	-538
6	137	149	202	-17	-913	-719	-721	-103	68
7	-280	-275	-140	-178	-1872	-1467	-1467	-561	-890
8	-220	-237	-285	-185	381	280	285	-163	-414
9	-139	-149	-150	517	-1823	-1184	-1179	-194	-303
10	15	19	13	-513	-630	-562	-573	-207	-180
11	-138	-149	-150	518	-1624	-1185	-1179	-194	-304
12	15	20	14	-516	-634	-566	-576	-210	-182
13	22	24	23	-144	-184	-168	-172	-61	-33
14	22	23	23	-144	-195	-167	-171	-61	-34
15	-101	-106	-112	-140	-2444	-1914	-1922	-465	-520
16	-101	-105	-112	-140	-2444	-1913	-1922	-466	-520
17	102	106	112	142	2420	1905	1913	467	522
18	103	107	112	143	2466	1920	1928	469	524
19	0	0	0	0	0	0	0	0	0



Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	-0.2
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
7	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2
8	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2
9	0.1	0.1	0.1	0.2	-0.1	-0.1	-0.1	1.6	1.6
10	0.0	0.0	0.0	1.5	1.0	0.9	0.8	2.2	2.1
11	0.1	0.1	0.1	0.4	-0.4	-0.3	-0.3	1.7	1.7
12	0.1	0.1	0.1	0.8	0.1	0.2	0.2	1.9	1.8
13	0.0	0.0	0.0	2.4	2.1	2.0	2.0	2.2	2.0
14	0.0	0.1	0.1	1.5	1.0	1.1	1.1	2.0	1.9
15	0.1	0.1	0.1	0.5	-1.0	-0.7	-0.7	1.6	1.6
16	0.1	0.1	0.1	0.4	-1.5	-1.2	-1.2	1.4	1.4
17	0.0	0.0	0.0	0.0	0.5	0.3	0.3	0.0	0.0
18	0.1	0.1	0.1	0.2	2.7	2.0	2.0	0.5	0.5
19	0.0	0.0	0.0	0.1	1.6	1.2	1.2	0.2	0.3

Minimum and Maximum Velocity

Ref.	January		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.1	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.2
6	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0
7	0.0	-0.1	0.0	-0.1	0.0	-0.1	-0.2	-0.1	-0.3	-0.3	-0.3	-0.3	0.3	-0.3	-0.2	0.0	-0.1	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.4	0.1	0.3	0.1	0.3	0.1	0.2	0.0	0.3	0.0
9	0.0	-0.1	0.0	-0.2	0.0	-0.2	0.2	0.1	-0.1	-0.3	-0.1	-0.2	-0.1	-0.2	0.0	0.3	0.0	0.3
10	0.1	0.0	0.1	0.0	0.1	-0.1	-0.8	0.0	-0.8	-0.1	-0.7	-0.1	-0.7	-0.1	-0.7	0.1	-0.8	0.2
11	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.2	0.1	-0.2	-0.4	-0.1	-0.3	-0.1	-0.3	0.0	0.3	0.0	0.3
12	0.1	0.0	0.1	-0.1	0.1	0.0	-0.1	-0.5	-0.3	-0.6	-0.2	-0.5	-0.2	-0.5	0.0	-0.2	0.0	-0.2
13	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.1	-0.6	0.2	-0.5	0.1
14	0.0	0.2	0.0	0.2	0.1	0.2	-0.2	-0.4	-0.7	-0.5	-0.4	-0.4	-0.4	-0.4	-0.2	0.0	-0.1	0.1
15	0.0	-0.2	0.0	-0.2	0.0	-0.2	-0.2	0.0	-1.4	-1.3	-1.2	-1.0	-1.2	-0.9	-0.3	0.2	-0.3	0.1
16	0.0	-0.2	0.0	-0.2	0.0	-0.2	-0.1	-0.1	-1.6	-1.4	-1.5	-1.0	-1.5	-1.0	-0.4	0.2	-0.4	0.0
17	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.9	1.7	0.6	1.3	0.6	1.3	0.1	0.2	0.1	0.2
18	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.9	2.0	0.7	1.7	0.7	1.7	0.2	0.1	0.2	0.2
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.1	-0.2	-0.1	0.0	0.0	0.0	0.0

TABLE A3-13 CONT.

Existing Demand Case Study (Run 413-Run 420)
Project-Base (Difference) Demand Condition
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1602	944	951	977	996	2	-30
2	-1581	-1278	-1259	-40	-41	-171	-172
3	-697	-413	-420	156	152	-70	-108
4	2786	2617	2604	158	158	442	458
5	-3881	-1050	-1046	696	700	-373	-394
6	-1868	-317	-315	669	665	-57	-130
7	-4827	-1470	-1470	709	707	-650	-651
8	937	-72	-78	-639	-642	-278	-211
9	-2069	-2374	-2371	-223	-222	-166	-137
10	-582	-285	-281	23	23	-209	-238
11	-2069	-2370	-2366	-224	-222	-166	-137
12	-591	-289	-283	24	24	-211	-243
13	-175	-53	-53	34	33	-80	-96
14	-174	-53	-52	34	34	-79	-96
15	-2818	-2695	-2683	-166	-165	-457	-474
16	-2816	-2691	-2679	-165	-164	-458	-475
17	2794	2656	2639	166	166	457	476
18	2844	2697	2681	168	166	459	478
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.07	0.05	0.05	0.04	0.04	-0.02	-0.02
2	-0.06	0.04	0.04	0.03	0.03	-0.03	-0.03
3	-0.05	0.04	0.04	0.04	0.04	-0.04	-0.04
4	-0.05	0.04	0.05	0.04	0.04	-0.03	-0.04
5	-0.12	0.02	0.02	0.04	0.05	-0.15	-0.16
6	-0.11	0.03	0.03	0.04	0.04	-0.11	-0.12
7	-0.18	0	0	0.03	0.03	-0.13	-0.17
8	-0.19	0	0	0.04	0.05	-0.11	-0.15
9	-0.22	-0.08	-0.08	0.16	0.16	1.58	1.82
10	0.56	-0.02	-0.02	0.06	0.06	2.17	2.29
11	-0.55	-0.51	-0.5	0.14	0.13	1.64	1.87
12	-0.2	-0.55	-0.55	0.12	0.11	1.9	1.96
13	1.65	-0.02	-0.01	0.04	0.04	2.18	2.36
14	0.51	-0.75	-0.75	0.09	0.1	1.89	1.98
15	-1.23	-1.19	-1.19	0.12	0.12	1.57	1.59
16	-1.86	-1.76	-1.76	0.11	0.1	1.4	1.43
17	0.58	0.57	0.58	0.05	0.08	0.01	0.01
18	3.05	2.83	2.84	0.11	0.11	0.46	0.48
19	1.72	1.62	1.61	0.04	0.03	0.35	0.38

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	-0.1	-0.2	0.0	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
3	-0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	-0.1	-0.6	0.1	-0.4	0.1	-0.4	0.1	-0.2	0.1	-0.2	0.0	0.0	0.0	0.0
6	0.0	-0.3	0.1	-0.2	0.1	-0.2	0.2	-0.1	0.2	-0.1	0.0	0.1	0.0	0.1
7	-0.3	-0.7	-0.1	-0.3	-0.1	-0.3	0.0	0.0	0.0	0.0	-0.2	0.0	-0.3	0.0
8	0.6	0.1	0.1	0.0	0.1	0.0	-0.1	-0.1	0.1	0.0	0.2	0.1	0.2	0.1
9	-0.3	-0.4	-0.3	-0.6	-0.2	-0.6	0.0	-0.2	0.0	-0.2	-0.1	0.3	-0.1	0.3
10	-0.8	-0.1	0.0	-0.2	0.0	-0.2	0.1	-0.1	0.1	-0.2	-0.7	0.1	-0.7	0.1
11	-0.3	-0.5	-0.3	-0.6	-0.3	-0.6	0.0	-0.3	0.0	-0.2	0.0	0.3	0.0	0.3
12	-0.3	-0.6	-0.2	-0.3	-0.2	-0.3	0.1	-0.1	0.1	-0.1	0.0	-0.2	0.0	0.3
13	-0.7	0.0	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	-0.6	0.2	-0.6	0.2
14	-0.8	-0.3	-0.2	-0.1	-0.2	-0.1	0.1	0.2	0.0	0.2	-0.3	0.0	-0.4	0.0
15	1.5	-1.5	-1.5	-1.7	-1.5	-1.7	0.0	-0.2	0.0	-0.2	-0.3	0.2	-0.3	0.2
16	-1.9	-1.7	-1.9	-1.8	-1.9	-1.8	0.0	-0.3	0.0	-0.3	-0.4	0.2	-0.4	0.2
17	1.0	1.9	0.9	1.8	0.9	1.8	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2
18	1.0	2.2	0.9	2.2	0.9	2.2	0.0	0.1	0.0	0.1	0.2	0.1	0.2	0.2
19	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0

TABLE A3-14

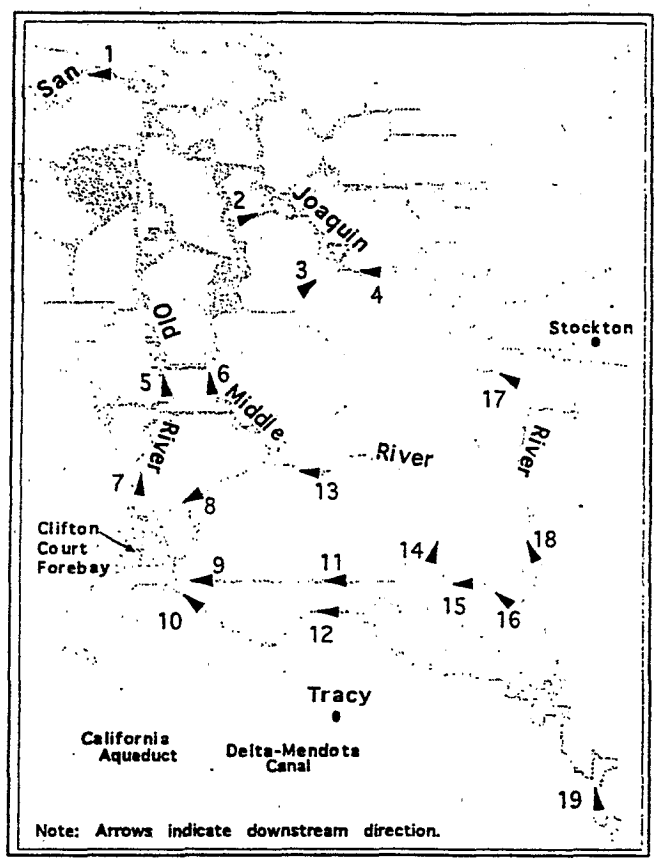
Existing Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 413 - Run 420)
Representative Below Normal Year

Average Net Discharge

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	2936	1114	64	0	120	110	120	37	72
2	47	-46	-93	-37	-1185	-931	-948	-178	-305
3	380	179	46	-2	-651	-528	-523	-72	-58
4	219	155	113	125	2569	2069	2075	457	530
5	2423	786	-201	-106	-1571	-1278	-1286	-356	-595
6	1753	750	142	-19	-990	-766	-768	-96	89
7	2745	808	-355	-176	-2007	-1654	-1656	-582	-961
8	-1463	-708	-250	-179	431	289	294	-178	-448
9	-302	-227	-148	521	-1795	-1372	-1366	-203	-319
10	30	20	10	-516	-641	-572	-585	-204	-186
11	-300	-225	-148	521	-1796	-1373	-1366	-203	-320
12	38	26	10	-525	-651	-575	-588	-208	-188
13	52	36	24	-143	-200	-171	-176	-61	-30
14	51	36	23	-141	-200	-170	-175	-61	-30
15	-215	-160	-115	-129	-2828	-2114	-2126	-472	-538
16	-219	-159	-115	-132	-2829	-2113	-2124	-472	-538
17	235	164	115	130	2595	2101	2112	473	541
18	236	166	116	131	2661	2121	2132	476	543
19	0	0	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	0.1	0.0	0.0	-0.1	-0.1	0.0	-0.2	-0.2
6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
7	0.1	0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2
8	0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2
9	0.3	0.2	0.1	0.2	-0.2	-0.1	-0.1	1.6	1.8
10	0.1	0.1	0.0	1.5	0.9	0.9	0.9	2.2	2.0
11	0.3	0.1	0.1	0.4	-0.5	-0.3	-0.3	1.7	1.7
12	0.3	0.1	0.1	0.8	0.1	0.2	0.2	1.9	1.8
13	0.1	0.1	0.0	2.4	2.1	2.0	2.0	2.2	2.0
14	0.2	0.1	0.1	1.5	0.9	1.0	1.1	1.9	1.9
15	0.3	0.1	0.1	0.5	-1.1	-0.8	-0.8	1.6	1.5
16	0.2	0.1	0.1	0.4	-1.7	-1.3	-1.3	1.4	1.4
17	0.1	0.1	0.0	0.0	0.6	0.4	0.4	0.0	0.1
18	0.2	0.1	0.1	0.1	2.9	2.3	2.2	0.5	0.5
19	0.0	0.0	0.0	0.0	1.7	1.3	1.3	0.2	0.3



Minimum and Maximum Velocity

Ref. No.	January		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
3	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
5	0.3	-0.1	0.1	-0.2	0.1	-0.2	0.0	0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.3	-0.2
6	0.4	0.0	0.2	-0.1	0.1	-0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0
7	0.2	0.2	0.0	0.0	0.0	-0.1	-0.2	-0.1	-0.3	-0.4	-0.3	-0.3	-0.3	-0.3	-0.2	0.0	0.1	0.0
8	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.2	0.0	0.4	-0.1	0.4	0.1	0.4	-0.1	0.2	0.0	0.3	-0.1
9	0.0	-0.2	0.0	-0.1	0.0	-0.2	0.2	0.1	-0.2	-0.3	-0.1	-0.2	-0.1	-0.2	0.0	0.3	0.0	0.3
10	0.2	-0.2	0.1	-0.1	0.1	-0.1	-0.8	0.0	-0.8	-0.1	-0.7	-0.1	-0.7	-0.1	-0.7	0.1	-0.8	0.2
11	0.0	-0.3	0.0	-0.2	0.0	-0.2	0.2	0.1	-0.2	-0.4	-0.1	-0.3	-0.1	-0.3	0.0	0.3	0.0	0.3
12	0.1	-0.1	0.1	-0.1	0.1	0.0	-0.1	-0.5	-0.3	-0.6	-0.3	-0.6	-0.3	-0.6	0.0	-0.3	0.0	-0.2
13	0.1	-0.1	0.0	0.0	0.0	0.0	-0.6	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.1	-0.6	0.2	-0.6	0.1
14	0.1	0.3	0.1	0.2	0.0	0.2	-0.2	-0.4	-0.7	-0.5	-0.5	-0.4	-0.6	-0.4	-0.1	0.0	-0.1	0.1
15	0.0	-0.3	0.0	-0.2	0.0	-0.2	-0.1	-0.1	-1.5	-1.4	-1.3	-1.1	-1.4	-1.1	-0.3	0.2	-0.3	0.1
16	0.0	-0.3	0.0	-0.2	0.0	-0.2	-0.1	-0.1	-2.0	-1.5	-1.7	-1.2	-1.7	-1.2	-0.4	0.1	-0.4	0.0
17	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	1.7	0.7	1.5	0.7	1.5	0.1	0.2	0.1	0.2
18	0.1	0.2	0.0	0.1	0.0	0.1	0.1	0.1	1.0	1.9	0.8	1.9	0.8	1.9	0.2	0.2	0.2	0.2
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.1	-0.2	-0.1	0.0	0.0	0.0	0.0

TABLE A3-14 CONT.

Existing Demand Case Study (Run 413-Run 420)
Project-Base (Difference) Demand Condition
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	-251	-2008	-885	-754	49	-21
2	-1130	-1598	-219	-244	-212	-176
3	-446	-721	-21	-16	-60	-92
4	2152	2719	93	95	461	454
5	-2034	-4189	-1337	-1338	-444	-406
6	-798	-2002	-279	-277	11	-108
7	-2626	-5222	-1770	-1764	-764	-676
8	180	1094	-59	-54	-367	-237
9	-1538	-2398	-134	-133	-203	-144
10	-519	-280	17	18	-200	-230
11	-1539	-2401	-133	-133	-203	-145
12	-522	-293	19	19	-202	-233
13	-145	-73	25	25	-67	-92
14	-144	-73	25	24	-68	-92
15	-2201	-2763	-87	-87	-473	-470
16	-2199	-2769	-87	-87	-473	-471
17	2190	2752	87	88	473	471
18	2209	2816	89	89	475	472
19	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	0	-0.05	0.01	0.02	0.02	-0.01
2	0.01	-0.04	0.01	0.01	-0.01	-0.03
3	0.01	-0.04	0	0	-0.04	-0.04
4	0.01	-0.04	0	0.01	-0.03	-0.03
5	-0.1	-0.08	0	0.01	-0.13	-0.15
6	-0.07	-0.07	0	0	-0.1	-0.11
7	-0.12	-0.12	-0.01	0	-0.11	-0.15
8	-0.12	-0.12	0.01	0.01	-0.08	-0.13
9	-0.1	-0.2	0.14	0.14	1.57	1.6
10	0.73	-0.14	0.03	0.03	2.08	2.24
11	-0.3	-0.69	0.11	0.11	1.61	1.64
12	0.14	-0.74	0.09	0.1	1.81	1.93
13	1.79	-0.11	0	0	2.07	2.31
14	0.89	-0.87	0.06	0.06	1.81	1.93
15	-0.77	-1.38	0.08	0.08	1.53	1.58
16	-1.22	-1.96	0.06	0.06	1.37	1.42
17	0.36	0.54	0.01	0.01	0.01	0.01
18	2.2	2.96	0.05	0.05	0.47	0.48
19	1.29	1.69	0.01	0.01	0.39	0.4

Minimum and Maximum Velocity

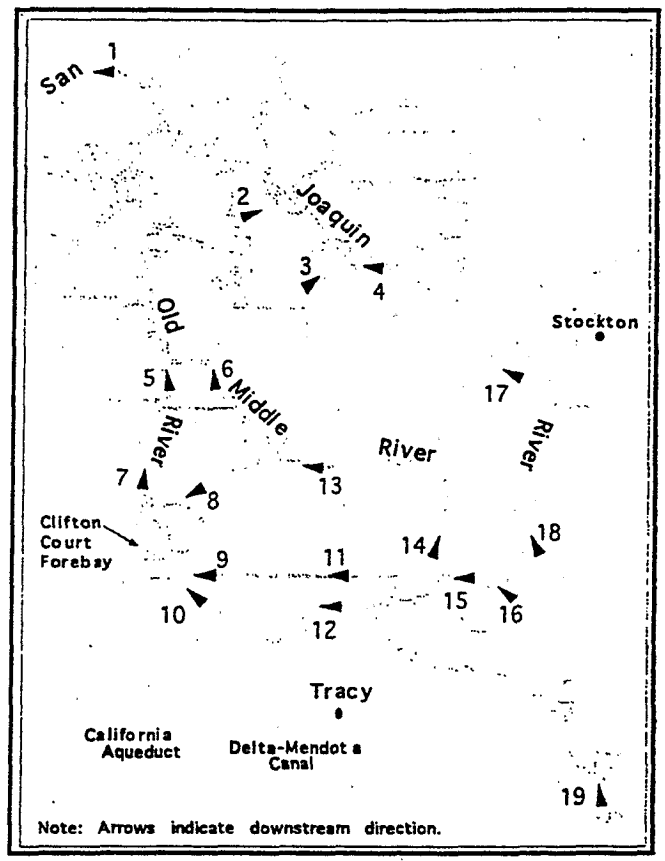
Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.2	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1
3	0.0	-0.1	0.0	-0.1	-0.1	-0.1	0.1	0.0	0.1	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
5	0.1	-0.4	0.0	-0.6	0.1	-0.4	0.1	-0.4	0.0	0.0	0.0	0.0
6	0.2	-0.2	0.0	-0.4	0.2	-0.2	0.2	-0.2	0.1	0.1	0.0	0.1
7	-0.1	-0.4	-0.3	-0.7	0.0	-0.3	0.0	-0.3	-0.2	0.0	-0.2	-0.1
8	0.5	0.0	0.3	0.1	0.1	0.0	0.1	0.0	0.3	0.0	0.2	0.1
9	-0.1	-0.3	-0.3	-0.5	-0.0	-0.1	0.0	-0.1	0.0	0.3	-0.1	0.3
10	-0.7	-0.1	-0.1	-0.2	0.1	0.0	0.1	0.0	0.0	0.1	-0.7	0.1
11	-0.1	-0.4	-0.4	-0.6	0.0	-0.1	0.0	-0.1	0.0	0.3	0.0	0.3
12	-0.3	-0.6	-0.2	-0.3	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	-0.2
13	-0.6	0.1	0.0	0.0	0.1	0.0	0.1	0.0	-0.6	0.1	-0.6	0.2
14	-0.7	-0.2	-0.4	-0.2	0.0	0.2	0.0	0.2	-0.2	0.1	-0.5	0.0
15	-1.1	-1.0	-1.5	-1.6	0.0	-0.1	0.0	-0.1	-0.3	0.2	-0.3	0.2
16	-1.8	-1.2	-2.0	-1.7	0.0	-0.1	0.0	-0.1	-0.4	0.2	-0.4	0.2
17	0.7	1.5	1.0	1.9	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.2
18	0.8	1.9	1.0	2.3	0.0	0.1	0.0	0.1	0.2	0.2	0.2	0.1
19	-0.2	-0.1	-0.2	-0.2	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0

TABLE A3-15

Existing Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 413 - Run 420)
Representative Above Normal Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	1519	1552	1307	72	15	124	140	165	50	87
2	-40	-38	-40	-98	-46	-1196	-1179	-1195	-190	-302
3	238	230	199	53	2	-633	-621	-614	-63	-55
4	191	191	177	115	138	2570	2532	2531	466	528
5	1141	1145	950	-204	-125	-1599	-1570	-1579	-380	-574
6	1036	1033	856	146	0	-967	-948	-953	-75	102
7	1208	1204	999	-350	-209	-2047	-2002	-2007	-630	-937
8	-967	-971	-787	-245	-215	399	396	402	-215	-457
9	-257	-257	-232	-150	527	-1805	-1766	-1760	-219	-320
10	17	17	31	8	-518	-637	-632	-645	-198	-184
11	-257	-257	-235	-150	526	-1806	-1766	-1760	-219	-320
12	19	19	21	9	-530	-651	-637	-651	-201	-186
13	40	39	37	24	-148	-201	-196	-201	-61	-29
14	39	38	38	24	-146	-201	-197	-202	-61	-29
15	-199	-199	-168	-117	-136	-2637	-2593	-2605	-482	-536
16	-198	-198	-172	-116	-140	-2640	-2592	-2603	-482	-536
17	199	199	184	116	142	2605	2563	2572	483	538
18	201	201	183	117	143	2665	2617	2627	485	541
19	0	0	0	0	0	0	0	0	0	0



Note: Arrows indicate downstream direction.

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	0.1	0.1	0.0	0.0	-0.1	0.0	0.0	-0.2	-0.2
6	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
7	0.1	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.2
8	0.1	0.1	0.1	0.0	0.1	-0.1	-0.1	-0.1	-0.1	-0.2
9	0.2	0.2	0.2	0.1	0.2	-0.2	-0.1	-0.1	1.6	1.6
10	0.1	0.1	0.1	0.0	1.5	1.0	0.9	0.9	2.2	2.0
11	0.2	0.2	0.1	0.1	0.4	-0.5	-0.4	-0.4	1.7	1.6
12	0.2	0.2	0.1	0.1	0.9	0.1	0.1	0.1	1.9	1.8
13	0.1	0.1	0.1	0.0	2.5	2.1	2.1	2.1	2.2	1.9
14	0.1	0.1	0.1	0.0	1.5	0.9	0.9	0.9	1.9	1.9
15	0.2	0.2	0.1	0.1	0.5	-1.1	-1.1	-1.1	1.6	1.5
16	0.2	0.2	0.1	0.1	0.4	-1.7	-1.7	-1.7	1.4	1.4
17	0.1	0.1	0.1	0.0	0.0	0.6	0.5	0.5	0.0	0.1
18	0.2	0.2	0.1	0.1	0.1	2.9	2.9	2.9	0.5	0.5
19	0.1	0.0	0.0	0.0	0.1	1.7	1.7	1.7	0.2	0.3

Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.0	-0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1
5	0.2	-0.2	0.2	-0.2	0.2	-0.2	0.1	-0.2	0.1	0.1	0.0	-0.1	0.0	-0.2	0.0	-0.2	0.0	0.0	0.3	-0.2
6	0.3	-0.1	0.3	-0.1	0.2	-0.1	0.1	-0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0
7	0.1	0.0	0.1	0.0	0.0	0.0	0.0	-0.1	-0.2	0.0	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	0.0	0.1	0.0
8	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.2	0.0	0.4	0.1	0.4	0.1	0.4	0.1	0.3	0.0	0.3	-0.1
9	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.0	-0.2	0.2	0.1	-0.2	-0.3	-0.2	-0.3	-0.2	-0.3	0.0	0.3	0.0	0.3
10	0.2	-0.1	0.2	-0.1	0.2	-0.1	0.1	-0.1	0.8	0.0	-0.8	-0.1	-0.8	-0.1	-0.8	-0.1	-0.7	-0.1	-0.6	0.2
11	0.0	-0.2	0.0	-0.2	0.0	-0.2	0.0	-0.2	0.2	0.1	-0.2	-0.4	-0.2	-0.4	-0.2	-0.4	0.0	0.3	0.0	0.3
12	0.0	-0.1	0.0	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.5	-0.3	-0.7	-0.3	-0.6	-0.3	-0.6	0.0	-0.3	0.0	-0.2
13	0.1	-0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.7	0.2	-0.7	0.1	-0.6	0.1	-0.6	0.1	-0.6	0.2	-0.6	0.1
14	0.1	0.2	0.1	0.2	0.1	0.2	0.0	0.2	-0.2	-0.4	-0.7	-0.5	-0.7	-0.4	-0.7	-0.4	-0.2	0.0	-0.1	0.1
15	0.0	-0.3	0.0	-0.3	0.0	-0.2	0.0	-0.2	-0.2	-0.1	-1.5	-1.4	-1.5	-1.3	-1.5	-1.3	-0.3	0.2	-0.2	0.1
16	-0.1	-0.3	-0.1	-0.3	0.0	-0.3	0.0	-0.2	-0.2	-0.1	-1.9	-1.5	-1.9	-1.5	-1.9	-1.5	-0.4	0.1	-0.4	0.0
17	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	1.0	1.8	0.9	1.7	0.9	1.7	0.1	0.2	0.1	0.2
18	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	1.0	2.0	1.0	2.0	1.0	2.0	0.2	0.2	0.2	0.2
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0	-0.1

TABLE A3-15 CONT.

Existing Demand Case Study (Run 413-Run 420)
Project-Base (Difference) Demand Condition
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1886	55	15	31	17	60	-2
2	-1587	-986	-960	-86	-80	-251	-178
3	-714	-349	-357	36	31	-57	-97
4	2742	1850	1846	106	106	494	467
5	-4200	-1551	-1548	-233	-229	-506	-390
6	-2039	-493	-491	118	114	45	-107
7	-5210	-2054	-2055	-392	-394	-848	-653
8	1055	55	47	-232	-235	-409	-234
9	-2029	-1658	-1656	-134	-133	-251	-153
10	-586	-203	-198	4	5	-194	-236
11	-2031	-1659	-1657	-134	-133	-251	-153
12	-596	-205	-201	5	5	-197	-239
13	-177	-26	-26	21	20	-59	-93
14	-177	-27	-25	20	20	-59	-93
15	-2786	-1892	-1885	-108	-107	-507	-485
16	-2788	-1891	-1884	-108	-108	-506	-485
17	2765	1886	1880	107	107	507	485
18	2821	1898	1892	108	108	509	487
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.09	0.02	0.02	0	0.01	0.03	-0.01
2	-0.08	0.01	0.01	0.01	0.01	0	-0.03
3	-0.08	0.01	0.02	0.01	0.01	-0.02	-0.04
4	-0.07	0.01	0.01	0.01	0.01	-0.01	-0.03
5	-0.12	0	0	0	0.01	-0.15	-0.16
6	-0.11	0	0.01	0.01	0.01	-0.11	-0.11
7	-0.17	-0.01	-0.01	0	0.01	-0.14	-0.15
8	-0.18	0	-0.01	0.01	0.01	-0.11	-0.14
9	-0.21	-0.03	-0.03	0.11	0.11	1.6	1.82
10	0.53	-0.01	0	0.02	0.02	2.08	2.27
11	-0.55	-0.31	-0.3	0.09	0.09	1.62	1.68
12	-0.22	-0.35	-0.34	0.08	0.08	1.81	1.95
13	1.64	-0.02	-0.02	0.01	0	2.05	2.35
14	0.51	-0.46	-0.45	0.06	0.06	1.84	1.96
15	-1.21	-0.74	-0.73	0.09	0.08	1.53	1.58
16	-1.82	-1.08	-1.08	0.08	0.08	1.37	1.42
17	0.53	0.27	0.27	0.02	0.03	0.02	0.01
18	2.99	1.75	1.75	0.07	0.07	0.48	0.48
19	1.71	1.09	1.08	0.04	0.03	0.34	0.37

Minimum and Maximum Velocity

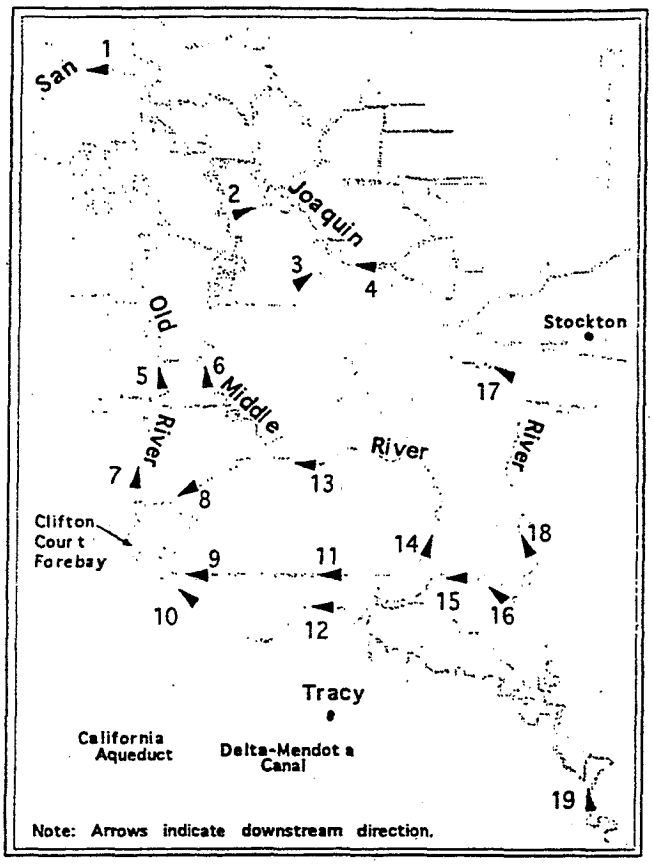
Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.2	-0.1	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
3	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
5	0.1	-0.6	0.1	-0.4	0.1	-0.4	0.1	-0.2	0.1	-0.2	0.1	-0.1	0.0	0.0
6	-0.1	-0.3	0.1	-0.3	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	0.0	0.0	0.1
7	0.4	-0.7	-0.1	-0.4	-0.1	-0.4	0.0	-0.1	0.0	-0.1	-0.1	0.1	-0.2	-0.1
8	0.6	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.1
9	0.3	-0.4	-0.1	-0.4	-0.1	-0.4	0.0	-0.1	0.0	-0.1	0.0	0.3	-0.1	0.3
10	0.8	-0.1	0.1	-0.2	0.0	-0.2	0.1	-0.1	0.1	-0.1	-0.6	0.1	-0.7	0.1
11	0.3	-0.5	-0.2	-0.5	-0.2	-0.5	0.0	-0.1	0.0	-0.1	0.0	0.3	0.0	0.3
12	0.3	-0.6	-0.1	-0.2	-0.1	-0.3	0.1	0.0	0.1	0.0	0.0	-0.2	0.0	0.3
13	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	0.1	-0.6	0.2
14	0.9	0.3	-0.1	0.0	-0.1	0.0	0.1	0.2	0.1	0.2	-0.2	0.1	-0.5	0.0
15	1.4	-1.4	-1.0	-1.2	-1.0	-1.2	0.0	-0.2	0.0	-0.2	-0.3	0.2	-0.3	0.2
16	-1.9	-1.6	-1.5	-1.2	-1.4	-1.2	0.0	-0.2	0.0	-0.2	-0.4	0.2	-0.4	0.2
17	1.0	1.9	0.6	1.2	0.5	1.2	0.1	0.0	0.1	0.0	0.1	0.2	0.1	0.2
18	1.0	2.2	0.7	1.7	0.7	1.7	0.0	0.1	0.0	0.1	0.2	0.2	0.2	0.2
19	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0

TABLE A3-16

Existing Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 413 - Run 420)
Representative Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	1478	3008	74	52	181	90	32
2	-59	109	-55	-76	-91	-148	-287
3	217	373	55	7	54	73	-85
4	183	156	69	134	105	81	634
5	1029	2590	-52	-38	22	-274	-634
6	1020	1909	89	-73	115	245	-102
7	1086	2980	-16	84	93	-426	-844
8	-946	-1553	31	216	-33	-345	-161
9	-248	-247	-149	-240	-199	-93	-487
10	18	27	44	99	81	34	-211
11	-246	-245	-150	-252	-207	-96	-482
12	23	35	51	102	84	34	-217
13	41	57	11	12	12	19	23
14	40	58	12	12	11	19	25
15	-181	-150	-83	-140	-111	-50	-654
16	-183	-155	-83	-148	-116	-58	-654
17	190	171	77	143	113	77	658
18	192	173	85	158	125	77	663
19	0	0	0	0	0	0	0



Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0
3	0.1	0.1	0.0	0.0	0.0	0.1	0.0
4	0.1	0.1	0.0	0.0	0.0	0.1	0.0
5	0.1	0.1	0.0	0.0	0.0	0.0	-0.2
6	0.1	0.1	0.0	0.0	0.0	0.0	-0.1
7	0.1	0.1	0.0	0.0	0.0	-0.1	-0.2
8	0.1	0.1	0.0	-0.1	-0.1	-0.1	-0.2
9	0.2	0.3	0.3	0.4	0.4	0.2	2.0
10	0.1	0.2	0.0	0.0	0.0	-0.1	3.0
11	0.2	0.3	0.2	0.2	0.3	0.2	2.0
12	0.2	0.3	0.1	0.1	0.2	0.2	2.4
13	0.1	0.1	0.0	0.0	0.0	0.0	3.2
14	0.1	0.2	0.0	0.0	0.1	0.1	2.6
15	0.2	0.2	0.1	0.1	0.1	0.1	1.8
16	0.2	0.2	0.0	0.0	0.0	0.1	1.5
17	0.1	0.1	0.0	0.1	0.1	0.0	0.0
18	0.1	0.2	0.1	0.1	0.1	0.1	0.5
19	0.0	0.0	0.0	0.1	0.0	0.0	0.2

Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.1	0.0	0.0
3	0.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1
5	0.2	-0.2	0.3	-0.1	0.1	-0.2	0.1	-0.1	0.2	-0.1	0.4	-0.3	0.1	-0.1
6	0.3	-0.1	0.4	0.0	0.1	-0.1	0.1	-0.1	0.3	0.0	0.5	-0.1	0.1	-0.1
7	0.1	-0.1	0.2	0.2	-0.1	-0.1	-0.1	-0.2	0.0	-0.1	0.2	-0.1	-0.1	-0.1
8	-0.1	-0.1	-0.2	-0.1	0.0	0.0	0.4	0.1	0.4	0.1	0.4	0.0	0.2	0.0
9	0.0	-0.1	0.0	-0.2	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.6
10	0.2	-0.1	0.2	-0.2	0.1	-0.1	0.1	-0.1	0.0	0.1	-0.1	0.0	-0.7	0.8
11	0.0	-0.1	0.0	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.8
13	0.1	-0.1	0.1	-0.1	0.0	0.0	0.1	-0.1	0.1	0.0	-0.1	-0.1	0.0	0.3
14	0.1	0.2	0.1	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
15	0.0	-0.2	0.0	-0.3	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	-0.1	-0.4	-0.3
16	-0.1	-0.3	0.0	-0.3	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	-0.1	-0.4	-0.4
17	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6
18	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-16 CONT.

Existing Demand Case Study (Run 413-Run 420)
Project-Base (Difference) Demand Condition
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	58	-2034	-1964	34	-2152
2	-648	-1013	-276	-267	-284
3	-293	-505	-137	-98	-163
4	1341	1578	67	599	49
5	-1007	-3516	-2419	-508	-2635
6	-375	-1522	-837	-108	-867
7	-1375	-4440	-3087	-815	-3285
8	-56	767	316	-210	458
9	-788	-1401	-82	-351	-50
10	-465	-176	3	-225	17
11	-789	-1401	-82	-352	-52
12	-468	-177	5	-227	15
13	-127	-27	19	-37	15
14	-127	-27	19	-37	16
15	-1376	-1607	-58	-616	-25
16	-1376	-1607	-58	-616	-29
17	1372	1602	59	619	39
18	1379	1610	59	623	38
19	0	0	0	0	0

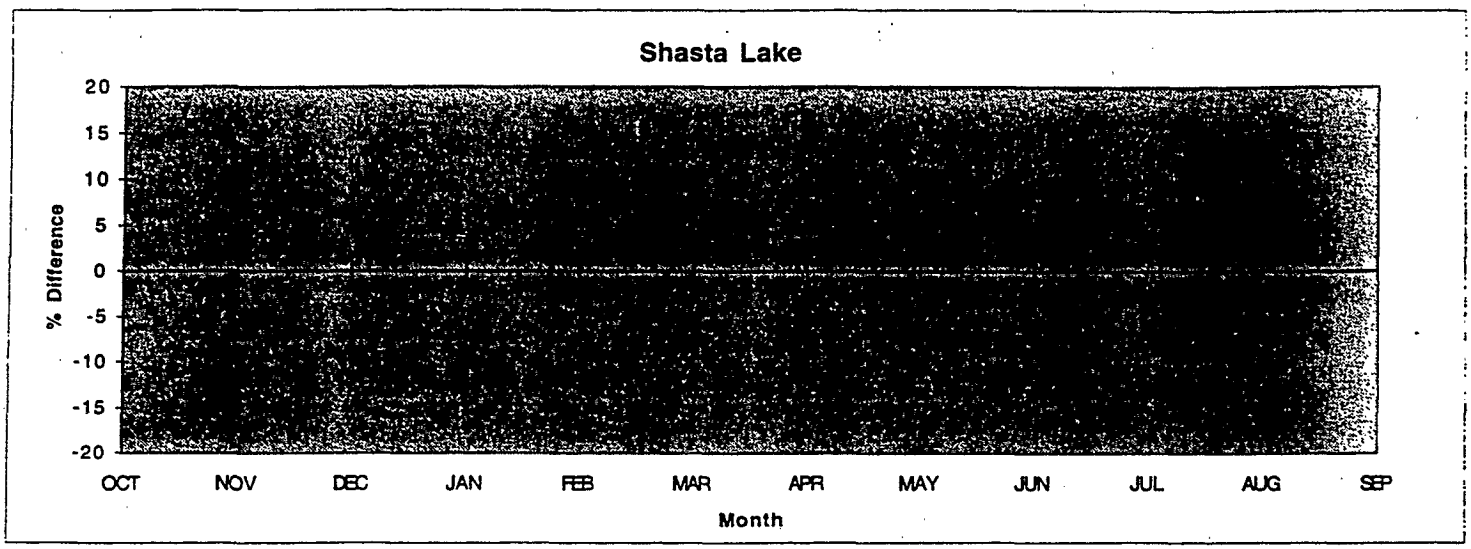
Minimum Water Surface Elevation

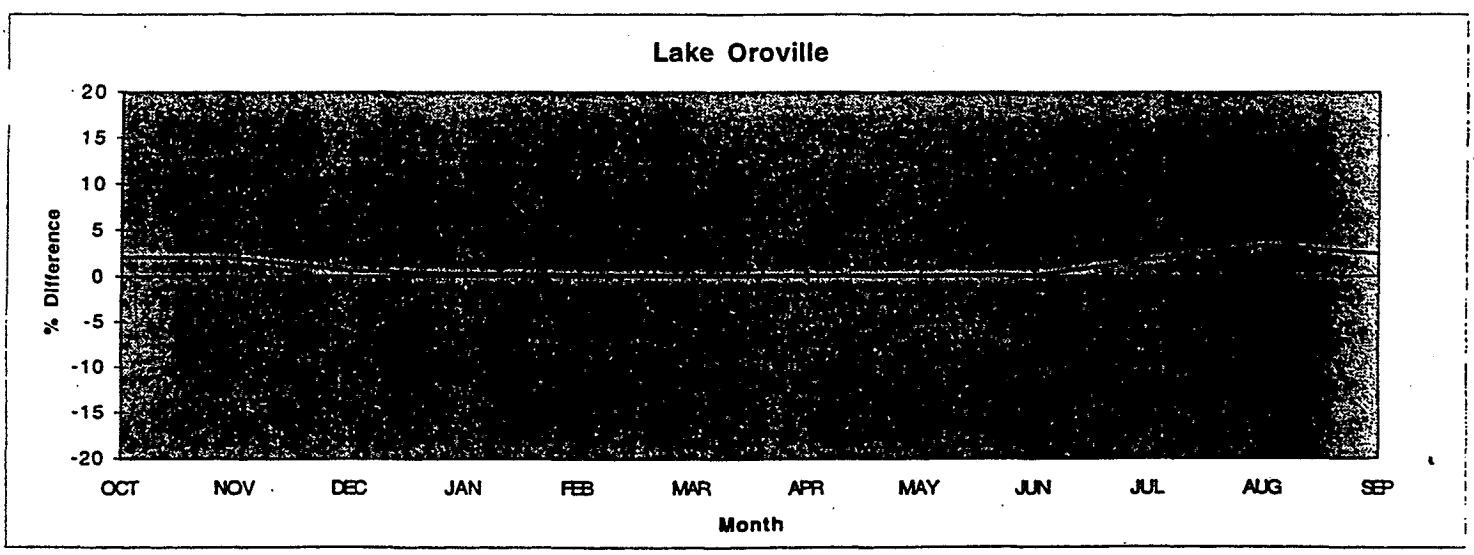
Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	0	-0.04	-0.02	0	-0.07
2	-0.02	-0.04	-0.03	-0.02	-0.06
3	-0.01	-0.05	-0.03	-0.03	-0.05
4	-0.02	-0.04	-0.03	-0.03	-0.05
5	-0.02	-0.07	-0.03	-0.16	-0.08
6	-0.02	-0.06	-0.03	-0.11	-0.07
7	-0.03	-0.09	-0.03	-0.14	-0.1
8	-0.01	-0.09	-0.05	-0.12	-0.09
9	0.03	-0.11	0.02	1.74	0.08
10	1.1	-0.08	-0.02	2.51	-0.08
11	-0.11	-0.39	-0.03	1.79	0.05
12	0.44	-0.43	-0.04	2.11	0.03
13	2.04	-0.08	-0.03	2.51	-0.08
14	1.31	-0.43	0	2.11	0.01
15	-0.4	-0.73	-0.03	1.71	0.01
16	-0.66	-0.98	-0.01	1.48	0
17	0.16	0.15	-0.03	0.02	-0.05
18	1.29	1.37	0.01	0.48	0.01
19	0.86	0.92	0.01	0.24	0

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec.		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.2	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	-0.2	0.0	-0.5	0.1	-0.4	0.0	0.0	0.1	-0.5
6	0.0	0.0	0.1	-0.3	0.1	-0.3	0.0	0.1	0.1	-0.3
7	-0.2	-0.2	-0.1	-0.6	0.0	-0.4	-0.2	0.1	-0.1	-0.5
8	0.4	0.0	0.2	0.0	0.1	0.0	0.2	0.0	0.4	0.0
9	0.0	-0.1	-0.2	-0.3	0.0	-0.1	0.0	0.3	0.0	-0.1
10	-0.7	0.0	0.0	-0.1	0.1	0.0	-0.7	0.2	0.0	-0.1
11	-0.1	-0.2	-0.2	-0.4	0.0	-0.1	0.0	0.3	0.0	-0.1
12	0.2	-0.5	-0.1	-0.2	0.0	0.0	0.0	-0.4	0.0	0.0
13	0.6	0.1	0.0	0.1	0.0	0.1	-0.6	0.2	-0.1	-0.1
14	0.6	-0.2	-0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.2
15	-0.8	-0.3	-0.9	-0.9	0.0	-0.1	-0.3	-0.2	0.0	-0.1
16	-1.1	-0.2	-1.3	-0.9	0.0	-0.1	-0.4	-0.3	0.0	-0.1
17	0.4	0.8	0.4	0.9	0.0	0.0	0.1	0.3	0.0	0.0
18	0.5	0.9	0.6	1.3	0.0	0.0	0.2	0.3	0.0	0.0
19	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0

Figure A3-17
Future Demand Case - Percent Difference
between ISDP and Base Condition
End of Month Storage





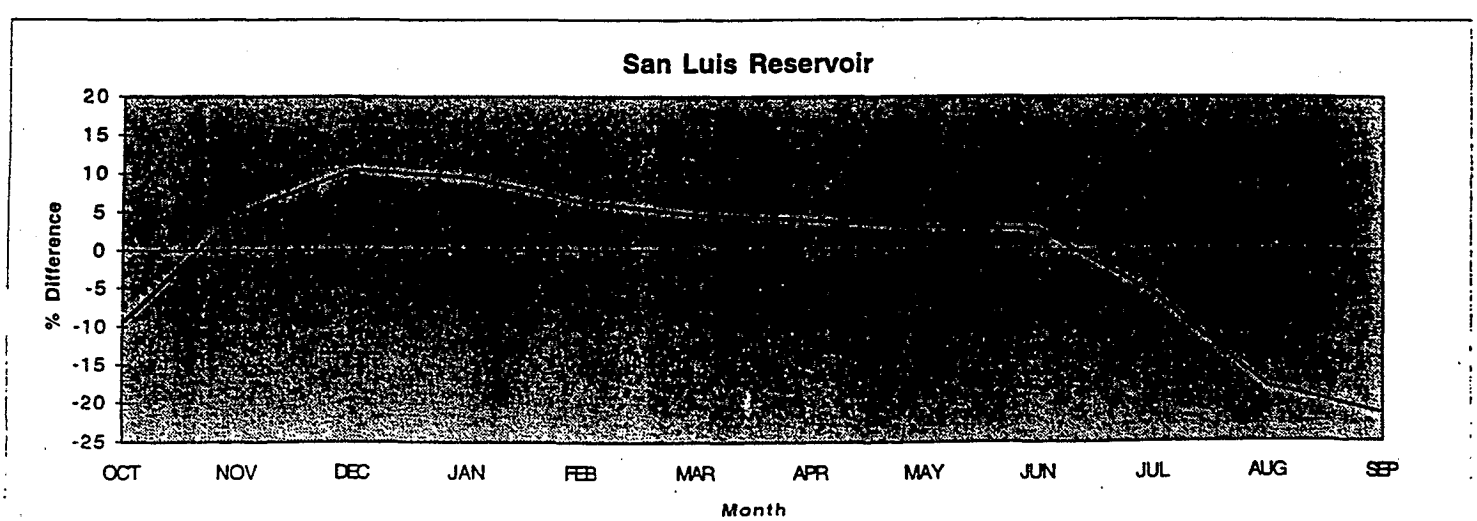
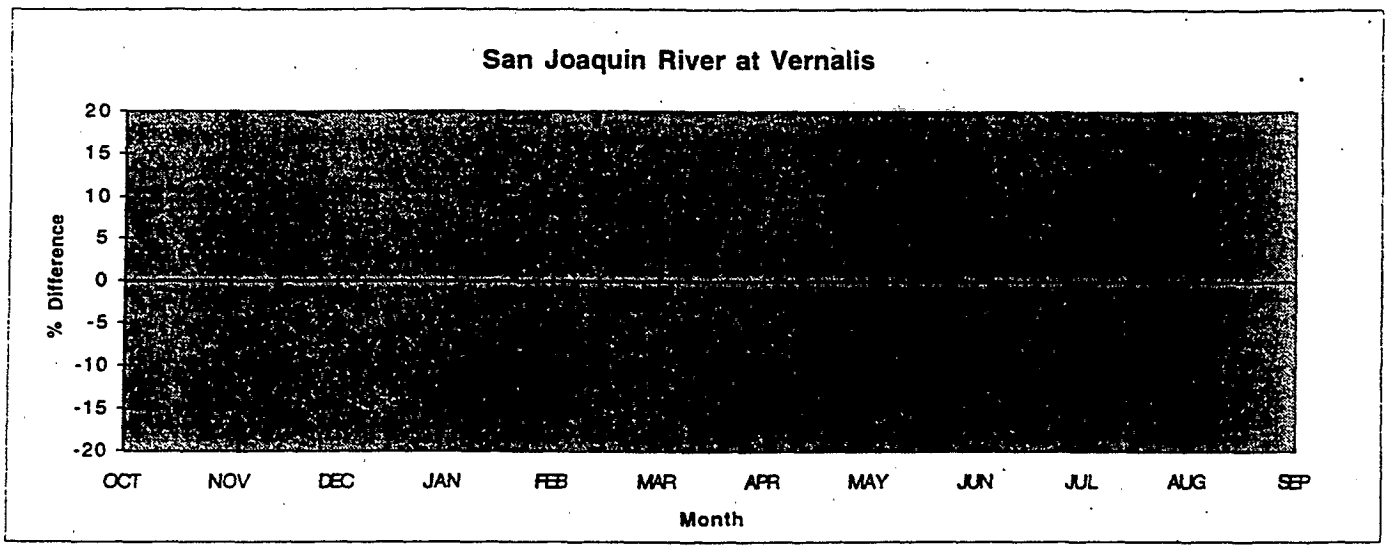
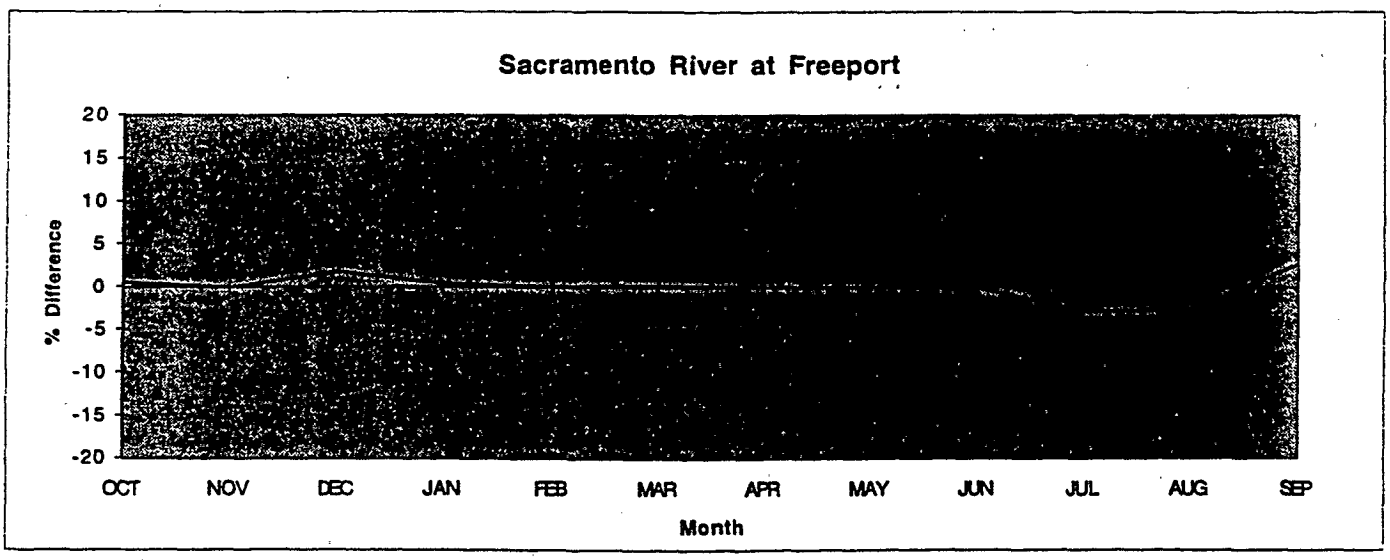


Figure A3-18
Future Demand Case - Percent Difference
between ISDP and Base Condition
River Flows





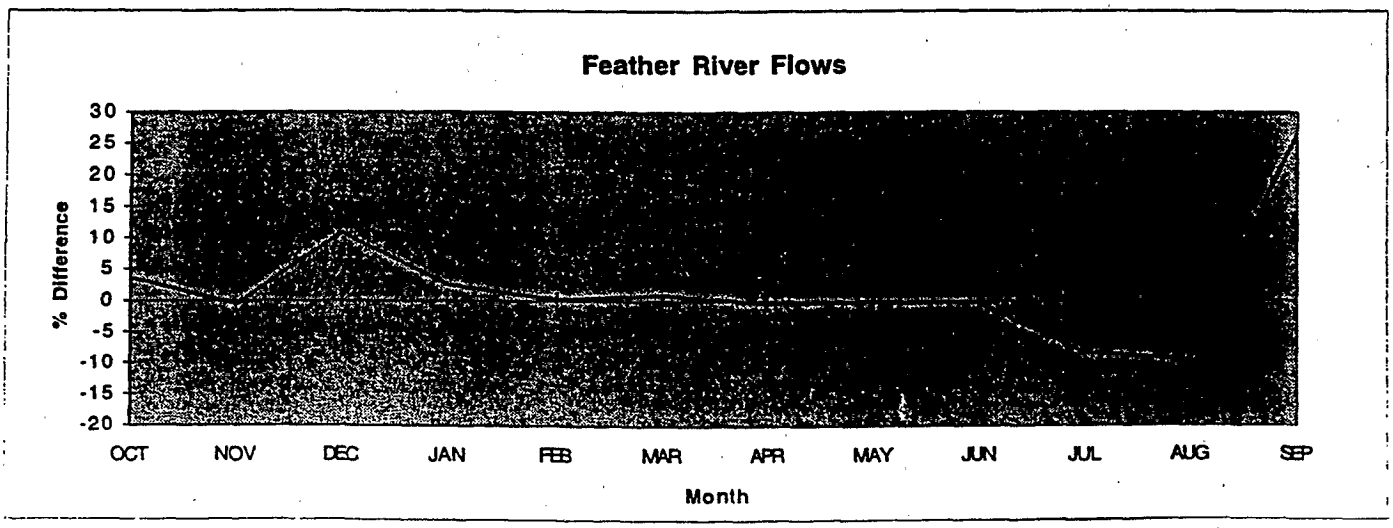
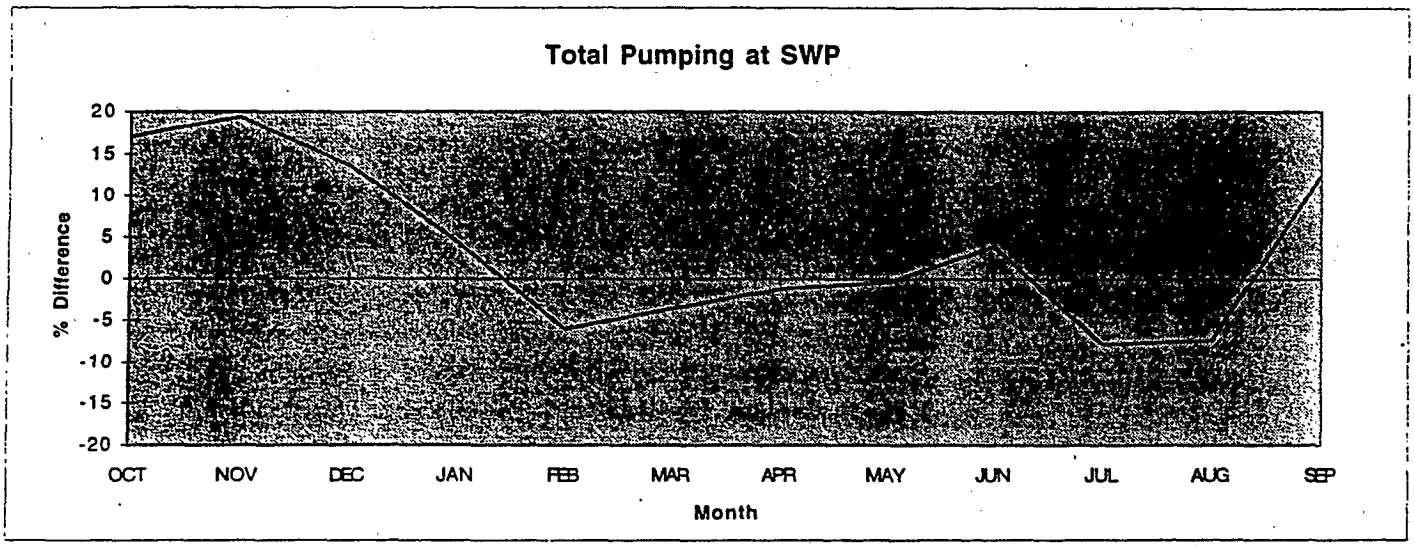
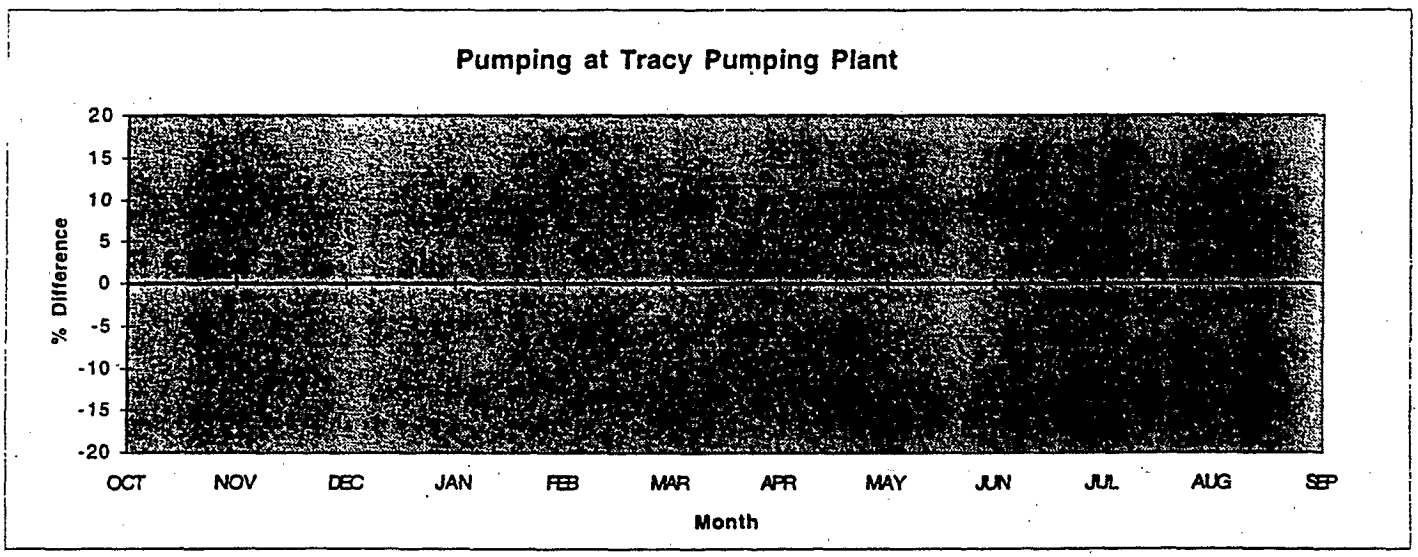


Figure A3-19
Future Demand Case - Percent Difference
between ISDP and Base Condition
Delta Exports





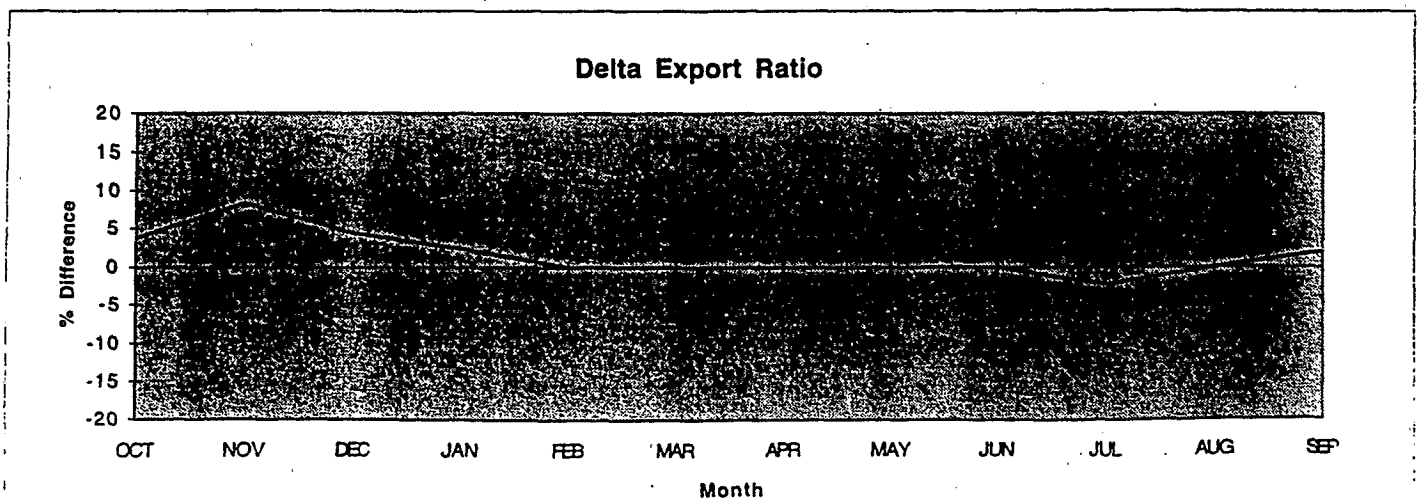
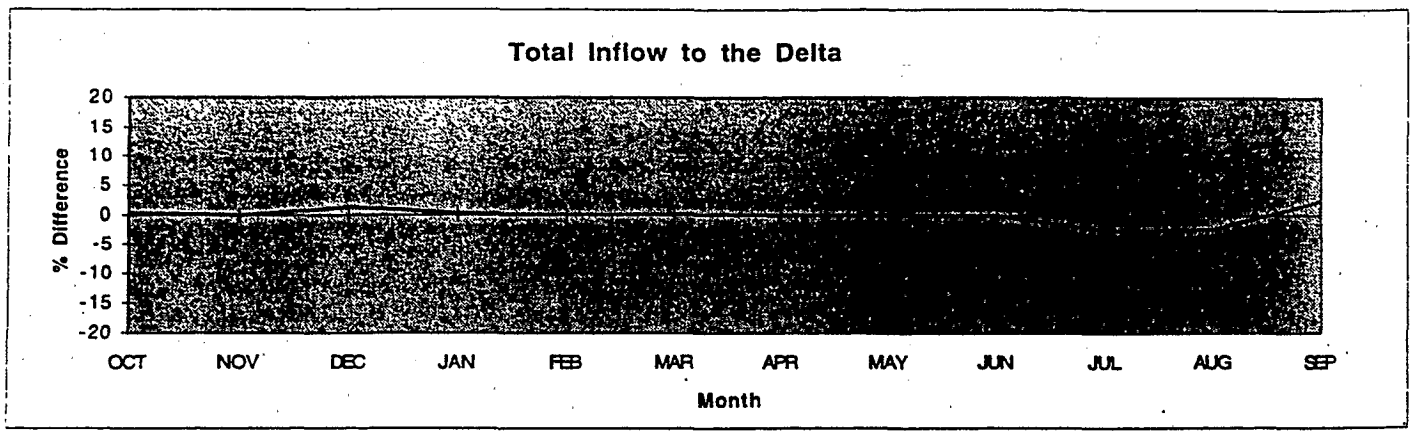
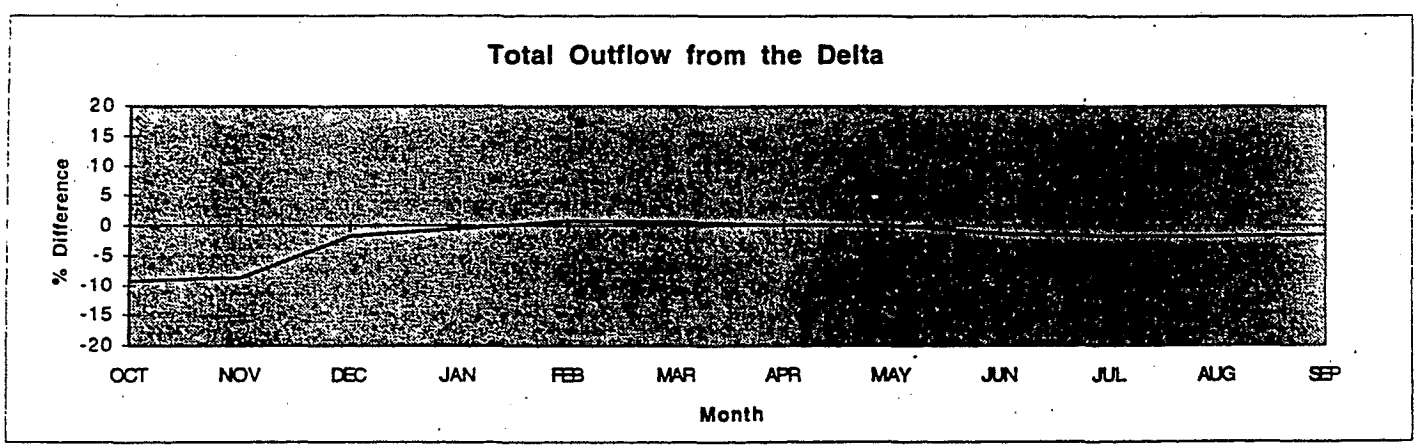
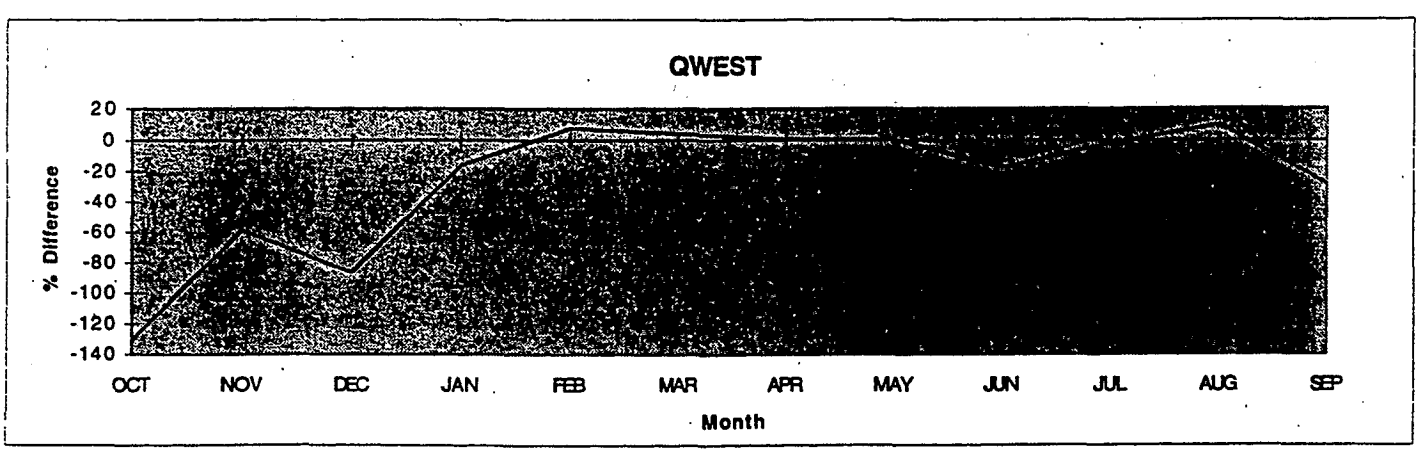


Figure A3-20
Future Demand Case - Percent Difference
between ISDP and Base Condition
Delta Inflow and Outflow







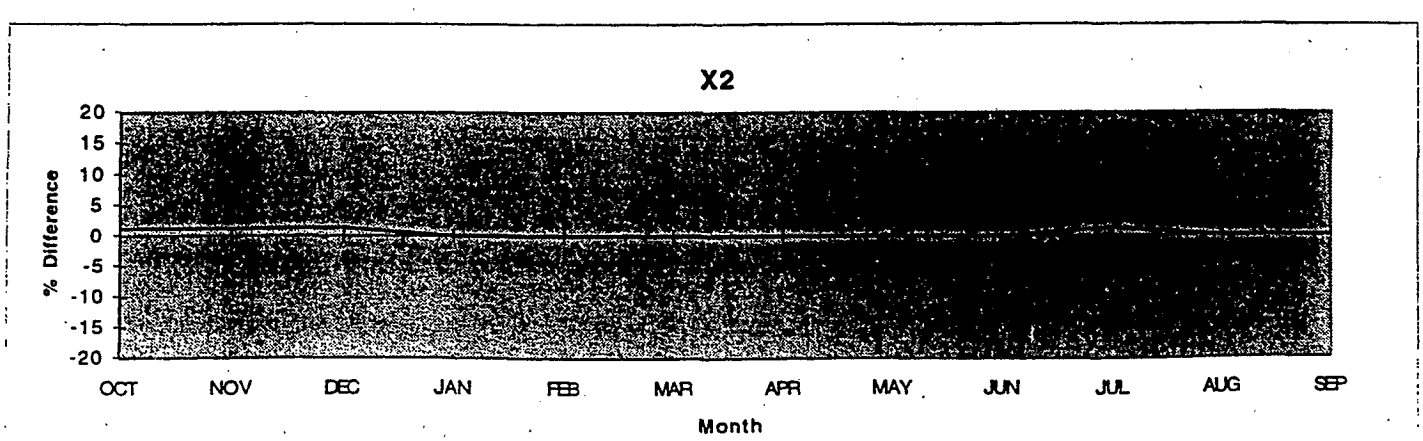


TABLE A3-17

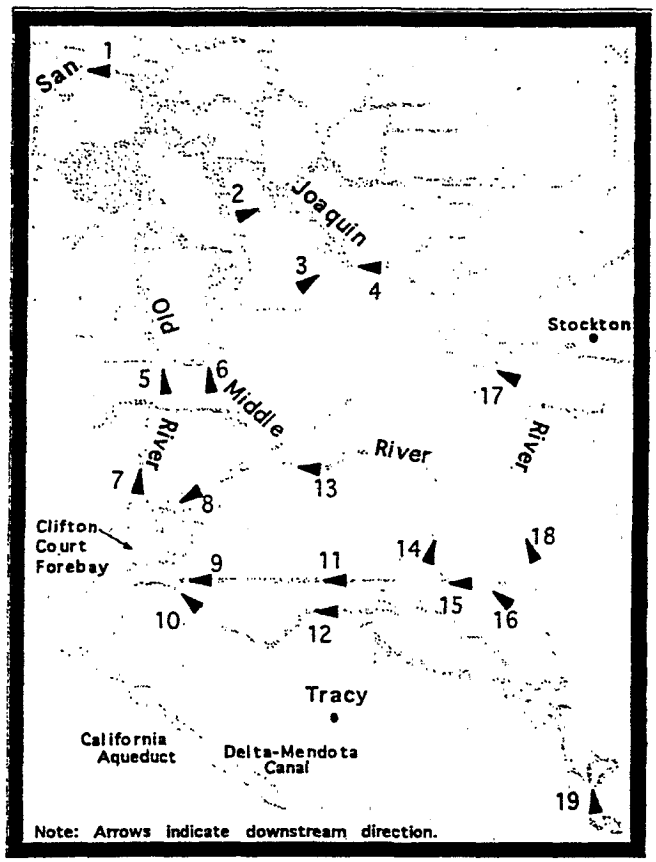
Future Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 414 - Run 411)
Representative Critical Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	3	-22	-23	74	8	70	60	60	35	104
2	-67	-60	-69	-151	-50	-639	-579	-587	-166	-101
3	8	6	10	60	-18	-408	-394	-389	-71	-23
4	98	98	104	154	142	1465	1348	1348	437	418
5	-248	-246	-261	-379	-105	-894	-802	-806	-337	-8
6	75	72	72	268	-33	-562	-538	-536	-96	130
7	-416	-420	-433	-647	-175	-1172	-1049	-1047	-556	-200
8	-207	-210	-206	-472	-159	174	181	183	-179	-394
9	-96	-97	-110	-178	440	-809	-710	-703	-175	-163
10	-19	-18	-13	-3	-456	-537	-518	-526	-205	-201
11	-98	-97	-110	-178	441	-808	-710	-702	-176	-164
12	-17	-17	-12	-3	-458	-539	-522	-530	-207	-202
13	14	13	16	28	-134	-161	-154	-157	-69	-71
14	13	13	15	28	-134	-160	-154	-157	-69	-70
15	-100	-100	-108	-153	-148	-1501	-1379	-1383	-452	-437
16	-100	-100	-106	-153	-148	-1501	-1379	-1383	-453	-437
17	98	98	105	152	147	1497	1377	1380	454	437
18	99	99	106	153	149	1505	1383	1387	455	439
19	0	0	-1	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
7	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1
8	0.0	0.0	0.0	0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1
9	0.1	0.1	0.1	0.1	0.1	-0.1	-0.1	-0.1	1.6	1.6
10	0.0	0.0	0.0	0.1	1.3	1.0	0.9	0.9	2.1	2.1
11	0.1	0.1	0.1	0.1	0.3	-0.2	-0.2	-0.2	1.6	1.6
12	0.1	0.1	0.1	0.1	0.7	0.3	0.3	0.3	1.9	1.9
13	0.0	0.0	0.0	0.0	2.3	2.1	2.1	2.1	2.1	2.1
14	0.1	0.1	0.1	0.1	1.6	1.3	1.3	1.3	1.9	1.9
15	0.1	0.1	0.1	0.1	0.4	-0.6	-0.5	-0.5	1.6	1.6
16	0.1	0.1	0.1	0.1	0.3	-0.9	-0.8	-0.8	1.4	1.4
17	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0
18	0.1	0.1	0.1	0.1	0.1	1.5	1.3	1.4	0.5	0.5
19	0.1	0.1	0.1	0.1	0.0	0.9	0.9	0.9	0.3	0.4



Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.1	-0.1	0.0	-0.1
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.2	-0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.2	-0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
7	0.0	-0.1	0.0	-0.1	-0.1	-0.1	0.1	-0.2	-0.2	-0.1	-0.2	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	-0.2	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.1	0.3	0.1	0.3	0.1	0.2	0.0	0.1	0.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.1	0.0	-0.2	0.0	-0.1	0.0	-0.1	0.0	0.3	0.0	0.3
10	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	-0.7	0.1	-0.7	-0.1	-0.7	0.0	-0.7	0.0	-0.7	0.1	-0.7	0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.2	0.1	-0.1	-0.2	0.0	-0.2	0.0	-0.2	0.0	0.3	0.0	0.3
12	0.1	-0.1	0.1	-0.1	0.1	0.0	0.0	-0.1	-0.1	-0.4	-0.2	-0.5	-0.2	-0.4	-0.2	-0.4	0.0	-0.2	0.0	-0.2
13	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.6	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.2	-0.6	0.2	-0.6	0.2
14	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	-0.2	-0.3	-0.4	-0.4	-0.3	-0.3	-0.3	-0.3	-0.2	0.0	-0.3	0.1
15	0.0	-0.2	0.0	-0.2	0.0	-0.2	0.0	-0.2	-0.1	0.0	-1.0	-0.6	-0.9	-0.5	-0.9	-0.4	-0.3	0.3	-0.3	0.2
16	0.0	-0.3	0.0	-0.3	0.0	-0.4	-0.1	-0.4	-0.1	0.0	-1.3	-0.5	-1.3	-0.3	-1.3	-0.3	-0.4	0.3	-0.3	0.2
17	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.4	1.0	0.4	0.9	0.4	0.9	0.1	0.2	0.1	0.1
18	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.6	1.4	0.5	1.2	0.5	1.2	0.2	0.1	0.2	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0

TABLE A3-17 CONT.

Future Demand Case Study (Run 414-Run 411)
Project-Base (Difference) Demand Condition
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	84	-98	-392	-99	-198	-196	-308
2	-613	-600	-544	-91	-73	-169	-232
3	-398	-354	-356	-17	-18	-151	-181
4	1420	1016	1014	82	80	350	401
5	-829	-1284	-1284	-441	-439	-565	-912
6	-505	-714	-713	-46	-48	-360	-496
7	-1106	-1642	-1645	-639	-642	-763	-1230
8	114	395	391	-109	-112	60	112
9	-758	-853	-852	-83	-83	-47	-77
10	-544	-144	-144	-10	-9	-221	-225
11	-758	-854	-853	-83	-83	-45	-77
12	-547	-146	-146	-9	-8	-224	-229
13	-159	-31	-31	12	12	-106	-103
14	-158	-31	-31	12	12	-107	-103
15	-1456	-1031	-1030	-80	-80	-372	-408
16	-1456	-1032	-1031	-80	-80	-372	-409
17	1452	1030	1030	80	80	368	409
18	1461	1035	1034	80	80	375	411
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.02	0	-0.01	0	0	-0.03	-0.02
2	-0.02	0	0	0	0	-0.05	-0.04
3	-0.02	0	-0.01	0	0	-0.06	-0.05
4	-0.02	0.01	-0.01	0	0	-0.04	-0.04
5	-0.04	-0.02	-0.02	0	0	-0.18	-0.17
6	-0.03	-0.01	-0.02	0	0	-0.14	-0.13
7	-0.08	-0.05	-0.06	-0.01	0	-0.24	-0.19
8	-0.08	-0.07	-0.07	0	0	-0.23	-0.17
9	-0.05	-0.09	-0.09	0.1	0.09	1.57	1.58
10	1.08	-0.08	-0.09	0.02	0.02	2.08	2.19
11	-0.18	-0.3	-0.3	0.08	0.07	1.59	1.62
12	0.41	-0.33	-0.33	0.07	0.07	1.85	1.89
13	2.19	-0.05	-0.05	0	-0.01	2.27	2.3
14	1.37	-0.42	-0.42	0.05	0.05	1.89	1.91
15	-0.52	-0.63	-0.62	0.07	0.07	1.54	1.54
16	-0.84	-0.88	-0.88	0.07	0.07	1.39	1.37
17	0.18	0.13	0.13	0.01	0.01	-0.02	0
18	1.43	1.07	1.05	0.06	0.06	0.42	0.44
19	0.92	0.74	0.73	0.04	0.04	0.42	0.34

Minimum and Maximum Velocity

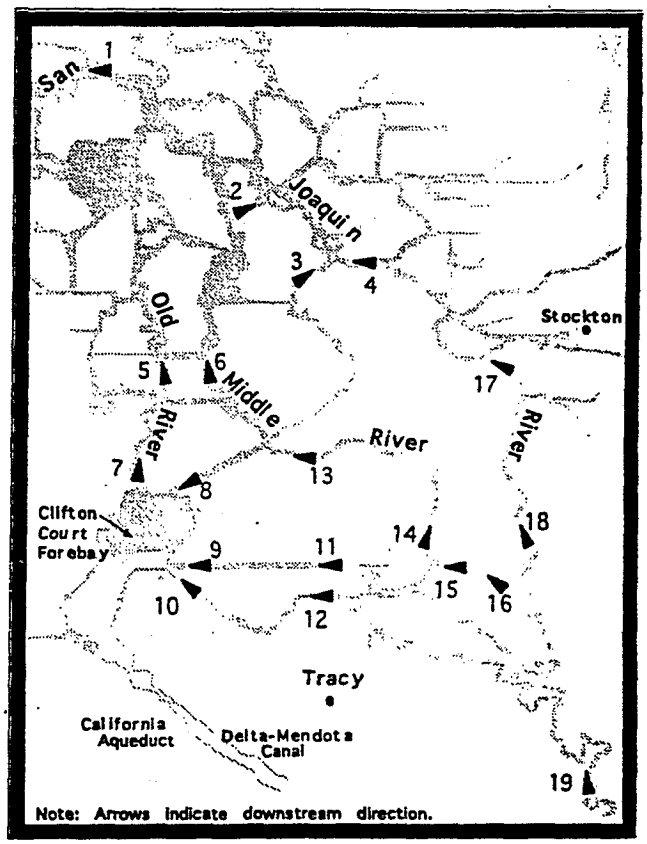
Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	-0.4	0.0	-0.4	0.1	-0.3	0.0	-0.3	-0.1	0.0	0.0	0.0
6	0.0	0.0	0.0	-0.3	0.0	-0.3	0.1	-0.1	0.1	-0.1	-0.1	0.1	0.0	0.1
7	-0.2	-0.2	-0.1	-0.4	-0.1	-0.4	-0.1	-0.2	-0.1	-0.2	-0.3	0.1	0.3	-0.1
8	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.3	0.1	0.3	0.1
9	0.0	-0.2	-0.1	-0.2	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
10	-0.8	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	-0.7	0.1	-0.7	0.1
11	0.0	-0.2	-0.1	-0.3	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3
12	-0.1	-0.5	0.0	-0.2	0.0	-0.2	0.1	0.0	0.1	0.0	-0.1	-0.1	0.0	-0.2
13	-0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	0.2	-0.6	0.2
14	-0.4	-0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	-0.4	-0.1	-0.4	-0.1
15	-1.0	-0.6	-0.8	-0.4	-0.8	-0.4	0.0	-0.2	0.0	-0.2	-0.3	0.2	-0.3	0.2
16	-1.3	-0.5	-1.1	-0.2	-1.1	-0.2	0.0	-0.3	0.0	-0.3	-0.4	0.3	-0.4	0.2
17	0.4	1.0	0.3	0.6	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
18	0.6	1.3	0.4	0.6	0.4	0.6	0.0	0.0	0.0	0.0	0.2	0.1	0.2	0.1
19	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-18

Future Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 414 - Run 411)
Representative Dry Year

Average Net Flow

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	-1013	-1057	1183	518	19	127	91	98	27	-318
2	-227	-217	-48	-109	-48	-1090	-806	-820	-175	-361
3	-25	-33	187	75	-8	-619	-497	-492	-75	-112
4	93	91	166	130	135	2385	1828	1832	451	507
5	-1507	-1508	804	36	-101	-1450	-1107	-1114	-358	-1157
6	-327	-334	795	287	-23	-919	-702	-703	-106	-193
7	-1997	-2006	803	-77	-168	-1856	-1433	-1435	-578	-1629
8	-36	-39	-766	-361	-177	388	270	273	-162	-245
9	-141	-145	-230	-174	522	-1611	-1146	-1140	-196	-296
10	19	17	28	16	-514	-632	-558	-568	-206	-184
11	-139	-143	-230	-174	522	-1612	-1146	-1140	-195	-296
12	15	15	19	17	-517	-637	-561	-572	-209	-186
13	24	23	35	27	-145	-195	-166	-170	-60	-29
14	25	24	38	27	-144	-196	-166	-169	-60	-28
15	-86	-88	-183	-131	-138	-2437	-1868	-1877	-466	-512
16	-88	-89	-187	-131	-138	-2437	-1868	-1876	-466	-512
17	87	86	172	131	140	2415	1860	1868	467	514
18	88	88	172	132	141	2460	1874	1882	469	517
19	0	0	0	0	0	0	0	0	0	0



Minimum Water Surface Elevation

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2
6	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2
7	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.3
8	0.0	0.0	0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2
9	0.1	0.1	0.2	0.1	0.2	-0.1	-0.1	-0.1	1.6	1.6
10	0.0	0.0	0.1	0.0	1.5	1.0	0.9	0.9	2.2	2.0
11	0.1	0.1	0.1	0.1	0.4	-0.4	-0.3	-0.3	1.7	1.6
12	0.1	0.1	0.1	0.1	0.8	0.1	0.2	0.2	1.9	1.7
13	0.0	0.0	0.1	0.0	2.4	2.1	2.0	2.0	2.2	1.9
14	0.0	0.0	0.1	0.1	1.5	1.0	1.1	1.2	1.9	1.8
15	0.1	0.1	0.1	0.1	0.5	-1.0	-0.7	-0.7	1.6	1.5
16	0.0	0.0	0.1	0.1	0.4	-1.6	-1.1	-1.1	1.4	1.3
17	0.0	0.0	0.1	0.0	0.0	0.5	0.3	0.3	0.0	0.1
18	0.0	0.0	0.1	0.1	0.2	2.7	1.8	1.9	0.5	0.5
19	0.0	0.0	0.0	0.0	0.1	1.6	1.2	1.2	0.2	0.3

Minimum and Maximum Velocity

Ref. No.	Jan 1-15		Jan 16-31		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.1	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
5	0.2	-0.4	0.2	-0.4	0.2	-0.2	0.1	-0.2	0.0	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	-0.3
6	0.2	-0.2	0.2	-0.2	0.2	-0.1	0.1	-0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	-0.1
7	0.0	-0.3	0.0	-0.3	0.1	0.0	0.0	-0.1	-0.2	-0.1	-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.2	0.0	0.1	-0.1
8	0.1	0.0	0.1	0.0	0.1	-0.1	0.0	0.0	0.2	0.0	0.4	0.1	0.3	0.1	0.3	0.1	0.2	0.0	0.3	0.0
9	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.2	0.1	-0.1	-0.3	-0.1	-0.2	-0.1	-0.2	0.0	0.3	0.0	0.3
10	0.1	0.0	0.1	0.0	0.1	-0.1	0.1	-0.1	-0.8	0.0	-0.8	-0.1	-0.7	-0.1	-0.7	-0.1	-0.7	0.1	-0.5	0.1
11	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.0	-0.2	0.2	0.1	-0.2	-0.4	-0.3	-0.3	-0.1	-0.3	0.0	0.3	0.0	0.3
12	0.0	0.0	0.0	0.0	0.1	0.0	0.1	-0.1	-0.1	-0.5	-0.3	-0.6	-0.2	-0.5	-0.2	-0.5	0.0	-0.2	0.0	-0.2
13	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	-0.8	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.1	-0.8	0.2	-0.6	0.1
14	0.1	0.2	0.0	0.2	0.1	0.2	0.1	0.2	0.2	-0.4	-0.6	-0.5	-0.4	-0.4	-0.4	-0.4	-0.2	0.0	-0.1	0.1
15	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.0	-0.2	-0.1	0.0	-1.4	-1.3	-1.1	-0.9	-1.1	-0.9	-0.3	0.2	-0.2	0.1
16	-0.1	-0.1	-0.1	-0.1	0.0	-0.2	0.0	-0.2	-0.1	-0.1	-1.6	-1.4	-1.5	-1.0	-1.5	-0.9	-0.4	0.1	-0.4	0.0
17	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.9	1.7	0.6	1.3	0.6	1.3	0.1	0.2	0.1	0.2
18	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.9	1.9	0.7	1.7	0.7	1.7	0.2	0.1	0.2	0.2
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.1	-0.2	-0.1	0.0	0.0	0.0	0.0

TABLE A3-18 CONT.

Future Demand Case Study (Run 414-Run 411)
Project-Base (Difference) Demand Condition
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1035	179	157	34	26	148	-251
2	-1509	-1332	-1308	-142	-130	-269	-271
3	-637	-493	-499	85	78	-38	-152
4	2741	2584	2571	113	111	508	458
5	-3241	-1839	-1835	-377	-379	-420	-972
6	-1523	-749	-747	241	236	168	-383
7	-4057	-2405	-2405	-635	-643	-749	-1365
8	693	246	239	-414	-417	-521	-47
9	-2035	-2334	-2330	-188	-192	-269	-155
10	-581	-281	-277	14	14	-194	-224
11	-2034	-2330	-2326	-183	-187	-269	-155
12	-589	-285	-279	15	15	-196	-227
13	-173	-57	-57	28	27	-53	-86
14	-172	-57	-56	29	29	-53	-87
15	-2777	-2657	-2645	-124	-126	-519	-468
16	-2776	-2654	-2641	-122	-123	-519	-468
17	2753	2619	2802	114	113	520	469
18	2802	2659	2644	116	116	522	470
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	0.12	0.18	0.18	0.19	0.2	0.21	0.16
2	0.04	0.08	0.07	0.09	0.09	0.09	0.04
3	-0.02	0.01	0.01	0.02	0.02	0	-0.05
4	0.01	0.09	0.09	0.08	0.08	0.04	0.04
5	-0.12	-0.01	-0.01	0.03	0.02	-0.19	-0.17
6	-0.01	0.11	0.1	0.13	0.13	-0.02	0.01
7	-0.11	0.02	0.02	0.09	0.09	-0.13	-0.08
8	-0.3	-0.15	-0.14	-0.06	-0.06	-0.21	-0.17
9	-0.03	0.06	0.07	0.31	0.31	1.68	1.71
10	-0.05	-0.73	-0.73	-0.55	-0.56	1.65	1.77
11	-0.51	-0.54	-0.54	0.12	0.12	1.65	1.64
12	0.41	-0.04	-0.04	0.55	0.55	1.89	2.08
13	0.92	-0.81	-0.8	-0.62	-0.63	1.8	1.91
14	0.18	-1.11	-1.11	-0.19	-0.19	1.63	1.76
15	-1.76	-1.74	-1.74	-0.34	-0.35	1.33	1.34
16	-0.31	-0.4	-0.4	1.21	1.22	1.74	1.82
17	-0.86	-0.8	-0.79	-1.12	-1.13	-0.48	-0.61
18	-2.67	-2.59	-2.8	-4.76	-4.79	-1.61	-1.66
19	10.73	10.22	10.21	7.86	7.85	4.68	4.84

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.9	-0.8	0.9	-0.8	0.8	-0.9	0.9	-0.8	0.8	-0.9	0.8	-0.8	0.8	-0.9
2	0.1	-0.3	0.0	-0.2	0.1	-0.2	0.2	-0.2	0.3	-0.1	0.3	-0.2	0.3	-0.2
3	-0.4	-0.2	-0.3	-0.2	-0.3	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2	0.0	-0.2	0.0
4	0.0	1.1	-0.2	1.2	-0.2	1.2	-0.3	1.1	-0.3	1.1	0.0	1.1	-0.3	0.9
5	0.0	-0.4	0.0	-0.3	0.0	-0.4	0.2	-0.3	0.2	-0.3	0.3	-0.1	0.0	0.1
6	0.1	0.7	-0.1	0.7	0.0	-0.7	0.1	0.9	0.1	0.9	0.3	1.0	0.0	0.6
7	-0.6	-2.8	-0.3	-2.7	-0.3	-2.7	-0.3	-2.7	-0.3	-2.8	-0.7	-2.4	-0.6	-2.0
8	0.5	0.7	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.6	0.9	0.3	0.8
9	0.1	-0.3	0.1	-0.3	0.2	-0.3	0.4	0.1	0.4	0.1	0.3	0.2	0.3	0.2
10	1.0	-0.4	-0.3	-0.6	-0.3	-0.6	-0.2	-0.5	-0.2	-0.5	-0.8	0.1	-0.9	0.1
11	0.3	-1.0	0.3	-0.7	0.3	-0.7	0.6	-0.3	0.6	-0.2	0.5	-0.4	0.6	-0.3
12	-0.5	-0.2	-0.4	0.5	-0.4	0.5	-0.2	0.7	-0.2	0.7	-0.3	0.5	-0.4	0.3
13	-0.6	-0.3	0.1	-0.2	0.1	-0.2	0.2	-0.1	0.2	-0.1	-0.3	-0.1	-0.4	0.0
14	-2.1	-1.8	-1.4	-1.9	-1.4	-1.9	-1.0	-1.5	-1.0	-1.5	-0.8	-0.2	-1.1	-0.3
15	-1.7	-1.9	-1.7	-1.9	-1.7	-1.9	-0.3	-0.4	-0.3	-0.4	-0.6	0.1	-0.5	0.2
16	-1.2	0.5	-1.2	0.5	-1.2	0.5	0.5	2.1	0.5	2.1	-0.1	1.0	-0.2	1.0
17	1.1	1.6	1.0	1.7	1.0	1.6	0.1	0.0	0.1	0.0	0.2	0.2	0.3	0.1
18	0.5	0.0	0.4	-0.1	0.4	-0.1	-0.4	-2.2	-0.4	-2.2	0.2	-1.7	0.2	-1.6
19	1.6	1.6	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	0.8	0.6	0.8	0.6

TABLE A3-19

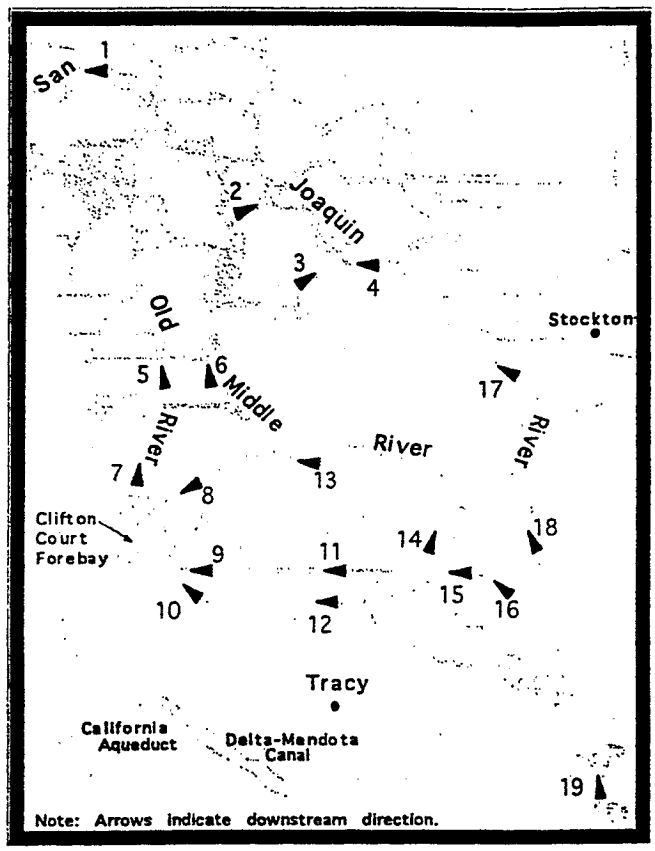
Future Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 414 - Run 411)
Representative Below Normal Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	280	1539	399	1	120	108	119	36	-622
2	-165	-38	-88	-37	-1176	-907	-923	-181	-425
3	107	230	87	-2	-646	-518	-512	-72	-170
4	136	180	137	126	2551	2016	2023	457	495
5	-170	1139	97	-106	-1582	-1247	-1255	-370	-1685
6	367	1001	345	-19	-983	-746	-748	-98	-474
7	-373	1210	-20	-179	-1998	-1616	-1619	-599	-2259
8	-512	-918	-425	-182	424	277	282	-178	-42
9	-165	-235	-179	519	-1779	-1327	-1320	-204	-274
10	25	22	12	-515	-639	-566	-579	-203	-190
11	-166	-235	-179	520	-1780	-1327	-1321	-205	-274
12	24	26	12	-524	-650	-570	-582	-207	-192
13	33	40	28	-142	-199	-169	-174	-61	-30
14	33	39	28	-141	-199	-169	-173	-61	-31
15	-115	-172	-140	-131	-2611	-2061	-2073	-473	-498
16	-119	-176	-139	-133	-2612	-2060	-2071	-472	-498
17	134	188	140	132	2579	2049	2061	473	500
18	132	188	141	133	2634	2069	2079	476	502
19	0	0	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.1	0.0	0.0	-0.1	-0.1	0.0	-0.2	-0.2
6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2
7	0.0	0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.3
8	0.0	0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.3
9	0.2	0.2	0.1	0.2	-0.2	-0.1	-0.1	1.6	1.6
10	0.1	0.1	0.0	1.5	0.9	0.9	0.9	2.2	1.9
11	0.2	0.2	0.1	0.4	-0.6	-0.3	-0.3	1.7	1.5
12	0.2	0.2	0.1	0.8	0.1	0.2	0.2	1.9	1.7
13	0.0	0.1	0.0	2.4	2.0	2.0	2.0	2.2	1.9
14	0.1	0.1	0.1	1.5	0.9	1.0	1.1	1.9	1.8
15	0.2	0.2	0.1	0.5	-1.1	-0.8	-0.8	1.6	1.4
16	0.1	0.1	0.1	0.4	-1.7	-1.2	-1.2	1.4	1.3
17	0.1	0.1	0.0	0.0	0.6	0.4	0.3	0.0	0.1
18	0.1	0.1	0.1	0.1	2.9	2.2	2.2	0.5	0.5
19	0.0	0.0	0.0	0.0	1.7	1.3	1.3	0.2	0.2



Minimum and Maximum Velocity

Ref. No.	January		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.0	-0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
5	0.2	-0.3	0.2	-0.2	0.1	-0.2	0.1	0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.2	-0.4
6	0.3	-0.2	0.2	-0.1	0.2	-0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	-0.1
7	0.1	-0.2	0.1	0.0	0.0	-0.1	-0.2	-0.1	-0.3	-0.4	-0.3	-0.3	-0.3	-0.3	-0.2	0.0	0.0	-0.2
8	0.0	0.0	-0.1	-0.1	0.0	0.0	0.2	0.0	0.4	0.1	0.4	0.1	0.4	0.1	0.2	0.0	0.3	0.0
9	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.2	0.1	-0.2	-0.3	-0.1	-0.2	-0.1	-0.2	0.0	0.3	-0.1	-0.3
10	0.1	-0.1	0.2	-0.1	0.1	-0.1	-0.8	0.0	-0.8	-0.1	-0.7	-0.1	-0.7	-0.1	-0.7	0.1	-0.8	0.1
11	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.2	0.1	-0.2	-0.4	-0.1	-0.3	-0.1	-0.3	0.0	0.3	0.0	0.3
12	0.0	0.0	0.1	0.0	0.1	-0.1	-0.1	-0.5	-0.3	-0.6	-0.3	-0.6	-0.3	-0.6	0.0	-0.3	0.0	-0.2
13	0.1	0.0	0.1	-0.1	0.0	0.0	-0.6	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.1	-0.6	0.2	-0.6	0.0
14	0.1	0.2	0.1	0.2	0.1	0.2	-0.2	-0.4	-0.7	-0.5	-0.5	-0.4	-0.5	-0.4	-0.1	0.0	0.1	0.1
15	0.0	-0.2	0.0	-0.2	0.0	-0.2	-0.1	-0.1	-1.5	-1.3	-1.2	-1.1	-1.2	-1.0	-0.3	0.2	-0.2	-0.1
16	-0.1	-0.2	0.0	-0.3	0.0	-0.3	-0.1	-0.1	-1.9	-1.5	-1.6	-1.1	-1.6	-1.1	-0.4	0.1	-0.4	0.0
17	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	1.7	0.7	1.4	0.7	1.4	0.1	0.2	0.1	0.2
18	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	1.0	2.0	0.8	1.8	0.8	1.8	0.2	0.2	0.2	0.2
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.1	-0.2	-0.1	0.0	0.0	0.0	0.0

TABLE A3-19 CONT.

Future Demand Case Study (Run 414-Run 411)
Project-Base (Difference) Demand Condition
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	118	-1999	-935	-876	-324	-132
2	-1036	-1669	-222	-237	-343	-225
3	-420	-744	-23	-17	-112	-120
4	2080	2847	100	102	465	447
5	-1518	-4265	-1361	-1362	-1186	-718
6	-601	-2057	-292	-289	-207	-255
7	-1998	-5311	-1797	-1793	-1637	-1055
8	69	1133	-50	-45	-257	-138
9	-1464	-2511	-123	-123	-220	-140
10	-521	-295	18	19	-189	-225
11	-1465	-2514	-123	-123	-219	-141
12	-524	-308	20	21	-192	-229
13	-146	-80	25	26	-57	-90
14	-146	-79	25	26	-57	-90
15	-2129	-2896	-76	-77	-469	-459
16	-2128	-2903	-76	-77	-468	-459
17	2120	2879	95	96	469	459
18	2137	2953	95	96	471	461
19	0	0	16	16	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	0.01	-0.05	0.01	0.01	0.02	-0.01
2	0	-0.05	0	0	0.02	-0.02
3	-0.01	-0.04	0	0	0	-0.05
4	0	-0.04	0	0	0.01	-0.03
5	-0.04	-0.09	0	0	-0.21	-0.15
6	-0.02	-0.07	-0.01	0	-0.15	-0.12
7	-0.06	-0.12	-0.01	-0.01	-0.24	-0.13
8	-0.05	-0.13	0	0.01	-0.23	-0.12
9	-0.03	-0.21	0.14	0.14	1.53	1.58
10	0.88	-0.15	0.02	0.02	1.84	2.19
11	-0.25	-0.74	0.11	0.11	1.49	1.62
12	0.25	-0.78	0.09	0.09	1.64	1.87
13	1.89	-0.13	-0.01	0	1.87	2.26
14	0.99	-0.92	0.06	0.06	1.68	1.89
15	-0.73	-1.48	0.08	0.08	1.41	1.54
16	-1.15	-2.09	0.06	0.06	1.27	1.38
17	0.34	0.59	0.01	0.01	0.05	0.01
18	2.12	3.15	0.06	0.06	0.46	0.47
19	1.25	1.78	0.03	0.03	0.37	0.39

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.8	-0.8	0.8	-0.9	0.8	-0.9	0.9	-0.8	0.8	-0.8	0.8	-0.9
2	0.2	-0.2	0.1	-0.2	0.3	-0.1	0.2	-0.1	0.3	-0.2	0.3	-0.2
3	-0.3	-0.1	-0.4	-0.2	-0.3	-0.1	-0.3	-0.1	-0.2	0.0	-0.2	0.0
4	-0.2	1.1	-0.2	1.2	-0.3	1.1	-0.3	1.1	0.0	1.1	-0.3	0.9
5	0.0	-0.2	-0.1	-0.5	0.1	-0.3	0.1	-0.3	0.2	-0.2	0.0	0.1
6	0.1	-0.8	-0.2	0.6	0.0	-0.8	0.0	0.8	0.2	-0.9	0.0	0.8
7	-0.5	-2.4	-0.4	-3.0	-0.2	-2.7	-0.3	-2.7	0.7	-2.8	-0.5	-2.0
8	0.5	-0.7	0.1	0.1	0.0	0.0	0.0	0.0	0.7	0.9	0.3	0.8
9	0.3	-0.2	0.1	-0.3	-0.4	0.2	0.4	0.2	0.3	0.2	0.3	0.1
10	1.0	0.3	-0.4	-0.6	-0.2	-0.5	-0.2	-0.5	0.7	0.1	-0.9	0.1
11	0.4	-0.9	0.2	-0.7	0.6	-0.2	0.6	-0.2	0.4	-0.4	0.6	-0.3
12	-0.5	0.2	-0.4	0.5	-0.2	0.7	-0.2	0.7	0.3	0.5	-0.4	0.3
13	-0.5	-0.2	0.1	-0.1	0.2	0.0	0.2	0.0	0.3	0.1	-0.4	0.0
14	-1.7	-1.4	-1.7	-2.1	-1.2	-1.7	-1.2	-1.7	0.8	-0.1	-1.1	-0.2
15	-1.4	-1.4	-1.9	-1.9	-0.3	-0.4	-0.3	-0.4	0.5	0.1	-0.5	0.2
16	-1.0	0.8	-1.3	0.5	0.7	2.2	0.7	2.2	0.1	0.9	-0.2	0.9
17	0.8	1.3	1.1	1.7	0.1	-0.1	0.1	-0.1	0.3	0.2	0.3	0.1
18	0.4	-0.3	0.5	0.1	-0.5	-2.2	-0.5	-2.2	0.3	-1.8	0.3	-1.5
19	1.3	1.3	1.6	1.6	1.8	1.8	1.8	1.8	0.7	0.5	0.7	0.5

TABLE A3-20

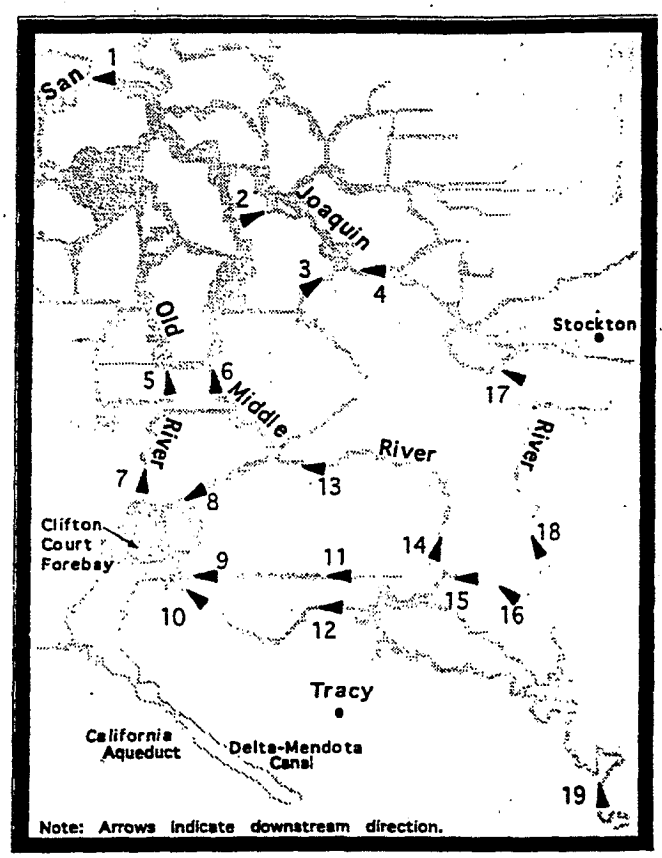
Future Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 414 - Run 411)
Representative Above Normal Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	-339	-598	922	1289	17	125	137	146	55	-4854
2	-236	-189	-125	-61	-47	-1197	-1149	-1158	-192	45
3	-22	-24	156	195	2	-633	-607	-599	-61	-131
4	93	91	163	185	140	2573	2472	2485	466	435
5	-1048	-1049	379	870	-125	-1600	-1535	-1539	-384	-2304
6	-207	-206	655	860	0	-967	-925	-923	-71	-712
7	-1410	-1414	275	878	-212	-2052	-1980	-1964	-635	-2958
8	-67	-72	-718	-825	-218	396	381	383	-221	153
9	-122	-122	-200	-220	526	-1807	-1713	-1706	-219	-261
10	13	14	19	24	-518	-637	-626	-640	-186	-186
11	-123	-122	-200	-225	526	-1808	-1714	-1707	-220	-261
12	14	14	21	12	-530	-650	-631	-644	-200	-187
13	23	22	36	36	-147	-200	-194	-200	-61	-26
14	23	22	35	37	-145	-201	-195	-198	-61	-25
15	-85	-86	-147	-174	-136	-2639	-2533	-2545	-481	-475
16	-85	-85	-150	-178	-141	-2642	-2531	-2543	-481	-474
17	86	85	164	190	144	2608	2505	2517	482	476
18	86	86	164	188	143	2667	2556	2555	485	478
19	0	0	0	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1
2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1
3	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1
4	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1
5	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	-0.2	-0.3
6	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	-0.1	-0.2
7	0.0	0.0	0.1	0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.3
8	0.0	0.0	0.1	0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.3
9	0.1	0.1	0.2	0.2	0.2	-0.1	-0.1	-0.1	1.6	1.4
10	0.0	0.0	0.1	0.1	1.5	1.0	0.9	0.9	2.2	1.8
11	0.1	0.1	0.2	0.1	0.4	-0.5	-0.4	-0.4	1.7	1.4
12	0.1	0.1	0.2	0.1	0.9	0.1	0.1	0.1	1.9	1.6
13	0.0	0.0	0.1	0.1	2.5	2.1	2.1	2.1	2.2	1.7
14	0.1	0.1	0.1	0.1	1.5	0.9	0.9	1.0	1.9	1.6
15	0.1	0.1	0.2	0.1	0.5	-1.1	-1.0	-1.0	1.6	1.3
16	0.1	0.1	0.2	0.1	0.4	-1.7	-1.6	-1.6	1.4	1.1
17	0.0	0.0	0.1	0.1	0.0	0.6	0.5	0.5	0.0	-0.1
18	0.1	0.1	0.1	0.1	0.1	2.9	2.8	2.8	0.5	0.3
19	0.0	0.0	0.0	0.0	0.1	1.7	1.6	1.6	0.2	0.2



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16		Jan. 17-31		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
2	0.1	0.0	-0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1	0.1	-0.1	-0.1	-0.1	0.0	0.0	0.1	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.0	-0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
5	0.1	-0.4	0.1	-0.4	0.2	-0.3	0.2	-0.2	0.0	0.0	0.0	-0.1	0.0	-0.2	0.0	-0.2	0.0	0.0	0.1	-0.4
6	0.1	-0.2	0.1	-0.2	0.3	-0.1	0.2	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.1	-0.1	0.2	-0.1
7	0.0	-0.3	0.0	-0.3	0.1	-0.1	0.1	0.0	-0.2	0.0	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.2	0.0	-0.2	-0.3
8	0.1	0.0	0.1	0.0	0.0	-0.1	-0.1	-0.1	0.2	0.0	0.4	0.1	0.4	0.1	0.4	0.1	0.3	0.0	0.3	0.0
9	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	-0.1	-0.2	-0.3	-0.2	-0.3	-0.2	-0.3	0.0	0.3	-0.1	0.3
10	0.1	-0.1	0.1	-0.1	0.2	-0.1	0.2	-0.1	-0.8	0.0	-0.8	-0.1	-0.8	-0.1	-0.8	-0.1	-0.7	0.1	-0.6	0.1
11	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.2	0.1	-0.2	-0.4	-0.2	-0.4	-0.2	-0.4	0.0	0.3	0.0	0.3
12	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	-0.1	-0.5	-0.3	-0.7	-0.3	-0.6	-0.3	-0.6	0.0	-0.3	0.0	-0.2
13	0.0	0.0	0.0	0.0	0.1	-0.1	0.1	-0.1	-0.8	-0.2	-0.6	0.1	-0.6	0.1	-0.6	0.1	-0.8	0.2	-0.6	0.0
14	0.0	0.2	0.0	0.2	0.1	0.2	0.1	0.2	-0.2	-0.4	-0.7	-0.5	-0.7	-0.4	-0.7	-0.4	-0.2	0.0	-0.1	0.1
15	0.0	-0.2	0.0	-0.1	0.0	-0.2	0.0	-0.3	-0.2	-0.1	-1.5	-1.4	-1.4	-1.3	-1.5	-1.3	-0.3	0.2	-0.2	0.1
16	0.0	-0.2	0.0	-0.2	-0.1	-0.2	-0.1	-0.3	-0.2	-0.1	-1.9	-1.5	-1.8	-1.5	-1.9	-1.5	-0.4	0.1	-0.3	0.1
17	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	1.0	1.8	0.9	1.7	0.9	1.7	0.1	0.2	0.1	0.2
18	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	1.0	2.0	0.9	2.0	0.9	2.0	0.2	0.2	0.2	0.2
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0

TABLE A3-20 CONT.

Future Demand Case Study (Run 414-Run 411)
Project-Base (Difference) Demand Condition
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1915	60	21	38	29	820	-239
2	-1572	-973	-948	-57	-53	-123	-310
3	-710	-346	-355	20	18	88	-134
4	2722	1826	1822	92	91	543	507
5	-4187	-1521	-1516	-180	-177	699	-966
6	-2023	-485	-483	107	104	742	-280
7	-5193	-2016	-2017	-318	-320	585	-1381
8	1045	54	47	-209	-211	-933	-155
9	-2010	-1636	-1634	-113	-112	-306	-214
10	-579	-202	-197	1	1	-201	-227
11	-2010	-1637	-1635	-113	-112	-306	-214
12	-589	-203	-199	1	2	-202	-230
13	-174	-25	-25	16	17	-54	-74
14	-174	-26	-25	17	17	-54	-74
15	-2755	-1868	-1861	-94	-93	-563	-517
16	-2756	-1867	-1860	-94	-94	-564	-517
17	2736	1863	1856	94	93	564	517
18	2786	1874	1868	94	94	567	519
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.1	0.02	0.02	0.01	0	0.06	0.01
2	-0.08	0.01	0.01	0	0	0.04	-0.02
3	-0.07	0.01	0.02	0.01	0.01	0.01	-0.04
4	-0.08	0.01	0.01	0.01	0.01	0.02	-0.03
5	-0.11	0	0	0	0	-0.16	-0.16
6	-0.11	0	0	0.01	0.01	-0.1	-0.11
7	-0.17	-0.01	-0.01	-0.01	-0.01	-0.15	-0.15
8	-0.17	0	0	0	0	-0.12	-0.12
9	-0.22	-0.03	-0.03	0.11	0.11	1.58	1.61
10	0.54	-0.01	-0.01	0.02	0.02	2.08	2.18
11	-0.55	-0.3	-0.3	0.08	0.09	1.65	1.64
12	-0.22	-0.34	-0.34	0.08	0.07	1.86	1.85
13	1.65	-0.02	-0.02	0	0	2.07	2.2
14	0.52	-0.46	-0.45	0.06	0.08	1.88	1.87
15	-1.2	-0.72	-0.72	0.08	0.08	1.57	1.54
16	-1.81	-1.07	-1.07	0.07	0.08	1.42	1.38
17	0.53	0.26	0.26	0.02	0.02	0.07	0.01
18	2.95	1.72	1.73	0.07	0.06	0.54	0.48
19	1.68	1.07	1.08	0.03	0.02	0.4	0.36

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	-0.1	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	-0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
4	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
5	-0.1	-0.6	0.1	-0.4	0.1	-0.4	0.1	-0.2	0.1	-0.2	0.3	0.0	0.0	-0.2
6	-0.1	-0.3	0.1	-0.2	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.4	0.1	0.0	0.0
7	-0.4	-0.7	-0.1	-0.4	-0.1	-0.4	0.0	-0.1	0.0	-0.1	0.1	0.3	-0.2	0.0
8	0.6	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	-0.1	0.3	0.0
9	-0.3	-0.4	-0.1	-0.4	-0.1	-0.4	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.3
10	-0.8	-0.1	0.0	-0.2	0.1	-0.2	0.1	0.0	0.1	0.0	-0.6	0.2	0.7	0.1
11	-0.3	-0.5	-0.2	-0.5	-0.2	-0.5	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.3
12	-0.3	-0.8	-0.1	-0.3	-0.1	-0.3	0.1	0.0	0.1	0.0	0.0	-0.2	0.0	-0.2
13	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	0.1	-0.6	0.1
14	-0.9	-0.3	-0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	-0.2	0.1	-0.2	0.0
15	-1.4	-1.4	-1.0	-1.2	-1.0	-1.2	0.0	-0.2	0.0	-0.2	-0.3	0.2	-0.3	0.2
16	-1.9	-1.8	-1.4	-1.2	-1.4	-1.2	0.0	-0.2	0.0	-0.2	-0.5	0.2	-0.4	0.2
17	1.0	1.8	0.5	1.2	0.5	1.2	0.0	0.0	0.1	0.0	0.1	0.2	0.1	0.2
18	1.0	2.2	0.7	1.7	0.7	1.7	0.0	0.1	0.0	0.1	0.3	0.2	0.2	0.2
19	-0.3	-0.2	-0.2	-0.1	-0.2	-0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0

TABLE A3-21

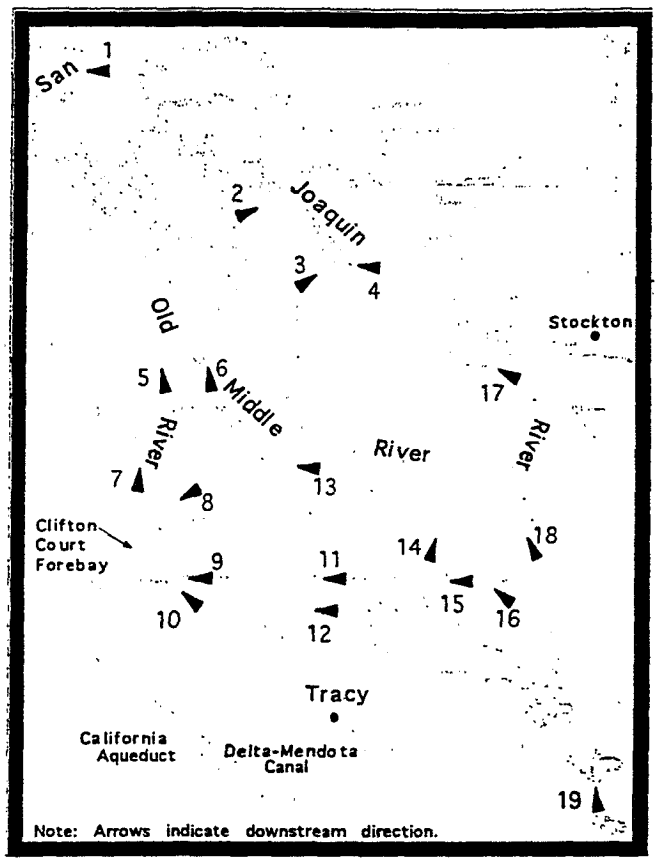
Future Demand Case Study
Difference Between ISDP and Base Condition
Without ISDP (Run 414 - Run 411)
Representative Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	-456	2791	621	63	45	109	352
2	-205	54	-24	-82	-114	-145	-220
3	29	339	117	10	39	77	-25
4	113	195	84	134	105	80	639
5	-922	2301	434	-53	-146	-253	-33
6	-25	1745	419	-55	54	258	179
7	-1258	2612	559	51	-124	-403	-248
8	-226	-1454	-292	181	-10	-353	-367
9	-154	-274	-158	-242	-197	-93	-498
10	18	30	55	101	82	33	-211
11	-155	-273	-181	-254	-206	-96	-495
12	20	36	60	104	83	33	-216
13	28	54	15	13	11	20	-26
14	29	54	16	12	11	19	28
15	-104	-185	-85	-140	-111	-51	-663
16	-105	-189	-90	-148	-116	-58	-663
17	110	208	94	143	112	78	667
18	110	209	99	158	123	76	673
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4	0.0	0.1	0.0	0.0	0.0	0.1	0.0
5	0.0	0.1	0.0	0.0	0.0	0.0	-0.2
6	0.0	0.1	0.0	0.0	0.0	0.0	-0.1
7	0.0	0.1	0.0	-0.1	0.0	-0.1	-0.2
8	0.0	0.1	0.0	-0.1	-0.1	-0.1	-0.1
9	0.1	0.3	0.3	0.4	0.4	0.2	2.0
10	0.0	0.2	0.0	0.0	0.0	0.0	3.0
11	0.1	0.3	0.2	0.3	0.3	0.2	2.0
12	0.1	0.3	0.1	0.2	0.2	0.2	2.4
13	0.0	0.1	0.0	0.0	0.0	0.0	3.3
14	0.1	0.2	0.1	0.0	0.1	0.1	2.6
15	0.1	0.2	0.1	0.1	0.1	0.1	1.9
16	0.1	0.2	0.0	0.0	0.0	0.1	1.5
17	0.0	0.1	0.0	0.1	0.1	0.1	0.1
18	0.1	0.2	0.1	0.1	0.1	0.1	0.5
19	0.0	0.1	0.0	0.1	0.0	0.0	0.2



Note: Arrows indicate downstream direction.

Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.1	0.0	0.0
3	0.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
5	0.2	-0.4	0.3	-0.1	0.1	-0.2	0.2	-0.1	0.3	-0.2	0.4	-0.3	0.1	0.0
6	0.2	-0.2	0.4	0.0	0.1	-0.1	0.2	-0.1	0.3	-0.1	0.5	-0.1	0.1	0.1
7	0.1	-0.3	0.2	0.1	-0.1	-0.1	-0.1	-0.2	0.1	-0.1	0.2	-0.1	-0.1	0.3
8	0.1	0.0	-0.1	-0.1	0.0	0.0	0.4	0.1	0.4	0.1	0.4	0.0	0.1	-0.1
9	0.0	-0.1	0.0	-0.2	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.6
10	0.1	-0.1	0.2	-0.2	0.1	0.0	0.1	-0.1	0.0	0.1	-0.1	0.0	-0.7	0.8
11	0.0	-0.1	0.0	-0.2	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4
12	0.0	0.0	0.1	-0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	-0.6
13	0.0	0.0	0.1	-0.1	0.0	0.0	0.1	-0.1	0.1	0.0	0.0	-0.1	-0.5	0.3
14	0.0	0.2	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.1	-0.1
15	0.0	-0.1	0.0	-0.3	0.0	-0.1	-0.1	0.0	-0.1	0.0	0.0	-0.1	-0.4	-0.3
16	-0.1	-0.1	0.0	-0.3	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.4	-0.5
17	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6
18	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-21 CONT.

Future Demand Case Study (Run 414-Run 411)
Project-Base (Difference) Demand Condition
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	28	-2045	-2094	51	-2000
2	-610	-1061	-263	-261	-636
3	-311	-521	-132	-96	-336
4	1293	1676	66	595	801
5	-992	-3575	-2412	-479	-3074
6	-427	-1561	-828	-102	-1310
7	-1342	-4510	-3075	-775	-3894
8	2	794	312	-211	610
9	-717	-1488	-81	-345	-446
10	480	-184	3	-225	-352
11	-718	-1489	-81	-345	-443
12	-482	-186	4	-228	-359
13	134	-31	19	-39	-22
14	-133	-31	18	-39	-20
15	-1326	-1707	-58	-613	-799
16	-1326	-1706	-58	-613	-803
17	1323	1702	58	616	814
18	1330	1711	59	618	822
19	0	0	0	0	0

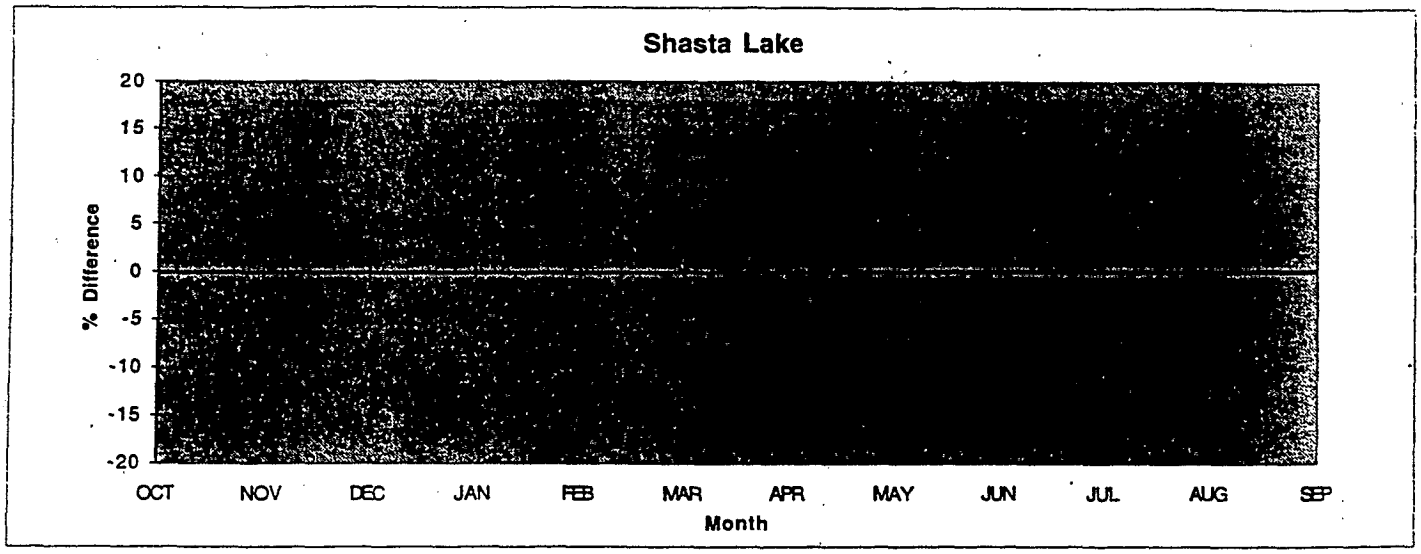
Minimum Water Surface Elevation

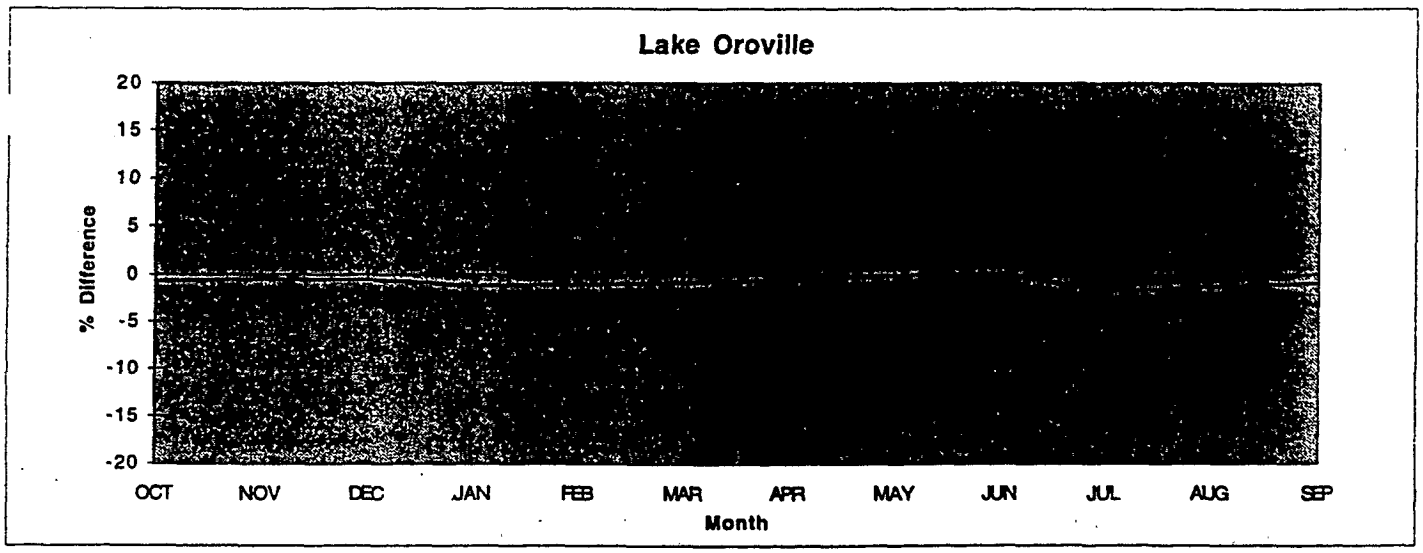
Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	-0.02	-0.04	-0.03	0	-0.07
2	-0.02	-0.05	-0.04	-0.02	-0.06
3	-0.02	-0.05	-0.04	-0.04	-0.08
4	-0.02	-0.04	-0.04	-0.03	-0.06
5	-0.03	-0.07	-0.04	-0.15	-0.24
6	-0.02	-0.07	-0.05	-0.12	-0.19
7	-0.03	-0.09	-0.05	-0.14	-0.3
8	-0.03	-0.09	-0.05	-0.12	-0.3
9	0.01	-0.12	0.02	1.73	2.04
10	1.11	-0.09	-0.02	2.5	3.15
11	-0.12	-0.41	-0.04	1.79	2.08
12	0.45	-0.45	-0.05	2.1	2.44
13	2.11	-0.08	-0.03	2.5	3.79
14	1.34	-0.45	0	2.1	2.84
15	-0.41	-0.77	-0.03	1.71	1.93
16	-0.68	-1.05	-0.01	1.48	1.61
17	0.16	0.16	-0.04	0.02	0.03
18	1.26	1.48	0	0.48	0.57
19	0.85	0.96	0	0.24	0.25

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec.		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	-0.1	-0.2	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	-0.1
4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	-0.1	0.0	-0.5	0.1	-0.4	0.0	0.0	-0.1	-0.6
6	0.0	0.0	0.0	-0.3	0.1	-0.3	0.0	0.1	0.0	-0.3
7	-0.2	-0.2	-0.2	-0.6	0.0	-0.4	-0.2	0.1	-0.5	-0.6
8	0.3	0.0	0.2	0.0	0.1	0.0	0.2	0.0	0.3	0.1
9	0.0	-0.1	-0.2	-0.3	0.0	-0.1	0.0	0.3	-0.1	0.6
10	-0.7	0.0	0.0	-0.1	0.1	0.0	-0.7	0.2	-0.8	0.8
11	-0.1	-0.1	-0.2	-0.4	0.0	-0.1	0.0	0.3	0.1	0.4
12	-0.2	-0.5	-0.1	-0.2	0.0	0.0	0.0	-0.4	0.1	-0.7
13	-0.6	0.1	0.0	0.1	0.0	0.1	-0.6	0.2	-0.7	0.8
14	-0.6	-0.2	-0.2	0.0	0.0	0.1	0.0	0.0	0.0	-0.2
15	-0.9	-0.3	-1.0	-1.0	0.0	-0.1	-0.3	-0.2	-0.4	-0.4
16	-1.2	-0.2	-1.4	-1.0	0.0	-0.1	-0.4	-0.3	-0.4	-0.6
17	0.4	0.7	0.5	1.1	0.0	0.0	0.1	0.3	0.2	0.8
18	0.5	0.8	0.6	1.5	0.0	0.0	0.2	0.3	0.2	0.9
9	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0

Figure A3-21
Existing Demand Case - Percent Difference
between Fisheries Alternative and Base Condition
End of Month Storage





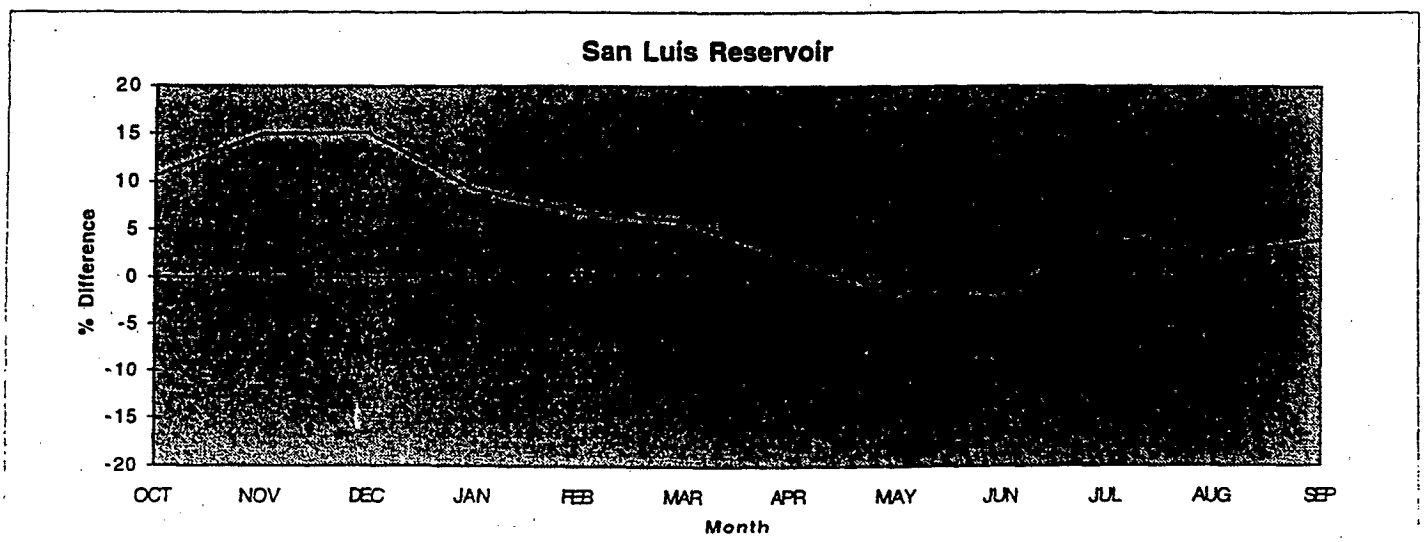
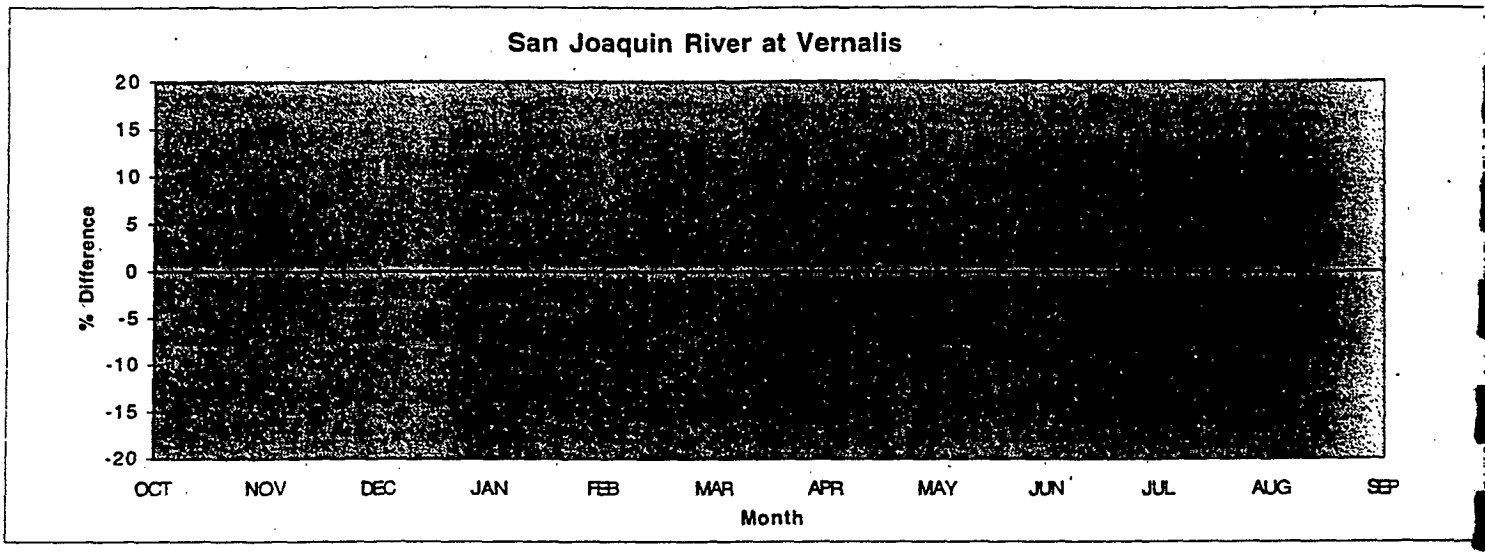
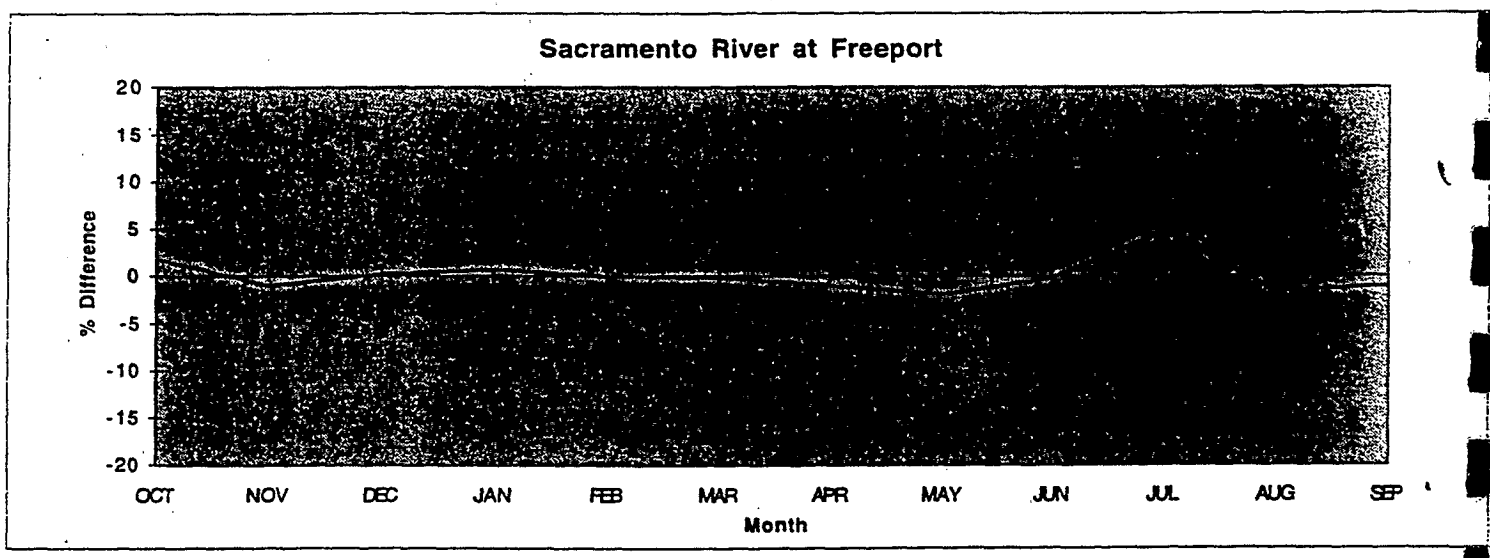


Figure A3-22
Existing Demand Case - Percent Difference
between Fisheries Alternative and Base Condition
River Flows





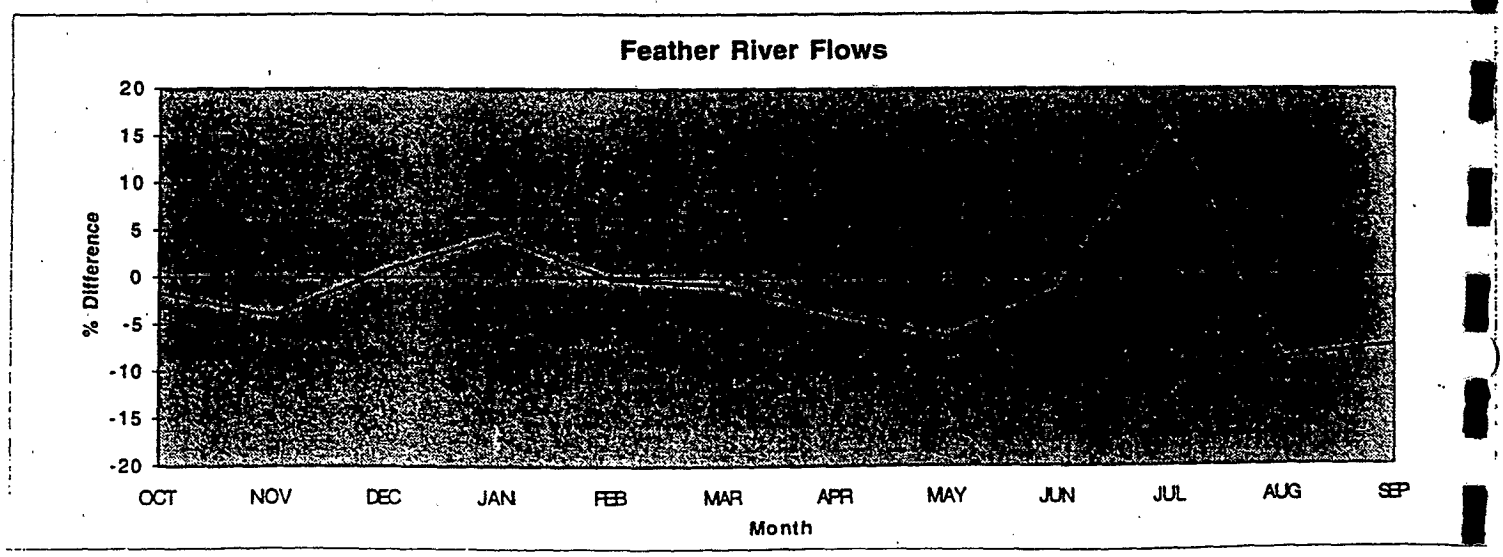
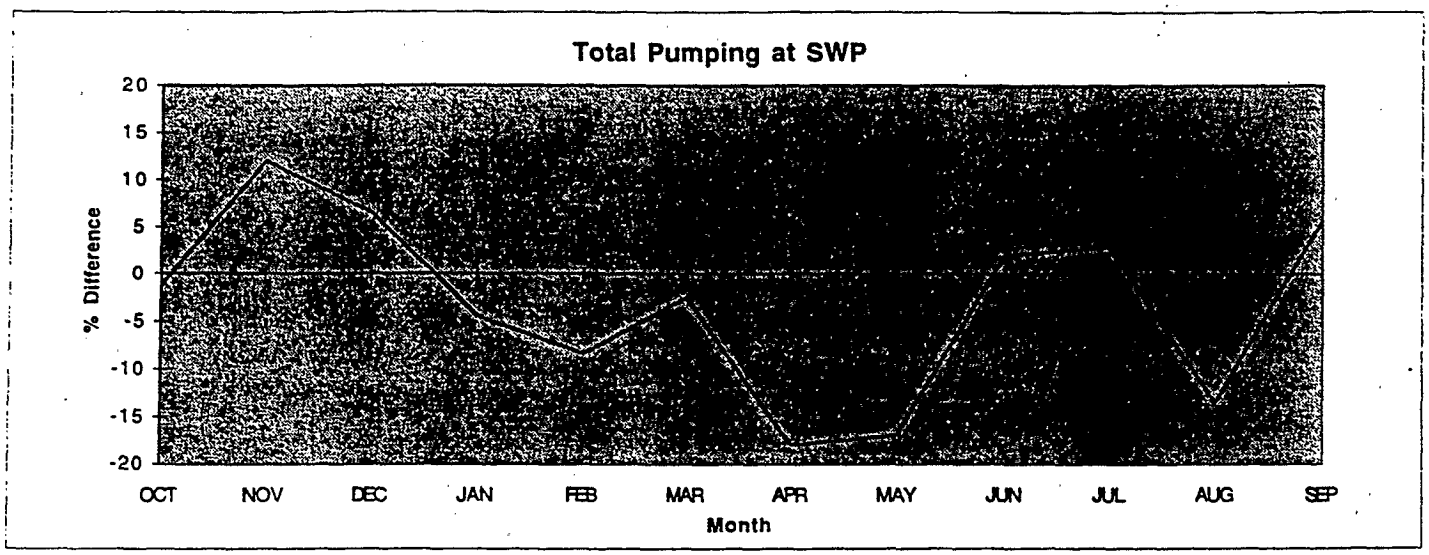
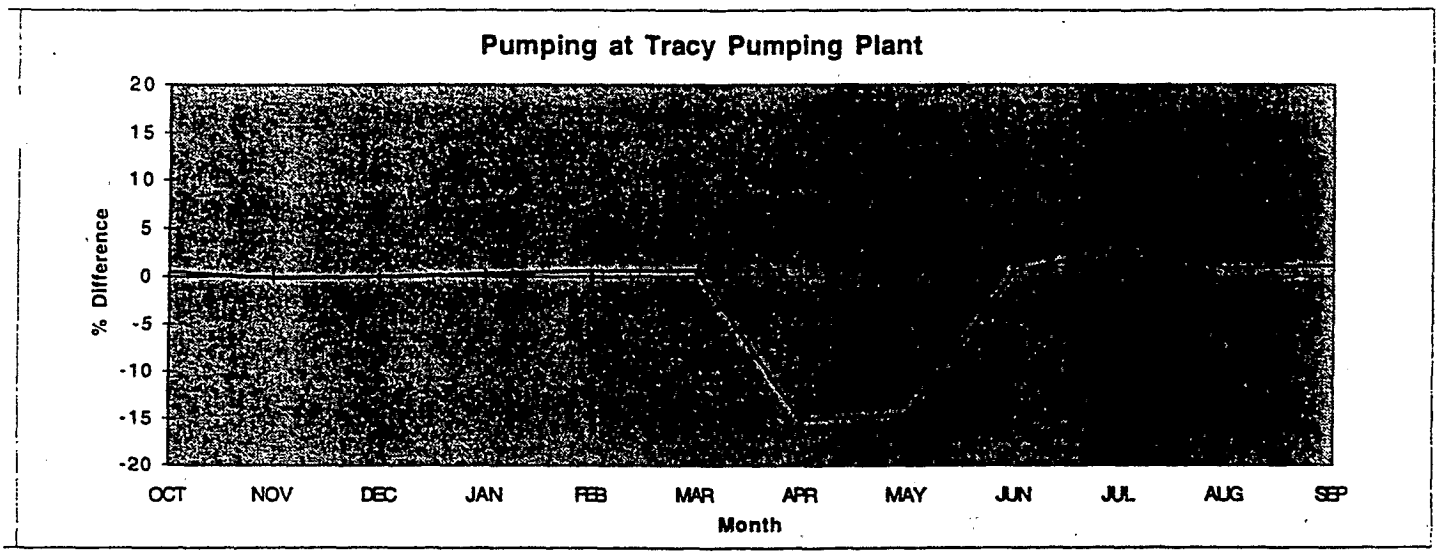


Figure A3-23
Existing Demand Case - Percent Difference
between Fisheries Alternative and Base Condition
Delta Exports





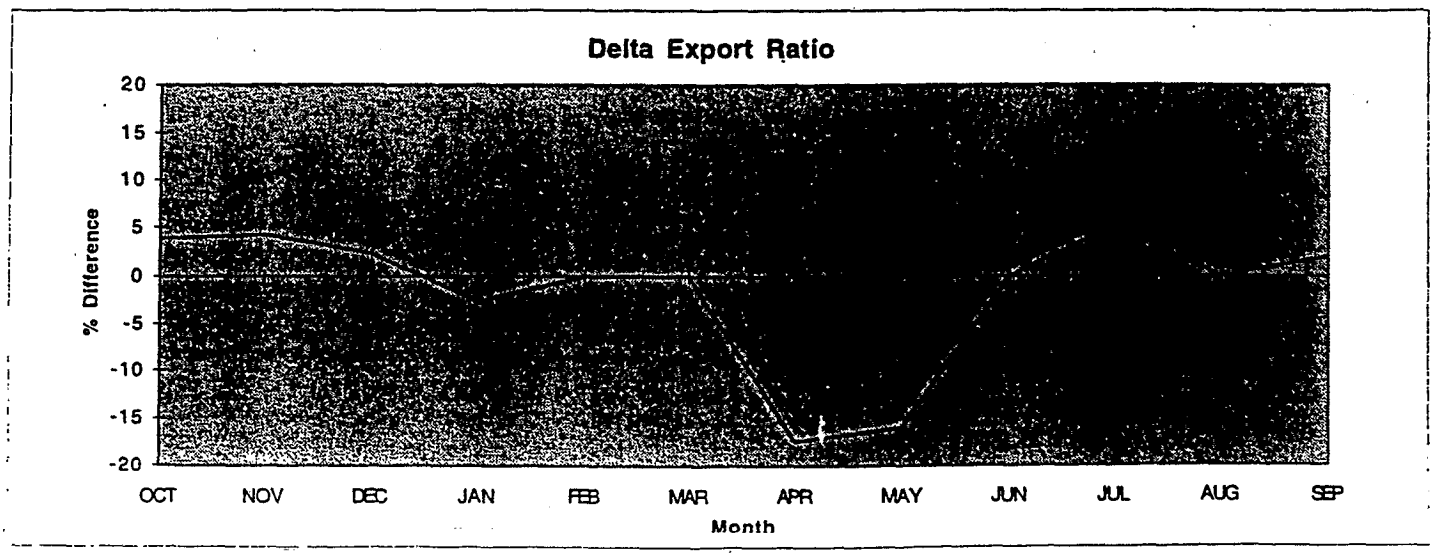
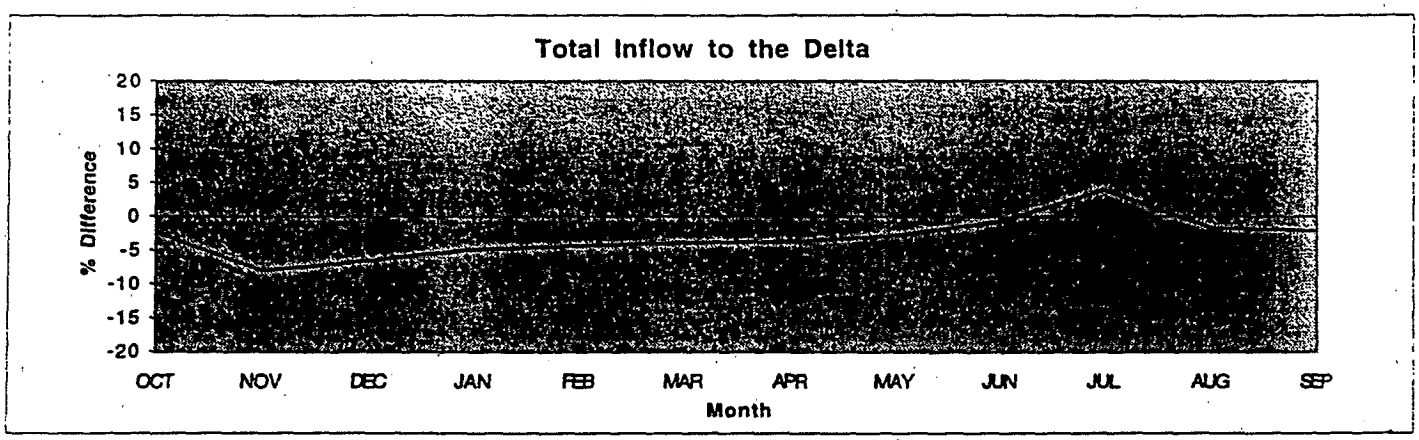
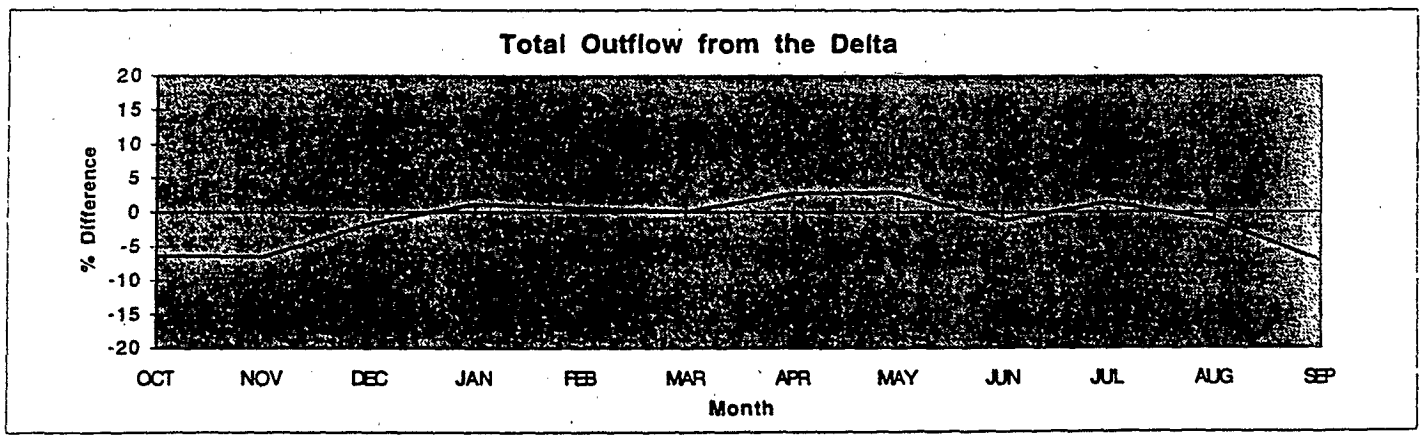
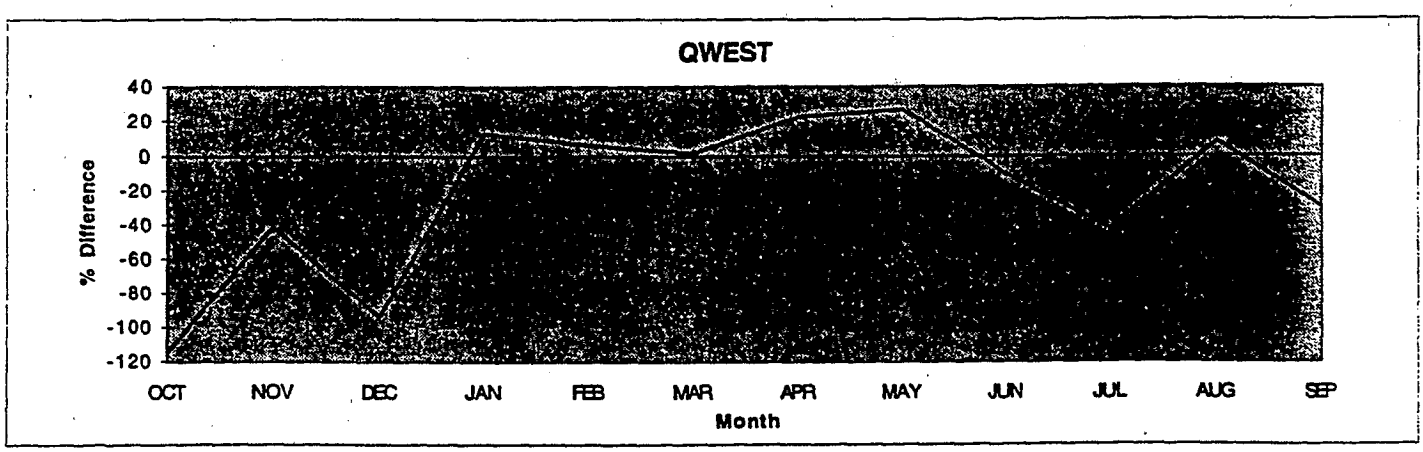


Figure A3-24
Existing Demand Case - Percent Difference
between Fisheries Alternative and Base Condition
Delta Inflow and Outflow







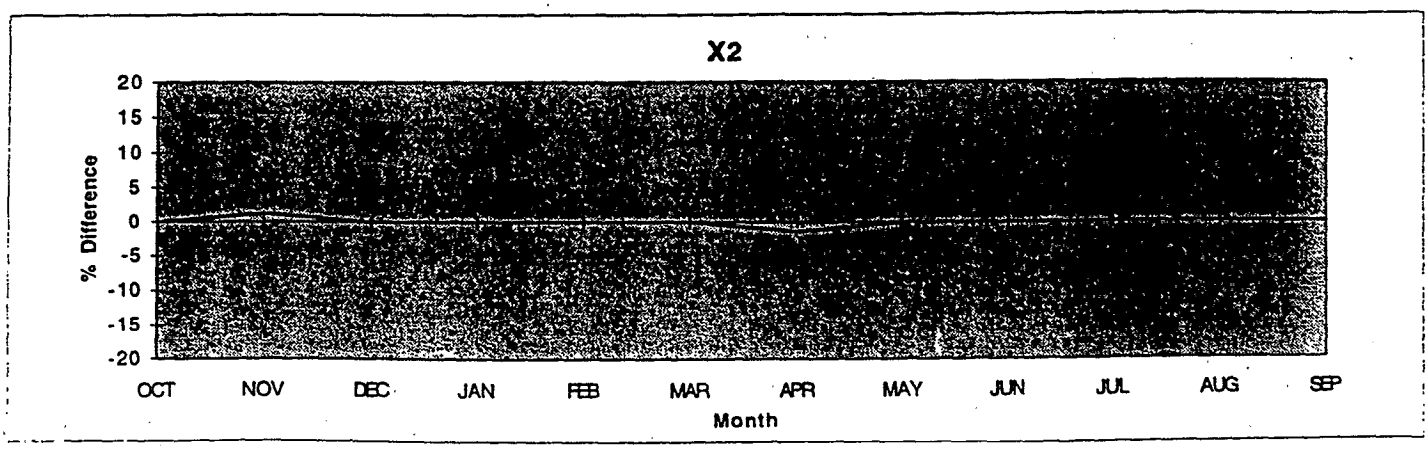
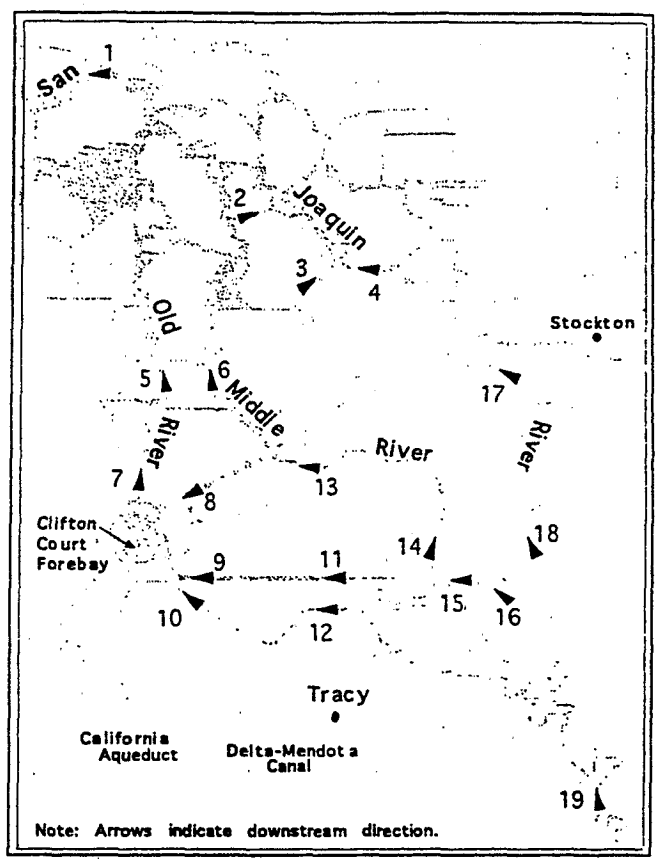


TABLE A3-22

Existing Demand Case Study
Difference Between Fisheries Alt. and Base Conditi
(Run 454 - Run 420)
Representative Critical Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-76	-145	-88	42	39	-26	-25	-44	269
2	-20	-10	-21	-41	-10	5	5	3	50
3	-23	-21	-22	-23	-3	2	1	4	72
4	-21	-22	-1	23	18	-18	-17	-33	34
5	-168	-170	-142	-105	12	-17	-18	-73	490
6	-107	-106	-88	-73	7	-11	-12	-9	314
7	-199	-199	-167	-126	15	-20	-21	-69	579
8	81	82	68	55	-6	9	8	10	-242
9	-3	-4	17	-1	18	-26	-25	-33	-50
10	0	-1	1	0	3	-4	-4	-11	-8
11	-3	-3	17	-1	18	-25	-26	-32	-49
12	-1	-1	1	-1	2	-4	-4	-12	9
13	-3	-3	-3	-2	1	-1	-1	-4	5
14	-2	-2	-2	-2	1	-1	-1	-4	5
15	-6	-6	15	-3	21	-30	-30	-49	-53
16	-6	-7	16	-3	21	-31	-30	-49	-53
17	-26	-25	-15	-14	13	-18	-17	-35	-37
18	-26	-26	-15	-14	13	-17	-18	-35	-37
19	-33	-33	0	-17	34	-48	-48	-84	-16



Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	-0.1	-0.1	0.0	0.0	0.1	-0.1	-0.1	-0.2	0.0

Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.1	0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.1	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.3	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0

TABLE A3-22 CONT.

Existing Fisheries Alternative Case Study (Run 454-Run 420)
Fisheries-Base (Difference) Demand Condition
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	103	-5	-117	-7	-245	-721	40
2	-681	-559	-527	-68	-197	-182	-32
3	-370	-302	-309	4	-72	-162	20
4	1419	1046	1046	71	291	-40	54
5	-895	-940	-939	-272	-693	-1381	-93
6	-482	-482	-484	50	-159	-701	113
7	-1179	-1225	-1227	-426	-931	-1734	-190
8	197	207	204	-174	-10	412	-192
9	-1188	-874	-874	-101	364	27	-81
10	-194	-142	-142	25	118	41	15
11	-1189	-875	-875	-101	365	27	-81
12	-199	-145	-145	25	119	40	15
13	-55	-43	-43	7	23	-11	7
14	-57	-44	-44	6	25	-11	7
15	-1449	-1066	-1065	-71	511	55	-57
16	-1449	-1066	-1065	-70	510	56	-57
17	1449	1066	1066	70	289	-54	56
18	1456	1071	1070	70	292	-55	56
19	1	1	1	0	806	0	-1

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	0	0.01	0.01	0.01	0.01	-0.02	0.01
2	0.01	0.01	0.01	0.01	0.02	-0.02	0.01
3	0	0	0	0.01	0.01	-0.02	0.01
4	0.01	0	0	0.01	0.01	-0.02	0.01
5	-0.02	-0.01	-0.01	0.01	0.02	-0.02	0.01
6	0	0	0	0.01	0.01	-0.02	0.01
7	-0.05	-0.04	-0.04	0	0.02	-0.04	-0.01
8	-0.07	-0.05	-0.05	0	0.03	-0.05	-0.01
9	-0.16	-0.14	-0.13	0	0.04	-0.06	-0.01
10	-0.09	-0.08	-0.08	0.01	0.04	-0.05	-0.01
11	-0.43	-0.37	-0.37	-0.02	0.05	-0.09	-0.03
12	-0.5	-0.44	-0.44	-0.06	0.03	-0.13	-0.06
13	-0.11	-0.1	-0.1	-0.05	-0.03	-0.08	-0.05
14	-0.62	-0.56	-0.55	-0.13	-0.05	-0.18	-0.14
15	-0.84	-0.72	-0.71	-0.08	0.07	-0.17	-0.09
16	-1.16	-0.97	-0.97	-0.06	0.18	-0.16	-0.08
17	0.2	0.14	0.14	0.01	0.04	-0.03	0.01
18	1.42	1.1	1.08	0.02	0.22	-0.09	0
19	0.82	0.78	0.76	0.03	1.47	-0.05	0.01

Minimum and Maximum Velocity

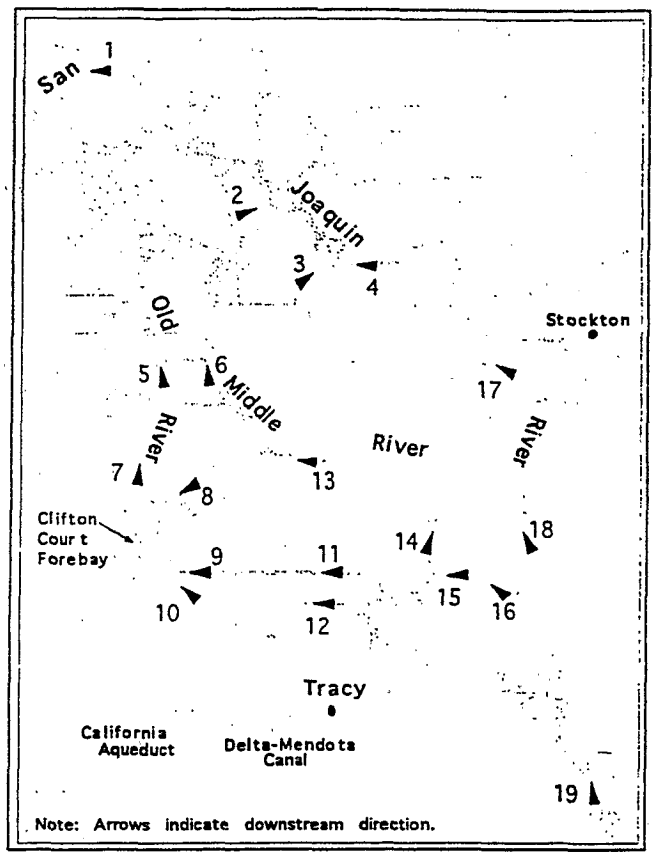
Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0
4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.1	-0.3	0.1	-0.3	0.1	-0.2	0.1	-0.3	0.1	-0.1	0.1	-0.1
6	0.1	-0.1	0.1	-0.2	0.1	-0.2	0.1	-0.1	0.2	-0.2	0.1	-0.1	0.1	0.0
7	-0.1	-0.2	0.0	-0.3	0.0	-0.3	0.0	-0.1	0.1	-0.3	-0.1	-0.3	0.0	-0.2
8	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.0	-0.1	-0.1	0.6	0.0	0.2	0.0
9	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	-0.2	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0
11	-0.2	-0.3	-0.1	-0.3	-0.1	-0.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
12	0.0	-0.2	0.0	-0.2	0.0	-0.2	0.1	-0.1	0.1	0.0	0.1	-0.1	0.1	-0.1
13	-0.1	0.1	-0.1	0.1	-0.1	0.0	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	0.1
14	0.1	-0.2	0.2	-0.2	0.2	-0.2	0.2	0.0	0.2	0.0	0.1	-0.2	0.2	-0.1
15	-0.9	-0.5	-0.8	-0.4	-0.8	-0.4	0.1	-0.2	0.2	0.4	0.0	-0.1	0.1	-0.1
16	-1.3	-0.5	-1.1	-0.1	-1.1	-0.2	0.1	-0.3	0.3	0.4	0.0	-0.1	0.1	-0.1
17	0.4	1.0	0.3	0.6	0.3	0.6	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
18	0.6	1.3	0.5	0.6	0.5	0.6	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0
19	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0

TABLE A3-23

Existing Demand Case Study
Difference Between Fisheries Alt. and Base Conditi
(Run 454 - Run 420)
Representative Dry Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	35	51	121	667	448	310	44	-258
2	-63	-75	-77	14	10	26	-60	-182
3	44	53	59	123	77	80	43	17
4	68	75	81	61	56	56	64	86
5	-177	-186	-127	592	395	389	-165	-867
6	127	138	169	497	353	358	131	35
7	-300	-321	-238	661	422	423	-290	-1211
8	-203	-218	-231	-407	-308	-306	-222	-312
9	-182	-195	-183	-186	-135	-135	-100	-117
10	82	90	76	76	50	49	30	42
11	-181	-195	-183	-186	-135	-135	-101	-118
12	81	89	76	76	49	48	29	41
13	29	32	30	44	29	29	10	0
14	30	32	30	44	29	28	9	-2
15	-70	-76	-79	-67	-80	-60	-63	-79
16	-70	-75	-78	-67	-59	-60	-62	-78
17	69	76	79	67	61	61	64	81
18	71	76	79	68	61	61	64	80
19	0	0	0	0	0	0	0	0



Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	0.0
13	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1
14	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	0.0
15	-0.2	-0.2	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1
16	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.2	-0.4
6	0.2	-0.1	0.2	-0.1	0.2	-0.1	0.2	0.1	0.2	0.0	0.2	0.0	0.1	0.0	0.3	-0.2
7	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	0.1	-0.2
8	0.0	-0.1	0.0	0.0	0.0	-0.1	0.2	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.4	0.0
9	0.0	-0.1	0.0	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
11	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1
13	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0
14	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	-0.1
15	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.0	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.2
16	0.1	-0.2	0.0	-0.1	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	-0.1	-0.3
17	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-23 CONT.

Existing Fisheries Case Study (Run 454-Run 420)
Fisheries-Base (Difference) Demand Condition
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1423	145	116	942	958	14	36
2	-1589	-1373	-1348	-43	-41	-76	-41
3	-670	-487	-493	165	159	37	20
4	2783	2622	2608	129	129	75	58
5	-3705	-1946	-1942	666	670	-270	-151
6	-1694	-771	-769	665	661	128	128
7	-4607	-2529	-2529	680	678	-450	-287
8	848	231	224	-627	-829	-277	-242
9	-2388	-2353	-2349	-268	-267	-98	-87
10	-300	-272	-268	92	92	23	25
11	-2387	-2349	-2346	-268	-267	-98	-87
12	-309	-277	-271	92	91	23	23
13	-130	-86	-85	41	40	-1	3
14	-130	-86	-85	40	40	-1	3
15	-2816	-2695	-2683	-137	-136	-76	-59
16	-2818	-2690	-2678	-135	-135	-75	-59
17	2794	2655	2639	136	137	75	59
18	2845	2697	2682	138	137	75	60
19	1	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.05	0.03	0.03	0.04	0.05	0.01	0.01
2	-0.03	0.02	0.03	0.04	0.04	0.01	0.01
3	-0.02	0.03	0.02	0.04	0.04	0.01	0.01
4	-0.02	0.02	0.03	0.05	0.05	0.02	0.01
5	-0.09	0	0	0.05	0.05	0.01	0.01
6	-0.08	0.01	0.01	0.04	0.05	0.01	0.01
7	-0.14	-0.03	-0.02	0.04	0.04	0.02	0
8	-0.15	-0.03	-0.03	0.05	0.05	0.03	0.01
9	-0.28	-0.16	-0.16	0.04	0.04	0.02	0
10	-0.18	-0.06	-0.06	0.05	0.05	0.02	0.01
11	-0.72	-0.61	-0.6	0.01	0	-0.01	-0.02
12	-0.79	-0.68	-0.68	-0.04	-0.05	-0.04	-0.06
13	-0.18	-0.09	-0.09	-0.01	-0.01	-0.03	-0.05
14	-1.03	-0.91	-0.93	-0.17	-0.16	-0.1	-0.14
15	-1.46	-1.3	-1.3	-0.11	-0.11	-0.07	-0.09
16	-2.1	-1.87	-1.87	-0.08	-0.08	-0.06	-0.07
17	0.6	0.56	0.56	0.05	0.05	0.02	0.01
18	3.05	2.82	2.84	0.06	0.05	0.02	0.01
19	1.72	1.62	1.61	0.03	0.02	0.03	0.02

Minimum and Maximum Velocity

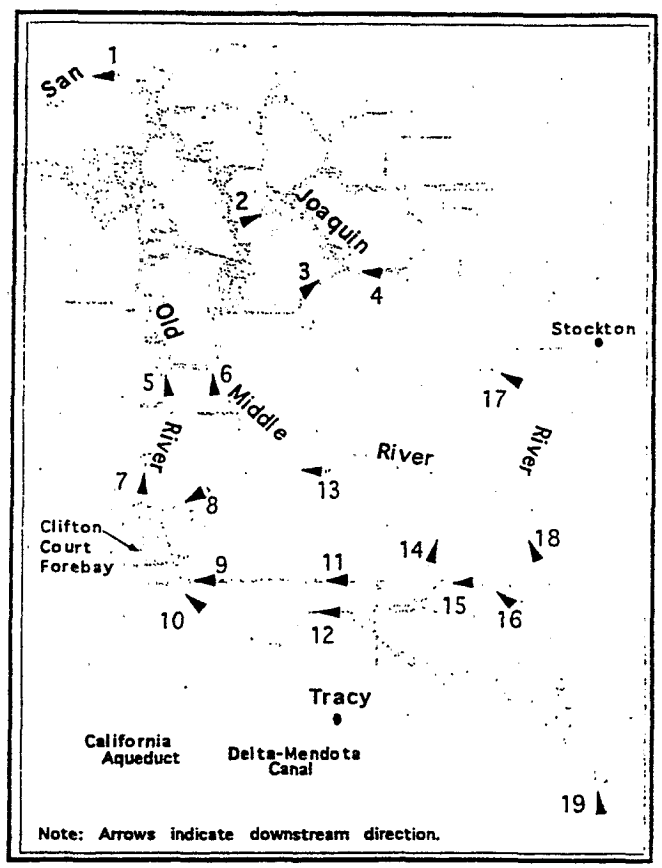
Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	-0.1	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
4	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	-0.6	0.1	-0.5	0.1	-0.5	0.2	-0.2	0.2	-0.2	0.1	-0.1	0.1	-0.1
6	0.1	-0.4	0.1	-0.3	0.1	-0.3	0.2	-0.1	0.2	-0.1	0.1	0.0	0.1	0.0
7	-0.2	-0.7	-0.1	-0.5	-0.1	-0.5	0.1	0.0	0.1	0.0	0.0	-0.2	0.0	-0.1
8	0.8	0.1	0.2	0.0	0.2	0.0	-0.1	-0.1	-0.1	-0.1	0.3	0.0	0.2	0.0
9	-0.4	-0.4	-0.3	-0.5	-0.3	-0.5	0.0	-0.3	0.0	-0.3	0.0	0.0	0.0	0.0
10	-0.2	-0.2	0.0	-0.2	0.0	-0.2	0.2	-0.2	0.2	-0.2	0.1	0.0	0.1	0.0
11	-0.4	-0.5	-0.3	-0.6	-0.3	-0.6	0.0	-0.3	0.0	-0.3	0.0	0.0	0.0	0.0
12	-0.1	-0.4	-0.2	-0.3	-0.2	-0.3	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1
13	-0.2	0.0	-0.1	0.0	-0.1	0.0	0.0	0.1	0.1	0.1	-0.1	0.1	-0.1	0.1
14	-0.3	-0.4	-0.1	-0.3	-0.1	-0.3	0.2	0.0	0.2	0.0	0.2	-0.1	0.2	-0.1
15	-1.4	-1.5	-1.5	-1.7	-1.5	-1.7	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2
16	-1.9	-1.7	-1.9	-1.8	-1.9	-1.8	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2
17	1.0	1.9	0.9	1.8	0.9	1.8	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0
18	1.0	2.2	0.9	2.2	0.9	2.2	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0
19	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-24

Existing Demand Case Study
Difference Between Fisheries Alt. and Base Condit
(Run 454 - Run 420))
Representative Below Normal Year

Average Net Discharge

Ref. No.	Jan	Feb.	March	April	May 1 20	May 21-31	June	July
1	2654	1090	-731	684	514	382	48	47
2	27	-48	-136	5	-1	14	-66	-153
3	367	189	-36	117	98	101	48	67
4	181	127	54	53	63	63	66	109
5	2164	764	-966	539	417	409	-178	-449
6	1626	752	-283	461	400	406	140	303
7	2438	787	-1279	594	438	439	-308	-717
8	-1359	-696	-45	-376	-358	-356	-237	-521
9	-349	-283	-131	-194	-159	-159	-105	-146
10	107	96	74	83	69	58	32	41
11	-346	-280	-131	-193	-159	-159	-105	-147
12	107	98	72	83	58	58	31	41
13	65	47	16	47	32	32	10	4
14	63	47	14	47	33	32	9	3
15	-179	-133	-47	-61	-69	-70	-66	-104
16	-182	-132	-46	-60	-68	-68	-65	-103
17	195	134	49	58	69	69	67	106
18	195	136	49	59	69	70	67	106
19	0	0	0	0	0	0	1	0



Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 1 20	May 21-31	June	July
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
7	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
8	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
9	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
10	0.1	0.1	-0.1	0.1	0.0	0.0	0.0	0.0
11	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
12	0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0
13	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1
14	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	0.0
15	0.0	-0.1	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1
16	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0
17	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
18	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Minimum and Maximum Velocity

Ref.	January		February		March		April		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.3	-0.1	0.2	-0.2	0.1	-0.3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.4	-0.3
6	0.4	0.0	0.2	-0.1	0.1	-0.2	0.2	0.1	0.2	0.0	0.2	0.0	0.1	0.0	0.4	-0.2
7	0.2	-0.1	0.1	0.0	-0.1	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.3	-0.2
8	-0.1	-0.1	-0.1	-0.1	0.1	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.4	-0.1
9	0.0	-0.3	0.0	-0.2	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10	0.2	-0.2	0.2	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.0
11	0.0	-0.3	0.0	-0.3	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
12	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1
13	0.0	0.0	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0
14	0.2	0.1	0.2	0.1	0.2	0.0	0.2	0.1	0.2	0.1	0.2	0.0	0.2	0.0	0.2	-0.1
15	0.1	-0.3	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.2
16	0.0	-0.3	0.1	-0.2	0.1	-0.1	0.0	-0.2	0.0	-0.2	0.1	-0.2	0.1	-0.3	-0.1	-0.3
17	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-24 CONT.

Existing Fisheries Case Study (Run 454-Run 420)
Fisheries-Base (Difference) Demand Condition
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	-126	-1969	-828	-759	-71	32
2	-1156	-1619	-208	-223	-133	-56
3	-419	-721	2	9	32	33
4	2156	2734	68	67	96	70
5	-1943	-4179	-1237	-1239	-515	-188
6	-672	-2001	-212	-209	116	140
7	-2508	-5198	-1643	-1638	-774	-341
8	142	1073	-100	-96	-327	-268
9	-1868	-2370	-187	-186	-116	-95
10	-234	-266	93	94	23	21
11	-1869	-2374	-186	-185	-115	-95
12	-239	-281	92	93	23	21
13	-86	-109	28	28	-2	3
14	-87	-109	29	29	-2	3
15	-2200	-2763	-62	-62	-95	-71
16	-2199	-2768	-62	-62	-93	-71
17	2193	2755	61	61	93	71
18	2211	2811	62	62	94	71
19	1	-1	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	0.02	-0.05	0.02	0.02	0.03	0.01
2	0.03	-0.04	0.01	0.01	0.02	0.01
3	0.03	-0.04	0.01	0.01	0.01	0.01
4	0.03	-0.03	0	0.01	0.01	0.01
5	-0.06	-0.08	0.01	0.01	0.02	0.02
6	-0.03	-0.06	0.01	0.01	0.02	0.01
7	-0.08	-0.12	0	0.01	0.03	0.01
8	-0.09	-0.12	0.01	0.01	0.04	0.02
9	-0.18	-0.25	0	0	0.04	0.01
10	-0.11	-0.15	0.02	0.02	0.05	0.02
11	-0.49	-0.75	-0.03	-0.03	0.02	-0.02
12	-0.56	-0.82	-0.06	-0.05	-0.02	-0.05
13	-0.12	-0.17	-0.05	-0.06	-0.02	-0.04
14	-0.73	-1.02	-0.24	-0.23	-0.07	-0.13
15	-1.02	-1.44	-0.15	-0.15	-0.04	-0.07
16	-1.47	-2.02	-0.12	-0.12	-0.03	-0.06
17	0.38	0.55	0.01	0.01	0.01	0.01
18	2.2	2.95	0	0	0.03	0.01
19	1.29	1.68	0	0	0.04	0.03

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	0.0	-0.2	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.2	-0.6	0.0	-0.6	0.2	-0.4	0.1	-0.4	0.1	-0.2	0.1	-0.1
6	0.2	-0.3	0.0	-0.4	0.2	-0.2	0.2	-0.2	0.2	-0.1	0.1	0.0
7	0.0	-0.4	-0.2	-0.7	0.0	-0.3	0.0	-0.4	0.0	-0.1	0.0	-0.2
8	0.5	-0.1	0.3	0.1	0.1	0.0	0.1	0.0	0.3	0.0	0.2	0.0
9	-0.2	-0.3	-0.3	-0.5	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
10	0.0	-0.1	-0.1	-0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
11	-0.3	-0.4	-0.4	-0.6	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
12	-0.1	-0.4	-0.2	-0.3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1
13	-0.1	0.0	-0.1	0.1	-0.1	0.0	-0.1	0.0	0.0	0.1	-0.1	0.1
14	-0.1	-0.3	-0.2	-0.3	0.2	0.0	0.2	0.0	0.2	-0.1	0.2	-0.1
15	-1.1	-1.1	-1.5	-1.6	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.1
16	-1.8	-1.2	-2.0	-1.7	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.1	-0.2
17	0.7	1.5	1.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.8	1.9	1.0	2.3	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0
19	-0.2	-0.1	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-25

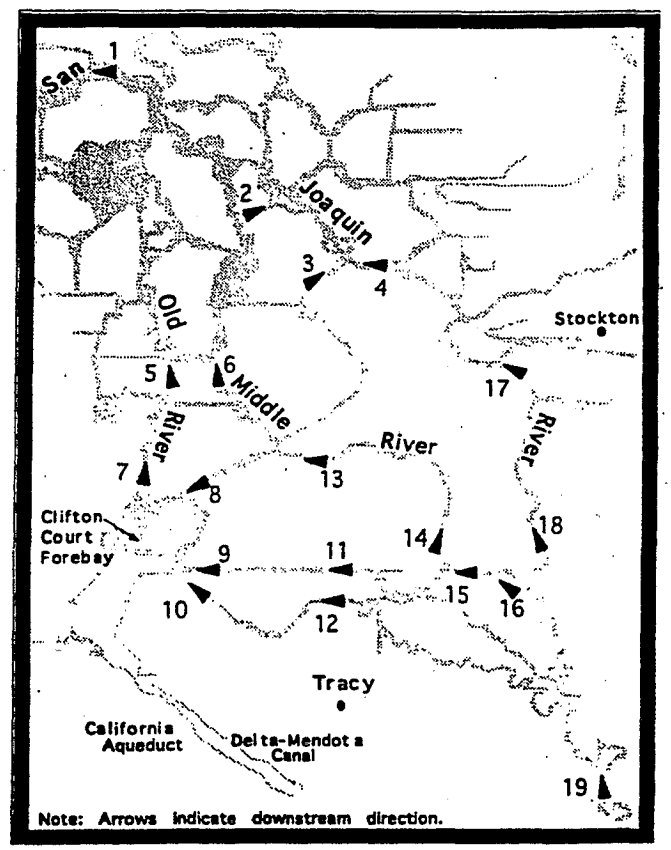
Existing Demand Case Study
Difference Between Fisheries Alt. and Base Condition (Run 454 - Run 420)
Representative Above Normal Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	1387	1413	1050	-217	745	603	660	75	-261
2	-50	-45	-50	-109	10	-18	-28	-61	-204
3	235	227	181	30	143	110	109	71	14
4	158	158	138	75	64	55	58	76	94
5	1012	1015	716	-469	637	404	399	-103	-938
6	980	976	729	-1	550	408	410	222	52
7	1058	1056	718	-669	707	425	428	-228	-1308
8	-923	-926	-691	-139	-453	-352	-349	-313	-351
9	-285	-285	-265	-164	-207	-184	-184	-118	-124
10	81	81	101	70	87	82	82	34	42
11	-288	-285	-268	-164	-207	-184	-184	-118	-124
12	82	82	80	70	85	82	81	33	42
13	40	39	41	23	48	44	43	10	1
14	39	39	43	22	48	44	43	9	-1
15	-164	-165	-128	-74	-72	-59	-61	-78	-88
16	-183	-164	-132	-73	-72	-59	-61	-76	-85
17	164	164	143	75	71	59	61	79	87
18	165	166	142	75	72	60	61	78	88
19	0	0	0	0	0	0	0	0	1

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 16-30	May 1-20	May 21-31	June	July
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
5	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
6	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
7	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
8	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0
11	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	-0.1	-0.1	0.0	-0.1	-0.1	0.0	0.0
13	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1
14	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	0.0
15	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.1	-0.1
16	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0
17	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
18	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.2	-0.2	0.2	-0.2	0.2	-0.2	0.1	-0.3	0.1	0.0	0.1	-0.1	0.1	0.0	0.1	-0.2	0.1	-0.4
6	0.3	-0.1	0.3	-0.1	0.2	-0.1	0.1	-0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.2
7	0.1	0.0	0.1	0.0	0.0	0.0	0.0	-0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.3	-0.3
8	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.4	0.0
9	0.0	-0.2	0.1	-0.2	0.0	-0.3	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10	0.2	-0.1	0.2	-0.1	0.2	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.0
11	0.0	-0.2	0.0	-0.2	0.0	-0.3	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
12	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	0.0
14	0.2	0.1	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.0	0.2	-0.1
15	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.2
16	0.0	-0.3	0.0	-0.3	0.1	-0.2	0.1	-0.2	0.0	-0.2	0.1	-0.2	0.0	-0.2	0.1	-0.3	-0.1	-0.3
17	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-25 CONT.

Existing Fisheries Case Study (Run 454-Run 420)
Fisheries-Base (Difference) Demand Condition
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-2122	95	56	64	53	15	32
2	-1587	-997	-970	-82	-75	-132	-52
3	-703	-338	-347	50	45	58	31
4	2748	1851	1847	82	82	103	65
5	-4244	-1517	-1513	-191	-188	-427	-182
6	-1971	-474	-472	152	148	229	138
7	-5252	-2003	-2003	-334	-336	-678	-328
8	1039	25	18	-251	-254	-432	-258
9	-2348	-1640	-1638	-160	-160	-135	-97
10	-295	-193	-188	60	60	32	26
11	-2350	-1641	-1639	-161	-160	-135	-97
12	-307	-195	-191	59	60	32	25
13	-134	-53	-53	20	19	2	4
14	-135	-54	-53	19	19	1	4
15	-2786	-1892	-1885	-83	82	-102	-67
16	-2788	-1890	-1883	-82	83	-100	-67
17	2769	1887	1880	83	82	101	66
18	2823	1898	1892	83	83	102	66
19	1	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.09	0.03	0.03	0.01	0.02	0.04	0.01
2	-0.07	0.02	0.02	0.02	0.02	0.03	0.01
3	-0.07	0.02	0.02	0.01	0.02	0.02	0.01
4	-0.07	0.02	0.02	0.02	0.02	0.03	0.01
5	-0.1	0.01	0	0.01	0.02	0.01	0.01
6	-0.1	0.01	0.02	0.02	0.02	0.02	0.02
7	-0.16	-0.01	-0.01	0.01	0.01	0.02	0.01
8	-0.16	-0.01	-0.01	0.02	0.01	0.03	0.01
9	-0.29	-0.09	-0.09	0	0.01	0.03	0.01
10	-0.19	-0.02	-0.02	0.01	0.02	0.04	0.01
11	-0.74	-0.38	-0.37	-0.02	-0.02	0.02	-0.02
12	-0.81	-0.45	-0.45	-0.06	-0.06	-0.01	-0.05
13	-0.19	-0.07	-0.07	-0.04	-0.04	-0.03	-0.04
14	-1.04	-0.61	-0.61	-0.15	-0.16	-0.07	-0.13
15	-1.46	-0.82	-0.82	-0.1	-0.1	-0.04	-0.08
16	-2.07	-1.17	-1.17	-0.08	-0.07	-0.03	-0.06
17	0.54	0.27	0.27	0.02	0.02	0.02	0.02
18	2.99	1.75	1.76	0.02	0.02	0.05	0.01
19	1.71	1.09	1.08	0.02	0.02	0.04	0.02

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	-0.1	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	-0.1	-0.1	0.1	-0.1	-0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	-0.1	-0.7	0.1	-0.4	0.1	-0.4	0.1	-0.3	0.1	-0.3	0.2	-0.3	0.1	-0.1
6	0.0	-0.4	0.2	-0.3	0.2	-0.3	0.2	-0.1	0.2	-0.1	0.2	-0.1	0.1	0.0
7	-0.3	-0.8	0.0	-0.4	0.0	-0.4	0.0	-0.1	0.0	-0.1	0.1	-0.1	0.0	-0.2
8	0.8	0.1	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.3	0.0	0.2	0.0
9	-0.4	-0.4	-0.1	-0.4	-0.1	-0.4	0.0	-0.2	0.0	-0.2	0.1	0.0	0.0	0.0
10	-0.2	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0
11	-0.5	-0.5	-0.2	-0.4	-0.2	-0.4	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
12	-0.1	-0.4	-0.1	-0.2	-0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1
13	-0.2	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	-0.1	0.0	0.0	-0.1	0.1
14	-0.3	-0.4	0.0	-0.2	0.0	-0.2	0.2	0.0	0.2	0.0	0.2	-0.1	0.2	-0.1
15	-1.4	-1.6	-1.0	-1.2	-1.0	-1.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2
16	-1.9	-1.7	-1.4	-1.2	-1.4	-1.2	0.1	-0.2	0.1	-0.2	0.0	-0.2	0.1	-0.2
17	1.0	1.9	0.5	1.2	0.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	1.0	2.2	0.7	1.7	0.7	1.7	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0
19	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-26

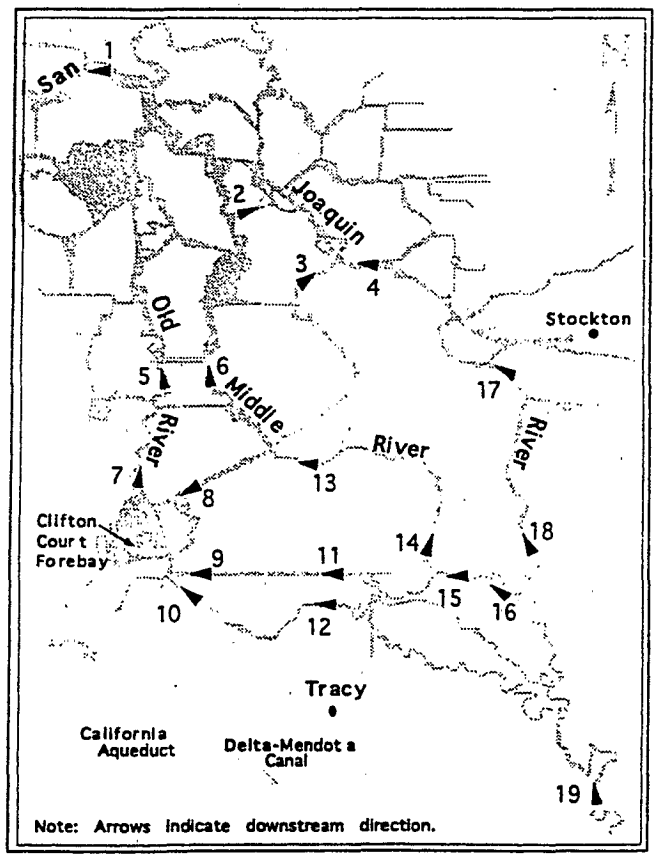
Existing Demand Case Study
Difference Between Fisheries Alt. and Base Conditi
(Run 454 - Run 420)
Representative Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	1350	3008	170	213	178	97	61
2	-67	105	-43	-44	-80	-146	-88
3	219	390	88	38	72	84	76
4	147	126	22	76	50	48	57
5	911	2594	32	108	15	-276	-210
6	971	1936	189	82	169	281	188
7	949	2986	71	236	54	-435	-384
8	-802	-1538	13	229	35	-326	-278
9	-290	-348	-368	-551	-480	-222	-186
10	90	119	185	281	255	135	90
11	-288	-345	-387	-558	-486	-225	-184
12	91	121	182	267	244	130	89
13	49	97	129	182	164	81	37
14	48	97	130	181	163	79	37
15	-148	-128	-67	-144	-108	-29	-58
16	-148	-129	-52	-119	-85	-31	-56
17	153	139	26	84	65	43	59
18	154	140	32	92	61	42	59
19	0	0	1	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
2	0.1	0.1	0.0	0.0	0.0	0.1	0.0
3	0.1	0.1	0.0	0.0	0.0	0.1	0.0
4	0.1	0.1	0.0	0.0	0.0	0.1	0.0
5	0.1	0.1	0.0	0.0	0.0	0.0	0.0
6	0.1	0.1	0.0	0.0	0.0	0.0	0.0
7	0.1	0.1	0.0	0.0	0.0	-0.1	0.0
8	0.1	0.1	0.0	-0.1	-0.1	-0.1	0.0
9	0.1	0.2	0.0	-0.1	-0.1	-0.1	0.0
10	0.1	0.2	0.0	-0.1	-0.1	-0.1	0.0
11	0.1	0.1	-0.1	-0.2	-0.2	0.0	0.0
12	0.0	0.1	-0.2	-0.2	-0.2	-0.1	-0.1
13	0.0	0.1	-0.1	-0.1	-0.1	-0.1	0.0
14	-0.2	-0.2	-0.8	-0.8	-0.7	-0.3	-0.2
15	0.0	-0.1	-0.5	-0.6	-0.6	-0.2	-0.2
16	0.0	-0.1	-0.3	-0.4	-0.4	-0.2	-0.2
17	0.1	0.1	0.0	0.0	0.1	0.0	0.0
18	0.1	0.1	0.0	0.1	0.1	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
3	0.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.3	-0.3	0.4	-0.1	0.1	-0.2	0.2	-0.1	0.3	-0.2	0.4	-0.3	0.1	-0.2
6	0.3	-0.1	0.4	0.0	0.1	-0.1	0.2	-0.1	0.3	-0.1	0.5	-0.1	0.1	-0.1
7	0.2	-0.1	0.3	0.2	-0.1	-0.2	-0.1	-0.2	0.0	-0.1	0.2	-0.2	0.0	-0.1
8	0.0	-0.1	-0.2	-0.1	0.0	0.0	0.3	0.1	0.4	0.1	0.4	0.0	0.3	0.0
9	0.0	-0.1	0.0	-0.3	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
10	0.2	-0.1	0.2	-0.2	0.1	-0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.0
11	0.0	-0.1	0.0	-0.3	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
12	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
13	0.0	0.0	0.0	0.0	-0.1	0.1	0.1	0.0	0.1	0.1	-0.1	0.1	-0.1	-0.1
14	0.2	0.1	0.2	0.2	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0
15	0.1	-0.2	0.0	-0.3	0.1	0.0	0.1	0.1	0.1	0.0	0.1	-0.1	0.1	-0.1
16	0.0	-0.2	0.0	-0.3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.1	-0.2
17	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
18	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-26 CONT.

Existing Fisheries Case Study (Run 454-Run 420)
Fisheries-Base (Difference) Demand Condition
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	148	-2006	-1951	48	-2156
2	-694	-1025	-274	-82	-277
3	-264	-503	-129	60	-155
4	1345	1579	45	71	19
5	-986	-3514	-2409	-220	-2634
6	-291	-1525	-825	178	-944
7	-1337	-4425	-3066	-385	-3282
8	-38	747	298	-298	454
9	-1161	-1377	-100	-150	-132
10	-157	-164	81	63	107
11	-1162	-1377	-100	-151	-133
12	-161	-165	80	63	102
13	-47	-63	-3	16	-33
14	-49	-63	4	16	34
15	-1375	-1607	-37	-71	-2
16	-1375	-1606	-36	-70	-4
17	1374	1602	36	71	7
18	1380	1610	36	72	6
19	1	0	0	0	0

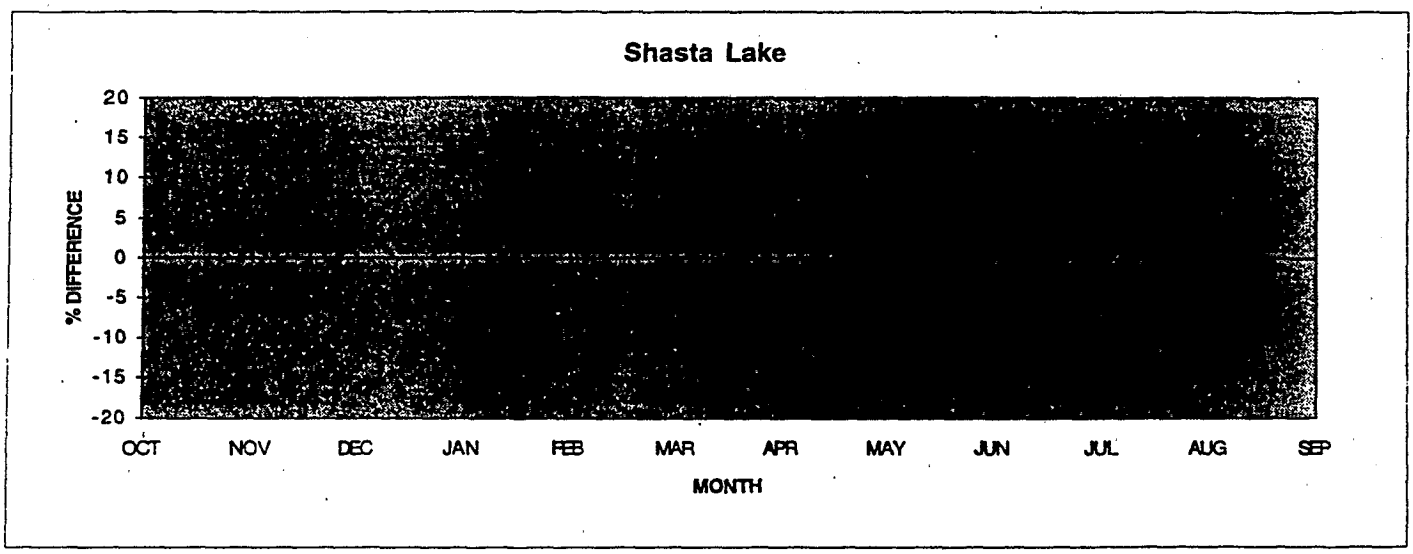
Minimum Water Surface Elevation

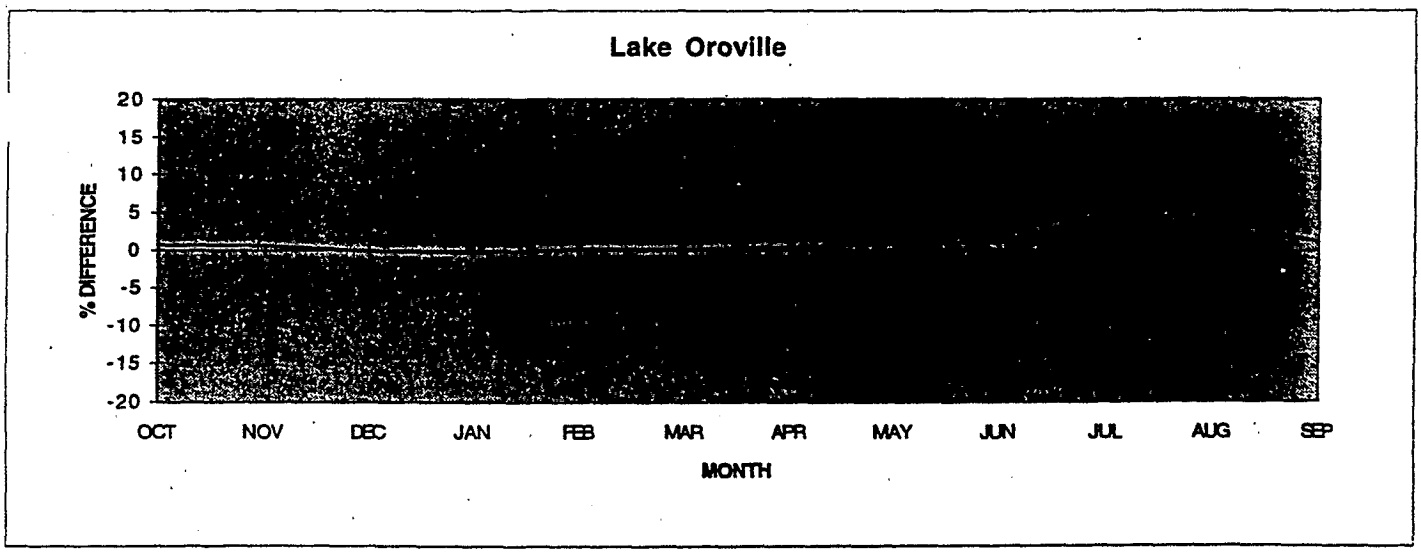
Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	0.02	-0.04	-0.01	0.02	-0.07
2	0.01	-0.04	-0.03	0.01	-0.05
3	0.01	-0.04	-0.03	0.02	-0.05
4	0.01	-0.04	-0.03	0.01	-0.05
5	0.01	-0.06	-0.03	0.02	-0.07
6	0.01	-0.06	-0.02	0.02	-0.06
7	-0.01	-0.08	-0.02	0.03	-0.09
8	0	-0.08	-0.05	0.03	-0.08
9	-0.08	-0.15	-0.06	0.03	-0.09
10	-0.02	-0.09	-0.03	0.03	-0.09
11	-0.34	-0.45	-0.12	-0.01	-0.11
12	-0.41	-0.51	-0.15	-0.05	-0.15
13	-0.07	-0.13	-0.07	-0.03	-0.12
14	-0.53	-0.59	-0.16	-0.13	-0.33
15	-0.7	-0.79	-0.17	-0.12	-0.27
16	-0.96	-1.04	-0.14	-0.09	-0.21
17	0.18	0.15	-0.03	0.01	-0.05
18	1.3	1.37	-0.03	0.01	-0.04
19	0.86	0.92	0	0.01	-0.01

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec.		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.2	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.0	-0.5	0.1	-0.4	0.1	-0.1	0.1	-0.5
6	0.1	-0.1	0.1	-0.3	0.1	-0.3	0.1	0.0	0.1	-0.3
7	-0.1	-0.2	-0.1	-0.6	0.0	-0.4	0.0	-0.1	-0.1	-0.6
8	0.4	0.0	0.2	0.0	0.1	0.0	0.3	0.0	0.4	0.0
9	-0.1	-0.2	-0.2	-0.3	0.0	-0.1	0.0	0.0	0.0	-0.1
10	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	-0.1
11	-0.2	-0.2	-0.2	-0.4	0.0	0.0	0.0	0.0	0.0	-0.1
12	0.0	-0.2	-0.1	-0.2	0.1	0.0	0.1	-0.1	0.1	-0.1
13	-0.1	0.1	-0.1	0.2	-0.1	0.2	-0.1	0.1	-0.1	0.0
14	0.1	-0.2	0.0	-0.2	0.2	0.0	0.2	0.0	0.2	-0.1
15	-0.8	-0.3	-0.9	-1.0	0.1	-0.1	0.1	-0.1	0.1	-0.1
16	-1.1	-0.2	-1.3	-0.9	0.1	-0.1	0.0	-0.2	0.1	-0.1
17	0.4	0.8	0.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0
18	0.5	0.9	0.6	1.3	0.0	0.0	0.0	0.1	0.0	0.0
19	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0

Figure A3-25
Future Demand Case - Percent Difference
between Fisheries Alternative and Base Condition
End of Month Storage





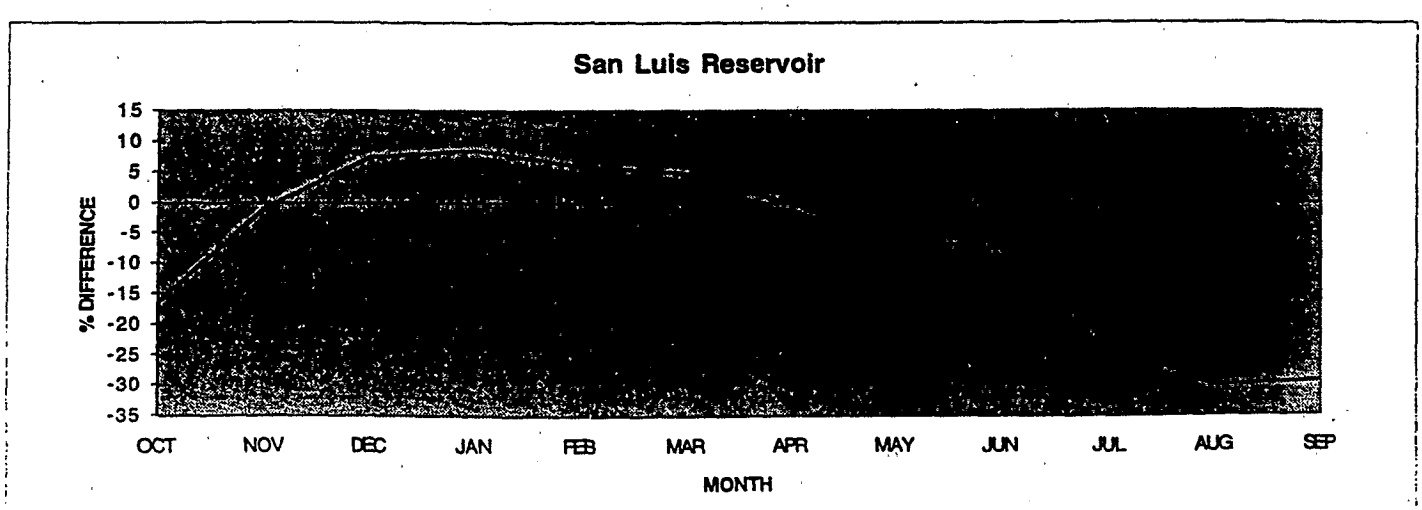
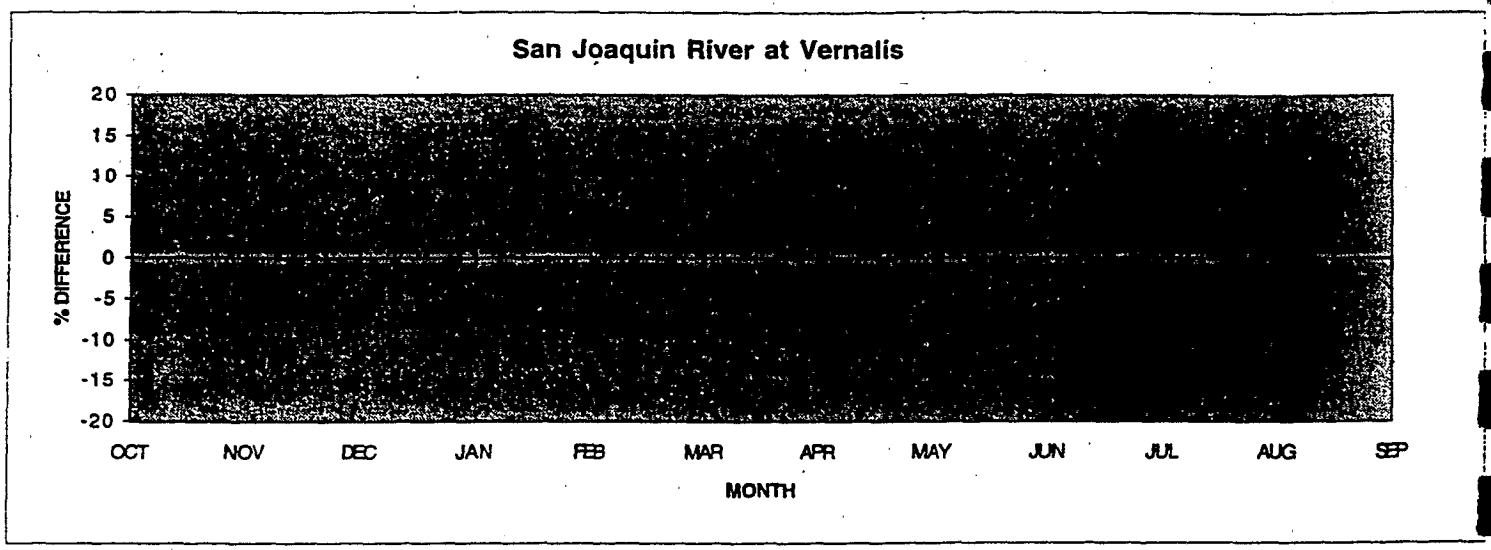
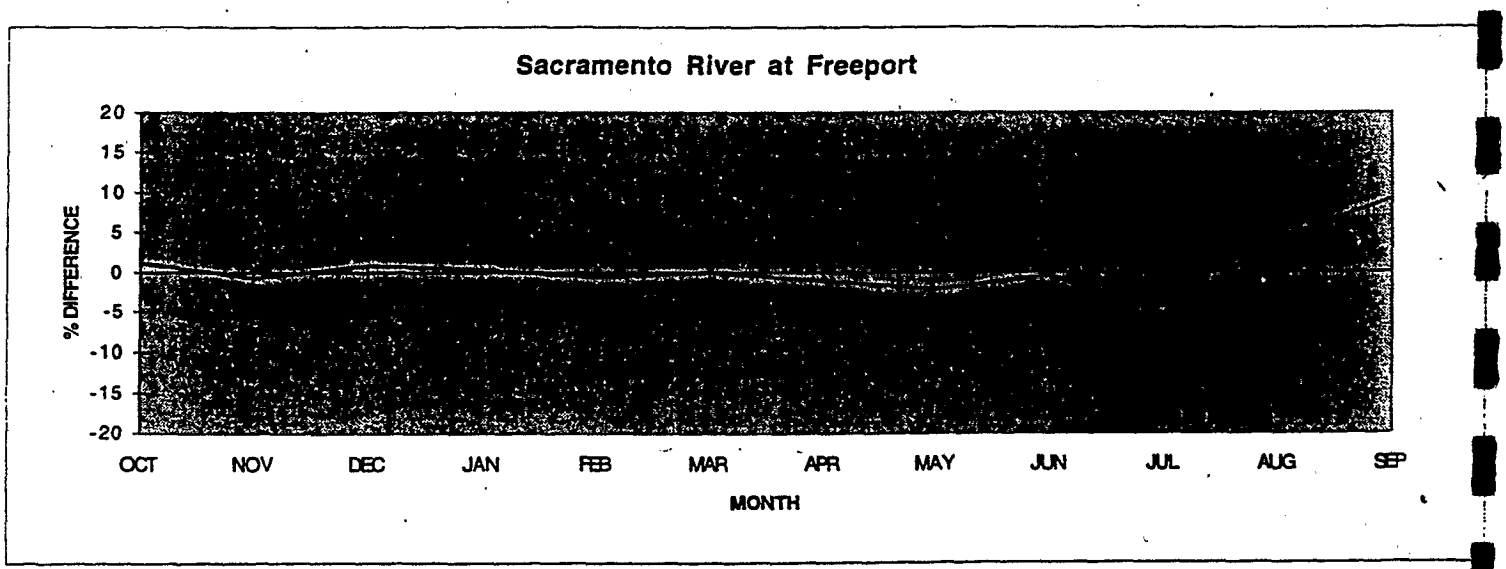


Figure A3-26
Future Demand Case - Percent Difference
between Fisheries Alternative and Base Condition
River Flows





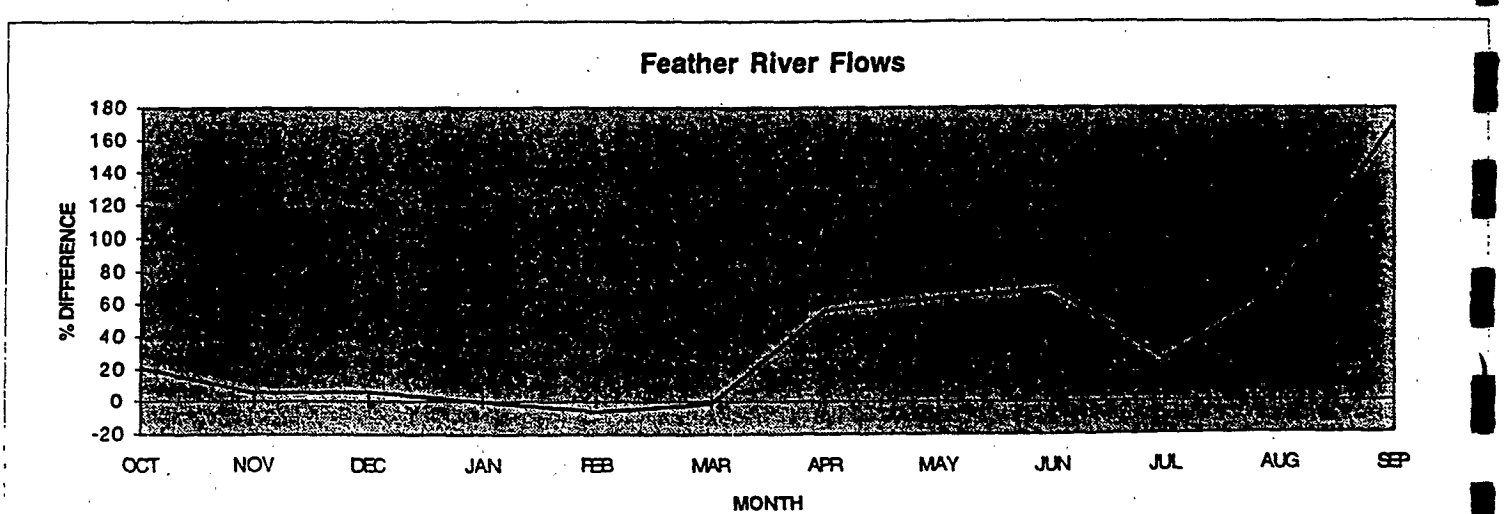
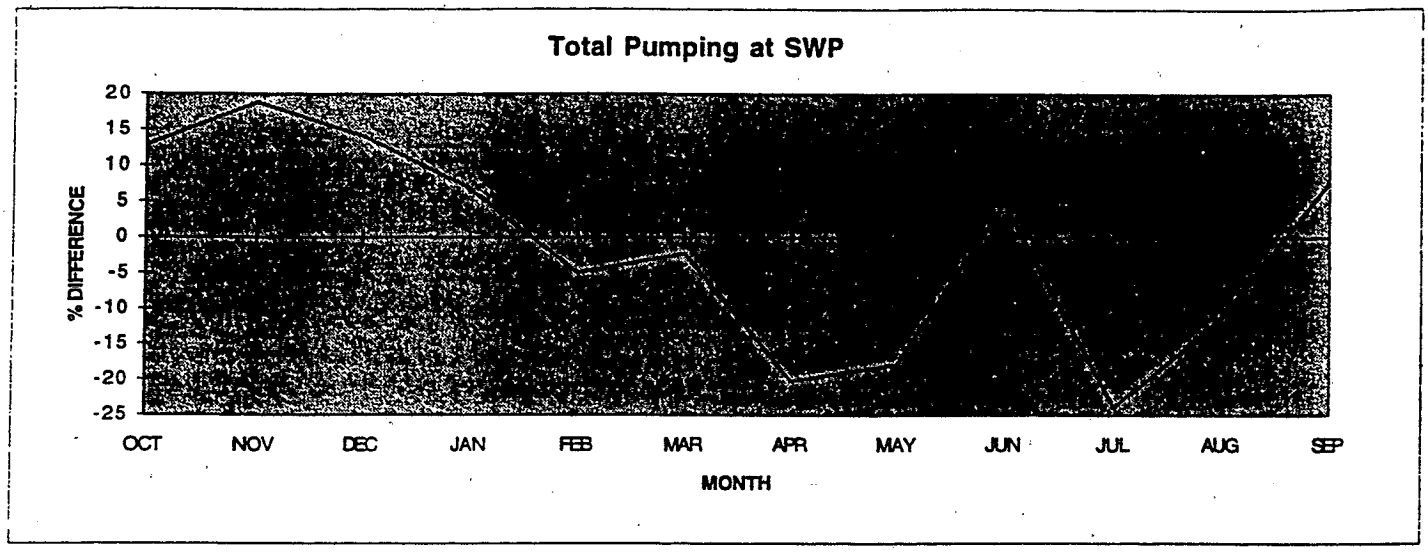
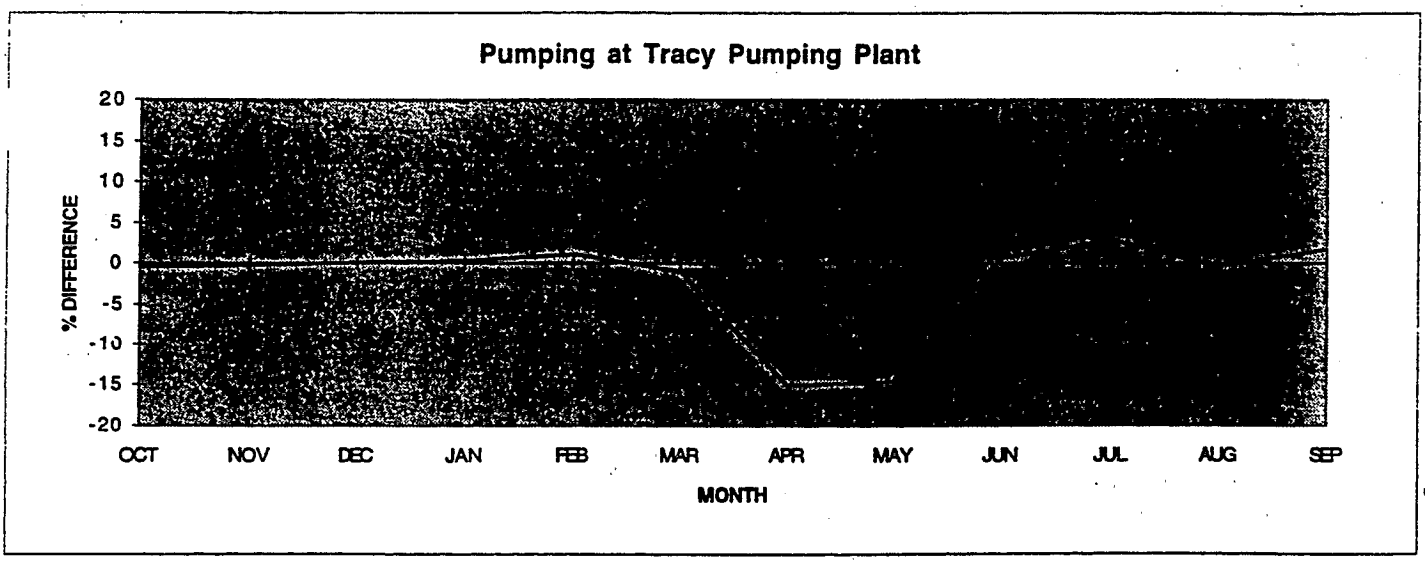


Figure A3-27
Future Demand Case - Percent Difference
between Fisheries Alternative and Base Condition
Delta Exports





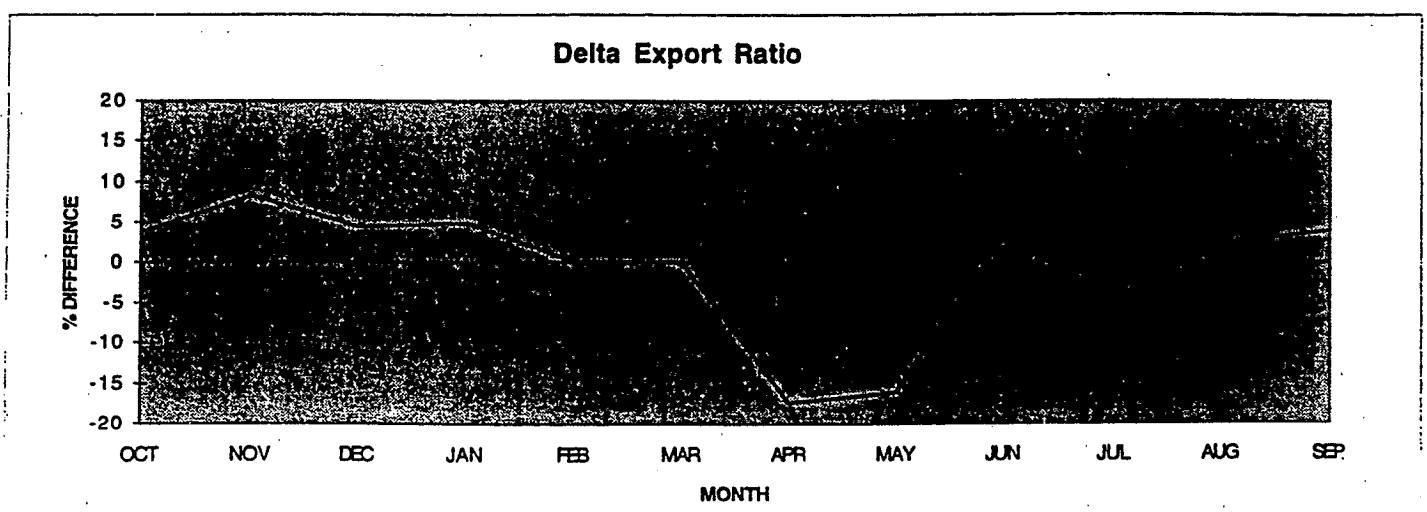
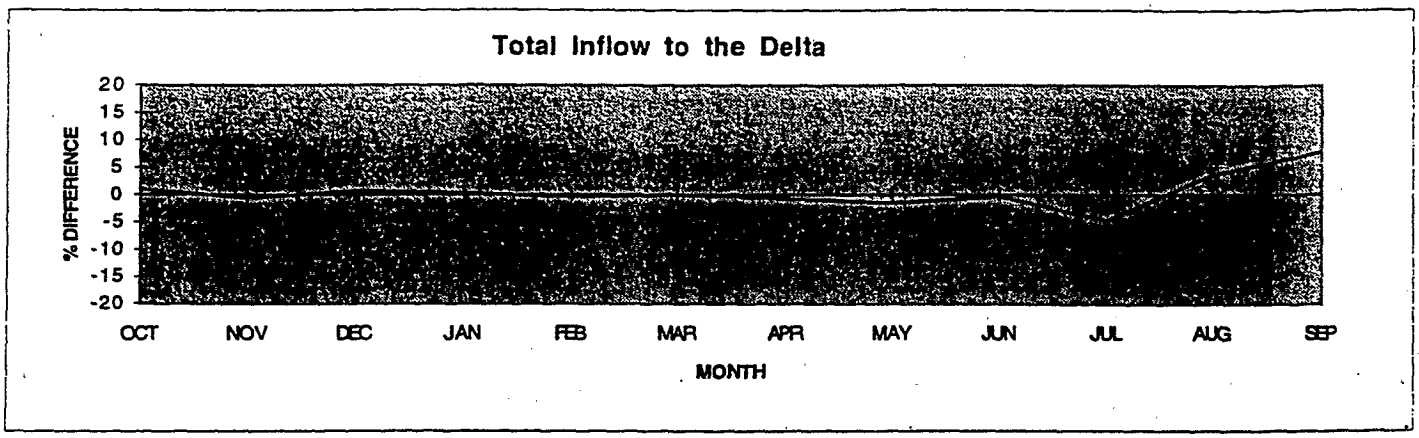
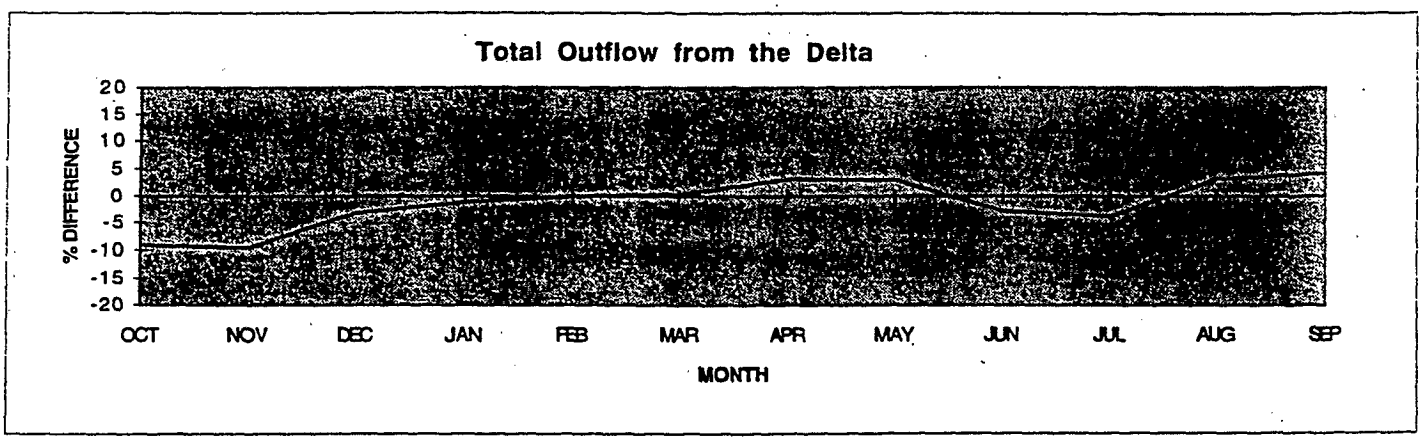
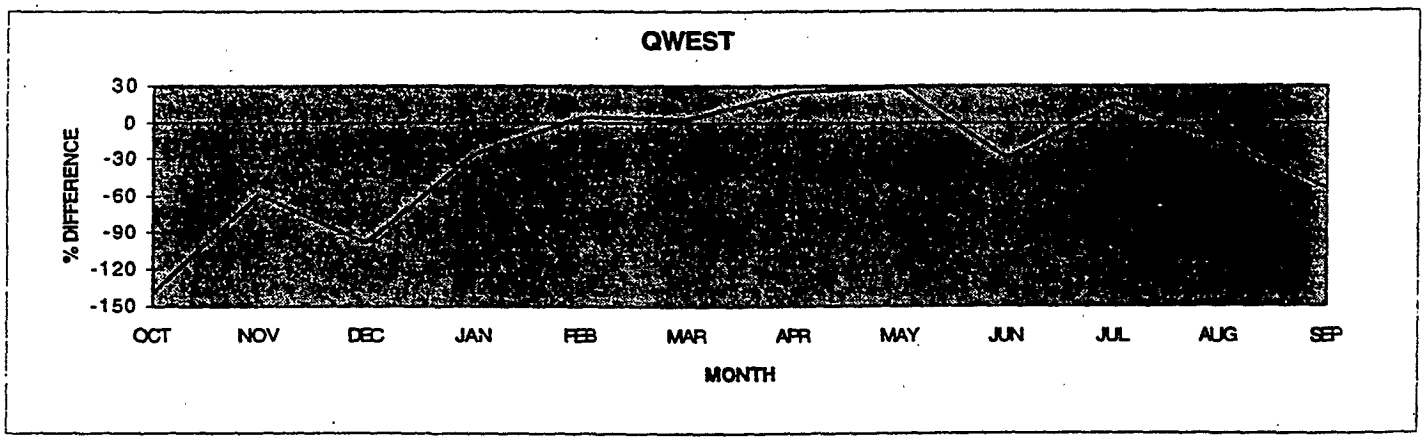


Figure A3-28
Future Demand Case - Percent Difference
between Fisheries Alternative and Base Condition
Delta Inflow and Outflow







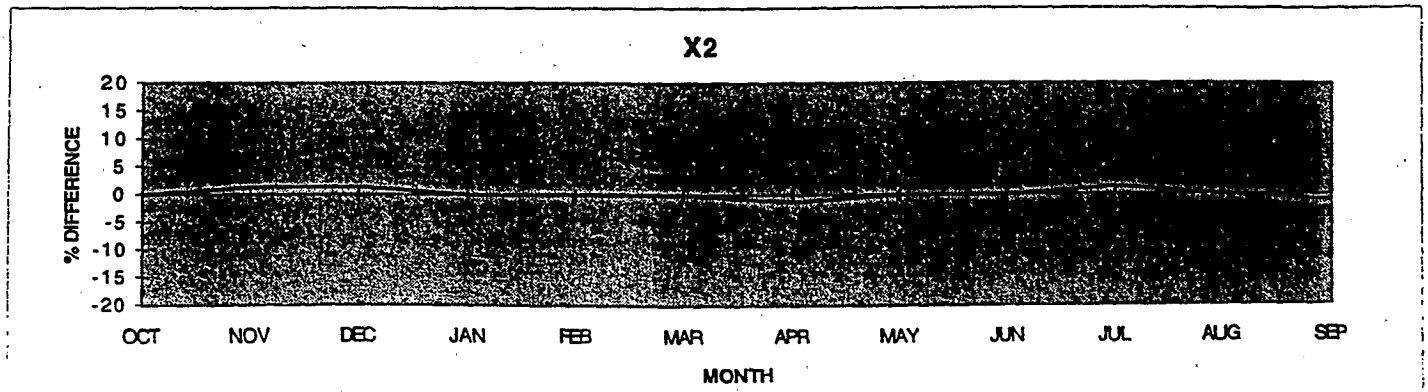
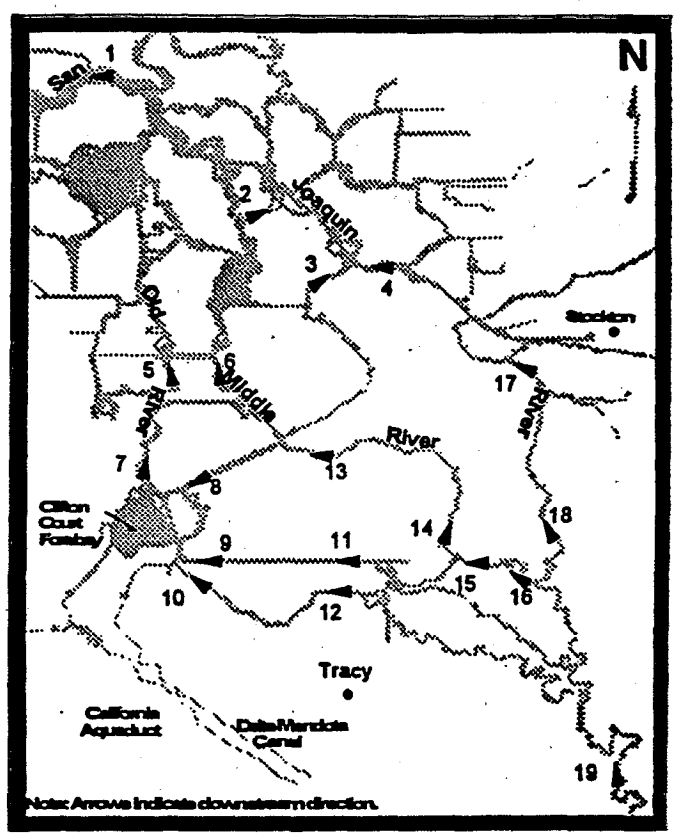


TABLE A3-27

Future Demand Case Study
Difference Between Fisheries Alt. and Base Condition
(Run 455-411)
Representative Critical Year



Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	29.0	0.0	-3.0	76.0	334.0	263.0	205.0	45.0	189.0
2	-70.0	-80.0	-67.0	-150.0	-4.0	3.0	7.0	-57.0	-9.0
3	17.0	14.0	19.0	71.0	63.0	36.0	39.0	38.0	98.0
4	58.0	86.0	89.0	135.0	53.0	50.0	51.0	85.0	101.0
5	-226.0	-223.0	-233.0	-370.0	237.0	208.0	204.0	-153.0	206.0
6	98.0	92.0	98.0	281.0	256.0	205.0	209.0	127.0	393.0
7	-379.0	-382.0	-391.0	-628.0	227.0	202.0	203.0	-284.0	138.0
8	-221.0	-224.0	-221.0	-487.0	-249.0	-201.0	-199.0	-230.0	-455.0
9	-107.0	-108.0	-125.0	-192.0	-113.0	-96.0	-97.0	-97.0	-106.0
10	12.0	13.0	24.0	44.0	34.0	26.0	25.0	25.0	-2.0
11	-108.0	-108.0	-124.0	-192.0	-113.0	-96.0	-98.0	-96.0	-107.0
12	13.0	13.0	25.0	44.0	34.0	26.0	25.0	25.0	-1.0
13	7.0	7.0	10.0	16.0	21.0	15.0	15.0	6.0	1.0
14	7.0	6.0	9.0	16.0	21.0	15.0	15.0	6.0	2.0
15	-88.0	-88.0	-90.0	-132.0	-58.0	-54.0	-55.0	-66.0	-106.0
16	-88.0	-88.0	-90.0	-132.0	-57.0	-53.0	-55.0	-65.0	-106.0
17	88.0	88.0	89.0	131.0	58.0	53.0	54.0	66.0	106.0
18	87.0	87.0	90.0	132.0	57.0	53.0	55.0	66.0	107.0
19	0.0	0.0	-1.0	0.0	0.0	0.0	0.0	0.0	0.0

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.1	0.0	-0.1	-0.1	0.0	0.0
10	0.0	0.0	0.0	0.1	0.0	-0.1	-0.1	0.0	0.1
11	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0
12	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	0.0
13	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	0.0	0.0
14	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.1	0.0
15	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	0.0
16	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.2	-0.3	0.1	0.0	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0
6	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.2	-0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.0
7	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	-0.2	0.0	-0.1	-0.1	0.1	-0.1	0.1	0.0	-0.1	0.1	-0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.1	0.2	0.0	0.2	0.0
9	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
11	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1
13	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.0	-0.1	0.1	0.0	0.1	-0.1	0.1	0.0	0.1	0.0	0.1
14	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	-0.1	0.2	-0.1	0.2	0.0	0.2	-0.1
15	0.1	-0.2	0.1	-0.2	0.1	-0.3	0.1	-0.3	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1
16	0.1	-0.3	0.1	-0.3	0.1	-0.4	-0.1	-0.4	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
18	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-27 CONT.

Future Fisheries Case Study (Run 455-Run 411)
Fisheries-Base (Difference) Demand Condition
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	124	-116	-443	-49	-107	-404	-298
2	-872	-628	-565	-76	-62	-118	-109
3	-360	-355	-357	2	-1	-106	-54
4	1421	1017	1015	71	89	-16	14
5	-841	-1359	-1360	-328	-325	-842	-707
6	-445	-751	-750	26	22	-417	-246
7	-1113	-1724	-1727	-494	-495	-1078	-929
8	164	417	413	-159	-162	222	68
9	-1198	-845	-844	-103	-104	1	-34
10	-196	-138	-138	26	28	29	27
11	-1199	-846	-845	-103	-104	1	-33
12	-199	-141	-140	27	28	29	26
13	-56	-44	-44	7	7	-5	0
14	-58	-44	-44	7	6	-5	1
15	-1456	-1031	-1030	-70	-69	26	8
16	-1456	-1031	-1030	-70	-69	27	8
17	1453	1030	1030	70	69	-25	8
18	1461	1035	1034	70	69	-25	8
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	0	0	0	-54.98	0	-0.01	0
2	0.01	0	0	-443.8	0.01	-0.01	0
3	0	0.01	0	-622.7	0	-0.01	0
4	0.01	0.01	0	150.26	0.01	-0.01	0
5	-0.01	-0.01	-0.02	-3333	0.01	-0.01	0
6	0	0	-0.01	-2180	0	-0.01	0
7	-0.05	-0.05	-0.06	-4078	0.01	-0.03	-0.01
8	-0.06	-0.07	-0.07	1471.5	0	-0.04	-0.01
9	-0.16	-0.15	-0.15	738.43	0	-0.04	-0.02
10	-0.1	-0.09	-0.11	156.55	0.01	-0.04	-0.02
11	-0.42	-0.38	-0.38	751.12	-0.03	-0.08	-0.05
12	-0.49	-0.44	-0.44	171.12	-0.06	-0.11	-0.08
13	-0.11	-0.1	-0.1	-33.62	-0.05	-0.07	-0.06
14	-0.62	-0.55	-0.56	13.02	-0.14	-0.16	-0.16
15	-0.85	-0.72	-0.72	973.9	-0.08	-0.14	-0.12
16	-1.16	-0.97	-0.97	978.7	-0.06	-0.13	-0.11
17	0.2	0.14	0.13	85.19	0.01	-0.02	0
18	1.43	1.07	1.05	100.54	0.02	-0.07	-0.03
19	0.92	0.74	0.73	1093.4	0.03	-0.04	-0.01

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.1	-0.4	0.1	-0.4	0.1	-0.2	0.1	-0.2	0.1	-0.1	0.1	-0.1
6	0.1	-0.1	0.1	-0.3	0.1	-0.3	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0
7	-0.1	-0.2	-0.1	-0.4	-0.1	-0.4	0.0	-0.1	0.0	-0.1	-0.1	-0.2	0.1	-0.3
8	0.3	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.2	0.0
9	-0.1	-0.2	-0.1	-0.2	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0
11	-0.2	-0.3	-0.1	-0.3	-0.2	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	-0.2	0.0	-0.2	0.0	-0.2	0.1	-0.1	0.1	0.0	0.1	-0.1	0.1	-0.1
13	-0.1	0.1	-0.1	0.1	-0.1	0.0	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	0.1
14	0.1	-0.2	0.2	-0.2	0.2	-0.2	0.2	-0.1	0.2	-0.1	0.1	-0.2	0.1	-0.1
15	-0.9	-0.5	-0.8	-0.4	-0.8	-0.4	0.1	-0.2	0.1	-0.2	0.0	-0.1	0.0	-0.1
16	-1.3	-0.5	-1.1	-0.2	-1.1	-0.2	0.1	-0.3	0.1	-0.3	0.0	-0.1	0.1	-0.2
17	0.4	1.0	0.3	0.6	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.6	1.3	0.4	0.6	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-28

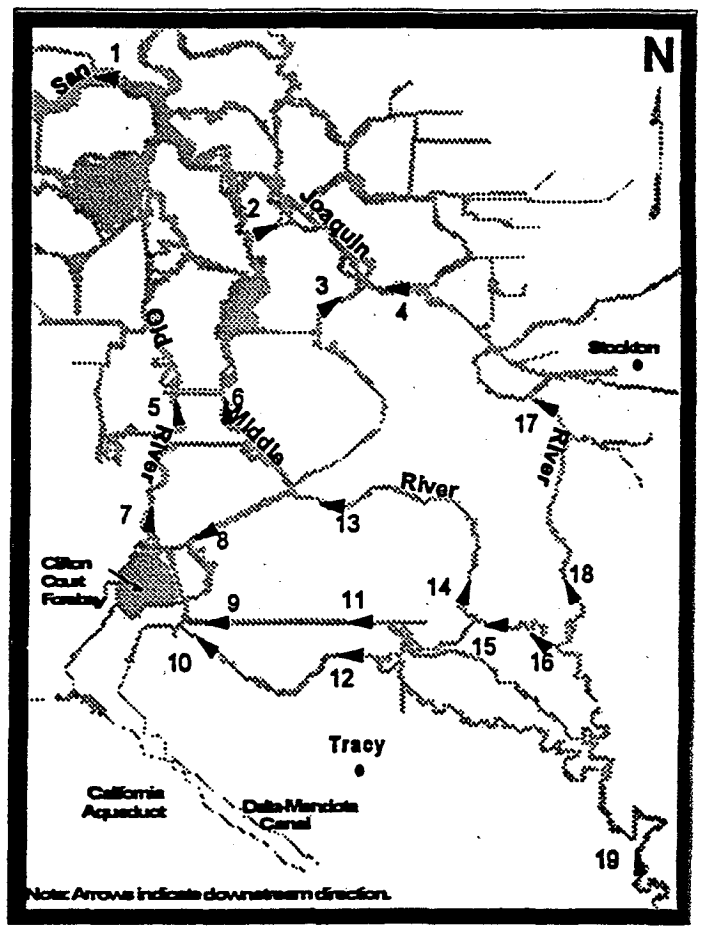
Future Demand Case Study
Difference Between Fisheries Alt. and Base Condition
(Run 455-411)
Representative Dry Year

Average Net Flow

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April	May 20-Jan	May 21-31	June	July
1	-1458.0	-1524.0	116.0	428.0	641.0	435.0	904.0	32.0	17.0
2	-254.0	-257.0	-125.0	-94.0	3.0	9.0	26.0	-63.0	-153.0
3	-61.0	-77.0	90.0	94.0	106.0	75.0	78.0	43.0	65.0
4	53.0	60.0	97.0	103.0	56.0	55.0	54.0	63.0	105.0
5	-1959.0	-1967.0	-227.0	65.0	500.0	382.0	378.0	-183.0	-475.0
6	-559.0	-574.0	250.0	319.0	430.0	345.0	350.0	128.0	292.0
7	-2536.0	-2530.0	-433.0	-34.0	548.0	408.0	408.0	-310.0	-747.0
8	128.0	125.0	-362.0	-374.0	-356.0	-303.0	-302.0	-221.0	-517.0
9	-162.0	-154.0	-212.0	-214.0	-178.0	-134.0	-134.0	-103.0	-147.0
10	88.0	87.0	80.0	79.0	76.0	47.0	46.0	30.0	41.0
11	-161.0	-154.0	-212.0	-214.0	-178.0	-134.0	-133.0	-102.0	-147.0
12	84.0	86.0	82.0	79.0	76.0	47.0	46.0	30.0	41.0
13	20.0	20.0	31.0	32.0	43.0	28.0	27.0	9.0	2.0
14	21.0	20.0	32.0	32.0	43.0	28.0	28.0	9.0	3.0
15	-44.0	-49.0	-87.0	-105.0	-81.0	-59.0	-87.0	-64.0	-105.0
16	-46.0	-49.0	-91.0	-104.0	-81.0	-59.0	-34.0	-62.0	-103.0
17	45.0	50.0	95.0	104.0	81.0	59.0	60.0	63.0	105.0
18	45.0	51.0	95.0	104.0	82.0	60.0	60.0	64.0	106.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Minimum Water Surface Elevation

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April	May 20-Jan	May 21-31	June	July
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	-0.1	-0.1	-0.1	0.0	0.0	-0.1	-0.1	-0.1	0.0
13	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
14	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	0.0
15	-0.2	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1
16	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



Minimum and Maximum Velocity

Ref. No.	Jan 1-15 MAX.	Jan 1-15 MIN.	Jan 16-31 MAX.	Jan 16-31 MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April MAX.	April MIN.	May 1-20 MAX.	May 1-20 MIN.	May 21-31 MAX.	May 21-31 MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.3	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.2	0.1	0.0	0.1	-0.1	0.1	0.0	0.1	-0.1	0.4	-0.3
6	0.2	-0.2	0.2	-0.2	0.2	-0.2	0.2	-0.1	0.1	0.1	0.2	0.0	0.2	0.0	0.1	0.0	0.4	-0.1
7	0.0	-0.4	0.0	-0.4	0.1	-0.2	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	0.3	-0.2
8	0.1	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1	0.2	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.4	-0.1
9	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.0
11	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
12	0.1	0.0	0.1	0.0	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1
13	-0.1	0.1	-0.1	0.1	-0.1	0.0	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.0
14	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	-0.1
15	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.2
16	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.3	0.1	-0.3
17	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-28 CONT.

Future Fisheries Case Study (Run 455-Run 411)
Fisheries-Base (Difference) Demand Condition
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1199	33	-93	2409	2389	1889	-392
2	-1618	-1415	-1377	42	49	254	-192
3	-875	-528	-532	343	341	456	-61
4	2817	2636	2622	173	170	324	41
5	-3679	-2191	-2188	1990	1988	3019	-1115
6	-1680	-932	-928	1504	1501	2143	-310
7	-4580	-2818	-2818	2219	2212	3366	-1457
8	838	356	349	-1278	-1279	-1738	35
9	-2356	-2315	-2310	-373	-376	-189	-62
10	-296	-269	-265	94	93	63	32
11	-2355	-2311	-2307	-368	-371	-200	-61
12	-304	-274	-268	94	93	14	32
13	128	-87	-86	52	51	72	3
14	128	-87	-86	52	52	28	3
15	-2777	-2657	-2645	-207	-208	-233	-33
16	-2776	-2653	-2640	-204	-205	-236	-32
17	2832	2667	2651	197	196	345	32
18	2885	2709	2694	200	199	326	32
19	82	50	50	0	0	57	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.04	0.02	0.02	0.1	0.11	0.1	0
2	-0.02	0.02	0.02	0.1	0.1	0.09	0
3	-0.01	0.02	0.01	0.09	0.09	0.08	0
4	-0.01	0.02	0.02	0.1	0.1	0.09	0
5	-0.08	0	0	0.1	0.1	0.04	0
6	-0.07	0.01	0	0.1	0.1	0.05	0
7	-0.13	-0.03	-0.03	0.1	0.1	0.03	0.01
8	-0.14	-0.04	-0.04	0.11	0.11	0.05	0.01
9	-0.27	-0.17	-0.16	0.1	0.1	0.07	0.01
10	-0.17	-0.07	-0.06	0.11	0.11	0.06	0.02
11	-0.7	-0.61	-0.61	0.06	0.05	0.12	-0.02
12	-0.77	-0.69	-0.69	0.03	0.02	0.1	-0.06
13	-0.17	-0.09	-0.1	0.04	0.04	0	-0.04
14	-1.01	-0.91	-0.92	-0.12	-0.12	0.08	-0.14
15	-1.43	-1.3	-1.3	-0.03	-0.04	0.09	-0.09
16	-2.05	-1.86	-1.86	-0.02	-0.02	0.13	-0.08
17	0.62	0.56	0.58	0.1	0.1	0.12	0.01
18	3.09	2.84	2.86	0.1	0.09	0.22	-0.01
19	1.83	1.68	1.68	0.04	0.04	0.28	0

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	-0.1	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
3	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.2	0.0	0.2	0.0	0.1	0.0	0.1	0.0
4	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	-0.6	0.1	-0.5	0.1	-0.5	0.3	-0.1	0.3	-0.1	0.5	0.2	0.1	-0.3
6	0.1	-0.4	0.1	-0.3	0.1	-0.3	0.3	0.0	0.3	0.0	0.5	0.2	0.1	-0.2
7	-0.2	-0.7	-0.1	-0.5	-0.1	-0.5	0.2	0.2	0.2	-0.2	0.4	0.5	0.0	-0.3
8	0.8	0.1	0.2	0.0	0.2	0.0	-0.2	-0.1	0.2	-0.1	0.0	-0.1	0.4	0.0
9	-0.4	-0.4	-0.3	-0.5	-0.3	-0.5	0.0	-0.4	0.0	-0.4	0.2	0.2	0.0	0.0
10	-0.2	-0.2	0.0	-0.2	0.0	-0.2	0.2	-0.2	0.2	-0.2	0.3	0.1	0.1	0.0
11	-0.4	-0.5	-0.3	-0.6	-0.3	-0.6	0.0	-0.3	0.0	-0.3	0.1	0.2	0.0	0.0
12	-0.1	-0.4	-0.2	-0.3	-0.2	-0.3	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.1
13	-0.2	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0
14	0.3	-0.4	-0.1	-0.3	-0.1	-0.3	0.2	0.1	0.2	0.1	0.2	0.0	0.2	0.1
15	-1.4	-1.5	-1.5	-1.6	-1.4	-1.6	0.1	-0.3	0.1	-0.3	0.1	-0.1	0.1	-0.2
16	-1.9	-1.7	-1.9	-1.7	-1.9	-1.7	0.0	-0.3	0.0	-0.3	0.0	-0.2	0.1	-0.2
17	1.0	1.9	0.9	1.8	0.9	1.8	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
18	1.0	2.2	1.0	2.3	1.0	2.2	0.0	0.2	0.0	0.2	0.1	0.2	0.0	0.0
19	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-29

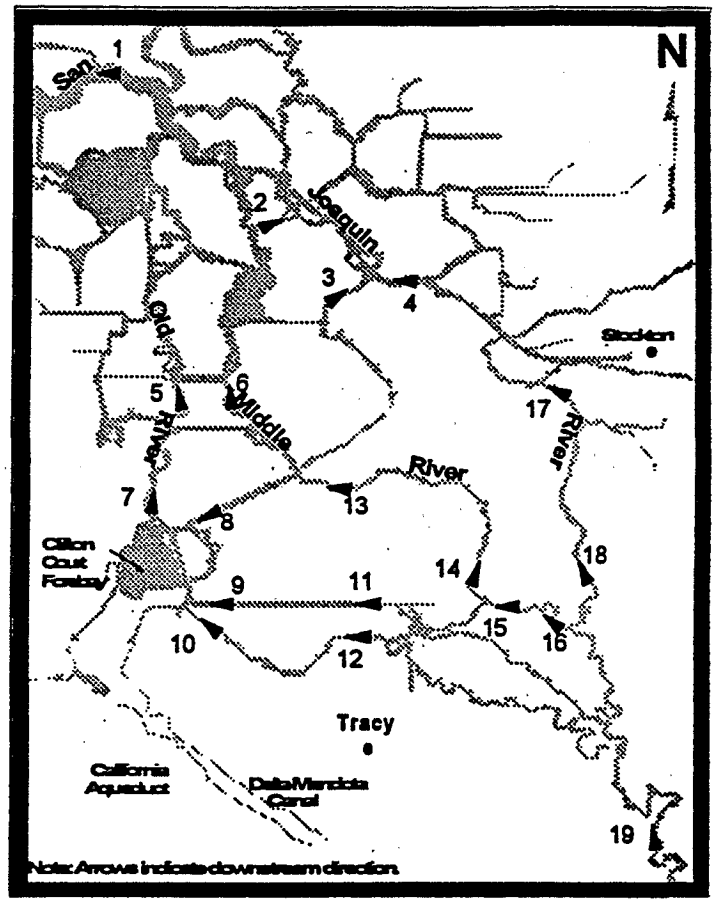
Future Demand Case Study
Difference Between Fisheries Alt. and Base Condition
(Run 455-411)
Representative Below Normal Year Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May 20-Jan	May 21-31	June	July
1	69.0	1541.0	189.0	683.0	508.0	379.0	26.0	-215.0
2	-157.0	-37.0	-95.0	5.0	-3.0	13.0	-69.0	-193.0
3	103.0	244.0	73.0	117.0	95.0	99.0	47.0	25.0
4	95.0	152.0	101.0	53.0	63.0	64.0	86.0	96.0
5	-359.0	1148.0	-94.0	537.0	404.0	399.0	-205.0	-850.0
6	294.0	1020.0	243.0	460.0	394.0	400.0	132.0	98.0
7	-595.0	1227.0	-247.0	590.0	476.0	426.0	-540.0	-1200.0
8	-448.0	-919.0	-352.0	-379.0	-354.0	-352.0	-232.0	-382.0
9	-227.0	-292.0	-199.0	-193.0	-156.0	-155.0	-108.0	-129.0
10	97.0	98.0	74.0	83.0	57.0	56.0	33.0	41.0
11	-224.0	-290.0	-200.0	-193.0	-154.0	-155.0	-107.0	-129.0
12	97.0	97.0	73.0	83.0	56.0	56.0	32.0	41.0
13	39.0	50.0	25.0	47.0	31.0	31.0	9.0	0.0
14	39.0	49.0	24.0	46.0	31.0	31.0	9.0	-1.0
15	-90.0	-147.0	-102.0	-63.0	-68.0	-70.0	-67.0	-90.0
16	-89.0	-150.0	-102.0	-61.0	-67.0	-68.0	-64.0	-89.0
17	91.0	160.0	102.0	60.0	69.0	69.0	65.0	90.0
18	92.0	159.0	103.0	61.0	69.0	69.0	66.0	91.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 20-Jan	May 21-31	June	July
1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
5	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1
8	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
14	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	0.0
15	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1
16	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.0
17	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
18	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



Minimum and Maximum Velocity

Ref. No.	January MAX.	January MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April MAX.	April MIN.	May 1-20 MAX.	May 1-20 MIN.	May 21-31 MAX.	May 21-31 MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.2	-0.4	0.2	-0.2	0.1	-0.3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.3	-0.4
6	0.3	-0.2	0.3	-0.1	0.2	-0.1	0.2	0.1	0.1	0.0	0.2	0.0	0.1	0.0	0.4	-0.2
7	0.1	-0.3	0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.3	-0.2
8	0.0	0.0	-0.1	-0.1	0.0	-0.1	0.2	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.4	0.0
9	0.0	-0.1	0.0	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10	0.2	0.0	0.2	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.2	0.0
11	0.0	-0.1	0.0	-0.3	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
12	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2
13	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.0
14	0.2	0.0	0.2	0.1	0.2	0.0	0.2	0.1	0.2	0.0	0.2	0.0	0.2	0.0	0.2	-0.1
15	0.1	-0.1	0.1	-0.2	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.2
16	0.0	-0.1	0.0	-0.2	0.1	-0.2	0.0	-0.2	0.1	-0.2	0.0	-0.2	0.1	-0.3	-0.1	-0.3
17	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-29 CONT.

Future Fisheries Case Study (Run 455-Run 411)
Fisheries-Base (Difference) Demand Condition
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	169	-2037	-952	-886	-248	-833
2	-1049	-1676	-219	-235	-199	-286
3	-378	-741	-12	-6	18	-156
4	2079	2849	71	72	107	3
5	-1391	-4263	-1371	-1372	-900	-1916
6	-461	-2058	-284	-281	73	-737
7	-1831	-5296	-1804	-1800	-1260	-2415
8	32	1111	-50	-46	-372	331
9	-1811	-2486	-174	-173	-122	-4
10	-233	-282	94	96	27	32
11	-1813	-2489	-173	-173	-121	-5
12	-236	-296	94	95	26	31
13	-77	-115	29	30	-5	-13
14	-78	-115	29	30	-6	-13
15	-2128	-2896	-49	-49	-101	14
16	-2128	-2902	-48	-49	-100	14
17	2120	2880	65	65	101	-14
18	2137	2954	65	65	102	-13
19	0	0	16	16	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	0.02	-0.05	0.02	0.01	0.03	-0.01
2	0.02	-0.04	0.01	0	0.05	0
3	0.01	-0.04	0	0.01	0.04	-0.01
4	0.02	-0.04	0	0	0.04	-0.01
5	-0.01	-0.08	0.01	0	-0.03	-0.01
6	0	-0.06	0	0.01	-0.01	-0.01
7	-0.03	-0.12	0	0	-0.05	-0.01
8	-0.03	-0.13	0	0.01	-0.04	-0.01
9	-0.13	-0.26	0	0.01	-0.03	-0.01
10	-0.05	-0.16	0.01	0.01	-0.04	0
11	-0.46	-0.8	-0.03	-0.03	-0.01	-0.04
12	-0.55	-0.86	-0.06	-0.06	-0.04	-0.08
13	-0.1	-0.18	-0.06	-0.05	-0.08	-0.06
14	-0.71	-1.08	-0.24	-0.24	-0.08	-0.15
15	-1	-1.54	-0.16	-0.16	-0.05	-0.11
16	-1.43	-2.15	-0.13	-0.13	-0.03	-0.11
17	0.35	0.6	0.01	0.01	0.05	-0.01
18	2.12	3.15	0.01	0.01	0.06	-0.03
19	1.25	1.78	0.02	0.02	0.05	-0.02

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	0.0	-0.2	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0
3	0.0	-0.1	0.0	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	-0.4	0.0	-0.6	0.2	-0.4	0.1	-0.4	0.3	-0.4	0.1	-0.4
6	0.1	-0.2	0.0	-0.4	0.2	-0.2	0.2	-0.2	0.4	-0.2	0.1	-0.2
7	-0.1	-0.3	-0.3	-0.7	0.0	-0.4	0.0	-0.4	0.2	-0.3	-0.1	-0.5
8	0.5	0.0	0.3	0.1	0.1	0.0	0.1	0.0	0.4	-0.1	0.4	0.0
9	-0.2	0.3	-0.4	-0.5	0.0	-0.1	0.0	-0.1	0.1	0.0	0.0	0.0
10	0.0	-0.1	-0.1	-0.2	0.1	0.0	0.1	0.0	0.2	0.0	0.1	-0.1
11	-0.3	-0.4	-0.4	-0.6	0.0	-0.1	0.0	-0.1	0.1	0.0	0.0	0.0
12	-0.1	-0.4	-0.2	-0.3	0.1	0.0	0.1	0.0	0.1	-0.1	0.1	-0.1
13	-0.1	0.0	-0.1	0.1	0.1	0.0	-0.1	0.1	0.0	0.0	-0.1	0.0
14	-0.1	-0.3	-0.3	-0.4	0.2	0.0	0.2	0.0	0.2	-0.1	0.2	-0.1
15	-1.1	-1.0	-1.6	-1.6	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.0	-0.2
16	-1.6	-1.2	-2.0	-1.8	0.0	-0.1	0.0	-0.1	-0.1	-0.2	0.0	-0.2
17	0.7	1.5	1.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.8	1.9	1.0	2.3	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0
19	-0.2	-0.1	-0.3	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-30

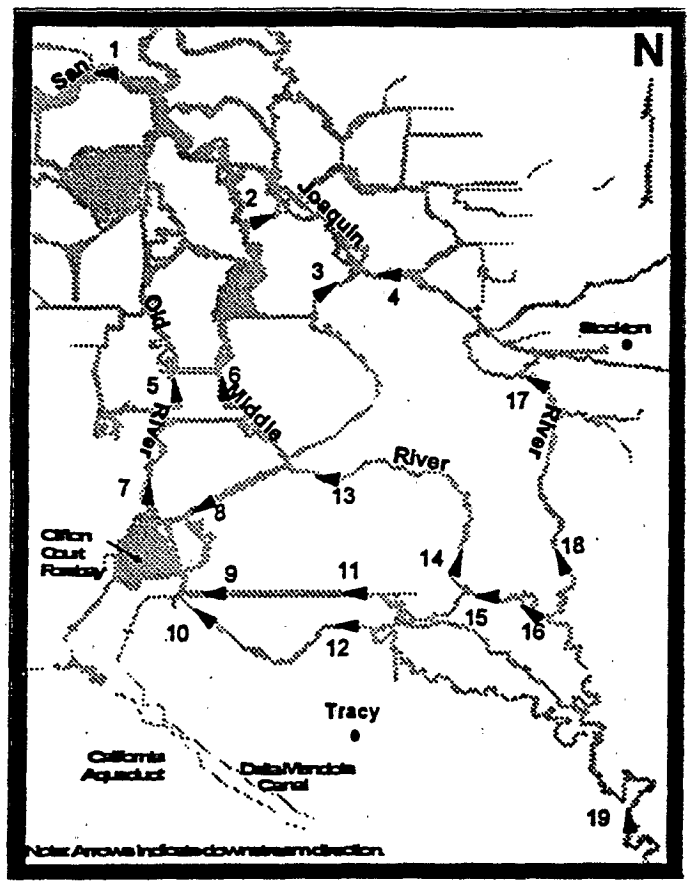
Future Demand Case Study
Difference Between Fisheries Alt. and Base Condition
(Run 455-411)
Representative Above Normal Year Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-122	-275	-617	1312	730	582	634	70	-4205
2	-190	-157	-220	-58	7	-19	-29	-64	272
3	34	29	8	211	141	107	106	71	67
4	81	80	84	159	85	56	54	76	47
5	-466	-666	-1165	899	617	384	378	-121	-1340
6	6	4	-141	889	639	396	398	219	-61
7	-942	-945	-1574	920	680	401	400	-249	-1746
8	-210	-214	-175	-640	-446	-346	-343	-314	-244
9	-178	-178	-176	-253	-207	-181	-181	-120	-133
10	79	79	83	84	87	80	80	33	38
11	-179	-178	-177	-258	-206	-181	-181	-121	-113
12	79	79	88	72	88	79	79	33	38
13	24	23	27	36	46	41	41	9	-6
14	24	23	28	37	48	41	42	9	-5
15	-76	-76	-80	-148	-72	-61	-61	-78	-50
16	-76	-76	-70	-151	-72	-60	-62	-77	-75
17	76	76	80	163	72	61	62	78	79
18	77	77	79	161	72	61	62	79	80
19	0	0	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.1
6	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.1
7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.1
8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.1
9	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.1
10	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	-0.1
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
12	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
14	-0.2	-0.2	-0.2	-0.1	-0.2	-0.2	-0.2	-0.1	-0.1
15	-0.1	-0.1	-0.1	0.0	-0.2	-0.2	-0.2	-0.1	-0.2
16	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1
17	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16 MAX.	Jan. 1-16 MIN.	Jan. 17-31 MAX.	Jan. 17-31 MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April MAX.	April MIN.	May 1-20 MAX.	May 1-20 MIN.	May 21-31 MAX.	May 21-31 MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0
2	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0
3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	-0.4	0.1	-0.4	0.2	-0.4	0.2	-0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.2	0.3	-0.4
6	0.2	-0.2	0.2	-0.2	0.2	-0.2	0.2	-0.1	0.2	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.4	-0.2
7	0.0	-0.3	0.0	-0.3	0.1	-0.3	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.2	-0.3
8	0.1	0.0	0.1	0.0	0.1	0.0	-0.1	-0.1	0.2	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.4	0.0
9	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
10	0.1	0.0	0.1	0.0	0.1	0.0	0.2	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
11	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
12	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.0	-0.1
13	-0.1	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	-0.1	0.0
14	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.1	0.2	0.1	0.2	0.1	0.2	0.0	0.2	0.0
15	0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	-0.2	0.1	-0.1	0.1	-0.1	0.0	-0.1	0.1	-0.2	0.1	-0.2
16	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.3	0.0	-0.2	0.0	-0.2	0.0	-0.2	0.0	-0.3	-0.1	-0.3
17	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-30 CONT.

Future Fisheries Case Study (Run 455-Run 411)
Fisheries-Base (Difference) Demand Condition
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-2037	96	56	56	56	397	-631
2	-1585	-983	-957	-52	-47	-91	-238
3	-703	-335	-345	35	32	129	-73
4	2722	1826	1821	67	66	139	53
5	-4235	-1488	-1483	-141	-137	135	-1454
6	-1965	-467	-465	142	138	596	-378
7	-5241	-1966	-1967	-261	-264	-16	-1893
8	1031	25	18	-228	-230	-720	26
9	-2331	-1619	-1617	-139	-139	-176	-72
10	-292	-191	-187	54	54	30	34
11	-2330	-1619	-1618	-139	-139	-176	-72
12	-302	-193	-189	53	54	30	34
13	-134	-52	-52	16	17	7	-4
14	-133	-53	-52	17	17	7	-4
15	-2755	-1868	-1861	-69	-68	-139	-42
16	-2756	-1866	-1859	-69	-68	-139	-41
17	2737	1863	1855	68	68	140	42
18	2786	1874	1868	68	68	140	42
19	0	0	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-0.09	0.03	0	0.01	0.01	0.06	0.01
2	-0.08	0.02	0	0.01	0.01	0.06	0
3	-0.06	0.02	0	0.01	0.01	0.05	0
4	-0.07	0.02	0	0.02	0.02	0.06	0
5	-0.09	0.01	0	0.01	0.01	-0.01	0
6	-0.09	0.01	0	0.01	0.01	0.01	0.01
7	-0.14	-0.01	0	0	0	-0.02	0
8	-0.15	-0.01	0	0.01	0.01	-0.01	0.01
9	-0.29	-0.09	0	0.01	0.01	0.01	0.01
10	-0.18	-0.02	0	0.01	0.01	0	0.02
11	-0.73	-0.37	0	-0.03	-0.02	0.03	-0.01
12	-0.8	-0.45	0	-0.06	-0.07	0	-0.05
13	-0.18	-0.07	0	-0.05	-0.05	-0.05	-0.08
14	-1.03	-0.61	0	-0.16	-0.16	-0.05	-0.14
15	-1.44	-0.81	0	-0.1	-0.1	-0.03	-0.09
16	-2.05	-1.16	0	-0.08	-0.08	-0.01	-0.07
17	0.54	0.27	0	0.02	0.02	0.06	0
18	2.95	1.72	0	0.02	0.02	0.09	0
19	1.68	1.07	0	0.01	0.01	0.08	0

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.2	-0.1	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
3	-0.1	-0.1	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
4	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	-0.1	-0.7	0.1	-0.4	0.1	-0.4	0.1	-0.2	0.1	-0.2	0.4	-0.2	0.1	-0.4
6	0.0	-0.4	0.2	-0.3	0.2	-0.3	0.2	-0.1	0.2	-0.1	0.4	-0.1	0.1	-0.2
7	-0.3	-0.8	0.0	-0.4	0.0	-0.4	0.0	-0.1	0.0	-0.1	0.3	0.0	0.0	-0.3
8	0.6	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3	-0.1	0.4	0.0
9	-0.4	-0.4	-0.1	-0.4	-0.1	-0.4	0.0	-0.1	0.0	-0.1	0.1	0.0	0.0	0.0
10	-0.2	-0.2	0.1	-0.2	0.1	-0.2	0.1	0.0	0.1	0.0	0.2	0.0	0.1	0.1
11	-0.5	-0.5	-0.2	-0.4	-0.2	-0.4	0.0	-0.1	0.0	-0.1	0.1	0.0	0.0	0.0
12	-0.1	-0.4	-0.1	-0.2	-0.1	-0.2	0.1	0.0	0.1	0.0	0.1	-0.1	0.1	-0.1
13	-0.2	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.1	0.1	0.1	0.0	0.1	-0.1	0.0
14	-0.3	-0.4	0.0	-0.2	0.0	-0.2	0.2	0.0	0.2	0.0	0.2	-0.1	0.2	-0.1
15	-1.4	-1.4	-1.0	-1.2	-1.0	-1.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2
16	-1.9	-1.8	-1.4	-1.2	-1.4	-1.2	0.1	-0.2	0.1	-0.2	-0.1	-0.2	0.0	-0.2
17	1.0	1.8	0.5	1.2	0.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	1.0	2.2	0.7	1.7	0.7	1.7	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.0
19	-0.3	-0.2	-0.2	-0.1	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-31

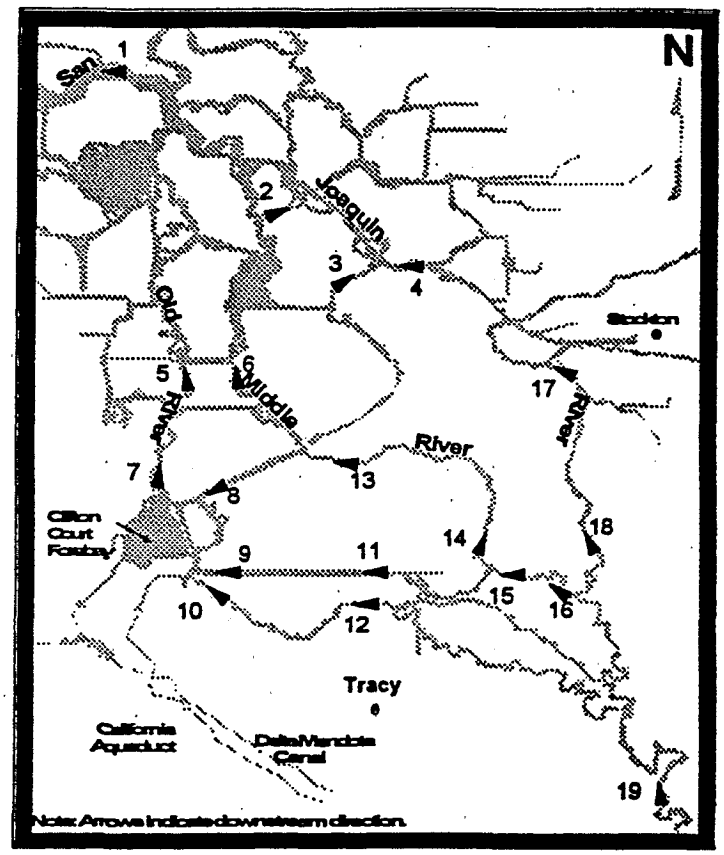
Future Demand Case Study
Difference Between Fisheries Alt. and Base Condition
(Run 455-411)
Representative Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	-442.0	2793.0	711.0	65.0	41.0	111.0	380.0
2	-201.0	54.0	-9.0	-64.0	-101.0	-141.0	-27.0
3	42.0	354.0	150.0	26.0	56.0	87.0	136.0
4	52.0	165.0	34.0	77.0	50.0	47.0	70.0
5	-910.0	2307.0	518.0	-68.0	-154.0	-257.0	293.0
6	-8.0	1768.0	519.0	4.0	106.0	292.0	485.0
7	-1239.0	2824.0	644.0	6.0	-162.0	-412.0	223.0
8	-234.0	-1449.0	-272.0	263.0	59.0	-335.0	-477.0
9	-201.0	-351.0	-351.0	-546.0	-477.0	-221.0	-214.0
10	95.0	114.0	199.0	281.0	256.0	132.0	91.0
11	-201.0	-349.0	-364.0	-554.0	-483.0	-223.0	-213.0
12	91.0	115.0	194.0	287.0	263.0	128.0	95.0
13	54.0	76.0	136.0	182.0	163.0	78.0	42.0
14	54.0	76.0	137.0	181.0	163.0	78.0	42.0
15	-75.0	-160.0	-69.0	-142.0	-107.0	-30.0	-77.0
16	-75.0	-163.0	-58.0	-117.0	-84.0	-32.0	-75.0
17	78.0	177.0	45.0	82.0	54.0	44.0	75.0
18	77.0	178.0	46.0	90.0	59.0	42.0	77.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.0	0.0	0.0	0.1	0.0
4	0.0	0.1	0.0	0.0	0.0	0.1	0.0
5	0.0	0.1	0.0	0.0	0.0	0.0	0.0
6	0.0	0.1	0.0	0.0	0.0	0.0	0.0
7	0.0	0.1	0.0	0.0	0.0	-0.1	0.0
8	0.0	0.1	0.0	-0.1	-0.1	-0.1	0.0
9	0.0	0.1	0.0	-0.1	-0.1	0.0	0.0
10	0.0	0.2	0.0	-0.1	-0.1	0.0	0.1
11	0.0	0.1	-0.1	-0.2	-0.2	-0.1	0.0
12	0.0	0.1	-0.2	-0.2	-0.2	-0.1	-0.1
13	0.0	0.1	0.0	-0.1	-0.1	-0.1	0.0
14	-0.2	-0.1	-0.6	-0.8	-0.7	-0.3	-0.2
15	-0.1	0.0	-0.5	-0.6	-0.6	-0.2	-0.2
16	-0.1	0.0	-0.3	-0.4	-0.4	-0.2	-0.1
17	0.0	0.1	0.0	0.0	0.0	0.0	0.0
18	0.0	0.1	0.0	0.1	0.1	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
3	0.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.2	-0.4	0.3	-0.1	0.1	-0.2	0.2	-0.2	0.3	-0.2	0.4	-0.3	0.1	-0.1
6	0.2	-0.2	0.4	0.0	0.1	-0.1	0.2	-0.1	0.3	-0.1	0.5	-0.1	0.1	0.0
7	0.1	-0.3	0.3	0.1	-0.1	-0.1	-0.1	-0.3	0.1	-0.2	0.2	-0.2	0.0	0.0
8	0.1	0.0	-0.1	-0.1	0.0	0.0	0.4	0.1	0.4	0.1	0.4	0.0	0.3	0.0
9	0.0	-0.1	0.0	-0.3	-0.1	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
10	0.1	0.0	0.2	-0.2	0.1	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.1
11	0.0	-0.1	0.0	-0.3	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0
12	0.1	0.0	0.1	-0.1	0.1	-0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
13	0.0	0.1	0.0	0.0	-0.1	0.1	0.1	0.0	0.1	0.1	-0.1	0.0	0.0	0.1
14	0.2	0.0	0.2	0.1	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.1
15	0.0	-0.1	0.1	-0.3	0.1	0.0	0.1	0.1	0.1	0.0	0.1	-0.1	0.1	-0.1
16	0.0	-0.1	0.0	-0.3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.1	-0.2
17	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
18	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-31 CONT.

Future Fisheries Case Study (Run 455-Run 411)
Fisheries-Base (Difference) Demand Condition
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	11	-2024	-2194	46	-2048
2	-686	-1073	-250	-80	-288
3	-303	-518	-122	60	-158
4	1296	1677	43	69	10
5	-1161	-3572	-2404	-215	-2647
6	-447	-1564	-813	174	-952
7	-1529	-4494	-3055	-374	-3306
8	97	773	293	-291	448
9	-1109	-1464	-100	-148	-141
10	-160	-172	61	62	95
11	-1111	-1465	-100	-148	-140
12	-162	-174	60	62	98
13	-51	-67	4	16	27
14	-51	-67	4	16	27
15	-1326	-1707	-37	-71	-12
16	-1325	-1705	-36	-70	-9
17	1323	1702	36	71	0
18	1330	1711	36	71	2
19	0	0	0	0	0

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	0	-0.04	-0.04	0.02	-0.07
2	0.01	-0.04	-0.04	0.01	-0.05
3	0	-0.04	-0.04	0.01	-0.05
4	0.01	-0.04	-0.04	0.01	-0.05
5	0	-0.06	-0.04	0.02	-0.06
6	0	-0.06	-0.05	0.01	-0.06
7	-0.02	-0.08	-0.05	0.02	-0.08
8	-0.02	-0.09	-0.06	0.03	-0.08
9	-0.1	-0.16	-0.07	0.02	-0.08
10	-0.04	-0.1	-0.04	0.03	-0.07
11	-0.36	-0.47	-0.14	-0.02	-0.11
12	-0.43	-0.53	-0.17	-0.06	-0.16
13	-0.08	-0.13	-0.08	-0.03	-0.12
14	-0.55	-0.62	-0.18	-0.14	-0.32
15	-0.72	-0.83	-0.18	-0.12	-0.25
16	-0.99	-1.11	-0.15	-0.1	-0.2
17	0.18	0.17	-0.04	0.01	-0.05
18	1.26	1.48	-0.04	0.01	-0.05
19	0.85	0.96	-0.01	0.01	-0.01

Minimum and Maximum Velocity

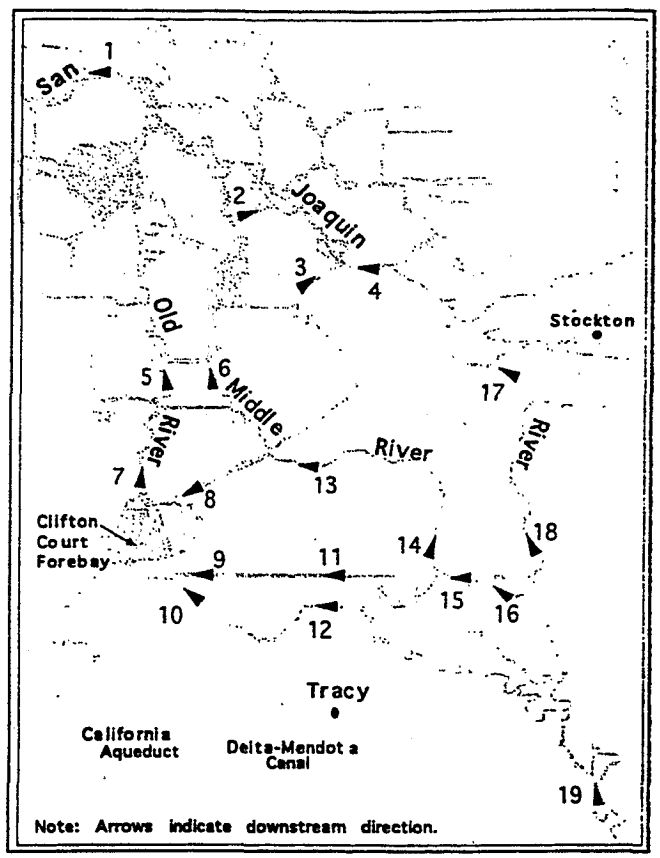
Ref.	Oct.		Nov.		Dec.		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.1	0.0	-0.2	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
3	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	0.0
4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	-0.2	0.0	-0.5	0.1	-0.4	0.1	-0.1	0.1	-0.5
6	0.1	-0.1	0.1	-0.3	0.1	-0.3	0.1	0.0	0.1	-0.3
7	-0.1	-0.3	-0.1	-0.6	0.0	-0.4	0.0	-0.1	0.0	-0.6
8	0.4	0.0	0.2	0.0	0.1	0.0	0.3	0.0	0.4	0.0
9	-0.1	-0.2	-0.2	-0.3	0.0	-0.1	0.0	0.0	0.0	-0.1
10	0.0	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	0.0	-0.1
11	-0.2	-0.2	-0.2	-0.4	0.0	0.0	0.0	0.0	0.0	-0.1
12	0.0	-0.2	-0.1	-0.2	0.1	0.0	0.1	-0.1	0.1	-0.1
13	-0.1	0.1	-0.1	0.1	-0.1	0.2	-0.1	0.1	-0.1	0.0
14	0.1	-0.2	-0.1	-0.2	0.2	0.0	0.2	0.0	0.2	-0.1
15	-0.9	-0.3	-1.0	-1.0	0.1	-0.1	0.1	-0.1	0.0	-0.1
16	-1.2	-0.2	-1.4	-1.0	0.0	-0.1	0.0	-0.2	0.0	-0.1
17	0.4	0.7	0.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0
18	0.5	0.9	0.6	1.5	0.0	0.0	0.0	0.0	0.0	0.0
19	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0

TABLE A3-32

Existing Demand Case Study (Run 413)
ISDP Representative
Critical Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	-122	-2039	-1802	-2473	207	267	-33	1320	266	-1205
2	-410	-144	-208	-825	-237	-817	-672	-859	-525	-524
3	-603	-552	-578	-957	-445	-830	-753	-789	-766	-890
4	125	101	160	324	578	1882	1784	1799	551	198
5	-3296	-3323	-3388	-6136	-1638	-2415	-1994	-1974	-3311	-4820
6	-2154	-2127	-2170	-3675	-1195	-1715	-1467	-1489	-2331	-3179
7	-4076	-4087	-4152	-7504	-1947	-2928	-2354	-2345	-3992	-5765
8	1491	1481	1498	2577	683	1011	804	810	1312	1875
9	612	611	730	941	1553	323	262	262	605	290
10	93	93	116	136	-311	-390	-415	-422	-167	-196
11	615	614	738	948	1565	334	289	280	640	329
12	104	104	131	164	-243	-323	-314	-322	-5	-23
13	-12	-12	-19	-10	139	-165	-186	-189	-174	-204
14	8	8	16	-8	-95	-121	-103	-106	-91	-50
15	729	728	905	1160	1327	-5	-7	-7	821	491
16	731	731	909	1162	1333	0	1	1	835	506
17	48	48	89	-40	-505	1834	1755	1755	522	181
18	54	54	102	-41	542	1878	1810	1810	590	252
19	791	791	1020	1153	1925	1925	1872	1872	1519	862



Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9
2	1.8	1.8	1.8	1.8	1.9	1.9	1.8	1.8	1.8	1.7
3	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.7
4	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.7
5	1.7	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.5	1.5
6	1.7	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.6	1.5
7	1.6	1.6	1.6	1.6	1.7	1.6	1.6	1.6	1.4	1.4
8	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.4	1.3
9	1.7	1.6	1.7	1.7	1.9	1.7	1.7	1.7	3.2	3.0
10	1.5	1.5	1.5	1.5	3.0	2.7	2.8	2.6	3.7	3.4
11	2.0	1.9	2.0	1.9	2.4	1.9	1.9	1.9	3.6	3.3
12	1.9	1.9	1.9	1.9	2.6	2.4	2.4	2.4	3.8	3.5
13	1.6	1.6	1.6	1.7	4.1	3.9	3.8	3.8	3.8	3.5
14	2.0	2.0	2.0	2.1	3.8	3.5	3.4	3.5	3.8	3.5
15	2.1	2.1	2.2	2.1	2.8	1.9	1.9	1.9	3.7	3.4
16	2.3	2.3	2.4	2.3	3.0	1.8	1.8	1.8	3.8	3.4
17	1.8	1.8	1.8	1.9	1.9	2.1	2.1	2.1	1.8	1.7
18	2.5	2.4	2.5	2.5	2.9	4.2	4.1	4.1	3.0	2.7
19	4.1	4.1	4.5	4.7	6.2	7.1	6.9	7.0	5.6	4.4

Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4
4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3
5	0.8	-1.5	0.8	-1.5	0.8	-1.5	0.8	-1.8	0.9	-1.0	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.7	-1.2	0.7	-1.3
6	0.9	-1.5	0.9	-1.4	0.9	-1.5	0.8	-1.7	0.9	-1.0	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	0.7	-1.3
7	0.8	-2.3	0.8	-2.3	0.8	-2.3	0.7	-2.8	1.0	-1.7	0.9	-1.9	0.9	-1.8	1.0	-1.8	0.8	-1.9	0.6	-2.2
8	0.9	-0.1	0.9	-0.1	0.9	-0.1	1.2	-0.1	1.1	-0.3	1.1	-0.2	1.1	-0.2	1.1	-0.2	1.1	-0.1	1.3	-0.1
9	1.0	-0.7	1.0	-0.7	1.0	-0.7	1.0	-0.5	1.2	-0.7	1.0	-0.9	1.0	-0.9	1.0	-1.0	1.0	-0.8	0.9	-0.7
10	0.8	-0.7	0.8	-0.6	0.8	-0.7	0.8	-0.5	0.0	-0.7	0.0	-0.8	0.0	-0.8	0.0	-0.8	0.0	-0.7	0.0	-0.8
11	0.9	-0.6	0.9	-0.6	0.9	-0.5	0.9	-0.4	1.1	-0.6	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.9	-0.5	0.8	-0.6
12	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	0.0	0.2	-0.5	0.1	-0.6	0.2	-0.6	0.2	-0.6	0.4	-0.4	0.3	-0.4
13	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6
14	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.6	0.3	-0.7	0.1	-0.8	0.2	-0.8	0.2	-0.8	0.3	-0.5	0.2	-0.5
15	1.0	-0.3	1.0	-0.3	1.1	-0.1	1.0	0.2	1.1	0.1	0.3	-0.4	0.3	-0.5	0.3	-0.5	0.9	0.2	0.7	-0.3
16	1.1	-0.4	1.1	-0.4	1.2	-0.2	1.2	0.3	1.3	0.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	1.0	0.2	0.8	-0.3
17	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.2	-0.9	1.6	0.0	1.6	0.0	1.6	-0.1	1.2	-0.9	1.1	-1.1
18	0.9	-1.1	0.9	-1.1	0.9	-1.0	0.9	-1.1	1.1	-0.8	1.6	0.5	1.6	0.4	1.6	0.4	1.2	-0.9	1.1	-1.0
19	0.7	0.5	0.7	0.5	0.8	0.6	0.9	0.8	1.2	-1.1	1.1	1.1	1.1	-1.0	1.1	1.0	1.0	0.9	0.7	0.5

TABLE A3-32 CONT.

Existing Case Study (Run 413)
Project Demand Condition
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	265	457	-1096	-33	-2048	324	-194
2	-822	-757	-532	-414	-134	-215	-372
3	-855	-747	-710	-615	-562	-489	-617
4	1779	1257	1238	166	141	459	537
5	-2523	-2727	-2748	-3219	-3247	-1786	-2655
6	-1814	-1865	-1842	-2126	-2097	-1362	-1880
7	-3092	-3359	-3368	-3951	-3962	-2087	-3231
8	1060	1224	1216	1434	1424	679	1092
9	370	-43	-44	748	748	292	556
10	-383	-26	-26	119	118	-267	-168
11	384	-32	-33	761	761	316	572
12	-345	-5	-5	134	134	-145	-97
13	-173	-48	-48	-25	-26	-171	-143
14	-117	-6	-5	21	21	-70	-78
15	-6	-4	-4	953	952	265	487
16	0	-1	-1	957	957	276	504
17	1791	1243	1243	110	111	452	506
18	1827	1265	1265	127	127	507	544
19	1854	1278	1278	1098	1098	859	1093

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.97	1.99	1.98	1.98	1.96	1.97	1.95
2	1.79	1.82	1.81	1.81	1.79	1.79	1.77
3	1.73	1.76	1.74	1.74	1.72	1.71	1.69
4	1.73	1.76	1.75	1.74	1.72	1.72	1.7
5	1.66	1.7	1.68	1.68	1.66	1.54	1.52
6	1.67	1.7	1.69	1.69	1.67	1.58	1.57
7	1.55	1.58	1.57	1.57	1.55	1.42	1.41
8	1.5	1.53	1.52	1.52	1.5	1.38	1.38
9	1.62	1.58	1.57	1.67	1.64	3.29	3.23
10	2.64	1.48	1.46	1.47	1.44	3.69	3.74
11	1.84	1.68	1.67	1.96	1.93	3.55	3.56
12	2.42	1.65	1.63	1.95	1.92	3.78	3.82
13	3.87	1.62	1.61	1.62	1.6	3.95	3.98
14	3.5	1.68	1.67	2.04	2.01	3.86	3.93
15	1.81	1.59	1.58	2.18	2.15	3.67	3.69
16	1.77	1.56	1.54	2.38	2.35	3.7	3.73
17	2.03	1.98	1.96	1.82	1.8	1.82	1.81
18	4.13	3.67	3.64	2.52	2.49	2.92	2.94
19	6.94	5.77	5.75	4.67	4.65	4.61	4.98

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4
2	0.4	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.5	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.2	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.3	0.4	-0.3
5	0.8	-1.1	0.9	-1.4	0.9	-1.4	0.8	-1.5	0.8	-1.5	0.8	-1.1	0.8	-1.2
6	0.9	-1.2	0.9	-1.4	0.9	-1.4	0.9	-1.5	0.9	-1.4	0.8	-1.2	0.8	-1.2
7	0.8	-1.8	1.0	-2.2	0.9	-2.1	0.8	-2.3	0.8	-2.3	0.7	-1.3	0.8	-1.8
8	1.1	-0.2	0.8	-0.2	0.8	-0.2	0.9	-0.1	0.9	-0.1	0.7	-0.1	1.1	-0.2
9	1.0	-0.9	0.9	-0.9	0.9	-0.9	1.0	-0.7	1.0	-0.7	0.9	-0.6	1.0	-0.6
10	0.0	-0.8	0.8	-0.8	0.8	-0.7	0.8	-0.7	0.8	-0.6	0.0	-0.7	0.0	-0.7
11	0.9	-0.8	0.8	-0.8	0.8	-0.8	0.9	-0.6	0.9	-0.5	0.8	-0.5	0.9	-0.5
12	0.2	-0.6	0.3	-0.2	0.3	-0.2	0.3	-0.1	0.3	-0.1	0.3	-0.4	0.3	-0.5
13	0.0	-0.6	0.7	-0.8	0.6	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.5	0.0	-0.5
14	0.1	-0.8	0.5	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.1	-0.6	0.1	-0.6
15	0.3	-0.4	0.3	-0.4	0.3	-0.4	1.1	-0.1	1.1	-0.1	0.7	-0.4	0.8	-0.2
16	0.1	-0.2	0.1	-0.2	0.1	-0.2	1.2	-0.2	1.2	-0.1	0.8	-0.4	0.9	-0.2
17	1.6	0.0	1.4	-0.5	1.4	-0.5	1.1	-1.1	1.1	-1.1	1.2	-1.0	1.2	-0.9
18	1.6	0.4	1.4	-0.4	1.4	-0.4	1.0	-1.0	1.0	-1.0	1.1	-0.9	1.2	-0.9
19	1.1	1.0	0.9	0.7	0.9	0.8	0.9	0.7	0.9	0.7	0.7	0.5	0.8	0.6

TABLE A3-33

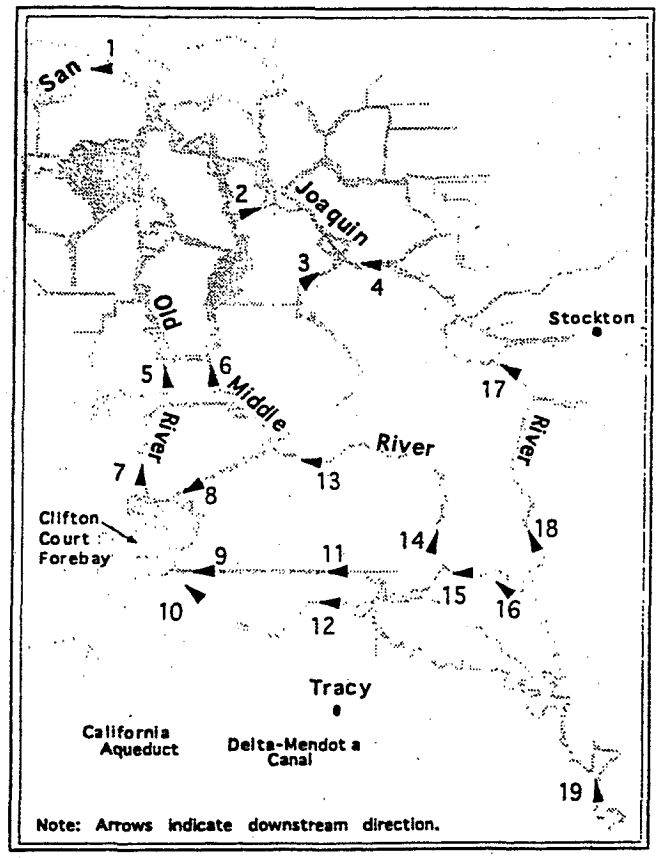
Existing Demand Case Study (Run 413)
ISDP Representative
Dry Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	313	-46	1406	537	641	-17	1809	113	-1942
2	-695	-664	-869	-507	-1554	-1039	-1298	-526	-848
3	-709	-737	-733	-605	-1213	-976	-1021	-738	-1115
4	995	995	1020	1257	3508	2535	2553	597	430
5	-3032	-3261	-2985	-1786	-3140	-2643	-2615	-3309	-6367
6	-1977	-2108	-1972	-1284	-2180	-1876	-1905	-2288	-3971
7	-3778	-4037	-3713	-2140	-3834	-3138	-3126	-3920	-7619
8	1432	1503	1408	760	1326	1067	1075	1301	2469
9	1740	1875	1816	2476	336	212	223	674	688
10	286	289	280	-255	-372	-404	-412	-159	-135
11	1742	1880	1621	2488	346	234	245	717	730
12	286	306	276	-195	-313	-297	-304	-1	24
13	50	36	41	-108	-158	-189	-193	-173	-179
14	49	58	47	-78	-129	-105	-108	-14	17
15	2064	2256	1959	2301	-3	-8	-8	938	978
16	2064	2258	1960	2304	0	1	1	951	991
17	798	918	702	1216	3494	2540	2540	582	397
18	792	934	700	1251	3574	2605	2605	653	470
19	2863	3209	2678	3601	3601	2674	2674	1701	1559

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	2.0	1.9
2	1.9	1.9	2.0	1.9	1.9	1.8	1.9	1.8	1.7
3	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.7
4	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.7
5	1.8	1.8	1.9	1.8	1.7	1.7	1.7	1.5	1.4
6	1.8	1.8	1.9	1.8	1.8	1.7	1.7	1.6	1.5
7	1.7	1.7	1.8	1.7	1.8	1.6	1.8	1.4	1.3
8	1.7	1.6	1.7	1.7	1.6	1.6	1.6	1.4	1.3
9	1.9	1.9	1.9	2.0	1.7	1.7	1.7	3.2	3.1
10	1.6	1.6	1.7	3.2	2.7	2.6	2.6	3.7	3.4
11	2.3	2.3	2.3	2.7	1.9	1.9	1.9	3.6	3.4
12	2.3	2.3	2.3	3.1	2.4	2.3	2.4	3.8	3.5
13	1.8	1.7	1.8	4.2	3.8	3.7	3.8	3.8	3.5
14	2.5	2.5	2.5	4.0	3.5	3.4	3.4	3.8	3.5
15	2.7	2.8	2.7	3.3	1.9	1.8	1.8	3.7	3.5
16	3.1	3.3	3.1	3.8	1.8	1.8	1.8	3.8	3.6
17	2.0	2.0	2.1	2.0	2.5	2.2	2.2	1.8	1.8
18	3.2	3.3	3.1	3.5	6.1	5.0	5.0	3.0	2.8
19	7.7	8.1	7.4	8.7	10.2	8.5	8.5	5.9	5.6



Minimum and Maximum Velocity

Ref. No.	January		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.3	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.6	0.4	-0.5	0.3	-0.6	0.5	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.1	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.5	-0.2	0.5	-0.3	0.5	-0.3	0.4	-0.3	0.4	-0.3
5	0.9	-1.5	0.9	-1.5	0.9	-1.5	0.9	-1.0	0.9	-1.2	0.9	-1.1	0.9	-1.1	0.8	-1.2	0.8	-1.6
6	1.0	-1.5	1.0	-1.5	1.0	-1.5	0.9	-1.0	0.8	-1.2	0.9	-1.1	0.9	-1.2	0.8	-1.2	0.7	-1.5
7	0.9	-2.3	0.9	-2.4	1.0	-2.3	1.0	-1.7	0.9	-2.0	0.9	-1.9	0.9	-1.9	0.8	-1.9	0.8	-2.4
8	0.9	-0.2	0.9	-0.2	0.9	-0.2	1.1	-0.3	1.2	-0.2	1.2	-0.2	1.2	-0.2	1.2	-0.2	1.5	-0.1
9	1.1	-0.5	1.1	-0.5	1.1	-0.6	1.3	-0.6	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	-0.6	0.9	-0.6
10	0.9	-0.6	0.9	-0.6	0.9	-0.6	0.0	-0.7	0.0	-0.8	0.0	-0.8	0.0	-0.8	0.0	-0.7	0.0	-0.7
11	1.0	-0.3	1.0	-0.3	1.0	-0.4	1.2	-0.4	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.9	-0.5	0.8	-0.5
12	0.4	0.0	0.4	0.0	0.4	0.0	0.3	-0.5	0.2	-0.6	0.2	-0.6	0.2	-0.6	0.4	-0.4	0.4	-0.3
13	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.5	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.7
14	0.6	-0.3	0.6	-0.3	0.6	-0.4	0.3	-0.7	0.1	-0.8	0.1	-0.8	0.1	-0.8	0.4	-0.5	0.4	-0.5
15	1.5	0.8	1.6	0.9	1.5	0.7	1.6	0.8	0.3	-0.4	0.3	-0.4	0.3	-0.4	0.9	0.2	0.9	0.2
16	1.7	1.0	1.9	1.1	1.7	0.9	1.8	1.1	0.1	-0.2	0.1	-0.2	0.1	-0.2	1.0	0.3	1.1	0.3
17	1.3	-0.8	1.3	-0.7	1.3	-0.8	1.4	-0.5	2.2	1.1	1.9	0.5	1.9	0.5	1.2	-0.9	1.1	1.0
18	1.2	-0.8	1.2	-0.5	1.2	-0.7	1.4	-0.2	2.2	1.6	1.9	1.1	1.9	1.1	1.2	-0.8	1.1	-0.9
19	1.6	1.5	1.7	1.6	1.5	1.4	1.8	1.7	1.5	1.5	1.3	1.3	1.3	1.3	1.1	1.0	1.1	1.0

TABLE A3-33 CONT.

Existing Case Study (Run 413)
Project Demand Condition
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1664	359	-2068	1400	-1250	-916	-564
2	-2673	-2267	-1911	-869	-500	-554	-477
3	-1881	-1511	-1461	-772	-710	-842	-753
4	3964	3619	3594	888	868	379	515
5	-8812	-5925	-5959	-3329	-3371	-4325	-3488
6	-5319	-3717	-3683	-2188	-2156	-2886	-2399
7	-10694	-7272	-7286	-4101	-4122	-5227	-4291
8	3510	2499	2487	1509	1499	1728	1430
9	-297	-36	-37	1771	1765	496	599
10	-283	-5	-5	275	269	-159	-148
11	309	-24	-25	1784	1779	523	615
12	-251	9	10	291	286	-43	-83
13	-180	-67	-67	14	13	-172	-144
14	-125	-24	-24	60	59	-66	-83
15	-5	-5	-5	2171	2160	582	543
16	0	-1	-1	2174	2163	591	549
17	3882	3565	3563	823	834	338	475
18	3963	3625	3624	845	855	392	508
19	3970	3637	3637	3036	3036	1053	1094

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.88	2	1.97	2.04	2	1.93	1.94
2	1.73	1.84	1.8	1.87	1.83	1.74	1.75
3	1.68	1.77	1.74	1.81	1.77	1.66	1.67
4	1.68	1.78	1.75	1.81	1.77	1.67	1.68
5	1.59	1.69	1.66	1.75	1.72	1.48	1.49
6	1.6	1.71	1.67	1.76	1.72	1.53	1.54
7	1.44	1.58	1.54	1.65	1.61	1.38	1.37
8	1.37	1.52	1.49	1.6	1.57	1.33	1.32
9	1.46	1.56	1.53	1.82	1.78	3.07	3.15
10	2.07	1.45	1.42	1.57	1.53	3.54	3.69
11	1.65	1.65	1.62	2.24	2.2	3.41	3.5
12	2	1.61	1.58	2.23	2.19	3.63	3.77
13	3.3	1.61	1.58	1.7	1.66	3.72	3.94
14	2.95	1.65	1.63	2.4	2.37	3.68	3.9
15	1.61	1.56	1.53	2.72	2.68	3.53	3.64
16	1.58	1.53	1.5	3.15	3.11	3.56	3.68
17	2.51	2.48	2.46	1.96	1.93	1.76	1.79
18	6.45	6.1	6.08	3.16	3.13	2.8	2.9
19	10.86	10.31	10.3	7.89	7.88	4.8	4.96

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4
2	0.1	-0.7	0.1	-0.6	0.2	-0.6	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.0	-0.5	0.1	-0.5	0.1	-0.5	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4
4	0.5	-0.2	0.5	-0.2	0.5	-0.2	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3
5	0.5	-1.9	0.8	-1.8	0.8	-1.8	0.9	-1.6	0.9	-1.5	0.7	-1.2	0.7	-1.2
6	0.5	-1.7	0.9	-1.8	0.8	-1.7	1.0	-1.5	1.0	-1.5	0.8	-1.3	0.7	-1.2
7	0.4	-3.0	0.8	-2.8	0.8	-2.8	0.9	-2.4	0.9	-2.4	0.6	-2.1	0.6	-1.9
8	1.6	-0.1	1.1	-0.1	1.1	-0.1	0.9	-0.2	0.9	-0.2	1.3	-0.1	1.1	-0.1
9	0.9	-1.1	0.9	-0.7	0.9	-0.7	1.1	-0.5	1.1	-0.5	1.0	-0.6	1.0	-0.6
10	0.0	-0.9	0.8	-0.6	0.8	-0.6	0.9	-0.6	0.9	-0.6	0.0	-0.7	0.0	-0.6
11	0.7	-1.0	0.7	-0.6	0.7	-0.6	1.0	-0.3	1.0	-0.3	0.8	-0.5	0.8	-0.5
12	0.2	-0.5	0.2	-0.2	0.2	-0.2	0.4	0.0	0.4	0.0	0.3	-0.4	0.3	-0.5
13	0.0	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.6	0.0	-0.6
14	0.3	-0.7	0.3	-0.6	0.3	-0.6	0.6	-0.3	0.5	-0.3	0.1	-0.6	0.0	-0.6
15	0.4	-0.4	0.3	-0.3	0.3	-0.3	1.6	0.9	1.6	0.9	0.8	-0.1	0.8	-0.1
16	0.2	-0.2	0.1	-0.2	0.1	-0.2	1.8	1.1	1.8	1.1	0.8	-0.1	0.9	0.0
17	2.4	1.2	2.3	1.1	2.3	1.1	1.3	-0.7	1.3	-0.7	1.2	-1.0	1.2	-1.0
18	2.3	1.8	2.2	1.7	2.2	1.7	1.2	-0.6	1.2	-0.6	1.1	-1.0	1.1	-0.9
19	1.6	1.6	1.5	1.5	1.5	1.5	1.6	1.5	1.6	1.5	0.8	0.6	0.8	0.7

TABLE A3-34

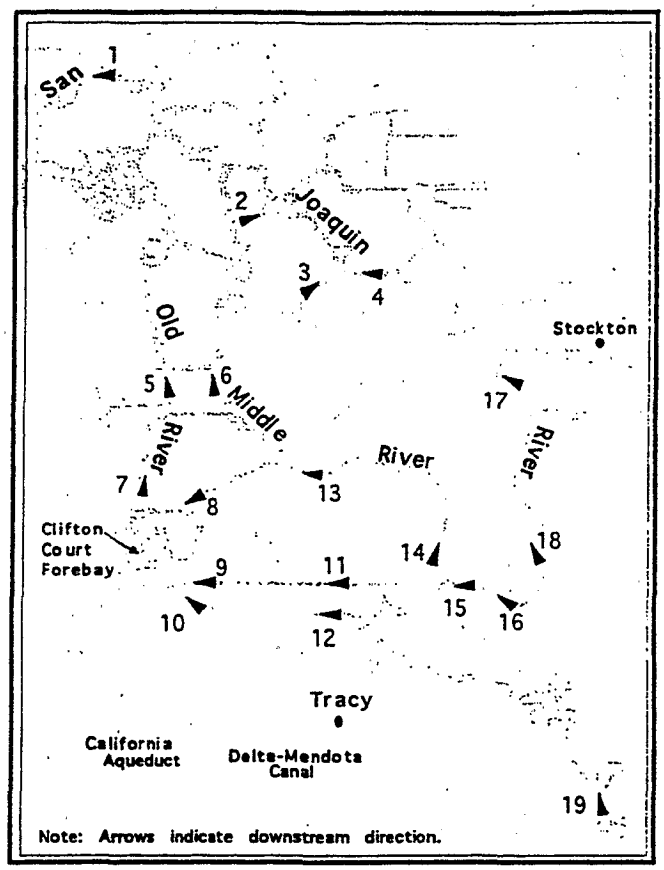
Existing Demand Case Study (Run 413)
ISDP Representative
Below Normal Year

Average Net Discharge

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	1113	150	-792	746	866	-126	2309	91	-2172
2	-943	-894	-542	-580	-1728	-1238	-1581	-565	-924
3	-795	-825	-705	-636	-1285	-1103	-1163	-770	-1175
4	1408	1262	590	1429	3873	2838	2862	597	430
5	-3022	-3563	-3678	-1713	-3178	-3246	-3209	-3526	-6877
6	-1983	-2278	-2322	-1252	-2223	-2238	-2276	-2413	-4232
7	-3775	-4409	-4493	-2055	-3886	-3878	-3864	-4185	-8234
8	1447	1640	1618	729	1339	1314	1323	1390	2663
9	2203	2066	1405	2625	309	206	219	689	719
10	330	303	212	-251	-376	-394	-402	-155	-135
11	2205	2072	1417	2639	322	227	240	729	758
12	349	325	242	-181	-307	-286	-295	5	19
13	73	57	-1	-113	-170	-193	-197	-171	-174
14	68	57	42	-63	-122	-107	-111	-18	-20
15	2598	2443	1744	2494	-5	-8	-8	953	989
16	2602	2447	1748	2497	0	1	1	966	1001
17	1235	1064	471	1355	3820	2841	2842	578	393
18	1243	1071	494	1396	3916	2912	2912	650	464
19	3860	3533	2268	3947	3947	2980	2980	1713	1560

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	2.0	1.9
2	2.0	1.9	1.9	1.9	1.9	1.8	1.9	1.8	1.7
3	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.7	1.7
4	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.7	1.7
5	1.8	1.8	1.8	1.8	1.7	1.7	1.8	1.5	1.4
6	1.8	1.8	1.8	1.8	1.8	1.7	1.8	1.6	1.5
7	1.8	1.7	1.7	1.7	1.6	1.6	1.7	1.4	1.3
8	1.7	1.7	1.6	1.7	1.6	1.6	1.6	1.4	1.3
9	2.0	1.9	1.8	2.1	1.7	1.7	1.7	3.2	3.1
10	1.7	1.6	1.6	3.2	2.6	2.6	2.6	3.7	3.4
11	2.5	2.4	2.2	2.7	1.9	1.8	1.9	3.6	3.4
12	2.5	2.4	2.2	3.2	2.4	2.3	2.4	3.8	3.5
13	1.8	1.8	1.7	4.2	3.8	3.7	3.8	3.8	3.5
14	2.7	2.6	2.3	4.0	3.5	3.3	3.4	3.8	3.5
15	3.1	2.9	2.5	3.5	1.9	1.8	1.8	3.7	3.5
16	3.6	3.4	2.8	3.9	1.8	1.8	1.8	3.8	3.6
17	2.1	2.0	1.9	2.0	2.6	2.3	2.3	1.8	1.8
18	3.6	3.4	2.9	3.6	6.4	5.3	5.3	3.0	2.8
19	9.0	8.6	6.7	9.2	10.8	9.1	9.1	5.9	5.6



Minimum and Maximum Velocity

Ref. No.	January		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.3	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.6	0.3	-0.6	0.3	-0.6	0.5	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.5	-0.2	0.5	-0.3	0.5	-0.3	0.4	-0.3	0.4	-0.3
5	0.9	-1.5	0.9	-1.6	0.9	-1.6	0.9	-1.0	0.8	-1.2	0.8	-1.2	0.9	-1.2	0.8	-1.2	0.6	-1.7
6	1.0	-1.5	0.9	-1.5	1.0	-1.6	0.9	-1.0	0.8	-1.2	0.8	-1.2	0.9	-1.2	0.8	-1.2	0.7	-1.5
7	1.0	-2.3	0.9	-2.4	0.9	-2.5	1.0	-1.7	0.8	-2.0	0.8	-2.0	0.8	-2.0	0.8	-2.0	0.5	-2.5
8	0.9	-0.2	1.0	-0.2	1.0	-0.2	1.1	-0.3	1.2	-0.2	1.2	-0.2	1.3	-0.2	1.2	-0.2	1.6	-0.1
9	1.2	-0.4	1.1	-0.3	1.0	-0.5	1.3	-0.6	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	-0.6	0.9	-0.6
10	0.9	-0.6	0.9	-0.5	0.8	-0.6	0.0	-0.7	0.0	-0.8	0.0	-0.8	0.0	-0.8	0.0	-0.7	0.0	-0.7
11	1.1	-0.2	1.0	-0.2	0.9	-0.4	1.2	-0.4	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.9	-0.5	0.8	-0.6
12	0.5	0.1	0.5	0.1	0.4	0.0	0.3	-0.5	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.4	-0.4	0.4	-0.3
13	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.5	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6
14	0.6	-0.3	0.6	-0.3	0.5	-0.4	0.4	-0.7	-0.1	-0.8	0.0	-0.8	0.0	-0.8	0.4	-0.5	0.4	-0.5
15	1.8	1.1	1.7	1.1	1.3	0.8	1.6	0.9	0.3	-0.4	0.3	-0.4	0.3	-0.4	0.9	0.2	0.9	0.2
16	2.0	1.4	1.9	1.3	1.5	0.7	1.9	1.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	1.0	0.3	1.0	0.3
17	1.4	-0.5	1.4	-0.6	1.2	-0.9	1.5	-0.4	2.4	1.2	2.0	0.7	2.0	0.7	1.2	-0.9	1.1	-1.0
18	1.3	-0.3	1.3	-0.4	1.1	-0.8	1.4	0.0	2.3	1.8	2.0	1.3	2.0	1.3	1.2	-0.8	1.1	-0.9
19	1.8	1.8	1.7	1.7	1.4	1.3	1.8	1.8	1.6	1.6	1.4	1.4	1.4	1.4	1.1	1.0	1.1	1.0

TABLE A3-34 CONT.

Existing Case Study (Run 413)
Project Demand Condition
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec 1-15	Dec 16-31	Aug	Sep
1	-1326	-3975	-3652	-969	-1541	-730
2	-1971	-2391	-1002	-1381	-707	-522
3	-1556	-1793	-1119	-1173	-985	-790
4	2740	3822	1163	1177	269	445
5	-7339	-9012	-6525	-6486	-5593	-3909
6	-4462	-5339	-3821	-3853	-3559	-2632
7	-8921	-10963	-7944	-7924	-6741	-4792
8	2917	3642	2675	2687	2212	1598
9	296	-5	2259	2263	453	542
10	-291	7	308	313	-160	-149
11	310	5	2262	2266	479	557
12	-257	14	314	319	-44	-81
13	-180	-77	29	30	-176	-147
14	-124	-43	45	45	72	-88
15	6	-4	2617	2629	532	483
16	0	-1	2616	2629	541	489
17	2659	3752	1017	1002	212	398
18	2706	3834	1025	1010	265	430
19	2728	3827	3652	3652	876	957

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec 1-15	Dec 16-31	Aug	Sep
1	1.92	1.94	1.94	1.98	1.93	1.94
2	1.76	1.79	1.78	1.82	1.74	1.75
3	1.7	1.73	1.71	1.75	1.65	1.67
4	1.7	1.73	1.72	1.76	1.66	1.68
5	1.58	1.63	1.66	1.7	1.47	1.49
6	1.6	1.64	1.66	1.7	1.52	1.54
7	1.45	1.5	1.56	1.6	1.36	1.38
8	1.39	1.44	1.52	1.56	1.32	1.33
9	1.49	1.48	1.77	1.81	3.01	3.11
10	2.18	1.37	1.49	1.53	3.4	3.63
11	1.68	1.52	2.25	2.29	3.31	3.45
12	2.12	1.47	2.22	2.26	3.48	3.71
13	3.39	1.55	1.62	1.66	3.58	3.88
14	3.04	1.61	2.49	2.52	3.83	3.82
15	1.84	1.44	2.8	2.83	3.4	3.58
16	1.61	1.42	3.33	3.36	3.42	3.61
17	2.18	2.49	1.9	1.94	1.74	1.78
18	5.06	6.32	3.31	3.34	2.71	2.85
19	8.67	10.64	8.72	8.73	4.43	4.7

Minimum and Maximum Velocity

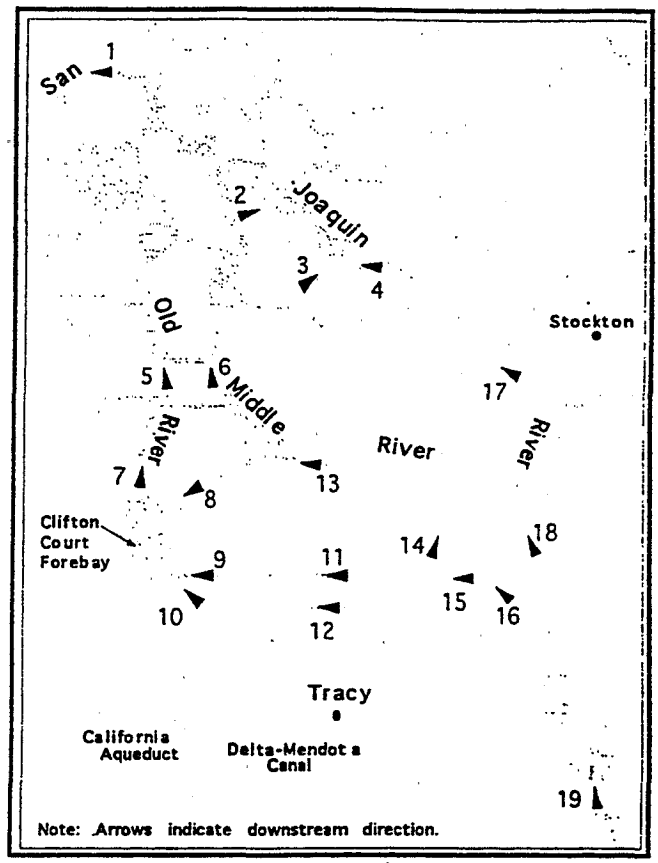
Ref. No.	Oct		Nov		Dec 1-15		Dec 16-31		Aug		Sep	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.2	-0.6	0.2	-0.6	0.3	-0.5	0.2	-0.5	0.4	-0.5	0.4	-0.5
3	0.1	-0.5	0.0	-0.5	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4
4	0.5	-0.3	0.5	-0.2	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3
5	0.6	-1.8	0.7	-2.0	0.8	-1.8	0.8	-1.8	0.7	-1.4	0.7	-1.2
6	0.7	-1.8	0.7	-1.9	0.9	-1.7	0.9	-1.7	0.7	-1.4	0.8	-1.2
7	0.5	-2.8	0.6	-3.1	0.8	-2.8	0.8	-2.9	0.5	-2.3	0.6	-2.0
8	1.6	-0.1	1.3	-0.1	1.2	-0.2	1.2	-0.2	1.4	-0.1	1.2	-0.1
9	0.9	-1.1	0.8	-0.7	1.1	-0.3	1.1	-0.3	0.9	-0.7	1.0	-0.6
10	0.0	-0.9	0.7	-0.6	0.8	-0.4	0.8	-0.5	0.0	-0.7	0.0	-0.7
11	0.8	-0.9	0.7	-0.6	1.0	-0.1	1.0	-0.1	0.8	-0.6	0.9	-0.5
12	0.2	-0.6	0.2	-0.1	0.4	0.1	0.4	0.1	0.3	-0.4	0.2	-0.5
13	0.0	-0.7	0.6	-0.6	0.7	-0.6	0.7	-0.6	0.0	-0.7	0.0	-0.5
14	-0.3	-0.8	0.1	-0.7	0.5	-0.3	0.5	-0.4	0.1	-0.6	-0.1	-0.6
15	0.4	-0.4	0.2	-0.2	1.7	1.2	1.7	1.2	0.7	-0.3	0.7	-0.2
16	0.2	-0.2	0.1	-0.1	2.0	1.5	2.0	1.5	0.8	-0.3	0.8	-0.2
17	1.9	0.6	2.3	1.2	1.4	-0.6	1.4	-0.7	1.1	-1.0	1.2	-1.0
18	1.9	1.1	2.3	1.8	1.3	-0.5	1.3	-0.5	1.1	-1.0	1.1	-1.0
19	1.3	1.3	1.6	1.6	1.8	1.7	1.8	1.7	0.7	0.5	0.8	0.6

TABLE A3-35

Existing Demand Case Study (Run 413)
ISDP Representative
Above Normal Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	604	-2001	981	1582	662	771	586	2977	194	-1890
2	-913	-544	-849	-910	-638	-1788	-1752	-2090	-698	-960
3	-825	-767	-790	-791	-693	-1328	-1316	-1371	-847	-1184
4	676	653	1029	812	1422	3854	3784	3800	606	430
5	-4256	-4294	-3464	-3568	-2106	-3580	-3570	-3535	-4026	-6876
6	-2671	-2640	-2234	-2314	-1481	-2448	-2450	-2489	-2704	-4244
7	-5252	-5271	-4313	-4403	-2550	-4388	-4311	-4299	-4805	-8231
8	1889	1878	1598	1615	902	1516	1488	1498	1598	2663
9	1608	1604	1844	1425	2678	346	295	306	701	713
10	250	245	291	226	-243	-362	-373	-381	-150	-137
11	1610	1606	1846	1431	2688	356	307	318	741	755
12	255	251	298	247	-189	-310	-301	-309	15	22
13	21	20	41	13	-104	-157	-167	-171	-170	-178
14	34	33	53	40	-78	-133	-128	-132	-24	-17
15	1892	1884	2200	1745	2498	-3	-4	-4	973	1001
16	1893	1885	2201	1748	2500	0	0	0	986	1014
17	537	545	860	473	1347	3810	3720	3718	553	390
18	541	549	855	489	1379	3901	3815	3815	624	463
19	2439	2439	3069	2254	3922	3922	3851	3851	1710	1574



Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	2.0	2.0	2.1	2.2	2.1	2.1	2.0	2.1	2.0	1.9
2	1.9	1.8	2.0	2.0	1.9	1.9	1.9	1.9	1.8	1.8
3	1.8	1.8	1.9	2.0	1.8	1.8	1.8	1.8	1.7	1.7
4	1.8	1.8	1.9	2.0	1.8	1.8	1.8	1.8	1.7	1.7
5	1.7	1.7	1.9	1.9	1.8	1.8	1.7	1.8	1.5	1.4
6	1.7	1.7	1.9	1.9	1.8	1.8	1.8	1.8	1.6	1.5
7	1.6	1.6	1.8	1.8	1.7	1.7	1.6	1.7	1.4	1.3
8	1.6	1.6	1.7	1.8	1.7	1.6	1.6	1.6	1.4	1.3
9	1.8	1.8	1.9	1.9	2.1	1.7	1.7	1.7	3.2	3.1
10	1.6	1.5	1.7	1.8	3.2	2.7	2.6	2.6	3.6	3.4
11	2.2	2.1	2.4	2.3	2.8	1.9	1.9	1.9	3.5	3.4
12	2.2	2.1	2.3	2.3	3.2	2.4	2.4	2.4	3.7	3.5
13	1.7	1.7	1.8	1.9	4.2	3.9	3.8	3.9	3.8	3.5
14	2.3	2.3	2.5	2.4	4.1	3.5	3.5	3.5	3.8	3.5
15	2.5	2.5	2.8	2.6	3.5	1.9	1.8	1.9	3.7	3.5
16	2.9	2.9	3.3	2.9	3.9	1.8	1.8	1.8	3.8	3.6
17	1.9	1.9	2.1	2.1	2.0	2.6	2.6	2.6	1.8	1.8
18	2.9	2.9	3.3	3.0	3.6	6.4	6.3	6.3	3.0	2.8
19	7.0	7.0	8.0	6.7	9.1	10.8	10.6	10.7	5.9	5.6

Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.3	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.3	-0.5	0.4	-0.5	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.2	-0.6	0.3	-0.6	0.2	-0.6	0.4	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.5	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.5	-0.2	0.5	-0.2	0.5	-0.2	0.4	-0.3	0.4	-0.3
5	0.9	-1.7	0.9	-1.7	0.9	-1.6	0.9	-1.6	0.9	-1.1	0.8	-1.2	0.8	-1.2	0.8	-1.3	0.8	-1.2	0.6	-1.7
6	0.9	-1.6	0.9	-1.6	1.0	-1.6	0.9	-1.6	0.9	-1.1	0.8	-1.3	0.8	-1.2	0.8	-1.2	0.8	-1.2	0.7	-1.5
7	0.9	-2.6	0.9	-2.5	0.9	-2.4	1.0	-2.5	0.9	-1.8	0.8	-2.1	0.8	-2.1	0.8	-2.1	0.7	-2.1	0.5	-2.5
8	1.0	-0.2	1.0	-0.2	1.0	-0.2	1.0	-0.2	1.1	-0.2	1.3	-0.2	1.3	-0.2	1.3	-0.2	1.3	-0.2	1.5	-0.1
9	1.1	-0.4	1.1	-0.4	1.1	-0.4	1.0	-0.5	1.3	-0.6	1.0	-1.0	1.0	-0.9	1.0	-1.0	1.0	-0.6	0.9	-0.6
10	0.9	-0.5	0.9	-0.5	0.9	-0.6	0.8	-0.6	0.0	-0.7	0.0	-0.8	0.0	-0.8	0.0	-0.8	0.0	-0.7	0.0	-0.7
11	1.0	-0.3	1.0	-0.3	1.0	-0.3	0.9	-0.4	1.2	-0.4	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.9	-0.5	0.8	-0.5
12	0.4	0.0	0.4	0.0	0.4	0.0	0.4	0.0	0.3	-0.5	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.4	-0.4	0.4	-0.3
13	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.5	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.8
14	0.5	-0.4	0.5	-0.4	0.5	-0.3	0.5	-0.4	0.4	-0.7	-0.2	-0.8	-0.1	-0.8	-0.2	-0.8	0.3	-0.5	0.4	-0.5
15	1.4	0.7	1.4	0.7	1.6	0.9	1.3	0.6	1.6	0.9	0.3	-0.4	0.3	-0.4	0.3	-0.4	0.9	0.2	0.9	0.2
16	1.6	0.9	1.6	0.9	1.8	1.1	1.5	0.7	1.9	1.2	0.1	-0.2	0.2	-0.2	0.1	-0.2	1.0	0.3	1.1	0.3
17	1.3	-0.9	1.3	-0.9	1.3	-0.7	1.2	-0.9	1.5	-0.4	2.4	1.2	2.3	1.2	2.3	1.1	1.2	-0.9	1.1	-1.0
18	1.1	-0.8	1.1	-0.8	1.2	-0.6	1.1	-0.8	1.4	-0.1	2.3	1.8	2.3	1.8	2.3	1.7	1.2	-0.8	1.1	-0.9
19	1.4	1.3	1.4	1.4	1.6	1.5	1.4	1.3	1.8	1.8	1.6	1.6	1.6	1.6	1.6	1.6	1.1	1.0	1.1	1.0

TABLE A3-35 CONT.

Existing Case Study (Run 413)
Project Demand Condition
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-920	-1131	-3928	-154	-2260	-1689	-682
2	-2814	-1711	-1303	-577	-281	-830	-525
3	-1925	-1355	-1295	-693	-643	-1066	-786
4	3937	2112	2082	393	372	346	506
5	-9105	-6809	-6848	-3675	-3705	-6119	-3788
6	-5506	-4120	-4081	-2351	-2325	-3832	-2563
7	-11077	-8299	-8316	-4490	-4505	-7375	-4645
8	3640	2797	2781	1613	1603	2412	1552
9	311	-33	-34	1228	1226	589	625
10	-285	-3	-3	194	192	-137	-137
11	323	-21	-22	1242	1240	616	639
12	-257	11	11	212	209	-22	-76
13	-177	-72	-72	-13	-14	-168	-141
14	-131	-29	-28	35	35	-63	-86
15	-5	-5	-5	1529	1524	699	563
16	0	-1	-1	1533	1528	709	569
17	3818	2079	2079	335	340	286	461
18	3902	2108	2108	354	359	339	492
19	3909	2119	2119	1904	1904	1118	1096

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.91	1.96	1.92	1.98	1.96	1.93	1.94
2	1.76	1.79	1.75	1.81	1.79	1.74	1.75
3	1.7	1.73	1.69	1.75	1.72	1.66	1.67
4	1.71	1.73	1.69	1.75	1.72	1.67	1.68
5	1.64	1.65	1.61	1.69	1.67	1.46	1.49
6	1.65	1.66	1.62	1.7	1.67	1.51	1.54
7	1.5	1.53	1.49	1.59	1.57	1.34	1.38
8	1.43	1.48	1.43	1.54	1.52	1.3	1.33
9	1.51	1.52	1.48	1.72	1.69	3.05	3.14
10	2.09	1.41	1.37	1.5	1.47	3.41	3.67
11	1.69	1.61	1.57	2.05	2.02	3.34	3.48
12	2.02	1.57	1.54	2.04	2.02	3.49	3.75
13	3.34	1.57	1.53	1.64	1.61	3.57	3.92
14	2.99	1.62	1.59	2.15	2.13	3.58	3.88
15	1.65	1.52	1.49	2.36	2.33	3.44	3.62
16	1.62	1.49	1.45	2.64	2.61	3.48	3.66
17	2.5	2.08	2.04	1.85	1.83	1.75	1.78
18	6.4	4.41	4.37	2.73	2.7	2.76	2.89
19	10.77	7.49	7.47	6.11	6.09	4.86	4.95

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4
2	0.1	-0.7	0.2	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.0	-0.5	0.2	-0.5	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.1	-0.4	0.2	-0.4
4	0.5	-0.2	0.5	-0.3	0.5	-0.3	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3
5	0.4	-1.9	0.8	-1.9	0.8	-1.9	0.9	-1.6	0.9	-1.6	0.6	-1.5	0.7	-1.2
6	0.4	-1.8	0.8	-1.8	0.8	-1.8	0.9	-1.6	0.9	-1.5	0.7	-1.5	0.8	-1.2
7	0.3	-3.1	0.7	-2.9	0.7	-2.9	0.9	-2.4	0.9	-2.4	0.5	-2.4	0.8	-2.0
8	1.6	0.0	1.2	-0.1	1.2	-0.1	1.0	-0.2	0.9	-0.2	1.5	-0.1	1.2	-0.1
9	0.8	-1.1	0.9	-0.7	0.9	-0.7	1.0	-0.6	1.0	-0.6	0.9	-0.7	1.0	-0.6
10	0.0	-0.9	0.7	-0.6	0.7	-0.6	0.9	-0.6	0.8	-0.6	0.0	-0.7	0.0	-0.6
11	0.7	-1.0	0.7	-0.6	0.7	-0.6	0.9	-0.4	0.9	-0.4	0.8	-0.5	0.9	-0.5
12	0.2	-0.5	0.2	-0.2	0.2	-0.2	0.4	0.0	0.4	0.0	0.3	-0.4	0.3	-0.5
13	0.0	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.7	0.0	-0.6
14	-0.3	-0.8	0.3	-0.6	0.3	-0.6	0.5	-0.4	0.5	-0.4	0.2	-0.6	0.1	-0.6
15	0.4	-0.4	0.3	-0.3	0.3	-0.3	1.3	0.5	1.3	0.5	0.7	-0.1	0.8	-0.1
16	0.2	-0.2	0.1	-0.2	0.1	-0.2	1.4	0.6	1.4	0.6	0.9	-0.1	0.9	-0.1
17	2.4	1.2	1.7	0.2	1.7	0.3	1.2	-1.0	1.2	-1.0	1.1	-1.0	1.2	-1.0
18	2.3	1.8	1.7	0.7	1.7	0.8	1.0	-0.9	1.0	-0.9	1.1	-1.0	1.1	-0.9
19	1.6	1.6	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.1	0.9	0.7	0.8	0.7

TABLE A3-36

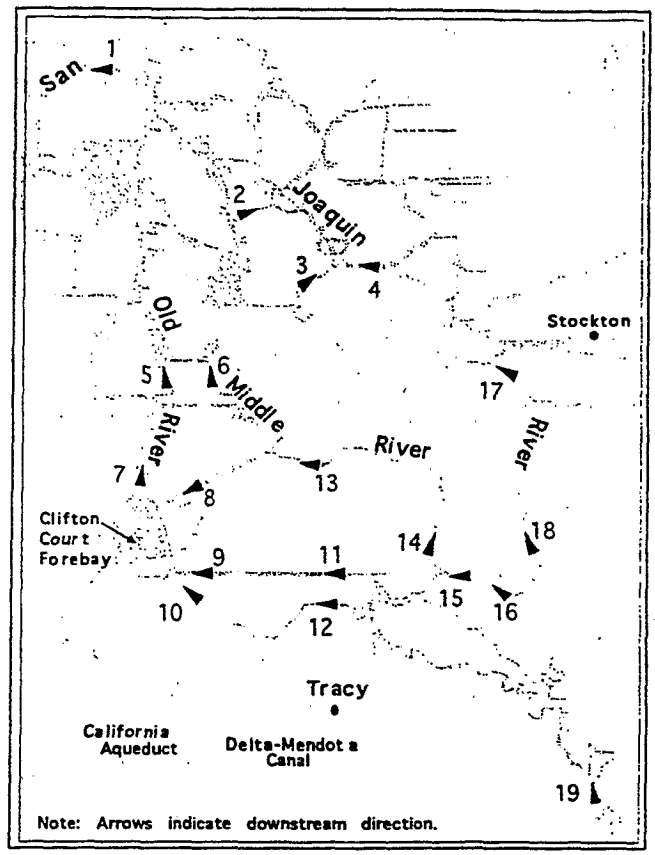
Existing Demand Case Study (Run 413)
ISDP Representative
Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	7768	10732	14489	24753	11612	2658	629
2	-2473	-2796	-3736	-5657	-3549	-1940	-1309
3	-1260	-1319	-1486	-2066	-1600	-1348	-1167
4	2444	3458	6123	10605	7678	2778	2053
5	-4007	-2351	-136	3329	827	-4675	-4339
6	-2749	-1883	-528	1430	230	-2956	-2885
7	-5263	-3142	-590	3366	770	-5610	-5228
8	1990	1320	585	-813	-20	1921	1760
9	2089	3145	6327	10473	8725	3545	1800
10	365	486	1212	2334	1695	426	-2
11	2085	3154	6332	10505	8766	3585	1843
12	330	512	1196	2396	1835	602	158
13	77	137	418	829	554	31	-47
14	46	133	393	835	630	175	-112
15	2401	3791	7827	13729	11340	4579	2355
16	2401	3807	7885	13828	11429	4607	2367
17	932	2113	4801	8794	7046	2486	1926
18	910	2123	4880	9185	7370	2576	2008
19	3309	5976	12888	23235	19046	7340	4478

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	2.5	2.6	2.6	3.1	2.4	2.1	2.0
2	2.3	2.5	2.5	3.0	2.3	1.9	1.8
3	2.3	2.4	2.5	3.0	2.3	1.9	1.7
4	2.3	2.4	2.5	3.0	2.3	1.9	1.7
5	2.2	2.3	2.4	3.0	2.3	1.8	1.5
6	2.2	2.3	2.4	3.0	2.2	1.8	1.8
7	2.1	2.3	2.4	3.1	2.3	1.7	1.4
8	2.1	2.2	2.4	3.2	2.3	1.6	1.4
9	2.3	2.5	3.2	4.7	3.6	2.1	3.6
10	2.0	2.2	2.5	3.6	2.7	1.6	4.4
11	2.7	3.1	4.4	6.5	5.4	2.9	4.2
12	2.7	3.1	4.3	6.3	5.2	2.8	4.5
13	2.2	2.3	2.5	3.2	2.4	1.7	4.9
14	2.9	3.5	5.3	7.9	6.6	3.1	4.9
15	3.2	4.0	6.5	10.1	8.5	4.1	4.8
16	3.6	4.9	8.2	12.6	10.8	5.2	5.1
17	2.4	2.7	3.4	4.9	3.9	2.3	2.0
18	3.6	4.7	7.6	11.5	9.9	4.9	4.1
19	8.4	11.6	17.9	24.8	22.1	12.9	10.0



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.3	-1.3	1.3	-1.3	1.4	-1.2	1.4	-1.1	1.3	-1.2	1.2	-1.3	1.2	-1.3
2	0.2	-0.6	0.2	-0.6	0.0	-0.7	-0.2	-0.9	0.1	-0.7	0.3	-0.6	0.3	-0.6
3	0.1	-0.4	0.1	-0.5	0.1	-0.5	0.0	-0.5	0.1	-0.5	0.1	-0.4	0.2	-0.4
4	0.4	-0.3	0.5	-0.3	0.6	-0.1	0.7	0.1	0.6	-0.1	0.5	-0.3	0.5	-0.3
5	0.9	-1.7	0.9	-1.5	1.0	-1.3	1.3	-0.9	1.2	-1.3	0.8	-1.6	0.8	-1.3
6	0.9	-1.7	0.9	-1.5	1.0	-1.3	1.2	-1.1	1.1	-1.1	0.8	-1.5	0.8	-1.5
7	0.9	-2.6	1.0	-2.3	1.2	-2.0	1.6	-1.2	1.6	-1.5	0.9	-2.4	0.7	-2.0
8	1.1	-0.2	0.9	-0.2	0.8	-0.3	0.8	-0.5	1.0	-0.4	1.3	-0.2	1.2	-0.2
9	1.1	-0.3	1.2	-0.1	1.7	-0.6	2.2	1.2	2.1	-1.0	1.4	-0.3	1.2	0.0
10	0.9	-0.5	1.0	-0.6	1.2	-0.1	1.6	0.2	1.4	-0.1	0.9	-0.6	0.0	0.0
11	1.0	-0.1	1.2	0.1	1.6	0.8	2.1	1.5	2.0	1.2	1.3	-0.1	1.1	-0.1
12	0.4	-0.1	0.6	0.2	1.0	0.6	1.5	1.2	1.3	0.9	0.7	0.2	0.6	-0.5
13	0.7	-0.7	0.7	-0.7	0.7	-0.6	1.1	-0.6	1.0	-0.5	0.7	-0.8	0.0	-0.5
14	0.5	-0.4	0.8	-0.2	1.3	0.9	2.0	1.8	1.7	1.5	0.9	0.3	0.6	-0.4
15	1.8	1.0	2.2	1.6	3.6	3.2	5.0	4.7	4.6	4.2	2.6	1.8	1.6	0.9
16	1.9	1.2	2.6	2.0	4.2	3.8	5.8	5.6	5.3	5.0	3.0	2.3	1.9	1.2
17	1.3	-0.8	1.7	0.0	2.7	1.5	3.9	3.0	3.5	2.5	1.8	0.4	1.6	0.2
18	1.2	-0.7	1.6	0.6	2.6	2.1	3.6	3.3	3.2	2.9	1.8	1.1	1.6	0.7
19	1.7	1.6	2.3	2.3	3.4	3.4	4.5	4.5	4.1	4.1	2.6	2.5	2.0	1.9

TABLE A3-36 CONT.

Existing Case Study (Run 413)
Project Demand Condition
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec	Aug	Sep
1	-834	-4358	43	-359	-579
2	-1124	-1606	-1492	-910	-1718
3	-1117	-1511	-1325	-1002	-1437
4	1433	1782	549	1069	1771
5	-5186	-8998	-7984	-4514	-7300
6	-3295	-5288	-4832	-2976	-4294
7	-6339	-10950	-9754	-5471	-8881
8	2118	3635	3320	1833	2945
9	347	-1	1313	1084	2810
10	-307	10	198	-85	391
11	359	8	1328	1111	2821
12	-289	14	214	32	434
13	-168	-74	-29	-106	53
14	-126	-44	0	-2	90
15	-5	-4	1564	1311	3381
16	-1	-1	1569	1320	3391
17	1408	1598	32	960	1654
18	1433	1616	39	1018	1684
19	1448	1625	1622	2409	5123

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec	Aug	Sep
1	1.94	1.96	2.29	1.96	1.95
2	1.76	1.81	2.15	1.77	1.8
3	1.7	1.74	2.09	1.69	1.75
4	1.7	1.75	2.09	1.7	1.75
5	1.62	1.65	2.01	1.49	1.7
6	1.63	1.67	2.02	1.55	1.7
7	1.5	1.52	1.9	1.39	1.59
8	1.45	1.46	1.83	1.35	1.54
9	1.56	1.49	1.94	3.28	1.86
10	2.5	1.4	1.79	3.91	1.51
11	1.75	1.53	2.17	3.71	2.47
12	2.3	1.49	2.14	4	2.44
13	3.62	1.57	1.93	4.08	1.65
14	3.3	1.63	2.31	4.11	2.78
15	1.72	1.45	2.4	4.01	3.28
16	1.69	1.44	2.88	4.14	4.04
17	1.95	2.01	2.15	1.85	2.02
18	3.78	3.91	2.81	3.23	3.94
19	6.11	6.47	5.64	7.11	10.57

Minimum and Maximum Velocity

Ref.	Oct		Nov		Dec		Aug		Sep	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.35	1.2	-1.4
2	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.37	-0.55	0.3	-0.6
3	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.16	-0.4	0.0	-0.4
4	0.4	-0.3	0.5	-0.3	0.4	-0.4	0.41	-0 31	0.5	-0.3
5	0.7	-1.5	0.7	-2.0	0.7	-1.9	0.73	-1.27	0.6	-1.8
6	0.8	-1.4	0.7	-1.9	0.7	-1.8	0.77	-1.28	0.7	-1.7
7	0.6	-2.4	0.6	-3.1	0.7	-3.0	0.63	-2.03	0.7	-2.8
8	1.4	-0.1	1.3	-0.1	1.3	-0.1	1.26	-0.11	1.4	-0.1
9	1.0	-1.0	0.8	-0.7	1.0	-0.4	1.05	-0.46	1.2	-0.7
10	0.0	-0.8	0.7	-0.6	0.7	-0.5	0	-0.56	0.8	-0.9
11	0.8	-0.9	0.7	-0.6	0.9	-0.3	0.94	-0.31	1.1	-0.5
12	0.1	-0.8	0.2	-0.1	0.3	0.0	0.41	-0.39	0.6	0.1
13	0.0	-0.7	0.6	-0.6	0.6	-0.6	0.01	-0.58	0.8	-0.9
14	-0.3	-0.8	0.1	-0.7	0.4	-0.5	0.46	-0.53	0.7	-0.2
15	0.3	-0.4	0.2	-0.2	1.2	0.6	1.06	0.4	2.1	1.2
16	0.2	-0.2	0.1	-0.1	1.5	0.7	1.24	0.54	2.4	1.7
17	1.5	-0.3	1.5	-0.1	1.1	-1.1	1.29	-0.66	1.6	-0.2
18	1.5	-0.2	1.5	0.2	0.9	-1.1	1.28	-0.57	1.5	0.3
19	0.9	0.8	1.0	0.9	1.1	1.0	1.38	1.31	2.1	2.1

TABLE A3-37

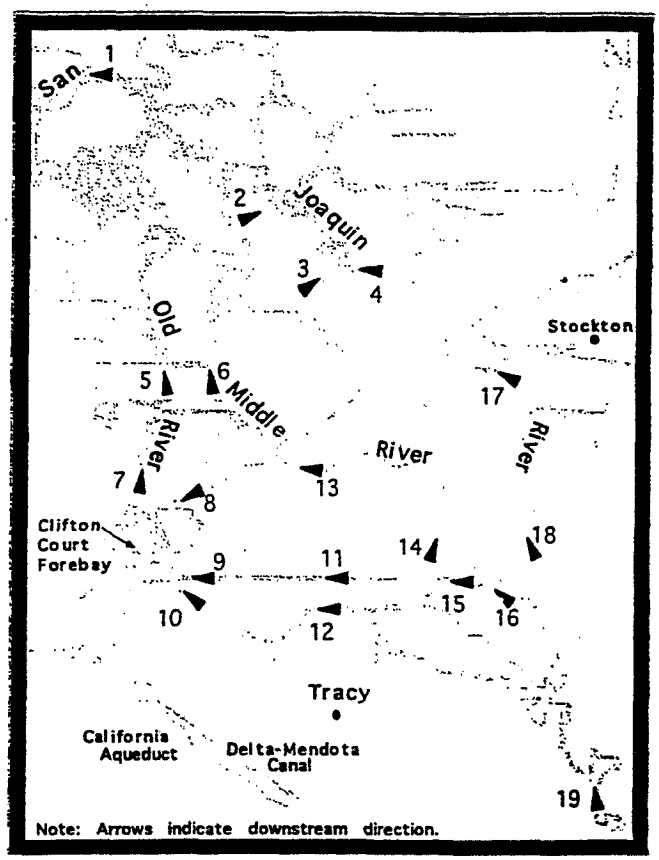
Future Demand Case Study (Run 414)
IDSP Representative
Critical Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	-190	-2179	-1886	-2429	245	307	-53	1304	245	-739
2	-438	-161	-237	-869	-246	-835	-653	-840	-531	-388
3	-622	-569	-595	-978	-448	-838	-743	-779	-736	-761
4	112	87	166	348	597	1920	1737	1752	515	257
5	-3477	-3505	-3542	-6252	-1625	-2414	-1985	-1965	-3386	-3760
6	-2254	-2226	-2252	-3740	-1188	-1717	-1461	-1482	-2331	-2591
7	-4293	-4305	-4335	-7644	-1931	-2928	-2342	-2333	-4041	-4483
8	1562	1552	1557	2620	678	1011	800	805	1342	1456
9	600	599	739	938	1572	323	252	262	571	229
10	92	92	117	135	310	-391	-415	-422	-176	-225
11	603	602	746	944	1584	335	270	280	608	269
12	103	103	132	162	242	-323	-315	-322	-14	-51
13	-13	-14	-20	-11	-138	-165	-186	-189	-176	-202
14	6	6	15	-9	-95	-121	-103	-106	-32	-47
15	714	714	914	1154	1348	-5	-7	-7	776	405
16	716	716	918	1156	1353	0	1	1	789	420
17	30	30	80	-51	518	1868	1708	1708	484	251
18	36	36	93	-52	556	1912	1762	1762	651	322
19	758	758	1020	1136	1959	1959	1824	1824	1435	846

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9
2	1.8	1.8	1.8	1.8	1.9	1.9	1.8	1.8	1.8	1.8
3	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.7
4	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7	1.7
5	1.7	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.6	1.5
6	1.7	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.6	1.5
7	1.6	1.6	1.6	1.6	1.7	1.6	1.6	1.6	1.5	1.4
8	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.4	1.3
9	1.7	1.6	1.7	1.7	1.9	1.7	1.7	1.7	3.2	3.1
10	1.5	1.4	1.5	1.5	3.0	2.7	2.6	2.6	3.6	3.5
11	1.9	1.9	2.0	1.9	2.4	1.9	1.9	1.9	3.5	3.4
12	1.9	1.9	1.9	1.9	2.8	2.4	2.4	2.4	3.7	3.6
13	1.6	1.6	1.6	1.7	4.1	3.9	3.8	3.8	3.8	3.6
14	2.0	2.0	2.0	2.1	3.8	3.5	3.4	3.5	3.8	3.6
15	2.1	2.1	2.2	2.1	2.8	1.9	1.9	1.9	3.7	3.5
16	2.3	2.3	2.4	2.3	3.0	1.8	1.8	1.8	3.7	3.5
17	1.8	1.8	1.8	1.9	1.9	2.1	2.0	2.1	1.8	1.8
18	2.5	2.4	2.5	2.5	2.9	4.2	4.1	4.1	2.9	2.7
19	4.0	4.0	4.5	4.7	6.3	7.1	6.8	6.9	5.5	4.4



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16 MAX.	Jan. 1-16 MIN.	Jan. 17-31 MAX.	Jan. 17-31 MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April 1-15 MAX.	April 1-15 MIN.	April 16-30 MAX.	April 16-30 MIN.	May 1-20 MAX.	May 1-20 MIN.	May 21-31 MAX.	May 21-31 MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.4
2	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.5	-0.5
3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4
4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3
5	0.8	-1.5	0.8	-1.5	0.8	-1.5	0.8	-1.8	0.9	-1.0	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	0.7	-1.2
6	0.9	-1.5	0.9	-1.5	0.9	-1.5	0.8	-1.7	0.9	-1.0	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.9	-1.2	0.7	-1.2
7	0.8	-2.3	0.8	-2.3	0.8	-2.4	0.7	-2.8	1.0	-1.7	0.9	-1.9	0.9	-1.8	1.0	-1.8	0.8	-2.0	0.6	-2.0
8	0.9	-0.1	0.9	-0.1	0.9	-0.1	1.2	-0.1	1.1	-0.3	1.1	-0.2	1.1	-0.2	1.1	-0.2	1.2	-0.2	1.2	-0.1
9	1.0	-0.7	1.0	-0.7	1.0	-0.7	1.0	-0.5	1.2	-0.7	1.0	-0.9	1.0	-0.9	1.0	-1.0	1.0	-0.8	0.9	-0.7
10	0.8	-0.7	0.8	-0.6	0.8	-0.6	0.8	-0.5	0.0	-0.7	0.0	-0.8	0.0	-0.8	0.0	-0.8	0.0	-0.7	0.0	-0.7
11	0.9	-0.6	0.9	-0.6	0.9	-0.5	0.9	-0.4	1.1	-0.6	0.8	-0.8	0.8	-0.8	0.9	-0.8	0.9	-0.5	0.8	-0.6
12	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	0.0	0.2	-0.5	0.1	-0.6	0.2	-0.6	0.2	-0.6	0.4	-0.4	0.3	-0.4
13	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6
14	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.6	0.3	-0.7	0.1	-0.8	0.2	-0.8	0.2	-0.8	0.3	-0.5	0.2	-0.5
15	1.0	-0.3	1.0	-0.3	1.1	-0.1	1.0	0.2	1.2	0.1	0.3	-0.4	0.3	-0.5	0.3	-0.5	0.8	0.0	0.7	-0.3
16	1.1	-0.4	1.1	-0.4	1.2	-0.2	1.2	0.3	1.3	0.3	0.1	-0.2	0.1	-0.2	0.1	-0.2	0.8	0.1	0.8	-0.3
17	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.2	-0.9	1.6	0.0	1.5	-0.1	1.6	-0.1	1.2	-1.0	1.1	-1.0
18	0.9	-1.1	0.9	-1.1	0.9	-1.0	0.9	-1.1	1.1	-0.8	1.6	0.5	1.6	0.4	1.6	0.4	1.2	-0.9	1.1	-1.0
19	0.7	0.4	0.7	0.5	0.8	0.6	0.9	0.8	1.3	1.1	1.1	1.1	1.1	1.0	1.1	1.0	1.0	0.9	0.7	0.5

TABLE A3-37 CONT.

Future Demand Case Study (Run 414)
Project Demand Condition
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	286	470	1098	-103	2200	281	-389
2	828	-765	639	-457	185	-212	417
3	860	-727	690	-640	585	-480	666
4	1783	1241	1222	163	137	426	610
5	2579	-2738	2759	-3444	3473	-1819	3042
6	1837	-1850	1828	-2250	2220	-1377	2105
7	3154	-3361	3369	-4221	4233	-2122	3706
8	1078	1225	1217	1523	1513	694	1251
9	369	-45	45	760	760	268	553
10	132	-27	27	122	121	-253	161
11	35	-34	34	773	773	294	568
12	144	-6	6	137	137	-132	90
13	73	-46	46	-27	27	-172	145
14	117	-3	3	20	20	-72	80
15	56	-4	4	966	965	257	499
16	0	-1	1	971	970	268	506
17	1791	1226	1226	97	98	422	471
18	1827	1248	1248	113	114	483	509
19	1854	1261	1261	1098	1098	826	1060

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.97	2	1.98	1.98	1.98	1.97	1.95
2	1.79	1.83	1.82	1.81	1.78	1.78	1.78
3	1.73	1.76	1.75	1.74	1.72	1.7	1.88
4	1.79	1.77	1.75	1.74	1.72	1.72	1.7
5	1.86	1.71	1.7	1.68	1.66	1.54	1.52
6	1.87	1.71	1.7	1.69	1.67	1.58	1.58
7	1.65	1.61	1.6	1.57	1.55	1.42	1.41
8	1.5	1.56	1.55	1.52	1.5	1.39	1.38
9	1.82	1.62	1.81	1.67	1.84	3.26	3.2
10	1.5	1.52	1.51	1.47	1.46	3.68	3.7
11	1.83	1.72	1.71	1.96	1.93	3.55	3.53
12	2.42	1.68	1.67	1.95	1.92	3.77	3.78
13	1.86	1.65	1.64	1.62	1.60	3.95	3.94
14	2.5	1.7	1.69	2.03	2.01	3.85	3.89
15	1.81	1.63	1.62	2.17	2.14	3.67	3.68
16	2.17	1.59	1.58	2.37	2.34	3.7	3.69
17	2.03	1.98	1.97	1.82	1.79	1.81	1.8
18	3.3	3.66	3.63	2.52	2.49	2.89	2.91
19	6.04	5.73	5.71	4.66	4.64	4.56	4.9

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4
2	0.4	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.3	0.4	-0.3
5	0.8	-1.1	0.9	-1.5	0.9	-1.5	0.8	-1.5	0.8	-1.6	0.8	-1.1	0.8	-1.1
6	0.9	-1.2	1.0	-1.5	1.0	-1.4	0.9	-1.5	0.9	-1.6	0.8	-1.1	0.8	-1.2
7	0.8	-1.6	1.0	-2.3	1.0	-2.2	0.8	-2.3	0.8	-2.3	0.8	-1.5	0.7	-1.6
8	1.1	-0.2	0.9	-0.2	0.9	-0.2	0.9	-0.1	0.9	-0.1	0.9	-0.2	1.2	-0.2
9	1.0	-0.9	0.9	-1.0	0.9	-0.9	1.0	-0.7	1.0	-0.7	0.9	-0.6	1.0	-0.9
10	0.0	-0.9	0.8	-0.8	0.8	-0.9	0.8	-0.7	0.8	-0.8	0.0	-0.7	0.0	-0.7
11	0.0	-0.8	0.7	-0.8	0.7	-0.9	0.9	-0.5	0.9	-0.6	0.8	-0.6	0.9	-0.5
12	0.2	-0.8	0.3	-0.2	0.3	-0.2	0.3	-0.1	0.3	-0.1	0.3	-0.4	0.3	-0.4
13	0.1	-0.1	0.6	-0.8	0.6	-0.8	0.7	-0.7	0.7	-0.7	0.0	-0.5	0.0	-0.5
14	0.1	-0.8	0.5	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.6	0.1	-0.6	0.0	-0.6
15	0.3	-0.4	0.3	-0.4	0.3	-0.4	1.1	-0.1	1.1	-0.0	0.7	-0.4	0.3	-0.2
16	0.1	-0.2	0.1	-0.2	0.1	-0.2	1.2	-0.1	1.2	-0.1	0.8	-0.4	0.8	-0.2
17	1.6	0.0	1.4	-0.5	1.4	-0.5	1.1	-1.1	1.1	-1.1	1.2	-1.0	1.2	-0.9
18	1.6	-0.4	1.4	-0.4	1.4	-0.4	1.0	-1.0	0.9	-1.0	1.1	-0.9	1.1	-0.9
19	1.1	1.0	0.9	0.7	0.9	0.7	0.9	0.7	0.9	0.7	0.7	0.5	0.8	0.5

TABLE A3-38

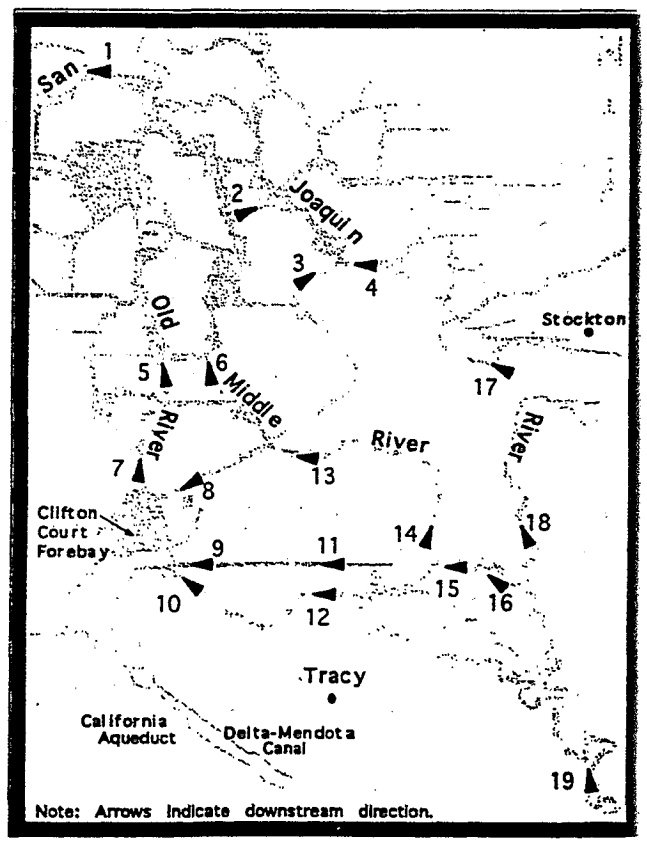
Future Demand Case Study (Run 414)
ISDP Representative
Dry Year

Average Net Flow

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	-726	-3841	-925	583	695	803	-45	1791	29	-2638
2	-1433	-1001	-703	-907	-499	-1543	-1006	-1264	-547	-979
3	-1197	-1134	-809	-801	-586	-1197	-959	-1005	-756	-1234
4	967	945	946	976	1274	3524	2456	2475	594	403
5	-6981	-7029	-4007	-3664	-1668	-3017	-2624	-2597	-3375	-7472
6	-4123	-4086	-2510	-2346	-1200	-2096	-1863	-1892	-2346	-4538
7	-8566	-8592	-4933	-4530	-1996	-3684	-3113	-3102	-4002	-8934
8	2897	2883	1783	1668	708	1273	1059	1066	1332	2876
9	2027	2021	1898	1619	2472	339	212	223	677	728
10	287	281	280	253	-256	-374	-405	-412	-158	-139
11	2029	2022	1903	1624	2483	349	234	245	720	770
12	287	281	298	269	-196	-316	-297	-305	0	20
13	28	27	28	34	-108	-158	-189	-192	-173	-179
14	27	26	51	40	-77	-129	-105	-108	-14	-16
15	2329	2317	2262	1947	2296	-3	-8	-8	942	1015
16	2328	2316	2263	1948	2299	0	1	1	955	1028
17	691	703	858	633	1221	3496	2460	2460	578	360
18	685	697	873	632	1256	3575	2524	2524	649	433
19	3024	3024	3155	2597	3601	3601	2593	2593	1701	1559

Minimum Water Surface Elevation

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.1	2.0	2.0	2.0	2.0	2.0	1.9
2	1.9	1.8	1.9	1.9	1.9	1.9	1.8	1.9	1.8	1.7
3	1.8	1.7	1.8	1.9	1.8	1.8	1.8	1.8	1.7	1.6
4	1.8	1.7	1.8	1.9	1.8	1.8	1.8	1.8	1.7	1.7
5	1.7	1.7	1.8	1.8	1.8	1.8	1.7	1.7	1.5	1.4
6	1.7	1.7	1.8	1.8	1.8	1.8	1.7	1.7	1.6	1.5
7	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.6	1.4	1.3
8	1.6	1.5	1.6	1.7	1.7	1.6	1.6	1.6	1.4	1.2
9	1.8	1.7	1.8	1.9	2.0	1.7	1.7	1.7	3.2	3.1
10	1.5	1.5	1.6	1.7	3.2	2.7	2.6	2.6	3.7	3.3
11	2.2	2.1	2.3	2.3	2.7	1.9	1.9	1.9	3.6	3.3
12	2.2	2.1	2.3	2.2	3.1	2.4	2.3	2.4	3.8	3.4
13	1.7	1.6	1.7	1.8	4.2	3.9	3.7	3.8	3.8	3.4
14	2.4	2.4	2.5	2.4	4.0	3.5	3.4	3.4	3.8	3.4
15	2.6	2.6	2.8	2.7	3.3	1.9	1.6	1.8	3.7	3.4
16	3.1	3.0	3.2	3.0	3.8	1.8	1.8	1.8	3.8	3.5
17	1.9	1.9	2.0	2.0	2.0	2.5	2.2	2.2	1.8	1.7
18	3.1	3.1	3.2	3.1	3.5	6.1	4.9	4.9	3.0	2.8
19	7.8	7.8	8.1	7.2	8.7	10.2	8.4	8.4	5.9	5.6



Minimum and Maximum Velocity

Ref. No.	Jan 1-15		Jan 16-31		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.3	-0.5	0.4	-0.5	0.3	-0.6	0.4	-0.5	0.3	-0.6	0.5	-0.5	0.4	-0.6
3	0.1	-0.4	0.1	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.1	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.5	-0.2	0.5	-0.3	0.5	-0.3	0.4	-0.3	0.4	-0.4
5	0.8	-1.8	0.8	-1.8	0.9	-1.6	0.9	-1.6	0.9	-1.0	0.9	-1.2	0.9	-1.1	0.9	-1.1	0.9	-1.2	0.6	-1.7
6	0.8	-1.8	0.8	-1.7	0.9	-1.6	0.9	-1.6	0.9	-1.0	0.9	-1.2	0.9	-1.1	0.9	-1.2	0.8	-1.2	0.7	-1.6
7	0.8	-2.9	0.8	-2.9	0.9	-2.5	0.9	-2.5	1.0	-1.7	0.8	-2.0	0.9	-1.9	0.9	-1.9	0.8	-2.0	0.5	-2.6
8	1.2	-0.2	1.2	-0.2	1.0	-0.2	1.0	-0.2	1.1	-0.3	1.2	-0.2	1.2	-0.2	1.2	-0.2	1.2	-0.2	1.5	-0.1
9	1.1	-0.3	1.1	-0.3	1.1	-0.3	1.1	-0.5	1.3	-0.6	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	-0.8	0.9	-0.7
10	0.8	-0.5	0.8	-0.5	0.9	-0.5	0.9	-0.6	0.0	-0.7	0.0	-0.8	0.0	-0.8	0.0	-0.8	0.0	-0.7	0.0	-0.7
11	1.0	-0.1	1.0	-0.1	1.0	-0.2	1.0	-0.3	1.2	-0.4	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.8	-0.5	0.8	-0.5
12	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.0	0.3	-0.5	0.2	-0.6	0.2	-0.6	0.2	-0.6	0.4	-0.4	0.4	-0.3
13	0.7	-0.6	0.7	-0.6	0.7	-0.7	0.7	-0.7	0.0	-0.5	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.8
14	0.5	-0.4	0.5	-0.4	0.5	-0.3	0.5	-0.4	0.3	-0.7	-0.1	-0.8	0.1	-0.8	0.1	-0.8	0.4	-0.5	0.4	-0.5
15	1.5	-1.1	1.5	1.1	1.6	-1.0	1.4	0.8	1.6	0.8	0.3	-0.4	0.3	-0.4	0.3	-0.4	0.9	0.2	0.9	0.2
16	1.8	-1.3	1.8	1.3	1.8	-1.2	1.7	0.9	1.8	-1.1	0.1	-0.2	0.1	-0.2	0.1	-0.2	1.0	0.3	1.1	0.3
17	1.3	-0.8	1.3	-0.8	1.3	-0.7	1.3	-0.8	1.4	-0.5	2.2	1.1	1.8	0.5	1.8	0.4	1.2	-0.9	1.1	-1.0
18	1.2	-0.7	1.2	-0.7	1.2	-0.6	1.1	-0.7	1.4	-0.2	2.2	1.6	1.9	1.1	1.9	1.0	1.2	0.8	1.1	-0.9
19	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.8	1.7	1.5	1.5	1.3	1.3	1.3	1.3	1.1	1.0	1.1	1.0

TABLE A3-38 CONT.

Future Demand Case Study (Run 414)
Project Demand Condition
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1321	-294	2853	-1010	3651	-2239	1081
2	2672	-2279	1931	-1056	670	-869	675
3	1616	-1550	1501	-1021	986	-1119	613
4	3885	3572	3547	799	780	299	1451
5	6198	-6469	6502	-5726	5708	-6684	4857
6	4988	-3988	3956	-3455	3425	-4116	3142
7	9951	-7918	7932	-6984	7006	-8042	5934
8	3276	2692	2679	2385	2374	2616	3069
9	209	-34	35	1911	1904	569	1037
10	286	-4	4	264	259	-142	130
11	112	-22	23	1925	1918	596	052
12	54	10	11	280	275	-27	55
13	130	-70	70	-3	44	-170	143
14	125	-27	27	43	42	-65	45
15	5	-5	5	2283	2271	672	396
16	0	-1	1	2286	2274	682	302
17	3803	3516	3514	710	722	233	390
18	3861	3575	3575	731	743	286	422
19	3889	3587	3587	3036	3038	1037	1061

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.9	1.98	1.95	1.97	1.94	1.91	1.94
2	1.76	1.82	1.78	1.81	1.77	1.73	1.75
3	1.7	1.75	1.72	1.74	1.7	1.64	1.66
4	1.71	1.76	1.73	1.74	1.7	1.66	1.68
5	1.58	1.67	1.64	1.69	1.65	1.43	1.48
6	1.6	1.69	1.65	1.69	1.65	1.49	1.53
7	1.44	1.55	1.62	1.59	1.55	1.3	1.38
8	1.57	1.5	1.47	1.54	1.5	1.25	1.34
9	1.47	1.54	1.51	1.76	1.72	3.03	3.09
10	2.13	1.43	1.41	1.5	1.46	3.34	3.57
11	1.67	1.63	1.6	2.16	2.13	3.3	3.42
12	2.05	1.59	1.58	2.16	2.12	3.42	3.84
13	1.34	1.59	1.57	1.64	1.6	3.5	3.1
14	2.99	1.64	1.61	2.33	2.3	3.5	3.77
15	1.83	1.54	1.51	2.64	2.6	3.38	3.55
16	2.6	1.51	1.48	3.07	3.04	3.41	3.59
17	2.5	2.45	2.43	1.89	1.85	1.73	1.77
18	6.36	6.04	6.02	3.08	3.04	2.71	2.84
19	10.73	10.22	10.21	7.86	7.85	4.68	4.84

Minimum and Maximum Velocity

Ref. No.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4
2	0.1	-0.7	0.1	-0.6	0.2	-0.6	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.3	-0.5
3	0.0	-0.5	0.1	-0.5	0.1	-0.5	0.2	-0.4	0.2	-0.4	0.1	-0.4	0.2	-0.4
4	0.5	-0.2	0.5	-0.2	0.5	-0.2	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3
5	0.8	-1.9	0.8	-1.8	0.8	-1.8	0.8	-1.8	0.8	-1.8	0.6	-1.6	0.7	-1.7
6	0.9	-1.7	0.8	-1.8	0.8	-1.7	0.9	-1.7	0.9	-1.7	0.7	-1.5	0.8	-1.5
7	0.5	-2.9	0.7	-2.9	0.7	-2.9	0.8	-2.8	0.8	-2.8	0.5	-2.4	0.6	-2.4
8	1.0	-0.1	1.2	-0.1	1.1	-0.1	1.1	-0.2	1.1	-0.2	1.5	-0.1	1.0	-0.1
9	0.9	-1.1	0.9	-0.7	0.9	-0.7	1.1	-0.3	1.1	-0.3	0.9	-0.7	0.9	-0.6
10	0.0	-0.9	0.8	-0.6	0.7	-0.6	0.8	-0.5	0.8	-0.5	0.0	-0.7	0.9	-0.7
11	0.2	-1.0	0.7	-0.6	0.7	-0.6	1.0	-0.1	1.0	-0.1	0.8	-0.6	0.8	-0.5
12	0.2	-0.6	0.2	-0.2	0.2	-0.2	0.4	0.1	0.4	-0.1	0.3	-0.4	0.3	-0.4
13	0.0	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.7	0.0	-0.6
14	0.3	-0.6	0.3	-0.6	0.3	-0.6	0.5	-0.4	0.5	-0.3	0.2	-0.6	0.0	-0.6
15	0.4	-0.4	0.3	-0.3	0.3	-0.3	1.5	1.0	1.0	-1.0	0.7	-0.2	0.7	-0.2
16	0.2	-0.2	0.1	-0.2	0.1	-0.2	1.8	1.2	1.8	-1.2	0.9	-0.2	0.8	-0.1
17	2.4	-1.2	2.2	1.1	2.2	-1.1	1.3	-0.8	1.3	-0.8	1.1	-1.0	1.2	-1.0
18	2.3	-1.8	2.2	1.7	2.2	-1.7	1.2	-0.7	1.2	-0.7	1.1	-1.0	1.1	-1.0
19	1.6	-1.6	1.5	1.5	1.5	-1.6	1.6	1.6	1.6	-1.6	0.8	0.6	0.8	-0.6

TABLE A3-39

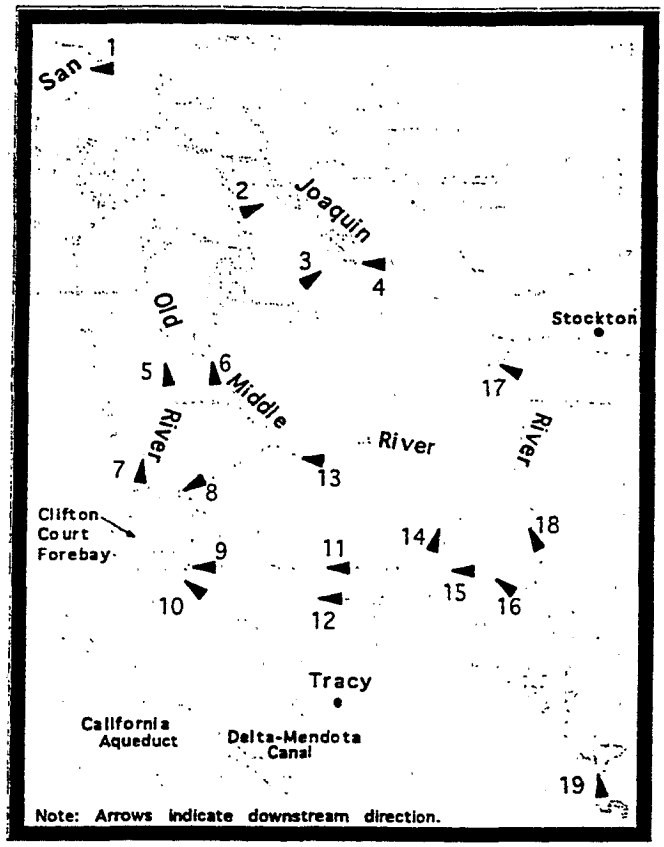
Future Demand Case Study (Run 414)
ISDP Representative
Below Normal Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	-1559	-112	-1371	879	998	-142	2302	14	-2855
2	-1151	-922	-641	-594	-1733	-1200	-1544	-587	-1047
3	-1070	-857	-745	-638	-1282	-1084	-1144	-788	-1289
4	1346	1244	566	1435	3860	2745	2770	594	391
5	-5608	-3860	-4057	-1744	-3200	-3217	-3180	-3592	-7982
6	-3362	-2441	-2535	-1259	-2223	-2219	-2257	-2470	-4805
7	-6882	-4767	-4952	-2094	-3913	-3842	-3828	-4267	-9549
8	2394	1752	1764	739	1345	1302	1311	1421	3076
9	2354	2069	1419	2608	310	206	219	692	756
10	327	299	211	-252	-376	-394	-402	-154	-140
11	2353	2074	1431	2623	323	227	240	732	795
12	339	321	241	-182	-308	-287	-295	6	14
13	55	54	-5	-113	-170	-193	-197	-171	-175
14	50	54	39	-64	-122	-107	-111	-18	-21
15	2714	2438	1753	2475	-5	-8	-8	957	1020
16	2717	2441	1758	2479	0	1	1	970	1032
17	1151	1034	445	1340	3787	2746	2747	574	346
18	1166	1041	468	1381	3882	2816	2816	646	417
19	3892	3498	2252	3913	3913	2883	2883	1713	1544

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April 1-15	April 16-30	May 1-20	May 21-31	June	July
1	2.0	2.1	2.0	2.0	2.0	2.0	2.0	2.0	1.9
2	1.9	1.9	1.9	1.9	1.9	1.8	1.9	1.8	1.7
3	1.8	1.9	1.8	1.8	1.8	1.8	1.8	1.7	1.6
4	1.8	1.9	1.8	1.8	1.8	1.8	1.8	1.7	1.7
5	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.5	1.4
6	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.6	1.5
7	1.7	1.7	1.6	1.7	1.7	1.6	1.7	1.4	1.3
8	1.6	1.7	1.6	1.7	1.6	1.6	1.6	1.4	1.2
9	1.9	1.9	1.8	2.1	1.7	1.7	1.7	3.2	3.1
10	1.6	1.6	1.6	3.2	2.6	2.6	2.6	3.7	3.3
11	2.4	2.4	2.1	2.7	1.9	1.8	1.9	3.6	3.3
12	2.4	2.3	2.1	3.2	2.4	2.3	2.4	3.7	3.4
13	1.7	1.8	1.7	4.2	3.8	3.7	3.8	3.8	3.4
14	2.7	2.6	2.2	4.0	3.5	3.3	3.4	3.8	3.4
15	3.0	2.9	2.5	3.4	1.9	1.8	1.8	3.7	3.4
16	3.5	3.4	2.8	3.9	1.8	1.8	1.8	3.8	3.5
17	2.0	2.0	1.9	2.0	2.6	2.3	2.3	1.8	1.8
18	3.5	3.4	2.9	3.6	6.4	5.2	5.2	3.0	2.8
19	9.1	8.6	6.7	9.1	10.8	8.9	8.9	5.9	5.6



Minimum and Maximum Velocity

Ref. No.	January		February		March		April 1-15		April 16-30		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.3	-0.5	0.3	-0.5	0.4	-0.6	0.4	-0.5	0.3	-0.6	0.3	-0.6	0.3	-0.6	0.5	-0.5	0.4	-0.6
3	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.4	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.5	-0.2	0.5	-0.3	0.5	-0.3	0.4	-0.3	0.4	-0.4
5	0.8	-1.8	0.9	-1.6	0.9	-1.6	0.9	-1.0	0.8	-1.2	0.8	-1.2	0.9	-1.2	0.8	-1.2	0.8	-1.8
6	0.9	-1.7	0.9	-1.6	0.9	-1.6	0.9	-1.0	0.8	-1.2	0.8	-1.2	0.9	-1.2	0.8	-1.2	0.8	-1.6
7	0.9	-2.8	0.9	-2.5	0.9	-2.5	1.0	-1.7	0.8	-2.0	0.8	-2.0	0.8	-2.0	0.8	-2.0	0.4	-2.7
8	1.1	-0.2	1.0	-0.2	1.0	-0.2	1.1	-0.3	1.2	-0.2	1.2	-0.2	1.2	-0.2	1.2	-0.2	1.5	-0.1
9	1.2	-0.3	1.1	-0.3	1.1	-0.5	1.3	-0.6	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	-0.6	0.8	-0.7
10	0.8	-0.5	0.9	-0.5	0.8	-0.6	0.0	-0.7	0.0	-0.8	0.0	-0.8	0.0	-0.8	0.0	-0.7	0.0	-0.8
11	1.1	-0.1	1.0	-0.1	0.9	-0.3	1.2	-0.4	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.9	-0.5	0.7	-0.5
12	0.5	0.1	0.5	0.1	0.4	0.0	0.3	-0.5	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.4	-0.4	0.4	-0.3
13	0.7	-0.6	0.7	-0.7	0.7	-0.7	0.0	-0.5	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.8
14	0.6	-0.3	0.5	-0.3	0.5	-0.4	0.4	-0.7	-0.1	-0.8	0.0	-0.8	0.0	-0.8	0.4	-0.5	0.4	-0.5
15	1.8	-1.3	1.7	1.1	1.3	0.7	1.6	0.9	0.3	-0.4	0.3	-0.4	0.3	-0.4	0.9	0.2	0.9	-0.2
16	2.1	-1.5	1.9	1.3	1.5	0.8	1.9	1.2	0.1	-0.2	0.1	-0.2	0.1	-0.2	1.0	0.3	1.1	-0.3
17	1.4	-0.6	1.4	-0.6	1.2	-0.9	1.5	-0.4	2.3	1.2	1.9	0.6	1.9	0.6	1.2	-0.9	1.1	-1.0
18	1.3	-0.4	1.3	-0.5	1.1	-0.8	1.4	-0.1	2.3	1.8	2.0	1.2	2.0	1.2	1.2	-0.8	1.1	-0.9
19	1.8	1.8	1.7	1.7	1.4	1.3	1.8	1.8	1.6	1.6	1.4	1.4	1.4	1.4	1.1	1.0	1.1	0.9

TABLE A3-39 CONT.

Future Demand Case Study (Run 414)
Project Demand Condition
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct.	Nov.	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	-827	-3707	-3586	-970	-2711	-981
2	-1794	-2530	-1038	-1407	-939	-603
3	-1443	-1834	-1131	-1184	-1192	-859
4	2659	4097	1224	1238	192	406
5	-6271	-9004	-6532	-6494	-7506	-4511
6	-3903	-5347	-3827	-3858	-4539	-2959
7	-7638	-10960	-7955	-7936	-9017	-5512
8	2524	3645	2679	2691	2917	1834
9	302	-5	2304	2307	509	543
10	-299	7	314	318	-151	-146
11	317	5	2306	2310	536	558
12	-265	14	319	325	36	-79
13	-179	-78	31	32	-178	-149
14	-123	-43	-47	48	-73	-90
15	6	-4	2668	2679	595	484
16	0	-1	2667	2679	605	490
17	2580	4008	1064	1049	116	347
18	2625	4102	1071	1057	169	379
19	2647	4094	3749	3749	844	907

Minimum Water Surface Elevation

Ref. No.	Oct.	Nov.	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	1.94	1.94	1.94	1.98	1.89	1.94
2	1.77	1.79	1.78	1.82	1.72	1.75
3	1.7	1.74	1.72	1.75	1.64	1.66
4	1.71	1.74	1.72	1.76	1.65	1.68
5	1.61	1.63	1.66	1.7	1.41	1.49
6	1.63	1.65	1.66	1.7	1.47	1.53
7	1.48	1.51	1.56	1.6	1.27	1.39
8	1.43	1.45	1.52	1.56	1.21	1.34
9	1.54	1.49	1.78	1.81	2.99	3.08
10	2.3	1.38	1.49	1.53	3.2	3.57
11	1.72	1.52	2.27	2.3	3.17	3.41
12	2.23	1.48	2.23	2.27	3.28	3.64
13	3.48	1.55	1.62	1.66	3.4	3.82
14	3.14	1.62	2.51	2.54	3.36	3.76
15	1.68	1.44	2.83	2.86	3.24	3.52
16	1.65	1.43	3.37	3.4	3.26	3.55
17	2.17	2.57	1.91	1.95	1.72	1.77
18	4.97	6.62	3.35	3.38	2.62	2.81
19	8.51	11.08	8.85	8.86	4.28	4.58

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.2	-0.6	0.1	-0.6	0.3	-0.5	0.2	-0.5	0.4	-0.6	0.4	-0.5
3	0.1	-0.4	0.0	-0.5	0.2	-0.4	0.2	-0.4	0.1	-0.4	0.2	-0.4
4	0.5	-0.3	0.5	-0.2	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.3
5	0.7	-1.6	0.7	-2.0	0.8	-1.8	0.8	-1.8	0.8	-1.7	0.7	-1.2
6	0.7	-1.6	0.7	-1.9	0.9	-1.7	0.9	-1.7	0.7	-1.6	0.8	-1.2
7	0.6	-2.8	0.6	-3.1	0.6	-2.8	0.8	-2.9	0.5	-2.6	0.6	-2.1
8	1.8	-0.1	1.3	-0.1	1.2	-0.2	1.2	-0.2	1.5	-0.1	1.3	-0.1
9	1.0	-1.0	0.8	-0.7	1.2	-0.2	1.2	-0.3	0.8	-0.7	1.0	-0.6
10	0.0	-0.9	0.7	-0.6	0.8	-0.4	0.8	-0.5	0.0	-0.8	0.0	-0.7
11	0.8	-0.9	0.7	-0.6	1.0	-0.1	1.0	-0.1	0.7	-0.6	0.8	-0.5
12	0.2	-0.6	0.2	-0.1	0.4	0.1	0.5	0.1	0.3	-0.4	0.2	-0.4
13	0.0	-0.7	0.6	-0.6	0.7	-0.6	0.7	-0.6	0.0	-0.8	0.0	-0.6
14	-0.3	-0.8	0.1	-0.7	0.6	-0.3	0.6	-0.3	0.2	-0.6	-0.1	-0.6
15	0.4	-0.4	0.2	-0.2	1.7	1.9	1.7	1.3	0.7	-0.3	0.7	-0.3
16	0.2	-0.2	0.1	-0.1	2.0	1.5	2.0	1.5	0.8	-0.3	0.8	-0.2
17	1.9	0.5	2.4	1.4	1.4	-0.6	1.4	-0.6	1.1	-1.1	1.2	-1.0
18	1.9	1.1	2.4	1.9	1.3	-0.4	1.3	-0.5	1.0	-1.1	1.1	-1.0
19	1.3	1.3	1.6	1.6	1.8	1.8	1.8	1.8	0.7	0.5	0.7	0.5

TABLE A3-40

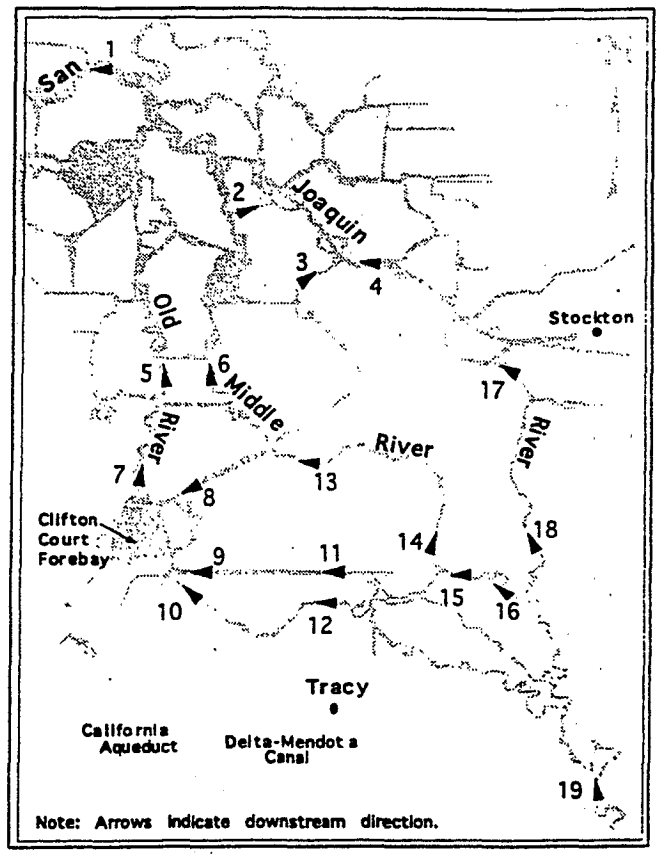
Future Demand Case Study (Run 414)
ISDP Representative
Above Normal Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 15-30	May 1-20	May 21-31	June	July
1	-761	-3360	-653	1063	728	836	592	2969	112	-6804
2	-1045	-673	-1010	-962	-641	-1791	-1718	-2048	-716	-619
3	-983	-929	-989	-867	-894	-1329	-1299	-1353	-862	-1262
4	668	646	989	799	1424	3857	3687	3717	599	339
5	-5679	-5718	-5188	-4149	-2149	-3624	-3551	-3510	-4089	-8605
6	-3417	-3386	-3181	-2652	-1493	-2460	-2438	-2470	-2757	-5060
7	-6956	-6987	-6398	-5112	-2602	-4442	-4287	-4274	-4882	-10251
8	2402	2391	2248	1846	917	1531	1480	1486	1628	3274
9	1739	1734	1964	1460	2879	346	296	309	896	772
10	251	247	277	228	-243	-362	-373	-382	-151	-139
11	1740	1736	1970	1466	2890	356	307	320	736	814
12	256	252	298	249	-189	-309	-301	-309	15	21
13	13	12	29	8	-104	-157	-167	-172	-171	-175
14	27	26	40	35	-78	-134	-128	-131	-25	-13
15	2017	2007	2304	1777	2500	-3	-4	-5	967	1062
16	2017	2008	2309	1779	2501	0	0	0	980	1076
17	509	517	787	443	1346	3810	3610	3611	542	328
18	512	521	794	458	1377	3901	3702	3690	613	400
19	2536	2536	3123	2254	3922	3922	3738	3738	1693	1574

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 1-15	April 15-30	May 1-20	May 21-31	June	July
1	2.0	2.0	2.1	2.2	2.1	2.1	2.0	2.1	2.0	1.8
2	1.8	1.8	1.8	2.0	1.9	1.9	1.9	1.9	1.8	1.6
3	1.8	1.7	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.6
4	1.8	1.7	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.6
5	1.7	1.7	1.8	1.9	1.8	1.8	1.7	1.8	1.5	1.4
6	1.7	1.7	1.8	1.9	1.8	1.8	1.8	1.8	1.6	1.4
7	1.6	1.6	1.7	1.8	1.7	1.7	1.6	1.7	1.4	1.2
8	1.6	1.5	1.7	1.7	1.7	1.6	1.6	1.6	1.4	1.2
9	1.8	1.7	1.9	1.9	2.1	1.7	1.7	1.7	3.2	2.9
10	1.5	1.5	1.6	1.7	3.2	2.7	2.6	2.6	3.6	3.2
11	2.1	2.1	2.3	2.2	2.8	1.9	1.9	1.9	3.5	3.1
12	2.1	2.1	2.3	2.2	3.2	2.4	2.4	2.4	3.7	3.3
13	1.7	1.6	1.8	1.8	4.2	3.9	3.8	3.9	3.8	3.2
14	2.3	2.3	2.5	2.4	4.1	3.5	3.5	3.5	3.8	3.3
15	2.5	2.5	2.8	2.6	3.6	1.9	1.8	1.9	3.7	3.3
16	2.9	2.9	3.2	2.9	3.9	1.8	1.8	1.8	3.8	3.3
17	1.8	1.9	2.0	2.0	2.0	2.6	2.6	2.6	1.8	1.7
18	2.9	2.9	3.2	3.0	3.6	6.4	6.2	6.2	3.0	2.7
19	7.1	7.1	6.0	6.7	9.1	10.8	10.5	10.5	5.9	5.6



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16		Jan. 17-31		February		March		April1-15		April1-15		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.2	-0.6	0.1	-0.6	0.2	-0.6	0.4	-0.5	0.5	-0.6
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.1	-0.4	0.1	-0.4	0.1	-0.5	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.5	-0.2	0.5	-0.2	0.5	-0.2	0.4	-0.3	0.4	-0.4
5	0.8	-1.8	0.8	-1.8	0.8	-1.8	0.9	-1.7	0.9	-1.1	0.8	-1.3	0.8	-1.2	0.8	-1.3	0.8	-1.2	0.4	-1.9
6	0.9	-1.7	0.9	-1.7	0.8	-1.7	0.9	-1.6	0.9	-1.1	0.8	-1.3	0.8	-1.2	0.8	-1.2	0.8	-1.2	0.5	-1.7
7	0.8	-2.8	0.8	-2.8	0.8	-2.7	0.9	-2.6	0.9	-1.8	0.8	-2.1	0.8	-2.1	0.8	-2.1	0.7	-2.1	0.2	-2.8
8	1.1	-0.2	1.1	-0.2	1.1	-0.2	1.0	-0.2	1.1	-0.2	1.3	-0.2	1.3	-0.2	1.3	-0.2	1.3	-0.2	1.5	-0.1
9	1.1	-0.4	1.1	-0.4	1.1	-0.3	1.0	-0.4	1.3	-0.6	1.0	-1.0	1.0	-0.9	1.0	-1.0	1.0	-0.8	0.8	-0.7
10	0.8	-0.5	0.8	-0.5	0.8	-0.5	0.8	-0.6	0.0	-0.7	0.0	-0.8	0.0	-0.8	0.0	-0.8	0.0	-0.7	0.0	-0.8
11	1.0	-0.2	1.0	-0.2	1.0	-0.1	0.9	-0.3	1.2	-0.4	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.9	-0.5	0.8	-0.5
12	0.4	-0.1	0.4	0.1	0.4	-0.1	0.4	0.0	0.3	-0.5	0.2	-0.6	0.1	-0.6	0.1	-0.6	0.4	-0.4	0.4	-0.3
13	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.5	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.6	0.0	-0.8
14	0.5	-0.4	0.5	-0.4	0.5	-0.4	0.5	-0.4	0.3	-0.7	-0.2	-0.8	-0.1	-0.8	-0.1	-0.8	0.3	-0.5	0.4	-0.5
15	1.4	0.8	1.4	0.9	1.6	1.0	1.3	0.6	1.6	0.9	0.3	-0.4	0.3	-0.4	0.3	-0.4	0.9	0.2	1.0	0.2
16	1.6	1.0	1.6	1.0	1.8	1.2	1.5	0.8	1.9	1.2	0.1	-0.2	0.2	-0.2	0.1	-0.2	1.0	0.3	1.1	0.3
17	1.2	-0.9	1.2	-0.9	1.3	-0.8	1.2	-0.9	1.5	-0.4	2.4	1.2	2.3	1.1	2.3	1.1	1.2	-0.9	1.1	-1.0
18	1.1	-0.8	1.1	-0.8	1.2	-0.7	1.1	-0.9	1.4	-0.1	2.3	1.8	2.2	1.7	2.2	1.7	1.2	-0.8	1.1	-0.9
19	1.5	1.4	1.5	1.4	1.6	1.6	1.4	1.3	1.8	1.8	1.6	1.6	1.6	1.5	1.6	1.5	1.1	1.0	1.1	1.0

TABLE A3-40 CONT.

Future Demand Case Study (Run 414)
Project Demand Condition
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1495	-1078	-3863	50	-1850	-1335	-1679
2	-2731	-1687	-1281	-489	-226	-753	-824
3	-1807	-1340	-1281	-640	-592	-999	-1037
4	-3692	2079	-2049	403	-383	351	-430
5	-9119	-6713	-6751	-3161	-3190	-5542	-5894
6	-5492	-4069	-4031	-2076	-2051	-3534	-3861
7	-11082	-8183	-8200	-3875	-3886	-6683	-7167
8	-3635	2762	-2747	1416	-1408	2197	-2358
9	-809	-33	-34	1181	-1179	560	-868
10	-282	-4	-5	191	-189	-146	-128
11	-821	-22	-22	1195	-1193	587	-882
12	-255	11	-11	209	-207	-30	-86
13	-175	-71	-71	-11	-11	-170	-141
14	-130	-28	-28	38	-38	-65	-66
15	-5	-5	-5	1481	-1477	660	-816
16	-0	-1	-1	1486	-1481	669	-820
17	-2762	2046	-2046	350	-354	293	-360
18	-3839	2074	-2074	369	-373	347	-390
19	-3845	2085	-2085	1871	-1871	1086	-1048

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.88	1.96	1.92	1.99	1.96	1.94	1.93
2	1.73	1.79	1.75	1.81	1.78	1.75	1.74
3	1.68	1.73	1.69	1.75	1.73	1.66	1.65
4	1.68	1.73	1.69	1.75	1.73	1.67	1.67
5	1.62	1.65	1.61	1.69	1.67	1.47	1.45
6	1.62	1.66	1.62	1.7	1.68	1.53	1.51
7	1.47	1.53	1.49	1.58	1.56	1.37	1.34
8	1.41	1.48	1.44	1.53	1.51	1.33	1.33
9	1.48	1.52	1.48	1.71	1.69	3.05	3.08
10	2.07	1.41	1.37	1.49	1.47	3.45	3.22
11	1.66	1.61	1.57	2.04	2.02	3.36	3.4
12	1.99	1.58	1.54	2.04	2.01	3.53	3.59
13	1.32	1.57	1.53	1.63	1.61	3.61	3.74
14	2.97	1.62	1.59	2.15	2.13	3.6	3.73
15	1.82	1.53	1.49	2.35	2.33	3.46	3.61
16	1.59	1.49	1.45	2.63	2.61	3.5	3.34
17	2.47	2.07	2.03	1.85	1.83	1.76	1.78
18	6.32	4.37	4.37	2.73	2.7	2.77	2.87
19	10.66	7.42	7.41	6.06	6.04	4.82	4.79

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.19	-1.33	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4
2	0.4	-0.7	0.2	-0.54	0.2	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.0	-0.5	0.15	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.2	-0.4
4	0.5	-0.2	0.46	-0.3	0.5	-0.3	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3
5	0.4	-1.8	0.78	-1.86	0.9	-1.9	0.9	-1.5	0.9	-1.5	0.7	-1.4	0.7	-1.4
6	0.4	-1.8	0.84	-1.78	0.9	-1.8	0.9	-1.5	0.9	-1.5	0.7	-1.4	0.7	-1.4
7	0.7	-3.1	0.73	-2.93	0.7	-2.9	0.9	-2.3	0.9	-2.3	0.5	-2.3	0.5	-2.3
8	1.6	-0.1	1.2	-0.13	1.2	-0.1	0.9	-0.2	0.9	-0.2	1.4	-0.1	1.4	-0.1
9	0.6	-1.1	0.89	-0.72	0.1	-0.7	1.0	-0.6	1.0	-0.6	0.9	-0.7	0.9	-0.7
10	0.0	-0.9	0.74	-0.6	0.7	-0.6	0.9	-0.6	0.7	-0.6	0.0	-0.7	0.0	-0.7
11	0.7	-1.0	0.72	-0.61	0.7	-0.6	0.9	-0.5	0.9	-0.5	0.8	-0.5	0.8	-0.5
12	0.2	-0.6	0.21	-0.19	0.2	-0.2	0.4	0.0	0.4	-0.0	0.3	-0.4	0.3	-0.4
13	0.0	-0.7	0.66	-0.71	0.7	-0.7	0.7	-0.7	0.7	-0.7	0.0	-0.7	0.0	-0.7
14	0.3	-0.6	0.29	-0.63	0.3	-0.6	0.5	-0.4	0.5	-0.4	0.2	-0.6	0.2	-0.6
15	0.4	-0.4	0.25	-0.33	0.3	-0.3	1.3	0.4	1.3	-0.4	0.7	-0.2	0.7	-0.2
16	0.2	-0.2	0.11	-0.16	0.1	-0.2	1.4	0.5	1.4	-0.5	0.9	-0.1	0.9	-0.1
17	2.4	-1.2	1.66	0.19	1.7	-0.2	1.2	-1.0	1.2	-1.0	1.1	-1.0	1.1	-1.0
18	2.3	-1.8	1.68	0.7	1.7	-0.7	1.1	-0.9	1.0	-0.9	1.1	-1.0	1.1	-1.0
19	1.6	-1.6	1.15	1.11	1.2	-1.1	1.2	1.1	1.2	-1.1	0.8	0.7	0.8	0.6

TABLE A3-41

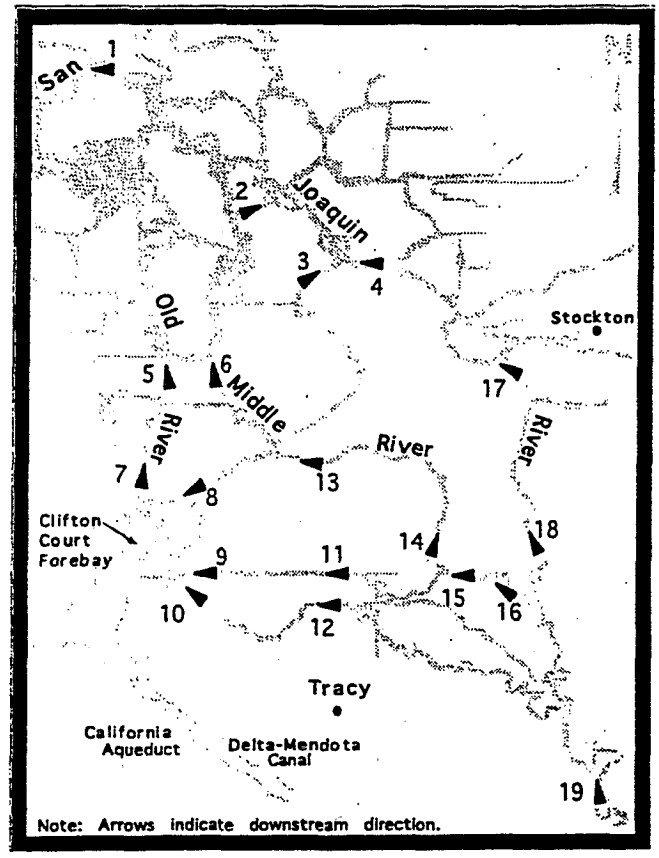
Future Demand Case Study (Run 414)
ISDP Representative
Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	6102	10049	14875	24742	11113	2538	910
2	-2691	-2684	-3841	-5688	-3588	-1943	-1277
3	-1469	-1312	-1514	-2080	-1649	-1349	-1133
4	2469	3037	6312	10592	7644	2746	2071
5	-5940	-2878	-108	3117	315	-4661	-3984
6	-3795	-2192	-502	1320	-70	-2975	-2700
7	-7594	-3769	-582	3099	142	-5594	-4804
8	2707	1520	559	-745	183	1922	1625
9	2225	2637	6506	10433	8676	3474	1789
10	371	415	1259	2323	1676	414	-2
11	2219	2644	6510	10465	8716	3514	1831
12	333	437	1241	2384	1815	590	158
13	67	101	434	825	546	27	-47
14	37	96	399	830	622	170	113
15	2528	3164	8080	13673	11261	4491	2344
16	2529	3173	8115	13771	11348	4518	2358
17	898	1646	4956	8756	8988	2428	1922
18	875	1649	5040	9143	7307	2516	2004
19	3406	4847	13275	23135	18901	7189	4462

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	2.42	2.56	2.63	3.08	2.4	2.06	2
2	2.28	2.43	2.52	3.01	2.29	1.91	1.81
3	2.22	2.38	2.48	2.99	2.24	1.84	1.73
4	2.23	2.38	2.49	3	2.25	1.85	1.75
5	2.16	2.31	2.44	2.98	2.23	1.77	1.52
6	2.17	2.32	2.43	2.96	2.21	1.78	1.59
7	2.07	2.22	2.42	3.09	2.27	1.67	1.43
8	2.03	2.18	2.43	3.17	2.31	1.63	1.39
9	2.24	2.45	3.24	4.67	3.6	2.05	3.65
10	2.01	2.17	2.57	3.66	2.61	1.62	4.44
11	2.64	2.96	4.48	6.52	5.34	2.83	4.22
12	2.61	2.91	4.38	6.31	5.14	2.74	4.54
13	2.11	2.26	2.5	3.18	2.36	1.72	4.87
14	2.87	3.22	5.36	7.89	6.56	3.09	4.92
15	3.11	3.67	6.67	10.02	8.44	4.02	4.79
16	3.57	4.32	8.37	12.52	10.69	5.07	5.14
17	2.39	2.6	3.42	4.88	3.87	2.26	2.02
18	3.57	4.22	7.76	11.51	9.84	4.83	4.06
19	8.46	10.33	18.15	24.7	22.05	12.79	9.95



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.25	-1.29	1.3	-1.25	1.38	-1.2	1.39	-1.05	1.3	-1.24	1.21	-1.3	1.22	-1.34
2	0.14	-0.61	0.16	-0.64	0	-0.69	-0.16	-0.88	0.11	-0.72	0.27	-0.6	0.31	-0.56
3	0.08	-0.45	0.14	-0.45	0.09	-0.49	0.01	-0.54	0.05	-0.48	0.08	-0.43	0.17	-0.44
4	0.44	-0.3	0.48	-0.28	0.58	-0.13	0.69	0.05	0.61	0.06	0.47	-0.27	0.46	-0.27
5	0.81	-1.81	0.89	-1.56	1.04	-1.31	1.26	-0.94	1.15	-1.16	0.83	-1.58	0.8	-1.3
6	0.81	-1.75	0.89	-1.56	1.01	-1.35	1.16	-1.15	1.09	-1.19	0.84	-1.52	0.9	-1.32
7	-0.6	-2.88	0.93	-2.41	1.23	-1.97	1.65	-1.25	1.44	-1.65	0.88	-2.39	0.75	-1.88
8	1.18	-0.16	0.95	-0.22	0.77	-0.33	0.8	-0.51	1	-0.41	1.34	-0.2	1.17	-0.23
9	1.09	-0.3	1.16	-0.23	1.72	0.62	2.19	1.18	2.04	0.95	1.35	-0.34	1.19	-0.03
10	0.83	-0.46	0.92	-0.58	1.18	-0.04	1.6	0.12	1.37	0.11	0.88	-0.64	0	-0.02
11	0.99	-0.1	1.08	-0.1	1.56	0.86	2.13	1.45	1.97	1.2	1.26	-0.1	1.09	-0.05
12	0.44	0.09	0.55	0.12	1	0.62	1.46	1.14	1.29	0.92	0.69	0.19	0.56	-0.48
13	0.64	-0.56	0.65	-0.72	0.73	-0.6	1.12	-0.68	0.87	-0.54	0.65	-0.77	0.01	-0.45
14	0.52	-0.43	0.66	-0.26	1.3	0.95	1.95	1.74	1.71	1.49	0.9	0.31	0.8	-0.39
15	1.61	1.09	1.97	1.32	3.66	3.25	5.01	4.71	4.53	4.2	2.57	1.75	1.54	0.91
16	1.88	1.33	2.32	1.64	4.27	3.91	5.8	5.56	5.23	4.97	3	2.28	1.85	1.19
17	1.31	-0.78	1.5	-0.31	2.71	1.6	3.91	3.03	3.46	2.51	1.82	0.32	1.58	0.13
18	1.24	-0.67	1.47	0.05	2.6	2.18	3.57	3.33	3.19	2.92	1.82	1.02	1.6	0.69
19	1.7	1.64	2.05	2.01	3.43	3.41	4.51	4.5	4.09	4.08	2.53	2.5	1.95	1.91

TABLE A3-41 CONT.

Future Demand Case Study (Run 414)
Project Demand Condition
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec	Aug	Sep
1	-616	-4552	-166	-264	-788
2	-1009	-1665	-1482	-901	-1993
3	-1037	-1532	-1322	-988	-1592
4	1433	1970	576	1076	2567
5	-4495	-9003	-7962	-4378	-7839
6	-2932	-5284	-4610	-2904	-4692
7	-5511	-10955	-9723	-5306	-9596
8	1857	3632	3309	1781	3138
9	360	-1	-1339	1074	2242
10	-322	10	-201	-86	-1
11	372	8	-1351	1101	2255
12	-303	13	-216	30	-11
13	167	-74	-28	-107	-3
14	125	-44	[illegible]	-3	-43
15	-5	-4	-1593	1298	2383
16	-1	-1	-1599	1307	2386
17	1408	1764	-50	956	2246
18	1433	1783	-56	1013	2280
19	1446	1792	-1671	2392	4689

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec	Aug	Sep
1	1.94	1.94	2.28	1.96	1.94
2	1.76	1.78	2.13	1.77	1.79
3	1.7	1.72	2.07	1.69	1.71
4	1.7	1.73	2.07	1.7	1.73
5	1.62	1.63	1.99	1.5	1.52
6	1.64	1.64	2	1.55	1.57
7	1.51	1.5	1.88	1.4	1.37
8	1.45	1.44	1.82	1.36	1.32
9	1.56	1.47	1.93	3.28	3.78
10	2.53	1.37	1.76	3.91	4.71
11	1.76	1.51	2.16	3.72	4.41
12	2.33	1.47	2.13	4	4.79
13	1.37	1.55	1.92	4.08	5.5
14	1.35	1.62	2.31	4.11	5.61
15	1.73	1.43	2.4	4.01	5.05
16	1.7	1.42	2.67	4.14	5.43
17	1.95	2.01	2.13	1.85	2.08
18	3.78	4.06	2.81	3.23	4.31
19	6.11	6.81	5.72	7.08	10.3

Minimum and Maximum Velocity

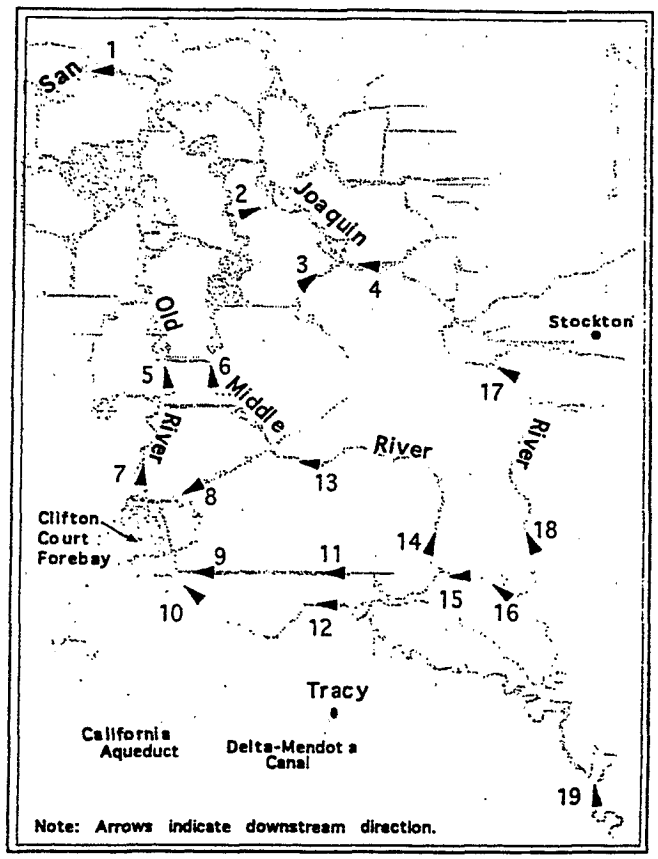
Ref. No.	Oct		Nov		Dec		Aug		Sep	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.35	1.2	-1.4
2	0.3	-0.5	0.3	-0.6	0.3	-0.5	0.37	-0.55	0.3	-0.6
3	0	-0.4	0.1	-0.4	0.1	-0.4	0.16	-0.4	0.1	-0.5
4	0.4	-0.3	0.5	-0.3	0.4	-0.4	0.41	-0.31	0.5	-0.3
5	0.7	-1.3	0.7	-2.0	0.7	-1.9	0.74	-1.26	0.5	-1.0
6	0.8	-1.3	0.7	-1.9	0.7	-1.8	0.77	-1.27	0.5	-1.7
7	0.6	-2.2	0.6	-3.1	0.7	-3.0	0.64	-2.01	1.2	-3.0
8	1.1	-0.1	1.3	-0.1	0.9	-0.1	1.25	-0.12	0.9	-0.1
9	1.0	-1.0	0.8	-0.7	1.0	-0.4	1.04	-0.46	1.3	0.0
10	0.0	-0.6	0.7	-0.6	0.7	-0.5	0	-0.56	0.0	0.0
11	0.9	-0.6	0.7	-0.6	0.9	-0.3	0.94	-0.31	1.2	0.0
12	0.1	-0.6	0.2	-0.1	0.3	0.0	0.41	-0.39	0.6	-0.6
13	0.0	-0.6	0.6	-0.6	0.6	-0.6	0.01	-0.58	0.0	0.0
14	0.2	-0.8	0.1	-0.7	0.4	-0.5	0.45	-0.53	0.6	-0.6
15	0.3	-0.4	0.2	-0.2	1.2	-0.6	1.05	0.4	1.6	-0.8
16	0.1	-0.2	0.1	-0.1	1.5	-0.7	1.23	0.53	1.9	1.1
17	1.5	-0.3	1.6	0.0	1.1	-1.1	1.29	-0.66	1.7	0.4
18	1.5	-0.2	1.6	0.4	1.0	-1.1	1.28	-0.58	1.7	0.9
19	0.9	0.8	1.1	1.0	1.1	1.0	1.37	1.3	2.0	2.0

TABLE A3-42

Existing Demand Case Study
Fisheries Alt. (Run 454)
Representative Critical Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-193	-2157	-1863	-2503	237	-113	1244	210	-843
2	-371	-101	-168	-718	-196	-74	-253	-365	-287
3	-630	-575	-605	-1038	-430	-349	-390	-665	-738
4	14	-11	62	194	455	389	404	78	-161
5	-3229	-3259	-3281	-5873	-1520	-1183	-1159	-3049	-3752
6	-2329	-2298	-2324	-4008	-1155	-923	-946	-2235	-2721
7	-3877	-3885	-3902	-6997	-1758	-1293	-1286	-3485	-4283
8	1769	1762	1763	3092	837	619	622	1521	1850
9	696	696	849	1116	1132	962	965	746	392
10	111	110	130	138	146	103	104	29	-24
11	699	699	856	1122	1143	980	982	782	433
12	120	120	144	165	216	207	208	193	151
13	-27	-27	-36	-39	-4	-32	-32	-107	-131
14	-7	-7	0	-37	39	51	51	37	23
15	814	814	1020	1307	1496	1372	1376	1228	842
16	816	816	1024	1309	1501	1380	1384	1242	857
17	-68	-68	-25	-203	371	331	328	30	-186
18	-63	-63	-13	-205	407	379	375	96	-117
19	758	758	1021	1136	1959	1824	1824	1435	846



Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
2	1.8	1.8	1.8	1.8	1.9	1.8	1.9	1.8	1.8
3	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7
4	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7
5	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.6
6	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.7
7	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.6	1.5
8	1.5	1.5	1.5	1.5	1.7	1.7	1.7	1.6	1.5
9	1.6	1.5	1.6	1.5	1.8	1.8	1.8	1.6	1.5
10	1.5	1.4	1.5	1.4	1.7	1.7	1.7	1.5	1.4
11	1.9	1.8	1.9	1.8	2.1	2.1	2.1	1.9	1.8
12	1.9	1.8	1.9	1.8	2.1	2.1	2.1	1.9	1.7
13	1.6	1.6	1.6	1.6	1.8	1.7	1.7	1.6	1.6
14	2.0	2.0	2.0	2.0	2.2	2.1	2.2	1.9	1.7
15	2.1	2.0	2.1	2.0	2.4	2.4	2.4	2.1	1.9
16	2.2	2.2	2.3	2.2	2.7	2.6	2.7	2.4	2.1
17	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.8	1.8
18	2.4	2.4	2.4	2.4	2.8	2.7	2.7	2.5	2.3
19	4.0	3.9	4.5	4.6	6.2	6.0	6.0	5.2	4.0

Minimum and Maximum Velocity

Ref.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.3	1.2	-1.3
2	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.5	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.1	-0.3	0.1	-0.3
4	0.4	-0.4	0.3	-0.4	0.3	-0.4	0.4	-0.4	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.3	-0.4
5	0.8	-1.3	0.8	-1.3	0.8	-1.3	0.6	-1.5	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	0.7	-1.3
6	0.8	-1.4	0.8	-1.4	0.8	-1.4	0.6	-1.6	0.9	-1.2	0.9	-1.1	0.9	-1.2	0.8	-1.3	0.8	-1.4
7	0.9	-2.2	0.9	-2.2	0.9	-2.2	0.7	-2.6	1.1	-1.6	1.2	-1.5	1.2	-1.6	1.0	-1.9	0.8	-2.0
8	0.9	-0.2	0.9	-0.2	0.9	-0.2	1.1	-0.1	0.9	-0.3	0.8	-0.3	0.8	-0.3	1.0	-0.2	1.0	-0.1
9	1.0	-0.7	1.0	-0.7	1.0	-0.7	0.9	-0.4	1.0	-0.8	1.0	-0.8	1.0	-0.8	1.0	-0.9	1.0	-0.9
10	0.7	-0.6	0.7	-0.6	0.7	-0.6	0.6	-0.5	0.7	-0.7	0.7	-0.8	0.7	-0.8	0.7	-0.8	0.7	-0.8
11	0.9	-0.5	0.9	-0.5	0.9	-0.5	0.8	-0.3	0.9	-0.8	0.9	-0.7	0.9	-0.7	0.9	-0.8	0.8	-0.8
12	0.3	-0.1	0.3	-0.1	0.3	-0.1	0.3	0.0	0.3	-0.1	0.3	-0.2	0.3	-0.2	0.3	-0.2	0.3	-0.2
13	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.6	0.6	-0.7	0.6	-0.7	0.6	-0.8	0.6	-0.8	0.6	-0.8
14	0.4	-0.6	0.3	-0.6	0.4	-0.6	0.3	-0.7	0.5	-0.5	0.5	-0.4	0.5	-0.4	0.5	-0.5	0.4	-0.6
15	1.0	-0.1	1.0	-0.1	1.1	0.1	1.0	0.5	1.3	0.1	1.2	0.0	1.2	0.0	1.1	-0.2	1.0	-0.55
16	1.1	-0.1	1.1	-0.1	1.2	0.2	1.3	0.7	1.5	-0.3	1.4	0.1	1.4	0.1	1.3	-0.2	1.1	-0.5
17	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.0	-1.1	1.2	-1.0	1.2	-1.0	1.2	-1.0	1.1	-1.1	1.0	-1.2
18	0.9	-1.1	0.9	-1.1	0.9	-1.1	0.8	-1.2	1.1	-0.8	1.0	-0.8	1.0	-0.9	1.0	-1.0	0.9	-1.1
19	0.7	0.5	0.7	0.5	0.8	0.7	0.9	0.8	1.3	1.1	1.2	1.1	1.2	1.1	1.1	0.9	0.8	0.5

TABLE A3-42 CONT.

Existing Fisheries Alternative Case Study (Run 454)
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	309	467	-1088	-13	-2224	-359	-140
2	-885	-773	-546	-418	-276	-252	-240
3	-820	-737	-701	-608	-629	-529	-489
4	1785	1258	1239	152	348	29	151
5	-2547	-2727	-2749	-3212	-3664	-2853	-2396
6	-1760	-1857	-1835	-2113	-2291	-1871	-1605
7	-3118	-3349	-3357	-3934	-4447	-3355	-2871
8	1115	1216	1208	1427	1584	1163	1031
9	-68	-34	-35	734	1199	374	589
10	-33	-19	-19	156	247	15	88
11	-55	-24	-24	747	1213	398	604
12	3	1	1	171	264	139	162
13	-68	-61	-61	-31	-15	-78	-37
14	-15	-19	-19	15	34	23	28
15	-8	-4	-4	968	1549	723	896
16	0	0	0	974	1553	735	904
17	1795	1244	1244	95	315	-6	105
18	1829	1266	1266	111	334	47	141
19	1855	1279	1279	1098	1904	859	1092

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.99	2	1.99	1.99	1.97	1.97	1.98
2	1.82	1.83	1.82	1.82	1.8	1.8	1.81
3	1.75	1.76	1.75	1.75	1.73	1.74	1.74
4	1.76	1.76	1.75	1.75	1.73	1.74	1.74
5	1.69	1.7	1.69	1.69	1.68	1.69	1.7
6	1.7	1.71	1.7	1.7	1.68	1.69	1.7
7	1.58	1.59	1.58	1.58	1.57	1.6	1.6
8	1.52	1.53	1.52	1.52	1.52	1.55	1.55
9	1.51	1.52	1.51	1.57	1.59	1.6	1.61
10	1.46	1.46	1.45	1.46	1.47	1.51	1.51
11	1.59	1.6	1.59	1.86	1.91	1.84	1.88
12	1.52	1.53	1.52	1.82	1.88	1.77	1.83
13	1.56	1.57	1.56	1.57	1.57	1.58	1.59
14	1.52	1.53	1.52	1.85	1.91	1.76	1.84
15	1.49	1.5	1.49	2.02	2.15	1.95	2.03
16	1.45	1.47	1.45	2.24	2.46	2.14	2.24
17	2.05	1.98	1.97	1.82	1.82	1.79	1.81
18	4.13	3.67	3.64	2.48	2.65	2.37	2.47
19	6.94	5.77	5.75	4.65	6.08	4.14	4.63

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.3
2	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.3	0.2	-0.3
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4
5	0.9	-1.3	0.9	-1.4	0.9	-1.4	0.9	-1.5	0.9	-1.6	0.9	-1.2	0.9	-1.2
6	1.0	-1.3	1.0	-1.4	1.0	-1.4	0.9	-1.5	1.0	-1.5	1.0	-1.3	1.0	-1.3
7	1.0	-1.9	1.0	-2.2	1.0	-2.2	0.9	-2.3	0.9	-2.4	1.0	-2.0	1.0	-1.9
8	1.1	-0.2	0.8	-0.2	0.8	-0.2	0.9	-0.2	0.9	-0.2	1.2	-0.2	1.1	-0.2
9	0.9	-1.0	1.0	-1.0	1.0	-1.0	1.0	-0.7	1.1	-0.6	1.0	-0.9	1.0	-0.9
10	0.8	-0.9	0.9	-0.8	0.8	-0.8	0.8	-0.7	0.9	-0.6	0.8	-0.8	0.8	-0.8
11	0.7	-0.8	0.8	-0.8	0.8	-0.8	0.9	-0.6	0.9	-0.5	0.8	-0.8	0.9	-0.7
12	0.3	-0.3	0.3	-0.3	0.3	-0.3	0.4	-0.1	0.4	-0.1	0.4	-0.4	0.4	-0.3
13	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7
14	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.6	-0.6
15	0.4	-0.4	0.4	-0.4	0.3	-0.4	1.2	-0.1	1.3	0.5	1.1	-0.7	1.1	-0.6
16	0.2	-0.2	0.2	-0.2	0.2	-0.2	1.3	-0.2	1.5	0.6	1.2	-0.7	1.3	-0.6
17	1.6	0.0	1.4	-0.5	1.4	-0.5	1.1	-1.1	1.2	-1.0	1.1	-1.1	1.1	-1.1
18	1.6	0.5	1.4	-0.4	1.4	-0.4	0.9	-1.0	1.0	-0.9	0.9	-1.0	0.9	-1.0
19	1.1	1.0	0.9	0.7	0.9	0.8	0.9	0.7	1.2	1.1	0.8	0.5	0.9	0.6

TABLE A3-43

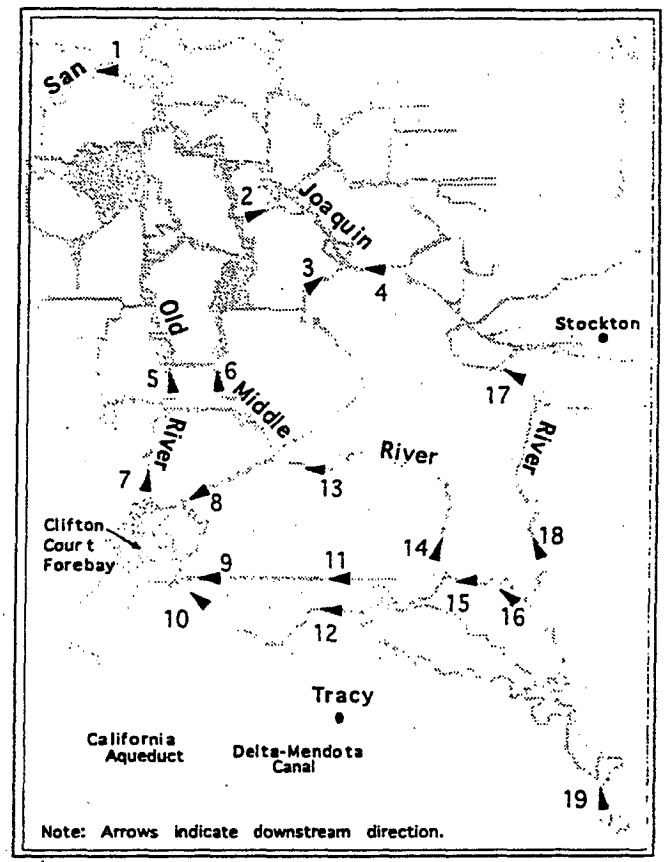
Existing Demand Case Study
Fisheries Alt. (Run 454)
Representative Dry Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	260	-92	1324	1184	339	2022	125	-2259
2	-694	-667	-880	-444	-203	-429	-414	-757
3	-701	-729	-729	-477	-392	-439	-620	-1045
4	963	967	992	1181	719	733	210	6
5	-3072	-3304	-3072	-1084	-1114	-1086	-3131	-6696
6	-1987	-2119	-2005	-770	-804	-826	-2054	-4002
7	-3616	-4083	-3611	-1301	-1249	-1236	-3649	-7940
8	1449	1522	1442	538	479	484	1242	2571
9	1697	1829	1583	1773	1261	1267	768	874
10	353	360	323	334	208	210	78	87
11	1699	1834	1588	1784	1284	1289	810	916
12	352	375	338	397	318	320	238	247
13	57	44	48	80	8	8	-102	-146
14	57	67	54	110	91	91	56	15
15	2095	2286	1992	2374	1848	1854	1340	1419
16	2095	2288	1994	2377	1855	1863	1355	1433
17	785	888	669	1141	696	688	179	-44
18	760	903	667	1176	746	738	248	26
19	2863	3209	2878	3601	2674	2674	1701	1559

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.1	2.1	2.1	2.1	2.0	2.1	2.0	1.9
2	1.9	1.9	2.0	1.9	1.9	1.9	1.8	1.8
3	1.8	1.9	1.8	1.9	1.8	1.8	1.8	1.7
4	1.8	1.9	1.9	1.9	1.8	1.8	1.8	1.7
5	1.8	1.8	1.9	1.8	1.8	1.8	1.7	1.6
6	1.8	1.8	1.9	1.8	1.8	1.8	1.7	1.6
7	1.7	1.7	1.8	1.8	1.7	1.7	1.6	1.5
8	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.4
9	1.7	1.8	1.8	1.9	1.8	1.8	1.6	1.5
10	1.6	1.6	1.7	1.8	1.7	1.7	1.5	1.3
11	2.1	2.2	2.2	2.3	2.1	2.2	1.9	1.7
12	2.1	2.1	2.1	2.2	2.1	2.1	1.8	1.7
13	1.7	1.7	1.8	1.8	1.7	1.7	1.6	1.5
14	2.2	2.2	2.2	2.3	2.1	2.1	1.8	1.6
15	2.5	2.6	2.5	2.7	2.4	2.5	2.1	1.9
16	2.9	3.1	2.9	3.3	2.8	2.9	2.4	2.2
17	2.0	2.0	2.0	2.0	1.9	2.0	1.8	1.8
18	3.1	3.2	3.1	3.4	3.0	3.0	2.6	2.4
19	7.6	8.1	7.4	8.7	7.3	7.3	5.7	5.4



Note: Arrows indicate downstream direction.

Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.3	-1.4	1.3	-1.3	1.2	-1.4	1.3	-1.3	1.2	-1.3	1.2	-1.4
2	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.9	-1.5	0.9	-1.6	0.9	-1.6	1.0	-1.1	1.0	-1.1	1.0	-1.1	0.8	-1.3	0.7	-1.8
6	1.0	-1.5	1.0	-1.5	1.0	-1.5	1.0	-1.1	1.0	-1.2	1.0	-1.2	0.9	-1.3	0.8	-1.7
7	1.0	-2.3	1.0	-2.4	1.0	-2.4	1.1	-1.6	1.1	-1.6	1.2	-1.6	1.0	-2.0	0.7	-2.7
8	0.9	-0.2	0.9	-0.2	0.9	-0.3	1.0	-0.3	1.0	-0.3	1.0	-0.3	1.2	-0.2	1.5	-0.1
9	1.1	-0.6	1.1	-0.5	1.1	-0.6	1.1	-0.7	1.0	-0.6	1.0	-0.8	1.0	-0.9	1.0	-1.0
10	0.9	-0.6	0.9	-0.6	0.9	-0.6	0.9	-0.7	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.7	-0.9
11	1.0	-0.4	1.0	-0.3	1.0	-0.4	1.0	-0.5	0.9	-0.8	0.9	-0.6	0.9	-0.7	0.9	-0.8
12	0.5	0.0	0.5	0.0	0.5	0.0	0.5	0.0	0.5	-0.1	0.5	-0.1	0.4	-0.2	0.4	-0.2
13	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.5	-0.7	0.5	-0.8
14	0.7	-0.5	0.7	-0.5	0.7	-0.5	0.7	-0.3	0.7	-0.4	0.7	-0.4	0.7	-0.5	0.6	-0.6
15	1.6	0.8	1.7	1.0	1.5	0.8	1.7	0.7	1.5	0.4	1.5	0.4	1.3	-0.2	1.2	-0.1
16	1.8	1.0	1.9	1.2	1.7	0.9	2.0	1.0	1.7	0.6	1.7	0.6	1.4	-0.1	1.4	-0.1
17	1.3	-0.8	1.3	-0.7	1.3	-0.8	1.4	-0.6	1.3	-0.8	1.3	-0.8	1.1	-1.1	1.0	-1.1
18	1.2	-0.8	1.2	-0.5	1.1	-0.7	1.3	-0.2	1.2	-0.8	1.2	-0.6	1.0	-0.9	0.9	-1.1
19	1.6	1.5	1.7	1.6	1.5	1.4	1.8	1.7	1.5	1.4	1.5	1.4	1.2	1.0	1.1	1.0

TABLE A3-43 CONT.

Existing Fisheries Case Study (Run 454)
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1485	-440	-2903	1365	-1288	-904	-498
2	-2681	-2362	-2000	-872	-500	-459	-346
3	-1854	-1585	-1534	-763	-703	-735	-625
4	3961	3624	3598	859	839	12	115
5	-8636	-6821	-6855	-3359	-3401	-4222	-3245
6	-5145	-4171	-4137	-2192	-2160	-2701	-2141
7	-10474	-8331	-8345	-4130	-4151	-5027	-3927
8	3421	2802	2789	1521	1512	1729	1399
9	-22	-15	-15	1726	1720	564	649
10	-1	8	8	344	338	73	115
11	-9	-3	-4	1740	1734	591	665
12	31	21	22	359	353	191	183
13	-135	-100	-99	21	20	-93	-45
14	-81	-57	-67	66	65	12	16
15	-5	-5	-5	2200	2189	963	958
16	0	0	0	2204	2192	974	965
17	3882	3564	3563	793	805	-44	58
18	3964	3625	3625	815	826	8	90
19	3971	3637	3637	3036	3036	1053	1094

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.9	1.98	1.95	2.04	2.01	1.96	1.97
2	1.76	1.82	1.79	1.88	1.84	1.78	1.79
3	1.71	1.76	1.72	1.81	1.77	1.71	1.72
4	1.71	1.76	1.73	1.82	1.78	1.72	1.73
5	1.62	1.67	1.64	1.76	1.72	1.64	1.66
6	1.63	1.69	1.65	1.76	1.73	1.65	1.67
7	1.48	1.55	1.52	1.66	1.62	1.53	1.54
8	1.41	1.49	1.46	1.61	1.57	1.47	1.48
9	1.4	1.48	1.45	1.7	1.66	1.51	1.53
10	1.33	1.41	1.38	1.56	1.52	1.39	1.41
11	1.48	1.55	1.52	2.11	2.07	1.76	1.81
12	1.41	1.48	1.45	2.07	2.03	1.69	1.75
13	1.47	1.54	1.5	1.65	1.61	1.51	1.53
14	1.41	1.49	1.45	2.14	2.11	1.69	1.78
15	1.38	1.45	1.42	2.49	2.45	1.89	1.96
16	1.34	1.42	1.39	2.96	2.93	2.1	2.18
17	2.53	2.47	2.44	1.96	1.92	1.77	1.79
18	6.45	6.09	6.08	3.11	3.07	2.36	2.43
19	10.86	10.31	10.3	7.88	7.87	4.48	4.6

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.3
2	0.1	-0.7	0.1	-0.6	0.2	-0.6	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.0	-0.5	0.1	-0.5	0.1	-0.5	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4
4	0.5	-0.2	0.5	-0.2	0.5	-0.2	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.6	-2.0	0.8	-1.9	0.8	-1.9	0.9	-1.6	0.9	-1.6	0.8	-1.4	0.8	-1.3
6	0.6	-1.8	0.9	-1.8	0.8	-1.8	1.0	-1.6	1.0	-1.5	0.9	-1.4	0.9	-1.3
7	0.5	-3.1	0.8	-3.0	0.8	-2.9	1.0	-2.4	1.0	-2.4	0.8	-2.2	0.8	-2.0
8	1.6	0.0	1.2	-0.1	1.2	-0.1	0.9	-0.2	0.9	-0.2	1.3	-0.1	1.2	-0.1
9	0.8	-1.1	0.9	-0.7	0.9	-0.7	1.1	-0.6	1.1	-0.6	1.0	-0.9	1.0	-0.8
10	0.6	-1.0	0.8	-0.6	0.7	-0.6	0.9	-0.6	0.9	-0.6	0.8	-0.8	0.8	-0.7
11	0.6	-1.0	0.7	-0.6	0.7	-0.6	1.0	-0.4	1.0	-0.4	0.9	-0.8	0.9	-0.7
12	0.4	-0.4	0.2	-0.2	0.2	-0.2	0.5	0.0	0.5	0.0	0.4	-0.3	0.4	-0.3
13	0.5	-0.8	0.6	-0.7	0.6	-0.7	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.6	-0.7
14	0.3	-0.8	0.4	-0.8	0.4	-0.8	0.7	-0.5	0.7	-0.5	0.6	-0.7	0.6	-0.7
15	0.4	-0.4	0.3	-0.3	0.3	-0.3	1.6	0.9	1.6	0.9	1.1	-0.5	1.2	-0.5
16	0.2	-0.2	0.1	-0.2	0.1	-0.2	1.9	1.1	1.9	1.1	1.3	-0.5	1.3	-0.5
17	2.4	1.2	2.3	1.1	2.3	1.1	1.3	-0.8	1.3	-0.7	1.1	-1.1	1.1	-1.1
18	2.3	1.8	2.2	1.7	2.2	1.7	1.2	-0.6	1.2	-0.6	0.9	-1.1	0.9	-1.0
19	1.6	1.6	1.5	1.5	1.5	1.5	1.6	1.5	1.6	1.5	0.9	0.6	0.9	0.6

TABLE A3-44

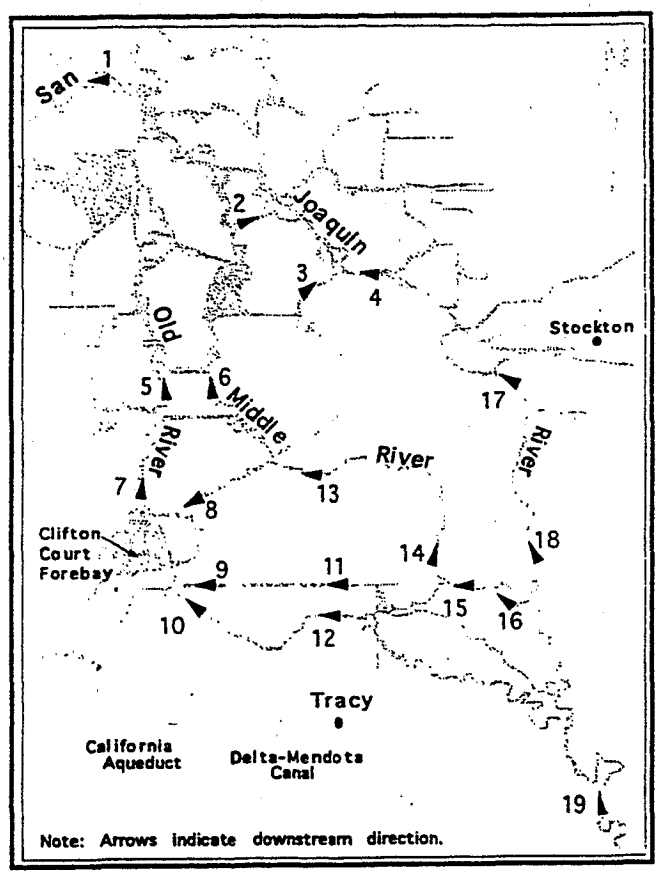
Existing Demand Case Study
Fisheries Alt. (Run 454)
Representative Below Normal Year

Average Net Discharge

Ref. No.	Jan	Feb.	March	April	May 1 20	May 21-31	June	July
1	831	126	-1587	1430	278	2571	102	-2197
2	-963	-896	-585	-538	-308	-619	-453	-772
3	-808	-815	-787	-517	-477	-539	-650	-1050
4	1370	1234	531	1357	832	850	206	9
5	-3281	-3585	-4443	-1068	-1551	-1514	-3348	-6731
6	-2110	-2276	-2747	-772	-1072	-1102	-2177	-4018
7	-4082	-4430	-5417	-1285	-1786	-1769	-3911	-7990
8	1551	1652	1913	532	667	673	1331	2590
9	2156	2010	1422	1910	1419	1426	787	892
10	407	379	276	348	237	241	81	92
11	2159	2017	1434	1925	1441	1447	827	931
12	420	397	304	427	347	351	244	248
13	86	68	9	77	10	11	-100	-140
14	80	68	33	125	96	96	52	13
15	2634	2470	1812	2562	2037	2048	1369	1423
16	2639	2474	1817	2569	2046	2057	1373	1436
17	1195	1034	405	1283	809	799	172	-42
18	1202	1041	427	1324	860	850	241	27
19	3860	3533	2268	3947	2980	2980	1714	1560

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 1 20	May 21-31	June	July
1	2.1	2.1	2.0	2.1	2.1	2.1	2.0	1.9
2	2.0	1.9	1.9	1.9	1.9	1.9	1.8	1.8
3	1.9	1.9	1.8	1.9	1.8	1.9	1.8	1.7
4	1.9	1.9	1.8	1.9	1.8	1.9	1.8	1.7
5	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.6
6	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6
7	1.8	1.7	1.6	1.8	1.7	1.8	1.6	1.5
8	1.7	1.7	1.6	1.7	1.7	1.7	1.6	1.4
9	1.8	1.8	1.7	1.9	1.8	1.8	1.6	1.5
10	1.7	1.6	1.5	1.8	1.7	1.7	1.5	1.4
11	2.3	2.2	2.0	2.4	2.2	2.2	1.9	1.7
12	2.3	2.2	2.0	2.3	2.1	2.1	1.8	1.7
13	1.8	1.7	1.6	1.8	1.7	1.7	1.6	1.5
14	2.4	2.3	2.0	2.4	2.1	2.2	1.8	1.6
15	2.8	2.7	2.3	2.8	2.5	2.5	2.1	1.9
16	3.4	3.2	2.8	3.4	2.9	3.0	2.4	2.2
17	2.1	2.0	1.9	2.1	2.0	2.0	1.8	1.8
18	3.5	3.4	2.8	3.5	3.1	3.1	2.6	2.4
19	9.0	8.6	6.7	9.1	7.8	7.8	5.7	5.4



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.3	-1.3	1.2	-1.4	1.3	-1.3	1.2	-1.3	1.2	-1.4
2	-0.3	-0.6	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.9	-1.6	0.9	-1.6	0.9	-1.7	1.0	-1.1	1.0	-1.1	1.0	-1.1	0.9	-1.3	0.7	-1.8
6	1.0	-1.5	1.0	-1.6	0.9	-1.6	1.0	-1.1	1.0	-1.2	1.0	-1.2	0.9	-1.3	0.8	-1.7
7	1.0	-2.4	1.0	-2.5	0.9	-2.6	1.1	-1.6	1.1	-1.7	1.1	-1.7	0.9	-2.1	0.7	-2.7
8	0.9	-0.2	1.0	-0.2	1.0	-0.2	1.0	-0.3	1.1	-0.3	1.1	-0.3	1.3	-0.2	1.5	-0.1
9	1.2	-0.4	1.2	-0.4	1.1	-0.5	1.1	-0.7	1.1	-0.7	1.1	-0.8	1.0	-0.9	1.0	-1.0
10	0.9	-0.6	0.9	-0.6	0.9	-0.6	0.9	-0.7	0.8	-0.7	0.8	-0.8	0.8	-0.8	0.7	-0.9
11	1.1	-0.3	1.0	-0.3	0.9	-0.4	1.0	-0.4	0.9	-0.5	1.0	-0.6	0.9	-0.7	0.9	-0.8
12	0.5	0.0	0.5	0.0	0.4	0.0	0.5	0.0	0.5	-0.1	0.5	-0.1	0.4	-0.2	0.4	-0.2
13	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.5	-0.7	0.5	-0.8
14	0.7	-0.5	0.7	-0.5	0.6	-0.6	0.8	-0.3	0.7	-0.3	0.7	-0.4	0.6	-0.5	0.6	-0.6
15	1.8	1.1	1.8	1.1	1.4	0.7	1.8	0.8	1.6	0.5	1.6	0.5	1.3	-0.2	1.2	-0.2
16	2.1	1.4	2.0	1.3	1.6	0.9	2.1	1.1	1.8	0.8	1.8	0.8	1.4	-0.1	1.4	-0.1
17	1.4	-0.5	1.4	-0.6	1.2	-0.9	1.4	-0.5	1.3	-0.8	1.3	-0.8	1.1	-1.1	1.0	-1.1
18	1.3	-0.3	1.3	-0.4	1.1	-0.8	1.3	-0.1	1.2	-0.5	1.2	-0.5	1.0	-0.9	0.9	-1.1
19	1.8	1.8	1.7	1.7	1.4	1.3	1.9	1.8	1.6	1.5	1.6	1.5	1.2	1.0	1.1	1.0

TABLE A3-44 CONT.

Existing Fisheries Case Study (Run 454)
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	-1201	-3936	-3595	-974	-1661	-677
2	-1996	-2412	-989	-1360	-628	-402
3	-1529	-1793	-1096	-1148	-893	-665
4	2744	3837	1136	1149	-96	61
5	-7248	-9002	-6425	-6387	-5664	-3691
6	-4336	-5338	-3754	-3785	-3454	-2384
7	-8803	-10939	-7817	-7798	-6751	-4457
8	2879	3621	2634	2645	2252	1567
9	-34	23	2206	2210	540	591
10	-6	21	384	389	63	102
11	-20	32	2209	2214	567	607
12	26	26	387	393	161	173
13	121	-113	32	33	-111	-52
14	-67	-79	49	50	-6	7
15	-5	-4	2642	2654	910	882
16	0	0	2641	2654	921	889
17	2662	3755	991	975	-168	-2
18	2708	3829	998	983	-116	29
19	2729	3826	3652	3652	876	957

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	1.94	1.94	1.95	1.98	1.94	1.96
2	1.78	1.79	1.78	1.82	1.77	1.79
3	1.72	1.73	1.72	1.76	1.7	1.72
4	1.72	1.74	1.72	1.76	1.7	1.72
5	1.62	1.63	1.67	1.7	1.62	1.66
6	1.64	1.65	1.67	1.71	1.64	1.66
7	1.49	1.5	1.57	1.61	1.5	1.54
8	1.42	1.44	1.52	1.56	1.44	1.48
9	1.41	1.43	1.63	1.67	1.48	1.52
10	1.34	1.36	1.48	1.52	1.37	1.41
11	1.49	1.46	2.11	2.15	1.72	1.79
12	1.42	1.39	2.07	2.11	1.65	1.73
13	1.48	1.49	1.57	1.6	1.49	1.53
14	1.42	1.46	2.19	2.23	1.65	1.76
15	1.39	1.38	2.57	2.6	1.83	1.93
16	1.36	1.36	3.15	3.18	2.02	2.13
17	2.2	2.5	1.9	1.94	1.74	1.78
18	5.08	6.31	3.26	3.29	2.27	2.38
19	8.67	10.63	8.71	8.72	4.08	4.33

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3
2	0.2	-0.8	0.2	-0.6	0.3	-0.5	0.2	-0.5	0.3	-0.5	0.4	-0.5
3	0.1	-0.5	0.1	-0.5	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4
4	0.5	-0.3	0.5	-0.2	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.7	-1.8	0.7	-2.0	0.8	-1.8	0.8	-1.8	0.8	-1.6	0.8	-1.3
6	0.7	-1.7	0.7	-1.9	0.9	-1.7	0.9	-1.8	0.8	-1.6	0.9	-1.3
7	0.6	-2.8	0.6	-3.2	0.9	-2.8	0.9	-2.9	0.7	-2.4	0.8	-2.1
8	1.6	-0.1	1.3	-0.1	1.1	-0.2	1.2	-0.2	1.5	-0.1	1.3	-0.1
9	0.8	-1.1	0.8	-0.7	1.2	-0.3	1.2	-0.3	1.0	-1.0	1.0	-0.9
10	0.7	-1.0	0.7	-0.6	0.9	-0.4	0.9	-0.4	0.8	-0.8	0.8	-0.7
11	0.7	-1.0	0.7	-0.6	1.0	-0.1	1.0	-0.1	0.8	-0.8	0.9	-0.7
12	0.3	-0.4	0.2	-0.2	0.5	0.1	0.5	0.1	0.4	-0.4	0.4	-0.3
13	0.5	-0.8	0.5	-0.5	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.6	-0.7
14	0.3	-0.8	0.3	-0.8	0.7	-0.5	0.7	-0.5	0.6	-0.7	0.5	-0.7
15	0.4	-0.4	0.2	-0.2	1.8	1.3	1.8	1.3	1.1	-0.6	1.1	-0.5
16	0.2	-0.2	0.1	-0.1	2.0	1.5	2.0	1.5	1.2	-0.6	1.2	-0.5
17	1.9	0.6	2.3	1.2	1.4	-0.6	1.4	-0.7	1.0	-1.2	1.1	-1.1
18	1.9	1.2	2.3	1.8	1.3	-0.5	1.3	-0.5	0.9	-1.1	0.9	-1.1
19	1.3	1.3	1.6	1.6	1.8	1.7	1.8	1.7	0.8	0.6	0.8	0.6

TABLE A3-45

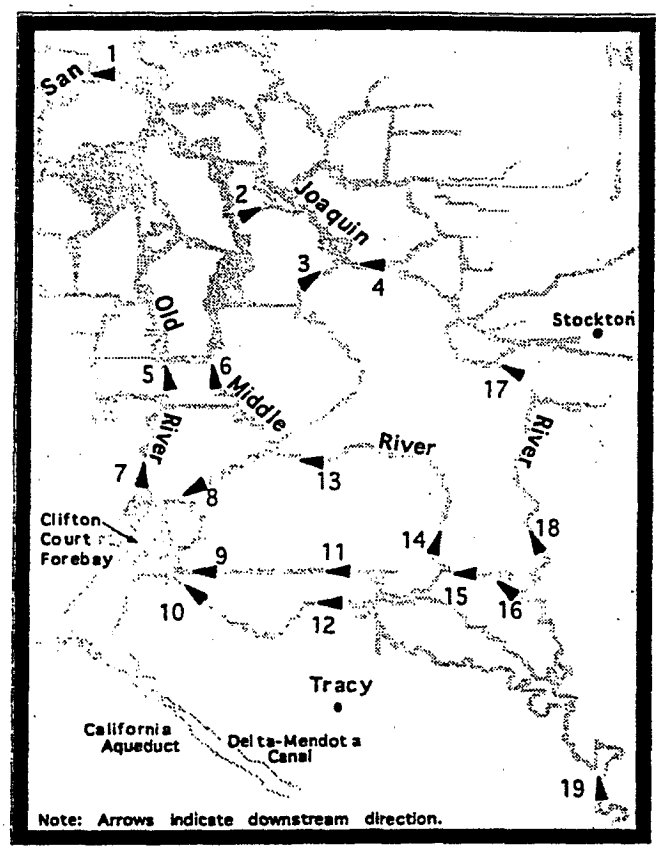
Existing Demand Case Study
Fisheries Alt. (Run 454)
Representative Above Normal Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	472	-2140	724	1293	1392	1049	3472	219	-2238
2	-923	-551	-859	-921	-582	-591	-923	-569	-862
3	-826	-770	-808	-814	-552	-585	-648	-713	-1115
4	643	620	990	772	1348	1307	1327	216	-4
5	-4385	-4424	-3698	-3833	-1344	-1596	-1557	-3749	-7240
6	-2727	-2697	-2361	-2461	-931	-1094	-1126	-2407	-4294
7	-5400	-5419	-4594	-4722	-1634	-1884	-1866	-4403	-8600
8	1933	1923	1694	1721	864	740	747	1500	2769
9	1580	1576	1811	1411	1944	1877	1882	802	909
10	314	309	361	288	362	341	346	82	69
11	1581	1578	1813	1417	1955	1889	1894	842	951
12	318	314	367	308	426	418	423	249	250
13	21	20	46	12	92	73	73	-99	-150
14	-34	34	58	38	116	113	113	46	11
15	1927	1918	2240	1788	2562	2530	2540	1377	1451
16	1928	1919	2241	1791	2568	2533	2542	1392	1465
17	502	510	809	432	1276	1216	1207	149	-61
18	505	514	814	447	1308	1258	1249	217	10
19	2439	2439	3069	2254	3922	3851	3851	1710	1575

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April 16-30	May 1-20	May 21-31	June	July
1	2.0	2.0	2.1	2.2	2.1	2.1	2.1	2.0	1.9
2	1.9	1.8	2.0	2.0	1.9	1.9	2.0	1.8	1.8
3	1.8	1.8	1.9	2.0	1.9	1.9	1.9	1.8	1.7
4	1.8	1.8	1.9	2.0	1.9	1.9	1.9	1.8	1.7
5	1.7	1.7	1.9	1.9	1.8	1.8	1.9	1.7	1.6
6	1.7	1.7	1.9	1.9	1.8	1.8	1.9	1.7	1.6
7	1.6	1.6	1.8	1.8	1.8	1.8	1.8	1.6	1.5
8	1.6	1.6	1.7	1.8	1.7	1.7	1.8	1.6	1.4
9	1.7	1.6	1.8	1.8	1.9	1.9	1.9	1.6	1.5
10	1.5	1.5	1.7	1.7	1.8	1.7	1.8	1.5	1.3
11	2.0	2.0	2.2	2.1	2.4	2.3	2.3	1.9	1.7
12	2.0	2.0	2.2	2.1	2.3	2.2	2.3	1.8	1.7
13	1.6	1.6	1.8	1.8	1.8	1.7	1.8	1.6	1.5
14	2.1	2.0	2.3	2.2	2.4	2.3	2.4	1.8	1.8
15	2.3	2.3	2.6	2.4	2.8	2.8	2.8	2.1	1.9
16	2.7	2.7	3.0	2.8	3.4	3.4	3.4	2.3	2.2
17	1.9	1.9	2.1	2.1	2.1	2.0	2.1	1.8	1.8
18	2.9	2.9	3.2	2.9	3.5	3.4	3.5	2.6	2.4
19	7.0	7.0	7.9	6.7	9.1	9.0	9.0	5.7	5.4



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16		Jan. 17-31		February		March		April		May 1-20		May 21-31		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.3	-1.3	1.2	-1.3	1.3	-1.3	1.2	-1.3	1.2	-1.4
2	0.3	-0.5	0.4	-0.5	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.9	-1.7	0.9	-1.7	0.9	-1.6	0.9	-1.6	1.0	-1.1	1.0	-1.1	1.0	-1.1	0.9	-1.4	0.7	-1.8
6	1.0	-1.7	0.9	-1.6	1.0	-1.6	1.0	-1.6	1.0	-1.2	1.0	-1.1	1.0	-1.2	0.9	-1.3	0.7	-1.7
7	0.9	-2.6	0.9	-2.6	0.9	-2.5	1.0	-2.5	1.1	-1.7	1.1	-1.7	1.1	-1.7	0.9	-2.2	0.7	-2.8
8	1.0	-0.2	1.0	-0.2	1.0	-0.2	1.0	-0.2	1.1	-0.3	1.1	-0.3	1.1	-0.3	1.3	-0.2	1.3	-0.1
9	1.1	-0.4	1.1	-0.4	1.1	-0.5	1.1	-0.6	1.1	-0.7	1.1	-0.7	1.1	-0.7	1.0	-0.9	1.0	-1.0
10	0.9	-0.6	0.9	-0.5	0.9	-0.6	0.9	-0.6	0.9	-0.7	0.9	-0.7	0.9	-0.7	0.8	-0.8	0.7	-0.9
11	1.0	-0.3	1.0	-0.3	1.0	-0.3	0.9	-0.4	1.0	-0.4	1.0	-0.5	1.0	-0.5	0.9	-0.7	0.9	-0.9
12	0.4	0.0	0.4	0.0	0.5	0.0	0.4	0.0	0.5	0.0	0.5	0.0	0.5	0.0	0.4	-0.2	0.4	-0.2
13	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.5	-0.7	0.5	-0.8
14	0.6	-0.6	0.6	-0.6	0.7	-0.5	0.6	-0.6	0.8	-0.3	0.8	-0.3	0.8	-0.3	0.6	-0.6	0.6	-0.6
15	1.5	0.6	1.5	0.8	1.6	0.9	1.4	0.7	1.8	0.8	1.8	0.8	1.8	0.8	1.3	-0.1	1.2	-0.1
16	1.7	0.9	1.7	0.9	1.9	1.1	1.6	0.8	2.1	1.1	2.1	1.1	2.1	1.1	1.4	-0.1	1.4	-0.1
17	1.2	-0.9	1.2	-0.9	1.3	-0.7	1.2	-0.9	1.4	-0.5	1.4	-0.5	1.4	-0.6	1.1	-1.1	1.0	-1.1
18	1.1	-0.8	1.1	-0.8	1.2	-0.6	1.1	-0.8	1.3	-0.1	1.3	-0.1	1.3	-0.2	1.0	-0.9	0.9	-1.1
19	1.4	1.3	1.4	1.4	1.6	1.5	1.4	1.3	1.8	1.8	1.8	1.8	1.8	1.8	1.2	1.0	1.1	1.0

TABLE A3-45 CONT.

Existing Fisheries Case Study (Run 454)
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1156	-1091	-3887	-121	-2224	-1734	-648
2	-2814	-1722	-1313	-573	-276	-711	-399
3	-1914	-1344	-1285	-679	-629	-951	-658
4	3943	2113	2083	369	348	-45	104
5	-9149	-6775	-6813	-3633	-3664	-6040	-3580
6	-5438	-4101	-4062	-2317	-2291	-3648	-2318
7	-11119	-8248	-8264	-4432	-4447	-7205	-4320
8	3624	2767	2752	1594	1584	2389	1528
9	-8	-15	-16	1202	1199	705	681
10	6	7	7	250	247	89	125
11	4	-3	-4	1215	1213	732	695
12	32	21	21	266	264	207	188
13	-134	-99	-99	-14	-15	-107	-44
14	-89	-56	-56	34	34	-3	11
15	-5	-5	-5	1554	1549	1104	981
16	0	0	0	1559	1553	1115	987
17	3822	2080	2079	311	315	-120	42
18	3904	2108	2108	329	334	-68	71
19	3910	2119	2119	1904	1904	1118	1096

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.91	1.97	1.93	1.99	1.97	1.94	1.96
2	1.77	1.8	1.78	1.82	1.8	1.77	1.79
3	1.71	1.74	1.69	1.75	1.73	1.7	1.72
4	1.71	1.74	1.7	1.76	1.73	1.71	1.72
5	1.66	1.66	1.61	1.7	1.68	1.62	1.66
6	1.66	1.67	1.63	1.71	1.68	1.64	1.67
7	1.52	1.53	1.49	1.6	1.57	1.5	1.54
8	1.45	1.47	1.43	1.55	1.52	1.44	1.48
9	1.43	1.46	1.42	1.61	1.59	1.48	1.53
10	1.37	1.4	1.35	1.49	1.47	1.37	1.41
11	1.5	1.54	1.5	1.94	1.91	1.74	1.8
12	1.43	1.47	1.43	1.9	1.88	1.67	1.75
13	1.51	1.52	1.48	1.59	1.57	1.49	1.53
14	1.44	1.47	1.43	1.94	1.91	1.67	1.79
15	1.4	1.44	1.4	2.17	2.15	1.87	1.96
16	1.37	1.4	1.36	2.48	2.46	2.08	2.18
17	2.51	2.08	2.04	1.85	1.82	1.75	1.78
18	6.4	4.41	4.38	2.68	2.65	2.33	2.42
19	10.77	7.49	7.47	6.09	6.08	4.56	4.6

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3
2	0.1	-0.7	0.2	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5	0.4	-0.5
3	0.0	-0.5	0.2	-0.5	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.2	-0.4
4	0.5	-0.2	0.5	-0.3	0.5	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4
5	0.5	-2.0	0.8	-1.9	0.8	-1.9	0.9	-1.6	0.9	-1.6	0.7	-1.7	0.8	-1.3
6	0.5	-1.8	0.9	-1.8	0.9	-1.8	1.0	-1.6	1.0	-1.5	0.8	-1.6	0.9	-1.3
7	0.4	-3.2	0.8	-3.0	0.8	-2.9	1.0	-2.5	0.9	-2.4	0.7	-2.5	0.8	-2.1
8	1.6	0.0	1.2	-0.1	1.2	-0.1	1.0	-0.2	0.9	-0.2	1.5	-0.1	1.2	-0.1
9	0.7	-1.2	0.9	-0.7	0.9	-0.7	1.1	-0.7	1.1	-0.6	1.0	-1.0	1.0	-0.8
10	0.6	-1.0	0.8	-0.6	0.8	-0.6	0.9	-0.6	0.9	-0.6	0.8	-0.9	0.8	-0.7
11	0.6	-1.0	0.7	-0.6	0.7	-0.6	0.9	-0.5	0.9	-0.5	0.9	-0.8	0.9	-0.7
12	0.4	-0.4	0.2	-0.2	0.2	-0.2	0.4	-0.1	0.4	-0.1	0.4	-0.3	0.4	-0.3
13	0.5	-0.8	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.5	-0.8	0.6	-0.7
14	0.3	-0.8	0.4	-0.8	0.4	-0.8	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.6	-0.7
15	0.4	-0.4	0.3	-0.3	0.3	-0.3	1.3	0.5	1.3	0.5	1.1	-0.5	1.2	-0.5
16	0.2	-0.2	0.1	-0.2	0.1	-0.2	1.5	0.6	1.5	0.6	1.2	-0.5	1.3	-0.5
17	2.4	1.2	1.7	0.2	1.7	0.3	1.2	-1.0	1.2	-1.0	1.0	-1.1	1.1	-1.1
18	2.3	1.8	1.7	0.7	1.7	0.8	1.0	-0.9	1.0	-0.9	0.9	-1.1	0.9	-1.0
19	1.6	1.8	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.1	0.9	0.7	0.9	0.6

TABLE A3-46

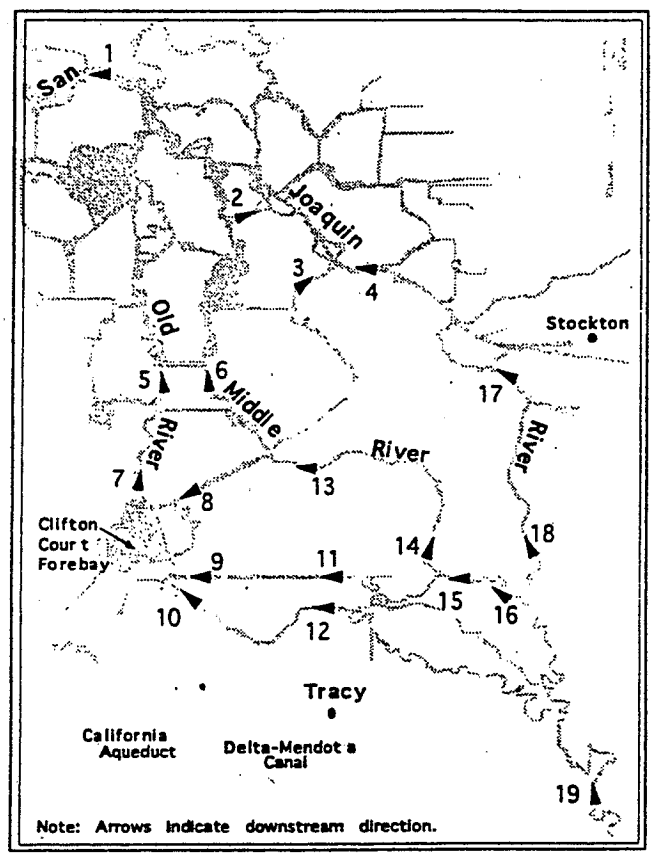
Existing Demand Case Study
Fisheries Alt. (Run 454)
Representative Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	7640	10732	14585	24914	11609	2665	658
2	-2481	-2800	-3724	-5625	-3538	-1938	-1110
3	-1258	-1302	-1453	-2035	-1582	-1337	-1006
4	2408	3428	6076	10547	7623	2745	1478
5	-4125	-2347	-52	3475	820	-4677	-4015
6	-2798	-1856	-428	1585	284	-2920	-2595
7	-5400	-3136	-503	3518	731	-5619	-4748
8	2034	1335	583	-800	48	1940	1643
9	2047	3044	6108	10162	8444	3416	2101
10	437	578	1353	2516	1869	527	289
11	2043	3054	6115	10199	8487	3456	2141
12	398	598	1327	2561	1995	698	464
13	85	177	538	999	706	93	32
14	54	172	501	1004	782	235	124
15	2434	3813	7843	13725	11343	4600	2951
16	2436	3833	7918	13857	11460	4634	2985
17	895	2081	4752	8735	6988	2452	1327
18	872	2090	4827	9119	7306	2541	1404
19	3309	5976	12889	23235	19046	7340	4478

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	2.5	2.6	2.6	3.1	2.4	2.1	2.0
2	2.3	2.5	2.5	3.0	2.3	1.9	1.8
3	2.3	2.4	2.5	3.0	2.3	1.9	1.8
4	2.3	2.4	2.5	3.0	2.3	1.9	1.8
5	2.2	2.3	2.4	3.0	2.3	1.8	1.7
6	2.2	2.4	2.4	3.0	2.2	1.8	1.7
7	2.1	2.3	2.4	3.1	2.3	1.7	1.6
8	2.1	2.2	2.4	3.2	2.4	1.7	1.6
9	2.2	2.4	2.9	4.1	3.1	1.9	1.7
10	2.0	2.2	2.5	3.6	2.8	1.6	1.5
11	2.6	3.0	4.1	6.1	5.0	2.7	2.2
12	2.5	2.9	4.0	5.9	4.6	2.6	2.1
13	2.1	2.3	2.4	3.1	2.3	1.7	1.6
14	2.6	3.1	4.6	7.1	5.8	2.8	2.2
15	2.9	3.7	6.0	9.4	7.8	3.7	2.8
16	3.4	4.6	7.8	12.1	10.3	4.9	3.5
17	2.4	2.7	3.4	4.9	3.9	2.3	2.0
18	3.5	4.6	7.5	11.5	9.8	4.8	3.6
19	8.3	11.6	17.8	24.7	22.1	12.9	9.8



Minimum and Maximum Velocity

Ref. No.	January		February		March		April		May		June		July	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.3	-1.3	1.3	-1.3	1.4	-1.2	1.4	-1.1	1.3	-1.2	1.2	-1.3	1.2	-1.3
2	0.2	-0.6	0.1	-0.6	0.0	-0.7	-0.2	-0.9	0.1	-0.7	0.3	-0.6	0.3	-0.5
3	0.1	-0.4	0.1	-0.5	0.1	-0.6	0.0	-0.5	0.1	-0.5	0.1	-0.4	0.2	-0.4
4	0.4	-0.3	0.5	-0.3	0.6	-0.1	0.7	0.1	0.8	-0.1	0.5	-0.3	0.5	-0.3
5	0.9	-1.7	0.9	-1.5	1.1	-1.3	1.3	-0.9	1.2	-1.1	0.8	-1.6	0.8	-1.4
6	0.9	-1.7	0.9	-1.5	1.0	-1.4	1.2	-1.1	1.1	-1.1	0.9	-1.5	0.9	-1.5
7	0.9	-2.7	1.0	-2.3	1.1	-2.0	1.7	-1.2	1.5	-1.6	0.9	-2.4	0.9	-2.2
8	1.1	-0.2	0.9	-0.3	0.8	-0.3	0.8	-0.5	1.0	-0.4	1.3	-0.2	1.3	-0.2
9	1.1	-0.3	1.2	-0.3	1.7	0.5	2.2	1.1	2.6	0.9	1.4	-0.4	1.2	-0.7
10	0.9	-0.5	1.0	-0.6	1.2	-0.1	1.6	0.1	1.4	-0.1	0.9	-0.6	0.9	-0.8
11	1.0	-0.1	1.2	-0.1	1.8	0.8	2.1	1.4	2.0	1.1	1.3	-0.1	1.1	-0.5
12	0.5	0.0	0.7	0.1	1.0	0.6	1.5	1.1	1.1	-0.9	0.7	0.2	0.6	0.1
13	0.6	-0.6	0.6	-0.6	0.6	-0.5	1.1	-0.6	0.8	-0.5	0.6	-0.6	0.6	-0.7
14	0.7	-0.6	0.9	-0.3	1.4	0.9	2.1	1.7	1.9	1.5	1.1	0.2	0.8	-0.3
15	1.7	1.0	2.3	1.6	3.7	3.2	5.2	4.8	4.7	4.3	2.7	1.8	2.0	1.1
16	1.9	1.2	2.7	2.0	4.3	3.9	6.0	5.7	5.4	6.1	3.1	2.3	2.3	1.6
17	1.3	-0.8	1.6	0.0	2.6	1.5	3.9	3.0	3.5	2.5	1.8	0.3	1.4	-0.4
18	1.2	-0.7	1.6	0.6	2.5	2.1	3.6	3.3	3.2	2.9	1.8	1.1	1.4	0.0
19	1.7	1.6	2.3	2.3	3.4	3.4	4.5	4.5	4.1	4.1	2.6	2.5	2.0	1.9

TABLE A3-46 CONT.

Existing Fisheries Case Study (Run 454)
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	-744	-4330	56	-345	-583
2	-1170	-1618	-1490	-725	-1711
3	-1088	-1509	-1317	-844	-1429
4	1437	1783	527	541	1741
5	-5165	-8996	-7974	-4226	-7299
6	-3211	-5291	-4820	-2690	-4271
7	-6301	-10935	-9733	-5041	-8878
8	2136	3615	3302	1745	2941
9	-26	23	1295	1285	2728
10	1	22	256	203	481
11	-14	32	1310	1312	2740
12	18	26	269	322	521
13	-88	-110	-45	-53	71
14	-48	-80	-15	51	108
15	-4	-4	1585	1856	3404
16	0	0	1591	1866	3416
17	1410	1598	9	412	1622
18	1434	1616	16	467	1652
19	1449	1625	1622	2409	5123

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	1.96	1.96	2.3	1.98	1.95
2	1.79	1.81	2.15	1.8	1.81
3	1.72	1.75	2.09	1.74	1.75
4	1.73	1.75	2.09	1.74	1.75
5	1.65	1.66	2.01	1.67	1.71
6	1.66	1.67	2.03	1.68	1.71
7	1.52	1.53	1.91	1.56	1.6
8	1.46	1.47	1.83	1.5	1.55
9	1.45	1.45	1.86	1.57	1.69
10	1.38	1.39	1.78	1.43	1.5
11	1.52	1.47	2.08	1.91	2.31
12	1.45	1.41	2.03	1.84	2.26
13	1.51	1.52	1.89	1.54	1.61
14	1.46	1.47	2.15	1.87	2.44
15	1.42	1.39	2.26	2.18	3
16	1.39	1.38	2.53	2.57	3.83
17	1.97	2.01	2.15	1.84	2.02
18	3.79	3.91	2.77	2.76	3.89
19	6.11	6.47	5.63	6.88	10.56

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec.		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4
2	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.3	-0.6
3	0.2	-0.4	0.1	-0.4	0.1	-0.4	0.2	-0.4	0.0	-0.4
4	0.4	-0.3	0.5	-0.3	0.4	-0.4	0.4	-0.3	0.5	-0.3
5	0.8	-1.5	0.7	-2.0	0.7	-1.9	0.8	-1.4	0.7	-1.8
6	0.8	-1.5	0.7	-1.9	0.7	-1.8	0.9	-1.4	0.7	-1.7
7	0.7	-2.4	0.6	-3.2	0.7	-3.0	0.8	-2.2	0.7	-2.9
8	1.5	-0.1	1.3	-0.1	1.3	-0.1	1.3	-0.1	1.4	-0.1
9	0.9	-1.0	0.8	-0.7	1.0	-0.4	1.1	-0.8	1.2	-0.8
10	0.7	-0.9	0.7	-0.6	0.7	-0.5	0.8	-0.8	0.8	-0.8
11	0.7	-0.9	0.7	-0.6	0.9	-0.3	0.9	-0.6	1.1	-0.5
12	0.3	-0.3	0.2	-0.2	0.4	0.0	0.5	-0.1	0.6	0.0
13	0.6	-0.7	0.5	-0.5	0.5	-0.5	0.6	-0.7	0.6	-0.8
14	0.4	-0.8	0.3	-0.8	0.5	-0.7	0.7	-0.5	0.8	-0.4
15	0.3	-0.4	0.2	-0.2	1.2	0.6	1.5	0.4	2.2	1.2
16	0.2	-0.2	0.1	-0.1	1.5	0.7	1.7	0.7	2.5	1.7
17	1.5	-0.3	1.5	-0.1	1.0	-1.1	1.2	-0.9	1.6	-0.3
18	1.5	-0.2	1.5	0.2	0.9	-1.1	1.1	-0.8	1.5	0.3
19	0.9	0.8	1.0	0.9	1.1	1.0	1.4	1.3	2.1	2.1

TABLE A3-47

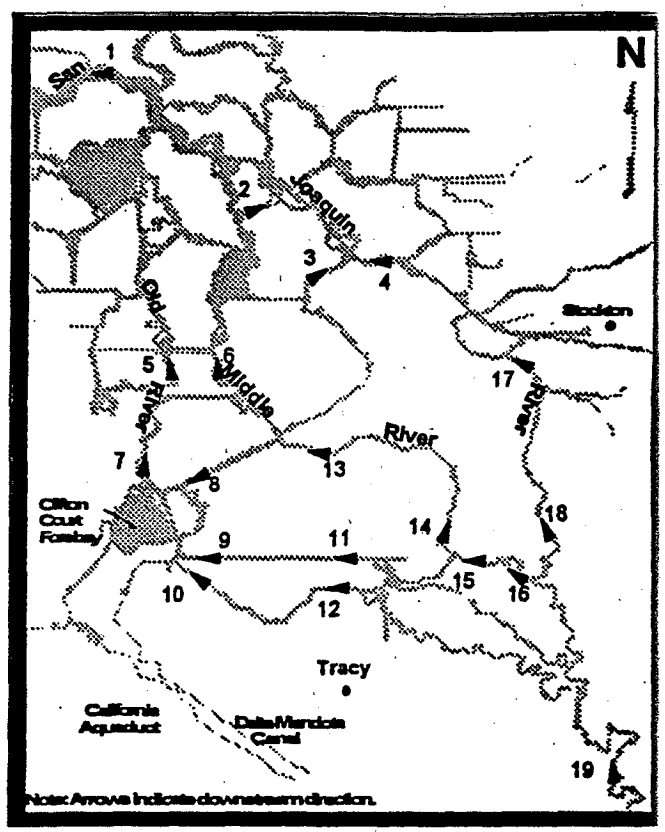
Future Demand Case Study
Fisheries Alt. (Run 455)
Representative Critical Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-164.0	-2157.0	-1866.0	-2427.0	571.0	150.0	1452.0	255.0	-654.0
2	-441.0	-161.0	-235.0	-868.0	-200.0	-71.0	-246.0	-422.0	-296.0
3	-513.0	-561.0	-586.0	-967.0	-377.0	-313.0	-351.0	-627.0	-642.0
4	100.0	75.0	151.0	329.0	508.0	439.0	456.0	143.0	-60.0
5	-3455.0	-3482.0	-3514.0	-6243.0	-1283.0	-975.0	-954.0	-3202.0	-3546.0
6	-2233.0	-2208.0	-2228.0	-3727.0	-699.0	-718.0	-737.0	-2108.0	-2328.0
7	-4256.0	-4267.0	-4293.0	-7625.0	-1529.0	-1091.0	-1085.0	-3769.0	-4145.0
8	1548.0	1538.0	1542.0	2605.0	588.0	418.0	425.0	1291.0	1395.0
9	589.0	588.0	724.0	924.0	1019.0	886.0	868.0	649.0	286.0
10	123.0	123.0	154.0	182.0	180.0	129.0	130.0	54.0	-26.0
11	591.0	591.0	792.0	930.0	1090.0	884.0	888.0	684.0	326.0
12	133.0	133.0	169.0	209.0	250.0	233.0	233.0	218.0	150.0
13	-20.0	-20.0	-20.0	-23.0	17.0	-17.0	-17.0	-101.0	-150.0
14	0.0	-1.0	0.0	-21.0	60.0	66.0	66.0	43.0	25.0
15	726.0	726.0	930.0	1175.0	1438.0	1318.0	1320.0	1162.0	734.0
16	728.0	728.0	934.0	1177.0	1444.0	1327.0	1329.0	1177.0	751.0
17	18.0	18.0	84.0	-72.0	427.0	384.0	382.0	96.0	-40.0
18	24.0	24.0	77.0	-73.0	454.0	432.0	430.0	182.0	-10.0
19	758.0	758.0	1020.0	1136.0	1959.0	1824.0	1824.0	1435.0	846.0

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	2.0	2.0	2.0	2.1	2.0	2.0	2.0	2.0
2	1.8	1.8	1.8	1.9	1.9	1.9	1.9	1.8	1.8
3	1.6	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.7
4	1.8	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.7
5	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.7
6	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.7	1.7
7	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.6	1.6
8	1.5	1.5	1.5	1.6	1.7	1.7	1.7	1.6	1.5
9	1.6	1.6	1.6	1.6	1.8	1.7	1.8	1.6	1.5
10	1.5	1.4	1.5	1.5	1.7	1.6	1.7	1.5	1.4
11	1.8	1.8	1.9	1.9	2.1	2.0	2.0	1.9	1.8
12	1.8	1.8	1.8	1.8	2.0	2.0	2.0	1.8	1.7
13	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.6	1.5
14	1.8	1.8	1.8	1.9	2.1	2.0	2.0	1.8	1.7
15	2.0	2.0	2.0	2.0	2.3	2.2	2.3	2.0	1.9
16	2.2	2.1	2.2	2.2	2.6	2.5	2.6	2.3	2.1
17	1.8	1.8	1.8	1.9	1.9	1.9	1.9	1.8	1.8
18	2.4	2.4	2.4	2.4	2.8	2.7	2.7	2.5	2.3
19	4.0	4.0	4.5	4.6	6.2	6.0	6.0	5.2	4.1



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16 MAX.	Jan. 1-16 MIN.	Jan. 17-31 MAX.	Jan. 17-31 MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April MAX.	April MIN.	May 1-20 MAX.	May 1-20 MIN.	May 21-31 MAX.	May 21-31 MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.3	-1.3	1.2	-1.3	1.2	-1.3
2	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.3	0.2	-0.3	0.2	-0.4	0.2	-0.3	0.3	-0.3	0.3	-0.3	0.2	-0.4	0.2	-0.4
4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.9	-1.5	0.8	-1.5	0.9	-1.5	0.8	-1.8	1.0	-1.1	1.0	-1.1	1.0	-1.2	0.9	-1.2	0.9	-1.3
6	0.9	-1.5	0.9	-1.5	0.9	-1.5	0.9	-1.7	1.0	-1.2	1.0	-1.2	1.0	-1.2	0.9	-1.3	0.9	-1.3
7	0.9	-2.3	0.9	-2.3	0.8	-2.4	0.8	-2.9	1.1	-1.7	1.1	-1.4	1.1	-1.5	0.9	-2.1	0.9	-2.1
8	0.9	-0.2	0.9	-0.2	0.9	-0.2	1.2	-0.1	1.0	-0.3	0.8	-0.3	0.8	-0.3	1.2	-0.2	1.2	-0.2
9	1.0	-0.7	1.0	-0.7	1.0	-0.7	1.0	-0.5	1.0	-0.8	1.0	-0.8	1.0	-0.8	1.0	-0.9	1.0	-0.9
10	0.8	-0.7	0.8	-0.7	0.8	-0.7	0.8	-0.5	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.8	-0.8
11	0.9	-0.6	0.9	-0.6	0.9	-0.5	0.9	-0.4	0.9	-0.6	0.9	-0.6	0.8	-0.7	0.9	-0.7	0.8	-0.8
12	0.4	-0.2	0.4	-0.2	0.4	-0.1	0.4	0.0	0.4	-0.2	0.4	-0.2	0.4	-0.2	0.4	-0.3	0.4	-0.4
13	0.8	-0.7	0.8	-0.6	0.8	-0.7	0.8	-0.6	0.8	-0.6	0.8	-0.7	0.8	-0.7	0.8	-0.7	0.8	-0.7
14	0.5	-0.7	0.5	-0.7	0.6	-0.6	0.5	-0.7	0.6	-0.5	0.6	-0.5	0.7	-0.5	0.6	-0.6	0.6	-0.7
15	1.1	-0.3	1.1	-0.3	1.1	-0.1	1.1	0.2	1.3	0.0	1.3	-0.1	1.3	-0.2	1.2	-0.4	1.1	-0.6
16	1.2	-0.4	1.2	-0.4	1.5	-0.2	1.2	0.3	1.5	0.1	1.5	-0.1	1.5	-0.1	1.4	-0.3	1.2	-0.6
17	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.0	-1.1	1.2	-1.0	1.2	-1.0	1.2	-1.0	1.1	-1.1	1.1	-1.1
18	0.9	-1.1	0.9	-1.1	0.9	-1.0	0.9	-1.1	1.1	-0.8	1.0	-0.8	1.1	-0.8	1.0	-1.0	0.9	-1.1
19	0.7	0.4	0.7	0.5	0.8	0.6	0.9	0.7	1.3	1.1	1.2	1.0	1.2	1.0	1.1	0.8	0.8	0.5

TABLE A3-47 CONT.

Future Fisheries Case Study (Run 455)
Representative Critical Year (1991)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-826	452	-1147	-53	-2109	73	-379
2	-887	-793	-660	-442	-164	-161	-294
3	-822	-728	-691	-621	-588	-435	-530
4	-1784	1242	-1223	152	-126	60	-123
5	-2585	-2813	-2835	-3331	-3359	-2096	-2837
6	-1777	-1887	-1865	-2178	-2150	-1434	-1855
7	-3161	-3443	-3451	-4076	-4086	-2437	-3405
8	-1126	1247	-1239	1473	-1483	856	-1207
9	-71	-37	-7	740	-738	316	-598
10	-24	-21	-21	158	-156	-3	-91
11	-51	-26	-26	753	-752	340	-612
12	-1	-1	-0	173	-173	121	-165
13	-70	-59	-59	-32	-32	-71	-42
14	-16	-16	-16	15	-14	30	-22
15	-6	-4	-4	976	-976	655	-899
16	0	0	-0	981	-981	667	-907
17	-1792	1226	-1226	87	-87	29	-70
18	-1927	1248	-1248	103	-103	83	-108
19	-1854	1261	-1261	1098	-1098	826	-1060

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.99	2	1.99	-53	1.96	1.99	1.97
2	1.82	1.83	1.82	-442	1.79	1.82	1.8
3	1.75	1.77	1.76	-621	1.72	1.75	1.73
4	1.76	1.77	1.76	152	1.73	1.75	1.74
5	1.69	1.72	1.7	-3331	1.67	1.71	1.69
6	1.7	1.72	1.71	-2178	1.67	1.71	1.69
7	1.59	1.61	1.6	-4076	1.58	1.63	1.59
8	1.52	1.56	1.55	1473	1.5	1.58	1.54
9	1.51	1.56	1.55	740	1.53	1.65	1.51
10	1.45	1.51	1.49	158	1.44	1.56	1.49
11	1.59	1.64	1.62	753	1.63	1.88	1.86
12	1.52	1.57	1.59	173	1.79	1.81	1.81
13	1.56	1.6	1.59	-32	1.56	1.61	1.58
14	1.51	1.57	1.55	15	1.82	1.8	1.82
15	1.48	1.54	1.52	976	1.99	1.99	2.01
16	1.45	1.5	1.49	981	2.2	2.18	2.19
17	2.05	1.99	1.97	87	1.79	1.81	1.5
18	4.18	3.66	3.93	103	2.45	2.4	2.41
19	6.04	5.73	5.74	1098	4.83	4.1	4.55

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3	1.2	-1.3
2	0.3	-0.6	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.3
4	0.1	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4	0.4	-0.4	0.4	-0.4
5	1.0	-1.3	1.0	-1.5	1.0	-1.5	0.9	-1.5	0.9	-1.5	0.9	-1.2	1.0	-1.2
6	1.0	-1.3	1.0	-1.5	1.0	-1.5	0.9	-1.5	0.9	-1.5	1.0	-1.2	1.0	-1.2
7	1.0	-1.9	1.1	-2.3	1.1	-2.3	0.9	-2.3	0.9	-2.3	1.0	-1.8	1.0	-2.0
8	1.1	-0.2	0.9	-0.3	0.9	-0.3	0.9	-0.2	0.9	-0.2	1.1	-0.2	1.2	-0.2
9	0.4	-0.9	0.9	-1.0	0.9	-1.0	1.0	-0.7	1.0	-0.7	1.0	-0.9	1.0	-0.9
10	0.9	-0.9	0.8	-0.8	0.8	-0.8	0.8	-0.7	0.8	-0.7	0.8	-0.8	0.9	-0.9
11	0.7	-0.9	0.7	-0.8	0.7	-0.8	0.9	-0.6	0.9	-0.6	0.8	-0.8	0.9	-0.9
12	0.3	-0.3	0.3	-0.3	0.3	-0.3	0.4	-0.1	0.4	-0.1	0.4	-0.4	0.4	-0.3
13	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.7
14	0.6	-0.7	0.6	-0.7	0.6	-0.7	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.7
15	0.4	-0.4	0.3	-0.4	0.3	-0.4	1.2	-0.1	1.1	-0.1	1.1	-0.7	1.1	-0.9
16	0.2	-0.2	0.1	-0.2	0.1	-0.2	1.3	-0.1	1.3	-0.1	1.2	-0.7	1.3	-0.9
17	1.6	-0.0	1.4	-0.5	1.4	-0.5	1.1	-1.1	1.1	-1.1	1.1	-1.1	1.1	-1.1
18	1.6	-0.5	1.4	-0.4	1.4	-0.4	0.9	-1.0	0.9	-1.0	0.9	-1.0	0.9	-1.0
19	1.1	-1.0	0.9	0.7	0.9	-0.7	0.9	0.7	0.9	-0.7	0.7	0.5	0.9	-0.6

TABLE A3-48

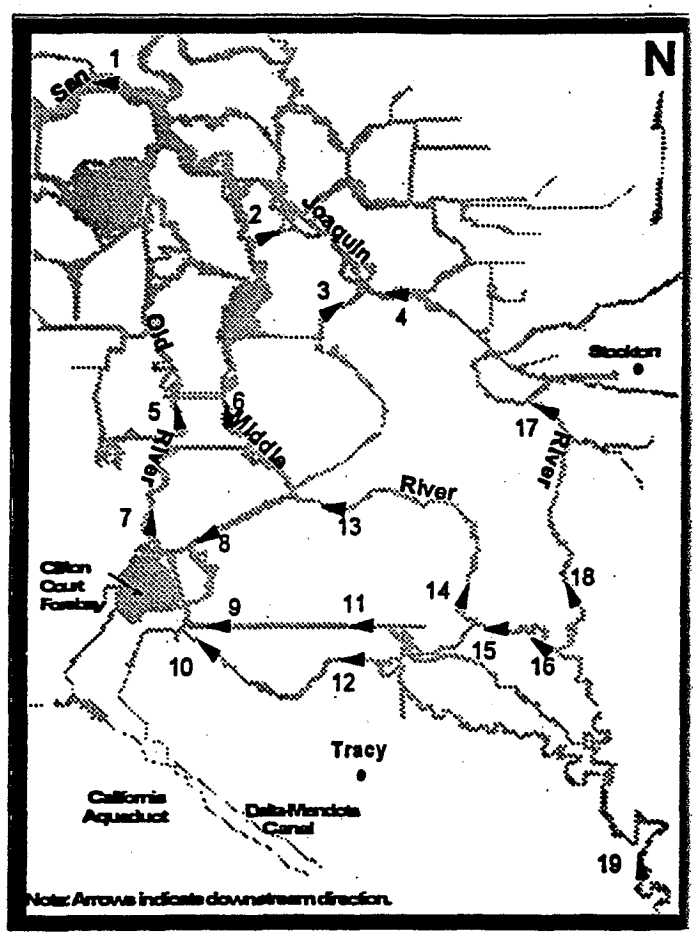
Future Demand Case Study
Fisheries Alt. (Run 455)
Representative Dry Year

Average Net Flow

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April	May 20-Jan	May 21-31	June	July
1	-1169.0	-4308.0	-1972.0	493.0	1317.0	299.0	1997.0	34.0	-2309.0
2	-1460.0	-1041.0	-780.0	-892.0	-450.0	-191.0	-418.0	-435.0	-771.0
3	-1235.0	-1178.0	-906.0	-782.0	-472.0	-387.0	-435.0	-638.0	-1057.0
4	927.0	914.0	877.0	949.0	1195.0	683.0	597.0	206.0	4.0
5	-7433.0	-7488.0	-5038.0	-3635.0	-1087.0	-1135.0	-1107.0	-3200.0	-6790.0
6	-4355.0	-4326.0	-3048.0	-2314.0	-747.0	-816.0	-839.0	-2112.0	-4053.0
7	-9105.0	-9116.0	-6169.0	-4487.0	-1279.0	-1272.0	-1259.0	-3734.0	-8052.0
8	3059.0	3047.0	2157.0	1655.0	527.0	486.0	491.0	1273.0	2804.0
9	2006.0	2012.0	1916.0	1579.0	1772.0	1224.0	1229.0	770.0	877.0
10	357.0	351.0	344.0	316.0	334.0	200.0	202.0	78.0	86.0
11	2007.0	2011.0	1921.0	1584.0	1763.0	1246.0	1252.0	813.0	919.0
12	356.0	352.0	336.0	331.0	357.0	311.0	313.0	239.0	247.0
13	24.0	24.0	24.0	39.0	80.0	5.0	5.0	-104.0	-148.0
14	23.0	22.0	47.0	45.0	110.0	89.0	89.0	55.0	16.0
15	2371.0	2356.0	2338.0	1973.0	2373.0	1801.0	1808.0	1344.0	1422.0
16	2370.0	2356.0	2339.0	1975.0	2376.0	1810.0	1818.0	1359.0	1437.0
17	649.0	667.0	781.0	606.0	1142.0	659.0	652.0	174.0	-49.0
18	642.0	660.0	796.0	604.0	1177.0	710.0	702.0	244.0	-22.0
19	3024.0	3024.0	3166.0	2597.0	3801.0	2593.0	2593.0	1701.0	1566.0

Minimum Water Surface Elevation

Ref. No.	Jan 1-15	Jan 16-31	Feb.	March	April	May 20-Jan	May 21-31	June	July
1	2.0	1.9	2.0	2.1	2.1	2.0	2.1	2.0	1.9
2	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.8	1.8
3	1.8	1.7	1.8	1.9	1.9	1.8	1.8	1.8	1.7
4	1.8	1.7	1.8	1.9	1.9	1.8	1.8	1.8	1.7
5	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.7	1.6
6	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.7	1.6
7	1.6	1.6	1.6	1.7	1.6	1.7	1.7	1.6	1.5
8	1.6	1.5	1.6	1.7	1.7	1.7	1.7	1.6	1.4
9	1.6	1.6	1.7	1.8	1.8	1.8	1.8	1.6	1.5
10	1.5	1.5	1.5	1.6	1.6	1.7	1.7	1.5	1.3
11	2.0	2.0	2.1	2.1	2.3	2.1	2.1	1.9	1.7
12	2.0	1.9	2.1	2.1	2.2	2.1	2.1	1.8	1.7
13	1.6	1.6	1.6	1.7	1.8	1.7	1.7	1.6	1.5
14	2.1	2.1	2.2	2.2	2.3	2.1	2.1	1.8	1.6
15	2.4	2.4	2.5	2.4	2.7	2.4	2.4	2.1	1.9
16	2.9	2.8	3.0	2.8	3.3	2.8	2.8	2.4	2.2
17	1.9	1.9	2.0	2.0	2.0	1.9	2.0	1.8	1.6
18	3.0	3.0	3.1	3.0	3.4	2.9	3.0	2.6	2.4
19	7.8	7.8	8.0	7.2	8.7	7.2	7.2	5.7	5.4



Minimum and Maximum Velocity

Ref. No.	Jan 1-15 MAX.	Jan 1-15 MIN.	Jan 16-31 MAX.	Jan 16-31 MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April MAX.	April MIN.	May 1-20 MAX.	May 1-20 MIN.	May 21-31 MAX.	May 21-31 MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.3	-1.3	1.2	-1.4	1.3	-1.3	1.2	-1.3	1.2	-1.4
2	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5
3	0.1	-0.4	0.1	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.3	0.2	-0.3	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.3
5	0.9	-1.9	0.8	-1.9	0.9	-1.7	0.9	-1.6	1.0	-1.1	1.0	-1.1	1.0	-1.1	0.9	-1.3	0.7	-1.5
6	0.8	-1.8	0.8	-1.8	0.9	-1.7	1.0	-1.6	1.0	-1.1	1.0	-1.2	1.0	-1.2	0.9	-1.3	0.8	-1.7
7	0.8	-3.0	0.8	-2.9	0.9	-2.7	1.0	-2.5	1.1	-1.8	1.1	-1.6	1.2	-1.6	1.0	-2.1	0.7	-2.7
8	1.2	-0.1	1.2	-0.1	1.1	-0.2	1.0	-0.2	1.0	-0.3	1.0	-0.3	1.0	-0.3	1.3	-0.2	1.5	-0.1
9	1.1	-0.3	1.1	-0.3	1.1	-0.3	1.1	-0.6	1.1	-0.7	1.0	-0.8	1.0	-0.8	1.0	-0.9	1.0	-1.0
10	0.8	-0.4	0.8	-0.4	0.9	-0.4	0.9	-0.6	0.9	-0.7	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.7	-0.8
11	1.0	-0.1	1.0	-0.1	1.0	-0.1	1.0	-0.4	1.0	-0.5	0.9	-0.6	0.9	-0.8	0.9	-0.7	0.9	-0.8
12	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.0	0.5	0.0	0.5	-0.1	0.5	-0.1	0.4	-0.2	0.4	-0.2
13	0.6	-0.5	0.6	-0.5	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.5	-0.7	0.5	-0.8
14	0.6	-0.6	0.6	-0.6	0.7	-0.5	0.6	-0.5	0.7	-0.5	0.7	-0.4	0.7	-0.4	0.7	-0.5	0.6	-0.6
15	1.8	1.1	1.6	1.1	1.8	1.1	1.5	0.8	1.7	0.7	1.5	0.4	1.5	0.5	1.3	-0.2	1.2	-0.1
16	1.9	1.2	1.8	1.3	1.9	1.3	1.7	0.9	2.0	1.0	1.7	0.6	1.7	0.6	1.4	-0.1	1.4	-0.1
17	1.3	0.8	1.3	-0.8	1.3	-0.7	1.3	-0.8	1.4	-0.6	1.3	-0.8	1.3	-0.8	1.1	-1.1	1.0	-1.1
18	1.2	-0.7	1.2	-0.7	1.2	-0.6	1.1	-0.7	1.3	-0.2	1.1	-0.6	1.1	-0.6	1.0	-0.9	0.9	-1.1
19	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.6	1.7	1.5	1.4	1.5	1.4	1.2	1.0	1.1	1.0

TABLE A3-48 CONT.

Future Fisheries Case Study (Run 455)
Representative Dry Year (1981)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1485	-440	-2903	1365	-1288	-498	-1222
2	-2681	-2362	-2000	-872	-500	-346	-696
3	-1854	-1585	-1534	-763	-703	-625	-822
4	3961	3624	3508	859	839	115	34
5	-6836	-6821	-6855	-3359	-3401	-3245	-5000
6	-4146	-4171	-4137	-2192	-2160	-2141	-3069
7	-10474	-8331	-8345	-4130	-4151	-3927	-6028
8	3421	2802	2789	1521	1512	1399	2051
9	-22	-15	-16	1726	1720	649	730
10	[illegible]	8	[illegible]	344	[illegible]	115	120
11	-27	-3	[illegible]	1740	[illegible]	665	746
12	31	21	22	359	353	183	194
13	135	-100	-99	21	20	-45	-82
14	61	-57	-57	66	65	16	12
15	[illegible]	-5	[illegible]	2200	1129	958	1031
16	10	0	0	2204	2192	965	1038
17	3982	3564	3563	793	805	58	47
18	3964	3625	3625	815	826	90	16
19	3971	3637	3637	3036	3036	1094	1061

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	2.19	1.98	1.95	2.04	2.01	1.97	1.95
2	1.76	1.82	1.79	1.88	1.84	1.79	1.78
3	1.71	1.76	1.72	1.81	1.77	1.72	1.71
4	1.71	1.76	1.73	1.82	1.78	1.73	1.71
5	1.62	1.67	1.64	1.76	1.72	1.66	1.64
6	1.65	1.69	1.65	1.76	1.73	1.67	1.65
7	1.48	1.55	1.52	1.66	1.62	1.54	1.53
8	1.41	1.49	1.46	1.61	1.57	1.48	1.47
9	1.41	1.48	1.45	1.7	1.66	1.53	1.52
10	1.38	1.41	1.38	1.56	1.52	1.41	1.4
11	1.81	1.55	1.52	2.11	2.07	1.81	1.78
12	1.41	1.48	1.45	2.07	2.03	1.75	1.72
13	1.47	1.54	1.5	1.65	1.61	1.53	1.52
14	1.41	1.49	1.45	2.14	2.11	1.78	1.75
15	1.38	1.45	1.42	2.49	2.45	1.96	1.92
16	1.34	1.42	1.39	2.96	2.91	2.18	2.13
17	2.51	2.47	2.44	1.96	1.92	1.79	1.77
18	3.45	6.09	6.08	3.11	3.07	2.43	2.37
19	10.36	10.31	10.3	7.88	7.87	4.6	4.5

Minimum and Maximum Velocity

Ref. No.	Oct. MAX.	Oct. MIN.	Nov. 1-15 MAX.	Nov. 1-15 MIN.	Nov. 16-30 MAX.	Nov. 16-30 MIN.	Dec. 1-16 MAX.	Dec. 1-16 MIN.	Dec. 17-31 MAX.	Dec. 17-31 MIN.	Aug. MAX.	Aug. MIN.	Sep. MAX.	Sep. MIN.
1	[illegible]	-1.1	1.2	-1.3	[illegible]	-1.4	1.2	-1.3	[illegible]	[illegible]	1.2	-1.3	[illegible]	[illegible]
2	[illegible]	-0.7	0.1	-0.6	0.2	-0.6	0.3	-0.5	[illegible]	[illegible]	0.4	-0.5	[illegible]	[illegible]
3	[illegible]	-0.5	0.1	-0.5	[illegible]	-0.5	0.2	-0.4	[illegible]	[illegible]	0.2	-0.4	[illegible]	[illegible]
4	[illegible]	-0.2	0.5	-0.2	[illegible]	-0.2	0.4	-0.3	[illegible]	[illegible]	0.4	-0.4	[illegible]	[illegible]
5	[illegible]	-2.0	0.8	-1.9	[illegible]	-1.9	0.9	-1.6	[illegible]	[illegible]	0.8	-1.3	[illegible]	[illegible]
6	[illegible]	-1.6	0.9	-1.8	[illegible]	-1.9	1.0	-1.6	[illegible]	[illegible]	0.9	-1.3	[illegible]	[illegible]
7	[illegible]	-3.1	0.8	-3.0	[illegible]	[illegible]	1.0	-2.4	[illegible]	[illegible]	0.8	-2.0	[illegible]	[illegible]
8	[illegible]	-0.0	1.2	-0.1	[illegible]	-0.1	0.9	-0.2	[illegible]	[illegible]	1.2	-0.1	[illegible]	[illegible]
9	[illegible]	-1.1	0.9	-0.7	[illegible]	-0.7	1.1	-0.6	[illegible]	[illegible]	1.0	-0.8	[illegible]	[illegible]
10	[illegible]	-1.0	0.8	-0.6	[illegible]	-0.6	0.9	-0.6	[illegible]	[illegible]	0.8	-0.7	[illegible]	[illegible]
11	[illegible]	-1.0	0.7	-0.6	[illegible]	-0.6	1.0	-0.4	[illegible]	[illegible]	0.9	-0.7	[illegible]	[illegible]
12	[illegible]	-0.4	0.2	-0.2	[illegible]	-0.2	0.5	0.0	[illegible]	[illegible]	0.4	-0.3	[illegible]	[illegible]
13	[illegible]	-0.8	0.6	-0.7	[illegible]	-0.7	0.6	-0.6	[illegible]	[illegible]	0.6	-0.7	[illegible]	[illegible]
14	[illegible]	-0.8	0.4	-0.8	[illegible]	-0.8	0.7	-0.5	[illegible]	[illegible]	0.6	-0.7	[illegible]	[illegible]
15	[illegible]	-0.4	0.3	-0.3	[illegible]	-0.3	1.6	0.9	[illegible]	[illegible]	1.2	-0.5	[illegible]	[illegible]
16	[illegible]	-0.2	0.1	-0.2	[illegible]	-0.2	1.9	1.1	[illegible]	[illegible]	1.3	-0.5	[illegible]	[illegible]
17	[illegible]	1.2	2.3	1.1	[illegible]	1.1	1.3	-0.8	[illegible]	[illegible]	1.1	-1.1	[illegible]	[illegible]
18	[illegible]	1.8	2.2	1.7	[illegible]	1.7	1.2	-0.6	[illegible]	[illegible]	0.9	-1.0	[illegible]	[illegible]
19	[illegible]	1.6	1.5	1.5	[illegible]	1.5	1.6	1.5	[illegible]	[illegible]	0.9	0.6	[illegible]	[illegible]

TABLE A3-49

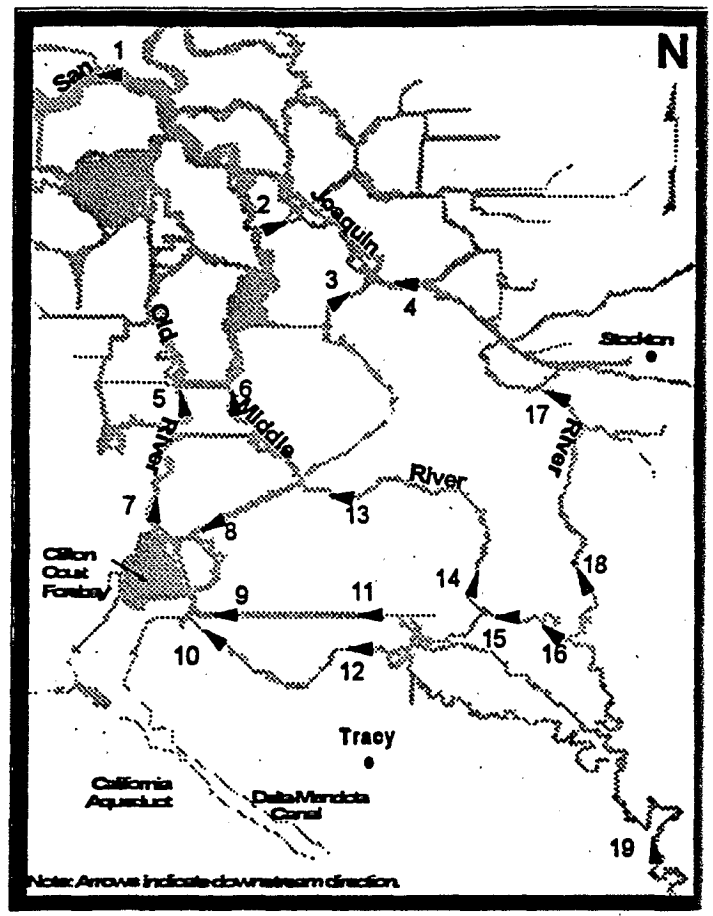
Future Demand Case Study
Fisheries Alt. (Run 455)
Representative Below Normal Year Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May 20-Jan	May 21-31	June	July
1	-1773.0	-110.0	-1581.0	1561.0	258.0	2562.0	6.0	-2448.0
2	-1153.0	-921.0	-548.0	-552.0	-298.0	-608.0	-475.0	-815.0
3	-1074.0	-843.0	-759.0	-519.0	-471.0	-533.0	-669.0	-1094.0
4	1903.0	1216.0	530.0	1362.0	792.0	811.0	202.0	-8.0
5	-5795.0	-3851.0	-4248.0	-1101.0	-1584.0	-1528.0	-3427.0	-7147.0
6	-3445.0	-2422.0	-2657.0	-760.0	-1078.0	-1109.0	-2240.0	-4233.0
7	-7104.0	-4750.0	-6178.0	-1325.0	-1800.0	-1783.0	-4008.0	-8490.0
8	2458.0	1751.0	1637.0	542.0	671.0	677.0	1367.0	2736.0
9	2292.0	2012.0	1399.0	1898.0	1377.0	1384.0	790.0	901.0
10	394.0	375.0	275.0	346.0	220.0	233.0	61.0	91.0
11	2294.0	2019.0	1410.0	1910.0	1379.0	1406.0	830.0	940.0
12	412.0	392.0	302.0	425.0	336.0	343.0	245.0	247.0
13	91.0	84.0	-4.0	76.0	7.0	8.0	-101.0	-145.0
14	59.0	84.0	95.0	123.0	93.0	93.0	52.0	9.0
15	2739.0	2483.0	1791.0	2543.0	1985.0	1995.0	1365.0	1428.0
16	2747.0	2487.0	1795.0	2551.0	1994.0	2004.0	1373.0	1441.0
17	1108.0	1006.0	407.0	1268.0	765.0	755.0	166.0	-64.0
18	1116.0	1012.0	430.0	1309.0	816.0	806.0	238.0	6.0
19	3892.0	3498.0	2252.0	3913.0	2883.0	2883.0	1713.0	1544.0

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May 20-Jan	May 21-31	June	July
1	2.0	2.1	2.0	2.1	2.1	2.1	2.0	1.9
2	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8
3	1.8	1.9	1.8	1.9	1.8	1.9	1.8	1.7
4	1.8	1.9	1.8	1.9	1.8	1.9	1.8	1.7
5	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.6
6	1.8	1.8	1.7	1.8	1.8	1.8	1.7	1.6
7	1.7	1.7	1.6	1.8	1.7	1.8	1.6	1.5
8	1.8	1.7	1.8	1.8	1.7	1.7	1.8	1.4
9	1.7	1.8	1.7	1.9	1.8	1.8	1.8	1.5
10	1.8	1.6	1.5	1.8	1.7	1.7	1.5	1.3
11	2.2	2.2	2.0	2.4	2.1	2.2	1.9	1.7
12	2.2	2.2	1.9	2.3	2.1	2.1	1.8	1.7
13	1.7	1.7	1.6	1.8	1.7	1.7	1.6	1.5
14	2.3	2.3	2.0	2.4	2.1	2.1	1.8	1.6
15	2.7	2.7	2.3	2.8	2.5	2.5	2.1	1.9
16	3.3	3.2	2.8	3.4	2.9	2.9	2.3	2.2
17	2.0	2.0	1.9	2.1	2.0	2.0	1.8	1.8
18	3.4	3.3	2.8	3.5	3.0	3.1	2.6	2.4
19	9.0	8.5	8.7	9.1	7.6	7.6	5.7	5.3



Minimum and Maximum Velocity

Ref. No.	January MAX.	January MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April MAX.	April MIN.	May 1-20 MAX.	May 1-20 MIN.	May 21-31 MAX.	May 21-31 MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.3	-1.3	1.2	-1.4	1.3	-1.3	1.2	-1.3	1.2	-1.4
2	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5
3	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.3	0.2	-0.4	0.2	-0.4	0.3	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.9	-1.6	0.9	-1.6	0.9	-1.7	1.0	-1.1	1.0	-1.1	1.0	-1.2	0.9	-1.3	0.7	-1.6
6	0.9	-1.7	1.0	-1.6	0.9	-1.6	1.0	-1.1	1.0	-1.2	1.0	-1.2	0.9	-1.3	0.8	-1.7
7	0.9	-2.8	1.0	-2.5	0.9	-2.5	1.1	-1.6	1.1	-1.7	1.1	-1.7	0.9	-2.1	0.7	-2.8
8	1.1	-0.2	1.0	-0.2	1.0	-0.2	1.0	-0.3	1.1	-0.3	1.1	-0.3	1.3	-0.2	1.3	-0.1
9	1.2	-0.3	1.2	-0.4	1.1	-0.5	1.1	-0.7	1.1	-0.7	1.1	-0.8	1.0	-0.9	1.0	-1.0
10	0.9	-0.4	0.9	-0.6	0.9	-0.6	0.9	-0.7	0.9	-0.7	0.9	-0.8	0.9	-0.8	0.7	-0.9
11	1.1	-0.1	1.0	-0.2	0.9	-0.4	1.0	-0.5	0.9	-0.6	0.9	-0.6	0.9	-0.7	0.9	-0.8
12	0.5	0.1	0.5	0.1	0.4	0.0	0.5	0.0	0.5	-0.1	0.5	-0.1	0.4	-0.2	0.4	-0.2
13	0.6	-0.6	0.6	-0.6	0.5	-0.6	0.6	-0.6	0.6	-0.6	0.6	-0.7	0.5	-0.7	0.5	-0.8
14	0.7	-0.5	0.7	-0.5	0.6	-0.6	0.6	-0.3	0.7	-0.4	0.7	-0.4	0.6	-0.5	0.6	-0.7
15	1.8	1.3	1.7	1.1	1.4	0.7	1.6	0.8	1.6	0.5	1.6	0.5	1.3	-0.2	1.2	-0.2
16	2.1	1.6	2.0	1.3	1.6	0.8	2.1	1.1	1.8	0.8	1.8	0.8	1.4	-0.1	1.4	-0.1
17	1.4	-0.6	1.4	-0.6	1.2	-0.9	1.4	-0.5	1.3	-0.8	1.3	-0.8	1.1	-1.1	1.0	-1.1
18	1.3	-0.4	1.3	-0.5	1.1	-0.6	1.3	-0.1	1.2	-0.5	1.2	-0.6	1.0	-0.9	0.9	-1.1
19	1.8	1.6	1.7	1.7	1.4	1.3	1.8	1.6	1.6	1.5	1.6	1.5	1.2	1.0	1.1	0.9

TABLE A3-49 CONT.

Future Fisheries Case Study (Run 455)
Representative Below Normal Year (1966)

Average Net Flow

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	-776	-3745	-3603	-980	-2635	-1682
2	-1807	-2537	-1035	-1405	-795	-664
3	-1401	-1831	-1120	-1173	-1062	-895
4	2658	4099	1195	1208	-166	-38
5	-6144	-9002	-6542	-6504	-7240	-5709
6	-3763	-5348	-3819	-3850	-4259	-3441
7	-7471	-10945	-7962	-7943	-8640	-6872
8	2487	3623	2679	2690	2802	2303
9	-45	20	2253	2257	807	679
10	-11	20	390	395	65	111
11	-31	30	2256	2260	634	694
12	23	26	393	399	182	181
13	110	-113	35	36	-126	-72
14	-55	-79	51	52	22	-13
15	-5	-4	2695	2707	963	957
16	0	0	2695	2707	973	963
17	2580	4009	1034	1018	-252	-126
18	2625	4103	1041	1026	-200	-95
19	2647	4094	3749	3749	844	907

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec. 1-15	Dec. 16-31	Aug.	Sep.
1	1.95	1.94	1.95	1.98	1.9	1.94
2	1.79	1.8	1.79	1.82	1.75	1.77
3	1.72	1.74	1.72	1.76	1.68	1.7
4	1.73	1.74	1.72	1.76	1.68	1.7
5	1.64	1.64	1.67	1.7	1.59	1.63
6	1.65	1.66	1.67	1.71	1.61	1.64
7	1.51	1.51	1.57	1.61	1.46	1.51
8	1.45	1.45	1.52	1.56	1.4	1.45
9	1.44	1.44	1.64	1.68	1.43	1.49
10	1.37	1.37	1.48	1.52	1.32	1.38
11	1.51	1.46	2.13	2.16	1.67	1.75
12	1.43	1.4	2.08	2.12	1.6	1.69
13	1.49	1.5	1.57	1.61	1.45	1.5
14	1.44	1.46	2.21	2.24	1.8	1.72
15	1.41	1.38	2.59	2.62	1.78	1.87
16	1.37	1.37	3.18	3.21	1.96	2.06
17	2.18	2.58	1.91	1.95	1.72	1.75
18	4.97	6.62	3.3	3.33	2.22	2.31
19	8.51	11.08	8.84	8.85	3.96	4.17

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec. 1-15		Dec. 16-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.3	1.2	-1.4	1.2	-1.4
2	0.2	-0.8	0.1	-0.6	0.3	-0.5	0.2	-0.5	0.3	-0.5	0.3	-0.5
3	0.1	-0.6	0.0	-0.5	0.2	-0.4	0.2	-0.4	0.1	-0.4	0.2	-0.4
4	0.6	-0.3	0.5	-0.2	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.7	-1.7	0.7	-2.0	0.8	-1.8	0.8	-1.8	0.7	-1.8	0.8	-1.6
6	0.8	-1.6	0.7	-1.9	0.9	-1.7	0.9	-1.8	0.8	-1.7	0.8	-1.6
7	0.7	-2.6	0.6	-3.2	0.9	-2.9	0.9	-2.9	0.7	-2.8	0.7	-2.5
8	1.6	-0.1	1.3	-0.1	1.2	-0.2	1.2	-0.2	1.6	-0.1	1.5	-0.1
9	0.9	-1.1	0.8	-0.7	1.2	-0.2	1.2	-0.3	1.0	-1.0	1.0	-0.9
10	0.7	-0.9	0.7	-0.6	0.9	-0.4	0.9	-0.4	0.7	-0.9	0.8	-0.8
11	0.7	-0.9	0.7	-0.6	1.0	0.0	1.0	-0.1	0.8	-0.9	0.9	-0.8
12	0.3	-0.4	0.2	-0.2	0.5	-0.1	0.5	0.1	0.3	-0.4	0.4	-0.4
13	0.6	-0.8	0.5	-0.5	0.8	-0.6	0.6	-0.6	0.5	-0.6	0.6	-0.7
14	0.4	-0.8	0.3	-0.8	0.7	-0.5	0.7	-0.5	0.5	-0.8	0.5	-0.8
15	0.4	-0.4	0.2	-0.2	1.8	1.3	1.8	1.3	1.0	-0.7	1.1	-0.6
16	0.2	-0.2	0.1	-0.1	2.1	1.6	2.1	1.6	1.1	-0.6	1.2	-0.6
17	1.9	0.5	2.4	1.4	1.4	-0.6	1.4	-0.6	1.0	-1.2	1.0	-1.1
18	1.8	1.1	2.4	1.9	1.3	-0.4	1.3	-0.5	0.8	-1.2	0.9	-1.1
19	1.3	1.3	1.6	1.6	1.8	1.8	1.8	1.8	0.8	0.5	0.8	0.5

TABLE A3-50

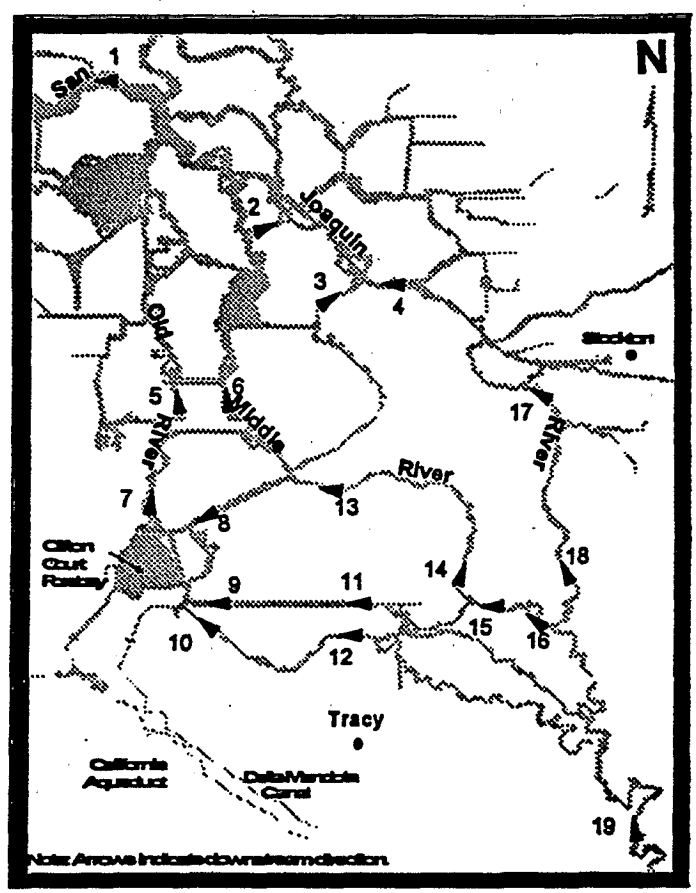
Future Demand Case Study
Fisheries Alt. (Run 455)
Representative Above Normal Year Year

Average Net Flow

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	-544	-3037	-2192	1086	1441	1037	3457	127	-6156
2	-969	-641	-1106	-959	-587	-588	-919	-588	-392
3	-927	-876	-1137	-851	-555	-585	-648	-730	-1064
4	656	635	914	773	1349	1271	1290	209	-49
5	-4297	-5335	-8740	-4120	-1407	-1632	-1583	-3826	-7641
6	-3204	-3176	-3677	-2623	-954	-1117	-1149	-2467	-4429
7	-6498	-6518	-6247	-5070	-1710	-1928	-1910	-4496	-6041
8	2259	2249	2791	1831	687	753	760	1533	2577
9	1682	1678	1966	1427	1946	1828	1834	795	920
10	317	312	361	288	362	333	338	80	85
11	1684	1680	1993	1433	1958	1840	1849	835	962
12	321	317	365	309	427	409	414	248	246
13	14	13	20	8	91	68	69	-101	-154
14	28	27	31	35	115	108	109	45	7
15	2026	2017	2363	1803	2584	2488	2479	1370	1457
16	2026	2017	2389	1806	2579	2471	2481	1384	1471
17	499	508	703	416	1274	1166	1156	138	-69
18	503	512	709	431	1306	1207	1197	207	2
19	2536	2536	3123	2254	3922	3738	3738	1693	1574

Minimum Water Surface Elevation

Ref. No.	Jan 1-16	Jan 17-31	Feb.	March	April	May 1-20	May 21-31	June	July
1	2.0	2.0	2.1	2.2	2.1	2.1	2.1	2.0	1.8
2	1.8	1.8	1.9	2.0	1.9	1.9	2.0	1.8	1.7
3	1.8	1.7	1.8	1.9	1.9	1.9	1.9	1.8	1.6
4	1.8	1.7	1.8	1.9	1.9	1.9	1.9	1.8	1.6
5	1.7	1.7	1.8	1.9	1.8	1.8	1.9	1.7	1.5
6	1.7	1.7	1.8	1.9	1.8	1.8	1.9	1.7	1.6
7	1.6	1.6	1.7	1.8	1.8	1.8	1.8	1.6	1.4
8	1.6	1.5	1.8	1.7	1.7	1.7	1.8	1.6	1.9
9	1.6	1.6	1.7	1.8	1.9	1.9	1.9	1.6	1.4
10	1.5	1.5	1.6	1.7	1.8	1.7	1.8	1.5	1.3
11	2.0	2.0	2.1	2.1	2.4	2.3	2.3	1.9	1.7
12	2.0	1.9	2.1	2.1	2.3	2.2	2.3	1.8	1.6
13	1.6	1.6	1.7	1.8	1.8	1.7	1.8	1.6	1.4
14	2.1	2.0	2.2	2.2	2.4	2.3	2.4	1.8	1.6
15	2.3	2.3	2.5	2.4	2.6	2.7	2.8	2.1	1.8
16	2.7	2.7	3.0	2.7	3.4	3.3	3.3	2.3	2.1
17	1.9	1.9	2.0	2.0	2.1	2.0	2.1	1.8	1.7
18	2.9	2.9	3.1	2.9	3.5	3.4	3.4	2.6	2.3
19	7.1	7.1	8.0	6.7	9.1	8.8	8.9	5.7	5.4



Minimum and Maximum Velocity

Ref. No.	Jan. 1-16 MAX.	Jan. 1-16 MIN.	Jan. 17-31 MAX.	Jan. 17-31 MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April MAX.	April MIN.	May 1-20 MAX.	May 1-20 MIN.	May 21-31 MAX.	May 21-31 MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	1.2	-1.3	1.2	-1.4	1.2	-1.4	1.2	-1.4	1.3	-1.3	1.2	-1.3	1.3	-1.3	1.2	-1.3	1.1	-1.4
2	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5	0.3	-0.5	0.4	-0.5	0.4	-0.5
3	0.2	-0.4	0.2	-0.4	0.1	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.2	-0.4	0.1	-0.4
4	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.3	0.4	-0.4	0.4	-0.4
5	0.9	-1.8	0.9	-1.8	0.8	-1.8	0.9	-1.7	1.0	-1.1	1.0	-1.1	1.0	-1.1	0.9	-1.4	0.7	-1.8
6	0.9	-1.7	0.9	-1.7	0.8	-1.8	0.9	-1.6	1.0	-1.2	1.0	-1.2	1.0	-1.2	0.9	-1.3	0.7	-1.7
7	0.9	-2.8	0.9	-2.7	0.8	-2.9	0.9	-2.6	1.1	-1.7	1.1	-1.7	1.1	-1.7	0.9	-2.2	0.8	-2.8
8	1.1	-0.2	1.1	-0.2	1.2	-0.2	1.0	-0.2	1.4	-0.3	1.1	-0.3	1.1	-0.3	1.3	-0.2	1.6	-0.1
9	1.1	-0.4	1.1	-0.4	1.1	-0.5	1.1	-0.5	1.1	-0.7	1.1	-0.7	1.1	-0.7	1.0	-0.9	1.0	-1.0
10	0.8	-0.5	0.8	-0.4	0.8	-0.4	0.9	-0.6	0.8	-0.7	0.9	-0.7	0.8	-0.7	0.8	-0.8	0.7	-0.9
11	1.0	-0.2	1.0	-0.2	1.0	-0.1	0.9	-0.4	1.0	-0.4	1.0	-0.5	1.0	-0.5	0.9	-0.7	0.8	-0.8
12	0.4	0.0	0.4	0.0	0.5	0.1	0.4	0.0	0.5	0.0	0.5	0.0	0.5	0.0	0.4	-0.2	0.4	-0.2
13	0.8	-0.8	0.8	-0.8	0.8	-0.8	0.6	-0.7	0.8	-0.8	0.6	-0.6	0.8	-0.8	0.5	-0.7	0.5	-0.8
14	0.8	-0.8	0.6	-0.6	0.7	-0.8	0.6	-0.6	0.8	-0.3	0.7	-0.3	0.8	-0.3	0.6	-0.6	0.8	-0.8
15	1.5	0.9	1.5	0.9	1.6	1.1	1.4	0.7	1.8	0.8	1.8	0.8	1.8	0.8	1.3	-0.2	1.2	-0.1
16	1.7	1.0	1.7	1.0	1.9	1.3	1.6	0.8	2.1	1.1	2.1	1.1	2.1	1.1	1.4	-0.1	1.3	0.0
17	1.2	-0.9	1.2	-0.9	1.3	-0.6	1.2	-0.9	1.4	-0.5	1.4	-0.6	1.6	-0.8	1.1	-1.1	1.0	-1.1
18	1.1	-0.8	1.1	-0.8	1.2	-0.7	1.1	-0.9	1.3	-0.1	1.3	-0.2	1.3	-0.3	1.0	-0.9	0.8	-1.0
19	1.5	1.4	1.5	1.4	1.6	1.6	1.4	1.3	1.8	1.6	1.8	1.7	1.8	1.7	1.2	1.0	1.1	1.0

TABLE A3-50 CONT.

Future Fisheries Case Study (Run 455)
Representative Above Normal Year (1957)

Average Net Flow

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	-1617	-1042	-3828	68	-1823	-1758	-2071
2	-2744	-1697	-1290	-484	-219	-721	-762
3	-1900	-1329	-1271	-625	-578	-958	-976
4	3892	2079	2048	378	1358	-53	-24
5	-9167	-6660	-6718	-3122	-3150	-6106	-6382
6	-5434	-4051	-4013	-2041	-2017	-3680	-3779
7	-8130	-6133	-6150	-3818	-3832	-7284	-7579
8	3821	2733	2718	1397	1389	2410	2539
9	12	-16	[illegible]	1155	1152	690	710
10	[illegible]	7	[illegible]	244	242	85	[illegible]
11	[illegible]	-4	[illegible]	1169	1166	717	724
12	32	21	[illegible]	261	260	202	190
13	-135	-98	-98	-11	-11	-109	[illegible]
14	-89	-55	[illegible]	38	38	-4	[illegible]
15	5	-5	[illegible]	1506	1502	1084	1090
16	0	0	[illegible]	1511	1507	1094	1088
17	3763	2046	2045	324	329	-131	[illegible]
18	3839	2074	2074	343	347	-80	[illegible]
19	3845	2085	2085	1871	1871	1086	1046

Minimum Water Surface Elevation

Ref. No.	Oct	Nov 1-15	Nov 16-30	Dec. 1-16	Dec. 17-31	Aug.	Sep.
1	1.89	1.97	[illegible]	1.99	1.97	1.94	1.93
2	[illegible]	1.8	[illegible]	1.82	1.8	1.77	1.76
3	1.69	1.74	1.67	1.75	1.73	1.7	1.69
4	1.69	1.74	1.68	1.76	1.74	1.71	[illegible]
5	1.64	1.66	[illegible]	1.7	1.68	1.62	1.61
6	1.64	1.67	[illegible]	1.7	1.68	1.64	[illegible]
7	[illegible]	1.53	[illegible]	1.59	1.57	1.5	1.49
8	[illegible]	1.47	[illegible]	1.54	1.52	1.44	[illegible]
9	1.41	1.46	[illegible]	1.61	1.59	1.48	[illegible]
10	1.35	1.4	[illegible]	1.48	1.46	1.37	[illegible]
11	[illegible]	1.54	[illegible]	1.93	1.91	1.74	[illegible]
12	[illegible]	1.47	[illegible]	1.9	1.87	1.67	[illegible]
13	[illegible]	1.52	[illegible]	1.58	[illegible]	1.49	[illegible]
14	[illegible]	1.47	[illegible]	1.93	1.91	1.67	[illegible]
15	[illegible]	1.44	[illegible]	2.17	2.15	1.86	[illegible]
16	[illegible]	1.4	[illegible]	2.48	2.45	2.07	[illegible]
17	2.48	2.08	[illegible]	1.85	1.83	1.75	[illegible]
18	[illegible]	4.37	[illegible]	2.68	[illegible]	2.32	[illegible]
19	6.56	7.42	[illegible]	6.04	6.03	4.5	[illegible]

Minimum and Maximum Velocity

Ref.	Oct.		Nov. 1-15		Nov. 16-30		Dec. 1-16		Dec. 17-31		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	[illegible]	[illegible]	1.2	-1.3	[illegible]	[illegible]	1.2	-1.3	[illegible]	[illegible]	1.2	-1.4	[illegible]	[illegible]
2	[illegible]	[illegible]	0.2	-0.5	[illegible]	[illegible]	0.4	-0.5	[illegible]	[illegible]	0.3	-0.5	[illegible]	[illegible]
3	[illegible]	[illegible]	0.2	-0.5	[illegible]	[illegible]	0.2	-0.4	[illegible]	[illegible]	0.2	-0.4	[illegible]	[illegible]
4	[illegible]	[illegible]	0.5	-0.3	[illegible]	[illegible]	0.4	-0.4	[illegible]	[illegible]	0.4	-0.4	[illegible]	[illegible]
5	[illegible]	[illegible]	0.8	-1.9	[illegible]	[illegible]	0.9	-1.5	[illegible]	[illegible]	0.7	-1.7	[illegible]	[illegible]
6	[illegible]	[illegible]	0.9	-1.8	[illegible]	[illegible]	1.0	-1.5	[illegible]	[illegible]	0.8	-1.6	[illegible]	[illegible]
7	[illegible]	[illegible]	0.8	-2.9	[illegible]	[illegible]	1.0	-2.3	[illegible]	[illegible]	0.7	-2.6	[illegible]	[illegible]
8	[illegible]	[illegible]	1.2	-0.1	[illegible]	[illegible]	0.9	-0.2	[illegible]	[illegible]	1.5	-0.1	[illegible]	[illegible]
9	[illegible]	[illegible]	0.9	-0.7	[illegible]	[illegible]	1.1	-0.7	[illegible]	[illegible]	1.0	-1.0	[illegible]	[illegible]
10	[illegible]	[illegible]	0.8	-0.6	[illegible]	[illegible]	0.9	-0.7	[illegible]	[illegible]	0.7	-0.9	[illegible]	[illegible]
11	[illegible]	[illegible]	0.7	-0.6	[illegible]	[illegible]	0.9	-0.5	[illegible]	[illegible]	0.9	-0.8	[illegible]	[illegible]
12	[illegible]	[illegible]	0.2	-0.2	[illegible]	[illegible]	0.4	-0.1	[illegible]	[illegible]	0.4	-0.3	[illegible]	[illegible]
13	[illegible]	[illegible]	0.6	-0.7	[illegible]	[illegible]	0.6	-0.7	[illegible]	[illegible]	0.5	-0.8	[illegible]	[illegible]
14	[illegible]	[illegible]	0.4	-0.8	[illegible]	[illegible]	0.6	-0.6	[illegible]	[illegible]	0.5	-0.7	[illegible]	[illegible]
15	[illegible]	[illegible]	0.3	-0.3	[illegible]	[illegible]	1.3	0.5	[illegible]	[illegible]	1.1	-0.5	[illegible]	[illegible]
16	[illegible]	[illegible]	0.1	-0.2	[illegible]	[illegible]	1.5	0.5	[illegible]	[illegible]	1.2	-0.5	[illegible]	[illegible]
17	[illegible]	[illegible]	1.7	0.2	[illegible]	[illegible]	1.2	-1.0	[illegible]	[illegible]	1.0	-1.1	[illegible]	[illegible]
18	[illegible]	[illegible]	1.7	0.7	[illegible]	[illegible]	1.0	-0.9	[illegible]	[illegible]	0.9	-1.1	[illegible]	[illegible]
19	[illegible]	[illegible]	1.2	1.1	[illegible]	[illegible]	1.2	1.1	[illegible]	[illegible]	0.9	0.6	[illegible]	[illegible]

TABLE A3-51

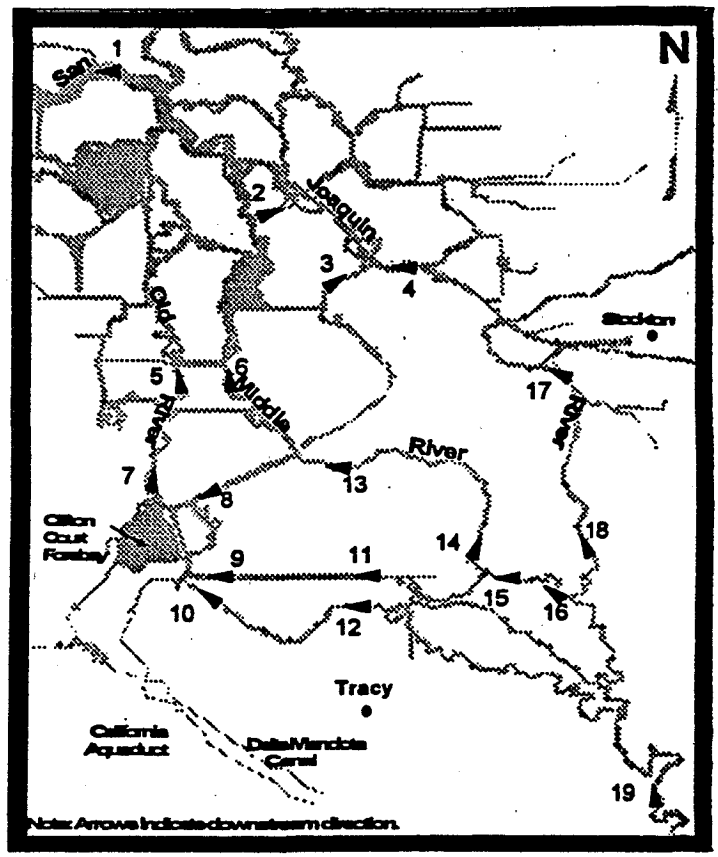
Future Demand Case Study
Fisheries Alt. (Run 455)
Representative Wet Year

Average Net Flow

Ref. No.	Jan	Feb.	March	April	May	June	July
1	6118.0	10051.0	14965.0	24744.0	11109.0	2540.0	936.0
2	-2667.0	-2884.0	-3828.0	-5670.0	-3575.0	-1939.0	-1084.0
3	-1456.0	-1297.0	-1461.0	-2064.0	-1652.0	-1339.0	-972.0
4	2438.0	3007.0	6262.0	10535.0	7589.0	2713.0	1502.0
5	-5628.0	-2872.0	-24.0	3102.0	307.0	-4665.0	-3668.0
6	-3778.0	-2169.0	-402.0	1379.0	-16.0	-2941.0	-2414.0
7	-7675.0	-3757.0	-477.0	3054.0	104.0	-5603.0	-4353.0
8	2600.0	1525.0	579.0	-663.0	252.0	1940.0	1515.0
9	2178.0	2580.0	6283.0	10129.0	6348.0	3348.0	2073.0
10	448.0	499.0	1402.0	2503.0	1850.0	513.0	300.0
11	2173.0	2568.0	6287.0	10165.0	6433.0	3387.0	2113.0
12	404.0	516.0	1575.0	2547.0	1975.0	685.0	467.0
13	79.0	123.0	565.0	994.0	896.0	85.0	-90.0
14	42.0	118.0	520.0	999.0	774.0	229.0	127.0
15	2557.0	3189.0	8076.0	13871.0	11285.0	4512.0	2880.0
16	2544.0	3199.0	8147.0	13802.0	11340.0	4544.0	2944.0
17	966.0	1615.0	4905.0	8695.0	6930.0	2394.0	1330.0
18	642.0	1618.0	4966.0	9075.0	7243.0	2482.0	1406.0
19	3406.0	4847.0	13275.0	23135.0	18901.0	7189.0	4462.0

Minimum Water Surface Elevation

Ref. No.	Jan	Feb.	March	April	May	June	July
1	2.4	2.6	2.8	3.1	2.4	2.1	2.0
2	2.3	2.4	2.5	3.0	2.3	1.9	1.8
3	2.2	2.4	2.5	3.0	2.3	1.9	1.8
4	2.2	2.4	2.6	3.0	2.3	1.9	1.8
5	2.2	2.3	2.5	3.0	2.2	1.8	1.7
6	2.2	2.3	2.6	3.0	2.2	1.8	1.7
7	2.1	2.2	2.4	3.1	2.3	1.7	1.6
8	2.0	2.2	2.8	3.2	2.3	1.6	1.6
9	2.1	2.3	2.9	4.1	3.1	1.9	1.7
10	2.0	2.2	2.6	3.6	2.8	1.6	1.5
11	2.5	2.8	4.2	6.1	4.0	2.6	2.2
12	2.5	2.8	4.1	5.9	4.8	2.5	2.1
13	2.1	2.2	2.5	3.1	2.3	1.7	1.6
14	2.6	2.9	4.0	7.1	5.8	2.7	2.2
15	2.9	3.4	6.1	9.3	7.8	3.7	2.8
16	3.4	4.1	6.0	12.1	10.3	4.8	3.6
17	2.4	2.6	3.4	4.9	3.9	2.3	2.0
18	3.5	4.2	7.7	11.5	9.8	4.8	3.6
19	8.5	10.3	18.1	24.7	22.0	12.8	9.7



Minimum and Maximum Velocity

Ref. No.	January MAX.	January MIN.	February MAX.	February MIN.	March MAX.	March MIN.	April MAX.	April MIN.	May MAX.	May MIN.	June MAX.	June MIN.	July MAX.	July MIN.
1	1.3	-1.3	1.3	-1.3	1.4	-1.2	1.4	-1.1	1.3	-1.2	1.2	-1.3	1.2	-1.3
2	0.1	-0.8	0.2	-0.6	0.0	-0.7	-0.2	-0.9	0.1	-0.7	0.3	-0.6	0.3	-0.5
3	0.1	-0.6	0.1	-0.5	0.1	-0.6	0.0	-0.5	0.1	-0.6	0.1	-0.4	0.2	-0.4
4	0.4	-0.3	0.5	-0.3	0.6	-0.1	0.7	0.1	0.6	-0.1	0.5	-0.3	0.5	-0.3
5	0.8	-1.8	0.9	-1.6	1.1	-1.3	1.3	-1.0	1.2	-1.2	0.9	-1.6	0.9	-1.4
6	0.8	-1.5	0.9	-1.6	1.1	-1.4	1.2	-1.2	1.1	-1.2	0.9	-1.5	0.9	-1.4
7	0.8	-2.0	1.0	-2.4	1.3	-2.0	1.7	-1.3	1.5	-1.7	0.8	-2.4	0.8	-2.1
8	1.2	-0.2	1.0	-0.2	0.8	-0.4	0.8	-0.5	1.0	-0.4	1.3	-0.2	1.3	-0.2
9	1.3	-0.3	1.2	-0.4	1.7	0.6	2.2	1.1	2.1	0.9	1.4	-0.4	1.3	-0.7
10	0.9	-0.4	0.9	-0.6	1.2	0.6	1.6	0.0	1.5	-0.1	0.9	-0.6	0.8	-0.7
11	1.0	-0.1	1.1	-0.2	1.7	0.8	2.1	1.4	2.0	1.1	1.3	-0.1	1.1	-0.6
12	0.6	0.1	0.6	0.1	1.0	0.6	1.5	1.1	1.0	0.8	0.7	0.2	0.8	0.1
13	0.6	-0.6	0.6	-0.6	0.6	-0.5	1.1	-0.6	0.6	-0.5	0.6	-0.6	0.6	-0.7
14	0.7	-0.6	0.8	-0.4	1.6	0.9	2.1	1.7	1.9	1.3	1.1	0.1	0.8	-0.3
15	1.7	1.1	2.1	1.3	3.8	3.3	5.2	4.8	4.7	4.3	2.7	1.7	2.0	1.1
16	1.9	1.4	2.4	1.7	4.4	4.0	5.9	5.6	5.4	5.0	3.1	2.3	2.3	1.5
17	1.3	-0.3	1.5	-0.3	2.7	1.6	3.9	3.0	3.4	2.5	1.8	0.3	1.4	-0.4
18	1.2	-0.1	1.5	0.1	2.6	2.2	3.6	3.3	3.2	2.8	1.8	1.0	1.4	0.8
19	1.7	1.6	2.1	2.0	3.4	3.4	4.5	4.5	4.1	4.1	2.5	2.5	2.0	1.9

TABLE A3-51 CONT.

Future Fisheries Case Study (Run 455)
Representative Wet Year (1982)

Average Net Flow

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	633	-4531	286	-269	-836
2	1086	-1677	1469	-720	-1645
3	1029	-1529	1312	-832	-1412
4	1436	1971	556	550	1566
5	1664	-9000	2354	-4114	7412
6	2952	-5287	1705	-2628	4334
7	5008	-10939	1709	-4905	3008
8	852	3611	1277	1701	2076
9	[illegible]	23	120	1271	2517
10	[illegible]	22	492	201	[illegible]
11	[illegible]	32	115	1298	2561
12	[illegible]	25	[illegible]	320	386
13	[illegible]	-110	[illegible]	-52	[illegible]
14	[illegible]	-80	[illegible]	52	80
15	[illegible]	-4	[illegible]	1840	170
16	[illegible]	0	1321	1850	1190
17	1408	1764	[illegible]	411	1152
18	1433	1783	[illegible]	466	1480
19	2448	1792	1673	2392	1889

Minimum Water Surface Elevation

Ref. No.	Oct	Nov	Dec.	Aug.	Sep
1	1.98	1.94	2.27	1.98	1.94
2	1.79	1.79	[illegible]	1.8	[illegible]
3	1.72	1.73	2.07	1.74	1.74
4	1.73	1.73	2.07	1.74	1.74
5	1.45	1.64	[illegible]	1.67	[illegible]
6	1.68	1.65	[illegible]	1.68	[illegible]
7	1.52	1.51	[illegible]	1.56	[illegible]
8	1.40	1.44	[illegible]	1.51	[illegible]
9	1.53	1.43	[illegible]	1.57	[illegible]
10	1.35	1.36	[illegible]	1.44	[illegible]
11	1.53	1.45	[illegible]	1.91	[illegible]
12	1.35	1.39	[illegible]	1.84	[illegible]
13	[illegible]	1.5	[illegible]	1.55	[illegible]
14	[illegible]	1.45	[illegible]	1.87	[illegible]
15	1.02	1.37	[illegible]	2.18	[illegible]
16	1.59	1.36	[illegible]	2.56	[illegible]
17	1.97	2.02	[illegible]	1.84	[illegible]
18	[illegible]	4.06	[illegible]	2.76	[illegible]
19	[illegible]	6.81	[illegible]	6.85	[illegible]

Minimum and Maximum Velocity

Ref.	Oct.		Nov.		Dec.		Aug.		Sep.	
No.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	[illegible]	[illegible]	1.2	-1.4	[illegible]	[illegible]	1.2	-1.3	[illegible]	[illegible]
2	[illegible]	[illegible]	0.3	-0.5	[illegible]	[illegible]	0.3	-0.5	[illegible]	[illegible]
3	[illegible]	[illegible]	0.1	-0.4	[illegible]	[illegible]	0.2	-0.4	[illegible]	[illegible]
4	[illegible]	[illegible]	0.5	-0.3	[illegible]	[illegible]	0.4	-0.3	[illegible]	[illegible]
5	[illegible]	[illegible]	0.7	-2.0	[illegible]	[illegible]	0.8	-1.4	[illegible]	[illegible]
6	[illegible]	[illegible]	0.7	-1.9	[illegible]	[illegible]	0.9	-1.4	[illegible]	[illegible]
7	[illegible]	[illegible]	0.6	-3.2	[illegible]	[illegible]	0.8	-2.2	[illegible]	[illegible]
8	[illegible]	[illegible]	1.3	-0.1	[illegible]	[illegible]	1.3	-0.2	[illegible]	[illegible]
9	[illegible]	[illegible]	0.8	-0.7	[illegible]	[illegible]	1.1	-0.8	[illegible]	[illegible]
10	[illegible]	[illegible]	0.7	-0.6	[illegible]	[illegible]	0.8	-0.8	[illegible]	[illegible]
11	[illegible]	[illegible]	0.7	-0.6	[illegible]	[illegible]	0.9	-0.6	[illegible]	[illegible]
12	[illegible]	[illegible]	0.2	-0.2	[illegible]	[illegible]	0.5	-0.1	[illegible]	[illegible]
13	[illegible]	[illegible]	0.5	-0.5	[illegible]	[illegible]	0.6	-0.7	[illegible]	[illegible]
14	[illegible]	[illegible]	0.3	-0.8	[illegible]	[illegible]	0.7	-0.5	[illegible]	[illegible]
15	[illegible]	[illegible]	0.2	-0.2	[illegible]	[illegible]	1.5	0.4	[illegible]	[illegible]
16	[illegible]	[illegible]	0.1	-0.1	[illegible]	[illegible]	1.7	0.7	[illegible]	[illegible]
17	[illegible]	[illegible]	1.5	0.0	[illegible]	[illegible]	1.2	-0.9	[illegible]	[illegible]
18	[illegible]	[illegible]	1.6	0.4	[illegible]	[illegible]	1.1	-0.8	[illegible]	[illegible]
19	[illegible]	[illegible]	1.1	1.0	[illegible]	[illegible]	[illegible]	1.3	[illegible]	[illegible]

DWRSIM Output

by

Year Type

Preferred Alternative and

Fisheries Alternative

71 Year Record-Critical Years
Total Exports = H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	8,063	7,492	11,038	11,865	8,041	6,114	2,798	2,973	4,369	7,429	4,859	3,944
1929	6,654	8,667	10,547	9,690	8,461	5,763	3,047	3,216	5,716	8,463	2,939	3,989
1931	4,759	4,534	6,281	10,047	6,382	4,267	3,175	2,668	4,268	5,477	784	3,187
1933	5,008	5,334	6,034	11,380	7,285	4,809	4,192	3,499	4,359	3,698	792	3,484
1934	4,801	3,683	9,269	13,475	6,238	6,725	3,662	2,755	4,879	3,643	797	3,252
1976	14,670	11,609	8,184	7,508	8,411	5,921	3,078	3,265	5,430	5,300	3,501	4,045
1977	5,442	5,435	8,108	10,733	5,900	4,231	2,998	2,396	1,078	1,806	932	2,965
1988	7,048	6,122	11,183	14,524	6,375	4,819	2,967	3,120	5,767	6,047	4,846	4,041
1990	4,974	3,378	7,818	12,208	6,078	4,469	3,626	2,808	5,815	7,835	5,352	3,373
1991	4,085	4,492	6,234	6,261	6,480	11,142	3,791	2,338	4,234	7,248	4,752	4,615
1992	4,369	3,582	6,390	7,795	14,544	7,571	3,606	3,005	5,286	7,301	3,955	4,062
Average	6,352	5,848	8,281	10,499	7,654	5,985	3,358	2,913	4,655	5,841	3,046	3,723

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	8,063	7,558	11,327	11,574	8,041	4,734	2,791	2,977	4,363	6,828	4,842	3,699
1929	6,654	8,667	11,303	9,690	8,461	4,346	3,049	3,215	5,713	8,167	2,950	3,848
1931	4,762	5,482	6,075	10,047	6,382	4,266	3,172	2,663	4,261	4,375	297	3,187
1933	5,012	5,338	6,029	11,380	7,285	4,809	3,695	3,492	5,183	3,828	991	3,686
1934	4,801	3,683	9,270	11,508	6,238	6,719	3,665	2,999	5,830	3,834	797	3,844
1976	11,027	10,941	10,586	8,448	9,183	6,038	3,081	3,266	5,879	5,372	3,501	4,045
1977	5,442	5,466	10,733	8,214	5,900	3,454	2,862	2,396	1,078	1,806	932	2,965
1988	6,311	6,124	11,175	11,273	6,371	4,729	2,965	3,113	5,768	7,150	4,958	4,415
1990	4,977	3,381	7,664	11,255	6,083	4,469	3,625	2,805	5,794	7,093	5,148	3,370
1991	4,086	4,077	6,052	6,161	6,371	11,142	3,791	2,873	5,582	7,185	2,564	4,544
1992	4,370	3,471	6,339	7,798	11,827	7,571	3,577	3,007	5,787	7,681	4,041	4,356
Average	5,955	5,835	8,778	9,759	7,467	5,662	3,298	2,982	5,022	5,756	2,820	3,814

Difference (Run 413- Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0	-66	-289	291	0	1,380	7	-4	6	601	17	245
1929	0	0	-756	0	0	1,417	-2	1	3	296	-11	141
1931	-3	-948	206	0	0	1	3	5	7	1,102	487	0
1933	-4	-4	5	0	0	0	497	7	-824	-130	-199	-202
1934	0	0	-1	1,967	0	6	-3	-244	-951	-191	0	-592
1976	3,643	668	-2,402	-940	-772	-117	-3	-1	-449	-72	0	0
1977	0	-31	-2,625	2,519	0	777	136	0	0	0	0	0
1988	737	-2	8	3,251	4	90	2	7	-1	-1,103	-112	-374
1990	-3	-3	154	953	-5	0	1	3	21	742	204	3
1991	-1	415	182	100	109	0	0	-535	-1,348	63	2,188	71
1992	-1	111	51	-3	2,717	0	29	-2	-501	-380	-86	-294
Average	397	13	-497	740	187	323	61	-69	-367	84	226	-91

Percent Difference [(Run 413-420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0%	-1%	-3%	3%	0%	29%	0%	0%	0%	9%	0%	7%
1929	0%	0%	-7%	0%	0%	33%	0%	0%	0%	4%	0%	4%
1931	0%	-17%	3%	0%	0%	0%	0%	0%	0%	25%	164%	0%
1933	0%	0%	0%	0%	0%	0%	13%	0%	-16%	-3%	-20%	-5%
1934	0%	0%	0%	17%	0%	0%	0%	-8%	-16%	-5%	0%	-15%
1976	33%	6%	-23%	-11%	-8%	-2%	0%	0%	-8%	-1%	0%	0%
1977	0%	-1%	-24%	31%	0%	22%	5%	0%	0%	0%	0%	0%
1988	12%	0%	0%	29%	0%	2%	0%	0%	0%	-15%	-2%	-8%
1990	0%	0%	2%	8%	0%	0%	0%	0%	0%	10.5%	4%	0%
1991	0%	10.2%	3%	2%	2%	0%	0%	-19%	-24%	1%	85%	2%
1992	0%	3%	1%	0%	23%	0%	1%	0%	-9%	-5%	-2%	-7%
Average	4%	0%	-4%	7%	1%	8%	2%	-2%	-7%	2%	21%	-2%

71 Year Record-Dry Years
Total Exports = H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	8,508	6,627	8,873	7,303	14,566	7,948	6,701	5,185	6,541	10,433	7,943	6,301
1926	9,186	6,918	7,690	12,314	14,598	6,531	6,038	5,132	5,533	10,751	7,841	6,253
1930	7,950	6,375	9,133	14,524	6,635	11,308	3,612	3,540	5,526	7,222	4,514	5,193
1932	6,189	5,303	12,039	13,021	7,583	4,009	5,096	4,293	2,324	3,129	3,317	5,362
1939	13,324	7,920	7,311	5,737	4,835	5,393	4,175	3,876	5,621	10,410	7,133	5,897
1944	9,711	10,388	7,364	11,423	13,422	8,381	4,047	3,983	6,634	9,716	7,091	6,079
1947	8,236	8,386	11,225	12,019	10,462	8,217	4,342	3,897	5,433	12,373	9,219	6,394
1949	10,560	7,984	8,570	8,700	7,125	14,658	4,945	4,853	6,217	8,673	6,994	6,519
1955	7,340	11,773	14,556	13,530	8,135	4,524	3,535	3,946	6,559	12,725	8,304	8,334
1960	8,925	5,880	10,190	10,383	14,183	8,015	3,802	3,402	5,628	13,906	8,619	6,611
1961	8,314	8,168	10,867	9,055	14,615	7,300	3,593	3,411	5,572	13,798	8,756	6,614
1964	12,678	14,569	9,686	7,607	6,443	5,071	3,628	3,933	5,617	13,069	9,852	7,129
1981	14,062	9,835	7,629	7,233	7,680	6,975	5,032	3,876	5,541	10,445	7,132	6,011
1985	14,299	11,369	7,802	7,541	8,603	7,407	3,696	4,421	5,488	12,653	8,711	6,506
1987	11,293	9,148	7,784	9,193	9,758	12,349	3,831	3,457	5,534	11,291	8,424	6,037
1989	4,341	5,611	6,837	8,333	6,838	14,674	5,467	4,079	5,507	13,113	9,228	6,503
Average	9,682	8,516	9,222	9,870	9,718	8,298	4,471	4,080	5,580	10,857	7,692	6,359

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	8,510	6,622	8,873	7,305	11,762	7,948	6,701	5,185	6,535	10,130	7,894	6,280
1926	9,187	6,921	7,586	11,483	11,762	6,268	6,038	5,130	5,527	10,311	7,795	6,234
1930	7,937	6,371	9,135	11,467	6,635	11,234	3,591	3,539	5,525	7,462	4,628	5,196
1932	6,189	5,303	11,235	11,466	7,583	3,095	5,100	4,298	2,298	3,103	3,292	5,362
1939	11,027	10,747	7,734	6,620	5,116	5,393	4,175	3,876	5,621	10,410	7,133	5,897
1944	9,711	10,398	7,364	11,423	12,388	9,179	4,040	3,983	6,634	9,806	7,116	6,078
1947	8,235	8,386	11,229	11,645	10,462	8,217	4,339	3,896	5,428	11,287	9,676	6,323
1949	10,821	7,979	8,588	8,696	7,125	11,538	4,945	4,858	6,202	8,205	6,933	6,522
1955	7,340	10,941	11,254	11,636	9,451	4,524	3,535	3,938	6,553	11,287	11,287	9,760
1960	8,925	6,736	11,131	9,382	11,792	7,957	3,799	3,401	5,623	11,287	10,831	6,570
1961	8,316	8,177	10,875	9,055	11,685	7,300	3,560	3,411	5,563	11,287	11,003	6,617
1964	11,027	10,941	10,097	11,602	6,441	5,072	3,627	3,933	5,618	11,287	11,271	7,084
1981	11,027	10,941	9,167	7,318	7,774	7,239	5,032	3,876	5,541	10,445	7,132	6,011
1985	11,027	10,941	11,064	7,680	8,930	7,407	3,696	4,421	5,483	11,287	10,073	6,506
1987	11,027	9,146	7,785	9,191	9,758	10,839	3,787	3,456	5,531	11,280	8,425	6,039
1989	4,175	5,517	6,844	8,336	6,832	11,402	5,467	4,051	5,499	11,287	10,989	6,506
Average	9,030	8,504	9,373	9,644	9,094	7,788	4,465	4,078	5,574	10,010	8,467	6,437

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	-2	5	0	-2	2,804	0	0	0	6	303	49	21
1926	-1	-3	104	831	2,836	263	0	2	6	440	46	19
1930	13	4	-2	3,057	0	74	21	1	1	-240	-114	-3
1932	0	0	804	1,555	0	914	-4	-5	26	26	25	0
1939	2,297	-2,827	-423	-883	-281	0	0	0	0	0	0	0
1944	0	-10	0	0	1,034	-798	7	0	0	-90	-25	1
1947	1	0	-4	374	0	0	3	1	5	1,086	-457	71
1949	-261	5	-18	4	0	3,120	0	-5	15	468	61	-3
1955	0	832	3,302	1,894	-1,316	0	0	8	6	1,438	-2,983	-1,426
1960	0	-856	-941	1,001	2,391	58	3	1	5	2,619	-2,212	41
1961	-2	-9	-8	0	2,930	0	33	0	9	2,511	-2,247	-3
1964	1,651	3,628	-411	-3,995	2	-1	1	0	-1	1,782	-1,419	45
1981	3,035	-1,106	-1,538	-85	-94	-264	0	0	0	0	0	0
1985	3,272	428	-3,262	-139	-327	0	0	0	5	1,366	-1,362	0
1987	266	2	-1	2	0	1,510	44	1	3	11	-1	-2
1989	166	94	-7	-3	6	3,272	0	28	8	1,826	-1,761	-3
Average	652	12	-150	226	624	509	7	2	6	847	-775	-78

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0%	0%	0%	0%	24%	0%	0%	0%	0%	3%	1%	0%
1926	0%	0%	1%	7%	24%	4%	0%	0%	0%	4%	1%	0%
1930	0%	0%	0%	27%	0%	1%	1%	0%	0%	-3%	-2%	0%
1932	0%	0%	7%	14%	0%	30%	0%	0%	1%	1%	1%	0%
1939	21%	-26%	-5%	-13%	-5%	0%	0%	0%	0%	0%	0%	0%
1944	0%	0%	0%	0%	8%	-9%	0%	0%	0%	-1%	0%	0%
1947	0%	0%	0%	3%	0%	0%	0%	0%	0%	9.6%	-5%	1%
1949	-2%	0%	0%	0%	0%	27%	0%	0%	0%	6%	1%	0%
1955	0%	8%	29%	16%	-14%	0%	0%	0%	0%	13%	-26%	-15%
1960	0%	-13%	-8%	11%	20%	1%	0%	0%	0%	23%	-20%	1%
1961	0%	0%	0%	0%	25%	0%	1%	0%	0%	22%	-20%	0%
1964	15%	33%	-4%	-34%	0%	0%	0%	0%	0%	16%	-13%	1%
1981	28%	-10.1%	-17%	-1%	-1%	-4%	0%	0%	0%	0%	0%	0%
1985	30%	4%	-29%	-2%	-4%	0%	0%	0%	0%	12%	-14%	0%
1987	2%	0%	0%	0%	0%	14%	1%	0%	0%	0%	0%	0%
1989	4%	2%	0%	0%	0%	29%	0%	1%	0%	16%	-16%	0%
Average	6%	0%	-2%	2%	5%	6%	0%	0%	0%	8%	-7%	-1%

71 Year Record-Below Normal Years
Total Exports = H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	14,670	13,002	7,861	7,420	5,937	5,508	7,713	6,265	6,549	10,005	9,241	6,292
1935	4,254	7,730	8,128	14,522	6,332	10,528	8,095	8,356	7,246	9,218	7,848	5,875
1936	7,319	6,838	9,712	14,524	14,530	8,905	7,181	6,071	6,490	8,277	6,995	5,985
1937	6,714	6,415	10,263	11,101	14,615	12,108	8,027	6,857	4,213	5,737	5,867	6,039
1945	8,967	10,932	13,050	11,287	10,454	8,523	5,881	5,055	7,472	6,674	7,081	6,340
1946	10,549	14,496	14,556	7,502	7,317	8,690	5,884	5,357	7,031	8,768	7,646	6,452
1948	9,175	7,476	7,668	10,893	6,427	6,021	6,573	7,708	8,266	14,898	10,197	7,982
1950	8,125	6,939	7,282	14,524	13,579	8,644	5,929	5,403	7,017	11,989	9,503	6,549
1959	9,380	7,978	7,793	6,380	4,972	6,378	3,765	3,930	5,929	10,658	7,254	6,953
1962	7,968	6,859	10,376	7,634	14,609	10,191	4,203	4,919	5,926	13,309	8,845	6,858
1966	11,701	14,569	13,300	7,754	8,411	7,705	5,072	4,863	5,919	11,281	9,096	6,623
1968	7,365	7,057	6,875	4,232	4,835	6,481	4,673	3,872	5,929	10,382	7,167	6,663
1972	13,580	11,584	10,825	7,840	9,589	9,175	4,590	3,928	5,876	12,891	8,428	6,986
1979	14,004	11,366	6,323	7,401	7,914	7,966	6,604	6,512	8,100	6,710	6,255	6,111
Average	9,555	9,517	9,572	9,501	9,252	8,345	6,014	5,650	6,569	10,057	7,959	6,551

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	11,027	10,941	11,678	9,532	4,079	6,096	7,713	6,265	6,534	11,282	9,604	6,446
1935	4,254	7,730	8,128	11,763	6,332	10,528	8,095	8,356	7,237	11,118	8,392	5,875
1936	7,319	6,831	7,640	11,863	12,821	11,700	7,181	6,071	6,485	10,857	7,736	5,985
1937	6,714	6,424	11,350	11,101	12,821	12,064	8,027	6,703	4,945	5,828	6,052	6,039
1945	8,967	10,941	11,420	11,287	12,263	8,523	5,881	5,055	7,473	6,674	7,081	6,340
1946	10,550	10,941	11,521	11,968	7,317	9,018	5,884	5,358	7,031	9,918	7,977	6,442
1948	9,171	7,766	7,604	10,897	6,433	6,021	6,573	7,708	8,266	11,287	11,287	10,995
1950	8,128	6,942	6,607	11,567	11,762	8,644	5,929	5,395	7,004	11,287	11,287	6,717
1959	11,027	7,978	7,793	7,159	5,733	6,378	3,765	3,930	5,929	10,658	7,254	6,953
1962	7,971	6,856	10,385	7,528	12,255	10,191	4,190	4,917	5,924	11,287	9,378	6,860
1966	11,027	10,941	11,557	12,208	10,126	7,731	5,072	4,863	5,924	11,276	9,096	6,623
1968	9,343	7,641	6,876	4,238	4,835	6,481	4,673	3,872	5,929	10,382	7,167	6,663
1972	11,027	10,941	11,264	10,520	9,646	9,175	4,606	3,928	5,878	11,287	10,007	6,986
1979	11,027	10,941	6,323	10,635	7,914	8,117	6,604	6,512	8,100	6,710	6,255	6,111
Average	9,111	8,844	9,296	10,162	8,881	8,619	6,014	5,638	6,619	9,989	8,470	6,788

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	3,643	2,061	-3,817	-2,112	1,858	-588	0	0	15	-1,277	-363	-154
1935	0	0	0	2,759	0	0	0	0	9	-1,900	-544	0
1936	0	7	2,072	2,661	1,709	-2,795	0	0	5	-2,580	-741	0
1937	0	-9	-1,087	0	1,794	44	0	154	-732	-91	-185	0
1945	0	-9	1,630	0	-1,809	0	0	0	-1	0	0	0
1946	-1	3,555	3,035	-4,466	0	-328	0	-1	0	-1,150	-331	10
1948	4	-290	64	-4	-6	0	0	0	0	3,611	-1,090	-3,013
1950	-3	-3	675	2,957	1,817	0	0	8	13	702	-1,784	-168
1959	-1,647	0	0	-779	-761	0	0	0	0	0	0	0
1962	-3	3	-9	106	2,354	0	13	2	2	2,022	-533	-2
1966	674	3,628	1,743	-4,454	-1,715	-26	0	0	-5	5	0	0
1968	-1,978	-584	-1	-6	0	0	0	0	0	0	0	0
1972	2,553	643	-439	-2,680	-57	0	-16	0	-2	1,604	-1,579	0
1979	2,977	425	0	-3,234	0	-151	0	0	0	0	0	0
Average	444	673	276	-661	370	-275	0	12	-50	68	-511	-238

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	33%	19%	-33%	-22%	46%	-9.6%	0%	0%	0%	-11%	-4%	-2%
1935	0%	0%	0%	23%	0%	0%	0%	0%	0%	-17%	-6%	0%
1936	0%	0%	27%	22%	13%	-24%	0%	0%	0%	-24%	-9.6%	0%
1937	0%	0%	-9.6%	0%	14%	0%	0%	2%	-15%	-2%	-3%	0%
1945	0%	0%	14%	0%	-15%	0%	0%	0%	0%	0%	0%	0%
1946	0%	32%	26%	-37%	0%	-4%	0%	0%	0%	-12%	-4%	0%
1948	0%	-4%	1%	0%	0%	0%	0%	0%	0%	32%	-9.7%	-27%
1950	0%	0%	10.2%	26%	15%	0%	0%	0%	0%	6%	-16%	-3%
1959	-15%	0%	0%	-11%	-13%	0%	0%	0%	0%	0%	0%	0%
1962	0%	0%	0%	1%	19%	0%	0%	0%	0%	18%	-6%	0%
1966	6%	33%	15%	-36%	-17%	0%	0%	0%	0%	0%	0%	0%
1968	-21%	-8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1972	23%	6%	-4%	-25%	-1%	0%	0%	0%	0%	14%	-16%	0%
1979	27%	4%	0%	-30%	0%	-2%	0%	0%	0%	0%	0%	0%
Average	4%	6%	3%	-6%	4%	-3%	0%	0%	-1%	0%	-5%	-2%

71 Year Record-Above Normal Years
Total Exports = H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	6,573	6,936	13,119	14,148	10,034	8,498	8,002	8,755	12,371	3,356	4,477	6,502
1928	9,589	14,569	12,164	8,294	8,140	8,546	7,372	5,843	6,317	10,199	7,450	6,309
1940	8,196	6,311	7,426	14,524	14,530	12,626	8,095	6,852	6,321	7,623	7,433	6,333
1951	10,531	14,569	14,556	9,387	8,411	8,117	6,243	6,975	6,306	11,226	7,985	6,600
1954	14,670	13,055	7,861	7,420	8,083	8,213	7,372	6,770	6,255	10,937	7,909	6,707
1957	14,670	10,982	7,452	9,139	8,054	7,644	5,804	5,587	6,759	11,275	10,076	6,548
1973	10,122	14,569	14,556	9,892	8,411	7,809	6,772	6,929	7,803	8,196	7,560	6,833
1978	3,915	3,778	10,852	7,217	5,319	5,279	6,313	6,696	6,622	2,839	4,473	8,219
1980	7,827	13,975	14,556	7,457	8,023	6,227	6,263	6,772	5,682	3,233	4,873	10,456
Average	**9,566**	**10,972**	**11,394**	**9,720**	**8,778**	**8,107**	**6,915**	**6,798**	**7,160**	**7,654**	**6,915**	**7,167**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	6,573	6,936	11,472	12,147	12,821	9,624	8,002	8,755	11,277	3,357	4,477	6,502
1928	9,590	10,941	11,364	11,774	8,790	8,572	7,372	5,844	6,317	10,346	7,492	6,307
1940	8,196	6,317	7,421	11,706	12,142	11,726	8,095	6,836	6,320	11,287	8,975	6,636
1951	10,530	10,941	11,853	12,729	10,914	8,131	6,243	6,975	6,302	11,206	7,985	6,600
1954	11,027	10,941	10,685	9,663	8,140	8,342	7,372	6,771	6,256	11,271	7,972	6,708
1957	11,027	10,778	7,452	11,393	10,038	7,670	5,804	5,587	6,754	11,280	10,076	6,548
1973	10,113	10,941	11,251	11,573	12,400	9,341	6,772	6,929	7,803	8,196	7,560	6,833
1978	3,915	3,778	10,857	8,178	5,319	5,279	6,313	6,696	6,622	2,839	4,473	8,219
1980	7,827	10,941	11,332	12,729	8,642	6,482	6,337	6,772	5,682	3,233	4,873	10,445
Average	**8,755**	**9,168**	**10,410**	**11,321**	**9,912**	**8,352**	**6,923**	**6,796**	**7,037**	**8,113**	**7,098**	**7,200**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0	0	1,647	2,001	-2,787	-1,126	0	0	1,094	-1	0	0
1928	-1	3,628	800	-3,480	-650	-26	0	-1	0	-147	-42	2
1940	0	-6	5	2,818	2,388	900	0	16	1	-3,664	-1,542	-303
1951	1	3,628	2,703	-3,342	-2,503	-14	0	0	4	20	0	0
1954	3,643	2,114	-2,824	-2,243	-57	-129	0	-1	-1	-334	-63	-1
1957	3,643	204	0	-2,254	-1,984	-26	0	0	5	-5	0	0
1973	9	3,628	3,305	-1,681	-3,989	-1,532	0	0	0	0	0	0
1978	0	0	-5	-961	0	0	0	0	0	0	0	0
1980	0	3,034	3,224	-5,272	-619	-255	-74	0	0	0	0	11
Average	**811**	**1,803**	**984**	**-1,602**	**-1,133**	**-245**	**-8**	**2**	**123**	**-459**	**-183**	**-32**

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0%	0%	14%	16%	-22%	-12%	0%	0%	9.7%	0%	0%	0%
1928	0%	33%	7%	-30%	-7%	0%	0%	0%	0%	-1%	-1%	0%
1940	0%	0%	0%	24%	20%	8%	0%	0%	0%	-32%	-17%	-5%
1951	0%	33%	23%	-26%	-23%	0%	0%	0%	0%	0%	0%	0%
1954	33%	19%	-26%	-23%	-1%	-2%	0%	0%	0%	-3%	-1%	0%
1957	33%	2%	0%	-20%	-20%	0%	0%	0%	0%	0%	0%	0%
1973	0%	33%	29%	-15%	-32%	-16%	0%	0%	0%	0%	0%	0%
1978	0%	0%	0%	-12%	0%	0%	0%	0%	0%	0%	0%	0%
1980	0%	28%	28%	-41%	-7%	-4%	-1%	0%	0%	0%	0%	0%
Average	**7%**	**16%**	**8%**	**-14%**	**-10%**	**-3%**	**0%**	**0%**	**1%**	**-4%**	**-2%**	**0%**

71 Year Record-Wet Years
Total Exports = H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	8,911	14,569	11,492	12,764	7,964	7,946	8,095	8,045	6,457	5,654	6,753	6,034
1938	7,039	14,569	14,556	7,318	7,925	6,929	6,688	8,129	10,258	4,910	4,730	13,316
1941	7,947	7,471	14,556	14,457	11,890	7,532	8,042	7,802	8,449	3,047	4,473	9,685
1942	14,670	7,829	7,613	7,214	7,612	6,905	8,550	8,755	11,263	3,090	4,477	10,675
1943	14,670	8,565	7,802	7,353	7,658	6,937	8,549	6,332	5,500	5,804	5,992	5,997
1952	9,077	11,950	14,556	13,837	8,411	6,983	7,258	8,302	9,853	8,454	5,688	14,801
1953	8,156	7,184	6,907	4,788	4,821	6,544	5,948	7,490	10,551	6,996	5,355	8,939
1956	6,629	7,706	14,556	14,457	10,566	7,644	7,588	8,755	10,011	5,284	7,856	11,474
1958	13,765	13,250	12,658	7,840	8,411	9,826	8,860	8,756	10,770	5,891	7,175	14,467
1963	14,670	14,560	9,577	7,517	8,080	10,654	8,098	8,356	7,051	7,226	7,433	8,516
1965	6,670	9,760	14,556	14,433	9,721	7,628	8,549	8,680	6,326	9,496	7,200	6,595
1967	8,732	10,525	14,556	13,502	7,524	6,342	7,644	8,129	10,258	10,776	5,927	13,884
1969	9,063	8,495	14,556	14,457	7,345	6,622	6,549	7,690	9,601	6,576	5,115	14,955
1970	8,686	7,887	6,989	4,142	4,821	6,544	5,995	4,706	6,275	9,362	7,040	6,514
1971	9,053	14,569	14,556	8,715	8,083	8,821	6,116	7,704	9,027	7,918	7,997	10,303
1974	11,124	14,569	12,456	7,607	8,262	8,624	8,549	8,701	8,864	6,933	6,914	14,884
1975	14,312	8,212	8,037	7,535	6,017	7,338	8,267	8,755	10,440	5,825	7,727	11,847
1982	8,384	14,569	14,556	9,910	8,083	8,717	8,615	9,528	11,317	8,588	8,123	14,955
1983	8,572	8,298	7,936	6,083	4,628	4,423	5,960	6,273	7,680	7,796	10,178	8,389
1984	7,062	5,299	5,241	3,218	4,143	6,342	6,270	5,104	6,673	8,309	6,850	10,703
1986	8,737	8,023	12,681	13,864	14,615	6,981	8,021	7,194	6,330	4,714	5,985	8,073
Average	**9,806**	**10,374**	**11,447**	**9,572**	**7,932**	**7,442**	**7,534**	**7,771**	**8,712**	**6,793**	**6,618**	**10,715**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	8,914	10,941	11,194	11,346	12,231	8,367	8,095	8,045	6,448	5,652	6,751	6,034
1938	7,039	10,941	11,351	12,352	9,510	7,196	6,762	8,129	10,258	4,910	4,730	11,243
1941	8,093	8,050	11,453	12,450	12,821	11,372	8,043	7,802	8,449	3,047	4,473	9,693
1942	11,027	10,941	7,719	7,318	7,774	7,169	8,550	8,755	11,263	3,090	4,477	10,665
1943	11,027	10,941	8,455	7,457	8,023	7,201	8,549	6,332	5,500	5,804	5,992	5,997
1952	9,077	10,941	11,304	12,729	12,599	8,529	7,258	8,302	9,853	8,454	5,688	11,243
1953	10,098	7,887	7,688	4,818	4,821	6,544	5,948	7,490	10,551	6,996	5,355	8,940
1956	6,633	7,725	11,301	12,729	12,447	10,549	7,588	8,755	10,011	5,369	7,883	11,243
1958	11,027	10,941	11,372	11,811	10,909	9,851	8,860	8,756	10,770	5,891	7,175	11,243
1963	11,027	10,941	11,266	11,463	8,639	10,654	8,098	8,356	7,055	7,048	7,433	8,516
1965	6,672	10,336	11,308	12,729	11,916	8,659	8,549	8,680	6,328	10,211	7,411	6,596
1967	8,732	10,941	11,526	11,916	12,157	6,367	7,644	8,129	10,258	10,776	5,927	11,243
1969	9,063	9,057	11,249	12,373	12,487	6,648	6,727	7,690	9,601	6,576	5,115	11,243
1970	11,027	7,887	7,427	4,946	4,821	6,544	5,995	4,706	6,275	9,362	7,040	6,514
1971	9,053	10,941	11,411	11,618	9,063	11,342	6,116	7,704	9,027	8,253	7,997	10,304
1974	11,027	10,941	11,352	12,044	8,474	8,649	8,549	8,701	8,864	6,933	6,914	11,243
1975	11,027	10,941	11,013	7,640	6,017	7,644	8,267	8,755	10,440	6,545	7,790	11,243
1982	8,384	10,941	11,217	12,015	12,821	8,837	8,615	9,779	11,277	8,588	8,123	11,243
1983	11,027	8,298	7,937	6,107	4,628	4,947	6,684	6,273	7,680	7,796	10,178	8,389
1984	7,062	5,299	5,241	3,218	4,143	6,342	6,270	5,104	6,673	8,309	6,850	10,689
1986	8,737	8,560	11,320	11,410	12,821	10,248	9,684	7,194	6,321	4,640	5,961	8,071
Average	**9,323**	**9,733**	**10,195**	**10,023**	**9,482**	**8,269**	**7,660**	**7,783**	**8,710**	**6,869**	**6,632**	**9,600**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	-3	3,628	298	1,418	-4,267	-421	0	0	9	2	2	0
1938	0	3,628	3,205	-5,034	-1,585	-267	-74	0	0	0	0	2,073
1941	-146	-579	3,103	2,007	-931	-3,840	-1	0	0	0	0	-8
1942	3,643	-3,112	-106	-104	-162	-264	0	0	0	0	0	10
1943	3,643	-2,376	-653	-104	-365	-264	0	0	0	0	0	0
1952	0	1,009	3,252	1,108	-4,188	-1,546	0	0	0	0	0	3,558
1953	-1,942	-703	-781	-30	0	0	0	0	0	0	0	-1
1956	-4	-19	3,255	1,728	-1,881	-2,905	0	0	0	-85	-27	231
1958	2,738	2,309	1,286	-3,971	-2,498	-25	0	0	0	0	0	3,224
1963	3,643	3,619	-1,689	-3,946	-559	0	0	0	-4	178	0	0
1965	-2	-576	3,248	1,704	-2,195	-1,031	0	0	-2	-715	-211	-1
1967	0	-416	3,030	1,586	-4,633	-25	0	0	0	0	0	2,641
1969	0	-562	3,307	2,084	-5,142	-26	-178	0	0	0	0	3,712
1970	-2,341	0	-438	-804	0	0	0	0	0	0	0	0
1971	0	3,628	3,145	-2,903	-980	-2,521	0	0	0	-335	0	-1
1974	97	3,628	1,104	-4,437	-212	-25	0	0	0	0	0	3,641
1975	3,285	-2,729	-2,976	-105	0	-306	0	0	0	-720	-63	604
1982	0	3,628	3,339	-2,105	-4,738	-120	0	-251	40	0	0	3,712
1983	-2,455	0	-1	-24	0	-524	-724	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	14
1986	0	-537	1,361	2,454	1,794	-3,267	-1,663	0	9	74	24	2
Average	**484**	**641**	**1,252**	**-451**	**-1,550**	**-827**	**-126**	**-12**	**2**	**-76**	**-13**	**1,115**

71 Year Record-Critical Years
Total Exports=H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	6,264	7,487	12,563	9,557	8,315	3,897	2,753	2,971	4,374	4,668	1,610	2,843
1929	6,248	9,032	11,134	9,715	8,573	3,685	3,007	3,213	5,728	7,923	1,767	3,795
1931	4,725	4,470	9,081	10,134	6,483	4,207	3,133	2,671	4,302	3,764	59	3,380
1933	4,907	3,573	5,441	11,212	6,735	4,596	4,166	3,457	5,915	6,768	1,930	3,920
1934	4,880	3,856	9,855	12,337	5,614	6,744	3,662	3,008	4,857	5,179	1,017	3,629
1976	14,670	14,069	8,576	7,902	8,107	5,509	3,084	3,241	5,939	9,628	4,041	3,794
1977	5,231	5,623	10,769	5,090	6,115	4,315	3,003	2,512	1,146	1,968	828	3,005
1988	3,773	6,178	11,938	14,524	2,863	4,826	2,943	2,246	4,892	8,437	2,214	3,298
1990	5,426	3,992	9,591	12,725	6,071	4,313	3,586	2,806	5,847	9,094	2,157	3,414
1991	4,162	4,484	6,605	6,529	6,731	11,319	3,797	2,873	5,613	5,762	2,704	5,271
1992	4,507	3,329	4,868	7,771	14,558	7,489	3,452	3,009	5,818	6,078	1,924	3,580
Average	**5,890**	**6,008**	**9,129**	**9,772**	**7,288**	**5,536**	**3,326**	**2,910**	**4,948**	**6,297**	**1,841**	**3,630**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	6,264	7,864	11,327	9,557	8,315	3,891	2,753	2,978	4,382	4,678	1,609	2,843
1929	6,249	9,031	9,798	9,716	8,573	3,576	3,005	3,210	5,720	7,976	1,669	3,027
1931	4,729	4,813	10,519	10,134	6,483	4,196	3,133	2,662	3,234	2,441	59	2,657
1933	4,910	3,545	5,442	11,212	6,735	4,596	4,165	3,456	5,915	7,516	1,012	2,720
1934	4,881	3,644	9,857	11,508	5,614	6,744	3,662	3,006	5,870	5,857	1,017	2,840
1976	11,027	10,941	9,818	8,540	9,349	5,509	3,093	3,241	5,937	11,087	3,173	3,799
1977	5,236	6,413	10,890	4,973	5,978	3,661	2,942	2,512	1,146	1,968	828	3,005
1988	3,775	6,174	11,191	11,285	2,864	4,727	2,943	3,119	5,793	9,578	2,214	3,298
1990	5,426	3,992	10,542	11,271	6,078	4,237	3,585	2,800	5,827	9,015	2,160	3,261
1991	4,105	3,454	6,295	6,429	6,621	11,319	3,800	2,872	5,611	6,298	2,132	4,228
1992	4,510	3,282	4,591	7,773	11,899	7,489	3,580	3,009	5,812	6,003	1,930	3,283
Average	**5,556**	**5,741**	**9,115**	**9,309**	**7,137**	**5,450**	**3,333**	**2,988**	**5,022**	**6,583**	**1,618**	**3,178**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0	-377	1,236	0	0	6	0	-7	-8	-10	1	0
1929	-1	1	1,336	-1	0	109	2	3	8	-53	98	768
1931	-4	-343	-1,438	0	0	11	0	9	1,068	1,323	0	723
1933	-3	28	-1	0	0	0	1	1	0	-748	918	1,200
1934	-1	212	-2	829	0	0	0	2	-1,013	-678	0	789
1976	3,643	3,128	-1,242	-638	-1,242	0	-9	0	2	-1,459	868	-5
1977	-5	-790	-121	117	137	654	61	0	0	0	0	0
1988	-2	4	747	3,239	-1	99	0	-873	-901	-1,141	0	0
1990	0	0	-951	1,454	-7	76	1	6	20	79	-3	153
1991	57	1,030	310	100	110	0	-3	1	2	-536	572	1,043
1992	-3	47	277	-2	2,659	0	-128	0	6	75	-6	297
Average	**335**	**267**	**14**	**463**	**151**	**87**	**-7**	**-78**	**-74**	**-286**	**223**	**452**

Percent Difference [(Run 414-411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0%	-5%	11%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1929	0%	0%	14%	0%	0%	3%	0%	0%	0%	-1%	6%	25%
1931	0%	-7%	-14%	0%	0%	0%	0%	0%	33%	54%	0%	27%
1933	0%	1%	0%	0%	0%	0%	0%	0%	0%	-9.95%	91%	44%
1934	0%	6%	0%	7%	0%	0%	0%	0%	-17%	-12%	0%	28%
1976	33%	29%	-13%	-7%	-13%	0%	0%	0%	0%	-13%	27%	0%
1977	0%	-12%	-1%	2%	2%	18%	2%	0%	0%	0%	0%	0%
1988	0%	0%	7%	29%	0%	2%	0%	-28%	-16%	-12%	0%	0%
1990	0%	0%	-9%	13%	0%	2%	0%	0%	0%	1%	0%	5%
1991	1%	30%	5%	2%	2%	0%	0%	0%	0%	-9%	27%	25%
1992	0%	1%	6%	0%	22%	0%	-4%	0%	0%	1%	0%	9%
Average	**3%**	**4%**	**1%**	**4%**	**1%**	**2%**	**0%**	**-2%**	**0%**	**0%**	**14%**	**15%**

71 Year Record-Dry Years
Total Exports=H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in (
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	7,993	6,660	9,186	7,284	14,528	7,639	6,741	5,143	6,607	8,425	6,387	5,932
1926	7,102	6,894	7,937	12,048	14,608	6,637	6,161	4,545	5,672	10,597	9,213	8,323
1930	7,729	5,870	9,860	14,523	6,711	11,066	3,619	3,547	5,676	6,393	4,130	4,802
1932	5,912	5,436	11,979	12,391	7,207	3,254	5,090	3,513	1,845	4,332	3,412	5,416
1939	14,670	12,994	10,000	8,299	7,059	5,356	4,152	3,827	5,669	11,679	10,917	6,943
1944	8,009	9,033	13,197	11,890	14,615	8,661	2,875	3,908	6,750	10,253	10,699	5,942
1947	7,325	8,698	11,554	12,156	10,605	8,112	4,314	3,846	5,540	10,373	10,959	5,959
1949	8,780	7,682	9,234	9,008	7,289	14,643	4,963	4,797	5,799	8,652	4,740	6,105
1955	7,233	10,440	14,556	14,447	9,484	4,033	3,593	3,910	6,634	10,804	11,729	6,414
1960	7,590	6,722	8,295	10,025	14,534	7,519	3,773	3,400	5,646	13,713	8,876	8,291
1961	6,337	8,616	10,911	9,405	13,643	7,424	3,601	3,409	5,681	9,077	10,203	5,708
1964	12,322	14,569	10,277	12,955	6,475	4,574	3,602	3,883	5,730	11,454	9,908	7,055
1981	13,094	10,498	11,467	13,977	8,877	8,036	4,824	3,832	5,664	12,197	10,927	8,318
1985	13,834	14,569	10,748	8,141	8,726	5,739	3,837	4,373	5,608	14,042	8,861	9,283
1987	10,667	6,953	11,924	12,063	9,581	10,763	3,851	3,451	5,648	10,119	5,466	4,954
1989	3,645	5,524	6,885	8,482	6,752	14,668	5,502	4,070	5,639	9,445	8,801	6,688
Average	8,890	8,822	10,501	11,068	10,043	8,008	4,406	3,966	5,613	10,097	8,452	6,633

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	7,993	6,661	9,183	7,285	11,762	7,689	6,741	5,143	6,676	10,240	5,473	5,930
1926	7,106	6,896	7,838	11,499	11,762	6,386	6,161	4,546	5,669	11,287	11,157	8,104
1930	7,699	5,303	9,867	11,522	6,711	11,066	3,601	3,540	5,674	8,563	3,196	4,807
1932	5,865	5,436	11,279	11,493	7,207	3,084	5,088	3,517	1,832	4,319	3,399	5,416
1939	11,027	10,941	11,318	10,993	7,125	5,356	4,152	3,826	5,665	11,287	11,147	6,262
1944	7,879	9,492	10,774	11,797	12,442	8,661	4,113	3,907	6,748	11,287	8,768	5,943
1947	7,328	8,701	11,425	10,780	10,605	8,112	4,315	3,846	5,538	11,287	10,473	5,965
1949	8,780	8,256	9,374	9,008	7,289	11,538	4,963	4,801	6,308	10,817	4,733	6,105
1955	7,240	10,442	11,278	11,685	9,474	4,269	3,593	3,910	6,626	11,287	11,008	6,440
1960	7,593	6,719	8,034	10,025	11,816	7,519	3,771	3,400	5,642	11,287	11,124	8,298
1961	6,339	8,619	10,920	9,405	11,673	7,424	3,572	3,409	5,675	11,286	8,978	5,708
1964	11,027	10,941	10,288	11,624	6,475	4,683	3,600	3,882	5,729	11,287	11,103	7,080
1981	11,027	10,484	11,454	11,926	10,634	8,480	4,824	3,830	5,656	11,287	11,150	7,398
1985	11,027	10,941	11,722	11,349	9,206	5,739	3,835	4,371	5,604	11,287	11,157	8,473
1987	10,667	7,314	10,591	11,484	9,581	10,763	3,849	3,451	5,635	9,168	5,468	4,956
1989	3,645	5,524	6,885	8,482	6,752	11,388	5,502	4,046	5,640	11,287	11,157	6,688
Average	8,265	8,292	10,139	10,647	9,407	7,635	4,480	3,964	5,645	10,454	8,718	6,473

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0	-1	3	-1	2,766	-50	0	0	-69	-1,815	914	2
1926	-4	-2	99	549	2,846	251	0	-1	3	-690	-1,944	219
1930	30	567	-7	3,001	0	0	18	7	2	-2,170	934	-5
1932	47	0	700	898	0	170	2	-4	13	13	13	0
1939	3,643	2,053	-1,318	-2,694	-66	0	0	1	4	392	-230	681
1944	130	-459	2,423	93	2,173	0	-1,238	1	2	-1,034	1,931	-1
1947	-3	-3	129	1,376	0	0	-1	0	2	-914	486	-6
1949	0	-574	-140	0	0	3,105	0	-4	-509	-2,165	7	0
1955	-7	-2	3,278	2,762	10	-236	0	0	8	-483	721	-26
1960	-3	3	261	0	2,718	0	2	0	4	2,426	-2,248	-7
1961	-2	-3	-9	0	1,970	0	29	0	6	-2,209	1,225	0
1964	1,295	3,628	-11	1,331	0	-109	2	1	1	167	-1,195	-25
1981	2,067	14	13	2,051	-1,757	-444	0	2	8	910	-223	920
1985	2,807	3,628	-974	-3,208	-480	0	2	2	4	2,755	-2,296	810
1987	0	-361	1,333	579	0	0	2	0	13	951	-2	-2
1989	0	0	0	0	0	3,280	0	24	-1	-1,842	-2,356	0
Average	625	531	361	421	636	373	-74	2	-32	-357	-266	160

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0%	0%	0%	0%	24%	-1%	0%	0%	-1%	-18%	17%	0%
1926	0%	0%	1%	5%	24%	4%	0%	0%	0%	-6%	-17%	3%
1930	0%	11%	0%	26%	0%	0%	0%	0%	0%	-25%	29%	0%
1932	1%	0%	6%	8%	0%	6%	0%	0%	1%	0%	0%	0%
1939	33%	19%	-12%	-25%	-1%	0%	0%	0%	0%	3%	-2%	11%
1944	2%	-5%	22%	1%	17%	0%	-30%	0%	0%	-9%	22%	0%
1947	0%	0%	1%	13%	0%	0%	0%	0%	0%	-8%	5%	0%
1949	0%	-7%	-1%	0%	0%	27%	0%	0%	-8%	-20%	0%	0%
1955	0%	0%	29%	24%	0%	-6%	0%	0%	0%	-4%	7%	0%
1960	0%	0%	3%	0%	23%	0%	0%	0%	0%	21%	-20%	0%
1961	0%	0%	0%	0%	17%	0%	1%	0%	0%	-20%	14%	0%
1964	12%	33%	0%	11%	0%	-2%	0%	0%	0%	1%	-11%	0%
1981	19%	0%	0%	17%	-17%	-5%	0%	0%	0%	8%	-2%	12%
1985	25%	33%	-8%	-28%	-5%	0%	0%	0%	0%	24%	-21%	9.6%
1987	0%	-5%	13%	5%	0%	0%	0%	0%	0%	10.4%	0%	0%
1989	0%	0%	0%	0%	0%	29%	0%	1%	0%	-16%	-21%	0%
Average	6%	5%	3%	4%	5%	3%	-2%	0%	0%	-4%	0%	2%

71 Year Record-Below Normal Years
Total Exports=H.O. Banks (Includes Wheeling)+Tracy Pumping Plant (In CFS)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	10,405	14,569	14,556	10,411	8,382	5,802	7,706	6,159	6,680	10,152	9,003	8,774
1935	4,308	8,147	8,444	14,524	6,352	10,449	8,095	8,299	7,399	11,131	8,436	6,938
1936	7,435	6,981	8,415	14,524	14,508	11,730	7,250	6,008	6,621	12,545	8,709	8,102
1937	6,678	6,996	14,556	11,518	14,615	11,207	8,050	6,588	8,424	7,757	7,748	5,952
1945	7,747	11,860	13,100	11,207	10,302	8,323	6,051	5,003	7,568	10,075	6,893	6,054
1946	8,685	13,242	14,556	9,930	7,334	8,682	5,894	5,289	7,147	8,918	9,062	5,776
1948	9,403	7,634	7,802	11,047	6,441	5,856	6,442	7,661	8,126	14,898	10,923	9,310
1950	6,895	7,048	6,773	14,524	13,681	8,433	5,951	4,845	7,154	9,822	9,160	8,379
1959	14,670	11,977	8,286	10,118	6,866	7,157	3,742	3,882	6,051	11,596	10,617	8,603
1962	5,956	7,276	10,605	7,521	14,598	10,009	4,949	4,874	6,072	11,491	11,225	6,056
1966	10,033	14,569	13,246	12,066	8,877	8,308	5,109	4,805	6,047	13,042	12,139	7,652
1968	13,923	8,779	8,700	6,420	6,579	7,393	4,690	3,825	6,040	12,226	10,744	8,565
1972	11,107	10,797	14,556	11,997	8,761	8,807	4,259	3,881	6,004	13,803	9,932	9,741
1979	11,039	10,861	8,639	14,524	13,515	9,116	6,742	6,407	8,283	12,551	10,636	6,495
Average	**9,163**	**10,053**	**10,874**	**11,452**	**10,058**	**8,662**	**6,066**	**5,538**	**6,973**	**11,429**	**9,659**	**7,600**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	10,387	10,941	11,757	12,729	8,342	5,804	7,810	6,196	6,670	11,287	11,144	8,788
1935	4,209	8,138	8,444	11,828	6,352	10,449	8,095	8,299	7,392	11,287	11,157	6,668
1936	7,436	7,445	8,350	11,896	12,821	11,627	7,250	6,008	6,619	11,287	11,157	7,996
1937	6,683	6,999	8,349	11,518	12,821	12,064	8,050	6,588	8,416	11,287	6,096	5,703
1945	7,751	10,941	11,433	11,207	10,917	8,251	6,051	5,003	7,566	11,278	5,656	6,055
1946	8,688	10,941	11,548	11,968	6,979	8,820	5,894	5,289	7,143	11,287	8,077	5,778
1948	9,404	7,808	7,781	11,051	6,443	5,856	6,442	7,661	8,126	11,287	11,157	11,169
1950	6,897	7,058	6,769	11,626	11,762	8,433	5,951	4,832	7,151	11,287	11,157	8,387
1959	11,027	10,941	8,286	11,920	9,865	7,078	3,741	3,881	6,055	11,287	11,142	8,622
1962	5,956	7,613	10,613	7,522	12,369	10,009	4,949	4,872	6,064	11,287	10,043	6,060
1966	10,019	10,941	11,573	12,219	11,207	8,870	5,109	4,801	6,042	11,287	11,143	7,092
1968	11,027	10,941	11,361	9,011	6,645	7,215	4,689	3,824	6,041	11,287	11,143	8,198
1972	11,027	10,789	11,291	11,603	9,401	8,556	4,260	3,879	6,000	11,287	11,140	9,564
1979	11,027	10,868	8,128	12,082	12,821	11,175	6,742	6,407	8,272	11,287	11,153	6,063
Average	**8,681**	**9,455**	**9,692**	**11,299**	**9,910**	**8,872**	**6,074**	**5,539**	**6,968**	**11,286**	**10,098**	**7,582**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	18	3,628	2,799	-2,318	40	-2	-104	-37	10	-1,135	-2,141	-14
1935	99	9	0	2,696	0	0	0	0	7	-156	-2,721	270
1936	-1	-464	65	2,628	1,687	103	0	0	2	1,258	-2,448	106
1937	-5	-3	6,207	0	1,794	-857	0	0	8	-3,530	1,652	249
1945	-4	919	1,667	0	-615	72	0	0	2	-1,203	1,237	-1
1946	-3	2,301	3,008	-2,038	355	-138	0	0	4	-2,369	985	-2
1948	-1	-174	21	-4	-2	0	0	0	0	3,611	-234	-1,859
1950	-2	-10	4	2,898	1,919	0	0	13	3	-1,465	-1,997	-8
1959	3,643	1,036	0	-1,802	-2,999	79	1	1	-4	309	-525	-19
1962	0	-337	-8	-1	2,229	0	0	2	8	204	1,182	-4
1966	14	3,628	1,673	-153	-2,330	-562	0	4	5	1,755	996	560
1968	2,896	-2,162	-2,661	-2,591	-66	178	1	1	-1	939	-399	367
1972	80	8	3,265	394	-640	251	-1	2	4	2,516	-1,208	177
1979	12	-7	511	2,442	694	-2,059	0	0	11	1,264	-517	432
Average	**482**	**598**	**1,182**	**154**	**148**	**-210**	**-7**	**-1**	**4**	**143**	**-438**	**18**

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0%	33%	24%	-18%	0%	0%	-1%	-1%	0%	-10.1%	-19%	0%
1935	2%	0%	0%	23%	0%	0%	0%	0%	0%	-1%	-24%	4%
1936	0%	-6%	1%	22%	13%	1%	0%	0%	0%	11%	-22%	1%
1937	0%	0%	74%	0%	14%	-7%	0%	0%	0%	-31%	27%	4%
1945	0%	8%	15%	0%	-6%	1%	0%	0%	0%	-11%	22%	0%
1946	0%	21%	26%	-17%	5%	-2%	0%	0%	0%	-21%	12%	0%
1948	0%	-2%	0%	0%	0%	0%	0%	0%	0%	32%	-2%	-17%
1950	0%	0%	0%	25%	16%	0%	0%	0%	0%	-13%	-18%	0%
1959	33%	9%	0%	-15%	-30%	1%	0%	0%	0%	3%	-5%	0%
1962	0%	-4%	0%	0%	18%	0%	0%	0%	0%	2%	12%	0%
1966	0%	33%	14%	-1%	-21%	-6%	0%	0%	0%	16%	9%	8%
1968	26%	-20%	-23%	-29%	-1%	2%	0%	0%	0%	8%	-4%	4%
1972	1%	0%	29%	3%	-7%	3%	0%	0%	0%	22%	-11%	2%
1979	0%	0%	6%	20%	5%	-18%	0%	0%	0%	11%	-5%	7%
Average	**4%**	**5%**	**12%**	**1%**	**1%**	**-2%**	**0%**	**0%**	**0%**	**1%**	**-2%**	**1%**

71 Year Record-Above Normal Years
Total Exports=H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	6,549	7,052	14,027	14,285	9,064	9,116	8,062	8,673	14,800	3,848	8,129	6,594
1928	7,711	14,569	12,587	14,524	9,444	8,221	7,372	5,811	6,430	8,657	11,472	5,137
1940	6,839	6,186	8,150	14,524	14,480	13,523	8,095	6,803	6,472	10,308	8,252	8,145
1951	9,304	14,569	14,519	8,684	8,202	8,573	6,257	7,063	6,428	13,283	9,306	9,750
1954	10,464	14,569	10,066	14,524	9,304	8,847	7,372	6,728	6,373	11,183	11,914	6,415
1957	14,670	10,828	6,624	11,272	11,107	8,610	5,876	5,549	6,853	13,954	9,142	9,965
1973	8,213	14,569	14,556	11,693	8,552	8,409	6,797	6,804	7,965	11,698	9,561	6,492
1978	3,844	4,421	11,242	13,082	5,480	7,093	8,310	8,630	7,276	5,745	7,759	6,413
1980	7,915	11,905	14,556	14,473	10,461	7,475	7,267	6,775	6,436	10,791	8,436	8,277
Average	8,390	10,963	11,814	13,007	9,566	8,874	7,268	6,982	7,670	9,941	9,330	7,465

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	6,549	7,052	11,518	12,179	12,821	10,333	8,062	8,673	11,277	9,872	7,498	6,570
1928	7,704	10,941	11,369	11,780	10,484	11,309	7,372	5,805	6,434	11,287	10,180	5,138
1940	6,842	6,185	8,051	11,815	12,142	11,580	8,095	6,781	6,467	11,287	11,157	7,726
1951	9,305	10,941	11,853	12,729	8,482	8,380	6,260	7,063	6,425	11,287	11,146	9,032
1954	10,488	10,941	10,074	11,532	11,762	10,834	7,372	6,726	6,374	11,287	11,147	6,191
1957	11,027	10,639	6,624	10,144	12,046	10,485	5,874	5,549	6,850	11,287	11,157	9,184
1973	8,220	10,941	11,259	11,622	11,767	8,295	6,797	6,804	7,956	11,287	10,510	6,479
1978	3,844	4,421	11,247	11,123	5,480	7,093	8,310	8,630	7,276	8,857	5,946	6,396
1980	7,924	10,941	11,365	12,729	12,821	8,245	7,267	6,775	6,432	10,600	10,553	8,277
Average	7,989	9,222	10,373	11,739	10,867	9,617	7,268	6,978	7,277	10,783	9,922	7,221

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0	0	2,509	2,106	-3,757	-1,217	0	0	3,523	-6,024	631	24
1928	7	3,628	1,218	2,744	-1,040	-3,088	0	6	-4	-2,630	1,292	-1
1940	-3	1	99	2,709	2,338	1,943	0	22	5	-979	-2,905	419
1951	-1	3,628	2,666	-4,045	-280	193	-3	0	3	1,996	-1,840	718
1954	-24	3,628	-8	2,992	-2,458	-1,987	0	2	-1	-104	767	224
1957	3,643	189	0	1,128	-939	-1,875	2	0	3	2,667	-2,015	781
1973	-7	3,628	3,297	71	-3,215	114	0	0	9	411	-949	13
1978	0	0	-5	1,959	0	0	0	0	0	-3,112	1,813	17
1980	-9	964	3,191	1,744	-2,360	-770	0	0	4	191	-2,117	0
Average	401	1,741	1,441	1,268	-1,301	-743	0	3	394	-843	-591	244

Percent Difference [(Run 414 Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0%	0%	22%	17%	-29%	-12%	0%	0%	31%	-61%	8%	0%
1928	0%	33%	11%	23%	-9.9%	-27%	0%	0%	0%	-23%	13%	0%
1940	0%	0%	1%	23%	19%	17%	0%	0%	0%	-9%	-26%	5%
1951	0%	33%	22%	-32%	-3%	2%	0%	0%	0%	18%	-17%	8%
1954	0%	33%	0%	26%	-21%	-18%	0%	0%	0%	-1%	7%	4%
1957	33%	2%	0%	11%	-8%	-18%	0%	0%	0%	24%	-18%	9%
1973	0%	33%	29%	1%	-27%	1%	0%	0%	0%	4%	-9%	0%
1978	0%	0%	0%	18%	0%	0%	0%	0%	0%	-35%	30%	0%
1980	0%	9%	28%	14%	-18%	-9%	0%	0%	0%	2%	-20%	0%
Average	4%	16%	13%	11%	-11%	-7%	0%	0%	4%	-9%	-3%	3%

71 Year Record-Wet Years
Total Exports=H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	7,273	14,569	11,156	13,480	7,922	8,987	8,101	7,944	6,599	12,146	9,550	6,253
1938	7,329	14,569	14,548	11,656	8,412	8,027	8,445	9,864	12,053	4,444	7,631	11,517
1941	6,741	8,039	14,556	14,440	13,569	8,529	9,655	8,673	8,562	7,059	8,246	8,942
1942	13,073	14,569	12,618	8,225	8,811	8,612	8,549	8,673	11,045	7,261	8,489	9,906
1943	14,670	14,569	10,270	8,226	8,811	8,488	8,549	7,614	6,434	10,439	9,217	6,962
1952	7,059	10,930	14,556	14,473	11,965	7,809	8,361	9,441	12,488	7,775	5,370	14,778
1953	14,670	11,163	8,700	6,920	6,579	7,955	6,121	7,428	10,429	10,639	9,735	9,047
1956	6,749	8,003	14,556	14,376	9,013	7,976	7,677	8,673	9,811	8,384	8,417	10,999
1958	12,284	12,436	14,556	11,082	8,811	8,666	9,722	8,673	13,781	5,094	8,014	12,366
1963	14,670	14,315	9,875	7,736	8,167	8,967	8,095	8,299	7,168	11,701	8,929	7,189
1965	6,638	10,076	14,556	14,387	8,190	7,938	8,549	8,529	6,449	11,558	9,347	6,303
1967	6,974	10,873	14,556	14,447	9,636	7,163	8,549	8,673	13,741	11,846	5,320	13,826
1969	7,498	8,807	14,556	14,428	11,050	7,030	8,361	9,620	11,801	5,932	6,477	14,905
1970	14,670	10,968	8,440	6,275	6,579	7,664	6,019	4,635	6,397	12,496	10,645	8,996
1971	7,506	14,569	14,556	12,912	8,531	9,261	6,158	7,654	8,872	11,542	9,181	10,662
1974	9,582	14,569	14,556	10,956	8,698	9,026	8,549	8,527	8,729	9,841	8,653	11,711
1975	13,690	13,403	10,073	8,194	6,945	7,660	8,308	8,673	10,264	8,160	8,600	11,623
1982	7,367	14,569	14,539	12,958	8,342	8,897	8,899	10,287	11,207	8,012	7,918	14,905
1983	14,670	9,435	8,521	7,023	5,139	5,906	7,957	8,335	10,020	10,138	12,303	10,615
1984	8,784	7,488	7,206	5,110	6,039	7,683	6,305	4,987	6,825	13,529	8,942	11,174
1986	6,340	8,227	12,231	14,094	14,327	8,607	8,949	7,178	6,445	11,260	8,246	8,352
Average	**9,916**	**11,721**	**12,342**	**11,019**	**8,835**	**8,136**	**8,089**	**8,209**	**9,482**	**9,488**	**8,535**	**10,525**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	7,274	10,941	11,148	11,357	12,291	9,126	8,101	7,944	6,600	11,287	10,598	6,116
1938	7,340	10,941	11,381	12,373	11,326	8,027	8,445	9,864	11,277	7,813	6,247	11,193
1941	6,748	8,044	11,507	12,466	12,821	11,477	10,053	8,673	8,556	9,690	6,917	8,792
1942	11,027	10,941	11,668	12,530	9,727	8,449	8,549	8,673	11,045	9,268	6,430	9,759
1943	11,027	10,941	11,448	11,699	8,679	8,476	8,549	7,608	6,433	11,287	10,037	6,046
1952	7,066	10,924	11,348	12,729	12,593	9,270	8,361	9,441	11,277	8,710	6,828	11,193
1953	11,027	10,941	11,483	10,163	6,645	7,955	6,121	7,428	10,429	11,287	11,157	9,044
1956	6,756	8,008	11,366	12,729	11,556	7,976	7,677	8,673	9,811	9,574	8,946	11,052
1958	11,027	10,941	11,391	11,876	12,685	8,805	9,722	8,673	11,277	9,930	6,828	11,193
1963	11,027	10,941	11,274	10,564	7,963	8,967	8,095	8,299	7,164	11,287	11,157	6,708
1965	6,648	10,073	11,346	12,729	10,347	7,938	8,549	8,529	6,453	11,287	11,146	6,276
1967	6,987	10,892	11,548	11,981	11,017	7,165	8,549	8,673	11,277	11,287	5,757	11,193
1969	7,502	9,376	11,287	12,411	12,821	7,388	8,361	9,620	11,277	7,372	6,828	11,193
1970	11,027	10,941	11,644	8,610	6,645	7,439	6,013	4,635	6,395	11,287	11,143	8,405
1971	7,511	10,941	11,433	11,613	10,995	11,449	6,158	7,654	8,872	11,287	11,157	10,829
1974	9,584	10,941	11,455	12,298	10,764	9,049	8,549	8,527	8,723	11,287	9,007	11,193
1975	11,027	10,941	11,426	10,344	7,090	7,609	8,308	8,673	10,264	11,002	6,999	11,193
1982	7,218	10,941	11,225	12,048	12,622	9,838	8,899	10,287	11,207	8,828	7,918	11,193
1983	11,027	10,941	11,853	8,103	5,205	5,906	7,957	8,335	10,020	10,138	11,157	11,193
1984	9,361	7,488	7,206	5,110	6,039	7,647	6,305	4,987	6,825	11,287	11,157	11,193
1986	6,284	8,230	11,339	11,448	12,533	10,041	9,971	7,178	6,442	10,971	9,820	8,352
Average	**8,785**	**10,251**	**11,227**	**11,199**	**10,113**	**8,571**	**8,157**	**8,208**	**9,125**	**10,294**	**8,916**	**9,681**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	-1	3,628	8	2,123	-4,369	-139	0	0	-1	859	-1,048	137
1938	-11	3,628	3,167	-717	-2,914	0	0	0	776	-3,369	1,384	324
1941	-7	-5	3,049	1,974	748	-2,948	-398	0	6	-2,631	1,329	150
1942	2,046	3,628	950	-4,305	-916	163	0	0	0	-2,007	2,059	147
1943	3,643	3,628	-1,178	-3,473	132	12	0	6	1	-848	-820	916
1952	-7	6	3,208	1,744	-628	-1,461	0	0	1,211	-935	-1,458	3,585
1953	3,643	222	-2,783	-3,243	-66	0	0	0	0	-648	-1,422	3
1956	-7	-5	3,190	1,647	-2,543	0	0	0	0	-1,190	-529	-53
1958	1,257	1,495	3,165	-794	-3,874	-139	0	0	2,504	-4,836	1,186	1,173
1963	3,643	3,374	-1,399	-2,828	204	0	0	0	4	414	-2,228	481
1965	-10	3	3,210	1,658	-2,157	0	0	0	-4	271	-1,799	27
1967	-13	-19	3,008	2,466	-1,381	-2	0	0	2,464	559	-437	2,633
1969	-4	-569	3,269	2,017	-1,771	-358	0	0	524	-1,440	-351	3,712
1970	3,643	27	-3,204	-2,335	-66	225	6	0	2	1,209	-498	591
1971	-5	3,628	3,123	1,299	-2,464	-2,188	0	0	0	255	-1,976	-167
1974	-2	3,628	3,101	-1,342	-2,066	-23	0	0	6	-1,446	-354	518
1975	2,663	2,462	-1,353	-2,150	-145	51	0	0	0	-2,842	1,601	430
1982	149	3,628	3,314	910	-4,280	-941	0	0	0	-816	0	3,712
1983	3,643	-1,506	-3,332	-1,080	-66	0	0	0	0	0	1,146	-578
1984	-577	0	0	0	0	36	0	0	0	2,242	-2,215	-19
1986	56	-3	892	2,646	1,794	-1,434	-1,022	0	3	289	-1,574	0
Average	**1,131**	**1,470**	**1,115**	**-180**	**-1,278**	**-436**	**-67**	**0**	**357**	**-805**	**-381**	**844**

71 Year Record-Wet Years
Total Exports=H.O. Banks (includes Wheeling)+Tracy Pumping Plant (in CFS)
Future Demand Level

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0%	33%	0%	19%	-36%	-2%	0%	0%	0%	8%	-9.9%	2%
1938	0%	33%	28%	-6%	-26%	0%	0%	0%	7%	-43%	22%	3%
1941	0%	0%	26%	16%	6%	-26%	-4%	0%	0%	-27%	19%	2%
1942	19%	33%	8%	-34%	-9%	2%	0%	0%	0%	-22%	32%	2%
1943	33%	33%	-10.3%	-30%	2%	0%	0%	0%	0%	-8%	-8%	15%
1952	0%	0%	28%	14%	-5%	-16%	0%	0%	11%	-11%	-21%	32%
1953	33%	2%	-24%	-32%	-1%	0%	0%	0%	0%	-6%	-13%	0%
1956	0%	0%	28%	13%	-22%	0%	0%	0%	0%	-12%	-6%	0%
1958	11%	14%	28%	-7%	-31%	-2%	0%	0%	22%	-49%	17%	10.5%
1963	33%	31%	-12%	-27%	3%	0%	0%	0%	0%	4%	-20%	7%
1965	0%	0%	28%	13%	-21%	0%	0%	0%	0%	2%	-16%	0%
1967	0%	0%	26%	21%	-13%	0%	0%	0%	22%	5%	-8%	24%
1969	0%	-6%	29%	16%	-14%	-5%	0%	0%	5%	-20%	-5%	33%
1970	33%	0%	-28%	-27%	-1%	3%	0%	0%	0%	11%	-4%	7%
1971	0%	33%	27%	11%	-22%	-19%	0%	0%	0%	2%	-18%	-2%
1974	0%	33%	27%	-11%	-19%	0%	0%	0%	0%	-13%	-4%	5%
1975	24%	23%	-12%	-21%	-2%	1%	0%	0%	0%	-26%	23%	4%
1982	2%	33%	30%	8%	-34%	-9.6%	0%	0%	0%	-9%	0%	33%
1983	33%	-14%	-28%	-13%	-1%	0%	0%	0%	0%	0%	10.3%	-5%
1984	-6%	0%	0%	0%	0%	0%	0%	0%	0%	20%	-20%	0%
1986	1%	0%	8%	23%	14%	-14%	-10.2%	0%	0%	3%	-16%	0%
Average	10%	13%	10%	-3%	-11%	-4%	-1%	0%	3%	-9%	-2%	8%

71 Year Record-Critical Years
Total Outflow from Delta (DV58+DV60+RF91) (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	4,168	5,401	6,865	6,412	9,614	10,430	5,837	5,218	4,000	5,801	3,415	3,008
1929	4,001	5,600	6,425	5,712	10,111	10,012	7,312	6,432	7,107	6,167	3,415	3,008
1931	4,001	4,504	5,277	6,027	7,798	7,068	7,819	4,505	4,000	4,449	3,415	3,008
1933	4,001	4,504	4,754	7,214	8,486	8,555	10,399	6,036	6,830	4,001	3,415	3,008
1934	2,992	3,645	6,440	7,470	12,775	11,401	10,399	5,577	6,897	4,001	3,415	3,008
1976	11,877	10,829	8,757	6,833	11,442	9,876	7,522	6,367	6,897	4,374	3,415	3,008
1977	2,992	4,689	6,445	6,436	7,852	6,788	6,897	4,505	4,000	4,001	3,415	3,008
1988	4,001	4,843	6,894	14,679	11,400	7,970	7,300	6,496	6,897	4,672	3,415	3,008
1990	4,001	4,504	6,450	6,912	11,400	7,308	10,251	5,919	6,897	6,026	3,702	3,008
1991	2,992	4,412	5,460	5,074	8,072	21,263	11,258	5,364	7,037	5,913	3,415	3,008
1992	2,992	4,199	5,533	5,377	20,980	14,086	10,513	5,700	6,764	5,707	3,415	3,008
Average	**4,365**	**5,194**	**6,300**	**7,104**	**10,903**	**10,432**	**8,682**	**5,647**	**6,121**	**5,010**	**3,441**	**3,008**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	4,168	5,403	6,989	6,379	9,614	10,430	5,837	5,221	4,000	5,458	3,415	3,008
1929	4,001	5,599	6,710	5,712	10,111	10,012	7,309	6,432	7,107	6,013	3,415	3,008
1931	4,001	4,504	4,879	6,029	7,800	7,068	7,819	4,505	4,000	4,001	3,415	3,008
1933	4,001	4,504	4,761	7,217	8,489	8,555	10,399	6,036	6,830	4,001	3,415	3,008
1934	2,992	3,645	6,440	9,436	12,775	11,401	10,399	5,577	6,897	4,001	3,415	3,008
1976	14,959	11,497	6,355	5,893	10,669	9,758	7,522	6,367	6,897	4,370	3,415	3,008
1977	2,992	4,679	7,111	5,797	7,852	6,788	6,897	4,505	4,000	4,001	3,415	3,008
1988	4,001	4,844	6,904	17,933	11,400	7,800	7,300	6,496	6,897	5,546	3,431	3,008
1990	4,001	4,504	6,391	7,867	11,400	7,309	10,251	5,911	6,897	5,610	3,551	3,008
1991	2,992	4,244	5,388	5,025	8,027	21,264	11,258	5,364	7,037	5,724	3,415	3,008
1992	2,992	4,162	5,512	5,375	23,697	14,087	10,377	5,700	6,765	5,860	3,415	3,008
Average	**4,645**	**5,235**	**6,131**	**7,515**	**11,076**	**10,407**	**8,670**	**5,647**	**6,121**	**4,962**	**3,429**	**3,008**

Difference (Run 413- Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0	-2	-124	33	0	0	0	-3	0	343	0	0
1929	0	1	-285	0	0	0	3	0	0	154	0	0
1931	0	0	398	-2	-2	0	0	0	0	448	0	0
1933	0	0	-7	-3	-3	0	0	0	0	0	0	0
1934	0	0	0	-1,966	0	0	0	0	0	0	0	0
1976	-3,082	-668	2,402	940	773	118	0	0	0	4	0	0
1977	0	10	-666	639	0	0	0	0	0	0	0	0
1988	0	-1	-10	-3,254	0	170	0	0	0	-874	-16	0
1990	0	0	59	-955	0	-1	0	8	0	416	151	0
1991	0	168	72	49	45	-1	0	0	0	189	0	0
1992	0	37	21	2	-2,717	-1	136	0	-1	-153	0	0
Average	**-280**	**-41**	**169**	**-411**	**-173**	**26**	**13**	**0**	**0**	**48**	**12**	**0**

Percent Difference [(Run 413-420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0%	0%	-2%	1%	0%	0%	0%	0%	0%	6%	0%	0%
1929	0%	0%	-4%	0%	0%	0%	0%	0%	0%	3%	0%	0%
1931	0%	0%	8%	0%	0%	0%	0%	0%	0%	11%	0%	0%
1933	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1934	0%	0%	0%	-21%	0%	0%	0%	0%	0%	0%	0%	0%
1976	-21%	-6%	38%	16%	7%	1%	0%	0%	0%	0%	0%	0%
1977	0%	0%	-9%	11%	0%	0%	0%	0%	0%	0%	0%	0%
1988	0%	0%	0%	-18%	0%	2%	0%	0%	0%	-16%	0%	0%
1990	0%	0%	1%	-12%	0%	0%	0%	0%	0%	7%	4%	0%
1991	0%	4%	1%	1%	1%	0%	0%	0%	0%	3%	0%	0%
1992	0%	1%	0%	0%	-11%	0%	1%	0%	0%	-3%	0%	0%
Average	**-2%**	**0%**	**3%**	**-2%**	**0%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**0%**

71 Year Record-Dry Years
Total Outflow from Delta (DV58+DV60+RF91) (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	5,056	5,062	5,790	6,001	41,775	14,227	20,769	11,424	8,328	6,960	5,213	3,891
1926	5,299	4,982	5,391	7,050	26,844	11,141	18,826	11,211	6,117	7,053	5,192	3,885
1930	4,896	5,273	6,487	11,020	12,969	21,136	10,647	8,269	6,117	5,690	4,066	3,008
1932	3,477	4,221	8,229	7,914	15,639	11,401	11,259	9,426	10,541	4,993	4,066	3,293
1939	13,449	11,570	9,523	11,357	12,201	9,698	10,399	7,579	6,269	6,946	4,811	3,669
1944	5,422	6,393	5,192	6,396	26,530	17,850	9,233	7,579	8,378	6,745	4,743	3,487
1947	4,634	5,356	6,644	6,430	12,826	15,081	11,259	7,579	6,131	7,313	5,638	3,961
1949	5,825	5,725	5,830	5,469	8,647	40,469	10,571	11,124	7,389	6,327	4,749	4,102
1955	4,001	7,109	13,331	12,835	11,400	7,598	7,983	8,221	8,080	7,363	5,370	5,000
1960	4,780	5,042	6,991	6,037	18,149	14,231	11,400	7,579	6,297	7,529	5,457	4,105
1961	4,470	5,688	7,031	6,070	19,994	13,281	10,362	7,579	6,182	7,539	5,513	3,793
1964	6,418	20,893	6,564	23,421	11,400	8,487	7,579	7,579	6,702	7,397	5,798	4,402
1981	6,099	7,359	11,018	22,654	24,183	29,932	12,223	7,579	6,117	6,952	4,792	3,487
1985	6,520	30,691	23,900	10,888	14,937	14,122	8,185	10,012	6,117	7,353	5,447	3,822
1987	4,478	5,633	4,598	5,773	12,343	23,407	10,629	7,579	6,117	7,171	5,397	3,533
1989	2,992	4,968	5,316	5,796	8,175	27,879	18,365	10,391	6,117	7,500	5,612	3,820
Average	**5,489**	**8,498**	**8,240**	**9,694**	**17,376**	**17,496**	**11,856**	**8,794**	**6,937**	**6,927**	**5,117**	**3,829**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	5,057	5,069	5,792	6,001	44,581	14,229	20,771	11,427	8,322	6,885	5,189	3,873
1926	5,299	4,980	5,333	7,883	29,682	10,656	18,833	11,210	6,117	6,950	5,170	3,868
1930	4,910	5,271	6,486	14,077	12,970	21,213	10,544	8,268	6,117	5,828	4,066	3,008
1932	3,477	4,221	9,032	9,469	15,639	11,401	11,259	9,426	10,541	4,993	4,066	3,297
1939	15,746	8,743	9,099	10,475	11,919	9,698	10,399	7,579	6,269	6,946	4,811	3,669
1944	5,422	6,383	5,192	6,396	27,563	17,051	9,233	7,579	8,378	6,782	4,755	3,488
1947	4,635	5,356	6,639	6,370	12,826	15,083	11,259	7,579	6,131	7,157	5,759	3,899
1949	5,562	5,728	5,811	5,472	8,645	43,592	10,575	11,124	7,369	6,060	4,721	4,104
1955	4,001	7,941	16,633	14,729	11,400	7,600	7,986	8,232	8,069	7,165	6,126	5,495
1960	4,780	5,482	7,174	5,714	20,540	14,127	11,400	7,579	6,291	7,187	6,026	4,070
1961	4,471	5,683	7,026	6,073	22,927	13,284	10,210	7,579	6,182	7,226	6,032	3,794
1964	8,069	24,690	6,154	19,426	11,400	8,490	7,579	7,579	6,703	7,163	6,062	4,379
1981	9,134	6,253	9,480	22,568	24,088	29,668	12,223	7,579	6,117	6,952	4,792	3,487
1985	9,792	31,119	20,638	10,749	14,610	14,122	8,185	10,012	6,117	7,170	5,817	3,822
1987	4,746	5,635	4,598	5,775	12,344	25,028	10,398	7,579	6,117	7,168	5,397	3,536
1989	2,992	4,936	5,310	5,795	8,175	31,153	18,368	10,267	6,117	7,276	6,031	3,821
Average	**6,131**	**8,593**	**8,150**	**9,811**	**18,082**	**17,900**	**11,826**	**8,787**	**6,935**	**6,807**	**5,301**	**3,851**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	-1	-7	-2	0	-2,806	-2	-2	-3	6	75	24	18
1926	0	2	58	-833	-2,838	485	-7	1	0	103	22	17
1930	-14	2	1	-3,057	-1	-77	103	1	0	-138	0	0
1932	0	0	-803	-1,555	0	0	0	0	0	0	0	-4
1939	-2,297	2,827	424	882	282	0	0	0	0	0	0	0
1944	0	10	0	0	-1,033	799	0	0	0	-37	-12	-1
1947	-1	0	5	60	0	-2	0	0	0	156	-121	62
1949	263	-3	19	-3	2	-3,123	-4	0	20	267	28	-2
1955	0	-832	-3,302	-1,894	0	-2	-3	-11	11	198	-756	-495
1960	0	-440	-183	323	-2,391	104	0	0	6	342	-569	35
1961	-1	5	5	-3	-2,933	-3	152	0	0	313	-519	-1
1964	-1,651	-3,797	410	3,995	0	-3	0	0	-1	234	-264	23
1981	-3,035	1,106	1,538	86	95	264	0	0	0	0	0	0
1985	-3,272	-428	3,262	139	327	0	0	0	0	183	-370	0
1987	-268	-2	0	-2	-1	-1,621	231	0	0	3	0	-3
1989	0	32	6	1	0	-3,274	-3	124	0	224	-419	-1
Average	**-642**	**-95**	**90**	**-116**	**-706**	**-403**	**29**	**7**	**3**	**120**	**-185**	**-22**

Percent Difference ((Run 413 - Run 420)/Run 420)*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0%	0%	0%	0%	-6%	0%	0%	0%	0%	1%	0%	0%
1926	0%	0%	1%	-11%	-9.6%	5%	0%	0%	0%	1%	0%	0%
1930	0%	0%	0%	-22%	0%	0%	1%	0%	0%	-2%	0%	0%
1932	0%	0%	-9%	-16%	0%	0%	0%	0%	0%	0%	0%	0%
1939	-15%	32%	5%	8%	2%	0%	0%	0%	0%	0%	0%	0%
1944	0%	0%	0%	0%	-4%	5%	0%	0%	0%	-1%	0%	0%
1947	0%	0%	0%	1%	0%	0%	0%	0%	0%	2%	-2%	2%
1949	5%	0%	0%	0%	0%	-7%	0%	0%	0%	4%	1%	0%
1955	0%	-10.5%	-20%	-13%	0%	0%	0%	0%	0%	3%	-12%	-9%
1960	0%	-8%	-3%	6%	-12%	1%	0%	0%	0%	5%	-9%	1%
1961	0%	0%	0%	0%	-13%	0%	1%	0%	0%	4%	-9%	0%
1964	-20%	-15%	7%	21%	0%	0%	0%	0%	0%	3%	-4%	1%
1981	-33%	18%	16%	0%	0%	1%	0%	0%	0%	0%	0%	0%
1985	-33%	-1%	16%	1%	2%	0%	0%	0%	0%	3%	-6%	0%
1987	-6%	0%	0%	0%	0%	-6%	2%	0%	0%	0%	0%	0%
1989	0%	1%	0%	0%	0%	-11%	0%	1%	0%	3%	-7%	0%
Average	**-6%**	**1%**	**1%**	**-2%**	**-2%**	**-1%**	**0%**	**0%**	**0%**	**2%**	**-3%**	**0%**

71 Year Record-Below Normal Years
Total Outflow from Delta (DV58+DV60+RF91) (in CFS)
Existing Demand Level
Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	7,937	10,200	36,622	32,819	22,061	9,197	21,430	11,771	8,076	7,279	5,863	3,653
1935	2,992	5,634	5,540	18,251	11,400	20,245	36,593	28,043	9,275	6,946	5,244	3,065
1936	4,285	5,217	6,485	20,689	64,123	28,235	18,029	11,167	8,262	6,505	4,790	3,182
1937	4,001	5,020	6,468	6,955	35,286	45,574	19,516	12,176	11,258	6,505	4,668	3,074
1945	5,325	6,052	6,793	6,290	48,296	25,397	11,053	9,818	9,725	6,505	4,781	3,352
1946	5,125	7,331	67,052	49,535	21,940	16,565	10,967	11,259	8,889	6,690	5,295	3,605
1948	5,162	5,442	5,808	6,412	11,400	10,953	19,889	25,895	11,572	9,940	6,400	4,818
1950	4,397	5,174	5,555	9,785	25,488	15,574	15,805	11,400	8,850	8,018	6,241	4,143
1959	16,845	10,762	6,131	34,908	55,886	16,221	8,416	7,579	6,840	7,620	5,385	4,359
1962	4,305	5,097	6,914	6,001	46,275	18,372	9,622	11,401	6,840	8,415	5,845	4,225
1966	5,819	15,268	7,245	28,137	23,540	21,441	11,151	11,124	6,840	7,789	6,183	4,179
1968	18,750	12,214	11,136	28,920	67,390	33,947	10,325	7,579	6,840	7,502	5,243	4,175
1972	6,392	6,592	14,539	13,008	18,599	24,722	9,863	7,579	6,840	8,288	5,920	3,765
1979	6,376	6,437	4,993	24,753	44,378	29,789	15,027	12,903	10,882	6,505	4,668	3,405
Average	**6,979**	**7,603**	**13,663**	**20,462**	**35,433**	**22,588**	**15,549**	**12,835**	**8,642**	**7,465**	**5,466**	**3,786**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	11,579	12,261	32,804	30,707	22,061	10,287	21,430	11,771	8,047	7,738	6,011	3,772
1935	2,992	5,634	5,540	21,010	11,400	20,245	36,593	28,043	9,270	7,680	5,504	3,065
1936	4,285	5,224	5,381	23,349	65,832	25,425	18,029	11,167	8,262	7,594	5,207	3,182
1937	4,001	5,010	6,831	6,955	37,080	43,607	19,516	11,475	11,258	6,505	4,668	3,074
1945	5,326	6,044	8,423	6,290	46,311	25,397	11,053	9,818	9,726	6,505	4,781	3,352
1946	5,124	10,887	70,086	45,069	21,940	16,236	10,967	11,259	8,889	7,258	5,453	3,615
1948	5,169	5,559	5,783	6,410	11,400	10,952	19,886	25,892	11,569	7,833	6,701	5,827
1950	4,398	5,175	5,240	12,745	27,308	15,577	15,810	11,368	8,843	7,828	6,728	4,230
1959	15,199	10,762	6,131	34,129	55,124	16,221	8,416	7,579	6,840	7,620	5,385	4,359
1962	4,307	5,103	6,909	6,001	48,632	18,376	9,571	11,401	6,840	7,838	6,061	4,228
1966	6,493	18,896	8,403	22,918	21,825	21,415	11,151	11,124	6,840	7,788	6,183	4,179
1968	16,772	11,631	11,135	28,915	67,390	33,947	10,325	7,579	6,840	7,502	5,243	4,175
1972	8,945	6,890	14,100	10,327	18,542	24,722	9,941	7,579	6,840	7,827	6,471	3,765
1979	9,354	6,862	4,993	21,520	44,378	29,638	15,027	12,903	10,882	6,505	4,668	3,405
Average	**7,425**	**8,281**	**13,697**	**19,739**	**35,659**	**22,289**	**15,551**	**12,783**	**8,639**	**7,430**	**5,647**	**3,873**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	-3,642	-2,061	3,818	2,112	0	-1,090	0	0	29	-459	-148	-119
1935	0	0	0	-2,759	0	0	0	0	5	-734	-260	0
1936	0	-7	1,104	-2,660	-1,709	2,810	0	0	0	-1,089	-417	0
1937	0	10	-363	0	-1,794	1,967	0	701	0	0	0	0
1945	-1	8	-1,630	0	1,985	0	0	0	-1	0	0	0
1946	1	-3,556	-3,034	4,466	0	329	0	0	0	-568	-158	-10
1948	-7	-117	25	2	0	1	3	3	3	2,107	-301	-1,009
1950	-1	-1	315	-2,960	-1,820	-3	-5	32	7	190	-487	-87
1959	1,646	0	0	779	762	0	0	0	0	0	0	0
1962	-2	-6	5	0	-2,357	-4	51	0	0	577	-216	-3
1966	-674	-3,628	-1,158	5,219	1,715	26	0	0	0	1	0	0
1968	1,978	583	1	5	0	0	0	0	0	0	0	0
1972	-2,553	-298	439	2,681	57	0	-78	0	0	461	-551	0
1979	-2,978	-425	0	3,233	0	151	0	0	0	0	0	0
Average	**-445**	**-678**	**-34**	**723**	**-226**	**299**	**-2**	**53**	**3**	**35**	**-181**	**-88**

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	**-31%**	**-17%**	**12%**	7%	0%	**-11%**	0%	0%	0%	-6%	-2%	-3%
1935	0%	0%	0%	**-13%**	0%	0%	0%	0%	0%	-9.6%	-5%	0%
1936	0%	0%	**21%**	**-11%**	-3%	**11%**	0%	0%	0%	**-14%**	-8%	0%
1937	0%	0%	-5%	0%	-5%	5%	0%	6%	0%	0%	0%	0%
1945	0%	0%	**-19%**	0%	4%	0%	0%	0%	0%	0%	0%	0%
1946	0%	**-33%**	-4%	9.9%	0%	2%	0%	0%	0%	-8%	-3%	0%
1948	0%	-2%	0%	0%	0%	0%	0%	0%	0%	**27%**	-4%	**-17%**
1950	0%	0%	6%	**-23%**	-7%	0%	0%	0%	0%	2%	-7%	-2%
1959	**11%**	0%	0%	2%	1%	0%	0%	0%	0%	0%	0%	0%
1962	0%	0%	0%	0%	-5%	0%	1%	0%	0%	7%	-4%	0%
1966	**-10.4%**	**-19%**	**-14%**	**23%**	8%	0%	0%	0%	0%	0%	0%	0%
1968	**12%**	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1972	**-29%**	-4%	3%	**26%**	0%	0%	-1%	0%	0%	6%	-9%	0%
1979	**-32%**	-6%	0%	**15%**	0%	1%	0%	0%	0%	0%	0%	0%
Average	**-6%**	**-5%**	**0%**	**3%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**-3%**	**-2%**

71 Year Record-Above Normal Years
Total Outflow from Delta (DV58+DV60+RF91) (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	4,001	4,976	6,797	9,148	42,012	30,918	19,274	44,198	25,805	8,002	5,302	3,614
1928	5,470	16,812	6,394	20,289	24,133	99,307	23,762	13,494	7,579	9,021	6,172	3,881
1940	4,751	5,225	5,656	17,503	48,054	100,482	63,761	14,523	7,579	8,002	5,659	3,473
1951	5,829	40,717	79,794	64,679	65,443	27,447	13,145	15,230	7,579	9,464	6,243	4,150
1954	7,092	13,351	9,206	28,098	59,105	44,719	39,037	17,583	7,579	9,349	6,378	4,202
1957	11,561	6,487	5,444	9,469	35,121	41,754	15,456	13,161	8,673	9,489	7,205	3,987
1973	5,728	11,885	15,712	75,801	93,831	59,525	15,653	14,633	10,310	8,002	5,853	4,170
1978	2,992	4,044	6,854	62,973	60,480	68,524	40,511	17,638	8,766	8,002	5,302	5,227
1980	4,001	7,224	8,904	113,449	132,382	69,367	16,291	12,001	7,579	8,002	5,302	5,425
Average	5,714	12,302	16,085	44,601	62,285	60,227	27,432	18,051	10,161	8,593	5,935	4,237

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	4,001	4,976	8,444	11,149	39,225	29,791	19,274	44,198	26,900	8,002	5,302	3,614
1928	5,470	20,454	7,194	16,809	23,483	99,281	23,762	13,494	7,579	9,086	6,197	3,882
1940	4,751	5,228	5,654	20,320	50,441	101,381	63,761	14,460	7,579	9,468	6,527	3,732
1951	5,836	44,349	81,991	61,340	62,943	27,433	13,145	15,230	7,579	9,455	6,243	4,150
1954	10,735	15,464	6,382	25,856	59,048	44,589	39,037	17,583	7,579	9,501	6,413	4,201
1957	15,084	6,691	5,444	7,215	33,138	41,729	15,457	13,161	8,673	9,491	7,205	3,987
1973	5,737	15,513	19,017	73,956	89,842	57,993	15,653	14,633	10,310	8,002	5,853	4,170
1978	2,992	4,044	6,849	62,011	60,480	68,770	40,511	17,638	8,766	8,002	5,302	5,227
1980	4,001	10,258	12,128	108,178	131,764	69,112	16,217	12,001	7,579	8,002	5,302	5,436
Average	6,512	14,109	17,011	42,982	61,152	60,009	27,424	18,044	10,283	8,779	6,038	4,267

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0	0	-1,647	-2,001	2,787	1,127	0	0	-1,095	0	0	0
1928	0	-3,642	-800	3,480	650	26	0	0	0	-65	-25	-1
1940	0	-3	2	-2,817	-2,387	-899	0	63	0	-1,466	-868	-259
1951	-7	-3,632	-2,197	3,339	2,500	14	0	0	0	9	0	0
1954	-3,643	-2,113	2,824	2,242	57	130	0	0	0	-152	-35	1
1957	-3,523	-204	0	2,254	1,983	25	-1	0	0	-2	0	0
1973	-9	-3,628	-3,305	1,845	3,989	1,532	0	0	0	0	0	0
1978	0	0	5	962	0	-246	0	0	0	0	0	0
1980	0	-3,034	-3,224	5,271	618	255	74	0	0	0	0	-11
Average	-798	-1,806	-927	1,619	1,133	218	8	7	-122	-186	-103	-30

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0%	0%	-20%	-18%	7%	4%	0%	0%	-4%	0%	0%	0%
1928	0%	-18%	-11%	21%	3%	0%	0%	0%	0%	-1%	0%	0%
1940	0%	0%	0%	-14%	-5%	-1%	0%	0%	0%	-15%	-13%	-7%
1951	0%	-8%	-3%	5%	4%	0%	0%	0%	0%	0%	0%	0%
1954	-34%	-14%	44%	9%	0%	0%	0%	0%	0%	-2%	-1%	0%
1957	-23%	-3%	0%	31%	6%	0%	0%	0%	0%	0%	0%	0%
1973	0%	-23%	-17%	2%	4%	3%	0%	0%	0%	0%	0%	0%
1978	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%
1980	0%	-30%	-27%	5%	0%	0%	0%	0%	0%	0%	0%	0%
Average	-6%	-11%	-4%	5%	2%	1%	0%	0%	0%	-2%	-2%	-1%

71 Year Record-Wet Years
Total Outflow from Delta (DV58+DV60+RF91) (in CFS)
Existing Demand Level
Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	5,104	8,710	6,552	22,561	119,983	37,358	45,857	19,941	8,052	8,002	5,741	3,174
1938	4,001	24,134	68,198	31,472	142,679	163,232	66,021	60,575	32,476	8,002	5,741	6,249
1941	4,362	5,577	41,427	99,976	116,631	96,675	79,543	39,001	11,632	8,002	5,741	5,525
1942	9,738	15,128	65,496	82,011	143,207	25,114	49,525	34,288	16,858	8,002	5,741	5,474
1943	11,176	17,891	26,449	81,091	59,789	80,525	26,501	16,226	7,579	8,002	5,741	3,152
1952	5,261	6,567	40,690	86,305	78,449	62,278	63,867	60,716	33,104	8,002	5,741	7,297
1953	17,537	12,042	43,744	102,303	25,722	17,525	16,340	21,029	15,704	8,002	5,741	5,690
1956	4,001	5,670	71,901	157,917	89,396	34,191	17,586	38,886	14,515	8,002	6,515	6,089
1958	6,590	6,805	15,822	34,615	158,994	122,756	102,118	39,711	30,334	8,002	5,741	6,673
1963	24,677	6,997	20,447	12,513	67,904	25,569	89,965	26,201	9,006	8,002	6,059	5,237
1965	4,001	6,428	70,730	110,627	29,169	16,388	45,176	20,515	7,579	8,405	5,741	3,697
1967	4,622	6,259	31,811	47,319	58,778	56,662	48,506	45,277	37,462	9,802	5,741	7,260
1969	5,281	5,646	10,537	116,302	135,202	57,007	47,611	59,410	26,877	8,002	5,741	9,946
1970	20,275	14,092	55,586	205,728	91,231	35,249	11,579	7,958	7,579	8,560	5,771	3,879
1971	5,178	12,272	62,846	48,702	23,675	46,264	16,812	26,488	12,689	8,002	6,375	5,962
1974	5,757	57,668	64,020	130,198	42,706	105,895	70,319	20,652	12,454	8,002	5,741	6,868
1975	9,422	11,740	12,038	10,420	67,661	85,827	20,860	28,861	15,245	8,002	6,390	6,353
1982	4,935	24,655	84,676	79,943	99,462	82,083	142,610	48,456	16,959	8,002	5,801	12,412
1983	33,847	46,767	89,977	107,986	189,091	263,314	111,070	83,414	74,552	32,035	9,718	26,028
1984	37,420	83,001	159,165	85,443	49,714	36,150	13,095	9,791	8,231	8,002	5,741	5,746
1986	4,817	5,252	7,027	8,751	216,422	153,962	31,569	10,966	7,579	8,002	5,741	4,039
Average	**10,857**	**18,252**	**49,959**	**79,152**	**95,517**	**76,382**	**53,168**	**34,208**	**19,356**	**9,278**	**6,048**	**6,988**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	5,108	12,345	6,855	23,983	115,721	39,033	45,857	19,941	8,052	8,002	5,741	3,174
1938	4,001	25,061	69,680	26,438	141,095	162,964	65,947	60,575	32,476	8,002	5,741	8,322
1941	4,216	5,799	40,548	97,207	115,701	92,835	79,543	39,001	11,632	8,002	5,741	5,518
1942	13,381	12,016	65,389	81,907	143,045	24,849	49,525	34,288	16,858	8,002	5,741	5,485
1943	14,819	15,515	25,796	80,987	59,424	80,261	26,501	16,226	7,579	8,002	5,741	3,152
1952	5,261	7,576	43,974	87,413	74,261	60,732	63,867	60,716	33,104	8,002	5,741	10,855
1953	15,595	11,339	42,964	102,273	25,722	17,525	16,340	21,029	15,704	8,002	5,741	5,690
1956	4,001	5,654	74,937	154,181	87,517	31,286	17,586	38,886	14,515	8,002	6,525	6,320
1958	9,328	9,114	17,108	30,644	156,494	122,731	102,118	39,711	30,334	8,002	5,741	9,897
1963	28,326	10,620	18,762	8,571	69,245	25,569	89,965	26,201	9,016	8,002	6,059	5,237
1965	4,001	6,655	73,614	112,333	26,976	15,363	45,171	20,516	7,579	8,833	5,741	3,695
1967	4,622	6,630	34,841	48,144	54,145	56,637	48,506	45,277	37,462	9,802	5,741	9,901
1969	5,281	5,879	13,843	117,615	130,059	56,981	47,432	59,410	26,877	8,002	5,741	13,658
1970	17,934	14,092	55,147	204,924	91,231	35,249	11,579	7,958	7,579	8,560	5,771	3,879
1971	5,178	15,900	65,991	45,799	22,695	43,743	16,812	26,488	12,689	8,002	6,375	5,961
1974	5,854	61,296	65,124	125,762	42,495	105,870	70,319	20,652	12,454	8,002	5,741	10,509
1975	12,707	9,011	9,062	10,316	67,661	85,521	20,860	28,861	15,245	8,002	6,171	6,958
1982	4,935	28,283	88,016	77,838	94,724	81,963	142,610	48,204	16,999	8,002	5,801	16,124
1983	31,392	46,767	89,976	107,962	189,091	262,790	110,346	83,414	74,552	32,035	9,718	26,028
1984	37,420	83,001	159,165	85,443	49,714	36,150	13,095	9,791	8,231	8,002	5,741	5,760
1986	4,817	5,501	7,088	11,204	218,610	150,695	29,906	10,967	7,579	8,002	5,741	4,042
Average	**11,342**	**18,955**	**50,851**	**78,140**	**94,077**	**75,655**	**53,042**	**34,196**	**19,358**	**9,298**	**6,038**	**8,103**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	-4	-3,635	-303	-1,422	4,262	-1,675	0	0	0	0	0	0
1938	0	-927	-1,482	5,034	1,584	268	74	0	0	0	0	-2,073
1941	146	-222	879	2,769	930	3,840	0	0	0	0	0	7
1942	-3,643	3,112	107	104	162	265	0	0	0	0	0	-11
1943	-3,643	2,376	653	104	365	264	0	0	0	0	0	0
1952	0	-1,009	-3,284	-1,108	4,188	1,546	0	0	0	0	0	-3,558
1953	1,942	703	780	30	0	0	0	0	0	0	0	0
1956	0	16	-3,036	3,736	1,879	2,905	0	0	0	0	-10	-231
1958	-2,738	-2,309	-1,286	3,971	2,500	25	0	0	0	0	0	-3,224
1963	-3,649	-3,623	1,685	3,942	-1,341	0	0	0	-10	0	0	0
1965	0	-227	-2,884	-1,706	2,193	1,025	5	-1	0	-428	0	2
1967	0	-371	-3,030	-825	4,633	25	0	0	0	0	0	-2,641
1969	0	-233	-3,306	-1,313	5,143	26	179	0	0	0	0	-3,712
1970	2,341	0	439	804	0	0	0	0	0	0	0	0
1971	0	-3,628	-3,145	2,903	980	2,521	0	0	0	0	0	1
1974	-97	-3,628	-1,104	4,436	211	25	0	0	0	0	0	-3,641
1975	-3,285	2,729	2,976	104	0	306	0	0	0	0	219	-605
1982	0	-3,628	-3,340	2,105	4,738	120	0	252	-40	0	0	-3,712
1983	2,455	0	1	24	0	524	724	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	-14
1986	0	-249	-61	-2,453	-2,188	3,267	1,663	-1	0	0	0	-3
Average	**-485**	**-703**	**-892**	**1,011**	**1,440**	**727**	**126**	**12**	**-2**	**-20**	**10**	**-1,115**

71 Year Record-Wet Years
Total Outflow from Delta (DV58+DV60+RF91) (in CFS)
Existing Demand Level

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0%	-29%	-4%	-6%	4%	-4%	0%	0%	0%	0%	0%	0%
1938	0%	-4%	-2%	19%	1%	0%	0%	0%	0%	0%	0%	-25%
1941	3%	-4%	2%	3%	1%	4%	0%	0%	0%	0%	0%	0%
1942	-27%	26%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
1943	-25%	15%	3%	0%	1%	0%	0%	0%	0%	0%	0%	0%
1952	0%	-13%	-7%	-1%	6%	3%	0%	0%	0%	0%	0%	-33%
1953	12%	6%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1956	0%	0%	-4%	2%	2%	9%	0%	0%	0%	0%	0%	-4%
1958	-29%	-25%	-8%	13%	2%	0%	0%	0%	0%	0%	0%	-33%
1963	-13%	-34%	9%	46%	-2%	0%	0%	0%	0%	0%	0%	0%
1965	0%	-3%	-4%	-2%	8%	7%	0%	0%	0%	-5%	0%	0%
1967	0%	-6%	-9%	-2%	9%	0%	0%	0%	0%	0%	0%	-27%
1969	0%	-4%	-24%	-1%	4%	0%	0%	0%	0%	0%	0%	-27%
1970	13%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1971	0%	-23%	-5%	6%	4%	6%	0%	0%	0%	0%	0%	0%
1974	-2%	-6%	-2%	4%	0%	0%	0%	0%	0%	0%	0%	-35%
1975	-26%	30%	33%	1%	0%	0%	0%	0%	0%	0%	4%	-9%
1982	0%	-13%	-4%	3%	5%	0%	0%	1%	0%	0%	0%	-23%
1983	8%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
1984	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1986	0%	-5%	-1%	-22%	-1%	2%	6%	0%	0%	0%	0%	0%
Average	-4%	-4%	-1%	3%	2%	1%	0%	0%	0%	0%	0%	-10%

71 Year Record-Critical Years
Total Outflow from Delta (2020C9A-SRWCB+SDI-414.F) (in CFS)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	4,001	5,398	7,169	5,764	9,958	10,430	5,835	5,268	4,000	4,001	3,415	3,008
1929	4,001	5,839	6,574	5,699	10,224	10,012	7,310	6,432	7,107	5,860	3,415	3,008
1931	4,001	4,504	6,655	6,163	7,914	6,941	7,819	4,505	4,000	4,001	3,415	3,008
1933	4,001	4,504	4,684	7,204	7,777	8,159	10,399	6,086	6,830	4,851	3,415	3,008
1934	2,992	3,890	6,502	6,873	11,653	11,401	10,399	5,614	6,897	4,026	3,415	3,008
1976	9,074	6,948	8,869	6,534	12,094	8,760	7,788	6,367	6,897	6,602	3,415	3,008
1977	2,992	4,690	7,093	4,505	7,939	6,956	6,897	4,505	4,000	4,001	3,415	3,008
1988	4,001	5,009	6,953	15,020	11,400	7,948	7,300	6,496	6,897	6,217	3,415	3,008
1990	4,001	4,504	6,892	7,234	11,400	6,994	10,251	5,943	6,897	6,521	3,415	3,008
1991	2,992	4,432	5,702	5,226	8,112	21,655	11,258	5,351	7,037	4,681	3,415	3,228
1992	2,992	4,027	4,440	5,324	22,291	13,941	10,512	5,700	6,765	4,754	3,415	3,008
Average	**4,095**	**4,886**	**6,503**	**6,868**	**10,978**	**10,291**	**8,706**	**5,661**	**6,121**	**5,047**	**3,415**	**3,028**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	4,001	5,554	6,922	5,764	9,958	10,430	5,835	5,272	4,000	4,001	3,415	3,008
1929	4,001	5,842	5,885	5,699	10,225	10,012	7,311	6,432	7,107	5,891	3,415	3,008
1931	4,001	4,504	6,999	6,166	7,917	6,928	7,819	4,505	4,000	4,001	3,415	3,008
1933	4,001	4,504	4,686	7,206	7,779	8,160	10,399	6,086	6,830	5,535	3,415	3,008
1934	2,992	3,661	6,501	7,703	11,654	11,401	10,399	5,608	6,897	4,461	3,415	3,008
1976	12,719	10,078	6,028	5,896	10,853	8,763	7,788	6,367	6,897	6,900	3,415	3,008
1977	2,992	5,120	7,145	4,505	7,884	6,956	6,897	4,505	4,000	4,001	3,415	3,008
1988	4,001	4,984	7,701	18,260	11,400	7,761	7,300	6,496	6,897	6,535	3,415	3,008
1990	4,001	4,504	7,076	8,688	11,400	6,853	10,251	5,943	6,897	6,499	3,415	3,008
1991	2,992	3,879	5,619	5,180	8,071	21,657	11,258	5,351	7,037	5,205	3,415	3,008
1992	2,992	3,975	4,346	5,325	24,952	13,945	10,389	5,700	6,764	4,708	3,415	3,008
Average	**4,427**	**5,146**	**6,264**	**7,308**	**11,099**	**10,261**	**8,695**	**5,660**	**6,121**	**5,249**	**3,415**	**3,008**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0	-156	247	0	0	0	0	-4	0	0	0	0
1929	0	-3	689	0	-1	0	-1	0	0	-31	0	0
1931	0	0	-344	-3	-3	13	0	0	0	0	0	0
1933	0	0	-2	-2	-2	-1	0	0	0	-684	0	0
1934	0	229	1	-830	-1	0	0	6	0	-435	0	0
1976	-3,645	-3,130	2,841	638	1,241	-3	0	0	0	-298	0	0
1977	0	-430	-52	0	55	0	0	0	0	0	0	0
1988	0	25	-748	-3,240	0	187	0	0	0	-318	0	0
1990	0	0	-184	-1,454	0	141	0	0	0	22	0	0
1991	0	553	83	46	41	-2	0	0	0	-524	0	220
1992	0	52	94	-1	-2,661	-4	123	0	1	46	0	0
Average	**-331**	**-260**	**239**	**-441**	**-121**	**30**	**11**	**0**	**0**	**-202**	**0**	**20**

Percent Difference [(Run 414-411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0%	-3%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1929	0%	0%	12%	0%	0%	0%	0%	0%	0%	-1%	0%	0%
1931	0%	0%	-5%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1933	0%	0%	0%	0%	0%	0%	0%	0%	0%	-12%	0%	0%
1934	0%	6%	0%	-11%	0%	0%	0%	0%	0%	-9.8%	0%	0%
1976	-29%	-31%	47%	11%	11%	0%	0%	0%	0%	-4%	0%	0%
1977	0%	-8%	-1%	0%	1%	0%	0%	0%	0%	0%	0%	0%
1988	0%	1%	-9.7%	-18%	0%	2%	0%	0%	0%	-5%	0%	0%
1990	0%	0%	-3%	-17%	0%	2%	0%	0%	0%	0%	0%	0%
1991	0%	14%	1%	1%	1%	0%	0%	0%	0%	-10.1%	0%	7%
1992	0%	1%	2%	0%	-11%	0%	1%	0%	0%	1%	0%	0%
Average	**-3%**	**-2%**	**4%**	**-3%**	**0%**	**0%**	**0%**	**0%**	**0%**	**-4%**	**0%**	**1%**

71 Year Record-Dry Years
Total Outflow from Delta (2020C9A-SRWCB+SDI-414.F) (in CFS)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	4,615	4,994	5,755	6,001	40,575	13,751	21,006	11,496	8,309	6,233	4,446	3,587
1926	4,001	4,958	5,416	6,944	26,050	11,282	19,645	11,056	6,117	7,061	5,635	5,002
1930	4,659	4,939	6,750	11,733	13,097	20,663	10,690	8,269	6,117	5,042	4,066	3,008
1932	3,187	4,226	8,333	7,564	14,929	11,401	11,259	9,454	10,541	4,993	4,066	3,324
1939	11,864	6,699	7,474	9,752	10,622	9,641	10,399	7,579	6,290	7,217	6,011	4,355
1944	4,126	6,059	7,245	6,678	20,117	15,253	9,858	7,579	8,378	6,916	5,958	3,418
1947	4,001	5,373	6,645	6,470	12,976	14,866	11,259	7,579	6,134	6,964	6,045	3,630
1949	4,876	5,647	6,157	5,582	8,812	41,276	10,787	11,124	7,346	6,360	4,066	3,681
1955	4,001	6,634	13,915	11,398	11,400	7,282	8,427	8,338	8,011	7,065	6,368	4,066
1960	4,064	5,517	6,227	5,914	18,606	13,296	11,400	7,579	6,312	7,535	5,566	4,972
1961	4,001	5,974	7,020	6,325	16,342	13,492	10,518	7,579	6,182	6,703	6,095	3,008
1964	6,354	18,329	6,217	15,649	11,400	7,806	7,579	7,579	6,729	7,174	5,825	4,416
1981	5,962	5,920	6,520	11,218	21,161	26,520	11,307	7,579	6,117	7,290	6,006	4,906
1985	6,181	24,800	21,228	9,560	11,695	10,983	9,004	10,012	6,117	7,530	5,524	5,275
1987	4,040	4,555	6,784	6,480	12,158	20,131	11,115	7,579	6,117	6,964	4,066	3,008
1989	2,992	4,916	5,215	5,831	8,175	27,974	18,560	10,351	6,117	6,940	5,569	3,903
Average	4,933	7,471	7,931	8,319	16,132	16,601	12,051	8,796	6,933	6,749	5,332	3,972

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	4,615	4,994	5,757	6,001	43,341	13,704	21,009	11,500	8,309	6,959	4,066	3,592
1926	4,001	4,960	5,391	7,495	28,899	10,817	19,646	11,056	6,117	7,198	6,078	4,917
1930	4,693	4,630	6,746	14,737	13,099	20,667	10,606	8,269	6,117	6,508	4,066	3,008
1932	3,234	4,226	9,033	8,462	14,929	11,401	11,259	9,454	10,541	4,993	4,066	3,327
1939	14,139	8,751	6,156	7,057	10,556	9,643	10,399	7,579	6,291	7,158	6,038	3,954
1944	4,256	6,391	6,380	6,771	22,291	15,257	9,757	7,579	8,378	7,126	5,447	3,423
1947	4,001	5,374	6,777	6,138	12,979	14,867	11,259	7,579	6,134	7,164	5,942	3,625
1949	4,876	5,871	6,017	5,582	8,812	44,383	10,789	11,124	7,346	7,046	4,066	3,682
1955	4,001	6,637	17,199	14,166	11,400	7,062	8,434	8,346	8,008	7,170	6,056	4,048
1960	4,065	5,516	5,909	5,917	21,327	13,298	11,400	7,579	6,302	7,233	6,072	4,967
1961	4,001	5,972	7,013	6,326	18,314	13,492	10,391	7,579	6,182	7,190	5,591	3,008
1964	7,649	21,957	6,206	16,980	11,400	7,717	7,579	7,579	6,729	7,157	6,050	4,400
1981	8,029	5,933	6,533	13,269	19,405	23,709	11,314	7,579	6,117	7,178	6,050	4,445
1985	8,989	28,429	20,255	6,354	11,217	10,983	9,004	10,012	6,117	7,167	6,108	4,936
1987	4,040	4,688	6,308	6,373	12,158	20,132	11,115	7,579	6,117	6,732	4,066	3,008
1989	2,992	4,916	5,214	5,831	8,175	31,104	18,560	10,235	6,117	7,293	6,087	3,903
Average	5,474	8,078	7,931	8,591	16,769	16,765	12,033	8,789	6,933	6,955	5,366	3,890

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0	0	-2	0	-2,766	47	-3	-4	0	-726	380	-5
1926	0	-2	25	-551	-2,849	465	-1	0	0	-137	-443	85
1930	-34	309	4	-3,004	-2	-4	84	0	0	-1,466	0	0
1932	-47	0	-700	-898	0	0	0	0	0	0	0	-3
1939	-2,275	-2,052	1,318	2,695	66	-2	0	0	-1	59	-27	401
1944	-130	-332	865	-93	-2,174	-4	101	0	0	-210	511	-5
1947	0	-1	-132	332	-3	-1	0	0	0	-200	103	5
1949	0	-224	140	0	0	-3,107	-2	0	0	-686	0	-1
1955	0	-3	-3,284	-2,768	0	220	-7	-8	3	-105	312	18
1960	-1	1	318	-3	-2,721	-2	0	0	10	302	-506	5
1961	0	2	7	-1	-1,972	0	127	0	0	-487	504	0
1964	-1,295	-3,628	11	-1,331	0	89	0	0	0	17	-225	16
1981	-2,067	-13	-13	-2,051	1,756	2,811	-7	0	0	112	-44	461
1985	-2,808	-3,629	973	3,206	478	0	0	0	0	363	-584	339
1987	0	-133	476	107	0	-1	0	0	0	232	0	0
1989	0	0	1	0	0	-3,130	0	116	0	-353	-518	0
Average	-541	-607	0	-273	-637	-164	18	7	1	-205	-34	82

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0%	0%	0%	0%	-6%	0%	0%	0%	0%	-10.4%	9%	0%
1926	0%	0%	0%	-7%	-9.9%	4%	0%	0%	0%	-2%	-7%	2%
1930	-1%	7%	0%	-20%	0%	0%	1%	0%	0%	-23%	0%	0%
1932	-1%	0%	-8%	-11%	0%	0%	0%	0%	0%	0%	0%	0%
1939	-16%	-23%	21%	38%	1%	0%	0%	0%	0%	1%	0%	10.1%
1944	-3%	-5%	14%	-1%	-9.8%	0%	1%	0%	0%	-3%	9%	0%
1947	0%	0%	-2%	5%	0%	0%	0%	0%	0%	-3%	2%	0%
1949	0%	-4%	2%	0%	0%	-7%	0%	0%	0%	-9.7%	0%	0%
1955	0%	0%	-19%	-20%	0%	3%	0%	0%	0%	-1%	5%	0%
1960	0%	0%	5%	0%	-13%	0%	0%	0%	0%	4%	-8%	0%
1961	0%	0%	0%	0%	-11%	0%	1%	0%	0%	-7%	9%	0%
1964	-17%	-17%	0%	-8%	0%	1%	0%	0%	0%	0%	-4%	0%
1981	-26%	0%	0%	-15%	9%	12%	0%	0%	0%	2%	-1%	10.4%
1985	-31%	-13%	5%	50%	4%	0%	0%	0%	0%	5%	-9.6%	7%
1987	0%	-3%	8%	2%	0%	0%	0%	0%	0%	3%	0%	0%
1989	0%	0%	0%	0%	0%	-10.1%	0%	1%	0%	-5%	-9%	0%
Average	-6%	-4%	2%	1%	-2%	0%	0%	0%	0%	-3%	0%	2%

71 Year Record-Below Normal Years
Total Outflow from Delta (2020C9A-SRWCB+SDI-414.F) (In CFS)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	5,727	8,753	30,156	30,326	22,825	9,656	21,584	11,583	8,100	7,358	5,779	5,068
1935	2,992	5,714	5,545	17,681	11,400	20,070	36,252	28,043	9,288	7,752	5,614	4,117
1936	4,167	5,257	5,637	21,489	61,804	24,388	18,500	11,190	8,253	8,185	5,686	4,667
1937	4,001	5,351	7,288	7,249	34,670	43,706	19,733	11,382	11,259	6,505	5,158	3,008
1945	4,544	6,197	6,890	6,209	42,483	21,043	12,034	9,897	9,689	7,141	4,668	3,093
1946	4,001	7,186	62,245	47,088	22,239	15,645	11,141	11,259	8,886	6,757	5,914	3,091
1948	5,274	5,482	5,826	6,446	11,400	10,681	19,308	24,883	11,055	9,950	6,610	5,364
1950	4,001	5,193	5,253	10,200	25,662	15,144	16,054	11,400	8,843	7,189	6,122	5,059
1959	9,892	6,600	5,684	32,378	54,575	16,935	8,416	7,579	6,840	7,911	6,616	5,103
1962	4,001	5,189	6,953	6,001	45,754	18,005	10,761	11,401	6,840	7,869	6,655	3,635
1966	5,061	15,721	7,185	22,355	23,230	18,178	11,553	11,124	6,840	8,337	6,996	4,711
1968	11,465	10,750	9,678	27,654	66,163	32,866	10,562	7,579	6,840	8,093	6,590	5,089
1972	5,512	6,448	7,685	8,074	19,710	25,024	10,060	7,579	6,840	8,546	6,476	5,206
1979	5,542	6,139	5,936	15,056	39,536	29,406	15,837	12,719	10,920	8,197	6,490	3,738
Average	**5,441**	**7,141**	**12,283**	**18,443**	**34,389**	**21,482**	**15,843**	**12,687**	**8,607**	**7,842**	**6,098**	**4,354**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	5,745	12,382	28,103	27,470	15,020	9,664	22,113	11,750	8,083	7,801	6,526	5,054
1935	2,992	5,722	5,545	20,377	11,400	20,072	36,254	28,043	9,283	7,828	6,614	3,918
1936	4,168	5,516	5,611	24,120	63,493	23,863	18,504	11,194	8,252	7,841	6,586	4,639
1937	4,001	5,353	5,181	7,253	36,468	42,858	19,743	11,393	11,259	7,754	4,668	3,008
1945	4,546	7,120	8,561	6,213	41,873	21,117	12,036	9,899	9,685	7,713	4,668	3,094
1946	4,001	9,490	66,638	45,051	22,239	15,831	11,144	11,259	8,882	7,830	5,483	3,093
1948	5,274	5,556	5,818	6,442	11,400	10,681	19,308	24,883	11,055	7,836	6,678	5,865
1950	4,001	5,186	5,259	13,099	27,582	15,146	16,057	11,338	8,843	7,845	6,716	5,054
1959	10,865	6,801	5,684	30,575	51,576	16,935	8,416	7,579	6,840	7,843	6,742	5,087
1962	4,001	5,372	6,945	6,001	47,983	18,011	10,769	11,401	6,840	7,835	6,321	3,639
1966	5,076	19,349	8,858	22,202	20,901	17,626	11,565	11,124	6,840	7,828	6,775	4,420
1968	14,362	8,588	7,017	25,064	66,097	33,048	10,562	7,579	6,840	7,839	6,690	4,943
1972	5,594	6,458	10,952	7,191	17,877	25,282	10,072	7,579	6,840	7,838	6,748	5,158
1979	5,554	6,132	5,742	17,498	40,176	27,354	15,846	12,728	10,920	7,836	6,619	3,367
Average	**5,727**	**7,788**	**12,565**	**18,468**	**33,863**	**21,249**	**15,885**	**12,696**	**8,604**	**7,819**	**6,274**	**4,310**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	-18	-3,629	2,053	2,856	7,805	-8	-529	-167	17	-443	-747	14
1935	0	-8	0	-2,696	0	-2	-2	0	5	-76	-1,000	199
1936	-1	-259	26	-2,631	-1,689	525	-4	-4	1	344	-900	28
1937	0	-2	2,107	-4	-1,798	848	-10	-11	0	-1,249	490	0
1945	-2	-923	-1,671	-4	610	-74	-2	-2	4	-572	0	-1
1946	0	-2,304	-4,393	2,037	0	-186	-3	0	4	-1,073	431	-2
1948	0	-74	8	4	0	0	0	0	0	2,114	-68	-501
1950	0	7	-6	-2,899	-1,920	-2	-3	62	0	-656	-594	5
1959	-973	-201	0	1,803	2,999	0	0	0	0	68	-126	16
1962	0	-183	8	0	-2,229	-6	-8	0	0	34	334	-4
1966	-15	-3,628	-1,673	153	2,329	552	-12	0	0	509	221	291
1968	-2,897	2,162	2,661	2,590	66	-182	0	0	0	254	-100	146
1972	-82	-10	-3,267	883	1,833	-258	-12	0	0	708	-272	48
1979	-12	7	194	-2,442	-640	2,052	-9	-9	0	361	-129	371
Average	**-286**	**-646**	**-282**	**-25**	**526**	**233**	**-42**	**-9**	**2**	**23**	**-176**	**44**

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0%	**-29%**	7%	**10.4%**	**52%**	0%	-2%	-1%	0%	-6%	**-11%**	0%
1935	0%	0%	0%	**-13%**	0%	0%	0%	0%	0%	-1%	**-15%**	5%
1936	0%	-5%	0%	**-11%**	-3%	2%	0%	0%	0%	4%	**-14%**	1%
1937	0%	0%	**41%**	0%	-5%	2%	0%	0%	0%	**-16%**	**10.5%**	0%
1945	0%	**-13%**	**-20%**	0%	1%	0%	0%	0%	0%	-7%	0%	0%
1946	0%	**-24%**	-7%	5%	0%	-1%	0%	0%	0%	**-14%**	8%	0%
1948	0%	-1%	0%	0%	0%	0%	0%	0%	0%	**27%**	-1%	-9%
1950	0%	0%	0%	**-22%**	-7%	0%	0%	1%	0%	-8%	-9%	0%
1959	-9%	-3%	0%	6%	6%	0%	0%	0%	0%	1%	-2%	0%
1962	0%	-3%	0%	0%	-5%	0%	0%	0%	0%	0%	5%	0%
1966	0%	**-19%**	**-19%**	1%	**11%**	3%	0%	0%	0%	7%	3%	7%
1968	**-20%**	**25%**	**38%**	**10.3%**	0%	-1%	0%	0%	0%	3%	-1%	3%
1972	-1%	0%	**-30%**	**12%**	**10.3%**	-1%	0%	0%	0%	9%	-4%	1%
1979	0%	0%	3%	**-14%**	-2%	8%	0%	0%	0%	5%	-2%	**11%**
Average	**-2%**	**-5%**	**1%**	**-1%**	**4%**	**1%**	**0%**	**0%**	**0%**	**0%**	**-2%**	**1%**

71 Year Record-Above Normal Years
Total Outflow from Delta (2020C9A-SRWCB+SDI-414.F) (in CFS)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	4,001	4,968	7,280	9,232	43,076	29,640	19,596	44,794	23,068	8,002	6,443	3,397
1928	4,214	12,783	6,452	12,916	20,400	96,316	24,129	13,622	7,579	8,024	8,146	3,008
1940	4,001	5,185	6,210	18,914	41,455	97,311	63,989	14,615	7,579	9,081	6,130	4,658
1951	4,886	39,090	89,577	65,165	65,538	26,023	13,319	15,925	7,579	10,176	6,874	5,519
1954	5,421	8,582	6,240	19,200	58,452	44,671	39,663	17,678	7,579	9,479	7,964	3,995
1957	8,096	6,481	4,992	7,108	33,000	41,174	15,945	13,277	8,647	10,280	6,909	5,540
1973	4,444	11,517	14,767	71,325	93,687	59,622	15,872	14,347	10,352	9,701	6,883	3,889
1978	2,992	4,152	6,799	58,152	62,007	62,666	39,688	16,622	9,263	8,002	6,206	3,725
1980	4,001	6,594	8,708	94,141	131,348	67,886	15,791	12,444	7,579	9,076	6,192	3,650
Average	**4,673**	**11,039**	**16,781**	**39,573**	**60,996**	**58,368**	**27,555**	**18,147**	**9,914**	**9,091**	**6,861**	**4,153**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	4,001	4,968	9,789	11,339	39,320	28,424	19,596	44,794	26,591	8,877	5,591	3,422
1928	4,225	16,415	7,673	15,663	19,363	93,261	24,130	13,622	7,579	9,547	7,329	3,008
1940	4,001	5,185	6,159	21,626	43,796	100,681	63,995	14,512	7,579	9,550	7,400	4,441
1951	4,887	42,534	85,847	61,122	65,260	26,221	13,321	15,932	7,579	9,556	7,517	5,307
1954	5,397	12,210	6,233	19,203	55,994	42,689	39,670	17,678	7,579	9,539	7,617	3,809
1957	11,739	6,670	4,992	6,651	30,986	39,304	15,945	13,283	8,647	9,545	7,612	5,301
1973	4,447	15,153	18,072	72,757	91,195	59,739	15,876	14,351	10,349	9,544	7,212	3,906
1978	2,992	4,152	6,794	60,111	62,007	61,985	39,167	16,622	9,263	8,369	5,302	3,742
1980	4,001	7,566	11,907	97,691	128,995	67,116	15,791	12,444	7,579	9,007	7,146	3,650
Average	**5,077**	**12,761**	**17,496**	**40,685**	**59,657**	**57,713**	**27,499**	**18,138**	**10,305**	**9,282**	**6,970**	**4,065**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0	0	-2,509	-2,107	3,756	1,216	0	0	-3,523	-875	852	-25
1928	-11	-3,632	-1,221	-2,747	1,037	3,055	-1	0	0	-1,523	817	0
1940	0	0	51	-2,712	-2,341	-3,370	-6	103	0	-469	-1,270	217
1951	-1	-3,444	3,730	4,043	278	-198	-2	-7	0	620	-643	212
1954	24	-3,628	7	-3	2,458	1,982	-7	0	0	-60	347	186
1957	-3,643	-189	0	457	2,014	1,870	0	-6	0	735	-703	239
1973	-3	-3,636	-3,305	-1,432	2,492	-117	-4	-4	3	157	-329	-17
1978	0	0	5	-1,959	0	681	521	0	0	-367	904	-17
1980	0	-972	-3,199	-3,550	2,353	770	0	0	0	69	-954	0
Average	**-404**	**-1,722**	**-716**	**-1,112**	**1,339**	**654**	**56**	**10**	**-391**	**-190**	**-109**	**88**

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0%	0%	-26%	-19%	9.6%	4%	0%	0%	-13%	-9.9%	15%	-1%
1928	0%	-22%	-16%	-18%	5%	3%	0%	0%	0%	-16%	11%	0%
1940	0%	0%	1%	-13%	-5%	-3%	0%	1%	0%	-5%	-17%	5%
1951	0%	-8%	4%	7%	0%	-1%	0%	0%	0%	6%	-9%	4%
1954	0%	-30%	0%	0%	4%	5%	0%	0%	0%	-1%	5%	5%
1957	-31%	-3%	0%	7%	6%	5%	0%	0%	0%	8%	-9%	5%
1973	0%	-24%	-18%	-2%	3%	0%	0%	0%	0%	2%	-5%	0%
1978	0%	0%	0%	-3%	0%	1%	1%	0%	0%	-4%	17%	0%
1980	0%	-13%	-27%	-4%	2%	1%	0%	0%	0%	1%	-13%	0%
Average	**-3%**	**-11%**	**-9%**	**-5%**	**3%**	**2%**	**0%**	**0%**	**-1%**	**-2%**	**-1%**	**2%**

71 Year Record-Wet Years
Total Outflow from Delta (2020C9A-SRWCB+SDI-414.F) (in CFS)
Future Demand Level
Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	4,001	10,291	6,511	19,600	123,492	39,419	46,787	19,787	8,053	9,748	7,067	3,379
1938	4,001	18,244	54,564	23,869	136,592	163,376	64,923	59,271	30,714	8,002	6,349	5,478
1941	4,001	5,801	35,484	97,106	114,943	96,014	78,944	38,032	11,611	8,002	6,228	4,687
1942	6,224	7,234	58,212	81,222	141,778	22,782	51,571	34,255	16,242	8,002	6,404	4,633
1943	6,678	8,533	22,949	79,473	58,208	79,264	27,178	16,154	7,579	9,038	6,943	4,028
1952	4,001	6,571	38,905	82,274	74,871	61,935	63,116	59,811	30,491	8,002	5,741	6,532
1953	10,267	8,423	43,459	100,295	23,813	16,028	17,348	21,112	15,355	9,000	7,280	5,264
1956	4,001	5,757	70,090	154,216	91,196	33,255	18,182	38,725	13,909	8,002	6,519	5,840
1958	6,174	6,713	14,077	32,490	152,110	124,615	105,086	40,424	27,069	8,002	6,587	6,278
1963	22,106	6,986	20,485	12,738	72,800	27,666	91,120	25,919	8,999	9,678	6,963	4,395
1965	4,001	6,467	69,535	111,923	30,735	15,089	47,127	20,233	7,579	9,453	6,873	3,390
1967	4,001	6,674	30,876	41,510	53,734	56,680	50,598	45,246	33,607	8,002	5,741	6,464
1969	4,219	5,668	10,597	108,396	131,846	56,885	46,552	57,275	21,641	8,002	5,741	7,359
1970	12,805	11,107	55,374	204,334	89,738	33,829	11,776	7,934	7,579	9,916	7,638	5,174
1971	4,060	11,461	56,479	42,049	24,038	43,675	17,152	26,474	12,173	9,577	7,022	5,930
1974	4,925	51,683	62,862	127,775	43,076	106,137	70,893	20,279	11,978	8,755	6,746	6,324
1975	6,216	6,599	11,380	10,232	69,574	86,093	21,201	28,383	14,689	8,002	6,690	6,147
1982	4,024	20,042	81,107	77,407	98,363	82,944	143,166	47,305	16,481	8,002	5,741	11,772
1983	27,692	47,329	89,720	107,328	188,766	262,508	110,415	81,238	71,386	28,993	7,311	23,168
1984	35,251	82,636	157,477	83,489	47,913	34,810	13,381	9,544	8,297	10,228	6,552	5,473
1986	4,001	5,159	6,867	8,896	212,449	153,027	30,871	10,914	7,579	9,247	6,131	3,932
Average	**8,698**	**16,161**	**47,477**	**76,506**	**94,287**	**76,001**	**53,685**	**33,729**	**18,239**	**9,698**	**6,584**	**6,459**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	4,001	13,920	6,521	21,723	118,319	39,283	46,791	19,791	8,053	9,396	7,490	3,227
1938	4,001	21,881	57,740	23,161	135,042	163,376	64,923	59,271	31,490	8,002	5,741	5,802
1941	4,001	5,803	38,538	94,252	115,696	93,065	78,546	38,032	11,611	8,623	5,741	4,837
1942	8,271	10,862	57,742	76,917	140,861	22,950	51,577	34,261	16,248	8,047	5,741	4,787
1943	10,328	12,167	22,464	76,006	58,345	79,277	27,179	16,152	7,579	9,447	7,305	3,189
1952	4,001	6,582	42,118	85,077	74,248	60,474	63,115	59,811	31,702	8,002	5,741	7,649
1953	13,910	8,645	40,675	97,052	23,747	16,028	17,348	21,112	15,355	9,388	7,815	5,267
1956	4,001	5,758	73,286	157,721	88,659	33,255	18,182	38,725	13,909	8,531	6,833	5,787
1958	7,438	8,214	17,247	31,701	150,123	124,476	105,086	40,424	29,572	8,697	5,741	7,451
1963	25,758	10,367	19,092	9,916	73,993	27,666	91,120	25,919	8,999	9,522	7,865	4,162
1965	4,001	6,478	69,717	113,589	28,586	15,089	47,127	20,233	7,579	9,342	7,632	3,379
1967	4,001	6,667	33,895	43,986	54,857	56,678	50,598	45,246	36,071	8,560	5,741	8,646
1969	4,221	5,900	13,871	110,871	130,080	56,527	46,552	57,275	22,166	8,002	5,770	9,196
1970	16,448	11,134	52,169	201,998	89,672	34,060	11,759	7,941	7,579	9,527	7,787	4,943
1971	4,063	15,095	59,608	43,370	23,437	41,600	17,154	26,477	12,175	9,440	7,804	5,765
1974	4,927	54,605	65,966	126,435	41,014	106,115	70,893	20,279	11,983	9,506	6,925	6,843
1975	8,879	8,293	9,060	7,071	69,429	86,145	21,202	28,384	14,691	9,325	5,741	6,579
1982	4,001	23,676	86,305	78,322	94,088	82,003	143,166	47,305	16,481	8,002	5,741	14,645
1983	31,335	45,823	86,388	106,247	188,700	262,508	110,415	81,238	71,386	28,993	8,457	22,590
1984	34,673	82,636	157,477	83,489	47,913	34,847	13,382	9,545	8,297	9,343	7,603	5,455
1986	4,001	5,164	7,766	11,549	215,733	151,593	29,849	10,914	7,579	9,132	7,036	3,932
Average	**9,822**	**17,603**	**48,459**	**76,212**	**93,454**	**75,572**	**53,617**	**33,730**	**18,595**	**9,849**	**6,774**	**6,863**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0	-3,629	-10	-2,123	5,173	136	-4	-4	0	352	-423	152
1938	0	-3,637	-3,176	708	1,550	0	0	0	-776	0	608	-324
1941	0	-2	-3,054	2,854	-753	2,949	398	0	0	-621	487	-150
1942	-2,047	-3,628	470	4,305	917	-168	-6	-6	-6	-45	663	-154
1943	-3,650	-3,634	485	3,467	-137	-13	-1	2	0	-409	-362	839
1952	0	-11	-3,213	-2,803	623	1,461	1	0	-1,211	0	0	-1,117
1953	-3,643	-222	2,784	3,243	66	0	0	0	0	-388	-535	-3
1956	0	-1	-3,196	-3,505	2,537	0	0	0	0	-529	-314	53
1958	-1,264	-1,501	-3,170	789	1,987	139	0	0	-2,503	-695	846	-1,173
1963	-3,652	-3,381	1,393	2,822	-1,193	0	0	0	0	156	-902	233
1965	0	-11	-182	-1,666	2,149	0	0	0	0	111	-759	11
1967	0	7	-3,019	-2,476	-1,123	2	0	0	-2,464	-558	0	-2,182
1969	-2	-232	-3,274	-2,475	1,766	358	0	0	-525	0	-29	-1,837
1970	-3,643	-27	3,205	2,336	66	-231	17	-7	0	389	-149	231
1971	-3	-3,634	-3,129	-1,321	601	2,075	-2	-3	-2	137	-782	165
1974	-2	-2,922	-3,104	1,340	2,062	22	0	0	-5	-751	-179	-519
1975	-2,663	-1,694	2,320	3,161	145	-52	-1	-1	-2	-1,323	949	-432
1982	23	-3,634	-5,198	-915	4,275	941	0	0	0	0	0	-2,873
1983	-3,643	1,506	3,332	1,081	66	0	0	0	0	0	-1,146	578
1984	578	0	0	0	0	-37	-1	-1	0	885	-1,051	18
1986	0	-5	-899	-2,653	-3,284	1,434	1,022	0	0	115	-905	0
Average	**-1,124**	**-1,442**	**-983**	**294**	**833**	**429**	**68**	**-1**	**-357**	**-151**	**-190**	**-404**

71 Year Record-Wet Years
Total Outflow from Delta (2020C9A-SRWCB+SDI-414.F) (in CFS)
Future Demand Level

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0%	-26%	0%	-9.8%	4%	0%	0%	0%	0%	4%	-6%	5%
1938	0%	-17%	-6%	3%	1%	0%	0%	0%	-2%	0%	11%	-6%
1941	0%	0%	-8%	3%	-1%	3%	1%	0%	0%	-7%	8%	-3%
1942	-25%	-33%	1%	6%	1%	-1%	0%	0%	0%	-1%	12%	-3%
1943	-35%	-30%	2%	5%	0%	0%	0%	0%	0%	-4%	-5%	26%
1952	0%	0%	-8%	-3%	1%	2%	0%	0%	-4%	0%	0%	-15%
1953	-26%	-3%	7%	3%	0%	0%	0%	0%	0%	-4%	-7%	0%
1956	0%	0%	-4%	-2%	3%	0%	0%	0%	0%	-6%	-5%	1%
1958	-17%	-18%	-18%	2%	1%	0%	0%	0%	-8%	-8%	15%	-16%
1963	-14%	-33%	7%	28%	-2%	0%	0%	0%	0%	2%	-11%	6%
1965	0%	0%	0%	-1%	8%	0%	0%	0%	0%	1%	-9.9%	0%
1967	0%	0%	-9%	-6%	-2%	0%	0%	0%	-7%	-7%	0%	-25%
1969	0%	-4%	-24%	-2%	1%	1%	0%	0%	-2%	0%	-1%	-20%
1970	-22%	0%	6%	1%	0%	-1%	0%	0%	0%	4%	-2%	5%
1971	0%	-24%	-5%	-3%	3%	5%	0%	0%	0%	1%	-10.02%	3%
1974	0%	-5%	-5%	1%	5%	0%	0%	0%	0%	-8%	-3%	-8%
1975	-30%	-20%	26%	45%	0%	0%	0%	0%	0%	-14%	17%	-7%
1982	1%	-15%	-6%	-1%	5%	1%	0%	0%	0%	0%	0%	-20%
1983	-12%	3%	4%	1%	0%	0%	0%	0%	0%	0%	-14%	3%
1984	2%	0%	0%	0%	0%	0%	0%	0%	0%	9%	-14%	0%
1986	0%	0%	-12%	-23%	-2%	1%	3%	0%	0%	1%	-13%	0%
Average	-9%	-11%	-2%	2%	1%	1%	0%	0%	-1%	-2%	-2%	-3%

71 Year Record-Critical Years
X2 Position (in Kilometers)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	86.5	84.7	82.2	82.0	78.8	77.1	81.0	83.1	85.9	83.9	87.3	89.4
1929	86.6	84.4	82.7	83.0	78.7	77.4	79.4	81.0	80.8	81.8	86.6	89.2
1931	87.7	86.5	84.8	83.3	80.8	80.7	80.0	83.9	86.1	86.0	88.0	89.7
1933	87.5	86.4	85.6	82.2	79.8	79.0	77.2	80.8	81.0	85.2	87.8	89.6
1934	90.2	88.9	84.1	81.4	76.4	75.6	76.1	81.0	81.0	85.2	87.8	89.6
1976	76.9	76.2	77.6	80.0	76.8	76.9	79.0	80.9	81.0	84.5	87.5	89.5
1977	90.2	87.0	83.5	82.3	80.4	80.9	81.0	84.3	86.2	86.9	88.3	89.8
1988	87.0	85.7	82.5	75.7	75.4	78.1	79.6	81.0	81.0	84.0	87.4	89.4
1990	86.8	86.2	83.2	81.7	77.4	79.4	77.4	81.0	81.0	82.0	86.1	89.0
1991	90.0	87.4	84.9	84.6	81.0	72.4	74.4	80.8	80.8	82.1	86.7	89.2
1992	90.1	87.8	84.9	84.2	73.5	73.1	75.2	80.5	81.0	82.5	86.9	89.3
Average	**87.2**	**85.6**	**83.3**	**81.9**	**78.1**	**77.3**	**78.2**	**81.7**	**82.3**	**84.0**	**87.3**	**89.4**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	86.4	84.6	82.1	82.0	78.8	77.1	81.0	83.1	85.9	84.4	87.5	89.5
1929	86.6	84.4	82.3	82.9	78.7	77.4	79.4	81.0	80.8	82.0	86.7	89.2
1931	87.7	86.5	85.4	83.5	80.9	80.8	80.0	83.9	86.1	86.9	88.3	89.8
1933	87.5	86.4	85.6	82.2	79.8	79.0	77.2	80.8	81.0	85.2	87.8	89.6
1934	90.2	88.9	84.1	79.6	75.8	75.4	76.0	81.0	81.0	85.2	87.8	89.6
1976	75.0	75.1	79.7	81.8	77.9	77.3	79.1	81.0	81.0	84.5	87.5	89.5
1977	90.2	87.0	82.7	82.9	80.6	81.0	81.0	84.3	86.2	86.9	88.3	89.8
1988	87.0	85.7	82.5	74.2	74.9	78.1	79.6	81.0	81.0	82.7	86.9	89.3
1990	86.7	86.1	83.3	80.7	77.1	79.3	77.4	81.0	81.0	82.6	86.6	89.2
1991	90.1	87.7	85.1	84.8	81.1	72.4	74.4	80.8	80.8	82.4	86.8	89.3
1992	90.1	87.9	85.0	84.2	72.6	72.8	75.2	80.5	81.0	82.2	86.8	89.3
Average	**87.0**	**85.5**	**83.4**	**81.7**	**78.0**	**77.3**	**78.2**	**81.7**	**82.3**	**84.1**	**87.4**	**89.5**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	-0.2	-0.1
1929	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	-0.2	-0.1	0.0
1931	0.0	0.0	-0.6	-0.2	-0.1	-0.1	0.0	0.0	0.0	-0.9	-0.3	-0.1
1933	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1934	0.0	0.0	0.0	1.8	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0
1976	1.9	1.1	-2.1	-1.8	-1.1	-0.4	-0.1	-0.1	0.0	0.0	0.0	0.0
1977	0.0	0.0	0.8	-0.6	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	1.5	0.5	0.0	0.0	0.0	0.0	1.3	0.5	0.1
1990	0.1	0.1	-0.1	1.0	0.3	0.1	0.0	0.0	0.0	-0.6	-0.5	-0.2
1991	-0.1	-0.3	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	-0.3	-0.1	-0.1
1992	0.0	-0.1	-0.1	0.0	0.9	0.3	0.0	0.0	0.0	0.3	0.1	0.0
Average	**0.2**	**0.1**	**-0.2**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.1**	**-0.1**	**0.0**

71 Year Record-Dry Years
X2 Position (in Kilometers)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	86.1	85.1	83.7	82.9	67.8	71.1	69.3	73.3	77.0	79.6	82.7	85.9
1926	84.6	84.7	84.1	81.8	70.9	74.0	71.0	74.0	79.6	80.4	83.0	86.0
1930	86.3	84.8	82.7	78.0	75.2	70.5	74.2	77.4	80.7	82.4	85.5	88.8
1932	89.1	87.4	81.7	80.2	74.5	75.0	75.3	76.7	76.3	82.0	85.4	88.1
1939	76.0	75.4	76.7	75.8	74.9	76.4	76.3	78.7	81.0	80.9	83.7	86.7
1944	84.9	82.8	83.8	82.5	71.2	70.5	75.3	78.4	78.7	80.4	83.7	87.1
1947	85.9	84.5	82.4	82.0	76.6	73.6	74.8	78.2	81.0	80.6	82.4	85.7
1949	83.1	83.1	83.0	83.4	80.1	67.1	73.2	74.8	78.4	80.8	83.8	85.9
1955	86.3	82.5	76.4	74.7	75.1	78.3	79.0	79.0	79.1	79.9	82.6	84.0
1960	85.1	84.8	82.1	82.4	74.0	73.2	74.6	78.2	80.8	80.3	82.5	85.5
1961	85.8	84.0	81.9	82.3	73.3	73.4	75.4	78.4	81.0	80.3	82.5	86.1
1964	82.2	72.9	78.7	70.9	73.8	77.1	79.0	79.6	80.8	80.4	82.1	84.8
1981	82.7	81.1	77.4	70.7	68.0	65.5	71.5	77.2	80.7	80.8	83.7	87.1
1985	82.0	69.9	67.8	73.2	72.5	72.7	77.0	76.8	80.5	80.4	82.6	86.0
1987	85.7	84.1	85.1	83.7	77.4	70.5	74.2	78.1	81.0	80.7	82.8	86.7
1989	90.2	86.5	84.8	83.6	80.5	70.1	69.9	74.2	79.7	79.9	82.2	85.9
Average	84.8	82.1	80.8	79.3	74.1	72.4	74.4	77.1	79.8	80.6	83.2	86.3

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	86.2	85.1	83.7	82.9	67.3	71.0	69.3	73.3	77.0	79.7	82.8	86.0
1926	84.7	84.7	84.2	81.0	69.8	74.0	71.0	74.0	79.6	80.5	83.0	86.1
1930	86.3	84.8	82.7	76.1	74.5	70.3	74.2	77.4	80.7	82.2	85.4	88.8
1932	89.1	87.4	81.0	78.6	73.9	74.8	75.2	76.7	76.3	81.9	85.4	88.1
1939	74.1	76.9	77.5	76.7	75.4	76.5	76.4	78.8	81.0	80.9	83.7	86.7
1944	84.9	82.9	83.8	82.5	70.9	70.7	75.4	78.4	78.7	80.4	83.6	87.1
1947	85.8	84.5	82.4	82.1	76.6	73.6	74.8	78.2	81.0	80.7	82.3	85.8
1949	83.0	83.1	83.0	83.4	80.1	66.6	73.0	74.7	78.4	81.1	84.0	85.9
1955	86.3	81.7	74.5	73.0	74.5	78.1	78.9	79.0	79.1	80.1	81.6	82.9
1960	85.1	84.1	81.7	82.7	73.2	72.9	74.5	78.1	80.8	80.6	81.9	85.3
1961	85.7	84.0	81.9	82.3	72.2	73.1	75.4	78.4	81.0	80.6	81.9	85.9
1964	80.5	71.0	78.6	72.3	74.3	77.2	79.0	79.6	80.8	80.6	81.9	84.8
1981	79.6	81.3	78.7	71.1	68.2	65.6	71.6	77.2	80.7	80.8	83.7	87.1
1985	78.8	68.7	68.6	73.5	72.8	72.8	77.0	76.8	80.6	80.6	82.2	85.9
1987	85.3	83.9	85.1	83.7	77.4	69.9	74.2	78.1	81.0	80.7	82.8	86.7
1989	90.1	86.6	84.8	83.6	80.5	69.3	69.7	74.2	79.7	80.2	81.8	85.8
Average	84.1	81.9	80.8	79.1	73.9	72.3	74.4	77.1	79.8	80.7	83.0	86.2

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	-0.1	0.0	0.0	0.0	0.5	0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1
1926	-0.1	0.0	-0.1	0.8	1.1	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1
1930	0.0	0.0	0.0	1.9	0.7	0.2	0.0	0.0	0.0	0.2	0.1	0.0
1932	0.0	0.0	0.7	1.6	0.6	0.2	0.1	0.0	0.0	0.1	0.0	0.0
1939	1.9	-1.5	-0.8	-0.9	-0.5	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
1944	0.0	-0.1	0.0	0.0	0.3	-0.2	-0.1	0.0	0.0	0.0	0.1	0.0
1947	0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1
1949	0.1	0.0	0.0	0.0	0.0	0.5	0.2	0.1	0.0	-0.3	-0.2	0.0
1955	0.0	0.8	1.9	1.7	0.6	0.2	0.1	0.0	0.0	-0.2	1.0	1.1
1960	0.0	0.7	0.4	-0.3	0.8	0.3	0.1	0.1	0.0	-0.3	0.6	0.2
1961	0.1	0.0	0.0	0.0	1.1	0.3	0.0	0.0	0.0	-0.3	0.6	0.2
1964	1.7	1.9	0.1	-1.4	-0.5	-0.1	0.0	0.0	0.0	-0.2	0.2	0.0
1981	3.1	-0.2	-1.3	-0.4	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
1985	3.2	1.2	-0.8	-0.3	-0.3	-0.1	0.0	0.0	-0.1	-0.2	0.4	0.1
1987	0.4	0.2	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.1	-0.1	0.0	0.0	0.0	0.8	0.2	0.0	0.0	-0.3	0.4	0.1
Average	0.7	0.2	0.0	0.2	0.3	0.2	0.0	0.0	0.0	-0.1	0.2	0.1

71 Year Record-Below Normal Years
X2 Position (in Kilometers)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	81.5	78.2	67.3	64.5	66.7	74.1	70.0	73.3	77.3	79.4	81.7	86.1
1935	90.2	85.6	84.2	74.6	75.0	70.8	64.9	65.0	73.5	78.5	82.3	87.6
1936	86.8	85.0	82.8	73.2	61.3	63.8	68.0	73.0	77.0	80.1	83.5	87.8
1937	87.4	85.5	83.0	81.6	68.7	62.5	67.0	72.0	74.3	79.3	83.4	88.0
1945	85.0	83.3	81.9	82.0	66.4	66.2	72.5	75.5	76.6	80.0	83.5	87.3
1946	85.4	82.0	63.9	60.3	65.3	69.1	73.6	74.8	77.0	79.9	82.7	86.5
1948	84.8	84.1	83.3	82.3	77.6	76.3	71.4	67.7	72.7	75.5	79.8	83.3
1950	86.1	84.9	83.9	79.3	70.4	71.3	71.5	74.0	76.8	78.5	80.9	84.9
1959	74.1	75.3	80.0	68.3	60.8	67.8	75.2	78.4	80.2	80.0	82.6	85.0
1962	86.3	85.0	82.3	82.5	66.9	68.9	74.5	75.0	79.1	78.9	81.6	84.9
1966	83.9	75.9	78.9	69.5	67.8	68.0	73.1	74.7	79.0	79.4	81.3	84.9
1968	73.0	74.0	75.0	68.1	59.3	61.7	71.6	77.2	79.8	80.0	82.8	85.4
1972	81.9	81.6	75.5	74.3	71.2	68.0	74.0	78.0	80.1	79.3	81.6	85.8
1979	82.4	82.0	83.8	72.1	63.8	64.2	69.5	72.4	74.7	79.4	83.5	87.2
Average	83.5	81.6	79.0	73.8	67.2	68.1	71.2	73.6	77.0	79.2	82.2	86.1

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	78.6	75.8	67.3	65.1	66.9	73.3	69.8	73.2	77.3	78.9	81.4	85.7
1935	90.2	85.6	84.2	73.5	74.7	70.7	64.8	64.9	73.5	77.7	81.6	87.4
1936	86.8	85.0	84.2	72.7	61.0	64.4	68.2	73.1	77.0	79.0	82.5	87.4
1937	87.3	85.5	82.6	81.4	68.3	62.7	67.0	72.5	74.5	79.3	83.4	88.0
1945	85.0	83.3	80.2	81.5	66.6	66.3	72.6	75.5	76.6	80.0	83.5	87.3
1946	85.4	78.9	62.5	60.6	65.4	69.3	73.6	74.8	77.0	79.3	82.2	86.4
1948	84.8	83.9	83.3	82.3	77.6	76.3	71.4	67.7	72.7	77.3	80.0	82.0
1950	86.1	84.9	84.4	77.4	69.3	70.9	71.3	74.0	76.8	78.7	80.4	84.6
1959	73.9	75.3	80.0	68.4	60.9	67.9	75.2	78.4	80.2	80.0	82.6	85.0
1962	86.2	85.0	82.3	82.5	66.5	68.7	74.5	75.0	79.1	79.4	81.5	84.9
1966	83.1	73.9	77.2	70.5	68.7	68.3	73.2	74.8	79.0	79.4	81.3	84.9
1968	73.1	74.4	75.2	68.1	59.3	61.7	71.6	77.2	79.8	80.0	82.8	85.4
1972	79.3	80.4	75.3	76.0	71.8	68.2	74.0	78.0	80.1	79.7	81.1	85.7
1979	79.5	80.5	83.3	73.0	64.1	64.3	69.6	72.4	74.7	79.4	83.5	87.2
Average	82.8	80.9	78.7	73.8	67.2	68.1	71.2	73.7	77.0	79.2	82.0	85.9

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	2.9	2.4	0.0	-0.6	-0.2	0.8	0.2	0.1	0.0	0.5	0.3	0.4
1935	0.0	0.0	0.0	1.1	0.3	0.1	0.1	0.1	0.0	0.8	0.7	0.2
1936	0.0	0.0	-1.4	0.5	0.3	-0.6	-0.2	-0.1	0.0	1.1	1.0	0.4
1937	0.1	0.0	0.4	0.2	0.4	-0.2	0.0	-0.5	-0.2	0.0	0.0	0.0
1945	0.0	0.0	1.7	0.5	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
1946	0.0	3.1	1.4	-0.3	-0.1	-0.2	0.0	0.0	0.0	0.6	0.5	0.1
1948	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.8	-0.2	1.3
1950	0.0	0.0	-0.5	1.9	1.1	0.4	0.2	0.0	0.0	-0.2	0.5	0.3
1959	0.2	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
1962	0.1	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0	-0.5	0.1	0.0
1966	0.8	2.0	1.7	-1.0	-0.9	-0.3	-0.1	-0.1	0.0	0.0	0.0	0.0
1968	-0.1	-0.4	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972	2.6	1.2	0.2	-1.7	-0.6	-0.2	0.0	0.0	0.0	-0.4	0.5	0.1
1979	2.9	1.5	0.5	-0.9	-0.3	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
Average	0.7	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2

71 Year Record-Above Normal Years
X2 Position (in Kilometers)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	82.9	84.1	82.1	79.2	66.6	64.8	67.8	62.4	64.8	74.6	80.9	85.9
1928	84.8	75.4	79.7	72.3	68.6	56.5	63.5	70.1	76.7	77.5	80.7	85.3
1940	85.7	84.7	83.7	74.8	64.1	54.9	55.4	66.9	75.7	78.1	81.6	86.4
1951	83.6	68.2	58.0	56.3	55.7	62.1	69.9	71.3	77.1	77.3	80.5	84.7
1954	81.3	76.0	77.2	69.0	60.6	60.0	60.8	67.2	75.8	76.9	80.3	84.6
1957	77.2	80.2	82.6	79.1	67.9	62.9	68.9	72.1	76.3	77.0	79.4	84.7
1973	84.0	77.8	73.6	60.2	54.2	55.7	66.4	70.5	74.5	77.7	81.2	84.9
1978	90.3	88.1	83.4	64.8	59.1	56.2	59.3	66.7	74.5	77.7	81.9	83.4
1980	87.2	82.7	79.6	59.1	51.2	53.5	65.4	71.6	77.2	78.6	82.2	83.2
Average	**84.1**	**79.7**	**77.8**	**68.3**	**60.9**	**58.5**	**64.2**	**68.8**	**74.7**	**77.3**	**81.0**	**84.8**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	82.9	84.1	80.5	77.1	66.4	65.0	67.9	62.5	64.5	74.4	80.9	85.9
1928	84.8	73.9	78.3	73.3	69.1	56.7	63.5	70.1	76.7	77.5	80.7	85.3
1940	85.7	84.7	83.7	73.6	63.3	54.6	55.3	66.9	75.7	76.8	80.1	85.4
1951	83.4	67.5	57.6	56.6	56.0	62.2	69.9	71.3	77.1	77.3	80.6	84.7
1954	78.1	73.9	79.3	70.3	61.0	60.1	60.9	67.2	75.8	76.8	80.2	84.5
1957	75.1	79.3	82.3	81.1	69.0	63.3	69.0	72.1	76.3	77.0	79.4	84.7
1973	83.9	75.7	71.5	59.7	54.3	55.9	66.5	70.5	74.5	77.7	81.2	84.9
1978	90.3	88.1	83.4	64.9	59.1	56.2	59.3	66.7	74.5	77.7	81.9	83.4
1980	87.2	80.0	76.3	58.4	51.0	53.5	65.4	71.6	77.2	78.6	82.2	83.2
Average	**83.5**	**78.6**	**77.0**	**68.3**	**61.0**	**58.6**	**64.2**	**68.8**	**74.7**	**77.1**	**80.8**	**84.7**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0.0	0.0	1.6	2.1	0.2	-0.2	-0.1	-0.1	0.3	0.2	0.0	0.0
1928	0.0	1.5	1.4	-1.0	-0.5	-0.2	0.0	0.0	0.0	0.0	0.0	0.0
1940	0.0	0.0	0.0	1.2	0.8	0.3	0.1	0.0	0.0	1.3	1.5	1.0
1951	0.2	0.7	0.4	-0.3	-0.3	-0.1	0.0	0.0	0.0	0.0	-0.1	0.0
1954	3.2	2.1	-2.1	-1.3	-0.4	-0.1	-0.1	0.0	0.0	0.1	0.1	0.1
1957	2.1	0.9	0.3	-2.0	-1.1	-0.4	-0.1	0.0	0.0	0.0	0.0	0.0
1973	0.1	2.1	2.1	0.5	-0.1	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0
1978	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.0	2.7	3.3	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	**0.6**	**1.1**	**0.8**	**0.0**	**-0.1**	**-0.1**	**0.0**	**0.0**	**0.0**	**0.2**	**0.2**	**0.1**

71 Year Record-Wet Years
X2 Position (in Kilometers)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	85.0	80.5	81.2	72.0	56.2	59.9	59.6	65.8	74.8	77.8	81.4	87.1
1938	87.5	73.5	61.0	62.8	51.8	47.2	52.6	55.0	60.6	73.2	79.8	81.4
1941	86.3	84.4	68.4	56.4	51.2	51.0	52.4	58.4	69.6	76.1	80.8	82.6
1942	78.9	74.3	61.5	55.6	49.4	60.7	59.2	61.6	67.8	75.5	80.6	82.6
1943	77.8	72.7	68.0	57.8	56.9	54.2	61.9	68.2	76.1	78.2	81.5	87.2
1952	84.3	82.5	67.9	57.3	54.6	55.5	55.6	56.0	60.8	73.2	79.9	80.2
1953	73.6	74.3	64.6	55.0	62.4	67.7	70.0	68.9	70.7	76.5	80.9	82.5
1956	86.1	84.2	64.1	51.5	51.7	59.1	66.7	63.0	69.4	76.1	79.8	81.6
1958	82.5	81.6	74.8	66.6	52.2	49.5	50.0	57.4	61.9	73.6	80.0	80.9
1963	72.5	78.1	71.7	73.4	61.0	64.4	55.9	62.5	72.9	77.2	80.7	83.0
1965	86.4	83.3	63.9	54.1	61.1	67.9	62.3	66.5	75.5	77.7	81.3	85.9
1967	85.4	83.2	70.0	62.6	58.6	57.5	58.3	59.1	60.9	71.7	79.4	80.1
1969	84.5	83.7	78.6	58.6	50.8	54.9	57.6	56.8	62.7	73.8	80.1	77.9
1970	71.7	72.5	62.2	48.8	50.7	58.5	69.7	76.2	78.7	78.6	81.6	85.6
1971	84.7	77.8	63.0	60.1	64.7	61.1	67.6	66.3	71.5	76.7	80.2	81.9
1974	83.7	65.6	58.9	51.2	57.3	52.3	53.8	63.7	70.8	76.5	80.9	81.0
1975	78.6	76.1	75.1	75.9	61.8	55.4	64.1	64.5	69.5	76.1	80.0	81.3
1982	85.6	72.7	59.1	55.0	52.0	52.5	48.4	55.4	65.7	74.8	80.3	76.3
1983	67.3	61.8	55.0	51.4	45.9	41.6	46.8	50.7	52.8	60.0	71.5	67.7
1984	63.7	56.3	48.8	51.2	56.1	60.1	69.2	74.5	77.5	78.7	81.7	82.6
1986	85.4	84.5	82.0	79.5	54.1	48.4	58.6	70.1	76.7	78.5	81.6	85.3
Average	**80.5**	**76.4**	**66.7**	**59.8**	**55.3**	**56.2**	**59.1**	**62.9**	**68.9**	**75.3**	**80.2**	**81.7**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	85.0	77.8	80.0	71.1	56.1	59.6	59.5	65.8	74.8	77.8	81.4	87.1
1938	87.5	73.2	60.7	64.1	52.3	47.4	52.7	55.1	60.6	73.2	79.8	79.2
1941	86.2	84.0	68.4	56.6	51.4	51.4	52.5	58.4	69.6	76.1	80.8	82.6
1942	76.5	75.3	61.9	55.8	49.5	60.8	59.3	61.6	67.8	75.5	80.6	82.6
1943	75.7	73.0	68.3	57.9	56.9	54.3	61.9	68.2	76.1	78.2	81.5	87.2
1952	84.3	81.4	66.9	56.9	54.9	55.8	55.7	56.0	60.8	73.2	79.9	77.1
1953	73.5	74.7	64.9	55.1	62.4	67.8	70.0	68.9	70.7	76.5	80.9	82.5
1956	85.8	84.1	63.7	51.5	51.9	59.9	66.9	63.1	69.4	76.1	79.8	81.3
1958	79.9	78.5	73.2	67.0	52.5	49.6	50.0	57.4	61.9	73.6	80.0	77.9
1963	71.4	74.6	71.2	76.1	61.7	64.6	55.9	62.6	72.9	77.2	80.7	83.0
1965	86.4	83.0	63.5	53.9	61.7	68.5	62.5	66.6	75.5	77.3	81.2	85.8
1967	85.4	82.7	69.2	62.2	59.0	57.7	58.4	59.2	60.9	71.7	79.4	77.7
1969	84.5	83.4	76.4	57.8	50.9	54.9	57.7	56.8	62.7	73.8	80.1	75.5
1970	71.9	72.5	62.3	48.9	50.7	58.6	69.7	76.2	78.7	78.6	81.6	85.6
1971	84.7	75.8	62.0	60.3	65.1	61.6	67.8	66.4	71.5	76.8	80.2	81.9
1974	83.5	65.1	58.6	51.4	57.4	52.3	53.8	63.7	70.8	76.5	80.9	77.7
1975	75.3	77.1	77.6	76.8	62.1	55.5	64.2	64.5	69.5	76.1	80.2	80.7
1982	85.6	71.7	58.4	55.0	52.4	52.7	48.5	55.4	65.7	74.8	80.3	74.3
1983	67.2	61.8	55.0	51.4	45.9	41.6	46.8	50.7	52.8	60.0	71.5	67.7
1984	63.7	56.3	48.8	51.2	56.1	60.1	69.2	74.5	77.5	78.7	81.7	82.6
1986	85.4	84.2	81.8	77.6	53.4	48.3	59.0	70.2	76.8	78.5	81.6	85.3
Average	**80.0**	**75.7**	**66.3**	**59.9**	**55.4**	**56.3**	**59.1**	**62.9**	**68.9**	**75.2**	**80.2**	**80.7**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0.0	**2.7**	**1.2**	0.9	0.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0
1938	0.0	0.3	0.3	**-1.3**	-0.5	-0.2	-0.1	-0.1	0.0	0.0	0.0	**2.2**
1941	0.1	0.4	0.0	-0.2	-0.2	-0.4	-0.1	0.0	0.0	0.0	0.0	0.0
1942	**2.4**	-1.0	-0.4	-0.2	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
1943	**2.1**	-0.3	-0.3	-0 1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
1952	0.0	**1.1**	1.0	0.4	-0.3	-0.3	-0.1	0.0	0.0	0.0	0.0	**3.1**
1953	0.1	-0.4	-0.3	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
1956	0.3	0.1	0.4	0.0	-0.2	-0.8	-0.2	-0.1	0.0	0.0	0.0	0.3
1958	**2.6**	**3.1**	**1.6**	-0.4	-0.3	-0.1	0.0	0.0	0.0	0.0	0.0	**3.0**
1963	**1.1**	**3.5**	0.5	**-2.7**	-0.7	-0.2	0.0	-0.1	0.0	0.0	0.0	0.0
1965	0.0	0.3	0.4	0.2	-0.6	-0.6	-0.2	-0.1	0.0	0.4	0.1	0.1
1967	0.0	0.5	0.8	0.4	-0.4	-0.2	-0.1	-0.1	0.0	0.0	0.0	**2.4**
1969	0.0	0.3	**2.2**	0.8	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	**2.4**
1970	-0.2	0.0	-0.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	**2.0**	1.0	-0.2	-0.4	-0.5	-0.2	-0.1	0.0	-0.1	0.0	0.0
1974	0.2	0.5	0.3	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	**3.3**
1975	**3.3**	-1.0	**-2.5**	-0.9	-0.3	-0.1	-0.1	0.0	0.0	0.0	-0.2	0.6
1982	0.0	1.0	0.7	0.0	-0.4	-0.2	-0.1	0.0	0.0	0.0	0.0	**2.0**
1983	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.0	0.3	0.2	**1.9**	0.7	0.1	-0.4	-0.1	-0.1	0.0	0.0	0.0
Average	**0.6**	**0.6**	**0.3**	**-0.1**	**-0.2**	**-0.2**	**-0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.9**

71 Year Record-Critical Years
X2 Position (in Kilometers)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	86.0	84.5	81.9	82.7	78.7	77.1	81.0	83.1	85.9	86.8	88.3	89.7
1929	87.0	84.3	82.4	82.9	78.6	77.4	79.4	81.0	80.8	82.2	86.8	89.3
1931	87.8	86.5	83.1	82.5	80.5	80.8	80.0	83.9	86.1	86.9	88.3	89.8
1933	87.5	86.4	85.7	82.2	80.5	79.5	77.4	80.8	81.0	83.7	87.3	89.4
1934	90.2	88.4	83.9	82.0	77.3	75.9	76.2	81.0	81.0	85.1	87.7	89.6
1976	79.0	80.3	78.8	80.7	76.6	77.7	79.0	81.0	81.0	81.3	86.5	89.2
1977	90.1	86.9	82.7	84.8	81.2	81.0	81.0	84.3	86.2	86.9	88.3	89.8
1988	87.7	85.6	82.5	75.5	75.3	78.1	79.6	81.0	81.0	81.8	86.6	89.2
1990	86.8	86.2	82.7	81.2	77.2	79.7	77.5	81.0	81.0	81.4	86.5	89.2
1991	90.1	87.4	84.5	84.3	80.8	72.2	74.4	80.8	80.8	83.9	87.3	88.9
1992	90.0	88.1	86.7	84.8	73.3	73.1	75.2	80.5	81.0	83.9	87.3	89.4
Average	**87.5**	**85.9**	**83.2**	**82.1**	**78.2**	**77.5**	**78.2**	**81.7**	**82.3**	**84.0**	**87.4**	**89.4**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	85.9	84.3	82.0	82.7	78.7	77.1	81.0	83.1	85.9	86.8	88.3	89.7
1929	87.1	84.3	83.3	83.2	78.7	77.4	79.4	81.0	80.8	82.1	86.8	89.2
1931	87.7	86.5	82.7	82.4	80.4	80.8	80.0	83.9	86.1	86.9	88.3	89.8
1933	87.5	86.4	85.7	82.2	80.5	79.5	77.4	80.8	81.0	82.7	86.9	89.3
1934	90.1	88.8	84.0	81.1	77.0	75.8	76.2	81.0	81.0	84.3	87.5	89.5
1976	76.4	76.6	80.6	82.1	77.9	78.1	79.1	81.0	81.0	81.0	86.4	89.1
1977	90.1	86.3	82.5	84.7	81.2	81.0	81.0	84.3	86.2	86.9	88.3	89.8
1988	87.7	85.7	81.7	73.8	74.8	78.1	79.6	81.0	81.0	81.4	86.5	89.2
1990	86.7	86.1	82.5	79.7	76.7	79.6	77.5	81.0	81.0	81.5	86.5	89.2
1991	90.1	88.4	85.0	84.5	80.9	72.2	74.4	80.8	80.8	83.1	87.1	89.3
1992	90.1	88.2	86.9	84.9	72.4	72.8	75.2	80.5	81.0	83.9	87.3	89.4
Average	**87.2**	**85.6**	**83.4**	**81.9**	**78.1**	**77.5**	**78.3**	**81.7**	**82.3**	**83.7**	**87.3**	**89.4**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0.1	0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1929	-0.1	0.0	-0.9	-0.3	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1
1931	0.1	0.0	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1933	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	0.1
1934	0.1	-0.4	-0.1	0.9	0.3	0.1	0.0	0.0	0.0	0.8	0.2	0.1
1976	**2.6**	**3.7**	**-1.8**	**-1.4**	**-1.3**	-0.4	-0.1	0.0	0.0	0.3	0.1	0.1
1977	0.0	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	-0.1	0.8	**1.7**	0.5	0.0	0.0	0.0	0.0	0.4	0.1	0.0
1990	0.1	0.1	0.2	**1.5**	0.5	0.1	0.0	0.0	0.0	-0.1	0.0	0.0
1991	0.0	-1.0	-0.5	-0.2	-0.1	0.0	0.0	0.0	0.0	0.8	0.2	-0.4
1992	-0.1	-0.1	-0.2	-0.1	0.9	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Average	**0.3**	**0.3**	**-0.2**	**0.2**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.1**	**0.0**

71 Year Record-Dry Years
X2 Position (in Kilometers)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	86.9	85.4	83.8	83.0	68.1	71.5	69.3	73.3	77.0	80.5	84.2	87.1
1926	87.2	85.5	84.3	82.0	71.2	74.0	70.7	74.0	79.6	80.4	82.3	83.9
1930	86.7	85.4	82.6	77.5	74.9	70.6	74.2	77.4	80.7	83.3	85.8	88.9
1932	89.8	87.6	81.7	80.5	74.9	75.2	75.3	76.7	76.3	82.0	85.4	88.0
1939	77.2	80.0	80.1	78.0	76.7	77.0	76.5	78.8	81.0	80.6	81.9	84.8
1944	86.2	83.7	81.5	81.4	72.9	72.3	75.4	78.4	78.7	80.2	81.9	86.7
1947	87.3	85.0	82.6	82.0	76.5	73.6	74.8	78.3	81.0	80.9	82.0	86.2
1949	84.1	83.6	82.7	83.2	79.8	66.9	73.0	74.7	78.4	80.8	85.0	87.1
1955	86.3	83.0	76.3	75.6	75.4	78.7	78.7	78.8	79.1	80.2	81.3	85.2
1960	85.8	84.3	82.9	82.8	74.0	73.7	74.7	78.2	80.8	80.2	82.4	84.0
1961	86.1	83.8	81.8	81.9	74.7	73.8	75.4	78.4	81.0	81.2	82.0	87.7
1964	82.6	74.0	79.5	74.2	74.9	78.1	79.3	79.7	80.8	80.6	82.2	84.8
1981	83.7	83.1	82.1	77.6	71.3	67.5	72.8	77.6	80.8	80.5	81.9	83.9
1985	82.3	71.6	69.3	74.7	74.9	75.4	77.1	76.9	80.6	80.2	82.4	83.5
1987	86.5	86.0	82.8	82.1	77.0	71.5	74.2	78.1	81.0	80.9	85.0	88.7
1989	90.1	86.6	85.0	83.6	80.5	70.1	69.8	74.2	79.7	80.5	82.5	85.9
Average	**85.6**	**83.0**	**81.2**	**80.0**	**74.9**	**73.1**	**74.5**	**77.1**	**79.8**	**80.8**	**83.0**	**86.0**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	86.9	85.4	83.8	83.0	67.6	71.3	69.3	73.2	77.0	79.6	84.6	87.2
1926	87.2	85.6	84.4	81.5	70.2	74.0	70.7	74.0	79.6	80.2	81.7	83.8
1930	86.7	85.9	82.8	75.8	74.4	70.4	74.2	77.4	80.7	81.4	85.2	88.7
1932	89.7	87.6	81.1	79.5	74.6	75.0	75.3	76.7	76.3	81.9	85.4	88.0
1939	75.8	77.5	80.7	80.7	77.6	77.3	76.6	78.9	81.0	80.7	81.9	85.6
1944	86.4	83.4	82.4	81.6	72.2	72.0	75.4	78.4	78.7	80.0	82.5	86.9
1947	87.3	85.0	82.4	82.4	76.6	73.7	74.8	78.3	81.0	80.7	82.0	86.3
1949	84.0	83.2	82.8	83.2	79.8	66.3	72.8	74.6	78.4	80.0	84.7	87.0
1955	86.4	83.1	74.7	73.4	74.7	78.7	78.7	78.8	79.1	80.1	81.7	85.3
1960	85.8	84.3	83.3	82.9	73.0	73.3	74.6	78.2	80.8	80.6	81.8	83.8
1961	86.1	83.8	81.8	81.9	73.8	73.5	75.4	78.4	81.0	80.7	82.5	87.9
1964	81.2	72.2	78.9	73.4	74.7	78.1	79.3	79.7	80.8	80.6	81.9	84.7
1981	81.3	82.2	81.8	76.3	71.5	68.4	73.1	77.7	80.8	80.6	81.9	84.7
1985	79.4	69.6	69.0	77.7	76.2	75.9	77.3	76.9	80.6	80.6	81.8	83.8
1987	86.4	85.7	83.2	82.3	77.1	71.5	74.2	78.1	81.0	81.2	85.1	88.7
1989	90.1	86.6	85.0	83.6	80.5	69.3	69.6	74.2	79.7	80.1	81.7	85.6
Average	**85.0**	**82.6**	**81.1**	**80.0**	**74.7**	**73.0**	**74.5**	**77.1**	**79.8**	**80.6**	**82.9**	**86.1**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0.0	0.0	0.0	0.0	0.5	0.2	0.0	0.1	0.0	0.9	-0.4	-0.1
1926	0.0	-0.1	-0.1	0.5	1.0	0.0	0.0	0.0	0.0	0.2	0.6	0.1
1930	0.0	-0.5	-0.2	1.7	0.5	0.2	0.0	0.0	0.0	1.9	0.6	0.2
1932	0.1	0.0	0.6	1.0	0.3	0.2	0.0	0.0	0.0	0.1	0.0	0.0
1939	1.4	2.5	-0.6	-2.7	-0.9	-0.3	-0.1	-0.1	0.0	-0.1	0.0	-0.8
1944	-0.2	0.3	-0.9	-0.2	0.7	0.3	0.0	0.0	0.0	0.2	-0.6	-0.2
1947	0.0	0.0	0.2	-0.4	-0.1	-0.1	0.0	0.0	0.0	0.2	0.0	-0.1
1949	0.1	0.4	-0.1	0.0	0.0	0.6	0.2	0.1	0.0	0.8	0.3	0.1
1955	-0.1	-0.1	1.6	2.2	0.7	0.0	0.0	0.0	0.0	0.1	-0.4	-0.1
1960	0.0	0.0	-0.4	-0.1	1.0	0.4	0.1	0.0	0.0	-0.4	0.6	0.2
1961	0.0	0.0	0.0	0.0	0.9	0.3	0.0	0.0	0.0	0.5	-0.5	-0.2
1964	1.4	1.8	0.6	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.1
1981	2.4	0.9	0.3	1.3	-0.2	-0.9	-0.3	-0.1	0.0	-0.1	0.0	-0.8
1985	2.9	2.0	0.3	-3.0	-1.3	-0.5	-0.2	0.0	0.0	-0.4	0.6	-0.3
1987	0.1	0.3	-0.4	-0.2	-0.1	0.0	0.0	0.0	0.0	-0.3	-0.1	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.8	0.2	0.0	0.0	0.4	0.8	0.3
Average	**0.5**	**0.5**	**0.1**	**0.1**	**0.2**	**0.1**	**0.0**	**0.0**	**0.0**	**0.3**	**0.1**	**-0.1**

71 Year Record-Below Normal Years
X2 Position (in Kilometers)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	84.0	80.2	69.4	65.9	66.9	73.8	69.9	73.4	77.3	79.3	81.8	83.6
1935	90.2	85.5	84.1	74.8	75.1	70.9	65.0	65.0	73.5	77.6	81.5	85.1
1936	86.2	84.8	83.8	73.2	61.6	65.0	68.2	73.1	77.0	78.4	81.6	84.2
1937	86.2	84.7	81.8	80.9	68.6	62.8	67.0	72.6	74.5	79.3	82.7	87.9
1945	86.1	83.5	81.8	82.1	67.4	68.0	72.5	75.4	76.6	79.3	83.4	87.9
1946	87.4	82.8	64.7	60.9	65.4	69.6	73.6	74.8	77.0	79.9	81.8	87.4
1948	84.8	84.0	83.3	82.3	77.6	76.5	71.6	68.1	73.2	75.6	79.6	82.5
1950	87.2	85.2	84.5	79.1	70.3	71.5	71.4	74.0	76.8	79.3	81.4	83.5
1959	78.3	80.4	82.3	69.6	61.4	67.7	75.1	78.3	80.2	79.7	80.9	83.3
1962	87.4	85.3	82.3	82.5	67.0	69.1	73.7	74.7	79.0	79.3	80.7	85.8
1966	85.0	76.0	79.0	71.3	68.5	69.5	73.3	74.8	79.0	78.9	80.2	83.7
1968	77.2	76.3	76.9	69.0	59.7	62.1	71.5	77.2	79.8	79.4	80.8	83.3
1972	82.9	82.1	80.5	79.6	72.5	68.3	74.0	78.0	80.1	79.1	80.8	83.1
1979	84.2	82.9	82.8	75.6	65.8	64.9	69.4	72.5	74.7	77.6	80.4	85.5
Average	84.8	82.4	79.8	74.8	67.7	68.6	71.2	73.7	77.1	78.8	81.3	84.8

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	84.1	77.5	69.1	66.5	70.3	74.9	70.1	73.3	77.3	78.8	80.7	83.3
1935	90.2	85.4	84.1	73.7	74.8	70.8	64.9	65.0	73.5	77.6	80.2	85.1
1936	86.2	84.4	83.7	72.3	61.1	65.0	68.2	73.1	77.0	78.7	80.6	83.9
1937	86.1	84.6	84.4	81.7	68.5	62.9	67.0	72.6	74.5	78.0	83.0	88.0
1945	86.1	82.4	79.8	81.4	67.3	67.9	72.4	75.4	76.6	78.7	83.2	87.9
1946	87.4	80.7	63.5	60.9	65.4	69.5	73.6	74.8	77.0	78.7	82.0	87.5
1948	84.8	83.9	83.3	82.3	77.6	76.5	71.6	68.1	73.2	77.4	80.1	81.9
1950	87.2	85.2	84.5	77.2	69.1	71.1	71.3	74.0	76.8	78.6	80.4	83.2
1959	77.2	79.9	82.1	69.9	62.0	67.9	75.2	78.4	80.2	79.8	80.8	83.3
1962	87.4	85.0	82.3	82.5	66.6	68.9	73.6	74.7	79.0	79.4	81.1	85.9
1966	84.9	74.4	76.9	70.7	69.1	69.9	73.4	74.8	79.0	79.4	80.6	84.3
1968	74.7	77.2	79.6	70.7	60.3	62.2	71.6	77.2	79.8	79.6	80.8	83.5
1972	82.8	82.1	77.8	79.6	73.3	68.5	74.0	78.0	80.1	79.7	80.7	83.1
1979	84.3	83.0	83.1	74.5	65.4	65.3	69.5	72.5	74.7	78.0	80.3	86.3
Average	84.5	81.8	79.6	74.6	67.9	68.7	71.2	73.7	77.1	78.7	81.0	84.8

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	-0.1	2.7	0.3	-0.6	-3.4	-1.1	-0.2	0.1	0.0	0.5	1.1	0.3
1935	0.0	0.1	0.0	1.1	0.3	0.1	0.1	0.0	0.0	0.0	1.3	0.0
1936	0.0	0.4	0.1	0.9	0.5	0.0	0.0	0.0	0.0	-0.3	1.0	0.3
1937	0.1	0.1	-2.6	-0.8	0.1	-0.1	0.0	0.0	0.0	1.3	-0.3	-0.1
1945	0.0	1.1	2.0	0.7	0.1	0.1	0.1	0.0	0.0	0.6	0.2	0.0
1946	0.0	2.1	1.2	0.0	0.0	0.1	0.0	0.0	0.0	1.2	-0.2	-0.1
1948	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.8	-0.5	0.6
1950	0.0	0.0	0.0	1.9	1.2	0.4	0.1	0.0	0.0	0.7	1.0	0.3
1959	1.1	0.5	0.2	-0.3	-0.6	-0.2	-0.1	-0.1	0.0	-0.1	0.1	0.0
1962	0.0	0.3	0.0	0.0	0.4	0.2	0.1	0.0	0.0	-0.1	-0.4	-0.1
1966	0.1	1.6	2.1	0.6	-0.6	-0.4	-0.1	0.0	0.0	-0.5	-0.4	-0.6
1968	2.5	-0.9	-2.7	-1.7	-0.6	-0.1	-0.1	0.0	0.0	-0.2	0.0	-0.2
1972	0.1	0.0	2.7	0.0	-0.8	-0.2	0.0	0.0	0.0	-0.6	0.1	0.0
1979	-0.1	-0.1	-0.3	1.1	0.4	-0.4	-0.1	0.0	0.0	-0.4	0.1	-0.8
Average	0.3	0.6	0.2	0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	0.2	0.0

71 Year Record-Above Normal Years
X2 Position (in Kilometers)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	82.9	84.1	81.6	79.0	66.3	65.0	67.8	62.3	65.6	74.8	79.5	85.9
1928	86.4	78.0	80.5	76.0	71.1	57.5	63.7	70.1	76.7	78.4	78.9	86.7
1940	86.4	85.0	83.1	74.0	64.9	55.4	55.5	66.9	75.7	77.1	80.6	83.9
1951	84.5	68.8	57.4	56.0	55.6	62.5	69.9	70.9	77.0	76.7	79.6	82.3
1954	83.3	80.1	81.5	73.3	62.1	60.5	60.9	67.2	75.7	76.8	78.5	84.4
1957	80.1	81.2	83.5	81.6	69.2	63.4	68.8	72.0	76.3	76.4	79.5	82.2
1973	85.1	78.4	74.3	60.9	54.4	55.8	66.3	70.6	74.5	76.2	79.5	84.9
1978	90.3	87.9	83.4	65.4	59.1	56.9	59.7	67.3	74.2	77.6	80.7	85.6
1980	86.6	83.2	79.9	60.6	51.7	53.9	65.8	71.5	77.2	77.6	80.7	85.8
Average	**85.1**	**80.7**	**78.4**	**69.6**	**61.6**	**59.0**	**64.3**	**68.8**	**74.8**	**76.8**	**79.7**	**84.6**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	82.9	84.1	79.3	76.6	66.2	65.3	67.8	62.3	64.5	73.7	80.2	86.1
1928	86.4	76.1	78.6	73.9	70.8	57.7	63.8	70.1	76.7	77.1	79.3	86.8
1940	86.7	85.0	83.2	73.0	64.2	54.9	55.4	66.9	75.7	76.8	79.1	83.7
1951	84.4	68.2	57.5	56.6	55.8	62.5	69.9	70.9	77.0	77.2	79.1	82.4
1954	83.3	77.4	80.6	73.0	62.3	60.9	61.0	67.2	75.8	76.8	78.9	84.8
1957	77.2	80.0	83.2	82.0	69.8	64.0	69.0	72.0	76.3	77.0	78.9	82.3
1973	85.1	76.3	72.1	60.0	54.3	55.7	66.3	70.6	74.5	76.4	79.1	84.7
1978	90.3	87.9	83.4	65.2	59.0	57.0	59.8	67.3	74.3	77.3	81.8	86.0
1980	86.9	82.2	77.2	59.4	51.5	53.9	65.8	71.5	77.2	77.7	79.6	85.4
Average	**84.8**	**79.7**	**77.2**	**68.9**	**61.5**	**59.1**	**64.3**	**68.8**	**74.7**	**76.7**	**79.6**	**84.7**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0.0	0.0	2.3	2.4	0.1	-0.3	0.0	0.0	1.1	1.1	-0.7	-0.2
1928	0.0	1.9	1.9	2.1	0.3	-0.2	-0.1	0.0	0.0	1.3	-0.4	-0.1
1940	-0.3	0.0	-0.1	1.0	0.7	0.5	0.1	0.0	0.0	0.3	1.5	0.2
1951	0.1	0.6	-0.1	-0.6	-0.2	0.0	0.0	0.0	0.0	-0.5	0.5	-0.1
1954	0.0	2.7	0.9	0.3	-0.2	-0.4	-0.1	0.0	-0.1	0.0	-0.4	-0.4
1957	2.9	1.2	0.3	-0.4	-0.6	-0.6	-0.2	0.0	0.0	-0.6	0.6	-0.1
1973	0.0	2.1	2.2	0.9	0.1	0.1	0.0	0.0	0.0	-0.2	0.4	0.2
1978	0.0	0.0	0.0	0.2	0.1	-0.1	-0.1	0.0	-0.1	0.3	-1.1	-0.4
1980	-0.3	1.0	2.7	1.2	0.2	0.0	0.0	0.0	0.0	-0.1	1.1	0.4
Average	**0.3**	**1.1**	**1.1**	**0.8**	**0.1**	**-0.1**	**0.0**	**0.0**	**0.1**	**0.2**	**0.2**	**-0.1**

71 Year Record-Wet Years
X2 Position (in Kilometers)
Future Demand Level
Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	86.1	79.6	81.0	73.0	56.3	59.5	59.3	65.8	74.8	76.3	79.3	85.9
1938	87.4	75.7	63.4	65.7	53.1	47.6	52.9	55.3	61.1	73.3	79.1	82.2
1941	86.1	84.0	69.4	56.9	51.5	51.2	52.5	58.6	69.7	76.1	80.2	83.7
1942	82.7	81.2	64.7	56.8	49.9	61.6	59.2	61.6	68.1	75.6	79.8	83.7
1943	82.1	79.7	71.4	59.1	57.5	54.6	61.8	68.2	76.1	77.3	79.7	84.7
1952	85.6	82.9	68.4	57.9	55.1	55.7	55.7	56.2	61.5	73.5	79.9	81.1
1953	78.0	78.5	66.1	55.6	63.2	68.7	69.9	68.8	70.9	75.6	78.8	82.4
1956	86.5	84.2	64.3	51.7	51.6	59.3	66.5	63.0	69.7	76.2	79.8	81.9
1958	82.2	81.6	75.7	67.4	52.8	49.6	49.8	57.2	62.7	73.9	79.0	81.1
1963	73.7	78.5	71.8	73.3	60.4	63.6	55.5	62.5	72.9	75.7	79.2	83.9
1965	86.4	83.3	64.0	54.1	60.7	68.4	62.1	66.6	75.5	76.8	79.6	86.0
1967	86.0	82.9	70.1	63.7	59.6	57.8	58.1	59.1	61.7	73.5	80.0	81.2
1969	85.5	84.0	78.7	59.1	51.2	55.1	57.9	57.2	64.4	74.4	80.3	80.3
1970	76.0	75.7	63.3	49.2	50.9	58.9	69.7	76.2	78.7	77.5	79.1	82.6
1971	85.6	78.6	64.1	61.6	65.1	61.6	67.7	66.3	71.8	75.5	79.1	81.5
1974	84.9	66.8	59.4	51.5	57.3	52.3	53.7	63.8	71.1	75.9	79.5	81.2
1975	81.9	81.6	77.4	76.8	61.9	55.4	64.0	64.6	69.8	76.2	79.7	81.4
1982	86.1	74.5	60.0	55.6	52.3	52.5	48.4	55.6	66.0	74.9	80.4	76.7
1983	68.9	62.3	55.2	51.5	46.0	41.6	46.8	50.9	53.2	60.9	74.0	69.4
1984	64.7	56.6	49.0	51.4	56.4	60.5	69.2	74.6	77.5	76.8	80.0	82.5
1986	86.0	84.9	82.3	79.5	54.2	48.5	58.8	70.2	76.7	77.4	80.7	85.2
Average	**82.0**	**78.0**	**67.6**	**60.5**	**55.6**	**56.4**	**59.0**	**63.0**	**69.2**	**74.9**	**79.4**	**81.8**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	86.1	77.3	80.2	71.9	56.2	59.5	59.3	65.8	74.8	76.6	78.9	86.1
1938	87.5	74.3	62.5	65.7	53.2	47.6	52.9	55.3	60.9	73.3	79.9	82.0
1941	86.1	84.0	68.8	57.0	51.5	51.4	52.6	58.6	69.7	75.6	80.6	83.6
1942	80.5	77.3	63.5	56.8	49.9	61.6	59.2	61.6	68.1	75.6	80.6	83.7
1943	78.8	75.9	70.3	59.1	57.5	54.6	61.8	68.2	76.1	77.0	79.2	86.3
1952	85.6	82.9	67.7	57.4	55.0	55.8	55.8	56.2	61.2	73.4	79.9	79.8
1953	75.2	77.4	66.2	55.9	63.3	68.7	69.9	68.8	70.9	75.3	78.2	82.1
1956	86.6	84.2	63.9	51.4	51.7	59.3	66.5	63.0	69.7	75.7	79.3	81.8
1958	80.9	79.6	73.5	66.9	52.8	49.6	49.8	57.2	62.0	73.0	79.8	80.0
1963	72.5	75.1	71.3	75.0	60.9	63.7	55.6	62.5	72.9	75.9	78.3	84.0
1965	86.4	83.2	64.0	54.0	61.2	68.5	62.2	66.6	75.5	76.9	78.9	85.8
1967	86.2	83.0	69.4	63.0	59.2	57.7	58.1	59.1	61.1	72.8	79.7	78.8
1969	85.6	83.7	76.5	58.2	51.0	55.0	57.9	57.2	64.2	74.4	80.2	78.5
1970	73.5	74.9	63.5	49.4	51.0	58.9	69.7	76.2	78.7	77.8	79.0	82.9
1971	85.7	76.5	63.0	61.0	65.1	62.0	67.8	66.4	71.8	75.6	78.3	81.5
1974	84.8	66.4	58.9	51.5	57.7	52.4	53.8	63.8	71.1	75.3	79.1	80.4
1975	78.9	78.9	78.2	79.9	62.9	55.7	64.1	64.6	69.8	75.0	80.4	81.2
1982	86.4	73.3	59.1	55.2	52.5	52.7	48.5	55.6	66.0	74.9	80.4	75.0
1983	67.4	62.0	55.4	51.6	46.0	41.6	46.8	50.9	53.2	60.9	72.8	69.2
1984	64.8	56.6	49.0	51.4	56.4	60.5	69.2	74.6	77.5	77.5	79.1	82.2
1986	86.1	84.9	81.4	77.2	53.4	48.2	59.0	70.3	76.8	77.5	79.7	84.9
Average	**81.2**	**76.7**	**67.0**	**60.5**	**55.6**	**56.4**	**59.1**	**63.0**	**69.1**	**74.8**	**79.2**	**81.4**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0.0	2.3	0.8	1.1	0.1	0.0	0.0	0.0	0.0	-0.3	0.4	-0.2
1938	-0.1	1.4	0.9	0.0	-0.1	0.0	0.0	0.0	0.2	0.0	-0.8	0.2
1941	0.0	0.0	0.6	-0.1	0.0	-0.2	-0.1	0.0	0.0	0.5	-0.4	0.1
1942	2.2	3.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.8	0.0
1943	3.3	3.8	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	-1.6
1952	0.0	0.0	0.7	0.5	0.1	-0.1	-0.1	0.0	0.3	0.1	0.0	1.3
1953	2.8	1.1	-0.1	-0.3	-0.1	0.0	0.0	0.0	0.0	0.3	0.6	0.3
1956	-0.1	0.0	0.4	0.3	-0.1	0.0	0.0	0.0	0.0	0.5	0.5	0.1
1958	1.3	2.0	2.2	0.5	0.0	0.0	0.0	0.0	0.7	0.9	-0.8	1.1
1963	1.2	3.4	0.5	-1.7	-0.5	-0.1	-0.1	0.0	0.0	-0.2	0.9	-0.1
1965	0.0	0.1	0.0	0.1	-0.5	-0.1	-0.1	0.0	0.0	-0.1	0.7	0.2
1967	-0.2	-0.1	0.7	0.7	0.4	0.1	0.0	0.0	0.6	0.7	0.3	2.4
1969	-0.1	0.3	2.2	0.9	0.2	0.1	0.0	0.0	0.2	0.0	0.1	1.8
1970	2.5	0.8	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	-0.3	0.1	-0.3
1971	-0.1	2.1	1.1	0.6	0.0	-0.4	-0.1	-0.1	0.0	-0.1	0.8	0.0
1974	0.1	0.4	0.5	0.0	-0.4	-0.1	-0.1	0.0	0.0	0.6	0.4	0.8
1975	3.0	2.7	-0.8	-3.1	-1.0	-0.3	-0.1	0.0	0.0	1.2	-0.7	0.2
1982	-0.3	1.2	0.9	0.4	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	1.7
1983	1.5	0.3	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2
1984	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	0.9	0.3
1986	-0.1	0.0	0.9	2.3	0.8	0.3	-0.2	-0.1	-0.1	-0.1	1.0	0.3
Average	**0.8**	**1.2**	**0.6**	**0.1**	**-0.1**	**0.0**	**0.0**	**0.0**	**0.1**	**0.2**	**0.2**	**0.4**

71 Year Record-Critical Years
Sacramento River Flow at Freeport River Flow (Regulated) (in CFS)
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	11,427	11,586	16,302	15,805	15,271	15,895	8,044	8,722	10,291	15,984	10,190	7,746
1929	10,070	12,117	14,460	12,551	15,361	14,130	9,362	9,815	14,192	17,377	8,273	7,847
1931	8,158	7,808	10,849	12,873	11,099	10,036	10,404	7,028	10,027	12,640	6,078	6,851
1933	8,446	8,949	9,735	14,414	13,420	11,651	12,994	8,384	12,799	10,139	5,735	7,142
1934	7,430	6,564	13,733	17,189	13,753	17,200	13,384	8,633	13,536	10,335	6,080	6,842
1976	24,913	20,509	15,624	13,398	19,051	15,023	9,790	10,202	14,148	12,745	8,159	7,657
1977	8,124	9,551	14,394	16,060	13,020	10,213	9,063	6,120	6,806	8,793	6,207	6,509
1988	10,789	9,948	15,984	25,075	17,055	12,197	9,117	9,507	14,260	13,620	10,162	7,773
1990	8,651	7,505	14,236	17,202	15,179	11,049	12,823	7,850	14,589	16,976	10,919	7,035
1991	6,482	8,580	11,406	10,632	13,762	28,554	14,064	7,460	12,529	16,317	10,004	8,342
1992	6,670	7,685	11,439	11,477	28,251	19,058	13,074	8,912	13,787	15,930	9,193	7,765
Average	10,105	10,073	13,469	15,152	15,929	15,001	11,102	8,421	12,451	13,714	8,273	7,410

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	11,427	11,655	16,715	15,481	15,271	14,513	8,034	8,727	10,282	15,037	10,170	7,498
1929	10,070	12,117	15,501	12,551	15,361	12,713	9,359	9,813	14,188	16,926	8,282	7,705
1931	8,158	8,754	10,243	12,873	11,099	10,035	10,401	7,023	10,019	11,090	5,591	6,851
1933	8,446	8,949	9,735	14,414	13,420	11,651	12,497	8,377	13,624	10,269	5,934	7,344
1934	7,430	6,564	13,733	17,189	13,753	17,194	13,388	8,876	14,487	10,526	6,080	7,435
1976	24,352	20,509	15,624	13,398	19,051	15,023	9,793	10,204	14,597	12,813	8,159	7,657
1977	8,124	9,571	17,685	12,903	13,020	9,436	8,927	6,120	6,806	8,793	6,207	6,509
1988	10,048	9,948	15,984	25,075	17,048	11,935	9,113	9,499	14,259	15,595	10,288	8,145
1990	8,651	7,505	14,022	17,202	15,181	11,049	12,821	7,837	14,566	15,817	10,563	7,031
1991	6,482	7,996	11,151	10,483	13,607	28,554	14,064	7,994	13,876	16,064	7,816	8,271
1992	6,670	7,536	11,367	11,477	28,251	19,058	12,909	8,913	14,286	16,461	9,277	8,058
Average	9,987	10,100	13,796	14,822	15,915	14,651	11,028	8,489	12,817	13,581	8,033	7,500

Difference (Run 413- Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0	-69	-413	324	0	1,382	10	-5	9	947	20	248
1929	0	0	-1,041	0	0	1,417	3	2	4	451	-9	142
1931	0	-946	606	0	0	1	3	5	8	1,550	487	0
1933	0	0	0	0	0	0	497	7	-825	-130	-199	-202
1934	0	0	0	0	0	6	-4	-243	-951	-191	0	-593
1976	561	0	0	0	0	0	-3	-2	-449	-68	0	0
1977	0	-20	-3,291	3,157	0	777	136	0	0	0	0	0
1988	741	0	0	0	7	262	4	8	1	-1,975	-126	-372
1990	0	0	214	0	-2	0	2	13	23	1,159	356	4
1991	0	584	255	149	155	0	0	-534	-1,347	253	2,188	71
1992	0	149	72	0	0	0	165	-1	-499	-531	-84	-293
Average	118	-27	-327	330	15	350	74	-68	-366	133	239	-90

Percent Difference [(Run 413-420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0%	-1%	-2%	2%	0%	9.5%	0%	0%	0%	6%	0%	3%
1929	0%	0%	-7%	0%	0%	11%	0%	0%	0%	3%	0%	2%
1931	0%	-11%	6%	0%	0%	0%	0%	0%	0%	14%	9%	0%
1933	0%	0%	0%	0%	0%	0%	4%	0%	-6%	-1%	-3%	-3%
1934	0%	0%	0%	0%	0%	0%	0%	-3%	-7%	-2%	0%	-8%
1976	2%	0%	0%	0%	0%	0%	0%	0%	-3%	-1%	0%	0%
1977	0%	0%	-19%	24%	0%	8%	2%	0%	0%	0%	0%	0%
1988	7%	0%	0%	0%	0%	2%	0%	0%	0%	-13%	-1%	-5%
1990	0%	0%	2%	0%	0%	0%	0%	0%	0%	7%	3%	0%
1991	0%	7%	2%	1%	1%	0%	0%	-7%	-9.7%	2%	28%	1%
1992	0%	2%	1%	0%	0%	0%	1%	0%	-3%	-3%	-1%	-4%
Average	1%	0%	-2%	3%	0%	3%	1%	-1%	-3%	1%	3%	-1%

71 Year Record-Dry Years
Sacramento River Flow at Freeport **River Flow (Regulated) (in CFS)**
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	12,686	10,532	11,812	10,687	37,188	18,965	22,118	13,005	16,325	19,830	14,996	10,971
1926	14,148	10,265	11,571	16,568	32,899	15,694	17,612	14,664	13,602	20,261	14,940	10,980
1930	12,624	11,262	14,735	21,393	15,973	28,809	12,692	11,733	13,474	15,483	10,476	8,828
1932	9,407	7,776	14,683	16,846	14,336	13,240	13,035	11,235	14,215	10,588	8,758	9,332
1939	24,402	17,721	14,446	13,544	12,882	12,852	12,873	10,842	13,834	19,821	13,774	10,421
1944	14,215	15,584	11,046	14,385	31,720	22,300	10,553	9,957	16,602	18,895	13,562	10,166
1947	12,325	11,377	15,258	15,927	19,573	20,090	13,650	10,914	13,314	22,128	16,731	11,008
1949	16,080	12,804	12,938	11,497	13,047	47,465	12,244	14,603	15,431	17,403	13,553	11,346
1955	10,702	17,256	25,052	20,129	16,735	10,906	8,689	10,562	16,455	22,556	15,455	13,774
1960	13,098	10,579	16,812	13,773	24,717	19,335	13,959	10,653	13,834	24,044	15,904	11,171
1961	12,243	12,411	17,270	11,510	31,471	18,815	13,232	11,015	13,664	24,166	16,049	10,436
1964	18,690	32,929	14,437	26,032	16,253	12,708	9,433	10,858	13,806	22,894	17,457	12,098
1981	17,237	14,220	16,221	25,220	28,023	32,372	14,642	10,826	13,594	19,735	13,699	10,096
1985	17,217	36,386	26,254	14,297	19,640	17,774	9,808	13,707	13,431	22,470	15,943	10,788
1987	10,657	12,390	9,415	12,798	19,140	32,321	13,500	11,405	13,578	21,171	15,740	10,230
1989	6,835	9,916	11,251	12,925	13,893	39,159	22,181	14,719	13,399	23,678	16,662	10,467
Average	13,910	15,213	15,200	16,096	21,718	22,675	13,764	11,919	14,285	20,320	14,606	10,757

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	12,686	10,532	11,812	10,687	37,188	18,965	22,118	13,005	16,309	19,450	14,920	10,930
1926	14,148	10,265	11,407	16,568	32,899	14,941	17,612	14,653	13,588	19,709	14,863	10,936
1930	12,624	11,256	14,735	21,393	15,973	28,809	12,564	11,730	13,470	15,858	10,587	8,828
1932	9,407	7,776	14,683	16,846	14,336	12,322	13,035	11,235	14,185	10,558	8,728	9,332
1939	24,402	17,721	14,446	13,544	12,882	12,852	12,873	10,842	13,834	19,821	13,774	10,421
1944	14,215	15,584	11,046	14,385	31,720	22,300	10,546	9,958	16,602	19,021	13,601	10,166
1947	12,325	11,377	15,258	15,493	19,573	20,090	13,645	10,910	13,305	20,884	17,306	10,872
1949	16,080	12,804	12,938	11,497	13,047	47,465	12,244	14,604	15,391	16,683	13,457	11,346
1955	10,702	17,256	25,052	20,129	18,051	10,906	8,689	10,562	16,434	20,916	19,191	15,691
1960	13,098	11,875	17,937	12,450	24,717	19,170	13,952	10,647	13,819	21,079	18,680	11,091
1961	12,243	12,411	17,270	11,510	31,471	18,815	13,043	11,009	13,650	21,338	18,811	10,436
1964	18,690	33,098	14,437	26,032	16,251	12,710	9,429	10,855	13,805	20,876	19,136	12,027
1981	17,237	14,220	16,221	25,220	28,023	32,372	14,642	10,826	13,594	19,735	13,699	10,096
1985	17,217	36,386	26,254	14,297	19,640	17,774	9,808	13,707	13,426	20,922	17,676	10,788
1987	10,657	12,390	9,415	12,798	19,140	32,430	13,220	11,400	13,571	21,154	15,736	10,231
1989	6,667	9,789	11,251	12,925	13,885	39,159	22,181	14,564	13,388	21,624	18,838	10,467
Average	13,900	15,296	15,260	15,986	21,800	22,568	13,725	11,907	14,273	19,351	15,563	10,854

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0	0	0	0	0	0	0	0	16	380	76	41
1926	0	0	164	0	0	753	0	11	14	552	77	44
1930	0	6	0	0	0	0	128	3	4	-375	-111	0
1932	0	0	0	0	0	918	0	0	30	30	30	0
1939	0	0	0	0	0	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	7	-1	0	-126	-39	0
1947	0	0	0	434	0	0	5	4	9	1,244	-575	136
1949	0	0	0	0	0	0	0	-1	40	740	96	0
1955	0	0	0	0	-1,316	0	0	0	21	1,640	-3,736	-1,917
1960	0	-1,296	-1,125	1,323	0	165	7	6	15	2,965	-2,776	80
1961	0	0	0	0	0	0	189	6	14	2,828	-2,762	0
1964	0	-169	0	0	2	-2	4	3	1	2,018	-1,679	71
1981	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	5	1,548	-1,733	0
1987	0	0	0	0	0	-109	280	5	7	17	4	-1
1989	168	127	0	0	8	0	0	155	11	2,054	-2,176	0
Average	11	-83	-60	110	-82	108	39	12	12	970	-957	-97

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	1%	0%
1926	0%	0%	1%	0%	0%	5%	0%	0%	0%	3%	1%	0%
1930	0%	0%	0%	0%	0%	0%	1%	0%	0%	-2%	-1%	0%
1932	0%	0%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%
1939	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1944	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%
1947	0%	0%	0%	3%	0%	0%	0%	0%	0%	6%	-3%	1%
1949	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	1%	0%
1955	0%	0%	0%	0%	-7%	0%	0%	0%	0%	8%	-19%	-12%
1960	0%	-11%	-6%	11%	0%	1%	0%	0%	0%	14%	-15%	1%
1961	0%	0%	0%	0%	0%	0%	1%	0%	0%	13%	-15%	0%
1964	0%	-1%	0%	0%	0%	0%	0%	0%	0%	9.7%	-9%	1%
1981	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1985	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	-9.8%	0%
1987	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%
1989	3%	1%	0%	0%	0%	0%	0%	1%	0%	9%	-12%	0%
Average	0%	-1%	0%	1%	0%	1%	0%	0%	0%	5%	-5%	-1%

71 Year Record-Below Normal Years
Sacramento River Flow at Freeport — River Flow (Regulated) (in CFS)
Existing Demand Level
Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	21,689	20,158	32,529	29,936	21,585	11,505	22,537	14,306	15,942	19,571	16,109	10,338
1935	7,074	11,460	11,884	25,114	14,471	22,470	20,470	32,262	16,670	18,370	14,092	9,196
1936	11,247	11,025	14,782	28,507	36,952	32,704	19,175	13,395	15,772	17,034	12,820	9,463
1937	10,536	10,518	14,471	13,204	32,730	38,638	20,992	14,379	16,500	14,451	11,470	9,228
1945	13,903	13,839	16,255	13,074	43,723	26,866	11,823	12,450	18,571	15,337	12,796	9,840
1946	13,113	19,518	59,163	42,827	25,203	20,884	12,043	14,192	17,460	17,840	14,248	10,412
1948	13,447	11,730	13,111	15,865	16,525	14,623	21,906	30,518	20,583	27,242	18,015	13,541
1950	12,090	10,897	12,190	19,664	33,851	21,344	17,676	14,468	17,616	22,451	17,450	11,358
1959	22,814	17,188	12,563	37,039	50,709	20,343	10,513	10,863	14,473	20,516	14,138	11,398
1962	11,720	10,614	16,264	12,136	41,752	24,120	11,406	15,093	14,989	24,093	15,763	11,470
1966	15,676	25,948	16,039	28,914	26,032	26,551	13,059	15,049	14,462	21,090	16,932	11,341
1968	23,545	17,983	16,175	28,229	61,379	34,431	12,167	10,611	14,462	19,933	13,287	11,369
1972	19,184	17,026	22,744	18,238	25,328	32,275	11,538	10,602	14,224	23,035	15,582	10,182
1979	18,421	15,858	10,623	25,053	40,292	30,623	16,639	15,506	20,505	15,470	12,224	9,952
Average	**15,319**	**15,269**	**19,200**	**24,129**	**33,609**	**25,527**	**15,853**	**15,978**	**16,588**	**19,745**	**14,638**	**10,649**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	21,687	20,158	32,529	29,936	19,727	13,182	22,537	14,306	15,897	21,307	16,620	10,610
1935	7,074	11,460	11,884	25,114	14,471	22,470	20,470	32,262	16,656	21,004	14,897	9,196
1936	11,247	11,025	11,605	28,507	36,952	32,690	19,175	13,395	15,767	20,703	13,978	9,463
1937	10,536	10,518	15,921	13,204	32,730	36,627	20,992	13,524	17,232	14,543	11,655	9,228
1945	13,903	13,839	16,255	13,074	43,548	26,866	11,823	12,450	18,572	15,337	12,796	9,840
1946	13,113	19,518	59,162	42,827	25,203	20,884	12,043	14,193	17,461	19,558	14,737	10,412
1948	13,447	12,134	13,020	15,865	16,529	14,623	21,906	30,518	20,583	21,528	19,409	17,567
1950	12,090	10,897	11,197	19,664	33,851	21,344	17,676	14,424	17,592	21,555	19,716	11,609
1959	22,814	17,188	12,563	37,039	50,709	20,343	10,513	10,863	14,473	20,516	14,138	11,398
1962	11,720	10,614	16,264	12,028	41,752	24,120	11,336	15,085	14,981	21,488	16,504	11,470
1966	15,676	25,948	15,454	28,149	26,032	26,551	13,059	15,049	14,468	21,084	16,932	11,341
1968	23,545	17,983	16,175	28,229	61,379	34,431	12,167	10,611	14,462	19,933	13,287	11,369
1972	19,184	16,681	22,744	18,238	25,328	32,275	11,631	10,602	14,226	20,971	17,713	10,182
1979	18,421	15,858	10,623	25,053	40,292	30,623	16,639	15,506	20,505	15,470	12,224	9,952
Average	**15,318**	**15,273**	**18,957**	**24,066**	**33,465**	**25,502**	**15,855**	**15,913**	**16,634**	**19,643**	**15,329**	**10,974**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	2	0	0	0	1,858	-1,677	0	0	45	-1,736	-511	-272
1935	0	0	0	0	0	0	0	0	14	-2,634	-805	0
1936	0	0	3,177	0	0	14	0	0	5	-3,669	-1,158	0
1937	0	0	-1,450	0	0	2,011	0	855	-732	-92	-185	0
1945	0	0	0	0	175	0	0	0	-1	0	0	0
1946	0	0	1	0	0	0	0	-1	-1	-1,718	-489	0
1948	0	-404	91	0	-4	0	0	0	0	5,714	-1,394	-4,026
1950	0	0	993	0	0	0	0	44	24	896	-2,266	-251
1959	0	0	0	0	0	0	0	0	0	0	0	0
1962	0	0	0	108	0	0	70	8	8	2,605	-741	0
1966	0	0	585	765	0	0	0	0	-6	6	0	0
1968	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	345	0	0	0	0	-93	0	-2	2,064	-2,131	0
1979	0	0	0	0	0	0	0	0	0	0	0	0
Average	**0**	**-4**	**243**	**62**	**145**	**25**	**-2**	**65**	**-46**	**103**	**-691**	**-325**

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0%	0%	0%	0%	9%	-13%	0%	0%	0%	-8%	-3%	-3%
1935	0%	0%	0%	0%	0%	0%	0%	0%	0%	-13%	-5%	0%
1936	0%	0%	27%	0%	0%	0%	0%	0%	0%	-18%	-8%	0%
1937	0%	0%	-9%	0%	0%	5%	0%	6%	-4%	-1%	-2%	0%
1945	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1946	0%	0%	0%	0%	0%	0%	0%	0%	0%	-9%	-3%	0%
1948	0%	-3%	1%	0%	0%	0%	0%	0%	0%	27%	-7%	-23%
1950	0%	0%	9%	0%	0%	0%	0%	0%	0%	4%	-11%	-2%
1959	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1962	0%	0%	0%	1%	0%	0%	1%	0%	0%	12%	-4%	0%
1966	0%	0%	4%	3%	0%	0%	0%	0%	0%	0%	0%	0%
1968	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1972	0%	2%	0%	0%	0%	0%	-1%	0%	0%	9.8%	-12%	0%
1979	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Average	**0%**	**0%**	**2%**	**0%**	**1%**	**-1%**	**0%**	**0%**	**0%**	**0%**	**-4%**	**-2%**

71 Year Record-Above Normal Years
Sacramento River Flow at Freeport
Existing Demand Level

River Flow (Regulated) (in CFS)

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	10,067	10,243	15,447	16,764	35,899	29,686	21,029	46,055	33,543	13,543	10,526	10,088
1928	14,214	28,828	15,226	24,291	26,608	88,293	27,042	17,295	15,793	21,680	15,566	11,016
1940	12,608	11,135	12,557	23,855	43,837	65,427	39,755	17,417	15,475	17,925	14,161	10,027
1951	15,613	42,431	58,852	58,194	60,212	29,014	14,312	18,263	15,375	23,151	15,765	11,393
1954	21,230	24,743	15,833	32,831	57,774	47,537	41,007	21,644	15,527	22,632	15,811	11,413
1957	22,643	16,316	11,897	15,674	38,076	42,687	17,520	15,063	16,803	23,051	18,641	10,781
1973	15,083	22,326	27,289	48,322	71,664	45,792	16,912	17,832	19,435	18,248	14,285	11,294
1978	6,628	7,065	15,429	44,882	50,421	49,008	37,669	19,631	14,216	12,930	10,740	13,677
1980	10,573	18,369	19,763	70,182	69,056	35,876	16,642	13,875	12,244	12,732	10,987	14,383
Average	**14,295**	**20,162**	**21,366**	**37,222**	**50,394**	**48,147**	**25,765**	**20,786**	**17,601**	**18,432**	**14,054**	**11,564**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	10,067	10,243	15,447	16,764	35,899	29,686	21,029	46,055	33,543	13,544	10,526	10,088
1928	14,214	28,841	15,226	24,291	26,608	88,293	27,042	17,296	15,794	21,892	15,633	11,016
1940	12,608	11,143	12,550	23,855	43,836	65,427	39,755	17,338	15,474	23,055	16,571	10,590
1951	15,613	42,431	58,342	58,194	60,212	29,014	14,312	18,263	15,372	23,122	15,765	11,393
1954	21,230	24,743	15,833	32,831	57,774	47,537	41,007	21,645	15,528	23,118	15,910	11,413
1957	22,523	16,316	11,897	15,674	38,076	42,687	17,521	15,063	16,798	23,058	18,641	10,781
1973	15,083	22,326	27,289	48,158	71,664	45,792	16,912	17,832	19,435	18,248	14,285	11,294
1978	6,628	7,065	15,429	44,882	50,421	49,253	37,669	19,631	14,216	12,930	10,740	13,677
1980	10,573	18,369	19,763	70,182	69,056	35,876	16,642	13,875	12,244	12,732	10,987	14,383
Average	**14,282**	**20,164**	**21,308**	**37,203**	**50,394**	**48,174**	**25,765**	**20,778**	**17,600**	**19,078**	**14,340**	**11,626**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0	0	0	0	0	0	0	0	0	-1	0	0
1928	0	-13	0	0	0	0	0	-1	-1	-212	-67	0
1940	0	-8	7	0	1	0	0	79	1	-5,130	-2,410	-563
1951	0	0	510	0	0	0	0	0	3	29	0	0
1954	0	0	0	0	0	0	0	-1	-1	-486	-99	0
1957	120	0	0	0	0	0	-1	0	5	-7	0	0
1973	0	0	0	164	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	-245	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0
Average	**13**	**-2**	**57**	**18**	**0**	**-27**	**0**	**9**	**1**	**-645**	**-286**	**-63**

Percent Difference [(Run 413 - Run 420)/Run 420] 100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1928	0%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%
1940	0%	0%	0%	0%	0%	0%	0%	0%	0%	-22%	-15%	-5%
1951	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1954	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%	-1%	0%
1957	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1973	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1978	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1980	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Average	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**-3%**	**-2%**	**-1%**

71 Year Record-Wet Years
Sacramento River Flow at Freeport River Flow (Regulated) (in CFS)
Existing Demand Level
Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	13,321	20,705	15,101	31,202	71,075	39,061	45,968	24,267	15,671	15,798	13,444	9,497
1938	10,268	35,878	58,222	30,781	81,652	77,641	46,028	54,986	32,939	13,527	11,241	17,630
1941	11,504	12,112	35,706	72,609	74,485	57,181	42,229	39,466	19,539	13,195	10,954	14,726
1942	22,317	21,116	65,494	63,181	79,077	23,987	44,096	36,372	26,443	13,144	11,006	14,557
1943	22,294	23,628	30,088	57,144	51,816	63,524	27,911	17,904	14,569	16,028	12,758	9,446
1952	13,817	16,464	48,658	66,163	64,256	56,067	57,566	60,752	38,553	17,255	12,128	20,134
1953	23,364	17,513	43,756	64,069	26,157	21,585	18,213	25,631	26,975	17,387	12,056	15,024
1956	10,107	12,471	31,018	79,318	68,673	34,601	18,590	41,361	21,943	15,150	14,984	16,677
1958	19,921	18,688	26,186	36,378	65,082	93,877	52,539	41,227	35,563	15,547	13,305	19,998
1963	28,838	20,913	27,934	15,997	52,278	30,283	68,830	29,281	15,882	17,220	14,339	14,097
1965	10,276	14,655	36,095	79,759	32,996	20,149	45,006	24,411	15,194	19,598	13,186	10,239
1967	12,728	14,560	40,010	36,521	42,876	52,468	38,491	45,174	40,192	15,166	12,454	19,477
1969	14,045	12,392	22,577	74,171	67,092	43,847	43,156	44,408	24,949	12,586	11,400	23,591
1970	21,824	18,757	51,680	91,518	56,216	33,273	13,136	10,289	14,742	19,845	13,638	10,670
1971	13,738	22,362	60,628	47,446	28,664	50,667	19,323	31,190	22,755	18,067	15,329	16,673
1974	15,380	58,950	60,495	78,775	42,015	97,768	36,823	24,438	21,148	16,585	13,532	22,138
1975	22,708	17,805	17,880	16,032	61,624	74,092	21,533	32,214	24,876	15,577	14,825	18,106
1982	12,930	33,656	71,411	53,074	70,537	62,008	78,803	35,744	22,540	15,018	13,803	23,120
1983	29,962	40,150	58,263	57,238	82,606	87,187	64,475	56,196	51,139	23,362	15,542	24,375
1984	27,488	64,594	85,103	45,529	38,969	33,026	14,103	12,536	15,388	18,316	13,131	15,630
1986	12,832	10,949	16,573	18,731	106,923	67,673	19,089	11,015	12,420	14,573	12,310	10,851
Average	**17,603**	**24,206**	**42,994**	**53,126**	**60,241**	**53,332**	**38,853**	**33,279**	**24,449**	**16,331**	**13,113**	**16,507**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	13,321	20,705	15,101	31,202	71,075	41,158	45,968	24,267	15,662	15,796	13,441	9,497
1938	10,268	33,176	56,500	30,781	81,652	77,641	46,028	54,986	32,939	13,527	11,241	17,630
1941	11,504	12,912	31,724	67,833	74,485	57,181	42,229	39,466	19,539	13,195	10,954	14,726
1942	22,317	21,116	65,494	63,181	79,077	23,987	44,096	36,372	26,443	13,144	11,006	14,557
1943	22,294	23,628	30,088	57,144	51,816	63,524	27,911	17,904	14,569	16,028	12,758	9,446
1952	13,817	16,464	48,690	66,163	64,256	56,067	57,566	60,752	38,553	17,255	12,128	20,134
1953	23,364	17,513	43,756	64,069	26,157	21,585	18,213	25,631	26,975	17,387	12,056	15,024
1956	10,107	12,471	30,797	73,853	68,673	34,601	18,590	41,361	21,943	15,234	15,020	16,677
1958	19,921	18,688	26,186	36,378	65,079	93,877	52,539	41,227	35,563	15,547	13,305	19,998
1963	28,838	20,913	27,934	15,997	54,175	30,283	68,830	29,281	15,896	17,042	14,339	14,097
1965	10,276	15,456	35,730	79,759	32,996	20,154	45,001	24,412	15,196	20,740	13,396	10,239
1967	12,728	15,346	40,010	35,761	42,876	52,468	38,491	45,174	40,192	15,166	12,454	19,477
1969	14,045	13,188	22,577	73,400	67,092	43,847	43,156	44,408	24,949	12,586	11,400	23,591
1970	21,824	18,757	51,680	91,518	56,216	33,273	13,136	10,289	14,742	19,845	13,638	10,670
1971	13,738	22,362	60,628	47,446	28,664	50,667	19,323	31,190	22,755	18,402	15,329	16,673
1974	15,380	58,950	60,495	78,775	42,015	97,768	36,823	24,438	21,148	16,585	13,532	22,138
1975	22,708	17,805	17,880	16,032	61,624	74,092	21,533	32,214	24,876	16,297	14,669	18,106
1982	12,930	33,656	71,411	53,074	70,537	62,008	78,803	35,744	22,540	15,018	13,803	23,120
1983	29,962	40,150	58,263	57,238	82,606	87,187	64,475	56,196	51,139	23,362	15,542	24,375
1984	27,488	64,594	85,103	45,529	38,969	33,026	14,103	12,536	15,388	18,316	13,131	15,630
1986	12,832	11,734	15,273	18,731	107,317	67,673	19,089	11,015	12,410	14,497	12,286	10,851
Average	**17,603**	**24,266**	**42,634**	**52,565**	**60,350**	**53,432**	**38,853**	**33,279**	**24,448**	**16,427**	**13,116**	**16,507**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0	0	0	0	0	-2,097	0	0	9	2	3	0
1938	0	2,702	1,722	0	0	0	0	0	0	0	0	0
1941	0	-800	3,982	4,776	0	0	0	0	0	0	0	0
1942	0	0	0	0	0	0	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	-32	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	221	5,465	0	0	0	0	0	-84	-36	0
1958	0	0	0	0	3	0	0	0	0	0	0	0
1963	0	0	0	0	-1,897	0	0	0	-14	178	0	0
1965	0	-801	365	0	0	-5	5	-1	-2	-1,142	-210	0
1967	0	-786	0	760	0	0	0	0	0	0	0	0
1969	0	-796	0	771	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	-335	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	-720	156	0
1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	-785	1,300	0	-394	0	0	0	10	76	24	0
Average	**0**	**-60**	**360**	**561**	**-109**	**-100**	**0**	**0**	**0**	**-96**	**-3**	**0**

71 Year Record-Wet Years
Sacramento River Flow at Freeport River Flow (Regulated) (In CFS)
Existing Demand Level

Percent Difference [(Run 413 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0%	0%	0%	0%	0%	-5%	0%	0%	0%	0%	0%	0%
1938	0%	8%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1941	0%	-6%	13%	7%	0%	0%	0%	0%	0%	0%	0%	0%
1942	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1943	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1952	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1953	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1956	0%	0%	1%	7%	0%	0%	0%	0%	0%	-1%	0%	0%
1958	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1963	0%	0%	0%	0%	-4%	0%	0%	0%	0%	1%	0%	0%
1965	0%	-5%	1%	0%	0%	0%	0%	0%	0%	-6%	-2%	0%
1967	0%	-5%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%
1969	0%	-6%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
1970	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1971	0%	0%	0%	0%	0%	0%	0%	0%	0%	-2%	0%	0%
1974	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1975	0%	0%	0%	0%	0%	0%	0%	0%	0%	-4%	1%	0%
1982	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1983	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1984	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1986	0%	-7%	9%	0%	0%	0%	0%	0%	0%	1%	0%	0%
Average	0%	-1%	1%	1%	0%	0%	0%	0%	0%	-1%	0%	0%

71 Year Record-Critical Years
Sacramento River Flow at Freeport
Future Demand Level

River Flow (Regulated) (in cubic feet per second)

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	9,510	11,636	18,088	12,726	15,862	13,642	7,778	8,841	10,349	11,320	6,817	6,454
1929	9,743	12,406	14,923	12,502	15,591	12,113	9,068	9,842	14,259	16,508	7,037	7,580
1931	8,185	7,636	15,095	12,632	11,198	9,924	10,143	7,064	10,133	10,372	5,292	7,021
1933	8,382	7,253	8,958	13,717	12,233	10,944	12,818	8,426	14,407	14,105	6,878	7,597
1934	7,562	7,048	13,925	15,374	11,792	17,317	13,361	8,943	13,593	12,008	6,300	7,219
1976	22,110	18,406	15,596	13,446	19,262	13,542	9,868	10,222	14,799	19,106	8,629	7,477
1977	8,003	9,611	17,557	8,410	13,342	10,516	9,022	6,291	7,076	9,088	6,155	6,553
1988	7,431	9,891	16,332	25,252	13,580	12,273	8,943	8,685	13,436	17,353	7,431	6,861
1990	9,096	8,075	16,484	17,804	15,016	10,596	12,590	7,875	14,709	18,709	7,400	7,000
1991	6,573	8,643	11,971	11,085	13,898	28,715	13,997	8,019	14,026	13,636	7,961	9,205
1992	6,766	7,295	8,768	11,245	28,984	18,667	12,853	8,976	14,410	13,873	7,172	7,295
Average	9,396	9,809	14,336	14,018	15,523	14,386	10,949	8,471	12,836	14,189	7,007	7,297

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	9,510	12,169	16,606	12,726	15,862	13,635	7,778	8,852	10,357	11,330	6,816	6,454
1929	9,743	12,406	12,897	12,502	15,591	12,001	9,063	9,836	14,247	16,589	6,936	6,808
1931	8,185	7,976	16,874	12,632	11,198	9,900	10,143	7,055	9,065	9,049	5,292	6,298
1933	8,382	7,223	8,958	13,717	12,233	10,944	12,816	8,424	14,405	15,536	5,959	6,395
1934	7,562	6,606	13,925	15,374	11,792	17,316	13,361	8,935	14,606	13,121	6,300	6,431
1976	22,110	18,406	13,996	13,446	19,262	13,542	9,873	10,217	14,792	20,858	7,756	7,477
1977	8,003	10,828	17,726	8,289	13,146	9,863	8,961	6,291	7,076	9,088	6,155	6,553
1988	7,431	9,861	16,332	25,252	13,580	11,987	8,943	9,559	14,338	18,813	7,431	6,861
1990	9,096	8,075	17,618	17,804	15,023	10,378	12,586	7,866	14,687	18,606	7,400	6,845
1991	6,513	7,058	11,576	10,938	13,745	28,715	13,997	8,016	14,023	14,693	7,387	7,941
1992	6,766	7,193	8,396	11,245	28,984	18,667	12,853	8,969	14,397	13,746	7,172	6,992
Average	9,391	9,800	14,082	13,993	15,492	14,268	10,943	8,547	12,908	14,675	6,782	6,823

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0	-533	1,482	0	0	7	0	-11	-8	-10	1	0
1929	0	0	2,026	0	0	112	5	6	12	-81	101	772
1931	0	-340	-1,779	0	0	24	0	9	1,068	1,323	0	723
1933	0	30	0	0	0	0	2	2	2	-1,431	919	1,202
1934	0	442	0	0	0	1	0	8	-1,013	-1,113	0	788
1976	0	0	1,600	0	0	0	-5	5	7	-1,752	873	0
1977	0	-1,217	-169	121	196	653	61	0	0	0	0	0
1988	0	30	0	0	0	286	0	-874	-902	-1,460	0	0
1990	0	0	-1,134	0	-7	218	4	9	22	103	0	155
1991	60	1,585	395	147	153	0	0	3	3	-1,057	574	1,264
1992	0	102	372	0	0	0	0	7	13	127	0	303
Average	5	9	254	24	31	118	6	-76	-72	-486	224	473

Percent Difference [(Run 414-411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0%	-4%	9%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1929	0%	0%	16%	0%	0%	1%	0%	0%	0%	0%	1%	11%
1931	0%	-4%	-11%	0%	0%	0%	0%	0%	12%	15%	0%	11%
1933	0%	0%	0%	0%	0%	0%	0%	0%	0%	-9%	15%	19%
1934	0%	7%	0%	0%	0%	0%	0%	0%	-7%	-8%	0%	12%
1976	0%	0%	11%	0%	0%	0%	0%	0%	0%	-8%	11%	0%
1977	0%	-11%	-1%	1%	1%	7%	1%	0%	0%	0%	0%	0%
1988	0%	0%	0%	0%	0%	2%	0%	-9%	-6%	-8%	0%	0%
1990	0%	0%	-6%	0%	0%	2%	0%	0%	0%	1%	0%	2%
1991	1%	22%	3%	1%	1%	0%	0%	0%	0%	-7%	8%	16%
1992	0%	1%	4%	0%	0%	0%	0%	0%	0%	1%	0%	4%
Average	0%	1%	2%	0%	0%	1%	0%	-1%	0%	-2%	3%	7%

71 Year Record-Dry Years
Sacramento River Flow at Freeport
Future Demand Level

River Flow (Regulated) (in cubic feet per second)

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	11,454	10,356	11,549	10,566	35,805	18,119	22,358	13,040	16,652	17,352	12,692	10,328
1926	10,803	10,213	11,741	15,963	31,874	16,879	18,130	14,821	13,996	20,363	16,763	14,154
1930	12,038	10,358	15,439	21,647	16,101	28,037	12,692	11,824	13,908	14,272	10,117	8,662
1932	8,869	7,774	14,039	15,763	13,175	12,517	12,980	10,558	14,011	11,845	8,853	9,400
1939	21,674	17,738	14,674	13,837	13,130	12,826	12,707	10,876	13,970	21,405	18,696	12,177
1944	11,315	13,965	18,807	14,827	26,089	19,995	9,837	9,877	16,955	19,651	18,386	9,965
1947	10,829	11,433	15,335	16,153	19,837	19,663	13,517	10,935	13,645	19,827	18,898	10,312
1949	13,463	12,508	13,604	11,770	13,321	48,044	12,279	14,624	15,204	17,473	10,604	10,506
1955	10,721	15,312	25,199	19,380	18,100	10,160	9,006	10,685	16,674	20,386	19,927	10,994
1960	11,160	12,004	14,086	12,957	25,262	18,516	13,765	10,697	13,888	24,128	16,368	13,796
1961	9,910	12,729	17,269	11,770	26,845	19,139	13,083	10,957	13,987	18,644	18,162	8,798
1964	18,308	30,020	14,767	23,337	16,453	11,532	9,230	10,829	14,150	21,099	17,633	12,121
1981	16,284	13,556	15,486	20,046	26,240	29,933	13,315	10,889	13,953	21,961	18,744	13,829
1985	16,485	33,060	26,417	13,574	16,434	12,832	10,570	13,769	13,781	24,111	16,221	15,046
1987	10,474	9,199	15,754	16,266	18,456	27,332	13,895	11,400	13,904	19,902	11,446	8,618
1989	6,167	9,636	10,931	13,064	13,781	39,108	22,385	14,689	13,824	19,720	16,429	10,705
Average	12,497	14,366	15,944	15,683	20,681	21,540	13,734	11,904	14,531	19,509	15,621	11,213

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	11,454	10,356	11,549	10,566	35,805	18,119	22,358	13,040	16,717	19,890	11,393	10,328
1926	10,803	10,213	11,614	15,963	31,874	16,163	18,130	14,821	13,992	21,189	19,149	13,849
1930	12,038	9,479	15,439	21,647	16,101	28,037	12,587	11,813	13,902	17,903	9,178	8,662
1932	8,869	7,774	14,039	15,763	13,175	12,344	12,975	10,558	13,995	11,828	8,837	9,400
1939	20,306	17,738	14,674	13,837	13,130	12,826	12,703	10,873	13,964	20,951	18,950	11,092
1944	11,315	14,755	15,519	14,827	26,089	19,995	10,968	9,871	16,947	20,889	15,938	9,965
1947	10,829	11,433	15,335	14,442	19,837	19,663	13,518	10,935	13,642	20,940	18,308	10,312
1949	13,463	13,306	13,604	11,770	13,321	48,044	12,279	14,626	15,711	20,322	10,595	10,506
1955	10,721	15,312	25,199	19,380	18,084	10,170	9,006	10,685	16,656	20,967	18,885	10,994
1960	11,160	11,996	13,504	12,957	25,262	18,516	13,761	10,695	13,872	21,398	19,120	13,796
1961	9,910	12,729	17,269	11,770	26,845	19,139	12,926	10,957	13,981	21,340	16,433	8,798
1964	18,308	30,020	14,767	23,337	16,453	11,544	9,219	10,818	14,139	20,905	19,042	12,119
1981	16,284	13,556	15,486	20,046	26,240	27,562	13,315	10,881	13,937	20,933	19,004	12,441
1985	16,485	33,060	26,417	13,574	16,434	12,825	10,559	13,759	13,767	20,983	19,092	13,887
1987	10,474	9,693	13,944	15,580	18,456	27,332	13,892	11,398	13,890	18,717	11,446	8,618
1989	6,167	9,636	10,931	13,064	13,781	38,958	22,385	14,548	13,824	21,915	19,303	10,705
Average	12,412	14,441	15,581	15,533	20,680	21,327	13,786	11,892	14,559	20,067	15,917	10,967

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0	0	0	0	0	0	0	0	-65	-2,538	1,299	0
1926	0	0	127	0	0	716	0	0	4	-826	-2,386	305
1930	0	879	0	0	0	0	105	11	6	-3,631	939	0
1932	0	0	0	0	0	173	5	0	16	17	16	0
1939	1,368	0	0	0	0	0	4	3	6	454	-254	1,085
1944	0	-790	3,288	0	0	0	-1,131	6	8	-1,238	2,448	0
1947	0	0	0	1,711	0	0	-1	0	3	-1,113	590	0
1949	0	-798	0	0	0	0	0	-2	-507	-2,849	9	0
1955	0	0	0	0	16	-10	0	0	18	-581	1,042	0
1960	0	8	582	0	0	0	4	2	16	2,730	-2,752	0
1961	0	0	0	0	0	0	157	0	6	-2,696	1,729	0
1964	0	0	0	0	0	-12	11	11	11	194	-1,409	2
1981	0	0	0	0	0	2,371	0	8	16	1,028	-260	1,388
1985	0	0	0	0	0	7	11	10	14	3,128	-2,871	1,159
1987	0	-494	1,810	686	0	0	3	2	14	1,185	0	0
1989	0	0	0	0	0	150	0	141	0	-2,195	-2,874	0
Average	86	-75	363	150	1	212	-52	12	-27	-558	-296	246

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0%	0%	0%	0%	0%	0%	0%	0%	0%	-13%	11%	0%
1926	0%	0%	1%	0%	0%	4%	0%	0%	0%	-4%	-12%	2%
1930	0%	9%	0%	0%	0%	0%	1%	0%	0%	-20%	10.2%	0%
1932	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
1939	7%	0%	0%	0%	0%	0%	0%	0%	0%	2%	-1%	9.8%
1944	0%	-5%	21%	0%	0%	0%	-10.3%	0%	0%	-6%	15%	0%
1947	0%	0%	0%	12%	0%	0%	0%	0%	0%	-5%	3%	0%
1949	0%	-6%	0%	0%	0%	0%	0%	0%	-3%	-14%	0%	0%
1955	0%	0%	0%	0%	0%	0%	0%	0%	0%	-3%	6%	0%
1960	0%	0%	4%	0%	0%	0%	0%	0%	0%	13%	-14%	0%
1961	0%	0%	0%	0%	0%	0%	1%	0%	0%	-13%	11%	0%
1964	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	-7%	0%
1981	0%	0%	0%	0%	0%	9%	0%	0%	0%	5%	-1%	11%
1985	0%	0%	0%	0%	0%	0%	0%	0%	0%	15%	-15%	8%
1987	0%	-5%	13%	4%	0%	0%	0%	0%	0%	6%	0%	0%
1989	0%	0%	0%	0%	0%	0%	0%	1%	0%	-10.0%	-15%	0%
Average	0%	0%	2%	1%	0%	1%	0%	0%	0%	-3%	-1%	2%

71 Year Record-Below Normal Years
Sacramento River Flow at Freeport
Future Demand Level

River Flow (Regulated) (in cubic feet per second)

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	15,252	20,019	31,950	30,033	24,748	13,619	22,245	14,035	16,321	19,871	15,800	14,273
1935	7,170	11,653	11,879	24,156	14,491	21,918	19,787	32,298	17,113	21,339	15,244	11,521
1936	11,327	11,185	12,476	28,879	36,136	31,662	19,550	13,364	16,157	23,219	15,469	13,116
1937	10,561	11,528	19,201	13,601	31,894	36,090	21,217	13,412	20,865	16,538	13,835	9,093
1945	11,913	14,510	16,104	12,951	37,521	22,185	12,832	12,494	18,839	19,430	12,500	9,311
1946	10,039	18,004	54,102	42,908	25,472	19,913	12,021	14,146	17,790	18,130	16,313	9,260
1948	13,715	11,900	13,238	16,070	16,597	14,201	21,002	29,475	20,196	27,330	19,005	15,449
1950	10,497	10,939	11,220	19,544	34,053	20,645	17,772	14,814	18,009	19,523	17,014	14,179
1959	21,474	17,123	12,709	37,852	51,015	21,875	10,334	10,935	14,882	21,859	18,826	13,760
1962	9,493	10,846	16,421	11,929	40,775	23,551	12,267	15,194	15,388	21,835	19,094	10,179
1966	13,420	25,919	15,637	27,368	26,193	23,984	13,282	15,141	14,873	23,507	20,928	13,006
1968	22,925	18,185	16,484	28,798	61,739	34,126	12,253	10,688	14,845	22,492	18,267	14,267
1972	15,886	16,071	19,171	17,465	25,598	32,241	11,782	10,685	14,618	24,328	17,752	14,482
1979	14,918	14,355	13,672	21,541	39,490	30,244	17,416	15,258	20,979	23,169	18,491	10,693
Average	**13,471**	**15,160**	**18,876**	**23,793**	**33,266**	**24,732**	**15,983**	**15,853**	**17,205**	**21,612**	**17,038**	**12,328**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	15,252	20,019	27,098	29,494	16,902	13,630	22,877	14,239	16,293	21,449	18,687	14,273
1935	7,072	11,653	11,879	24,156	14,491	21,918	19,787	32,296	17,099	21,569	18,962	11,049
1936	11,327	11,905	12,384	28,879	36,136	31,031	19,550	13,364	16,149	21,613	18,813	12,978
1937	10,561	11,528	10,884	13,601	31,894	36,090	21,217	13,412	20,846	21,306	11,682	8,834
1945	11,913	14,510	16,104	12,951	37,521	22,185	12,832	12,494	18,831	21,201	11,261	9,311
1946	10,039	18,004	55,486	42,908	25,115	20,235	12,021	14,142	17,778	21,568	14,894	9,260
1948	13,715	12,147	13,208	16,070	16,599	14,201	21,002	29,475	20,196	21,606	19,307	17,810
1950	10,497	10,939	11,220	19,544	34,053	20,645	17,772	14,736	18,003	21,642	19,603	14,179
1959	18,804	16,287	12,709	37,852	51,015	21,794	10,330	10,930	14,882	21,478	19,475	13,760
1962	9,493	11,366	16,421	11,930	40,775	23,551	12,267	15,184	15,371	21,589	17,570	10,179
1966	13,420	25,919	15,637	27,368	26,193	23,984	13,282	15,124	14,854	21,229	19,697	12,141
1968	22,925	18,185	16,484	28,798	61,739	34,126	12,246	10,681	14,840	21,293	18,760	13,747
1972	15,886	16,071	19,171	16,187	24,402	32,241	11,786	10,674	14,604	21,095	19,222	14,247
1979	14,918	14,355	12,967	21,541	39,437	30,244	17,416	15,258	20,958	21,535	19,127	9,882
Average	**13,273**	**15,206**	**17,975**	**23,663**	**32,591**	**24,705**	**16,028**	**15,858**	**17,193**	**21,441**	**17,647**	**12,261**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0	0	4,852	539	7,846	-11	-632	-204	28	-1,578	-2,887	0
1935	98	0	0	0	0	0	0	2	14	-230	-3,718	472
1936	0	-720	92	0	0	631	0	0	8	1,606	-3,344	138
1937	0	0	8,317	0	0	0	0	0	19	-4,768	2,153	259
1945	0	0	0	0	0	0	0	0	8	-1,771	1,239	0
1946	0	0	-1,384	0	357	-322	0	4	12	-3,438	1,419	0
1948	0	-247	30	0	-2	0	0	0	0	5,724	-302	-2,361
1950	0	0	0	0	0	0	0	78	6	-2,119	-2,589	0
1959	2,670	836	0	0	0	81	4	5	0	381	-649	0
1962	0	-520	0	-1	0	0	0	10	17	246	1,524	0
1966	0	0	0	0	0	0	0	17	19	2,278	1,231	865
1968	0	0	0	0	0	0	7	7	5	1,199	-493	520
1972	0	0	0	1,278	1,196	0	-4	11	14	3,233	-1,470	235
1979	0	0	705	0	53	0	0	0	21	1,634	-636	811
Average	**198**	**-47**	**901**	**130**	**675**	**27**	**-45**	**-5**	**12**	**171**	**-609**	**67**

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0%	0%	18%	2%	46%	0%	-3%	-1%	0%	-7%	-15%	0%
1935	1%	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-20%	4%
1936	0%	-6%	1%	0%	0%	2%	0%	0%	0%	7%	-18%	1%
1937	0%	0%	76%	0%	0%	0%	0%	0%	0%	-22%	18%	3%
1945	0%	0%	0%	0%	0%	0%	0%	0%	0%	-8%	11%	0%
1946	0%	0%	-2%	0%	1%	-2%	0%	0%	0%	-16%	9.5%	0%
1948	0%	-2%	0%	0%	0%	0%	0%	0%	0%	26%	-2%	-13%
1950	0%	0%	0%	0%	0%	0%	0%	1%	0%	-9.8%	-13%	0%
1959	14%	5%	0%	0%	0%	0%	0%	0%	0%	2%	-3%	0%
1962	0%	-5%	0%	0%	0%	0%	0%	0%	0%	1%	9%	0%
1966	0%	0%	0%	0%	0%	0%	0%	0%	0%	11%	6%	7%
1968	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	-3%	4%
1972	0%	0%	0%	8%	5%	0%	0%	0%	0%	15%	-8%	2%
1979	0%	0%	5%	0%	0%	0%	0%	0%	0%	8%	-3%	8%
Average	**1%**	**-1%**	**7%**	**1%**	**4%**	**0%**	**0%**	**0%**	**0%**	**1%**	**-2%**	**1%**

71 Year Record-Above Normal Years
Sacramento River Flow at Freeport . River Flow (Regulated) (in cubic feet per second)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	10,054	10,193	16,242	16,813	35,917	28,853	21,005	46,646	33,391	14,305	15,483	10,005
1928	11,084	24,637	15,535	23,088	24,166	85,048	27,234	17,494	16,115	19,201	21,584	8,956
1940	10,524	11,056	13,838	24,459	37,415	63,170	39,818	17,620	15,905	21,907	15,463	13,103
1951	13,395	40,542	68,521	58,162	60,320	28,035	14,379	19,122	15,733	26,003	17,761	16,003
1954	15,444	21,399	15,063	30,830	58,257	47,976	41,420	21,879	15,902	23,131	21,502	10,979
1957	19,283	16,251	10,675	15,256	38,724	42,980	17,945	15,170	17,126	26,673	17,529	15,842
1973	11,918	21,268	26,196	45,483	71,145	46,117	16,981	17,492	19,802	23,590	17,435	10,799
1978	6,603	7,400	15,068	45,086	50,511	43,913	38,263	19,124	14,132	16,169	15,221	10,643
1980	10,828	15,540	19,087	57,684	69,255	35,241	16,841	14,350	13,110	21,498	15,546	10,487
Average	12,126	18,698	22,247	35,207	49,523	46,815	25,987	20,989	17,913	21,386	17,503	11,869

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	10,054	10,193	16,242	16,813	35,917	28,853	21,005	46,646	33,391	21,205	14,000	10,005
1928	11,084	24,637	15,535	23,088	24,166	85,081	27,234	17,487	16,118	23,354	19,474	8,956
1940	10,524	11,052	13,685	24,459	37,415	64,591	39,818	17,488	15,893	23,348	19,630	12,460
1951	13,395	40,355	62,124	58,162	60,320	28,035	14,379	19,122	15,724	23,382	20,239	15,067
1954	15,444	21,399	15,063	27,841	58,257	47,976	41,420	21,871	15,895	23,288	20,381	10,561
1957	19,283	16,251	10,675	13,671	37,649	42,980	17,937	15,170	17,116	23,263	20,241	14,816
1973	11,918	21,268	26,196	46,836	71,862	46,117	16,981	17,492	19,787	23,018	18,708	10,799
1978	6,603	7,400	15,068	45,086	50,511	43,232	37,743	19,124	14,132	19,649	12,504	10,643
1980	10,828	15,540	19,087	59,482	69,255	35,241	16,841	14,350	13,106	21,238	18,617	10,487
Average	12,126	18,677	21,519	35,049	49,484	46,901	25,929	20,972	17,907	22,416	18,199	11,533

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0	0	0	0	0	0	0	0	0	-6,900	1,483	0
1928	0	0	0	0	0	-33	0	7	-3	-4,153	2,110	0
1940	0	4	153	0	0	-1,421	0	132	12	-1,441	-4,167	643
1951	0	187	6,397	0	0	0	0	0	9	2,621	-2,478	936
1954	0	0	0	2,989	0	0	0	8	7	-157	1,121	418
1957	0	0	0	1,585	1,075	0	8	0	10	3,410	-2,712	1,026
1973	0	0	0	-1,353	-717	0	0	0	15	572	-1,273	0
1978	0	0	0	0	0	681	520	0	0	-3,480	2,717	0
1980	0	0	0	-1,798	0	0	0	0	4	260	-3,071	0
Average	0	21	728	158	40	-86	59	16	6	-1,030	-697	336

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0%	0%	0%	0%	0%	0%	0%	0%	0%	-33%	11%	0%
1928	0%	0%	0%	0%	0%	0%	0%	0%	0%	-18%	11%	0%
1940	0%	0%	1%	0%	0%	-2%	0%	1%	0%	-6%	-21%	5%
1951	0%	0%	10.3%	0%	0%	0%	0%	0%	0%	11%	-12%	6%
1954	0%	0%	0%	11%	0%	0%	0%	0%	0%	-1%	6%	4%
1957	0%	0%	0%	12%	3%	0%	0%	0%	0%	15%	-13%	7%
1973	0%	0%	0%	-3%	-1%	0%	0%	0%	0%	2%	-7%	0%
1978	0%	0%	0%	0%	0%	2%	1%	0%	0%	-18%	22%	0%
1980	0%	0%	0%	-3%	0%	0%	0%	0%	0%	1%	-16%	0%
Average	0%	0%	1%	2%	0%	0%	0%	0%	0%	-5%	-2%	2%

71 Year Record-Wet Years
Sacramento River Flow at Freeport — River Flow (Regulated) (in cubic feet per second)
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	10,607	21,736	15,418	28,799	74,874	42,498	46,687	24,042	16,156	24,125	17,591	9,929
1938	10,622	29,985	44,169	27,398	75,844	78,047	46,215	54,521	32,184	13,080	14,773	15,047
1941	10,012	12,934	29,060	69,686	74,431	57,327	42,694	39,478	19,743	17,287	15,245	13,180
1942	17,379	19,938	62,717	63,279	79,293	23,337	45,702	36,400	25,720	17,401	15,706	13,004
1943	17,981	20,083	28,769	57,485	52,014	63,865	28,431	19,220	15,578	21,776	17,204	11,306
1952	10,594	15,337	46,229	62,887	64,346	56,262	57,781	60,487	38,369	16,730	11,888	19,438
1953	22,758	17,765	44,667	64,150	26,175	21,505	19,090	25,555	26,675	22,313	18,132	14,820
1956	10,288	12,782	28,390	74,547	68,954	34,122	19,071	41,245	21,322	18,369	15,665	16,066
1958	18,075	17,859	26,069	36,996	58,396	94,251	53,179	41,041	35,119	14,864	15,085	17,607
1963	26,048	20,706	28,105	16,257	57,185	30,624	69,616	29,066	16,249	23,489	16,873	12,054
1965	10,227	14,742	34,411	79,889	33,068	19,182	46,803	24,137	15,464	22,845	16,591	9,667
1967	10,446	14,848	38,831	31,411	40,050	52,988	39,284	44,691	39,780	14,427	11,959	18,735
1969	11,498	12,451	22,143	65,921	67,344	44,090	43,469	44,031	24,519	12,088	12,866	21,086
1970	21,388	18,837	52,542	91,745	56,396	32,963	13,177	10,371	15,283	24,467	19,196	14,533
1971	11,137	20,893	53,966	44,956	29,508	48,476	19,365	31,137	22,363	23,382	17,267	17,095
1974	12,982	51,961	60,625	78,889	42,177	98,175	37,190	24,029	20,629	20,371	16,382	18,425
1975	18,976	17,056	18,514	16,114	62,308	74,482	21,742	31,759	24,272	18,035	16,093	17,715
1982	11,005	28,600	67,687	53,221	70,735	62,414	79,360	35,456	22,210	14,449	13,512	22,795
1983	29,942	41,158	58,507	57,385	82,786	87,464	65,312	56,056	50,761	22,747	15,156	23,926
1984	27,216	65,736	85,233	45,578	39,113	33,204	14,250	12,211	16,218	25,866	16,089	15,798
1986	9,693	10,601	15,649	18,890	103,700	67,949	19,266	10,936	12,615	22,443	14,992	10,979
Average	**15,661**	**23,143**	**41,033**	**51,690**	**59,938**	**53,487**	**39,414**	**33,137**	**24,344**	**19,550**	**15,632**	**15,867**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	10,607	21,736	15,418	28,799	74,069	42,498	46,687	24,042	16,153	22,910	19,058	9,635
1938	10,622	29,985	44,169	27,398	77,198	78,047	46,215	54,521	32,184	16,450	12,782	15,047
1941	10,012	12,934	29,060	64,854	74,431	57,327	42,694	39,478	19,737	20,539	13,429	13,180
1942	17,379	19,938	61,297	63,279	79,293	23,337	45,702	36,400	25,720	19,447	12,976	13,004
1943	17,981	20,083	29,456	57,485	52,014	63,865	28,431	19,211	15,577	23,032	18,386	9,551
1952	10,594	15,337	46,229	63,940	64,346	56,262	57,781	60,487	38,369	17,664	13,346	16,970
1953	22,758	17,765	44,667	64,150	26,175	21,505	19,090	25,555	26,675	23,349	20,089	14,820
1956	10,288	12,782	28,390	76,398	68,954	34,122	19,071	41,245	21,322	20,088	16,507	16,066
1958	18,075	17,859	26,069	36,996	60,277	94,251	53,179	41,041	35,119	20,395	13,054	17,607
1963	26,048	20,706	28,105	16,257	58,167	30,624	69,616	29,066	16,246	22,919	20,005	11,340
1965	10,227	14,742	31,375	79,889	33,068	19,182	46,803	24,137	15,468	22,464	19,148	9,629
1967	10,446	14,848	38,831	31,411	42,544	52,988	39,284	44,691	39,780	14,427	12,395	18,284
1969	11,498	13,246	22,143	66,374	67,344	44,090	43,469	44,031	24,519	13,527	13,246	19,211
1970	21,388	18,837	52,542	91,745	56,396	32,963	13,147	10,371	15,273	22,862	19,836	13,704
1971	11,137	20,893	53,966	44,970	31,365	48,587	19,365	31,137	22,363	22,987	20,022	17,095
1974	12,982	51,252	60,625	78,889	42,177	98,175	37,190	24,029	20,629	22,568	16,917	18,425
1975	18,976	16,288	17,547	15,102	62,308	74,482	21,742	31,759	24,272	22,199	13,542	17,715
1982	10,827	28,600	69,566	53,221	70,735	62,414	79,360	35,456	22,210	15,265	13,512	21,955
1983	29,942	41,158	58,507	57,385	82,786	87,464	65,312	56,056	50,761	22,747	15,156	23,926
1984	27,216	65,736	85,233	45,578	39,113	33,204	14,250	12,211	16,217	22,738	19,354	15,798
1986	9,628	10,601	15,649	18,890	105,182	67,949	19,266	10,936	12,612	22,039	17,471	10,979
Average	**15,649**	**23,111**	**40,897**	**51,572**	**60,378**	**53,492**	**39,412**	**33,136**	**24,343**	**20,506**	**16,201**	**15,426**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0	0	0	0	805	0	0	0	3	1,215	-1,467	294
1938	0	0	0	0	-1,354	0	0	0	0	-3,370	1,991	0
1941	0	0	0	4,832	0	0	0	0	6	-3,252	1,816	0
1942	0	0	1,420	0	0	0	0	0	0	-2,046	2,730	0
1943	0	0	-687	0	0	0	0	9	1	-1,256	-1,182	1,755
1952	0	0	0	-1,053	0	0	0	0	0	-934	-1,458	2,468
1953	0	0	0	0	0	0	0	0	0	-1,036	-1,957	0
1956	0	0	0	-1,851	0	0	0	0	0	-1,719	-842	0
1958	0	0	0	0	-1,881	0	0	0	0	-5,531	2,031	0
1963	0	0	0	0	-982	0	0	0	3	570	-3,132	714
1965	0	0	3,036	0	0	0	0	0	-4	381	-2,557	38
1967	0	0	0	0	-2,494	0	0	0	0	0	-436	451
1969	0	-795	0	-453	0	0	0	0	0	-1,439	-380	1,875
1970	0	0	0	0	0	0	30	0	10	1,605	-640	829
1971	0	0	0	-14	-1,857	-111	0	0	0	395	-2,755	0
1974	0	709	0	0	0	0	0	0	0	-2,197	-535	0
1975	0	768	967	1,012	0	0	0	0	0	-4,164	2,551	0
1982	178	0	-1,879	0	0	0	0	0	0	-816	0	840
1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	1	3,128	-3,265	0
1986	65	0	0	0	-1,482	0	0	0	3	404	-2,479	0
Average	**12**	**32**	**136**	**118**	**-440**	**-5**	**1**	**0**	**1**	**-955**	**-570**	**441**

71 Year Record-Wet Years
Sacramento River Flow at Freeport
Future Demand Level

River Flow (Regulated) (in cubic feet per second)

Percent Difference [(Run 414 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0%	0%	0%	0%	1%	0%	0%	0%	0%	5%	-8%	3%
1938	0%	0%	0%	0%	-2%	0%	0%	0%	0%	-20%	16%	0%
1941	0%	0%	0%	7%	0%	0%	0%	0%	0%	-16%	14%	0%
1942	0%	0%	2%	0%	0%	0%	0%	0%	0%	-11%	21%	0%
1943	0%	0%	-2%	0%	0%	0%	0%	0%	0%	-5%	-6%	18%
1952	0%	0%	0%	-2%	0%	0%	0%	0%	0%	-5%	-11%	15%
1953	0%	0%	0%	0%	0%	0%	0%	0%	0%	-4%	-9.7%	0%
1956	0%	0%	0%	-2%	0%	0%	0%	0%	0%	-9%	-5%	0%
1958	0%	0%	0%	0%	-3%	0%	0%	0%	0%	-27%	16%	0%
1963	0%	0%	0%	0%	-2%	0%	0%	0%	0%	2%	-16%	6%
1965	0%	0%	9.7%	0%	0%	0%	0%	0%	0%	2%	-13%	0%
1967	0%	0%	0%	0%	-6%	0%	0%	0%	0%	0%	-4%	2%
1969	0%	-6%	0%	-1%	0%	0%	0%	0%	0%	-11%	-3%	9.8%
1970	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	-3%	6%
1971	0%	0%	0%	0%	-6%	0%	0%	0%	0%	2%	-14%	0%
1974	0%	1%	0%	0%	0%	0%	0%	0%	0%	-9.7%	-3%	0%
1975	0%	5%	6%	7%	0%	0%	0%	0%	0%	-19%	19%	0%
1982	2%	0%	-3%	0%	0%	0%	0%	0%	0%	-5%	0%	4%
1983	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1984	0%	0%	0%	0%	0%	0%	0%	0%	0%	14%	-17%	0%
1986	1%	0%	0%	0%	-1%	0%	0%	0%	0%	2%	-14%	0%
Average	0%	0%	1%	0%	-1%	0%	0%	0%	0%	-5%	-2%	3%

71 Year Record-Critical Years
Percent Fraction Sacramento River Flow Diverted
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	47.589	33.894	30.628	30.914	18.728	18.515	23.608	33.605	49.606	42.374	49.814	56.287
1929	50.050	33.342	31.784	33.344	18.697	19.165	22.153	31.982	44.025	41.325	54.563	55.932
1931	54.915	39.985	35.192	33.046	20.768	21.562	21.271	37.137	50.145	45.831	63.689	59.801
1933	54.049	37.602	36.754	31.816	19.478	20.419	19.678	34.196	45.629	49.916	65.737	58.569
1934	57.429	43.525	32.331	30.165	19.327	18.122	19.493	33.754	44.740	49.521	63.668	59.851
1976	37.691	28.412	31.023	32.594	17.653	18.818	21.767	31.484	44.070	45.696	54.921	56.602
1977	55.022	36.572	31.833	30.766	19.670	21.414	22.443	39.820	60.006	53.065	62.977	61.407
1988	48.670	35.967	30.812	16.606	18.159	20.095	22.398	32.397	43.955	44.648	49.862	56.195
1990	53.462	40.746	31.947	30.153	18.763	20.807	19.769	35.236	43.629	41.612	48.439	59.005
1991	61.540	38.310	34.526	35.468	19.321	16.204	19.191	36.086	45.981	42.109	50.190	54.351
1992	60.630	40.286	34.487	34.443	16.233	17.651	19.642	33.292	44.455	42.417	52.029	56.214
Average	52.822	37.149	32.847	30.847	18.800	19.343	21.038	34.454	46.931	45.319	55.990	57.656

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	47.589	33.822	30.404	31.109	18.728	19.011	23.625	33.597	49.630	43.200	49.853	57.175
1929	50.050	33.342	31.101	33.344	18.697	19.822	22.160	31.978	44.030	41.646	54.540	56.431
1931	54.915	37.971	35.995	33.046	20.768	21.565	21.267	37.149	50.165	48.142	66.679	59.801
1933	54.049	37.602	36.754	31.816	19.478	20.419	19.933	34.213	44.642	49.654	64.526	57.761
1934	57.429	43.525	32.331	30.165	19.327	18.123	19.495	33.360	43.729	49.154	63.668	57.404
1976	37.882	28.412	31.023	32.594	17.653	18.818	21.760	31.478	43.619	45.610	54.921	56.602
1977	55.022	36.548	29.918	33.023	19.670	22.086	22.583	39.820	60.006	53.065	62.977	61.407
1988	50.100	35.967	30.812	16.606	18.160	20.243	22.397	32.414	43.958	42.700	49.611	54.966
1990	53.462	40.746	32.107	30.153	18.760	20.807	19.764	35.256	43.650	42.511	49.086	59.024
1991	61.540	39.545	34.822	35.667	19.394	16.204	19.191	34.939	44.364	42.312	56.039	54.564
1992	60.630	40.658	34.574	34.443	16.233	17.651	19.723	33.288	43.931	41.996	51.827	55.237
Average	52.970	37.103	32.713	31.088	18.806	19.523	21.082	34.317	46.520	45.454	56.702	57.307

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0.000	0.072	0.224	-0.195	0.000	-0.495	-0.017	0.008	-0.024	-0.826	-0.039	-0.888
1929	0.000	0.000	0.683	0.000	0.000	-0.657	-0.007	0.004	-0.005	-0.321	0.023	-0.499
1931	0.000	2.013	-0.803	0.000	0.000	-0.002	0.003	-0.012	-0.020	-2.312	-2.990	0.000
1933	0.000	0.000	0.000	0.000	0.000	0.000	-0.254	-0.017	0.987	0.262	1.210	0.808
1934	0.000	0.000	0.000	0.000	0.000	-0.001	-0.002	0.395	1.011	0.367	0.000	2.447
1976	-0.191	0.000	0.000	0.000	0.000	0.000	0.007	0.006	0.451	0.086	0.000	0.000
1977	0.000	0.024	1.915	-2.257	0.000	-0.672	-0.140	0.000	0.000	0.000	0.000	0.000
1988	-1.430	0.000	0.000	0.000	-0.002	-0.148	0.001	-0.017	-0.003	1.948	0.251	1.228
1990	0.000	0.000	-0.160	0.000	0.002	0.000	0.005	-0.020	-0.021	-0.900	-0.648	-0.019
1991	0.000	-1.235	-0.296	-0.199	-0.073	0.000	0.000	1.147	1.617	-0.203	-5.849	-0.213
1992	0.000	-0.372	-0.086	0.000	0.000	0.000	-0.081	0.004	0.524	0.421	0.202	0.977
Average	-0.147	0.046	0.134	-0.241	-0.007	-0.180	-0.044	0.136	0.411	-0.134	-0.713	0.349

71 Year Record-Dry Years
Percent Fraction Sacramento River Flow Diverted
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	45.775	35.150	34.076	35.398	15.529	17.669	17.049	28.789	42.101	39.839	43.238	48.346
1926	44.070	35.509	34.336	30.486	15.821	18.580	18.005	27.680	44.663	39.613	43.286	48.333
1930	45.857	34.257	31.598	28.472	18.487	16.179	19.831	29.856	44.812	42.802	49.255	52.979
1932	51.515	40.059	31.628	30.340	19.085	19.562	19.662	30.334	44.003	49.037	53.163	51.693
1939	37.866	29.536	31.794	32.479	19.733	19.748	19.739	30.751	44.405	39.842	44.475	49.352
1944	44.003	30.660	34.945	31.839	15.914	17.018	21.160	31.797	41.887	40.360	44.713	49.862
1947	46.256	34.121	31.249	30.847	17.534	17.427	19.377	30.667	44.998	38.743	41.791	48.283
1949	42.295	32.693	32.988	34.418	19.652	15.047	20.067	27.713	42.842	41.309	44.721	47.717
1955	48.832	29.758	16.609	28.909	18.255	20.897	22.845	31.055	41.999	38.566	42.821	44.475
1960	45.259	35.088	30.353	32.295	16.653	17.590	19.242	30.958	44.405	37.993	42.442	48.008
1961	46.369	33.059	30.122	34.405	15.935	17.704	19.566	30.558	44.592	37.950	42.320	49.329
1964	40.482	15.819	31.800	16.484	18.403	19.822	22.093	30.733	44.437	38.429	41.273	46.578
1981	41.423	31.561	30.676	16.586	16.258	15.862	18.959	30.759	44.674	39.889	44.558	50.000
1985	41.436	15.577	16.458	31.902	17.520	17.964	21.758	28.285	44.859	38.603	42.407	48.674
1987	48.916	33.075	37.270	33.115	17.633	15.866	19.437	30.162	44.690	39.172	42.579	49.726
1989	59.883	36.013	34.708	32.998	19.269	15.417	17.037	27.645	44.899	38.128	41.844	49.269
Average	45.640	31.371	30.663	30.061	17.605	17.647	19.739	29.859	44.017	40.017	44.055	48.914

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	45.775	35.150	34.076	35.398	15.529	17.669	17.049	28.789	42.118	40.046	43.311	48.417
1926	44.070	35.509	34.523	30.486	15.821	18.847	18.005	27.687	44.679	39.906	43.363	48.409
1930	45.857	34.257	31.598	28.472	18.487	16.179	19.898	29.855	44.818	42.483	49.041	52.979
1932	51.515	40.059	31.628	30.340	19.085	20.029	19.662	30.334	44.032	49.091	53.242	51.693
1939	37.866	29.536	31.794	32.479	19.733	19.748	19.739	30.751	44.405	39.842	44.475	49.352
1944	44.003	30.660	34.945	31.839	15.914	17.018	21.164	31.794	41.887	40.287	44.666	49.862
1947	46.256	34.121	31.249	31.104	17.534	17.427	19.377	30.678	45.013	39.308	41.379	48.528
1949	42.295	32.693	32.988	34.418	19.652	15.047	20.067	27.712	42.882	41.841	44.832	47.717
1955	48.832	29.758	16.609	28.909	17.894	20.897	22.845	31.055	42.017	39.290	40.191	42.617
1960	45.259	33.583	29.804	33.438	16.653	17.626	19.245	30.966	44.424	39.214	40.487	48.147
1961	46.369	33.059	30.122	34.405	15.935	17.704	19.658	30.566	44.608	39.095	40.407	49.329
1964	40.482	15.805	31.800	16.484	18.399	19.819	22.091	30.732	44.440	39.313	40.223	46.678
1981	41.423	31.561	30.676	16.586	16.258	15.862	18.959	30.759	44.674	39.889	44.558	50.000
1985	41.436	15.577	16.458	31.902	17.520	17.964	21.758	28.285	44.868	39.289	41.124	48.674
1987	48.916	33.075	37.270	33.115	17.633	15.856	19.569	30.167	44.698	39.179	42.584	49.731
1989	60.642	36.204	34.708	32.998	19.273	15.417	17.037	27.740	44.913	38.966	40.397	49.269
Average	45.687	31.288	30.641	30.148	17.583	17.694	19.758	29.867	44.030	40.440	43.392	48.838

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.017	-0.208	-0.073	-0.072
1926	0.000	0.000	-0.187	0.000	0.000	-0.267	0.000	-0.007	-0.017	-0.293	-0.076	-0.076
1930	0.000	0.000	0.000	0.000	0.000	0.000	-0.067	0.001	-0.006	0.318	0.214	0.000
1932	0.000	0.000	0.000	0.000	0.000	-0.467	0.000	0.000	-0.030	-0.054	-0.080	0.000
1939	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1944	0.000	0.000	0.000	0.000	0.000	0.000	-0.005	0.003	0.000	0.073	0.047	0.000
1947	0.000	0.000	0.000	-0.257	0.000	0.000	0.000	-0.011	-0.015	-0.565	0.412	-0.245
1949	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	-0.040	-0.532	-0.111	0.000
1955	0.000	0.000	0.000	0.000	0.361	0.000	0.000	0.000	-0.017	-0.724	2.630	1.858
1960	0.000	1.505	0.549	-1.143	0.000	-0.037	-0.002	-0.008	-0.019	-1.222	1.955	-0.139
1961	0.000	0.000	0.000	0.000	0.000	0.000	-0.092	-0.008	-0.016	-1.145	1.913	0.000
1964	0.000	0.014	0.000	0.000	0.004	0.003	0.001	0.001	-0.003	-0.884	1.050	-0.100
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.009	-0.686	1.284	0.000
1987	0.000	0.000	0.000	0.000	0.000	0.0102	-0.132	-0.004	-0.008	-0.008	-0.004	-0.005
1989	-0.759	-0.191	0.000	0.000	-0.004	0.000	0.000	-0.095	-0.014	-0.838	1.447	0.000
Average	-0.047	0.083	0.023	-0.088	0.023	-0.047	-0.018	-0.008	-0.013	-0.423	0.663	0.076

71 Year Record-Below Normal Years
Percent Fraction Sacramento River Flow Diverted
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	38.937	28.540	15.847	16.068	17.142	20.504	16.977	27.897	42.410	39.978	42.275	49.516
1935	58.849	34.031	34.004	16.600	19.031	16.987	17.347	15.870	41.836	40.675	44.131	52.023
1936	47.879	34.531	31.565	16.207	15.544	15.836	17.622	28.503	42.550	41.570	45.601	51.390
1937	49.136	35.168	31.781	32.763	15.833	15.446	17.249	27.853	41.964	43.762	47.524	51.951
1945	44.329	31.845	30.655	32.874	15.196	16.385	20.308	29.229	40.552	42.929	45.631	50.539
1946	45.238	28.773	14.702	15.236	16.589	17.272	20.186	27.966	41.271	41.015	43.971	49.376
1948	44.843	33.743	32.835	30.879	18.318	18.970	17.087	16.017	39.455	16.342	40.899	44.738
1950	46.584	34.688	33.692	29.079	15.748	17.185	17.990	27.799	41.167	38.609	41.278	47.702
1959	38.463	29.788	33.328	15.538	14.934	17.377	21.183	30.728	43.744	39.486	44.080	47.631
1962	47.133	35.048	30.651	33.743	15.285	16.737	20.568	27.430	43.245	37.974	42.562	47.524
1966	42.632	16.495	30.781	16.169	16.484	16.421	19.649	27.457	43.749	39.208	41.643	47.729
1968	38.178	29.411	30.702	16.235	14.650	15.707	20.112	31.006	43.756	39.783	45.029	47.682
1972	40.195	29.866	28.060	29.669	16.575	15.870	20.489	31.013	43.996	38.372	42.716	49.823
1979	40.644	30.502	35.480	16.609	15.358	16.008	18.282	27.209	39.493	42.812	46.401	50.301
Average	**44.503**	**30.888**	**29.577**	**22.690**	**16.192**	**16.907**	**18.932**	**26.856**	**42.085**	**38.751**	**43.839**	**49.138**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	38.936	28.540	15.847	16.068	17.504	19.587	16.977	27.897	42.448	39.109	41.877	49.001
1935	58.849	34.031	34.004	16.600	19.031	16.987	17.347	15.870	41.847	39.250	43.331	52.023
1936	47.879	34.531	34.304	16.207	15.544	15.837	17.622	28.503	42.557	39.395	44.255	51.390
1937	49.136	35.168	30.846	32.763	15.833	15.562	17.249	28.416	41.429	43.670	47.233	51.951
1945	44.329	31.845	30.655	32.874	15.204	16.385	20.308	29.229	40.550	42.929	45.631	50.539
1946	45.238	28.773	14.702	15.236	16.589	17.272	20.186	27.964	41.269	39.984	43.482	49.376
1948	44.843	33.328	32.919	30.879	18.313	18.970	17.087	16.017	39.455	39.010	40.069	41.197
1950	46.584	34.688	34.768	29.079	15.748	17.185	17.990	27.822	41.178	38.998	39.902	47.300
1959	38.463	29.788	33.328	15.538	14.934	17.377	21.183	30.728	43.744	39.486	44.080	47.631
1962	47.133	35.048	30.651	33.854	15.285	16.737	20.616	27.438	43.248	39.026	41.966	47.524
1966	42.632	16.495	31.125	16.246	16.484	16.421	19.649	27.457	43.745	39.215	41.643	47.729
1968	38.178	29.411	30.702	16.235	14.650	15.707	20.112	31.006	43.756	39.783	45.029	47.682
1972	40.195	30.046	28.060	29.669	16.575	15.870	20.428	31.013	43.990	39.264	41.100	49.823
1979	40.644	30.502	35.480	16.609	15.358	16.008	18.282	27.209	39.493	42.812	46.401	50.301
Average	**44.503**	**30.871**	**29.814**	**22.704**	**16.218**	**16.850**	**18.931**	**26.898**	**42.051**	**40.138**	**43.286**	**48.819**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0.001	0.000	0.000	0.000	-0.362	0.917	0.000	0.000	-0.038	0.868	0.397	0.515
1935	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.011	1.425	0.801	0.000
1936	0.000	0.000	-2.739	0.000	0.000	-0.001	0.000	0.000	-0.007	2.175	1.345	0.000
1937	0.000	0.000	0.935	0.000	0.000	-0.116	0.000	-0.563	0.535	0.091	0.291	0.000
1945	0.000	0.000	0.000	0.000	-0.008	0.000	0.000	0.000	0.002	0.000	0.000	0.000
1946	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	1.031	0.489	0.000
1948	0.000	0.415	-0.084	0.000	0.004	0.000	0.000	0.000	0.000	-22.667	0.830	3.542
1950	0.000	0.000	-1.077	0.000	0.000	0.000	0.000	-0.022	-0.011	-0.389	1.376	0.403
1959	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1962	0.000	0.000	0.000	-0.112	0.000	0.000	-0.048	-0.008	-0.003	-1.053	0.596	0.000
1966	0.000	0.000	-0.343	-0.077	0.000	0.000	0.000	0.000	0.004	-0.006	0.000	0.000
1968	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1972	0.000	-0.180	0.000	0.000	0.000	0.000	0.061	0.000	0.006	-0.892	1.616	0.000
1979	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Average	**0.000**	**0.017**	**-0.236**	**-0.013**	**-0.026**	**0.057**	**0.001**	**-0.042**	**0.034**	**-1.387**	**0.553**	**0.319**

71 Year Record-Above Normal Years
Percent Fraction Sacramento River Flow Diverted
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	50.065	35.546	31.132	30.381	15.610	16.092	17.243	15.099	15.771	44.732	49.154	50.020
1928	44.006	16.175	31.269	27.648	16.416	14.239	16.367	26.354	42.532	38.939	42.728	48.275
1940	45.876	34.405	33.336	27.759	15.190	14.567	15.384	26.302	42.805	40.960	44.058	50.145
1951	42.689	15.253	14.708	14.725	14.676	16.158	19.096	25.965	42.894	38.327	42.556	47.643
1954	39.147	27.196	30.897	15.827	14.735	15.043	15.322	24.871	42.758	38.534	42.521	47.612
1957	38.528	30.240	33.992	30.994	15.477	15.241	18.031	27.451	41.737	38.367	40.513	48.688
1973	43.155	27.837	16.336	15.016	14.456	15.110	18.200	26.133	40.057	40.755	43.927	47.804
1978	60.833	41.953	31.143	15.146	14.944	14.991	15.501	25.480	44.000	45.460	48.762	44.578
1980	49.068	29.245	29.044	14.481	14.501	15.609	18.279	28.173	46.374	45.712	48.321	43.830
Average	**45.930**	**28.650**	**27.984**	**21.331**	**15.112**	**15.228**	**17.047**	**25.092**	**39.881**	**41.309**	**44.727**	**47.622**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	50.065	35.546	31.132	30.381	15.610	16.092	17.243	15.099	15.771	44.736	49.154	50.020
1928	44.006	16.175	31.269	27.648	16.416	14.239	16.367	26.353	42.535	38.845	42.666	48.275
1940	45.876	34.389	33.347	27.759	15.191	14.567	15.384	26.335	42.807	38.365	41.911	49.037
1951	42.689	15.253	14.722	14.725	14.676	16.158	19.096	25.965	42.896	38.340	42.556	47.643
1954	39.147	27.196	30.897	15.827	14.735	15.043	15.322	24.874	42.761	38.338	42.432	47.612
1957	38.578	30.240	33.992	30.994	15.477	15.241	18.030	27.451	41.743	38.364	40.513	48.688
1973	43.155	27.837	16.336	15.021	14.456	15.110	18.200	26.133	40.057	40.755	43.934	47.804
1978	60.833	41.953	31.143	15.146	14.944	14.984	15.501	25.480	44.000	45.460	48.762	44.578
1980	49.068	29.245	29.044	14.481	14.501	15.609	18.279	28.173	46.374	45.712	48.321	43.830
Average	**45.935**	**28.648**	**27.987**	**21.331**	**15.112**	**15.227**	**17.047**	**25.096**	**39.883**	**40.991**	**44.472**	**47.499**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.004	0.000	0.000
1928	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	-0.004	**0.094**	**0.062**	0.000
1940	0.000	**0.016**	**-0.011**	0.000	0.000	0.000	0.000	**-0.033**	-0.003	**2.595**	**2.147**	**1.108**
1951	0.000	0.000	**-0.014**	0.000	0.000	0.000	0.000	0.000	-0.002	**-0.013**	0.000	0.000
1954	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	-0.004	**0.196**	**0.089**	0.000
1957	**-0.050**	0.000	0.000	0.000	0.000	0.000	0.001	0.000	-0.006	0.003	0.000	0.000
1973	0.000	0.000	0.000	-0.005	0.000	0.000	0.000	0.000	0.000	0.000	-0.007	0.000
1978	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Average	**-0.006**	**0.002**	**-0.003**	**-0.001**	**0.000**	**0.001**	**0.000**	**-0.004**	**-0.002**	**0.319**	**0.254**	**0.123**

71 Year Record-Wet Years
Percent Fraction Sacramento River Flow Diverted
Existing Demand Level

Project (Run 413)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	44.989	28.346	31.349	15.957	14.466	15.422	15.104	24.235	42.639	42.531	44.845	51.311
1938	49.659	15.611	14.725	15.994	14.316	14.367	15.102	14.807	15.817	44.748	47.896	41.157
1941	47.470	33.347	15.622	14.442	14.414	14.750	15.262	15.401	39.997	45.138	48.384	43.494
1942	38.666	28.211	14.566	14.612	14.348	16.755	15.181	15.581	16.435	45.199	48.292	43.656
1943	38.674	27.476	16.056	14.750	14.901	14.606	16.270	26.106	43.647	42.338	45.681	51.429
1952	44.431	30.163	15.005	14.553	14.590	14.779	14.740	14.665	15.451	41.414	46.537	39.679
1953	38.247	29.629	15.196	14.594	16.470	17.142	17.850	16.535	16.374	41.324	46.632	43.211
1956	49.975	32.997	15.971	14.345	14.508	15.696	17.757	15.304	38.823	43.096	43.246	41.830
1958	39.792	29.104	16.467	15.578	14.574	14.183	14.878	15.310	15.631	42.741	45.006	39.749
1963	16.177	28.274	16.267	30.806	14.886	16.039	14.504	16.130	42.457	41.440	43.873	44.123
1965	49.640	31.252	15.598	14.339	15.811	17.415	15.142	24.206	43.056	39.963	45.146	49.712
1967	45.718	31.319	15.371	15.569	15.232	14.880	15.453	15.135	15.364	43.083	46.082	40.032
1969	44.179	33.078	28.108	14.418	14.535	15.191	15.222	15.166	37.677	45.908	47.632	38.159
1970	38.879	29.077	14.903	14.206	14.775	15.791	19.610	31.383	43.474	39.834	44.625	48.885
1971	44.512	27.824	14.668	15.047	16.191	14.937	17.590	15.957	38.484	40.870	42.932	41.834
1974	42.887	14.706	14.671	14.352	15.273	14.148	15.552	24.200	39.181	41.899	44.746	38.739
1975	38.502	29.497	29.827	30.782	14.645	14.419	17.150	15.872	37.703	42.717	43.400	40.843
1982	45.460	15.762	14.461	14.862	14.475	14.637	14.352	15.619	38.571	43.215	44.440	38.339
1983	16.067	15.365	14.723	14.749	14.304	14.251	14.585	14.775	14.920	38.246	42.749	37.875
1984	16.316	14.583	14.274	15.120	15.428	15.809	19.180	29.156	42.884	40.713	45.214	42.674
1986	45.589	34.624	30.483	29.454	14.076	14.524	17.644	30.558	46.127	43.642	46.279	48.558
Average	**39.801**	**26.678**	**18.015**	**17.073**	**14.867**	**15.226**	**16.101**	**19.338**	**32.606**	**42.384**	**45.411**	**43.109**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	44.989	28.346	31.349	15.957	14.466	15.314	15.104	24.235	42.645	42.530	44.848	51.311
1938	49.659	15.798	14.766	15.994	14.316	14.367	15.102	14.807	15.817	44.748	47.896	41.157
1941	47.470	32.598	15.912	14.522	14.414	14.750	15.262	15.401	39.997	45.138	48.384	43.494
1942	38.666	28.211	14.566	14.612	14.348	16.755	15.181	15.581	16.435	45.199	48.292	43.656
1943	38.674	27.476	16.056	14.750	14.901	14.606	16.270	26.106	43.647	42.338	45.681	51.429
1952	44.431	30.163	15.003	14.553	14.590	14.779	14.740	14.665	15.451	41.414	46.537	39.679
1953	38.247	29.629	15.196	14.594	16.470	17.142	17.850	16.535	16.374	41.324	46.632	43.211
1956	49.975	32.997	15.992	14.422	14.508	15.696	17.757	15.304	38.823	43.022	43.216	41.830
1958	39.792	29.104	16.467	15.578	14.573	14.183	14.878	15.310	15.631	42.741	45.006	39.749
1963	16.177	28.274	16.267	30.806	14.830	16.039	14.504	16.130	42.451	41.562	43.873	44.123
1965	49.640	30.739	15.620	14.339	15.811	17.411	15.142	24.205	43.057	39.378	44.901	49.712
1967	45.718	30.809	15.371	15.618	15.232	14.880	15.453	15.135	15.364	43.083	46.082	40.032
1969	44.179	32.363	28.108	14.429	14.535	15.191	15.222	15.166	37.677	45.908	47.632	38.159
1970	38.879	29.077	14.903	14.206	14.775	15.791	19.610	31.383	43.474	39.834	44.625	48.885
1971	44.512	27.824	14.668	15.047	16.191	14.937	17.590	15.957	38.484	40.659	42.932	41.834
1974	42.887	14.706	14.671	14.352	15.273	14.148	15.552	24.200	39.181	41.899	44.746	38.739
1975	38.502	29.497	29.827	30.782	14.645	14.419	17.150	15.872	37.703	42.124	43.548	40.843
1982	45.460	15.762	14.461	14.862	14.475	14.637	14.352	15.619	38.571	43.215	44.440	38.339
1983	16.067	15.365	14.723	14.749	14.304	14.251	14.585	14.775	14.920	38.246	42.749	37.875
1984	16.316	14.583	14.274	15.120	15.428	15.809	19.180	29.156	42.884	40.713	45.214	42.674
1986	45.589	33.731	31.245	29.454	14.072	14.524	17.644	30.558	46.140	43.719	46.313	48.558
Average	**39.801**	**26.526**	**18.069**	**17.083**	**14.865**	**15.220**	**16.101**	**19.338**	**32.606**	**42.324**	**45.407**	**43.109**

Difference (Run 413 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0.000	0.000	0.000	0.000	0.000	**0.108**	0.000	0.000	-0.005	0.001	-0.003	0.000
1938	0.000	**-0.186**	**-0.042**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1941	0.000	**0.750**	**-0.290**	**-0.081**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1942	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1943	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1952	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1953	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1956	0.000	0.000	**-0.020**	**-0.077**	0.000	0.000	0.000	0.000	0.000	**0.074**	**0.030**	0.000
1958	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1963	0.000	0.000	0.000	0.000	**0.056**	0.000	0.000	0.000	0.006	**-0.122**	0.000	0.000
1965	0.000	**0.513**	**-0.022**	0.000	0.000	0.004	0.001	0.001	-0.001	**0.585**	**0.245**	0.000
1967	0.000	**0.509**	0.000	**-0.048**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1969	0.000	**0.715**	0.000	**-0.011**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1971	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.211**	0.000	0.000
1974	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1975	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.593**	**-0.148**	0.000
1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.000	**0.893**	**-0.761**	0.000	0.003	0.000	0.000	0.000	**-0.013**	**-0.077**	**-0.033**	0.000
Average	**0.000**	**0.152**	**-0.054**	**-0.010**	**0.003**	**0.005**	**0.000**	**0.000**	**-0.001**	**0.060**	**0.004**	**0.000**

71 Year Record-Critical Years
Percent Fraction Sacramento River Flow Diverted
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	51.272	33.843	29.732	33.184	18.529	19.374	23.965	33.413	49.493	47.765	59.968	61.683
1929	50.754	33.057	31.468	33.387	18.620	20.144	22.442	31.945	43.958	41.961	59.002	56.873
1931	54.832	40.414	31.355	33.265	20.700	21.655	21.473	37.047	49.926	49.450	68.783	59.066
1933	54.235	41.417	38.067	32.339	20.077	20.879	19.769	34.121	43.805	44.119	59.683	56.812
1934	56.943	41.998	32.180	31.176	20.327	18.086	19.505	33.244	44.677	46.702	62.476	58.249
1976	38.752	29.224	31.040	32.560	17.605	19.421	21.696	31.462	43.422	40.239	53.517	57.256
1977	55.417	36.479	29.982	39.144	19.510	21.187	22.489	39.262	58.833	52.300	63.266	61.193
1988	57.422	36.053	30.615	16.585	19.404	20.052	22.565	33.667	44.857	41.347	57.422	59.758
1990	52.276	39.368	30.533	29.864	18.820	21.121	19.881	35.175	43.511	40.472	57.541	59.157
1991	61.098	38.181	33.915	34.903	19.262	16.187	19.226	34.892	44.204	44.625	55.558	52.004
1992	60.183	41.302	38.424	34.709	16.161	17.743	19.746	33.189	43.803	44.367	58.436	57.944
Average	53.926	37.394	32.483	31.920	19.001	19.623	21.160	34.310	46.408	44.850	59.605	58.181

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	51.272	33.290	30.465	33.184	18.529	19.377	23.952	33.394	49.483	47.749	59.962	61.683
1929	50.754	33.057	33.023	33.387	18.620	20.207	22.443	31.954	43.967	41.901	59.429	60.003
1931	54.832	39.594	30.325	33.265	20.700	21.677	21.473	37.066	52.355	52.393	68.783	62.480
1933	54.235	41.506	38.067	32.339	20.077	20.879	19.772	34.129	43.811	42.752	64.373	61.986
1934	56.943	43.385	32.180	31.176	20.327	18.087	19.505	33.262	43.612	45.225	62.476	61.794
1976	38.752	29.224	32.123	32.560	17.605	19.421	21.696	31.467	43.429	39.318	56.253	57.256
1977	55.417	34.771	29.900	39.402	19.603	21.707	22.553	39.262	58.833	52.300	63.266	61.193
1988	57.422	36.092	30.615	16.585	19.404	20.214	22.565	32.326	43.876	40.408	57.422	59.758
1990	52.276	39.368	29.952	29.864	18.818	21.285	19.887	35.202	43.528	40.530	57.541	59.839
1991	61.385	41.967	34.330	35.080	19.331	16.187	19.226	34.893	44.206	43.524	57.588	55.623
1992	60.183	41.582	39.173	34.709	16.161	17.743	19.746	33.203	43.815	44.507	58.436	59.196
Average	53.952	37.621	32.741	31.959	19.016	19.708	21.165	34.196	46.447	44.601	60.503	60.074

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0.000	0.554	-0.732	0.000	0.000	-0.003	0.013	0.019	0.009	0.016	0.006	0.000
1929	0.000	0.000	-1.555	0.000	0.000	-0.063	-0.001	-0.009	-0.009	0.060	-0.427	-3.130
1931	0.000	0.820	1.030	0.000	0.000	-0.022	0.000	-0.019	-2.429	-2.942	0.000	-3.414
1933	0.000	-0.089	0.000	0.000	0.000	0.000	-0.003	-0.008	-0.006	1.367	-4.690	-5.174
1934	0.000	-1.387	0.000	0.000	0.000	-0.001	0.000	-0.019	1.065	1.477	0.000	-3.545
1976	0.000	0.000	-1.083	0.000	0.000	0.000	0.001	-0.006	-0.007	0.920	-2.736	0.000
1977	0.000	1.708	0.083	-0.258	-0.093	-0.521	-0.064	0.000	0.000	0.000	0.000	0.000
1988	0.000	-0.039	0.000	0.000	0.000	-0.161	0.000	1.342	0.981	0.939	0.000	0.000
1990	0.000	0.000	0.580	0.000	0.002	-0.164	-0.006	-0.028	-0.018	-0.057	0.000	-0.682
1991	-0.286	-3.785	-0.414	-0.177	-0.069	0.000	0.000	-0.001	-0.002	1.100	-2.029	-3.618
1992	0.000	-0.280	-0.750	0.000	0.000	0.000	0.000	-0.015	-0.012	-0.141	0.000	-1.252
Average	-0.026	-0.227	-0.258	-0.039	-0.015	-0.085	-0.006	0.114	-0.039	0.249	-0.898	-1.892

71 Year Record-Dry Years
Percent Fraction Sacramento River Flow Diverted
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	47.547	35.390	34.367	35.557	15.615	17.876	17.010	28.765	41.851	41.344	45.769	49.535
1926	48.644	35.582	34.154	30.821	15.900	18.212	17.871	27.589	44.234	39.562	41.765	44.065
1930	46.661	35.383	31.135	28.392	18.446	16.257	19.831	29.770	44.327	43.946	49.956	53.429
1932	52.870	40.069	32.089	30.940	19.590	19.925	19.684	31.066	44.215	46.940	52.909	51.532
1939	38.941	29.524	31.634	32.247	19.612	19.765	19.824	30.710	44.259	39.066	40.479	46.465
1944	47.768	31.751	29.420	31.537	16.478	17.444	21.724	31.892	41.628	39.937	40.667	50.276
1947	48.601	34.059	31.203	30.713	17.477	17.515	19.435	30.645	44.617	39.840	40.359	49.573
1949	44.827	32.963	32.432	34.121	19.526	15.026	20.050	27.701	43.048	41.264	49.010	49.191
1955	48.792	30.825	16.588	29.190	17.878	21.457	22.507	30.922	41.838	39.552	39.785	48.308
1960	48.029	33.456	32.060	32.971	16.582	17.779	19.324	30.906	44.348	37.960	42.070	44.448
1961	50.394	32.760	30.123	34.121	16.387	17.629	19.636	30.620	44.241	40.512	40.805	53.058
1964	40.714	16.063	31.577	27.896	18.337	20.491	22.286	30.760	44.071	39.206	41.156	46.539
1981	42.133	32.060	31.112	28.938	16.460	16.069	19.527	30.692	44.277	38.819	40.450	44.414
1985	41.978	15.808	16.436	32.452	18.346	19.763	21.145	28.245	44.467	37.970	42.186	43.194
1987	49.255	37.156	30.945	30.653	17.794	16.333	19.266	30.167	44.333	39.800	47.562	53.551
1989	63.191	36.447	35.084	32.877	19.316	15.419	17.002	27.667	44.416	39.899	42.023	48.828
Average	**47.521**	**31.831**	**30.022**	**31.464**	**17.734**	**17.935**	**19.758**	**29.882**	**43.761**	**40.351**	**43.559**	**48.525**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	47.547	35.390	34.367	35.557	15.615	17.876	17.010	28.765	41.802	39.809	47.643	49.535
1926	48.644	35.582	34.295	30.821	15.900	18.431	17.871	27.589	44.240	39.167	40.216	44.393
1930	46.661	36.692	31.135	28.392	18.446	16.257	19.886	29.781	44.332	40.976	52.070	53.429
1932	52.870	40.069	32.089	30.940	19.590	20.018	19.692	31.066	44.230	46.973	52.948	51.532
1939	39.594	29.524	31.634	32.247	19.612	19.765	19.822	30.709	44.264	39.277	40.327	48.143
1944	47.768	31.189	31.091	31.537	16.478	17.444	20.861	31.902	41.636	39.308	42.414	50.276
1947	48.601	34.059	31.203	31.796	17.477	17.515	19.433	30.645	44.620	39.279	40.714	49.573
1949	44.827	32.264	32.432	34.121	19.526	15.026	20.050	27.704	42.601	39.583	49.023	49.191
1955	48.792	30.825	16.588	29.190	17.883	21.455	22.507	30.922	41.847	39.266	40.365	48.308
1960	48.029	33.461	32.509	32.971	16.582	17.779	19.323	30.912	44.370	39.069	40.230	44.448
1961	50.394	32.760	30.123	34.121	16.387	17.629	19.712	30.620	44.253	39.096	42.019	53.058
1964	40.714	16.063	31.577	27.896	18.337	20.478	22.291	30.773	44.084	39.297	40.274	46.547
1981	42.133	32.060	31.112	28.938	16.460	16.309	19.527	30.705	44.299	39.282	40.297	46.098
1985	41.978	15.808	16.436	32.452	18.346	19.766	21.148	28.251	44.483	39.260	40.247	44.351
1987	49.255	36.356	32.164	31.053	17.794	16.333	19.270	30.172	44.348	40.466	47.562	53.551
1989	63.191	36.447	35.084	32.877	19.316	15.427	17.002	27.750	44.416	38.836	40.128	48.828
Average	**47.562**	**31.784**	**30.240**	**31.557**	**17.734**	**17.969**	**19.713**	**29.892**	**43.739**	**39.934**	**43.530**	**48.829**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.049	1.535	-1.874	0.000
1926	0.000	0.000	-0.141	0.000	0.000	-0.219	0.000	0.000	-0.005	0.395	1.548	-0.328
1930	0.000	-1.308	0.000	0.000	0.000	0.000	-0.054	-0.011	-0.005	2.970	-2.115	0.000
1932	0.000	0.000	0.000	0.000	0.000	-0.093	-0.008	0.000	-0.015	-0.034	-0.039	0.000
1939	-0.654	0.000	0.000	0.000	0.000	0.000	0.002	0.001	-0.005	-0.212	0.152	-1.678
1944	0.000	0.561	-1.671	0.000	0.000	0.000	0.863	-0.009	-0.008	0.629	-1.748	0.000
1947	0.000	0.000	0.000	-1.084	0.000	0.000	0.001	0.000	-0.002	0.561	-0.356	0.000
1949	0.000	0.699	0.000	0.000	0.000	0.000	0.000	-0.003	0.447	1.681	-0.013	0.000
1955	0.000	0.000	0.000	0.000	-0.005	0.001	0.000	0.000	-0.009	0.285	-0.580	0.000
1960	0.000	-0.006	-0.449	0.000	0.000	0.000	0.002	-0.006	-0.022	-1.109	1.840	0.000
1961	0.000	0.000	0.000	0.000	0.000	0.000	-0.076	0.000	-0.012	1.416	-1.214	0.000
1964	0.000	0.000	0.000	0.000	0.000	0.013	-0.005	-0.013	-0.013	-0.091	0.882	-0.008
1981	0.000	0.000	0.000	0.000	0.000	-0.239	0.000	-0.013	-0.022	-0.464	0.153	-1.684
1985	0.000	0.000	0.000	0.000	0.000	-0.003	-0.003	-0.006	-0.016	-1.290	1.939	-1.157
1987	0.000	0.800	-1.220	-0.400	0.000	0.000	-0.004	-0.005	-0.016	-0.666	0.000	0.000
1989	0.000	0.000	0.000	0.000	0.000	-0.008	0.000	-0.083	0.000	1.062	1.895	0.000
Average	**-0.041**	**0.047**	**-0.218**	**-0.093**	**0.000**	**-0.034**	**0.045**	**-0.009**	**0.022**	**0.417**	**0.029**	**-0.303**

71 Year Record-Below Normal Years
Percent Fraction Sacramento River Flow Diverted
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	43.004	28.588	15.894	16.059	16.648	19.385	17.029	28.073	42.105	39.817	42.532	43.943
1935	58.452	33.820	34.010	27.683	19.019	17.082	17.491	15.868	41.512	39.093	43.007	47.444
1936	47.753	34.341	33.416	16.171	15.594	15.918	17.540	28.524	42.236	38.301	42.808	45.235
1937	49.086	33.952	29.259	32.431	15.900	15.597	17.208	28.489	39.315	41.940	44.409	52.282
1945	46.848	31.358	30.744	32.978	15.509	17.039	19.763	29.190	40.395	40.057	46.024	51.745
1946	50.125	29.405	14.833	15.233	16.555	17.461	20.198	28.001	41.046	40.827	42.114	51.868
1948	44.542	33.563	32.732	30.759	18.292	19.139	17.246	16.112	39.646	16.334	40.300	42.831
1950	49.214	34.638	34.742	29.124	15.734	17.317	17.966	27.589	40.907	40.004	41.583	44.044
1959	39.033	29.820	33.197	15.489	14.925	17.088	21.318	30.645	43.341	38.863	40.402	44.491
1962	51.311	34.750	30.565	33.959	15.333	16.819	20.054	27.373	42.884	38.873	40.248	49.838
1966	44.873	16.498	31.016	16.329	16.466	16.757	19.538	27.402	43.354	38.189	39.287	45.371
1968	38.417	29.321	30.533	16.178	14.642	15.730	20.069	30.913	43.382	38.591	40.740	43.948
1972	42.459	30.378	29.273	30.026	16.540	15.871	20.336	30.922	43.597	37.890	41.071	43.730
1979	43.310	31.466	32.373	28.425	15.399	16.040	18.058	27.343	39.263	38.323	40.604	48.845
Average	46.316	30.850	29.470	24.346	16.183	16.946	18.844	26.889	41.642	37.650	41.795	46.830

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	43.004	28.588	16.359	16.112	18.205	19.384	16.925	27.937	42.129	39.041	40.483	43.943
1935	58.852	33.820	34.010	27.683	19.019	17.082	17.491	15.866	41.523	38.991	40.323	48.213
1936	47.753	33.557	33.503	16.171	15.594	15.971	17.540	28.524	42.244	38.972	40.408	45.400
1937	49.086	33.952	35.143	32.431	15.900	15.597	17.208	28.489	39.326	39.111	47.192	52.954
1945	46.848	31.358	30.744	32.978	15.509	17.039	19.763	29.190	40.396	39.159	47.855	51.745
1946	50.125	29.405	14.795	15.233	16.600	17.396	20.198	28.002	41.056	38.988	43.333	51.868
1948	44.542	33.309	32.753	30.759	18.296	19.139	17.246	16.112	39.646	38.971	40.125	41.033
1950	49.214	34.638	34.742	29.124	15.734	17.317	17.966	27.640	40.910	38.957	39.963	44.044
1959	40.417	30.257	33.197	15.489	14.925	17.106	21.326	30.650	43.341	39.031	40.031	44.491
1962	51.311	34.137	30.565	33.956	15.333	16.819	20.054	27.384	42.899	38.983	41.195	49.838
1966	44.873	16.498	31.016	16.329	16.466	16.757	19.538	27.413	43.369	39.145	39.910	46.512
1968	38.417	29.321	30.533	16.178	14.642	15.730	20.072	30.924	43.383	39.116	40.442	44.504
1972	42.459	30.378	29.273	30.697	16.695	15.871	20.329	30.935	43.611	39.208	40.173	43.967
1979	43.310	31.466	32.961	28.425	15.402	16.040	18.058	27.343	39.274	39.006	40.226	50.445
Average	46.444	30.763	29.971	24.398	16.309	16.946	18.837	26.886	41.651	39.048	41.547	47.068

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0.000	0.000	-0.466	-0.053	-1.557	0.001	0.103	0.135	-0.023	0.775	2.049	0.000
1935	-0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.002	-0.011	0.102	2.684	-0.769
1936	0.000	0.783	-0.087	0.000	0.000	-0.053	0.000	0.000	-0.009	-0.671	2.400	-0.165
1937	0.000	0.000	-5.884	0.000	0.000	0.000	0.000	0.000	-0.012	2.829	-2.783	-0.673
1945	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.898	-1.831	0.000
1946	0.000	0.000	0.038	0.000	-0.044	0.065	0.000	-0.001	-0.011	1.839	-1.219	0.000
1948	0.000	0.254	-0.021	0.000	-0.004	0.000	0.000	0.000	0.000	-22.637	0.175	1.798
1950	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.051	-0.003	1.047	1.620	0.000
1959	-1.384	-0.438	0.000	0.000	0.000	-0.018	-0.008	-0.005	0.000	-0.168	0.371	0.000
1962	0.000	0.613	0.000	0.003	0.000	0.000	0.000	-0.011	-0.015	-0.109	-0.947	0.000
1966	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.011	-0.015	-0.956	-0.623	-1.140
1968	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	-0.011	-0.001	-0.525	0.298	-0.557
1972	0.000	0.000	0.000	-0.672	-0.155	0.000	0.007	-0.013	-0.014	-1.318	0.899	-0.237
1979	0.000	0.000	-0.588	0.000	-0.003	0.000	0.000	0.000	-0.011	-0.684	0.378	-1.600
Average	-0.127	0.087	-0.501	-0.052	-0.126	0.000	0.007	0.002	-0.009	-1.398	0.248	-0.239

71 Year Record-Above Normal Years
Percent Fraction Sacramento River Flow Diverted
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	50.090	35.613	30.667	30.357	15.608	16.172	17.248	15.077	15.783	43.908	42.802	50.185
1928	48.150	27.223	31.078	27.963	16.730	14.274	16.344	26.272	42.271	40.185	38.983	52.635
1940	49.154	34.497	32.245	27.605	15.515	14.613	15.382	26.220	42.439	38.841	42.818	45.249
1951	44.905	15.345	14.509	14.724	14.675	16.258	19.063	25.651	42.586	16.487	41.068	42.361
1954	42.832	28.118	31.375	15.988	14.723	15.028	15.302	24.809	42.441	38.338	39.020	48.338
1957	40.139	30.275	35.410	31.253	15.440	15.228	17.921	27.390	41.504	16.406	41.223	42.495
1973	46.837	28.160	16.464	15.122	14.465	15.099	18.185	26.269	39.855	38.160	41.285	48.653
1978	60.957	41.014	31.371	15.138	14.941	15.187	15.467	25.648	44.091	42.229	43.033	48.934
1980	48.605	30.689	29.308	14.737	14.497	15.652	18.223	27.868	45.240	39.022	42.744	49.232
Average	**47.963**	**30.104**	**28.048**	**21.432**	**15.177**	**15.279**	**17.015**	**25.023**	**39.579**	**34.842**	**41.442**	**47.565**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	50.090	35.613	30.667	30.357	15.608	16.172	17.248	15.077	15.783	39.156	44.229	50.185
1928	48.150	27.223	31.078	27.963	16.730	14.275	16.344	26.277	42.270	38.250	40.033	52.635
1940	49.154	34.501	32.364	27.605	15.515	14.584	15.382	26.275	42.453	38.252	39.949	46.075
1951	44.905	15.354	14.634	14.724	14.675	16.258	19.063	25.651	42.591	38.239	39.626	43.174
1954	42.832	28.118	31.375	16.278	14.723	15.028	15.302	24.809	42.447	38.273	39.556	49.086
1957	40.139	30.275	35.410	32.375	15.501	15.228	17.924	27.390	41.511	38.284	39.627	43.406
1973	46.837	28.160	16.464	15.070	14.454	15.099	18.185	26.269	39.860	38.379	40.475	48.653
1978	60.957	41.014	31.371	15.138	14.941	15.218	15.497	25.648	44.091	39.936	46.017	48.934
1980	48.605	30.689	29.308	14.694	14.497	15.652	18.223	27.868	45.246	39.142	40.527	49.232
Average	**47.963**	**30.105**	**28.075**	**21.578**	**15.183**	**15.279**	**17.019**	**25.029**	**39.583**	**38.657**	**41.116**	**47.931**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**4.752**	**-1.427**	0.000
1928	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.005	0.002	**1.935**	**-1.050**	0.000
1940	0.000	-0.003	**-0.119**	0.000	0.000	**0.029**	0.000	**-0.055**	**-0.013**	**0.590**	**2.869**	**-0.826**
1951	0.000	-0.009	**-0.124**	0.000	0.000	0.000	0.000	0.000	-0.005	**-21.752**	**1.441**	**-0.813**
1954	0.000	0.000	0.000	**-0.290**	0.000	0.000	0.000	0.000	-0.006	**0.065**	**-0.537**	**-0.749**
1957	0.000	0.000	0.000	**-1.122**	**-0.061**	0.000	-0.002	0.000	-0.007	**-21.878**	**1.596**	**-0.911**
1973	0.000	0.000	0.000	**0.053**	**0.011**	0.000	0.000	0.000	-0.005	**-0.218**	**0.810**	0.000
1978	0.000	0.000	0.000	0.000	0.000	**-0.031**	**-0.030**	0.000	0.000	**2.293**	**-2.985**	0.000
1980	0.000	0.000	0.000	**0.044**	0.000	0.000	0.000	0.000	-0.006	**-0.120**	**2.217**	0.000
Average	**0.000**	**-0.001**	**-0.027**	**-0.146**	**-0.006**	**0.000**	**-0.004**	**-0.007**	**-0.005**	**-3.815**	**0.326**	**-0.367**

71 Year Record-Wet Years
Percent Fraction Sacramento River Flow Diverted
Future Demand Level

Project (Run 414)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	49.005	28.013	31.152	16.178	14.407	15.250	15.075	24.287	42.238	37.965	41.180	50.347
1938	48.974	16.065	15.176	16.326	14.393	14.362	15.095	14.820	15.877	45.275	43.444	43.191
1941	50.170	32.581	16.153	14.489	14.413	14.747	15.241	15.401	39.888	41.389	43.011	45.159
1942	41.326	28.619	14.621	14.610	14.346	16.853	15.113	15.577	16.524	41.308	42.608	45.371
1943	40.921	28.566	16.181	14.743	14.894	14.598	16.215	25.619	42.714	38.896	41.450	47.789
1952	49.028	30.814	15.092	14.618	14.588	14.774	14.735	14.671	15.460	41.793	46.879	40.050
1953	38.483	29.513	15.157	14.592	16.466	17.154	17.643	16.545	16.409	38.668	40.828	43.401
1956	49.611	32.718	16.221	14.412	14.502	15.729	17.645	15.311	39.100	40.677	42.643	42.307
1958	40.863	29.470	16.479	15.542	14.720	14.179	14.859	15.319	15.661	43.360	43.155	41.171
1963	16.481	28.344	16.250	30.658	14.750	16.007	14.491	16.153	42.163	38.197	41.688	46.640
1965	49.731	31.197	15.710	14.337	15.807	17.621	15.072	24.266	42.816	38.450	41.896	50.926
1967	49.311	31.129	15.434	15.940	15.371	14.864	15.411	15.155	15.385	43.786	46.776	40.454
1969	47.478	33.017	28.239	14.557	14.531	15.180	15.206	15.182	37.824	46.592	45.546	39.211
1970	39.073	29.044	14.878	14.203	14.771	15.815	19.595	31.280	42.976	37.843	40.191	43.680
1971	48.065	28.282	14.835	15.144	16.111	15.009	17.583	15.962	38.644	38.239	41.403	41.527
1974	45.401	14.896	14.667	14.351	15.267	14.144	15.528	24.287	39.430	39.561	42.058	40.640
1975	40.314	29.855	29.545	30.737	14.631	14.413	17.114	15.910	37.912	40.887	42.285	41.095
1982	48.296	16.199	14.524	14.857	14.472	14.628	14.345	15.639	38.712	43.768	44.768	38.469
1983	16.068	15.314	14.716	14.744	14.302	14.248	14.569	14.778	14.933	38.489	43.092	38.034
1984	16.347	14.561	14.273	15.119	15.419	15.796	19.116	29.424	42.188	16.504	42.290	42.531
1986	50.861	35.063	31.012	29.386	14.099	14.520	17.601	30.642	45.866	38.613	43.243	48.338
Average	**41.705**	**26.822**	**18.110**	**17.121**	**14.870**	**15.233**	**16.060**	**19.344**	**32.510**	**39.536**	**42.878**	**43.349**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	49.005	28.013	31.152	16.178	14.419	15.250	15.075	24.287	42.240	38.424	40.267	50.991
1938	48.974	16.065	15.176	16.326	14.373	14.362	15.095	14.820	15.877	42.006	45.650	43.191
1941	50.170	32.581	16.153	14.579	14.413	14.747	15.241	15.401	39.890	39.476	44.866	45.159
1942	41.326	28.619	14.652	14.610	14.346	16.853	15.113	15.577	16.524	40.047	45.407	45.371
1943	40.921	28.566	16.116	14.743	14.894	14.598	16.215	25.621	42.717	38.377	40.667	51.178
1952	49.028	30.814	15.092	14.596	14.588	14.774	14.735	14.671	15.460	41.135	44.957	41.615
1953	38.483	29.513	15.157	14.592	16.466	17.154	17.643	16.545	16.409	38.250	39.703	43.401
1956	49.611	32.718	16.221	14.385	14.502	15.729	17.645	15.311	39.100	39.705	41.964	42.307
1958	40.863	29.470	16.479	15.542	14.676	14.179	14.859	15.319	15.661	39.549	45.312	41.171
1963	16.481	28.344	16.250	30.658	14.725	16.007	14.491	16.153	42.164	38.418	39.745	47.734
1965	49.731	31.197	15.943	14.337	15.807	17.621	15.072	24.266	42.811	38.604	40.213	51.002
1967	49.311	31.129	15.434	15.940	15.248	14.864	15.411	15.155	15.385	43.786	46.164	40.730
1969	47.478	32.312	28.239	14.549	14.531	15.180	15.206	15.182	37.824	44.748	45.078	40.180
1970	39.073	29.044	14.878	14.203	14.771	15.815	19.609	31.280	42.984	38.444	39.837	44.549
1971	48.065	28.282	14.835	15.143	15.945	15.006	17.583	15.962	38.644	38.391	39.736	41.527
1974	45.401	14.916	14.667	14.351	15.267	14.144	15.528	24.287	39.430	38.559	41.656	40.640
1975	40.314	30.255	29.988	31.353	14.631	14.413	17.114	15.910	37.912	38.713	44.735	41.095
1982	48.601	16.199	14.491	14.857	14.472	14.628	14.345	15.639	38.712	42.994	44.768	38.820
1983	16.068	15.314	14.716	14.744	14.302	14.248	14.569	14.778	14.933	38.489	43.092	38.034
1984	16.347	14.561	14.273	15.119	15.419	15.796	19.116	29.424	42.190	38.491	40.100	42.531
1986	51.007	35.063	31.012	29.386	14.088	14.520	17.601	30.642	45.869	38.786	41.263	48.338
Average	**41.727**	**26.808**	**18.139**	**17.152**	**14.852**	**15.233**	**16.060**	**19.344**	**32.511**	**39.781**	**42.628**	**43.789**

Difference (Run 414 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	0.000	0.000	0.000	0.000	-0.012	0.000	0.000	0.000	-0.002	-0.460	0.914	-0.644
1938	0.000	0.000	0.000	0.000	0.019	0.000	0.000	0.000	0.000	3.269	-2.206	0.000
1941	0.000	0.000	0.000	-0.090	0.000	0.000	0.000	0.000	-0.002	1.913	-1.855	0.000
1942	0.000	0.000	-0.030	0.000	0.000	0.000	0.000	0.000	0.000	1.261	-2.799	0.000
1943	0.000	0.000	0.065	0.000	0.000	0.000	0.000	-0.002	-0.003	0.519	0.783	-3.389
1952	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.659	1.922	-1.564
1953	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.418	1.125	0.000
1956	0.000	0.000	0.000	0.027	0.000	0.000	0.000	0.000	0.000	0.972	0.679	0.000
1958	0.000	0.000	0.000	0.000	0.045	0.000	0.000	0.000	0.000	3.811	-2.156	0.000
1963	0.000	0.000	0.000	0.000	0.026	0.000	0.000	0.000	-0.002	-0.221	1.943	-1.094
1965	0.000	0.000	-0.233	0.000	0.000	0.000	0.000	0.000	0.005	-0.154	1.683	-0.076
1967	0.000	0.000	0.000	0.000	0.123	0.000	0.000	0.000	0.000	0.000	0.613	-0.276
1969	0.000	0.706	0.000	0.007	0.000	0.000	0.000	0.000	0.000	1.844	0.469	-0.969
1970	0.000	0.000	0.000	0.000	0.000	0.000	-0.014	0.000	-0.008	-0.601	0.354	-0.869
1971	0.000	0.000	0.000	0.000	0.166	0.003	0.000	0.000	0.000	-0.152	1.666	0.000
1974	0.000	-0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.002	0.402	0.000
1975	0.000	-0.401	-0.443	-0.616	0.000	0.000	0.000	0.000	0.000	2.174	-2.449	0.000
1982	-0.304	0.000	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.774	0.000	-0.351
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	-21.986	2.190	0.000
1986	-0.146	0.000	0.000	0.000	0.011	0.000	0.000	0.000	-0.003	-0.172	1.980	0.000
Average	**-0.021**	**0.014**	**-0.029**	**-0.031**	**0.018**	**0.000**	**-0.001**	**0.000**	**-0.001**	**-0.244**	**0.250**	**-0.440**

71 Year Record-Critical Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	4,563	3,196	6,812	7,636	4,020	4,492	985	1,078	1,374	2,211	113	1,605
1929	3,942	4,380	6,283	5,461	4,230	4,670	1,113	1,223	2,865	3,510	687	2,367
1931	2,230	2,309	3,306	5,818	3,191	2,135	1,176	952	1,463	1,552	739	1,167
1933	1,757	1,585	2,733	7,151	3,504	4,282	1,537	1,314	2,945	867	328	1,874
1934	1,594	2,152	5,449	9,246	3,087	2,834	1,418	1,120	1,299	339	104	1,086
1976	10,295	7,569	3,922	3,514	4,090	3,020	1,165	1,248	2,085	1,136	1,176	1,702
1977	2,548	1,361	3,880	9,107	3,410	1,437	433	819	332	2	2	849
1988	2,616	1,830	6,922	10,295	5,714	2,460	1,109	1,174	2,887	2,105	113	1,516
1990	2,509	1,149	3,597	7,979	3,041	2,234	1,402	1,060	1,781	3,392	667	1,336
1991	1,140	1,376	1,967	2,030	2,360	6,670	1,522	905	68	2,254	2,176	1,592
1992	1,645	1,110	2,027	3,573	10,219	3,882	1,416	1,122	2,568	2,660	220	2,031
Average	**3,167**	**2,547**	**4,263**	**6,528**	**4,261**	**3,465**	**1,207**	**1,092**	**1,788**	**1,821**	**575**	**1,557**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	3,496	2,940	7,066	7,345	4,020	2,992	1,396	1,494	2,183	673	109	1,765
1929	2,874	4,049	6,795	5,461	4,230	3,219	1,528	1,611	2,859	2,068	589	2,226
1931	2,233	3,257	3,100	5,818	3,191	2,135	1,587	1,263	1,271	442	219	1,234
1933	1,761	1,589	2,728	7,151	3,504	4,531	1,339	1,747	2,660	657	303	1,874
1934	1,594	2,152	5,450	7,279	3,119	2,886	1,835	1,501	2,185	544	109	1,711
1976	6,652	6,672	6,325	4,455	4,862	3,437	1,543	1,635	2,232	497	1,175	1,701
1977	2,547	1,397	6,563	6,664	3,464	653	686	1,012	332	2	2	851
1988	1,028	1,596	6,689	7,044	5,627	2,369	1,484	1,557	2,888	1,848	225	1,803
1990	2,510	1,151	3,306	7,026	3,047	2,234	1,815	1,403	1,532	506	415	1,333
1991	1,141	961	1,694	1,882	2,251	6,670	1,895	1,437	1,424	648	183	1,662
1992	1,644	1,221	1,927	3,494	7,506	3,882	1,789	1,506	2,900	1,221	305	2,437
Average	**2,498**	**2,453**	**4,695**	**5,784**	**4,075**	**3,183**	**1,536**	**1,470**	**2,042**	**828**	**330**	**1,691**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	1,067	256	-254	291	0	1,500	-411	-416	-809	1,538	4	-160
1929	1,068	331	-512	0	0	1,451	-415	-388	6	1,442	98	141
1931	-3	-948	206	0	0	0	-411	-311	192	1,110	520	-67
1933	-4	-4	5	0	0	-249	198	-433	285	210	25	0
1934	0	0	-1	1,967	-32	-52	-417	-381	-886	-205	-5	-625
1976	3,643	897	-2,403	-941	-772	-417	-378	-387	-147	639	1	1
1977	1	-36	-2,683	2,443	-54	784	-253	-193	0	0	0	-2
1988	1,588	234	233	3,251	87	91	-375	-383	-1	257	-112	-287
1990	-1	-2	291	953	-6	0	-413	-343	249	2,886	252	3
1991	-1	415	273	148	109	0	-373	-532	-1,356	1,606	1,993	-70
1992	1	-111	100	79	2,713	0	-373	-384	-332	1,439	-85	-406
Average	**669**	**94**	**-431**	**745**	**186**	**283**	**-329**	**-377**	**-254**	**993**	**245**	**-134**

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	31%	9%	-4%	4%	0%	50%	-29%	-28%	-37%	229%	4%	-9%
1929	37%	8%	-8%	0%	0%	45%	-27%	-24%	0%	70%	17%	6%
1931	0%	-29%	7%	0%	0%	0%	-26%	-25%	15%	251%	237%	-5%
1933	0%	0%	0%	0%	0%	-5%	15%	-25%	11%	32%	8%	0%
1934	0%	0%	0%	27%	-1%	-2%	-23%	-25%	-41%	-38%	-5%	-37%
1976	55%	13%	-38%	-21%	-16%	-12%	-24%	-24%	-7%	129%	0%	0%
1977	0%	-3%	-41%	37%	-2%	120%	-37%	-19%	0%	0%	0%	0%
1988	154%	15%	3%	46%	2%	4%	-25%	-25%	0%	14%	-50%	-16%
1990	0%	0%	9%	14%	0%	0%	-23%	-24%	16%	570%	61%	0%
1991	0%	43%	16%	8%	5%	0%	-20%	-37%	-95%	248%	1089%	-4%
1992	0%	-9%	5%	2%	36%	0%	-21%	-25%	-11%	118%	-28%	-17%
Average	**25%**	**4%**	**-5%**	**11%**	**2%**	**18%**	**-22%**	**-26%**	**-14%**	**147%**	**121%**	**-7%**

71 Year Record-Dry Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	4,080	2,479	4,571	3,058	10,239	4,020	2,819	2,117	3,208	6,267	3,158	1,618
1926	4,817	2,650	3,429	8,085	10,277	3,400	2,537	2,012	2,774	7,010	3,198	1,645
1930	3,575	2,341	4,872	10,295	3,698	7,003	1,404	1,388	3,407	3,945	2,425	1,723
1932	1,811	1,666	7,778	8,792	3,966	3,781	1,909	1,345	163	164	160	1,423
1939	8,948	3,651	3,049	2,206	2,758	2,857	1,610	1,496	2,817	6,450	2,459	1,273
1944	5,007	5,739	3,646	7,194	9,922	3,992	1,528	1,536	3,308	5,915	2,453	1,422
1947	5,084	4,095	6,538	7,788	6,016	4,109	1,699	1,509	2,723	6,852	3,585	1,836
1949	6,469	5,053	4,330	4,476	3,511	10,186	1,941	1,973	3,104	3,221	2,137	1,887
1955	4,651	6,803	10,295	10,049	3,814	2,262	1,368	1,606	3,212	6,822	3,647	2,506
1960	4,619	1,673	6,015	6,189	9,862	4,077	1,490	1,357	2,819	9,915	3,900	1,996
1961	4,346	4,127	6,869	4,924	10,294	3,650	1,406	1,326	2,792	9,832	3,695	1,934
1964	8,285	10,300	5,416	4,494	2,719	2,536	1,349	1,546	2,802	9,291	4,532	1,969
1981	9,412	6,820	3,429	3,089	3,453	3,512	1,939	1,496	2,779	6,664	2,511	1,336
1985	9,924	7,174	3,541	3,312	4,671	3,704	1,448	1,770	2,751	8,748	3,705	1,891
1987	6,874	4,084	3,725	5,399	5,437	8,354	1,476	1,346	2,772	6,881	4,629	1,469
1989	1,410	2,562	2,571	4,095	2,775	10,200	2,333	1,657	2,759	8,786	4,745	2,903
Average	5,582	4,451	5,005	5,840	5,838	4,853	1,766	1,593	2,762	6,923	3,184	1,802

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	2,303	2,474	4,493	3,014	7,441	3,973	3,350	2,593	3,271	5,459	3,161	1,625
1926	2,731	2,652	3,325	7,254	7,441	3,137	3,018	2,567	2,766	5,708	3,062	1,579
1930	1,949	2,336	4,874	7,238	3,700	6,929	1,810	1,770	3,702	3,237	2,457	1,726
1932	1,489	1,666	6,974	7,237	3,967	3,095	3,105	1,346	137	138	135	1,423
1939	6,652	6,478	3,473	3,089	3,040	2,697	2,088	1,939	2,813	3,725	2,400	1,242
1944	5,336	6,129	3,646	7,194	8,067	4,791	2,020	1,996	3,322	3,121	2,383	1,423
1947	3,015	4,102	6,836	7,416	6,141	4,109	2,171	1,949	2,717	6,684	3,853	1,668
1949	5,231	3,710	4,356	4,467	3,562	7,066	2,473	2,433	3,106	2,735	2,200	1,867
1955	2,960	6,672	6,993	7,407	5,130	2,262	1,767	1,968	3,279	6,684	6,554	3,485
1960	2,538	2,548	6,893	5,146	7,471	4,052	1,902	1,703	2,818	6,684	6,035	1,915
1961	2,297	4,137	6,876	4,924	7,364	3,650	1,782	1,708	2,783	6,684	5,832	1,962
1964	6,652	6,672	5,836	7,373	2,717	2,537	1,815	1,968	2,813	6,684	5,053	1,812
1981	6,652	6,672	4,906	3,089	3,453	3,513	2,520	1,939	2,775	3,761	2,399	1,356
1985	6,652	6,672	6,159	2,364	4,606	3,704	1,847	2,212	2,744	6,684	4,992	1,851
1987	6,652	4,877	3,726	4,962	5,437	7,019	1,896	1,730	2,768	5,574	2,713	1,384
1989	1,244	2,468	2,577	4,084	2,802	6,930	2,734	2,028	2,751	6,684	5,461	2,905
Average	4,022	4,392	5,121	5,391	5,146	4,342	2,269	1,991	2,785	5,015	3,668	1,826

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	1,777	5	78	44	2,798	47	-531	-476	-63	808	-3	-7
1926	2,086	-2	104	831	2,836	263	-481	-555	8	1,302	136	66
1930	1,626	5	-2	3,057	-2	74	-406	-382	-295	708	-32	-3
1932	322	0	804	1,555	-1	686	-1,196	-1	26	26	25	0
1939	2,296	-2,827	-424	-883	-282	160	-478	-443	4	2,725	59	31
1944	-329	-390	0	0	1,855	-799	-492	-460	-14	2,794	70	-1
1947	2,069	-7	-298	372	-125	0	-472	-440	6	2,168	-268	168
1949	1,238	1,343	-26	9	-51	3,120	-532	-460	-2	486	-63	20
1955	1,691	131	3,302	2,642	-1,316	0	-399	-362	-67	2,138	-2,907	-979
1960	2,081	-875	-878	1,043	2,391	25	-412	-346	1	3,231	-2,135	81
1961	2,049	-10	-7	0	2,930	0	-376	-382	9	3,148	-2,137	-28
1964	1,633	3,628	-420	-2,879	2	-1	-466	-422	-11	2,607	-521	157
1981	2,760	148	-1,477	0	0	-1	-581	-443	4	2,903	112	-20
1985	3,272	502	-2,618	948	65	0	-399	-442	7	2,064	-1,287	40
1987	222	-793	-1	437	0	1,335	-420	-384	4	1,307	1,916	85
1989	166	94	-6	11	-27	3,270	-401	-371	8	2,102	-716	-2
Average	1,560	60	-117	449	692	511	-503	-398	-23	1,907	-484	-25

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	77%	0%	2%	1%	38%	1%	-16%	-18%	-2%	15%	0%	0%
1926	76%	0%	3%	11%	38%	8%	-16%	-22%	0%	23%	4%	4%
1930	83%	0%	0%	42%	0%	1%	-22%	-22%	-8%	22%	-1%	0%
1932	22%	0%	12%	21%	0%	22%	-39%	0%	19%	19%	19%	0%
1939	35%	-44%	-12%	-29%	-9%	6%	-23%	-23%	0%	73%	2%	2%
1944	-6%	-6%	0%	0%	23%	-17%	-24%	-23%	0%	90%	3%	0%
1947	69%	0%	-4%	5%	-2%	0%	-22%	-23%	0%	32%	-7%	10%
1949	24%	36%	-1%	0%	-1%	44%	-22%	-19%	0%	18%	-3%	1%
1955	57%	2%	47%	36%	-26%	0%	-23%	-18%	-2%	32%	-44%	-28%
1960	82%	-34%	-13%	20%	32%	1%	-22%	-20%	0%	48%	-35%	4%
1961	89%	0%	0%	0%	40%	0%	-21%	-22%	0%	47%	-37%	-1%
1964	25%	54%	-7%	-39%	0%	0%	-26%	-21%	0%	39%	-10%	9%
1981	41%	2%	-30%	0%	0%	0%	-23%	-23%	0%	77%	5%	-1%
1985	49%	8%	-43%	40%	1%	0%	-22%	-20%	0%	31%	-26%	2%
1987	3%	-16%	0%	9%	0%	19%	-22%	-22%	0%	23%	71%	6%
1989	13%	4%	0%	0%	-1%	47%	-15%	-18%	0%	31%	-13%	0%
Average	46%	0%	-3%	7%	8%	8%	-22%	-20%	1%	39%	-5%	0%

71 Year Record-Below Normal Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Existing Demand Level
Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	10,295	8,837	3,600	3,191	2,343	2,390	3,144	2,494	3,203	5,933	5,362	1,680
1935	1,294	3,674	3,858	10,291	3,168	6,056	3,336	3,540	3,614	4,988	3,963	1,872
1936	3,392	2,569	3,379	10,295	10,209	6,646	2,879	2,397	3,157	4,114	2,807	1,717
1937	3,522	2,155	6,182	6,710	10,294	7,797	3,187	2,767	2,479	1,212	1,855	1,774
1945	4,593	6,663	8,789	7,058	6,185	4,051	2,228	2,045	3,631	3,128	2,485	1,683
1946	6,173	10,300	10,295	3,251	3,226	4,347	2,229	2,092	3,487	5,252	3,049	1,795
1948	5,357	3,378	3,555	6,719	3,217	3,011	2,826	3,377	4,133	10,207	4,911	2,74
1950	4,792	2,812	3,151	10,295	9,258	4,723	2,432	2,164	3,471	8,155	3,765	1,92
1959	5,006	3,709	3,532	2,368	2,896	3,248	1,415	1,524	2,971	6,775	2,637	2,298
1962	3,972	2,814	6,367	3,498	10,288	6,226	1,659	2,008	2,970	9,403	3,828	2,204
1966	7,197	10,300	8,767	3,969	4,147	4,660	2,001	1,980	2,962	6,771	4,716	1,96
1968	2,990	2,788	2,614	2,201	2,758	3,248	1,749	1,494	2,970	6,608	2,547	2,01
1972	9,192	6,821	7,116	3,610	5,197	5,428	1,781	1,524	2,943	9,065	3,509	2,331
1979	9,522	7,114	2,717	3,209	3,593	3,749	2,590	2,618	3,937	3,351	2,221	2,045
Average	**5,521**	**5,281**	**5,280**	**5,476**	**5,484**	**4,684**	**2,390**	**2,287**	**3,281**	**6,069**	**3,404**	**2,00**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	6,652	6,672	7,417	5,303	485	3,048	3,856	3,133	3,270	5,974	3,493	1,79
1935	1,354	3,678	2,681	7,534	3,167	6,056	4,048	4,178	3,620	5,619	3,807	2,04
1936	2,952	2,547	3,247	7,634	8,500	7,254	3,591	3,035	3,245	4,319	3,003	1,905
1937	2,347	2,140	7,052	6,872	8,500	7,592	4,014	3,351	1,443	890	1,882	1,755
1945	2,510	6,672	7,159	7,058	7,942	4,051	2,940	2,528	3,739	2,071	2,348	1,68
1946	4,093	6,672	7,260	7,739	3,230	4,650	2,941	2,681	3,519	5,315	3,244	1,78
1948	3,277	3,655	3,491	6,717	3,223	3,011	3,286	3,854	4,133	6,684	6,554	5,75
1950	2,730	2,820	2,476	7,338	7,441	4,544	2,964	2,699	3,505	6,684	5,495	2,062
1959	6,652	3,709	3,532	3,147	3,657	3,249	1,883	1,965	2,968	3,973	2,521	2,29
1962	1,912	2,808	6,373	3,392	7,934	6,128	2,096	2,461	2,968	6,684	4,246	2,20
1966	6,652	6,672	7,296	7,979	5,805	4,228	2,536	2,433	2,966	5,963	2,990	1,96
1968	4,968	3,372	2,615	2,207	2,759	3,249	2,340	1,937	2,968	3,697	2,434	2,008
1972	6,652	6,672	7,003	5,202	4,542	5,081	2,312	1,967	2,944	6,684	4,989	2,331
1979	6,652	6,672	2,717	6,331	3,589	3,749	3,302	3,256	3,157	993	2,085	2,27
Average	**4,243**	**4,626**	**5,023**	**6,032**	**5,055**	**4,706**	**3,008**	**2,820**	**3,175**	**4,682**	**3,507**	**2,277**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	3,643	2,165	-3,817	-2,112	1,858	-658	-712	-639	-67	-41	1,869	-11
1935	-60	-4	1,177	2,757	1	0	-712	-638	-6	-631	156	-171
1936	440	22	132	2,661	1,709	-608	-712	-638	-88	-205	-196	-191
1937	1,175	15	-870	-162	1,794	205	-827	-584	1,036	322	-27	19
1945	2,083	-9	1,630	0	-1,757	0	-712	-483	-108	1,057	137	-2
1946	2,080	3,628	3,035	-4,488	-4	-303	-712	-589	-32	-63	-195	8
1948	2,080	-277	64	2	-6	0	-460	-477	0	3,523	-1,643	-3,013
1950	2,062	-8	675	2,957	1,817	179	-532	-535	-34	1,471	-1,730	-14
1959	-1,646	0	0	-779	-761	-1	-468	-441	3	2,802	116	0
1962	2,060	6	-6	106	2,354	98	-437	-453	2	2,719	-418	-1
1966	545	3,628	1,471	-4,010	-1,658	432	-535	-453	-4	808	1,726	0
1968	-1,978	-584	-1	-6	-1	-1	-591	-443	2	2,911	113	2
1972	2,540	149	113	-1,592	655	347	-531	-443	-1	2,381	-1,480	0
1979	2,870	442	0	-3,122	4	0	-712	-638	780	2,358	136	-23
Average	**1,278**	**655**	**257**	**-556**	**429**	**-22**	**-618**	**-532**	**106**	**1,387**	**-103**	**-27**

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	55%	32%	-51%	-40%	383%	-22%	-18%	-20%	-2%	-1%	54%	-6%
1935	-4%	0%	44%	37%	0%	0%	-18%	-15%	0%	-11%	4%	-8%
1936	15%	1%	4%	35%	20%	-8%	-20%	-21%	-3%	-5%	-7%	-10
1937	50%	1%	-12%	-2%	21%	3%	-21%	-17%	72%	36%	-1%	1%
1945	83%	0%	23%	0%	-22%	0%	-24%	-19%	-3%	51%	6%	0%
1946	51%	54%	42%	-58%	0%	-7%	-24%	-22%	-1%	-1%	-6%	0%
1948	63%	-8%	2%	0%	0%	0%	-14%	-12%	0%	53%	-25%	-52
1950	76%	0%	27%	40%	24%	4%	-18%	-20%	-1%	22%	-31%	-7
1959	-25%	0%	0%	-25%	-21%	0%	-25%	-22%	0%	71%	5%	0%
1962	108%	0%	0%	3%	30%	2%	-21%	-18%	0%	41%	-10%	0%
1966	8%	54%	20%	-50%	-29%	10%	-21%	-19%	0%	14%	58%	0%
1968	-40%	-17%	0%	0%	0%	0%	-25%	-23%	0%	79%	5%	0%
1972	38%	2%	2%	-31%	14%	7%	-23%	-23%	0%	36%	-30%	0%
1979	43%	7%	0%	-49%	0%	0%	-22%	-20%	25%	23 /%	7%	-10%
Average	**37%**	**9%**	**7%**	**-10%**	**30%**	**-1%**	**-21%**	**-19%**	**6%**	**44%**	**2%**	**-7%**

71 Year Record-Above Normal Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	2,369	2,667	8,858	9,919	5,713	4,026	3,175	3,639	9,348	310	307	1,743
1928	5,688	10,300	7,901	4,718	3,819	4,283	3,154	2,320	3,164	5,535	2,847	1,649
1940	3,819	2,042	3,167	10,295	10,209	8,153	3,336	2,670	3,162	4,254	2,837	1,717
1951	6,657	10,300	10,295	4,966	4,090	4,349	2,409	2,848	3,152	7,137	3,678	1,947
1954	10,019	9,208	3,600	3,370	3,902	4,352	3,154	2,788	3,135	6,478	3,630	2,054
1957	10,295	6,713	3,509	4,990	4,147	4,349	2,276	2,366	3,302	7,559	5,496	1,893
1973	6,149	10,300	10,295	5,432	4,090	4,202	2,674	2,825	3,800	4,682	2,964	2,567
1978	1,404	1,336	6,591	3,515	1,516	2,846	2,863	2,630	2,085	455	303	3,392
1980	3,478	8,655	10,295	4,527	3,702	3,008	2,776	2,647	1,549	307	703	5,242
Average	5,542	6,836	7,168	5,748	4,576	4,396	2,869	2,748	3,633	4,080	2,529	2,467

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	2,369	2,652	7,211	7,918	8,500	5,065	4,001	4,377	6,672	311	307	1,847
1928	5,215	6,672	7,103	7,545	4,469	4,228	3,687	2,926	3,161	3,661	2,759	1,652
1940	1,740	2,048	3,160	7,477	7,821	7,254	4,048	3,419	3,164	6,684	4,242	1,981
1951	4,671	6,672	7,592	8,500	6,593	4,363	3,121	3,488	3,154	6,004	3,252	1,945
1954	6,652	6,672	6,424	5,434	3,819	4,349	3,687	3,390	3,132	4,682	3,143	2,053
1957	6,652	6,509	3,506	7,164	6,131	4,375	2,903	2,793	3,381	6,644	3,294	1,893
1973	3,783	6,672	6,990	7,344	8,079	5,734	3,386	3,465	3,907	3,467	2,827	2,662
1978	1,404	1,334	6,584	3,949	1,516	2,846	2,863	2,630	2,017	453	303	3,564
1980	3,460	6,672	7,071	8,500	4,321	3,255	2,887	3,386	1,551	307	703	5,790
Average	3,994	5,100	6,182	7,092	5,694	4,608	3,398	3,319	3,349	3,579	2,314	2,599

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0	15	1,647	2,001	-2,787	-1,039	-826	-738	2,676	-1	0	-104
1928	473	3,628	798	-2,827	-650	55	-533	-606	3	1,874	88	-3
1940	2,079	-6	7	2,818	2,388	899	-712	-749	-2	-2,430	-1,405	-264
1951	1,986	3,628	2,703	-3,534	-2,503	-14	-712	-640	-2	1,133	426	2
1954	3,367	2,536	-2,824	-2,064	83	3	-533	-602	3	1,796	487	1
1957	3,643	204	3	-2,174	-1,984	-26	-627	-427	-79	915	2,202	0
1973	2,366	3,628	3,305	-1,912	-3,989	-1,532	-712	-640	-107	1,215	137	-95
1978	0	2	7	-434	0	0	0	0	68	2	0	-172
1980	18	1,983	3,224	-3,973	-619	-247	-111	-739	-2	0	0	-548
Average	1,548	1,735	986	-1,344	-1,118	-211	-530	-571	284	500	215	-131

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0%	1%	23%	25%	-33%	-21%	-21%	-17%	40%	0%	0%	-6%
1928	9%	54%	11%	-37%	-15%	1%	-14%	-21%	0%	51%	3%	0%
1940	119%	0%	0%	38%	31%	12%	-18%	-22%	0%	-36%	-33%	-13%
1951	43%	54%	36%	-42%	-38%	0%	-23%	-18%	0%	19%	13%	0%
1954	51%	38%	-44%	-38%	2%	0%	-14%	-18%	0%	38%	15%	0%
1957	55%	3%	0%	-30%	-32%	-1%	-22%	-15%	-2%	14%	67%	0%
1973	63%	54%	47%	-26%	-49%	-27%	-21%	-18%	-3%	35%	5%	-4%
1978	0%	0%	0%	-11%	0%	0%	0%	0%	3%	0%	0%	-5%
1980	1%	30%	46%	-47%	-14%	-8%	-4%	-22%	0%	0%	0%	-9%
Average	38%	26%	13%	-19%	-17%	-5%	-15%	-17%	4%	13%	8%	-4%

71 Year Record-Wet Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Existing Demand Level
Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	4,535	10,300	7,723	8,044	3,643	4,026	3,336	3,384	3,188	1,674	2,326	1,774
1938	3,054	10,300	10,295	3,182	3,604	3,641	3,238	4,062	5,653	306	305	8,662
1941	4,416	3,198	10,295	10,228	7,459	3,701	3,953	3,639	4,025	307	303	4,883
1942	10,295	3,689	3,352	2,989	3,358	3,111	3,449	3,639	6,658	311	307	5,300
1943	10,295	6,003	3,541	3,132	3,608	3,144	3,449	2,484	2,437	2,325	1,917	1,458
1952	4,702	7,666	10,295	9,687	4,090	3,760	3,449	3,818	6,033	3,851	955	10,147
1953	3,781	2,915	2,646	2,254	2,744	3,248	2,443	3,270	5,946	2,393	1,543	4,187
1956	4,090	3,755	10,295	10,228	6,597	4,349	2,968	3,639	5,406	3,164	3,281	6,814
1958	9,410	9,032	8,386	3,610	4,090	5,425	4,451	3,639	8,085	1,288	2,442	9,812
1963	10,295	10,291	5,352	3,288	3,759	6,281	3,336	3,540	3,488	3,772	2,836	3,959
1965	4,013	5,863	10,295	10,204	5,532	4,349	3,449	3,414	3,170	6,048	3,241	1,977
1967	4,693	6,156	10,295	9,426	3,203	3,179	3,449	3,639	6,828	6,173	1,194	9,230
1969	4,689	4,225	10,295	10,228	3,024	3,077	3,155	3,624	4,995	1,973	382	10,300
1970	4,309	3,618	2,727	2,254	2,744	3,248	2,152	1,871	3,138	5,805	2,470	1,860
1971	4,678	10,300	10,295	4,565	3,762	4,349	2,526	3,376	4,513	4,138	3,366	5,635
1974	6,646	10,300	8,498	3,378	3,941	5,249	3,449	3,612	4,432	2,330	2,556	9,757
1975	10,295	4,195	3,776	3,363	3,941	4,349	3,307	3,639	5,835	4,504	3,216	7,077
1982	4,009	10,300	10,295	5,755	3,762	4,245	4,906	5,461	6,712	3,985	3,390	10,300
1983	4,197	4,029	3,674	2,958	3,019	1,988	2,510	2,207	3,074	3,193	5,445	3,734
1984	2,687	2,361	1,968	1,759	2,499	3,111	2,423	2,070	3,250	4,746	2,253	6,043
1986	4,218	3,915	8,392	9,635	10,294	4,325	4,571	2,767	3,167	1,462	1,815	3,576
Average	**5,681**	**6,305**	**7,271**	**5,722**	**4,223**	**3,912**	**3,332**	**3,371**	**4,763**	**3,036**	**2,169**	**6,023**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,457	6,672	6,933	7,117	7,910	4,447	4,048	4,023	2,677	1,049	2,187	1,952
1938	3,108	6,672	7,090	8,123	5,189	3,888	3,312	4,063	5,653	307	305	6,588
1941	2,361	3,766	7,192	8,221	8,500	7,542	3,954	3,736	3,977	307	303	5,038
1942	6,652	6,672	3,458	3,089	3,453	3,376	3,965	4,377	6,658	311	307	6,010
1943	6,652	6,672	4,194	3,228	3,702	3,408	3,946	2,343	2,288	866	1,822	1,458
1952	2,620	6,672	7,043	8,500	8,278	5,306	3,808	4,236	5,248	3,851	955	6,588
1953	5,723	3,618	3,427	2,284	2,745	3,249	2,973	3,745	5,946	311	622	4,285
1956	2,603	3,769	7,040	8,500	8,500	7,254	3,793	4,377	5,406	1,967	3,150	6,588
1958	6,652	6,672	7,111	7,582	4,852	5,512	4,704	4,690	6,165	1,288	2,442	6,588
1963	6,652	6,672	7,005	7,234	2,013	6,281	4,050	4,178	3,536	2,445	2,700	3,861
1965	2,183	6,358	7,047	8,500	7,821	5,380	4,274	4,699	3,167	4,737	3,241	1,995
1967	2,618	6,672	7,265	7,687	7,836	3,205	4,194	4,063	5,653	6,173	1,194	6,588
1969	2,606	4,788	6,988	8,144	8,166	3,103	3,277	3,624	4,996	1,973	382	6,588
1970	6,652	3,618	3,166	3,058	2,745	3,249	3,000	2,353	3,141	2,677	2,307	1,859
1971	2,596	6,672	7,150	7,389	4,742	6,870	3,057	3,851	4,513	3,650	3,264	5,649
1974	6,652	6,672	7,091	7,815	4,093	4,281	4,274	4,458	4,432	2,330	2,181	6,588
1975	6,652	6,672	6,752	3,464	3,941	4,349	4,134	4,377	5,835	1,185	3,057	6,588
1982	1,928	6,672	6,956	7,786	8,500	4,365	4,906	5,713	6,672	3,985	3,390	6,588
1983	6,652	4,029	3,676	2,983	3,020	2,514	3,234	2,207	3,075	3,193	5,445	3,734
1984	2,687	2,361	1,969	1,759	2,499	3,112	3,136	2,552	3,342	1,624	2,117	6,034
1986	2,281	4,427	7,059	7,181	8,500	7,592	6,234	3,597	2,698	860	1,791	3,416
Average	**4,237**	**5,562**	**5,982**	**6,174**	**5,572**	**4,680**	**3,918**	**3,870**	**4,528**	**2,147**	**2,055**	**4,980**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,078	3,628	790	927	-4,267	-421	-712	-639	511	625	139	-178
1938	-54	3,628	3,205	-4,941	-1,585	-247	-74	-1	0	-1	0	2,074
1941	2,055	568	3,103	2,007	-1,041	-3,841	-1	-97	48	0	0	-155
1942	3,643	2,983	-106	-100	-95	-265	-516	-738	0	0	0	-710
1943	3,643	-669	-653	-96	-94	-264	-497	141	149	1,459	95	0
1952	2,082	994	3,252	1,187	-4,188	-1,546	-359	-418	785	0	0	3,559
1953	-1,942	-703	-781	-30	-1	-1	-530	-475	0	2,082	921	-98
1956	1,487	-14	3,255	1,728	-1,903	-2,905	-825	-738	0	1,197	131	226
1958	2,758	2,360	1,275	-3,972	-762	-87	-253	-1,051	1,920	0	0	3,224
1963	3,643	3,619	-1,653	-3,946	1,746	0	-714	-638	-48	1,327	136	98
1965	1,830	-495	3,248	1,704	-2,289	-1,031	-825	-1,285	3	1,311	0	-18
1967	2,075	-516	3,030	1,739	-4,633	-26	-745	-424	1,175	0	0	2,642
1969	2,083	-563	3,307	2,084	-5,142	-26	-122	0	-1	0	0	3,712
1970	-2,343	0	-439	-804	-1	-1	-848	-482	-3	3,128	163	1
1971	2,082	3,628	3,145	-2,824	-980	-2,521	-531	-475	0	488	102	-14
1974	-6	3,628	1,407	-4,437	-152	968	-825	-846	0	0	375	3,169
1975	3,643	-2,477	-2,976	-101	0	0	-827	-738	0	3,319	159	489
1982	2,081	3,628	3,339	-2,031	-4,738	-120	0	-252	40	0	0	3,712
1983	-2,455	0	-2	-25	-1	-526	-724	0	-1	0	0	0
1984	0	0	-1	0	0	-1	-713	-482	-92	3,122	136	9
1986	1,937	-512	1,333	2,454	1,794	-3,267	-1,663	-830	469	602	24	160
Average	**1,444**	**743**	**1,289**	**-451**	**-1,349**	**-768**	**-586**	**-498**	**236**	**889**	**113**	**1,043**

71 Year Record-Wet Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Existing Demand Level

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	85%	54%	11%	13%	-54%	-9%	-18%	-16%	19%	60%	6%	-9%
1938	-2%	54%	45%	-61%	-31%	-6%	-2%	0%	0%	0%	0%	31%
1941	87%	-15%	43%	24%	-12%	-51%	0%	-3%	1%	0%	0%	-3%
1942	55%	-45%	-3%	-3%	-3%	-8%	-13%	-17%	0%	0%	0%	-12%
1943	55%	-10%	-16%	-3%	-3%	-8%	-13%	6%	7%	168%	5%	0%
1952	79%	15%	46%	14%	-51%	-29%	-9%	-10%	15%	0%	0%	54%
1953	-34%	-19%	-23%	-1%	0%	0%	-18%	-13%	0%	669%	148%	-2%
1956	57%	0%	46%	20%	-22%	-40%	-22%	-17%	0%	61%	4%	3%
1958	41%	35%	18%	-52%	-16%	-2%	-5%	-22%	31%	0%	0%	49%
1963	55%	54%	-24%	-55%	87%	0%	-18%	-15%	-1%	54%	5%	3%
1965	84%	-8%	46%	20%	-29%	-19%	-19%	-27%	0%	28%	0%	-1%
1967	79%	-8%	42%	23%	-59%	-1%	-18%	-10%	21%	0%	0%	40%
1969	80%	-12%	47%	26%	-63%	-1%	-4%	0%	0%	0%	0%	56%
1970	-35%	0%	-14%	-26%	0%	0%	-28%	-20%	0%	117%	7%	0%
1971	80%	54%	44%	-38%	-21%	-37%	-17%	-12%	0%	13%	3%	0%
1974	0%	54%	20%	-57%	-4%	23%	-19%	-19%	0%	0%	17%	48%
1975	55%	-37%	-44%	-3%	0%	0%	-20%	-17%	0%	280%	5%	7%
1982	108%	54%	48%	-26%	-56%	-3%	0%	-4%	1%	0%	0%	56%
1983	-37%	0%	0%	-1%	0%	-21%	-22%	0%	0%	0%	0%	0%
1984	0%	0%	0%	0%	0%	0%	-23%	-19%	-3%	192%	6%	0%
1986	85%	-12%	19%	34%	21%	-43%	-27%	-23%	17%	70%	1%	5%
Average	47%	10%	17%	-7%	-15%	-12%	-15%	-12%	5%	82%	10%	16%

71 Year Record-Critical Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	3,453	3,272	8,209	7,595	4,157	2,493	967	0	185	799	34	630
1929	2,759	4,768	7,670	5,486	4,286	4,203	1,104	1,225	2,517	3,115	539	1,862
1931	2,163	2,484	3,908	5,905	3,242	2,119	1,155	877	1,117	1,365	1,190	1,255
1933	1,690	2,514	3,100	6,983	3,227	2,298	1,606	1,284	2,961	3,110	2,092	1,946
1934	1,629	2,204	5,940	8,108	2,840	2,834	1,421	1,122	1,719	815	109	1,952
1976	10,295	9,939	5,392	3,947	4,349	3,041	1,173	1,240	2,975	4,936	2,700	1,655
1977	2,421	1,998	5,269	3,458	3,912	2,172	1,078	583	249	2	2	838
1988	699	1,960	7,677	10,295	1,648	2,471	1,095	371	325	3,831	82	639
1990	2,694	1,222	4,178	8,496	3,037	2,203	1,378	1,058	1,245	5,685	964	1,651
1991	1,101	2,290	2,209	2,277	2,665	6,847	1,521	548	2,393	2,138	1,438	2,134
1992	1,682	1,778	2,420	3,669	10,235	4,093	1,415	468	1,211	1,728	107	1,409
Average	**2,781**	**3,130**	**5,088**	**6,020**	**3,963**	**3,161**	**1,265**	**798**	**1,536**	**2,502**	**842**	**1,452**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	3,452	3,252	7,066	5,328	4,157	2,487	1,380	104	76	152	33	630
1929	2,760	4,390	4,740	5,487	4,286	2,994	1,506	1,606	2,695	1,082	93	1,140
1931	2,169	2,758	6,539	5,905	3,242	2,101	1,568	87	61	62	59	521
1933	1,685	1,538	2,944	6,983	3,235	2,298	2,086	1,732	2,961	3,045	106	779
1934	1,630	2,044	5,942	7,279	2,807	2,854	1,834	1,505	2,546	1,107	111	586
1976	6,652	6,672	5,557	4,479	5,591	3,227	1,549	1,623	2,972	6,684	1,179	1,571
1977	2,426	2,425	6,866	3,345	3,779	795	678	1,022	247	2	2	837
1988	326	1,574	6,930	7,056	1,649	2,367	1,474	1,185	1,163	1,229	85	639
1990	2,687	1,216	5,902	7,042	3,044	2,121	1,795	1,400	1,379	725	236	1,167
1991	1,077	1,133	2,084	2,207	2,588	6,847	1,901	1,438	2,811	2,183	93	1,146
1992	1,682	1,758	2,241	3,670	7,578	4,093	1,790	878	847	619	110	966
Average	**2,413**	**2,615**	**5,165**	**5,344**	**3,814**	**2,926**	**1,596**	**1,144**	**1,614**	**1,535**	**192**	**907**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	1	20	1,143	2,267	0	6	-413	-104	109	647	1	0
1929	-1	378	2,930	-1	0	1,209	-402	-381	-178	2,033	446	722
1931	-6	-274	-2,631	0	0	18	-413	790	1,056	1,303	1,131	734
1933	5	976	156	0	-8	0	-480	-448	0	65	1,986	1,167
1934	-1	160	-2	829	33	-20	-413	-383	-827	-292	-2	1,366
1976	3,643	3,267	-165	-532	-1,242	-186	-376	-383	3	-1,748	1,521	84
1977	-5	-427	-1,597	113	133	1,377	400	-439	2	0	0	1
1988	373	386	747	3,239	-1	104	-379	-814	-838	2,602	-3	0
1990	7	6	-1,724	1,454	-7	82	-417	-342	-134	4,960	728	484
1991	24	1,157	125	70	77	0	-380	-890	-418	-45	1,345	988
1992	0	20	179	-1	2,657	0	-375	-410	364	1,109	-3	443
Average	**367**	**515**	**-76**	**676**	**149**	**235**	**-332**	**-346**	**-78**	**967**	**650**	**544**

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0%	1%	16%	43%	0%	0%	-30%	-100%	143%	426%	3%	0%
1929	0%	9%	62%	0%	0%	40%	-27%	-24%	-7%	188%	480%	63%
1931	0%	-10%	-40%	0%	0%	1%	-26%	908%	1731%	2102%	1917%	141%
1933	0%	63%	5%	0%	0%	0%	-23%	-26%	0%	2%	1874%	150%
1934	0%	8%	0%	11%	1%	-1%	-23%	-25%	-32%	-26%	-2%	233%
1976	55%	49%	-3%	-12%	-22%	-6%	-24%	-24%	0%	-26%	129%	5%
1977	0%	-18%	-23%	3%	4%	173%	59%	-43%	1%	0%	0%	0%
1988	114%	25%	11%	46%	0%	4%	-26%	-69%	-72%	212%	-4%	0%
1990	0%	0%	-29%	21%	0%	4%	-23%	-24%	-10%	684%	308%	41%
1991	2%	102%	6%	3%	3%	0%	-20%	-62%	-15%	-2%	1446%	86%
1992	0%	1%	8%	0%	35%	0%	-21%	-47%	43%	179%	-3%	46%
Average	**16%**	**21%**	**1%**	**10%**	**2%**	**20%**	**-17%**	**42%**	**162%**	**340%**	**559%**	**70%**

71 Year Record-Dry Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	3,618	2,607	4,974	3,059	8,620	3,794	2,838	2,106	3,141	3,695	2,020	1,430
1926	3,758	2,643	4,935	7,819	10,287	3,437	2,590	1,812	2,839	4,747	5,187	3,443
1930	3,318	1,741	5,599	10,293	3,609	6,817	1,410	1,389	2,947	1,615	2,420	1,590
1932	1,442	1,838	7,718	8,162	3,738	3,251	1,907	1,248	216	144	141	1,307
1939	10,295	8,723	6,930	4,070	4,490	2,677	1,600	1,473	2,841	6,411	7,349	2,864
1944	3,224	4,866	9,798	7,661	10,294	4,269	1,591	1,527	3,364	4,913	6,116	1,447
1947	3,261	4,445	7,212	7,917	6,043	4,056	1,687	1,481	2,772	5,208	6,521	2,020
1949	5,841	2,998	7,249	4,780	3,645	10,171	1,949	1,966	1,287	2,672	137	1,863
1955	3,010	5,612	10,295	10,211	5,155	2,264	1,396	1,592	3,257	5,136	6,680	2,006
1960	3,108	2,492	4,005	5,796	10,213	3,759	1,476	1,356	2,826	8,002	5,434	4,474
1961	2,187	4,536	6,877	5,176	9,674	3,713	1,409	1,323	2,845	4,628	5,577	2,194
1964	7,154	10,300	6,005	9,521	3,239	2,201	1,363	1,537	2,846	6,202	5,117	4,052
1981	8,326	5,788	7,155	10,295	6,240	4,157	1,923	1,476	2,839	6,813	7,492	4,234
1985	9,545	10,300	7,311	3,912	4,405	2,875	1,448	1,747	2,816	8,311	5,273	5,847
1987	6,292	2,522	9,537	7,834	5,197	6,325	22	1,347	2,644	5,207	865	1,286
1989	706	2,768	2,914	4,254	2,562	10,194	2,351	1,650	2,829	3,791	6,005	3,000
Average	4,693	4,636	6,782	6,923	6,088	4,623	1,685	1,564	2,644	4,843	4,521	2,691

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	2,525	2,606	4,971	3,061	7,441	3,844	3,371	2,572	3,340	2,664	870	1,325
1926	2,635	2,642	3,515	7,270	7,441	3,197	3,081	2,276	2,837	6,684	4,829	1,245
1930	1,919	1,248	5,606	7,293	3,607	6,755	1,801	1,771	3,195	4,024	950	1,595
1932	1,438	1,836	7,018	7,264	3,680	3,084	3,060	1,253	130	131	128	1,307
1939	6,652	6,672	7,057	6,764	4,556	2,677	2,078	1,915	2,835	6,684	3,444	658
1944	3,504	5,223	7,032	7,568	8,121	4,330	2,058	1,954	3,377	5,832	951	1,338
1947	2,942	4,395	7,164	6,317	6,284	4,056	2,159	1,924	2,772	6,684	2,084	1,360
1949	3,800	3,987	5,113	4,779	3,645	7,066	2,482	2,405	3,157	2,753	130	1,915
1955	2,854	6,136	7,017	7,456	5,153	2,140	1,796	1,955	3,315	6,684	2,386	1,835
1960	2,416	2,486	3,744	5,796	7,495	3,759	1,887	1,702	2,827	6,684	5,498	1,782
1961	2,187	4,542	6,882	5,176	7,352	3,713	1,787	1,706	2,840	6,309	1,127	2,194
1964	6,652	6,672	5,833	7,395	3,239	2,348	1,802	1,943	2,869	6,684	3,763	1,302
1981	6,652	6,215	7,193	7,697	6,313	4,601	2,412	1,916	2,831	6,684	3,890	1,338
1985	6,652	6,672	7,461	7,120	4,885	2,875	1,919	2,187	2,804	6,684	6,554	1,723
1987	6,292	3,045	6,865	7,255	5,260	6,354	300	1,727	2,013	499	865	1,486
1989	705	2,766	2,909	4,167	2,594	6,916	2,751	2,024	2,823	6,684	5,068	3,001
Average	3,739	4,196	5,961	6,399	5,442	4,232	2,172	1,952	2,748	5,148	2,659	1,588

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	1,093	1	3	-2	1,179	-50	-533	-466	-199	1,031	1,150	105
1926	1,123	1	1,420	549	2,846	240	-491	-464	2	-1,937	358	2,198
1930	1,399	493	-7	3,000	2	62	-391	-382	-248	-2,409	1,470	-5
1932	4	2	700	898	58	167	-1,153	-5	86	13	13	0
1939	3,643	2,051	-127	-2,694	-66	0	-478	-442	6	-273	3,905	2,206
1944	-280	-357	2,766	93	2,173	-61	-467	-427	-13	-919	5,165	109
1947	319	50	48	1,600	-241	0	-472	-443	0	-1,476	4,437	660
1949	2,041	-989	2,136	1	0	3,105	-533	-439	-1,870	-81	7	-52
1955	156	-524	3,278	2,755	2	124	-400	-363	-58	-1,548	4,294	171
1960	692	6	261	0	2,718	0	-411	-346	-1	1,318	-64	2,692
1961	0	-6	-5	0	2,322	0	-378	-383	5	-1,681	4,450	0
1964	502	3,628	172	2,126	0	-147	-439	-406	-23	-482	1,354	2,750
1981	1,674	-427	-38	2,598	-73	-444	-489	-440	8	129	3,602	2,896
1985	2,893	3,628	-150	-3,208	-480	0	-471	-440	12	1,627	-1,281	4,124
1987	0	-523	2,672	579	-63	-29	-278	-380	631	4,708	0	-200
1989	1	2	5	87	-32	3,278	-400	-374	6	-2,893	937	-1
Average	954	440	821	524	647	390	-487	-388	-104	-305	1,862	1,103

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	43%	0%	0%	0%	16%	-1%	-16%	-18%	-6%	39%	132%	8%
1926	43%	0%	40%	8%	38%	8%	-16%	-20%	0%	-29%	7%	177%
1930	73%	40%	0%	41%	0%	1%	-22%	-22%	-8%	-60%	155%	0%
1932	0%	0%	10%	12%	2%	5%	-38%	0%	66%	10%	10%	0%
1939	55%	31%	-2%	-40%	-1%	0%	-23%	-23%	0%	-4%	113%	335%
1944	-8%	-7%	39%	1%	27%	-1%	-23%	-22%	0%	-16%	543%	8%
1947	11%	1%	1%	25%	-4%	0%	-22%	-23%	0%	-22%	213%	49%
1949	54%	-25%	42%	0%	0%	44%	-21%	-18%	-59%	-3%	5%	-3%
1955	5%	-9%	47%	37%	0%	6%	-22%	-19%	-2%	-23%	180%	9%
1960	29%	0%	7%	0%	36%	0%	-22%	-20%	0%	20%	-1%	151%
1961	0%	0%	0%	0%	32%	0%	-21%	-22%	0%	-27%	395%	0%
1964	8%	54%	3%	29%	0%	-6%	-24%	-21%	-1%	-7%	36%	211%
1981	25%	-7%	-1%	34%	-1%	-10%	-20%	-23%	0%	2%	93%	216%
1985	43%	54%	-2%	-45%	-10%	0%	-25%	-20%	0%	24%	-20%	239%
1987	0%	-17%	39%	8%	-1%	0%	-93%	-22%	31%	943%	0%	-13%
1989	0%	0%	0%	2%	-1%	47%	-15%	-18%	0%	-43%	18%	0%
Average	24%	7%	14%	7%	8%	6%	-26%	-20%	1%	50%	118%	87%

71 Year Record-Below Normal Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Future Demand Level
Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	5,011	10,300	10,295	7,233	4,172	2,903	3,193	2,474	3,254	5,169	4,409	4,981
1935	1,335	4,013	4,179	10,295	3,175	5,977	3,336	3,526	3,696	5,552	5,548	4,163
1936	3,061	2,745	4,154	10,295	10,187	7,241	2,913	2,379	3,221	7,241	5,163	5,647
1937	2,292	2,711	4,342	6,963	10,294	10,169	3,198	2,576	4,189	5,086	5,765	3,216
1945	4,268	7,604	8,839	6,978	6,330	4,028	2,305	2,034	3,687	4,439	2,967	1,817
1946	6,199	8,196	10,295	7,005	3,571	4,155	2,234	2,073	3,545	3,774	4,498	1,827
1948	5,704	3,389	2,381	8,468	3,222	2,929	2,687	3,366	4,062	8,162	6,527	4,684
1950	3,873	2,874	2,584	10,295	9,360	4,332	2,443	1,947	3,588	4,253	5,227	3,813
1959	10,295	7,706	4,025	6,982	4,556	3,974	1,408	1,500	3,029	6,279	7,177	4,334
1962	1,815	3,215	5,585	3,372	10,277	5,928	1,943	1,997	3,042	6,574	7,851	2,685
1966	5,470	10,300	9,007	8,014	4,556	4,375	2,023	1,982	3,030	7,416	7,345	5,254
1968	10,295	5,139	4,439	3,997	4,490	4,177	1,765	1,472	3,025	6,851	7,495	4,362
1972	6,542	6,183	10,295	8,911	5,056	4,406	1,680	1,502	3,009	8,086	7,051	5,224
1979	6,563	6,228	5,403	10,295	9,158	4,644	2,650	2,579	4,040	7,045	7,565	4,123
Average	**5,195**	**5,757**	**6,202**	**7,793**	**6,315**	**4,946**	**2,413**	**2,242**	**3,458**	**6,138**	**6,042**	**4,009**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	6,012	6,672	7,496	8,500	4,172	2,907	3,903	3,098	3,339	6,684	5,692	1,567
1935	1,257	4,016	2,901	7,599	3,176	5,977	4,048	4,150	3,698	6,684	6,554	1,674
1936	3,050	3,139	3,943	7,667	8,500	7,155	3,625	3,004	3,312	6,684	6,554	1,668
1937	2,297	2,693	3,942	7,289	8,500	7,592	4,025	3,295	4,826	6,346	1,853	1,676
1945	2,520	6,672	7,172	6,978	6,497	3,[illegible]	3,026	2,502	3,788	3,621	986	1,689
1946	4,360	6,672	7,287	7,739	3,180	4,43[illegible]	2,946	2,646	3,575	6,684	1,534	1,913
1948	3,474	3,558	3,463	6,774	3,225	2,929	3,222	3,831	4,062	6,684	6,554	4,585
1950	2,642	2,880	2,570	7,397	7,441	4,[illegible]16	2,976	2,418	3,578	6,684	4,998	1,592
1959	6,652	6,672	4,025	7,691	7,555	3,895	1,871	1,942	3,033	6,684	4,088	2,346
1962	1,815	3,546	6,593	3,376	8,048	5,928	2,474	2,437	3,034	6,684	2,091	2,294
1966	5,644	6,672	7,312	7,990	6,886	4,937	2,555	2,402	3,027	6,684	3,087	1,854
1968	6,652	6,672	7,100	6,588	4,556	4,001	2,345	1,913	3,026	6,684	4,123	1,889
1972	6,652	6,472	7,030	7,374	4,831	4,347	2,132	1,942	3,005	6,684	5,372	2,279
1979	6,652	6,599	4,386	7,853	8,500	6,703	3,371	3,203	4,138	6,684	4,973	2,159
Average	**4,263**	**5,210**	**5,373**	**7,201**	**6,076**	**4,927**	**3,037**	**2,770**	**3,532**	**6,441**	**4,176**	**2,085**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	-1,001	3,628	2,799	-1,267	0	-4	-710	-624	-85	-1,515	-1,283	3,414
1935	78	-3	1,278	2,696	-1	0	-712	-624	-2	-1,132	-1,006	2,489
1936	11	-394	211	2,628	1,687	86	-712	-625	-91	557	-1,391	3,979
1937	-5	18	400	-326	1,794	2,577	-827	-719	-637	-1,260	3,912	1,54[illegible]
1945	1,748	932	1,667	0	-167	72	-721	-468	-101	818	1,981	128
1946	1,839	1,524	3,008	-734	391	-280	-712	-573	-30	-2,910	2,964	-86
1948	2,230	-169	-1,082	1,694	-3	0	-535	-465	0	1,478	-27	99
1950	1,231	-6	14	2,898	1,919	116	-533	-471	10	-2,431	229	2,22[illegible]
1959	3,643	1,034	0	-709	-2,999	79	-463	-442	-4	-405	3,089	1,98[illegible]
1962	0	-331	-8	-4	2,229	0	-531	-440	8	-110	5,760	391
1966	-174	3,628	1,695	24	-2,330	-562	-532	-440	3	732	4,258	3,400
1968	3,643	-1,533	-2,661	-2,591	-66	176	-580	-441	-1	167	3,372	2,47[illegible]
1972	-110	-289	3,265	1,537	225	59	-452	-440	4	1,402	1,679	2,94[illegible]
1979	-89	-371	1,017	2,442	658	-2,059	-721	-624	-98	361	2,592	1,964
Average	**932**	**548**	**829**	**592**	**238**	**19**	**-624**	**-528**	**-73**	**-303**	**1,866**	**1,92[illegible]**

Percent Difference ((Run. 455 - Run 411)/Run 411)*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	-17%	54%	37%	-15%	0%	0%	-18%	-20%	-3%	-23%	-23%	218%
1935	6%	0%	44%	35%	0%	0%	-18%	-15%	0%	-17%	-15%	149[illegible]
1936	0%	-13%	5%	34%	20%	1%	-20%	-21%	-3%	8%	-21%	239[illegible]
1937	0%	1%	10%	-4%	21%	34%	-21%	-22%	-13%	-20%	211%	92[illegible]
1945	69%	14%	23%	0%	-3%	2%	-24%	-19%	-3%	23%	201%	8%
1946	42%	23%	41%	-9%	12%	-6%	-24%	-22%	-1%	-44%	193%	-4[illegible]
1948	64%	-5%	-31%	25%	0%	0%	-17%	-12%	0%	22%	0%	2[illegible]
1950	47%	0%	1%	39%	26%	3%	-18%	-19%	0%	-36%	5%	140[illegible]
1959	55%	15%	0%	-9%	-40%	2%	-25%	-23%	0%	-6%	76%	85%
1962	0%	-9%	0%	0%	28%	0%	-21%	-18%	0%	-2%	275%	17[illegible]
1966	-3%	54%	23%	0%	-34%	-11%	-21%	-18%	0%	11%	138%	183[illegible]
1968	55%	-23%	-37%	-39%	-1%	4%	-25%	-23%	0%	2%	82%	131[illegible]
1972	-2%	-4%	46%	21%	5%	1%	-21%	-23%	0%	21%	31%	129%
1979	-1%	-6%	23%	31%	8%	-31%	-21%	-19%	-2%	5%	52%	91%
Average	**23%**	**7%**	**13%**	**8%**	**3%**	**0%**	**-21%**	**-20%**	**-2%**	**-4%**	**86%**	**106[illegible]**

71 Year Record-Above Normal Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Future Demand Level
Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	3,727	10,300	6,949	9,243	3,601	4,643	3,337	3,348	3,260	6,639	7,187	3,055
1938	3,093	10,300	10,287	7,431	4,091	4,644	3,931	5,056	9,212	318	2,544	6,774
1941	2,353	3,752	10,295	10,211	9,251	4,644	4,210	3,619	4,236	3,983	5,262	3,643
1942	8,278	10,300	10,295	4,270	4,490	4,644	3,449	3,619	6,440	3,392	5,445	4,476
1943	10,128	10,300	8,053	3,997	4,490	4,520	3,449	2,898	3,222	5,425	6,976	3,399
1952	2,707	6,813	10,295	10,244	7,473	4,644	3,449	3,811	10,300	3,172	662	10,251
1953	10,295	7,493	4,439	3,997	4,490	4,644	2,529	3,250	5,824	4,731	7,438	4,814
1956	3,171	3,943	10,295	10,142	4,939	4,644	3,012	3,619	5,206	4,685	5,270	5,921
1958	8,144	8,218	10,295	6,569	4,490	4,644	4,701	3,619	10,300	492	3,009	7,740
1963	10,295	9,742	6,503	3,504	3,843	4,644	3,336	3,526	3,549	6,189	6,017	4,508
1965	2,240	6,073	10,295	10,157	3,893	4,644	3,449	3,366	3,227	6,592	6,042	3,736
1967	2,976	6,596	10,295	10,218	5,289	3,961	3,449	3,619	10,300	7,243	717	9,221
1969	3,224	4,571	10,295	10,199	6,715	3,961	3,923	6,453	7,196	1,329	820	10,300
1970	10,295	7,776	4,179	3,997	4,490	4,353	2,157	1,849	3,204	7,152	7,297	5,171
1971	2,645	10,300	10,295	8,684	3,969	4,809	2,547	3,364	4,435	5,703	6,306	6,261
1974	4,812	10,300	10,295	7,292	4,377	4,520	3,449	3,545	4,362	4,647	5,136	7,215
1975	9,325	8,592	7,229	3,965	4,370	4,498	3,328	3,619	5,659	4,470	5,103	6,685
1982	3,200	10,300	10,278	8,729	4,021	4,644	5,427	6,189	6,602	3,409	3,315	10,300
1983	10,295	5,166	4,260	3,508	3,518	3,457	4,485	4,237	5,415	5,535	7,700	6,010
1984	4,409	4,174	3,919	3,638	4,382	4,556	2,440	2,026	3,324	7,937	5,471	6,592
1986	2,325	4,285	7,970	9,865	10,294	6,155	5,477	2,759	3,227	5,969	5,052	3,490
Average	**5,616**	**7,585**	**8,429**	**7,136**	**5,070**	**4,565**	**3,597**	**3,685**	**5,643**	**4,715**	**4,894**	**6,170**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,520	6,672	6,936	7,128	7,970	4,782	4,051	3,972	3,304	6,684	5,366	1,799
1938	3,108	6,672	7,120	8,144	7,005	4,644	4,973	5,766	6,672	3,687	2,225	6,588
1941	2,362	3,738	7,246	8,237	8,500	7,592	5,942	4,575	4,281	6,684	2,710	4,187
1942	6,652	6,672	7,407	8,301	5,406	4,481	4,274	4,336	6,440	6,023	2,223	5,154
1943	6,652	6,672	7,187	7,470	4,358	4,508	4,274	3,806	3,221	6,684	4,870	1,441
1952	2,712	6,650	7,087	8,500	8,272	6,105	4,889	5,343	6,672	4,107	2,225	6,588
1953	6,652	6,672	7,222	7,239	4,556	4,644	3,061	3,713	5,824	6,684	5,938	3,185
1956	2,537	3,931	7,105	8,500	7,235	4,644	3,839	4,336	5,206	6,684	4,739	6,447
1958	6,652	6,672	7,130	7,647	8,364	4,783	5,544	4,575	6,672	5,352	2,225	6,588
1963	6,652	6,672	7,013	6,335	3,642	4,644	4,048	4,150	3,584	6,684	6,554	1,993
1965	2,250	6,045	7,085	8,500	6,108	4,643	4,274	4,494	3,230	6,684	6,082	1,964
1967	2,490	6,586	7,287	7,752	6,696	3,963	5,077	4,575	6,672	6,684	1,154	6,588
1969	2,562	5,133	7,026	8,182	8,500	4,319	4,889	5,522	6,672	2,769	2,225	6,588
1970	6,652	6,672	7,383	6,331	4,556	4,128	3,010	2,317	3,202	6,684	4,448	1,760
1971	2,617	6,672	7,172	7,384	6,359	7,064	3,079	3,827	4,435	6,684	6,403	4,462
1974	5,198	6,672	7,194	8,069	6,308	4,664	4,274	4,264	4,362	6,684	4,404	6,588
1975	6,652	6,672	7,165	6,115	4,515	4,447	4,154	4,336	5,659	6,684	2,427	6,588
1982	2,070	6,672	6,964	7,819	8,301	5,585	5,427	6,189	6,602	4,225	3,315	6,588
1983	6,652	6,672	7,592	4,588	3,584	3,457	4,485	4,237	5,415	5,535	6,554	6,588
1984	4,986	4,174	3,919	3,638	4,382	4,520	3,152	2,494	3,415	6,684	6,554	5,435
1986	2,269	4,286	7,078	7,219	8,500	7,592	6,499	3,589	3,224	6,684	5,613	3,747
Average	**4,328**	**6,061**	**7,015**	**7,290**	**6,339**	**5,010**	**4,439**	**4,306**	**4,989**	**5,965**	**4,203**	**4,803**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	1,207	3,628	13	2,115	-4,369	-139	-714	-624	-44	-45	1,821	1,256
1938	-15	3,628	3,167	-713	-2,914	0	-1,042	-710	2,540	-3,369	319	186
1941	-9	14	3,049	1,974	751	-2,948	-1,732	-956	-45	-2,701	2,552	-544
1942	1,626	3,628	2,888	-4,031	-916	163	-825	-717	0	-2,631	3,222	-678
1943	3,476	3,628	866	-3,473	132	12	-825	-908	1	-1,259	2,106	1,958
1952	-5	163	3,208	1,744	-799	-1,461	-1,440	-1,532	3,628	-935	-1,563	3,663
1953	3,643	821	-2,783	-3,242	-66	0	-532	-463	0	-1,953	1,500	1,629
1956	634	12	3,190	1,642	-2,296	0	-827	-717	0	-1,999	531	-526
1958	1,492	1,546	3,165	-1,078	-3,874	-139	-843	-956	3,628	-4,860	784	1,152
1963	3,643	3,070	-510	-2,831	201	0	-712	-624	-35	-495	-537	2,515
1965	-10	28	3,210	1,657	-2,215	1	-825	-1,128	-3	-92	-40	1,772
1967	486	10	3,008	2,466	-1,407	-2	-1,628	-956	3,628	559	-437	2,633
1969	662	-562	3,269	2,017	-1,785	-358	-966	931	524	-1,440	-1,405	3,712
1970	3,643	1,104	-3,204	-2,334	-66	225	-853	-468	2	468	2,849	3,411
1971	28	3,628	3,123	1,300	-2,390	-2,255	-532	-463	0	-981	-97	1,799
1974	-386	3,628	3,101	-777	-1,931	-144	-825	-719	0	-2,037	732	627
1975	2,673	1,920	64	-2,150	-145	51	-826	-717	0	-2,214	2,676	97
1982	1,130	3,628	3,314	910	-4,280	-941	0	0	0	-816	0	3,712
1983	3,643	-1,506	-3,332	-1,080	-66	0	0	0	0	0	1,146	-578
1984	-577	0	0	0	0	36	-7 2	-468	-91	1,253	-1,083	1,157
1986	56	-1	892	2,646	1,794	-1,437	-1,022	-830	3	-715	-561	-257
Average	**1,288**	**1,525**	**1,414**	**-154**	**-1,269**	**-445**	**-842**	**-620**	**654**	**-1,251**	**691**	**1,366**

71 Year Record-Wet Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Future Demand Level
Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	3,727	10,300	6,949	9,243	3,601	4,643	3,337	3,348	3,260	6,639	7,187	3,055
1938	3,093	10,300	10,287	7,431	4,091	4,644	3,931	5,056	9,212	318	2,544	6,774
1941	2,353	3,752	10,295	10,211	9,251	4,644	4,210	3,619	4,236	3,983	5,262	3,643
1942	8,278	10,300	10,295	4,270	4,490	4,644	3,449	3,619	6,440	3,392	5,445	4,476
1943	10,128	10,300	8,053	3,997	4,490	4,520	3,449	2,898	3,222	5,425	6,976	3,399
1952	2,707	6,813	10,295	10,244	7,473	4,644	3,449	3,811	10,300	3,172	662	10,251
1953	10,295	7,493	4,439	3,997	4,490	4,644	2,529	3,250	5,824	4,731	7,438	4,814
1956	3,171	3,943	10,295	10,142	4,939	4,644	3,012	3,619	5,206	4,685	5,270	5,921
1958	8,144	8,218	10,295	6,569	4,490	4,644	4,701	3,619	10,300	492	3,009	7,740
1963	10,295	9,742	6,503	3,504	3,843	4,644	3,336	3,526	3,549	6,189	6,017	4,508
1965	2,240	6,073	10,295	10,157	3,893	4,644	3,449	3,366	3,227	6,592	6,042	3,736
1967	2,976	6,596	10,295	10,218	5,289	3,961	3,449	3,619	10,300	7,243	717	9,221
1969	3,224	4,571	10,295	10,199	6,715	3,961	3,923	6,453	7,196	1,329	820	10,300
1970	10,295	7,776	4,179	3,997	4,490	4,353	2,157	1,849	3,204	7,152	7,297	5,171
1971	2,645	10,300	10,295	8,684	3,969	4,809	2,547	3,364	4,435	5,703	6,306	6,261
1974	4,812	10,300	10,295	7,292	4,377	4,520	3,449	3,545	4,362	4,647	5,136	7,215
1975	9,325	8,592	7,229	3,965	4,370	4,498	3,328	3,619	5,659	4,470	5,103	6,685
1982	3,200	10,300	10,278	8,729	4,021	4,644	5,427	6,189	6,602	3,409	3,315	10,300
1983	10,295	5,166	4,260	3,508	3,518	3,457	4,485	4,237	5,415	5,535	7,700	6,010
1984	4,409	4,174	3,919	3,638	4,382	4,556	2,440	2,026	3,324	7,937	5,471	6,592
1986	2,325	4,285	7,970	9,865	10,294	6,155	5,477	2,759	3,227	5,969	5,052	3,490
Average	**5,616**	**7,585**	**8,429**	**7,136**	**5,070**	**4,565**	**3,597**	**3,685**	**5,643**	**4,715**	**4,894**	**6,170**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,520	6,672	6,936	7,128	7,970	4,782	4,051	3,972	3,304	6,684	5,366	1,799
1938	3,108	6,672	7,120	8,144	7,005	4,644	4,973	5,766	6,672	3,687	2,225	6,588
1941	2,362	3,738	7,246	8,237	8,500	7,592	5,942	4,575	4,281	6,684	2,710	4,187
1942	6,652	6,672	7,407	8,301	5,406	4,481	4,274	4,336	6,440	6,023	2,223	5,154
1943	6,652	6,672	7,187	7,470	4,358	4,508	4,274	3,806	3,221	6,684	4,870	1,441
1952	2,712	6,650	7,087	8,500	8,272	6,105	4,889	5,343	6,672	4,107	2,225	6,588
1953	6,652	6,672	7,222	7,239	4,556	4,644	3,061	3,713	5,824	6,684	5,938	3,185
1956	2,537	3,931	7,105	8,500	7,235	4,644	3,839	4,336	5,206	6,684	4,739	6,447
1958	6,652	6,672	7,130	7,647	8,364	4,783	5,544	4,575	6,672	5,352	2,225	6,588
1963	6,652	6,672	7,013	6,335	3,642	4,644	4,048	4,150	3,584	6,684	6,554	1,993
1965	2,250	6,045	7,085	8,500	6,108	4,643	4,274	4,494	3,230	6,684	6,082	1,964
1967	2,490	6,586	7,287	7,752	6,696	3,963	5,077	4,575	6,672	6,684	1,154	6,588
1969	2,562	5,133	7,026	8,182	8,500	4,319	4,889	5,522	6,672	2,769	2,225	6,588
1970	6,652	6,672	7,383	6,331	4,556	4,128	3,010	2,317	3,202	6,684	4,448	1,760
1971	2,617	6,672	7,172	7,384	6,359	7,064	3,079	3,827	4,435	6,684	6,403	4,462
1974	5,198	6,672	7,194	8,069	6,308	4,664	4,274	4,264	4,362	6,684	4,404	6,588
1975	6,652	6,672	7,165	6,115	4,515	4,447	4,154	4,336	5,659	6,684	2,427	6,588
1982	2,070	6,672	6,964	7,819	8,301	5,585	5,427	6,189	6,602	4,225	3,315	6,588
1983	6,652	6,672	7,592	4,588	3,584	3,457	4,485	4,237	5,415	5,535	6,554	6,588
1984	4,986	4,174	3,919	3,638	4,382	4,520	3,152	2,494	3,415	6,684	6,554	5,435
1986	2,269	4,286	7,078	7,219	8,500	7,592	6,499	3,589	3,224	6,684	5,613	3,747
Average	**4,328**	**6,061**	**7,015**	**7,290**	**6,339**	**5,010**	**4,439**	**4,306**	**4,989**	**5,965**	**4,203**	**4,808**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	1,207	3,628	13	2,115	-4,369	-139	-714	-624	-44	-45	1,821	1,256
1938	-15	3,628	3,167	-713	-2,914	0	-1,042	-710	2,540	-3,369	319	186
1941	-9	14	3,049	1,974	751	-2,948	-1,732	-956	-45	-2,701	2,552	-544
1942	1,626	3,628	2,888	-4,031	-916	163	-825	-717	0	-2,631	3,222	-678
1943	3,476	3,628	866	-3,473	132	12	-825	-908	1	-1,259	2,106	1,958
1952	-5	163	3,208	1,744	-799	-1,461	-1,440	-1,532	3,628	-935	-1,563	3,663
1953	3,643	821	-2,783	-3,242	-66	0	-532	-463	0	-1,953	1,500	1,629
1956	634	12	3,190	1,642	-2,296	0	-827	-717	0	-1,999	531	-526
1958	1,492	1,546	3,165	-1,078	-3,874	-139	-843	-956	3,628	-4,860	784	1,152
1963	3,643	3,070	-510	-2,831	201	0	-712	-624	-35	-495	-537	2,515
1965	-10	28	3,210	1,657	-2,215	1	-825	-1,128	-3	-92	-40	1,772
1967	486	10	3,008	2,466	-1,407	-2	-1,628	-956	3,628	559	-437	2,633
1969	662	-562	3,269	2,017	-1,785	-358	-966	931	524	-1,440	-1,405	3,712
1970	3,643	1,104	-3,204	-2,334	-66	225	-853	-468	2	468	2,849	3,411
1971	28	3,628	3,123	1,300	-2,390	-2,255	-532	-463	0	-981	-97	1,799
1974	-386	3,628	3,101	-777	-1,931	-144	-825	-719	0	-2,037	732	627
1975	2,673	1,920	64	-2,150	-145	51	-826	-717	0	-2,214	2,676	97
1982	1,130	3,628	3,314	910	-4,280	-941	0	0	0	-816	0	3,712
1983	3,643	-1,506	-3,332	-1,080	-66	0	0	0	0	0	1,146	-578
1984	-577	0	0	0	0	36	-712	-468	-91	1,253	-1,083	1,157
1986	56	-1	892	2,646	1,794	-1,437	-1,022	-830	3	-715	-561	-257
Average	**1,288**	**1,525**	**1,414**	**-154**	**-1,269**	**-445**	**-842**	**-620**	**654**	**-1,251**	**691**	**1,366**

71 Year Record-Wet Years
Total Banks Export for SWP (Banks-Wheeling) (in cubic feet per second)
Future Demand Level

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	48%	54%	0%	30%	-55%	-3%	-18%	-16%	-1%	-1%	34%	70%
1938	0%	54%	44%	-9%	-42%	0%	-21%	-12%	38%	-91%	14%	3%
1941	0%	0%	42%	24%	9%	-39%	-29%	-21%	-1%	-40%	94%	-13%
1942	24%	54%	39%	-49%	-17%	4%	-19%	-17%	0%	-44%	145%	-13%
1943	52%	54%	12%	-46%	3%	0%	-19%	-24%	0%	-19%	43%	136%
1952	0%	2%	45%	21%	-10%	-24%	-29%	-29%	54%	-23%	-70%	56%
1953	55%	12%	-39%	-45%	-1%	0%	-17%	-12%	0%	-29%	25%	51%
1956	25%	0%	45%	19%	-32%	0%	-22%	-17%	0%	-30%	11%	-8%
1958	22%	23%	44%	-14%	-46%	-3%	-15%	-21%	54%	-91%	35%	17%
1963	55%	46%	-7%	-45%	6%	0%	-18%	-15%	-1%	-7%	-8%	126%
1965	0%	0%	45%	19%	-36%	0%	-19%	-25%	0%	-1%	-1%	90%
1967	20%	0%	41%	32%	-21%	0%	-32%	-21%	54%	8%	-38%	40%
1969	26%	-11%	47%	25%	-21%	-8%	-20%	17%	8%	-52%	-63%	56%
1970	55%	17%	-43%	-37%	-1%	5%	-28%	-20%	0%	7%	64%	194%
1971	1%	54%	44%	18%	-38%	-32%	-17%	-12%	0%	-15%	-2%	40%
1974	-7%	54%	43%	-10%	-31%	-3%	-19%	-17%	0%	-30%	17%	10%
1975	40%	29%	1%	-35%	-3%	1%	-20%	-17%	0%	-33%	110%	1%
1982	55%	54%	48%	12%	-52%	-17%	0%	0%	0%	-19%	0%	56%
1983	55%	-23%	-44%	-24%	-2%	0%	0%	0%	0%	0%	17%	-9%
1984	-12%	0%	0%	0%	0%	1%	-23%	-19%	-3%	19%	-17%	21%
1986	2%	0%	13%	37%	21%	-19%	-16%	-23%	0%	-11%	-10%	-7%
Average	24%	23%	20%	-4%	-18%	-6%	-19%	-15%	10%	-24%	19%	44%

71 Year Record-Critical Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	4,900	5,385	6,882	6,412	9,614	10,430	5,837	4,977	4,000	5,442	3,415	3,008
1929	4,397	5,576	6,433	5,712	10,111	10,012	7,311	6,432	7,107	5,982	3,415	3,008
1931	4,001	4,504	5,277	6,027	7,798	7,068	7,819	4,505	4,000	4,861	3,415	3,008
1933	4,001	4,504	4,754	7,214	8,486	8,555	10,399	6,093	6,830	4,001	3,415	3,008
1934	2,992	3,645	6,440	7,470	12,656	11,401	10,399	5,593	6,897	4,001	3,415	3,008
1976	9,283	10,568	8,757	6,834	11,442	9,759	7,737	6,367	6,897	4,602	3,415	3,008
1977	2,992	4,686	6,424	6,420	7,830	6,803	6,901	4,698	4,000	4,001	3,415	3,008
1988	4,001	4,830	6,894	14,679	11,400	7,970	7,509	6,496	6,897	5,295	3,415	3,008
1990	4,001	4,504	6,456	6,912	11,400	7,308	10,251	6,103	6,897	6,116	3,738	3,008
1991	2,992	4,411	5,458	5,074	8,071	21,264	11,472	5,364	7,037	5,704	3,415	3,008
1992	2,992	4,065	5,491	5,373	20,984	14,087	10,590	5,700	6,764	5,638	3,415	3,008
Average	**4,232**	**5,153**	**6,297**	**7,102**	**10,890**	**10,423**	**8,748**	**5,666**	**6,121**	**5,058**	**3,444**	**3,008**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	3,496	2,940	7,066	7,345	4,020	2,992	1,396	1,494	2,183	673	109	1,765
1929	2,874	4,049	6,795	5,461	4,230	3,219	1,528	1,611	2,859	2,068	589	2,226
1931	2,233	3,257	3,100	5,818	3,191	2,135	1,587	1,263	1,271	442	219	1,234
1933	1,761	1,589	2,728	7,151	3,504	4,531	1,339	1,747	2,660	657	303	1,874
1934	1,594	2,152	5,450	7,279	3,119	2,886	1,835	1,501	2,185	544	109	1,711
1976	6,652	6,672	6,325	4,455	4,862	3,437	1,543	1,635	2,232	497	1,175	1,701
1977	2,547	1,397	6,563	6,664	3,464	653	686	1,012	332	2	2	851
1988	1,028	1,596	6,689	7,044	5,627	2,369	1,484	1,557	2,888	1,848	225	1,803
1990	2,510	1,151	3,306	7,026	3,047	2,234	1,815	1,403	1,532	506	415	1,333
1991	1,141	961	1,694	1,882	2,251	6,670	1,895	1,437	1,424	648	183	1,662
1992	1,644	1,221	1,927	3,494	7,506	3,882	1,789	1,506	2,900	1,221	305	2,437
Average	**2,498**	**2,453**	**4,695**	**5,784**	**4,075**	**3,183**	**1,536**	**1,470**	**2,042**	**828**	**330**	**1,691**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	1,404	2,445	-184	-933	5,594	7,438	4,441	3,483	1,817	4,769	3,306	1,243
1929	1,523	1,527	-362	251	5,881	6,793	5,783	4,821	4,248	3,914	2,826	782
1931	1,768	1,247	2,177	209	4,607	4,933	6,232	3,242	2,729	4,419	3,196	1,774
1933	2,240	2,915	2,026	63	4,982	4,024	9,060	4,346	4,170	3,344	3,112	1,134
1934	1,398	1,493	990	191	9,537	8,515	8,564	4,092	4,712	3,457	3,306	1,297
1976	2,631	3,896	2,432	2,379	6,580	6,322	6,194	4,732	4,665	4,105	2,240	1,307
1977	445	3,289	-139	-244	4,366	6,150	6,215	3,686	3,668	3,999	3,413	2,157
1988	2,973	3,234	205	7,635	5,773	5,601	6,025	4,939	4,009	3,447	3,190	1,205
1990	1,491	3,353	3,150	-114	8,353	5,074	8,436	4,700	5,365	5,610	3,323	1,675
1991	1,851	3,450	3,764	3,192	5,820	14,594	9,577	3,927	5,613	5,056	3,232	1,346
1992	1,348	2,844	3,564	1,879	13,478	10,205	8,801	4,194	3,864	4,417	3,110	571
Average	**1,734**	**2,699**	**1,602**	**1,319**	**6,816**	**7,241**	**7,212**	**4,197**	**4,078**	**4,231**	**3,114**	**1,317**

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	40%	83%	-3%	-13%	139%	249%	318%	233%	83%	709%	3033%	70%
1929	53%	38%	-5%	5%	139%	211%	378%	299%	149%	189%	480%	35%
1931	79%	38%	70%	4%	144%	231%	393%	257%	215%	1000%	1459%	144%
1933	127%	183%	74%	1%	142%	89%	677%	249%	157%	509%	1027%	61%
1934	88%	69%	18%	3%	306%	295%	467%	273%	216%	635%	3033%	76%
1976	40%	58%	38%	53%	135%	184%	401%	289%	209%	826%	191%	77%
1977	17%	235%	-2%	-4%	126%	942%	906%	364%	1105%	199950%	170650%	253%
1988	289%	203%	3%	108%	103%	236%	406%	317%	139%	187%	1418%	67%
1990	59%	291%	95%	-2%	274%	227%	465%	335%	350%	1109%	801%	126%
1991	162%	359%	222%	170%	259%	219%	505%	273%	394%	780%	1766%	81%
1992	82%	233%	185%	54%	180%	263%	492%	278%	133%	362%	1020%	23%
Average	**94%**	**163%**	**63%**	**34%**	**177%**	**286%**	**492%**	**288%**	**286%**	**18750%**	**16807%**	**92%**

71 Year Record-Dry Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	5,035	5,056	5,756	6,001	41,888	14,227	21,832	12,376	8,069	7,045	5,188	3,867
1926	5,300	4,982	5,391	7,050	26,844	11,141	19,891	11,011	6,117	7,206	5,236	3,926
1930	4,896	5,273	6,487	11,020	12,969	21,136	10,647	8,269	6,117	6,236	4,066	3,008
1932	3,481	4,221	8,229	7,915	15,639	11,401	11,259	9,904	10,541	4,993	4,066	3,293
1939	13,450	14,173	11,759	13,109	14,950	9,996	10,399	7,579	6,269	7,087	4,839	3,696
1944	5,244	6,306	5,192	6,396	25,392	17,940	9,297	7,666	8,333	6,962	4,788	3,491
1947	5,392	5,345	6,462	6,429	12,673	15,081	11,308	7,579	6,131	7,462	5,361	4,047
1949	6,029	6,171	5,838	5,467	8,525	39,264	11,634	11,124	7,322	5,861	4,691	4,080
1955	5,046	6,516	13,393	11,780	11,400	7,598	8,732	8,897	7,811	7,460	5,396	4,432
1960	4,811	5,076	7,005	6,046	18,149	14,308	11,400	7,769	6,290	7,582	5,484	4,131
1961	4,912	5,688	7,032	6,070	19,200	13,281	10,406	7,579	6,182	7,594	5,402	3,817
1964	6,415	19,784	8,113	20,764	11,400	8,487	7,691	7,754	6,663	7,498	5,633	4,125
1981	6,064	6,104	10,954	22,569	24,088	29,761	12,235	7,579	6,117	7,124	4,845	3,508
1985	6,520	29,597	23,900	10,888	14,549	14,122	8,934	10,012	6,117	7,449	5,367	3,857
1987	4,454	5,239	4,598	5,923	12,343	22,657	10,736	7,579	6,117	7,207	5,676	3,610
1989	2,992	4,955	5,308	5,794	8,175	27,882	19,011	10,274	6,117	7,524	5,694	3,820
Average	5,628	8,405	8,464	9,576	17,387	17,393	12,213	8,934	6,895	7,018	5,108	3,794

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	2,303	2,474	4,493	3,014	7,441	3,973	3,350	2,593	3,271	5,459	3,161	1,625
1926	2,731	2,652	3,325	7,254	7,441	3,137	3,018	2,567	2,766	5,708	3,062	1,579
1930	1,949	2,336	4,874	7,238	3,700	6,929	1,810	1,770	3,702	3,237	2,457	1,726
1932	1,489	1,666	6,974	7,237	3,967	3,095	3,105	1,346	137	138	135	1,423
1939	6,652	6,478	3,473	3,089	3,040	2,697	2,088	1,939	2,813	3,725	2,400	1,242
1944	5,336	6,129	3,646	7,194	8,067	4,791	2,020	1,996	3,322	3,121	2,383	1,423
1947	3,015	4,102	6,836	7,416	6,141	4,109	2,171	1,949	2,717	6,684	3,853	1,668
1949	5,231	3,710	4,356	4,467	3,562	7,066	2,473	2,433	3,106	2,735	2,200	1,867
1955	2,960	6,672	6,993	7,407	5,130	2,262	1,767	1,968	3,279	6,684	6,554	3,485
1960	2,538	2,548	6,893	5,146	7,471	4,052	1,902	1,703	2,818	6,684	6,035	1,915
1961	2,297	4,137	6,876	4,924	7,364	3,650	1,782	1,708	2,783	6,684	5,832	1,962
1964	6,652	6,672	5,836	7,373	2,717	2,537	1,815	1,968	2,813	6,684	5,053	1,812
1981	6,652	6,672	4,906	3,089	3,453	3,513	2,520	1,939	2,775	3,761	2,399	1,356
1985	6,652	6,672	6,159	2,364	4,606	3,704	1,847	2,212	2,744	6,684	4,992	1,851
1987	6,652	4,877	3,726	4,962	5,437	7,019	1,896	1,730	2,768	5,574	2,713	1,384
1989	1,244	2,468	2,577	4,084	2,802	6,930	2,734	2,028	2,751	6,684	5,461	2,905
Average	4,022	4,392	5,121	5,391	5,146	4,342	2,269	1,991	2,785	5,015	3,668	1,826

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	2,732	2,582	1,263	2,987	34,447	10,254	18,482	9,783	4,798	1,586	2,027	2,242
1926	2,569	2,330	2,066	-204	19,403	8,004	16,873	8,444	3,351	1,498	2,174	2,347
1930	2,947	2,937	1,613	3,782	9,269	14,207	8,837	6,499	2,415	2,999	1,609	1,282
1932	1,992	2,555	1,255	678	11,672	8,306	8,154	8,558	10,404	4,855	3,931	1,870
1939	6,798	7,695	8,286	10,020	11,910	7,299	8,311	5,640	3,456	3,362	2,439	2,454
1944	-92	177	1,546	-798	17,325	13,149	7,277	5,670	5,011	3,841	2,405	2,068
1947	2,377	1,243	-374	-987	6,532	10,972	9,137	5,630	3,414	778	1,508	2,379
1949	798	2,461	1,482	1,000	4,963	32,198	9,161	8,691	4,216	3,126	2,491	2,213
1955	2,086	-156	6,400	4,373	6,270	5,336	6,965	6,929	4,532	776	-1,158	947
1960	2,273	2,528	112	900	10,678	10,256	9,498	6,066	3,472	898	-551	2,216
1961	2,615	1,551	156	1,146	11,836	9,631	8,624	5,871	3,399	910	-430	1,855
1964	-237	13,112	2,277	13,391	8,683	5,950	5,876	5,786	3,850	814	580	2,313
1981	-588	-568	6,048	19,480	20,635	26,248	9,715	5,640	3,342	3,363	2,446	2,152
1985	-132	22,925	17,741	8,524	9,943	10,418	7,087	7,800	3,373	765	375	2,006
1987	-2,198	362	872	961	6,906	15,638	8,840	5,849	3,349	1,633	2,963	2,226
1989	1,748	2,487	2,731	1,710	5,373	20,952	16,277	8,246	3,366	840	233	915
Average	1,606	4,0[illegible]	3,342	4,185	12,240	13,051	9,945	6,944	4,109	2,003	1,440	1,968

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	119%	104%	28%	99%	463%	258%	552%	377%	147%	29%	64%	138%
1926	94%	88%	62%	-3%	261%	255%	559%	329%	121%	26%	71%	149%
1930	151%	126%	33%	52%	251%	205%	488%	367%	65%	93%	65%	74%
1932	134%	153%	18%	9%	294%	268%	263%	636%	7594%	3518%	2912%	131%
1939	102%	119%	239%	324%	392%	271%	398%	291%	123%	90%	102%	198%
1944	-2%	3%	42%	-11%	215%	274%	360%	284%	151%	123%	101%	145%
1947	79%	30%	-5%	-13%	106%	267%	421%	289%	126%	12%	39%	143%
1949	15%	66%	34%	22%	139%	456%	370%	357%	136%	114%	113%	119%
1955	70%	-2%	92%	59%	122%	236%	394%	352%	138%	12%	-18%	27%
1960	90%	99%	2%	17%	143%	253%	499%	356%	123%	13%	-9%	116%
1961	114%	37%	2%	23%	161%	264%	484%	344%	122%	14%	-7%	95%
1964	-4%	197%	39%	182%	320%	235%	324%	294%	137%	12%	11%	128%
1981	-9%	-9%	123%	631%	598%	747%	386%	291%	120%	89%	102%	159%
1985	-2%	344%	288%	361%	216%	281%	384%	353%	123%	11%	8%	108%
1987	-33%	7%	23%	19%	127%	223%	466%	338%	121%	29%	109%	161%
1989	141%	101%	106%	42%	192%	302%	595%	407%	122%	13%	4%	31%
Average	66%	91%	70%	113%	250%	300%	434%	354%	592%	262%	229%	120%

71 Year Record-Below Normal Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Existing Demand Level
Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	6,649	10,097	36,622	32,819	22,482	9,048	22,855	13,048	7,757	7,507	6,186	3,670
1935	2,992	5,639	5,536	18,253	11,400	20,245	38,018	28,043	9,237	7,089	5,618	3,601
1936	4,519	5,217	5,381	20,689	65,708	26,537	19,454	12,444	7,917	6,663	5,088	3,574
1937	4,661	5,021	6,555	6,867	33,793	44,084	21,168	13,653	11,061	6,505	4,668	3,008
1945	5,326	6,052	6,793	6,290	48,885	25,527	12,477	10,783	9,307	6,505	4,869	3,350
1946	5,125	7,610	66,045	49,557	21,949	16,635	12,392	11,259	8,771	7,231	5,360	3,611
1948	5,449	5,414	5,763	6,403	11,400	10,956	21,681	26,852	11,576	9,938	6,209	4,535
1950	5,217	5,184	5,525	9,655	25,488	15,574	16,869	11,792	8,692	8,249	5,869	4,157
1959	16,845	10,762	6,131	34,692	55,540	16,493	8,466	7,579	6,840	7,816	5,428	4,359
1962	4,684	5,089	6,908	6,001	46,440	18,372	10,222	11,401	6,840	8,566	5,731	4,225
1966	5,776	15,268	7,025	27,534	23,483	20,162	12,223	11,124	6,840	7,840	6,302	4,178
1968	18,750	12,214	11,136	28,501	67,390	34,040	10,320	7,579	6,840	7,763	5,298	4,174
1972	6,390	6,511	13,603	13,008	18,669	23,995	10,608	7,579	6,840	8,522	5,857	3,765
1979	6,358	6,420	4,993	24,716	44,378	29,638	16,452	14,181	10,448	6,505	4,937	3,918
Average	**7,053**	**7,607**	**13,430**	**20,356**	**35,500**	**22,236**	**16,658**	**13,380**	**8,498**	**7,621**	**5,530**	**3,866**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	6,652	6,672	7,417	5,303	485	3,048	3,856	3,133	3,270	5,974	3,493	1,791
1935	1,354	3,678	2,681	7,534	3,167	6,056	4,048	4,178	3,620	5,619	3,807	2,043
1936	2,952	2,547	3,247	7,634	8,500	7,254	3,591	3,035	3,245	4,319	3,003	1,908
1937	2,347	2,140	7,052	6,872	8,500	7,592	4,014	3,351	1,443	890	1,882	1,755
1 5	2,510	6,672	7,159	7,058	7,942	4,051	2,940	2,528	3,739	2,071	2,348	1,685
1946	4,093	6,672	7,260	7,739	3,230	4,650	2,941	2,681	3,519	5,315	3,244	1,787
1948	3,277	3,655	3,491	6,717	3,223	3,011	3,286	3,854	4,133	6,684	6,554	5,759
1950	2,730	2,820	2,476	7,338	7,441	4,544	2,964	2,699	3,505	6,684	5,495	2,062
1959	6,652	3,709	3,532	3,147	3,657	3,249	1,883	1,965	2,968	3,973	2,521	2,298
1962	1,912	2,808	6,373	3,392	7,934	6,128	2,096	2,461	2,968	6,684	4,246	2,205
1966	6,652	6,672	7,296	7,979	5,805	4,228	2,536	2,433	2,966	5,963	2,990	1,966
1968	4,968	3,372	2,615	2,207	2,759	3,249	2,340	1,937	2,968	3,697	2,434	2,008
1972	6,652	6,672	7,003	5,202	4,542	5,081	2,312	1,967	2,944	6,684	4,989	2,331
1979	6,652	6,672	2,717	6,331	3,589	3,749	3,302	3,256	3,157	993	2,085	2,279
Average	**4,243**	**4,626**	**5,023**	**6,032**	**5,055**	**4,706**	**3,008**	**2,820**	**3,175**	**4,682**	**3,507**	**2,277**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	-3	3,425	29,205	27,516	21,997	6,000	18,999	9,915	4,487	1,533	2,693	1,879
1935	1,638	1,961	2,855	10,719	8,233	14,189	33,970	23,865	5,617	1,470	1,811	1,558
1936	1,567	2,670	2,134	13,055	57,208	19,283	15,863	9,409	4,672	2,344	2,085	1,666
1937	2,314	2,881	-497	-5	25,293	36,492	17,154	10,302	9,618	5,615	2,786	1,253
1945	2,816	-620	-366	-768	40,943	21,476	9,537	8,255	5,568	4,434	2,521	1,665
1946	1,032	938	58,785	41,818	18,719	11,985	9,451	8,578	5,252	1,916	2,116	1,824
1948	2,172	1,759	2,272	-314	8,177	7,945	18,395	22,998	7,443	3,254	-345	-1,224
1950	2,487	2,364	3,049	2,317	18,047	11,030	13,905	9,093	5,187	1,565	374	2,09
1959	10,193	7,053	2,599	31,545	51,883	13,244	6,583	5,614	3,872	3,843	2,907	2,06
1962	2,772	2,281	535	2,609	38,506	12,244	8,126	8,940	3,872	1,882	1,485	2,020
1966	-876	8,596	-271	19,555	17,678	15,934	9,687	8,691	3,874	1,877	3,312	2,210
1968	13,782	8,842	8,521	26,294	64,631	30,791	7,980	5,642	3,872	4,066	2,864	2,16
1972	-262	-161	6,600	7,806	14,127	18,914	8,296	5,612	3,896	1,838	868	1,43
1979	-294	-252	2,276	18,385	40,789	25,889	13,150	10,925	7,291	5,512	2,852	1,639
Average	**2,810**	**2,981**	**8,407**	**14,324**	**30,445**	**17,530**	**13,650**	**10,560**	**5,323**	**2,939**	**2,024**	**1,58**

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0%	51%	394%	519%	4535%	197%	493%	316%	137%	26%	77%	105%
1935	121%	53%	106%	142%	260%	234%	839%	571%	155%	26%	48%	76%
1936	53%	105%	66%	171%	673%	266%	442%	310%	144%	54%	69%	87%
1937	99%	135%	-7%	0%	298%	481%	427%	307%	667%	631%	148%	71%
1945	112%	-9%	-5%	-11%	516%	530%	324%	327%	149%	214%	107%	99%
1946	25%	14%	810%	540%	580%	258%	321%	320%	149%	36%	65%	102%
1948	66%	48%	65%	-5%	254%	264%	560%	597%	180%	49%	-5%	-21%
1950	91%	84%	123%	32%	243%	243%	469%	337%	148%	23%	7%	102
1959	153%	190%	74%	1002%	1419%	408%	350%	286%	130%	97%	115%	90%
1962	145%	81%	8%	77%	485%	200%	388%	363%	130%	28%	35%	92%
1966	-13%	129%	-4%	245%	305%	377%	382%	357%	131%	31%	111%	112
1968	277%	262%	326%	1191%	2343%	948%	341%	291%	130%	110%	118%	108
1972	-4%	-2%	94%	150%	311%	372%	359%	285%	132%	27%	17%	62%
1979	-4%	-4%	84%	290%	1137%	691%	398%	336%	231%	555%	137%	72%
Average	**80%**	**81%**	**152%**	**310%**	**954%**	**390%**	**435%**	**357%**	**187%**	**136%**	**75%**	**83**

71 Year Record-Above Normal Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	4,001	4,976	6,797	9,148	42,012	30,918	20,926	45,675	24,223	8,002	5,302	3,512
1928	5,650	14,662	6,396	19,636	24,133	99,245	24,825	13,323	7,579	8,985	6,247	3,884
1940	4,746	5,225	5,657	17,503	44,468	95,245	65,185	14,541	7,579	8,120	5,737	3,469
1951	6,015	41,413	80,013	64,871	65,443	27,244	14,570	16,507	7,579	9,719	6,459	4,149
1954	6,677	12,929	9,903	27,223	58,965	44,256	40,101	17,448	7,579	9,411	6,594	4,201
1957	9,864	6,487	5,439	9,389	34,707	41,278	15,542	14,545	8,393	9,828	7,258	3,988
1973	5,884	12,018	15,862	75,506	93,831	59,818	17,078	15,911	9,934	8,375	5,931	4,364
1978	2,992	4,043	6,855	62,409	60,480	68,897	40,511	18,022	8,699	8,002	5,302	5,138
1980	4,001	7,012	8,351	111,271	132,383	69,359	17,002	13,478	7,579	8,002	5,302	5,116
Average	5,537	12,085	16,141	44,106	61,825	59,584	28,416	18,828	9,905	8,716	6,015	4,202

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	2,369	2,652	7,211	7,918	8,500	5,065	4,001	4,377	6,672	311	307	1,847
1928	5,215	6,672	7,103	7,545	4,469	4,228	3,687	2,926	3,161	3,661	2,759	1,652
1940	1,740	2,048	3,160	7,477	7,821	7,254	4,048	3,419	3,164	6,684	4,242	1,981
1951	4,671	6,672	7,592	8,500	6,593	4,363	3,121	3,488	3,154	6,004	3,252	1,945
1954	6,652	6,672	6,424	5,434	3,819	4,349	3,687	3,390	3,132	4,682	3,143	2,053
1957	6,652	6,509	3,506	7,164	6,131	4,375	2,903	2,793	3,381	6,644	3,294	1,893
1973	3,783	6,672	6,990	7,344	8,079	5,734	3,386	3,465	3,907	3,467	2,827	2,662
1978	1,404	1,334	6,584	3,949	1,516	2,846	2,863	2,630	2,017	453	303	3,564
1980	3,460	6,672	7,071	8,500	4,321	3,255	2,887	3,386	1,551	307	703	5,790
Average	3,994	5,100	6,182	7,092	5,694	4,608	3,398	3,319	3,349	3,579	2,314	2,599

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	1,632	2,324	-414	1,230	33,512	25,853	16,925	41,298	17,551	7,691	4,995	1,665
1928	435	7,990	-707	12,091	19,664	95,017	21,138	10,397	4,418	5,324	3,488	2,232
1940	3,006	3,177	2,497	10,026	36,647	87,991	61,137	11,122	4,415	1,436	1,495	1,488
1951	1,344	34,741	72,421	56,371	58,850	22,881	11,449	13,019	4,425	3,715	3,207	2,204
1954	25	6,257	3,479	21,789	55,146	39,907	36,414	14,058	4,447	4,729	3,451	2,148
1957	3,212	-22	1,933	2,225	28,576	36,903	12,639	11,752	5,012	3,184	3,964	2,095
1973	2,101	5,346	8,872	68,162	85,752	54,084	13,692	12,446	6,027	4,908	3,104	1,702
1978	1,588	2,709	271	58,460	58,964	66,051	37,648	15,392	6,682	7,549	4,999	1,574
1980	541	340	1,280	102,771	128,062	66,104	14,115	10,092	6,028	7,695	4,599	-674
Average	1,543	6,985	9,959	37,014	56,130	54,977	25,017	15,508	6,556	5,137	3,700	1,604

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	69%	88%	-6%	16%	394%	510%	423%	944%	263%	2473%	1627%	90%
1928	8%	120%	-10%	160%	440%	2247%	573%	355%	140%	145%	126%	135%
1940	173%	155%	79%	134%	469%	1213%	1510%	325%	140%	21%	35%	75%
1951	29%	521%	954%	663%	893%	524%	367%	373%	140%	62%	99%	113%
1954	0%	94%	54%	401%	1444%	918%	988%	415%	142%	101%	110%	105%
1957	48%	0%	55%	31%	466%	843%	435%	421%	148%	48%	120%	111%
1973	56%	80%	127%	928%	1061%	943%	404%	359%	154%	142%	110%	64%
1978	113%	203%	4%	1480%	3889%	2321%	1315%	585%	331%	1666%	1650%	44%
1980	16%	5%	18%	1209%	2964%	2031%	489%	298%	389%	2507%	654%	-12%
Average	57%	141%	142%	558%	1336%	1283%	723%	453%	205%	796%	503%	81%

71 Year Record-Wet Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Existing Demand Level
Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	5,098	8,710	6,648	23,052	119,988	36,601	47,282	21,219	7,880	8,002	5,741	3,559
1938	4,094	19,264	68,198	31,378	142,680	163,211	66,021	60,575	32,476	8,002	5,741	6,249
1941	4,920	5,575	39,933	99,976	116,742	96,082	79,655	39,525	11,632	8,002	5,741	5,464
1942	9,488	14,983	65,496	82,007	143,140	25,114	51,177	35,765	16,858	8,002	5,741	5,147
1943	10,450	16,112	26,449	81,084	59,519	80,525	28,153	15,968	7,579	8,002	5,741	3,152
1952	5,260	6,565	39,374	86,226	78,449	62,223	64,228	61,381	32,319	8,002	5,741	7,296
1953	17,538	12,042	43,745	102,059	25,722	17,525	17,403	21,980	15,704	8,002	5,741	5,551
1956	4,581	5,656	71,200	156,594	89,433	34,191	19,238	40,363	14,515	8,002	6,124	6,094
1958	6,592	6,811	15,833	34,615	158,449	122,685	102,075	41,188	28,414	8,002	5,741	6,673
1963	25,338	6,997	20,531	12,513	67,538	25,556	91,392	27,478	8,852	8,002	6,143	5,096
1965	4,882	6,176	70,285	110,627	29,323	16,371	46,846	20,272	7,579	9,017	6,045	3,726
1967	5,019	6,230	31,899	46,677	58,858	56,259	49,253	46,128	36,287	9,802	5,741	7,259
1969	5,281	5,645	10,774	116,695	135,202	57,405	47,555	59,410	26,877	8,002	5,741	9,946
1970	20,276	14,092	55,586	205,728	91,231	35,324	11,571	8,923	7,579	9,091	5,893	3,880
1971	5,178	12,428	62,463	48,641	23,677	46,262	17,875	27,439	12,689	8,002	6,438	5,945
1974	5,655	56,170	63,717	130,199	42,707	104,902	71,971	22,129	12,454	8,002	5,887	6,803
1975	9,064	11,488	12,038	10,364	66,172	85,521	22,512	30,338	15,245	8,002	6,042	6,309
1982	4,937	25,205	84,808	79,870	99,462	82,227	142,869	48,456	16,959	8,002	5,801	12,412
1983	33,848	46,767	89,978	107,987	189,091	263,316	111,070	63,414	74,552	32,035	9,718	26,028
1984	37,420	83,001	159,166	85,444	49,714	36,157	14,520	10,756	7,894	8,339	5,741	5,727
1986	4,705	5,200	7,022	8,751	217,339	154,185	31,569	12,627	7,579	8,002	5,741	3,881
Average	**10,934**	**17,863**	**49,769**	**79,071**	**95,449**	**76,269**	**54,011**	**35,016**	**19,139**	**9,348**	**6,047**	**6,962**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,457	6,672	6,933	7,117	7,910	4,447	4,048	4,023	2,677	1,049	2,187	1,952
1938	3,108	6,672	7,090	8,123	5,189	3,888	3,312	4,063	5,653	307	305	6,588
1941	2,361	3,766	7,192	8,221	8,500	7,542	3,954	3,736	3,977	307	303	5,038
1942	6,652	6,672	3,458	3,089	3,453	3,376	3,965	4,377	6,658	311	307	6,010
1943	6,652	6,672	4,194	3,228	3,702	3,408	3,946	2,343	2,288	866	1,822	1,458
1952	2,620	6,672	7,043	8,500	8,278	5,306	3,808	4,236	5,248	3,851	955	6,588
1953	5,723	3,618	3,427	2,284	2,745	3,249	2,973	3,745	5,946	311	622	4,285
1956	2,603	3,769	7,040	8,500	8,500	7,254	3,793	4,377	5,406	1,967	3,150	6,588
1958	6,652	6,672	7,111	7,582	4,852	5,512	4,704	4,690	6,165	1,288	2,442	6,588
1963	6,652	6,672	7,005	7,234	2,013	6,281	4,050	4,178	3,536	2,445	2,700	3,861
1965	2,183	6,358	7,047	8,500	7,821	5,380	4,274	4,699	3,167	4,737	3,241	1,995
1967	2,618	6,672	7,265	7,687	7,836	3,205	4,194	4,063	5,653	6,173	1,194	6,588
1969	2,606	4,788	6,988	8,144	8,166	3,103	3,277	3,624	4,996	1,973	382	6,588
1970	6,652	3,618	3,166	3,058	2,745	3,249	3,000	2,353	3,141	2,677	2,307	1,859
1971	2,596	6,672	7,150	7,389	4,742	6,870	3,057	3,851	4,513	3,650	3,264	5,649
1974	6,652	6,672	7,091	7,815	4,093	4,281	4,274	4,458	4,432	2,330	2,181	6,588
1975	6,652	6,672	6,752	3,464	3,941	4,349	4,134	4,377	5,835	1,185	3,057	6,588
1982	1,928	6,672	6,956	7,786	8,500	4,365	4,906	5,713	6,672	3,985	3,390	6,588
1983	6,652	4,029	3,676	2,983	3,020	2,514	3,234	2,207	3,075	3,193	5,445	3,734
1984	2,687	2,361	1,969	1,759	2,499	3,112	3,136	2,552	3,342	1,624	2,117	6,034
1986	2,281	4,427	7,059	7,181	8,500	7,592	6,234	3,597	2,698	860	1,791	3,416
Average	**4,237**	**5,562**	**5,982**	**6,174**	**5,572**	**4,680**	**3,918**	**3,870**	**4,528**	**2,147**	**2,055**	**4,980**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,641	2,038	-285	15,935	112,078	32,154	43,234	17,196	5,203	6,953	3,554	1,607
1938	986	12,592	61,108	23,255	137,491	159,323	62,709	56,512	26,823	7,695	5,436	-339
1941	2,559	1,809	32,741	91,755	108,242	88,540	75,701	35,789	7,655	7,695	5,438	426
1942	2,836	8,311	62,038	78,918	139,687	21,738	47,212	31,388	10,200	7,691	5,434	-863
1943	3,798	9,440	22,255	77,856	55,817	77,117	24,207	13,625	5,291	7,136	3,919	1,694
1952	2,640	-107	32,331	77,726	70,171	56,917	60,420	57,145	27,071	4,151	4,786	708
1953	11,815	8,424	40,318	99,775	22,977	14,276	14,430	18,235	9,758	7,691	5,119	1,266
1956	1,978	1,887	64,160	148,094	80,933	26,937	15,445	35,986	9,109	6,035	2,974	-494
1958	-60	139	8,722	27,033	153,597	117,173	97,371	36,498	22,249	6,714	3,299	85
1963	18,686	325	13,526	5,279	65,525	19,275	87,342	23,300	5,316	5,557	3,443	1,235
1965	2,699	-182	63,238	102,127	21,502	10,991	42,572	15,573	4,412	4,280	2,804	1,731
1967	2,401	-442	24,634	38,990	51,022	53,054	45,059	42,065	30,634	3,629	4,547	671
1969	2,675	857	3,786	108,551	127,036	54,302	44,278	55,786	21,881	6,029	5,359	3,358
1970	13,624	10,474	52,420	202,670	88,486	32,075	8,571	6,570	4,438	6,414	3,586	2,021
1971	2,582	5,756	55,313	41,252	18,935	39,392	14,818	23,588	8,176	4,352	3,174	296
1974	-997	49,498	56,626	122,384	38,614	100,621	67,697	17,671	8,022	5,672	3,706	215
1975	2,412	4,816	5,286	6,900	62,231	81,172	18,378	25,961	9,410	6,817	2,985	-279
1982	3,009	18,533	77,852	72,084	90,962	77,862	137,963	42,743	10,287	4,017	2,411	5,824
1983	27,196	42,738	86,302	105,004	186,071	260,802	107,836	81,207	71,477	28,842	4,273	22,294
1984	34,733	80,640	157,197	83,685	47,215	33,045	11,384	8,204	4,552	6,715	3,624	-307
1986	2,424	773	-37	1,570	208,839	146,593	25,335	9,030	4,881	7,142	3,950	465
Average	**6,697**	**12,301**	**43,787**	**72,897**	**89,878**	**71,589**	**50,093**	**31,146**	**14,612**	**7,201**	**3,991**	**1,982**

71 Year Record-Wet Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Existing Demand Level

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	107%	31%	-4%	224%	1417%	723%	1068%	427%	194%	663%	163%	82%
1938	32%	189%	862%	286%	2650%	4098%	1893%	1391%	474%	2507%	1782%	-5%
1941	108%	48%	455%	1116%	1273%	1174%	1915%	958%	192%	2507%	1795%	8%
1942	43%	125%	1794%	2555%	4045%	644%	1191%	717%	153%	2473%	1770%	-14%
1943	57%	141%	531%	2412%	1508%	2263%	613%	582%	231%	824%	215%	116%
1952	101%	-2%	459%	914%	848%	1073%	1587%	1349%	516%	108%	501%	11%
1953	206%	233%	1176%	4368%	837%	439%	485%	487%	164%	2473%	823%	30%
1956	76%	50%	911%	1742%	952%	371%	407%	822%	168%	307%	94%	-7%
1958	-1%	2%	123%	357%	3166%	2126%	2070%	778%	361%	521%	135%	1%
1963	281%	5%	193%	73%	3255%	307%	2157%	558%	150%	227%	128%	32%
1965	124%	-3%	897%	1201%	275%	204%	996%	331%	139%	90%	87%	87%
1967	92%	-7%	339%	507%	651%	1655%	1074%	1035%	542%	59%	381%	10%
1969	103%	18%	54%	1333%	1556%	1750%	1351%	1539%	438%	306%	1403%	51%
1970	205%	289%	1656%	6628%	3224%	987%	286%	279%	141%	240%	155%	109%
1971	99%	86%	774%	558%	399%	573%	485%	613%	181%	119%	97%	5%
1974	-15%	742%	799%	1566%	943%	2350%	1584%	396%	181%	243%	170%	3%
1975	36%	72%	78%	199%	1579%	1866%	445%	593%	161%	575%	98%	-4%
1982	156%	278%	1119%	926%	1070%	1784%	2812%	748%	154%	101%	71%	88%
1983	409%	1061%	2348%	3520%	6161%	10374%	3334%	3680%	2324%	903%	78%	597%
1984	1293%	3416%	7984%	4758%	1889%	1062%	363%	321%	136%	413%	171%	-5%
1986	106%	17%	-1%	22%	2457%	1931%	406%	251%	181%	830%	221%	14%
Average	172%	323%	1074%	1679%	1912%	1798%	1263%	850%	342%	785%	492%	58%

71 Year Record-Critical Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	4,001	5,427	7,157	6,382	9,958	10,430	5,833	5,135	4,000	4,101	3,415	3,008
1929	4,001	5,841	6,833	5,699	10,224	10,012	7,406	6,432	7,107	5,788	3,415	3,008
1931	4,001	4,504	6,152	6,163	7,914	6,979	7,819	4,505	4,000	4,550	3,415	3,008
1934	2,992	3,829	6,500	6,873	11,774	11,401	10,399	5,613	6,897	4,199	3,415	3,008
1935	2,992	5,736	5,543	17,681	11,400	20,070	37,677	28,043	9,250	7,396	6,276	5,029
1976	8,450	6,762	7,447	6,417	11,530	8,760	7,997	6,367	6,897	6,561	3,415	3,008
1977	2,992	4,885	6,782	4,505	7,937	7,003	6,897	4,724	4,000	4,001	3,415	3,008
1988	4,001	4,992	6,953	15,020	11,400	7,947	7,513	6,496	6,897	6,215	3,415	3,008
1990	4,001	4,504	6,643	7,234	11,400	7,003	10,251	6,134	6,897	6,762	3,415	3,008
1991	2,992	4,475	5,559	5,212	8,101	21,656	11,470	5,542	7,037	4,594	3,415	3,008
1992	2,992	4,028	4,397	5,325	22,293	13,942	10,598	5,763	6,764	4,906	3,415	3,008
Average	**3,947**	**4,998**	**6,361**	**7,865**	**11,266**	**11,382**	**11,260**	**7,705**	**6,341**	**5,370**	**3,675**	**3,192**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	3,452	3,252	7,066	5,328	4,157	2,487	1,380	104	76	152	33	630
1929	2,760	4,390	4,740	5,487	4,286	2,994	1,506	1,606	2,695	1,082	93	1,140
1931	2,169	2,758	6,539	5,905	3,242	2,101	1,568	87	61	62	59	521
1933	1,685	1,538	2,944	6,983	3,235	2,298	2,086	1,732	2,961	3,045	106	779
1934	1,630	2,044	5,942	7,279	2,807	2,854	1,834	1,505	2,546	1,107	111	586
1976	6,652	6,672	5,557	4,479	5,591	3,227	1,549	1,623	2,972	6,684	1,179	1,571
1977	2,426	2,425	6,866	3,345	3,779	795	678	1,022	247	2	2	837
1988	326	1,574	6,930	7,056	1,649	2,367	1,474	1,185	1,163	1,229	85	639
1990	2,687	1,216	5,902	7,042	3,044	2,121	1,795	1,400	1,379	725	236	1,167
1991	1,077	1,133	2,084	2,207	2,588	6,847	1,901	1,438	2,811	2,183	93	1,146
1992	1,682	1,758	2,241	3,670	7,578	4,093	1,790	878	847	619	110	966
Average	**2,413**	**2,615**	**5,165**	**5,344**	**3,814**	**2,926**	**1,596**	**1,144**	**1,614**	**1,535**	**192**	**907**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	549	2,175	91	1,054	5,801	7,943	4,453	5,031	3,924	3,949	3,382	2,378
1929	1,241	1,451	2,093	212	5,938	7,018	5,900	4,826	4,412	4,706	3,322	1,868
1931	1,832	1,746	-387	258	4,672	4,878	6,251	4,418	3,939	4,488	3,356	2,487
1933	1,307	2,291	3,556	-110	8,539	9,103	8,313	3,881	3,936	1,154	3,309	2,229
1934	1,362	3,692	-399	10,402	8,593	17,216	35,843	26,538	6,704	6,289	6,165	4,443
1976	1,798	90	1,890	1,938	5,939	5,533	6,448	4,744	3,925	-123	2,236	1,437
1977	566	2,460	-84	1,160	4,158	6,208	6,219	3,702	3,753	3,999	3,413	2,171
1988	3,675	3,418	23	7,964	9,751	5,580	6,039	5,311	5,734	4,986	3,330	2,369
1990	1,314	3,288	741	192	8,356	4,882	8,456	4,734	5,518	6,037	3,179	1,841
1991	1,915	3,342	3,475	3,005	5,513	14,809	9,569	4,104	4,226	2,411	3,322	1,862
1992	1,310	2,270	2,156	1,655	14,715	9,849	8,808	4,885	5,917	4,287	3,305	2,042
Average	**1,534**	**2,384**	**1,196**	**2,521**	**7,452**	**8,456**	**9,664**	**6,561**	**4,726**	**3,835**	**3,484**	**2,284**

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	16%	67%	1%	20%	140%	319%	323%	4838%	5163%	2598%	10248%	377%
1929	45%	33%	44%	4%	139%	234%	392%	300%	164%	435%	3572%	164%
1931	84%	63%	-6%	4%	144%	232%	399%	5078%	6457%	7239%	5688%	477%
1933	78%	149%	121%	-2%	264%	396%	399%	224%	133%	38%	3122%	286%
1934	84%	181%	-7%	143%	306%	603%	1954%	1763%	263%	568%	5554%	758%
1976	27%	1%	34%	43%	106%	171%	416%	292%	132%	-2%	190%	91%
1977	23%	101%	-1%	35%	110%	781%	917%	362%	1519%	199950%	170650%	259%
1988	1127%	217%	0%	113%	591%	236%	410%	448%	493%	406%	3918%	371%
1990	49%	270%	13%	3%	275%	230%	471%	338%	400%	833%	1347%	158%
1991	178%	295%	167%	136%	213%	216%	503%	285%	150%	110%	3572%	162%
1992	78%	129%	96%	45%	194%	241%	492%	556%	699%	693%	3005%	211%
Average	**163%**	**137%**	**42%**	**49%**	**226%**	**333%**	**607%**	**1317%**	**1416%**	**19352%**	**19170%**	**301%**

71 Year Record-Dry Years
Total Outflow from Delta (DV58+DV60+RF91) (In cubic feet per second)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	4,615	4,994	5,754	6,001	42,205	13,751	22,069	12,425	8,057	6,216	4,584	3,665
1926	4,661	4,956	6,219	6,944	25,616	11,282	20,615	10,882	6,117	6,752	5,791	4,881
1930	4,639	4,888	6,750	11,735	13,097	20,661	10,691	8,269	6,117	4,993	4,066	3,008
1932	2,992	4,221	8,333	7,564	14,930	11,401	11,259	9,456	10,541	4,993	4,066	3,324
1939	14,004	6,700	6,283	9,752	10,105	9,641	10,399	7,579	6,300	7,099	6,366	4,640
1944	4,001	6,095	7,350	6,678	19,827	15,253	9,871	7,821	8,292	6,626	6,191	3,506
1947	4,103	5,379	6,615	6,468	12,684	14,867	11,309	7,579	6,134	6,811	6,334	4,154
1949	5,420	5,441	7,001	5,583	8,814	41,209	11,850	11,124	7,287	5,752	4,066	4,194
1955	4,001	6,400	13,863	11,164	11,400	7,300	9,178	8,988	7,769	6,776	6,386	4,157
1960	4,001	5,496	6,213	5,914	18,606	13,296	11,400	7,772	6,302	7,401	5,869	5,278
1961	4,001	5,972	7,016	6,325	16,773	13,492	10,555	7,579	6,181	6,744	5,877	3,008
1964	6,047	17,647	6,215	14,868	11,400	7,852	7,955	7,857	6,638	7,059	5,767	5,152
1981	5,830	5,760	6,571	10,671	19,477	25,248	12,285	7,579	6,117	7,171	6,183	5,135
1985	6,227	24,990	20,404	9,560	11,695	10,983	9,059	10,012	6,117	7,391	5,806	5,612
1987	4,040	4,511	7,072	6,480	12,081	20,077	11,129	7,579	6,117	6,891	4,066	3,439
1989	2,992	4,916	5,218	5,831	8,175	27,826	19,207	10,242	6,117	6,652	6,308	3,904
Average	5,098	7,398	7,930	8,221	16,055	16,509	12,427	8,921	6,888	6,583	5,483	4,191

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	2,525	2,606	4,971	3,061	7,441	3,844	3,371	2,572	3,340	2,664	870	1,325
1926	2,635	2,642	3,515	7,270	7,441	3,197	3,081	2,276	2,837	6,684	4,829	1,245
1930	1,919	1,248	5,606	7,293	3,607	6,755	1,801	1,771	3,195	4,024	950	1,595
1932	1,438	1,836	7,018	7,264	3,680	3,084	3,060	1,253	130	131	128	1,307
1939	6,652	6,672	7,057	6,784	4,556	2,677	2,078	1,915	2,835	6,684	3,444	658
1944	3,504	5,223	7,032	7,568	8,121	4,330	2,058	1,954	3,377	5,832	951	1,338
1947	2,942	4,395	7,164	6,317	6,284	4,056	2,159	1,924	2,772	6,684	2,084	1,360
1949	3,800	3,987	5,113	4,779	3,645	7,066	2,482	2,405	3,157	2,753	130	1,915
1955	2,854	6,136	7,017	7,456	5,153	2,140	1,796	1,955	3,315	6,684	2,386	1,835
1960	2,416	2,486	3,744	5,796	7,495	3,759	1,887	1,702	2,827	6,684	5,498	1,782
1961	2,187	4,542	6,882	5,176	7,352	3,713	1,787	1,706	2,840	6,309	1,127	2,194
1964	6,652	6,672	5,833	7,395	3,239	2,348	1,802	1,943	2,869	6,684	3,763	1,302
1981	6,652	6,215	7,193	7,697	6,313	4,601	2,412	1,916	2,831	6,684	3,890	1,338
1985	6,652	6,672	7,461	7,120	4,885	2,875	1,919	2,187	2,804	6,684	6,554	1,723
1987	6,292	3,045	6,865	7,255	5,260	6,354	300	1,727	2,013	499	865	1,486
1989	705	2,766	2,909	4,167	2,594	6,916	2,751	2,024	2,823	6,684	5,068	3,001
Average	3,739	4,196	5,961	6,399	5,442	4,232	2,172	1,952	2,748	5,148	2,659	1,588

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	2,090	2,388	783	2,940	34,764	9,907	18,698	9,853	4,717	3,552	3,714	2,340
1926	2,026	2,314	2,704	-326	18,175	8,085	17,534	8,606	3,280	68	962	3,636
1930	2,720	3,640	1,144	4,442	9,490	13,906	8,890	6,498	2,922	969	3,116	1,413
1932	1,554	2,385	1,315	300	11,250	8,317	8,199	8,203	10,411	4,862	3,938	2,017
1939	7,352	28	-774	2,988	5,549	6,964	8,321	5,664	3,465	415	2,922	3,982
1944	497	872	318	-890	11,706	10,923	7,813	5,867	4,915	794	5,240	2,168
1947	1,161	984	-549	151	6,400	10,811	9,150	5,655	3,362	127	4,250	2,794
1949	1,620	1,454	1,888	804	5,169	34,143	9,368	8,719	4,130	2,999	3,936	2,279
1955	1,147	264	6,846	3,708	6,247	5,160	7,382	7,033	4,454	92	4,000	2,322
1960	1,585	3,010	2,469	118	11,111	9,537	9,513	6,070	3,475	717	371	3,496
1961	1,814	1,430	134	1,149	9,421	9,779	8,768	5,873	3,341	435	4,750	814
1964	-605	10,975	382	7,473	8,161	5,504	6,153	5,914	3,769	375	2,004	3,850
1981	-822	-455	-622	2,974	13,164	20,647	9,873	5,663	3,286	487	2,293	3,797
1985	-425	18,318	12,943	2,440	6,810	8,108	7,140	7,825	3,313	707	-748	3,889
1987	-2,252	1,466	207	-775	6,821	13,723	10,829	5,852	4,104	6,392	3,201	1,953
1989	2,287	2,150	2,309	1,664	5,581	20,910	16,456	8,218	3,294	-32	1,240	903
Average	1,359	3,201	1,969	1,823	10,614	12,277	10,255	6,970	4,140	1,435	2,824	2,603

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	83%	92%	16%	96%	467%	258%	555%	383%	141%	133%	427%	177%
1926	77%	88%	77%	-4%	244%	253%	569%	378%	116%	1%	20%	292%
1930	142%	292%	20%	61%	263%	206%	494%	367%	91%	24%	328%	89%
1932	108%	130%	19%	4%	306%	270%	268%	655%	8008%	3711%	3077%	154%
1939	111%	0%	-11%	44%	122%	260%	400%	296%	122%	6%	85%	605%
1944	14%	17%	5%	-12%	144%	252%	380%	300%	146%	14%	551%	162%
1947	39%	22%	-8%	2%	102%	267%	424%	294%	121%	2%	204%	205%
1949	43%	36%	37%	17%	142%	483%	377%	363%	131%	109%	3028%	119%
1955	40%	4%	98%	50%	121%	241%	411%	360%	134%	1%	168%	127%
1960	66%	121%	66%	2%	148%	254%	504%	357%	123%	11%	7%	196%
1961	83%	31%	2%	22%	128%	263%	491%	344%	118%	7%	421%	37%
1964	-9%	164%	7%	101%	252%	234%	341%	304%	131%	6%	53%	296%
1981	-12%	-7%	-9%	39%	209%	449%	409%	296%	116%	7%	59%	284%
1985	-6%	275%	173%	34%	139%	282%	372%	358%	118%	11%	-11%	226%
1987	-36%	48%	3%	-11%	130%	216%	3610%	339%	204%	1281%	370%	131%
1989	324%	78%	79%	40%	215%	302%	598%	406%	117%	0%	24%	30%
Average	67%	87%	36%	30%	196%	281%	638%	362%	621%	333%	551%	196%

71 Year Record-Below Normal Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Future Demand Level
Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	5,135	8,473	27,876	29,276	15,020	9,649	23,551	12,998	7,767	7,207	5,797	5,354
1935	2,992	5,736	5,543	17,681	11,400	20,070	37,677	28,043	9,250	7,396	6,276	5,029
1936	4,168	5,275	5,637	21,489	61,804	24,380	19,924	12,439	7,908	7,974	6,121	5,530
1937	4,001	5,343	5,309	7,074	33,816	40,282	21,385	12,818	11,126	6,935	6,256	4,114
1945	5,164	6,184	6,890	6,209	40,620	21,043	13,380	10,833	9,304	6,666	5,082	3,431
1946	5,100	6,784	59,983	45,202	22,658	15,456	12,569	11,259	8,775	6,505	5,937	3,640
1948	5,582	5,476	5,393	6,701	11,400	10,683	20,378	25,247	11,058	8,246	6,660	5,367
1950	4,471	5,188	5,247	9,878	25,662	15,144	17,118	11,254	8,820	6,716	6,547	5,057
1959	10,593	6,602	5,684	31,284	54,083	17,064	8,458	7,579	6,840	7,703	7,106	5,215
1962	4,001	5,183	6,953	6,001	46,006	18,005	11,825	11,401	6,840	7,746	7,128	4,271
1966	4,625	15,143	7,197	22,178	23,230	17,828	12,616	11,124	6,840	8,029	6,946	5,555
1968	10,719	10,121	9,678	27,163	66,163	32,934	10,596	7,579	6,840	7,863	6,899	5,261
1972	5,423	6,378	7,651	7,138	19,095	25,076	10,577	7,579	6,840	8,226	6,875	5,229
1979	5,377	6,047	6,148	14,858	35,388	29,151	17,183	13,968	10,514	7,926	6,850	5,004
Average	**5,525**	**6,995**	**11,799**	**18,009**	**33,310**	**21,198**	**16,946**	**13,152**	**8,480**	**7,510**	**6,463**	**4,861**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	6,012	6,672	7,496	8,500	4,172	2,907	3,903	3,098	3,339	6,684	5,692	1,567
1935	1,257	4,016	2,901	7,599	3,176	5,977	4,048	4,150	3,698	6,684	6,554	1,674
1936	3,050	3,139	3,943	7,667	8,500	7,155	3,625	3,004	3,312	6,684	6,554	1,668
1937	2,297	2,693	3,942	7,289	8,500	7,592	4,025	3,295	4,826	6,346	1,853	1,676
1945	2,520	6,672	7,172	6,978	6,497	3,956	3,026	2,502	3,788	3,621	986	1,689
1946	4,360	6,672	7,287	7,739	3,180	4,435	2,946	2,646	3,575	6,684	1,534	1,913
1948	3,474	3,558	3,463	6,774	3,225	2,929	3,222	3,831	4,062	6,684	6,554	4,585
1950	2,642	2,880	2,570	7,397	7,441	4,216	2,976	2,418	3,578	6,684	4,998	1,592
1959	6,652	6,672	4,025	7,691	7,555	3,895	1,871	1,942	3,033	6,684	4,088	2,348
1962	1,815	3,546	6,593	3,376	8,048	5,928	2,474	2,437	3,034	6,684	2,091	2,294
1966	5,644	6,672	7,312	7,990	6,886	4,937	2,555	2,402	3,027	6,684	3,087	1,854
1968	6,652	6,672	7,100	6,588	4,556	4,001	2,345	1,913	3,026	6,684	4,123	1,889
1972	6,652	6,472	7,030	7,374	4,831	4,347	2,132	1,942	3,005	6,684	5,372	2,278
1979	6,652	6,599	4,386	7,853	8,500	6,703	3,371	3,203	4,138	6,684	4,973	2,159
Average	**4,263**	**5,210**	**5,373**	**7,201**	**6,076**	**4,927**	**3,037**	**2,770**	**3,532**	**6,441**	**4,176**	**2,085**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	-877	1,801	20,380	20,776	10,848	6,742	19,648	9,900	4,428	523	105	3,787
1935	1,735	1,720	2,642	10,082	8,224	14,093	33,629	23,893	5,552	712	-278	3,355
1936	1,118	2,136	1,694	13,822	53,304	17,225	16,299	9,435	4,596	1,290	-433	3,862
1937	1,704	2,650	1,367	-215	25,316	32,690	17,360	9,523	6,300	589	4,403	2,438
1945	2,644	-488	-282	-769	34,123	17,087	10,354	8,331	5,516	3,045	4,096	1,742
1946	740	112	52,696	37,463	19,478	11,021	9,623	8,613	5,200	-179	4,403	1,727
1948	2,108	1,918	1,930	-73	8,175	7,754	17,156	21,416	6,996	1,562	106	782
1950	1,829	2,308	2,677	2,481	18,221	10,928	14,142	8,836	5,242	32	1,549	3,465
1959	3,941	-70	1,659	23,593	46,528	13,169	6,587	5,637	3,807	1,019	3,018	2,867
1962	2,186	1,637	360	2,625	37,958	12,077	9,351	8,964	3,806	1,062	5,037	1,977
1966	-1,019	8,471	-115	14,188	16,344	12,891	10,061	8,722	3,813	1,345	3,859	3,701
1968	4,067	3,449	2,578	20,575	61,607	28,933	8,251	5,666	3,814	1,179	2,776	3,372
1972	-1,229	-94	621	-236	14,264	20,729	8,445	5,637	3,835	1,542	1,503	2,951
1979	-1,275	-552	1,762	7,005	26,888	22,448	13,812	10,765	6,376	1,242	1,877	2,845
Average	**1,262**	**1,786**	**6,426**	**10,608**	**27,234**	**16,271**	**13,908**	**10,381**	**4,949**	**1,069**	**2,287**	**2,77[illegible]**

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	-15%	27%	272%	244%	260%	232%	503%	320%	133%	8%	2%	242%
1935	138%	43%	91%	133%	259%	236%	831%	576%	150%	11%	-4%	200%
1936	37%	68%	43%	180%	627%	241%	450%	314%	139%	19%	-7%	232%
1937	74%	98%	35%	-3%	298%	431%	431%	289%	131%	9%	238%	145%
1945	105%	-7%	-4%	-11%	525%	432%	342%	333%	146%	84%	415%	103%
1946	17%	2%	723%	484%	613%	249%	327%	326%	145%	-3%	287%	90%
1948	61%	54%	56%	-1%	253%	265%	532%	559%	172%	23%	2%	17%
1950	69%	80%	104%	34%	245%	259%	475%	365%	147%	0%	31%	218%
1959	59%	-1%	41%	307%	616%	338%	352%	290%	126%	15%	74%	122%
1962	120%	46%	5%	78%	472%	204%	378%	368%	125%	16%	241%	86%
1966	-18%	127%	-2%	178%	237%	261%	394%	363%	126%	20%	125%	200%
1968	61%	52%	36%	312%	1352%	723%	352%	296%	126%	18%	67%	179%
1972	-18%	-1%	9%	-3%	295%	477%	396%	290%	128%	23%	28%	130%
1979	-19%	-8%	40%	89%	316%	335%	410%	336%	154%	19%	38%	132%
Average	**48%**	**41%**	**104%**	**144%**	**455%**	**334%**	**441%**	**359%**	**139%**	**19%**	**110%**	**150%**

71 Year Record-Above Normal Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	4,001	4,968	7,280	9,232	43,076	29,640	21,247	46,230	23,068	8,002	6,839	4,284
1928	4,001	11,904	6,453	12,916	20,256	93,980	25,192	13,442	7,579	8,002	8,193	4,247
1940	4,001	5,177	6,197	18,914	41,812	96,912	65,413	14,512	7,579	8,922	6,619	5,502
1951	4,962	42,421	89,577	65,102	65,538	26,506	14,743	17,174	7,579	9,862	7,490	5,642
1954	5,440	8,234	6,237	17,649	57,917	44,745	40,729	17,555	7,579	8,973	8,158	5,134
1957	7,279	6,481	4,968	6,944	30,722	41,211	16,071	14,616	8,379	10,049	7,327	5,809
1973	4,426	12,361	14,966	71,553	92,777	59,845	17,297	15,596	9,981	9,357	7,597	4,632
1978	2,992	4,149	6,799	58,128	62,007	62,002	40,985	18,434	9,263	8,002	6,930	4,342
1980	4,001	6,128	8,708	91,933	130,414	67,886	17,443	13,882	7,579	9,092	7,017	3,516
Average	**4,567**	**11,314**	**16,798**	**39,152**	**60,502**	**58,081**	**28,791**	**19,049**	**9,843**	**8,918**	**7,352**	**4,790**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	2,325	2,746	7,257	7,950	8,500	5,718	4,030	4,336	6,672	6,684	3,291	1,965
1928	3,329	6,672	7,108	7,551	6,163	7,064	3,687	2,904	3,222	6,684	1,511	1,915
1940	1,723	1,980	3,806	7,586	7,821	7,254	4,048	3,393	3,237	6,684	6,554	1,459
1951	4,948	6,672	7,592	8,500	4,161	4,451	3,131	3,531	3,217	6,684	6,343	1,847
1954	6,102	6,672	5,631	7,303	7,441	6,362	3,687	3,364	3,191	6,684	3,099	2,077
1957	6,652	6,370	2,448	5,915	7,725	6,552	2,938	2,774	3,428	6,684	6,554	1,853
1973	3,964	6,672	6,998	7,393	7,446	4,413	3,399	3,402	3,980	6,684	5,181	2,614
1978	1,330	1,614	6,986	6,894	1,517	4,644	4,838	4,532	3,638	5,463	1,739	1,791
1980	3,537	6,672	7,104	8,500	8,500	4,942	3,795	3,387	3,219	6,684	6,346	3,672
Average	**3,768**	**5,119**	**6,103**	**7,510**	**6,586**	**5,711**	**3,728**	**3,514**	**3,756**	**6,548**	**4,513**	**2,133**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	1,676	2,222	23	1,282	34,576	23,922	17,217	41,894	16,396	1,318	3,548	2,319
1928	672	5,232	-655	5,365	14,093	86,916	21,505	10,538	4,357	1,318	6,682	2,332
1940	2,278	3,197	2,391	11,328	33,991	89,658	61,365	11,119	4,342	2,238	65	4,043
1951	14	35,749	81,985	56,602	61,377	22,055	11,612	13,643	4,362	3,178	1,147	3,795
1954	-662	1,562	606	10,346	50,476	38,383	37,042	14,191	4,388	2,289	5,059	3,057
1957	627	111	2,520	1,029	22,997	34,659	13,133	11,842	4,951	3,365	773	3,956
1973	462	5,689	7,968	64,160	85,331	55,432	13,898	12,194	6,001	2,673	2,416	2,018
1978	1,662	2,535	-187	51,234	60,490	57,358	36,147	13,902	5,625	2,539	5,191	2,551
1980	464	-544	1,604	83,433	121,914	62,944	13,648	10,495	4,360	2,408	671	-156
Average	**799**	**6,195**	**10,695**	**31,642**	**53,916**	**52,370**	**25,063**	**15,535**	**6,087**	**2,370**	**2,839**	**2,657**

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	72%	81%	0%	16%	407%	418%	427%	966%	246%	20%	108%	118%
1928	20%	78%	-9%	71%	229%	1230%	583%	363%	135%	20%	442%	122%
1940	132%	161%	63%	149%	435%	1236%	1516%	328%	134%	33%	1%	277%
1951	0%	536%	1080%	666%	1475%	496%	371%	386%	136%	48%	18%	205%
1954	-11%	23%	11%	142%	678%	603%	1005%	422%	138%	34%	163%	147%
1957	9%	2%	103%	17%	298%	529%	447%	427%	144%	50%	12%	213%
1973	12%	85%	114%	868%	1146%	1256%	409%	358%	151%	40%	47%	77%
1978	125%	157%	-3%	743%	3987%	1235%	747%	307%	155%	46%	299%	142%
1980	13%	-8%	23%	982%	1434%	1274%	360%	310%	135%	36%	11%	-4%
Average	**41%**	**124%**	**153%**	**406%**	**1121%**	**920%**	**652%**	**430%**	**153%**	**36%**	**122%**	**144%**

71 Year Record-Wet Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Future Demand Level
Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	4,393	10,291	6,492	20,152	124,583	39,497	48,214	21,036	7,894	9,364	7,910	4,253
1938	4,001	14,644	54,310	23,866	135,670	163,376	65,965	59,981	28,950	8,002	5,741	5,616
1941	4,001	5,794	34,648	95,877	114,939	96,066	80,368	39,469	11,443	8,002	7,179	4,330
1942	6,139	7,184	55,486	80,948	141,778	22,782	53,223	35,691	16,242	8,002	7,264	4,225
1943	6,250	8,462	20,016	79,473	58,208	79,264	28,830	15,865	7,579	8,856	8,064	4,476
1952	4,001	6,664	39,097	80,320	75,043	62,259	64,579	61,631	28,074	8,002	5,741	6,563
1953	10,267	7,824	43,459	99,990	23,813	16,028	18,412	22,038	15,355	8,190	8,422	5,379
1956	4,088	5,745	69,503	155,576	90,957	33,255	19,834	40,161	13,909	8,156	7,090	5,381
1958	6,114	6,719	14,162	32,773	151,232	124,951	105,929	41,860	25,944	8,002	6,286	6,299
1963	21,519	6,964	19,596	12,741	72,189	27,666	92,545	27,168	8,852	9,267	7,643	5,290
1965	4,001	6,499	67,852	111,924	30,992	15,268	48,607	20,029	7,579	9,289	7,439	4,735
1967	4,001	6,626	30,585	41,435	51,598	56,765	52,250	46,682	32,443	8,002	5,741	6,464
1969	4,282	5,654	10,598	108,895	131,860	57,022	47,518	56,344	21,641	8,002	5,741	8,448
1970	12,805	10,031	55,374	204,333	89,738	33,979	11,763	8,870	7,579	9,711	8,016	5,444
1971	4,001	12,454	56,954	42,048	23,945	43,197	18,215	27,410	12,173	8,862	7,706	5,776
1974	4,463	49,385	62,862	127,210	43,076	106,170	72,545	21,715	11,983	8,334	7,277	6,216
1975	6,206	6,513	9,964	10,232	67,918	86,093	22,853	29,819	14,689	8,064	6,878	5,957
1982	4,142	20,274	80,266	77,550	98,363	83,077	143,166	47,305	16,481	8,002	5,741	11,772
1983	27,692	47,329	89,720	107,328	188,766	262,508	110,415	81,238	71,386	28,993	7,311	23,168
1984	35,251	82,636	157,477	83,489	47,913	34,922	14,805	10,481	7,958	9,824	7,150	5,449
1986	4,001	5,153	6,867	8,896	212,367	153,030	30,871	12,575	7,579	8,942	6,938	3,690
Average	**8,648**	**15,850**	**46,918**	**76,431**	**94,045**	**76,056**	**54,805**	**34,637**	**17,892**	**9,518**	**7,013**	**6,616**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,520	6,672	6,936	7,128	7,970	4,782	4,051	3,972	3,304	6,684	5,366	1,799
1938	3,108	6,672	7,120	8,144	7,005	4,644	4,973	5,766	6,672	3,687	2,225	6,588
1941	2,362	3,738	7,246	8,237	8,500	7,592	5,942	4,575	4,281	6,684	2,710	4,187
1942	6,652	6,672	7,407	8,301	5,406	4,481	4,274	4,336	6,440	6,023	2,223	5,154
1943	6,652	6,672	7,187	7,470	4,358	4,508	4,274	3,806	3,221	6,684	4,870	1,441
1952	2,712	6,650	7,087	8,500	8,272	6,105	4,889	5,343	6,672	4,107	2,225	6,588
1953	6,652	6,672	7,222	7,239	4,556	4,644	3,061	3,713	5,824	6,684	5,938	3,185
1956	2,537	3,931	7,105	8,500	7,235	4,644	3,839	4,336	5,206	6,684	4,739	6,447
1958	6,652	6,672	7,130	7,647	8,364	4,783	5,544	4,575	6,672	5,352	2,225	6,588
1963	6,652	6,672	7,013	6,335	3,642	4,644	4,048	4,150	3,584	6,684	6,554	1,993
1965	2,250	6,045	7,085	8,500	6,108	4,643	4,274	4,494	3,230	6,684	6,082	1,964
1967	2,490	6,586	7,287	7,752	6,696	3,963	5,077	4,575	6,672	6,684	1,154	6,588
1969	2,562	5,133	7,026	8,182	8,500	4,319	4,889	5,522	6,672	2,769	2,225	6,588
1970	6,652	6,672	7,383	6,331	4,556	4,128	3,010	2,317	3,202	6,684	4,448	1,760
1971	2,617	6,672	7,172	7,384	6,359	7,064	3,079	3,827	4,435	6,684	6,403	4,462
1974	5,198	6,672	7,194	8,069	6,308	4,664	4,274	4,264	4,362	6,684	4,404	6,588
1975	6,652	6,672	7,165	6,115	4,515	4,447	4,154	4,336	5,659	6,684	2,427	6,588
1982	2,070	6,672	6,964	7,819	8,301	5,585	5,427	6,189	6,602	4,225	3,315	6,588
1983	6,652	6,672	7,592	4,588	3,584	3,457	4,485	4,237	5,415	5,535	6,554	6,588
1984	4,986	4,174	3,919	3,638	4,382	4,520	3,152	2,494	3,415	6,684	6,554	5,435
1986	2,269	4,286	7,078	7,219	8,500	7,592	6,499	3,589	3,224	6,684	5,613	3,747
Average	**4,328**	**6,061**	**7,015**	**7,290**	**6,339**	**5,010**	**4,439**	**4,306**	**4,989**	**5,965**	**4,203**	**4,803**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	1,873	3,619	-444	13,024	116,613	34,715	44,163	17,064	4,590	2,680	2,544	2,454
1938	893	7,972	47,190	15,722	128,665	158,732	60,992	54,215	22,278	4,315	3,516	-972
1941	1,639	2,056	27,402	87,640	106,439	88,474	74,426	34,894	7,162	1,318	4,469	143
1942	-513	512	48,079	72,647	136,372	18,301	48,949	31,355	9,802	1,979	5,041	-929
1943	-402	1,790	12,829	72,003	53,850	74,756	24,555	12,059	4,358	2,172	3,194	3,035
1952	1,289	14	32,010	71,820	66,771	56,154	59,690	56,288	21,402	3,895	3,516	-25
1953	3,615	1,152	36,237	92,751	19,257	11,384	15,351	18,325	9,531	1,506	2,484	2,194
1956	1,551	1,814	62,398	147,076	83,722	28,611	15,995	35,825	8,703	1,472	2,351	-1,066
1958	-538	47	7,032	25,126	142,868	120,168	100,385	37,285	19,272	2,650	4,061	-289
1963	14,867	292	12,583	6,406	68,547	23,022	88,497	23,018	5,268	2,583	1,089	3,297
1965	1,751	454	60,767	103,424	24,884	10,625	44,333	15,535	4,349	2,605	1,357	2,771
1967	1,511	40	23,298	33,683	44,902	52,802	47,173	42,107	25,771	1,318	4,587	-124
1969	1,720	521	3,572	100,713	123,360	52,703	42,629	50,822	14,969	5,233	3,516	1,860
1970	6,153	3,359	47,991	198,002	85,182	29,851	8,753	6,553	4,377	3,027	3,568	3,684
1971	1,384	5,782	49,782	34,664	17,586	36,133	15,136	23,583	7,738	2,178	1,303	1,314
1974	-735	42,713	55,668	119,141	36,768	101,506	68,271	17,451	7,621	1,650	2,873	-372
1975	-446	-159	2,799	4,117	63,403	81,646	18,699	25,483	9,030	1,380	4,451	-631
1982	2,072	13,602	73,302	69,731	90,062	77,492	137,739	41,116	9,879	3,777	2,426	5,184
1983	21,040	40,657	82,128	102,740	185,182	259,051	105,930	77,001	65,971	23,458	757	16,580
1984	30,265	78,462	153,558	79,851	43,531	30,402	11,653	7,987	4,543	3,140	596	14
1986	1,732	867	-211	1,677	203,867	145,438	24,372	8,986	4,355	2,258	1,325	-57
Average	**4,320**	**9,789**	**39,903**	**69,141**	**87,706**	**71,046**	**50,366**	**30,331**	**12,903**	**3,552**	**2,811**	**1,813**

71 Year Record-Wet Years
Total Outflow from Delta (DV58+DV60+RF91) (in cubic feet per second)
Future Demand Level

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	74%	54%	-6%	183%	1463%	726%	1090%	430%	139%	40%	47%	136%
1938	29%	119%	663%	193%	1837%	3418%	1226%	940%	334%	117%	158%	-15%
1941	69%	55%	378%	1064%	1252%	1165%	1253%	763%	167%	20%	165%	3%
1942	-8%	8%	649%	875%	2523%	408%	1145%	723%	152%	33%	227%	-18%
1943	-6%	27%	179%	964%	1236%	1658%	575%	317%	135%	32%	66%	211%
1952	48%	0%	452%	845%	807%	920%	1221%	1053%	321%	95%	158%	0%
1953	54%	17%	502%	1281%	423%	245%	502%	494%	164%	23%	42%	69%
1956	61%	46%	878%	1730%	1157%	616%	417%	826%	167%	22%	50%	-17%
1958	-8%	1%	99%	329%	1708%	2512%	1811%	815%	289%	50%	183%	-4%
1963	223%	4%	179%	101%	1882%	496%	2186%	555%	147%	39%	17%	165%
1965	78%	8%	858%	1217%	407%	229%	1037%	346%	135%	39%	22%	141%
1967	61%	1%	320%	435%	671%	1332%	929%	920%	386%	20%	397%	-2%
1969	67%	10%	51%	1231%	1451%	1220%	872%	920%	224%	189%	158%	28%
1970	92%	50%	650%	3127%	1870%	723%	291%	283%	137%	45%	80%	209%
1971	53%	87%	694%	469%	277%	512%	492%	616%	174%	33%	20%	29%
1974	-14%	640%	774%	1477%	583%	2176%	1597%	409%	175%	25%	65%	-6%
1975	-7%	-2%	39%	67%	1404%	1836%	450%	588%	160%	21%	183%	-10%
1982	100%	204%	1053%	892%	1085%	1388%	2538%	664%	150%	89%	73%	79%
1983	316%	609%	1082%	2239%	5167%	7494%	2362%	1817%	1218%	424%	12%	252%
1984	607%	1880%	3918%	2195%	993%	673%	370%	320%	133%	47%	9%	0%
1986	76%	20%	-3%	23%	2398%	1916%	375%	250%	135%	34%	24%	-2%
Average	94%	183%	638%	997%	1457%	1508%	1083%	669%	240%	68%	103%	60%

71 Year Record-Critical Years
X2 Position (In Kilometers)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	85.2	84.3	82.1	81.9	78.8	77.1	81.0	83.5	86.0	84.5	87.5	89.5
1929	85.9	84.2	82.6	83.0	78.7	77.4	79.4	81.0	80.8	82.0	86.7	89.2
1931	87.7	86.5	84.8	83.3	80.8	80.7	80.0	83.9	86.1	85.4	87.8	89.6
1933	87.5	86.4	85.6	82.2	79.8	79.0	77.2	80.7	81.0	85.2	87.8	89.6
1934	90.2	88.9	84.1	81.4	76.5	75.7	76.1	81.0	81.0	85.2	87.8	89.6
1976	78.9	77.0	77.9	80.0	76.8	77.0	78.8	80.9	81.0	84.1	87.4	89.5
1977	90.2	87.0	83.5	82.4	80.5	80.9	81.0	83.9	86.1	86.9	88.3	89.8
1988	86.9	85.7	82.5	75.7	75.4	78.1	79.4	80.9	81.0	83.0	87.0	89.3
1990	86.8	86.2	83.2	81.7	77.4	79.4	77.4	80.8	80.9	81.9	86.0	89.0
1991	90.0	87.4	84.9	84.6	81.0	72.4	74.3	80.7	80.8	82.4	86.8	89.3
1992	90.1	88.0	85.1	84.2	73.5	73.1	75.1	80.5	81.0	82.5	86.9	89.3
Average	**87.2**	**85.6**	**83.3**	**81.9**	**78.1**	**77.3**	**78.2**	**81.6**	**82.3**	**83.9**	**87.3**	**89.4**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	86.4	84.6	82.1	82.0	78.8	77.1	81.0	83.1	85.9	84.4	87.5	89.5
1929	86.6	84.4	82.3	82.9	78.7	77.4	79.4	81.0	80.8	82.0	86.7	89.2
1931	87.7	86.5	85.4	83.5	80.9	80.8	80.0	83.9	86.1	86.9	88.3	89.8
1933	87.5	86.4	85.6	82.2	79.8	79.0	77.2	80.8	81.0	85.2	87.8	89.6
1934	90.2	88.9	84.1	79.6	75.8	75.4	76.0	81.0	81.0	85.2	87.8	89.6
1976	75.0	75.1	79.7	81.8	77.9	77.3	79.1	81.0	81.0	84.5	87.5	89.5
1977	90.2	87.0	82.7	82.9	80.6	81.0	81.0	84.3	86.2	86.9	88.3	89.8
1988	87.0	85.7	82.5	74.2	74.9	78.1	79.6	81.0	81.0	82.7	86.9	89.3
1990	86.7	86.1	83.3	80.7	77.1	79.3	77.4	81.0	81.0	82.6	86.6	89.2
1991	90.1	87.7	85.1	84.8	81.1	72.4	74.4	80.8	80.8	82.4	86.8	89.3
1992	90.1	87.9	85.0	84.2	72.6	72.8	75.2	80.5	81.0	82.2	86.8	89.3
Average	**87.0**	**85.5**	**83.4**	**81.7**	**78.0**	**77.3**	**78.2**	**81.7**	**82.3**	**84.1**	**87.4**	**89.5**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	-1.2	-0.3	0.0	-0.1	0.0	0.0	0.0	0.4	0.1	0.1	0.0	0.0
1929	-0.7	-0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1931	0.0	0.0	-0.6	-0.2	-0.1	-0.1	0.0	0.0	0.0	-1.5	-0.5	-0.2
1933	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
1934	0.0	0.0	0.0	1.8	0.7	0.3	0.1	0.0	0.0	0.0	0.0	0.0
1976	3.9	1.9	-1.8	-1.8	-1.1	-0.3	-0.3	-0.1	0.0	-0.4	-0.1	0.0
1977	0.0	0.0	0.8	-0.5	-0.1	-0.1	0.0	-0.4	-0.1	0.0	0.0	0.0
1988	-0.1	0.0	0.0	1.5	0.5	0.0	-0.2	-0.1	0.0	0.3	0.1	0.0
1990	0.1	0.1	-0.1	1.0	0.3	0.1	0.0	-0.2	-0.1	-0.7	-0.6	-0.2
1991	-0.1	-0.3	-0.2	-0.2	-0.1	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
1992	0.0	0.1	0.1	0.0	0.9	0.3	-0.1	0.0	0.0	0.3	0.1	0.0
Average	**0.2**	**0.1**	**-0.1**	**0.1**	**0.1**	**0.0**	**-0.1**	**-0.1**	**0.0**	**-0.2**	**-0.1**	**0.0**

71 Year Record-Dry Years
X2 Position (in Kilometers)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	86.2	85.1	83.7	83.0	67.8	71.1	68.9	72.6	77.0	79.5	82.7	86.0
1926	84.7	84.7	84.1	81.8	70.9	74.0	70.6	74.0	79.6	80.2	82.9	85.9
1930	86.3	84.8	82.7	78.0	75.2	70.5	74.2	77.4	80.7	81.7	85.3	88.8
1932	89.1	87.4	81.7	80.2	74.5	75.0	75.3	76.3	76.2	81.9	85.3	88.1
1939	76.0	73.8	74.6	74.0	72.8	75.5	76.0	78.6	81.0	80.8	83.6	86.6
1944	85.1	83.0	83.8	82.5	71.5	70.6	75.3	78.3	78.7	80.2	83.5	87.0
1947	84.7	84.2	82.5	82.0	76.7	73.6	74.8	78.2	81.0	80.4	82.7	85.7
1949	83.0	82.5	82.8	83.4	80.1	67.4	72.5	74.6	78.4	81.4	84.1	86.0
1955	84.5	82.6	76.4	75.4	75.3	78.4	78.3	78.2	79.1	79.8	82.5	84.9
1960	85.1	84.7	82.1	82.4	74.0	73.1	74.6	78.0	80.7	80.2	82.5	85.4
1961	85.0	83.8	81.8	82.2	73.6	73.5	75.4	78.4	81.0	80.3	82.6	86.1
1964	82.3	73.3	77.2	71.3	74.0	77.1	78.9	79.4	80.7	80.3	82.3	85.4
1981	82.9	82.5	78.0	70.9	68.1	65.6	71.5	77.2	80.7	80.6	83.6	87.0
1985	82.0	70.1	67.9	73.2	72.7	72.8	76.3	76.6	80.5	80.2	82.7	86.0
1987	85.9	84.7	85.3	83.6	77.4	70.7	74.2	78.1	81.0	80.6	82.4	86.4
1989	90.1	86.5	84.8	83.6	80.5	70.1	69.7	74.2	79.7	79.9	82.1	85.9
Average	84.6	82.1	80.6	79.2	74.1	72.4	74.2	76.9	79.8	80.5	83.2	86.3

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	86.2	85.1	83.7	82.9	67.3	71.0	69.3	73.3	77.0	79.7	82.8	86.0
1926	84.7	84.7	84.2	81.0	69.8	74.0	71.0	74.0	79.6	80.5	83.0	86.1
1930	86.3	84.8	82.7	76.1	74.5	70.3	74.2	77.4	80.7	82.2	85.4	88.8
1932	89.1	87.4	81.0	78.6	73.9	74.8	75.2	76.7	76.3	81.9	85.4	88.1
1939	74.1	76.9	77.5	76.7	75.4	76.5	76.4	78.8	81.0	80.9	83.7	86.7
1944	84.9	82.9	83.8	82.5	70.9	70.7	75.4	78.4	78.7	80.4	83.6	87.1
1947	85.8	84.5	82.4	82.1	76.6	73.6	74.8	78.2	81.0	80.7	82.3	85.8
1949	83.0	83.1	83.0	83.4	80.1	66.6	73.0	74.7	78.4	81.1	84.0	85.9
1955	86.3	81.7	74.5	73.0	74.5	78.1	78.9	79.0	79.1	80.1	81.6	82.9
1960	85.1	84.1	81.7	82.7	73.2	72.9	74.5	78.1	80.8	80.6	81.9	85.3
1961	85.7	84.0	81.9	82.3	72.2	73.1	75.4	78.4	81.0	80.6	81.9	85.9
1964	80.5	71.0	78.6	72.3	74.3	77.2	79.0	79.6	80.8	80.6	81.9	84.8
1981	79.6	81.3	78.7	71.1	68.2	65.6	71.6	77.2	80.7	80.8	83.7	87.1
1985	78.8	68.7	68.6	73.5	72.8	72.8	77.0	76.8	80.6	80.6	82.2	85.9
1987	85.3	83.9	85.1	83.7	77.4	69.9	74.2	78.1	81.0	80.7	82.8	86.7
1989	90.1	86.6	84.8	83.6	80.5	69.3	69.7	74.2	79.7	80.2	81.8	85.8
Average	84.1	81.9	80.8	79.1	73.9	72.3	74.4	77.1	79.8	80.7	83.0	86.2

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0.0	0.0	0.0	0.1	0.5	0.1	-0.4	-0.7	0.0	-0.2	-0.1	0.0
1926	0.0	0.0	-0.1	0.8	1.1	0.0	-0.4	0.0	0.0	-0.3	-0.1	-0.2
1930	0.0	0.0	0.0	1.9	0.7	0.2	0.0	0.0	0.0	-0.5	-0.1	0.0
1932	0.0	0.0	0.7	1.6	0.6	0.2	0.1	-0.4	-0.1	0.0	-0.1	0.0
1939	1.9	-3.1	-2.9	-2.7	-2.6	-1.0	-0.4	-0.2	0.0	-0.1	-0.1	-0.1
1944	0.2	0.1	0.0	0.0	0.6	-0.1	-0.1	-0.1	0.0	-0.2	-0.1	-0.1
1947	-1.1	-0.3	0.1	-0.1	0.1	0.0	0.0	0.0	0.0	-0.3	0.4	-0.1
1949	0.0	-0.6	-0.2	0.0	0.0	0.8	-0.5	-0.1	0.0	0.3	0.1	0.1
1955	-1.8	0.9	1.9	2.4	0.8	0.3	-0.6	-0.8	0.0	-0.3	0.9	2.0
1960	0.0	0.6	0.4	-0.3	0.8	0.2	0.1	-0.1	-0.1	-0.4	0.6	0.1
1961	-0.7	-0.2	-0.1	-0.1	1.4	0.4	0.0	0.0	0.0	-0.3	0.7	0.2
1964	1.8	2.3	-1.4	-1.0	-0.3	-0.1	-0.1	-0.2	-0.1	-0.3	0.4	0.6
1981	3.3	1.2	-0.7	-0.2	-0.1	0.0	-0.1	0.0	0.0	-0.2	-0.1	-0.1
1985	3.2	1.4	-0.7	-0.3	-0.1	0.0	-0.7	-0.2	-0.1	-0.4	0.5	0.1
1987	0.6	0.8	0.2	-0.1	0.0	0.8	0.0	0.0	0.0	-0.1	-0.4	-0.3
1989	0.0	-0.1	0.0	0.0	0.0	0.8	0.0	0.0	0.0	-0.3	0.3	0.1
Average	0.5	0.2	-0.2	0.1	0.2	0.2	-0.2	-0.2	0.0	-0.2	0.2	0.1

71 Year Record-Below Normal Years
X2 Position (in Kilometers)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	83.0	78.7	67.5	64.6	66.6	74.2	69.6	72.4	77.3	79.1	81.2	85.9
1935	90.2	85.6	84.2	74.6	75.0	70.8	64.6	64.9	73.5	78.3	81.7	86.2
1936	85.9	84.8	84.1	73.6	61.3	64.2	67.5	72.1	77.0	80.0	83.0	86.7
1937	85.9	85.0	82.7	81.6	69.0	62.9	66.5	71.0	74.1	79.2	83.4	88.1
1945	85.0	83.3	81.9	82.0	66.3	66.2	71.6	74.5	76.6	80.0	83.3	87.3
1946	85.3	81.7	63.9	60.3	65.3	69.1	72.6	74.5	77.0	79.3	82.4	86.4
1948	84.3	83.9	83.3	82.3	77.6	76.3	70.7	67.2	72.5	75.4	80.0	83.9
1950	84.8	84.4	83.8	79.3	70.4	71.3	71.0	73.6	76.8	78.3	81.3	85.0
1959	74.1	75.3	80.0	68.3	60.8	67.7	75.1	78.3	80.2	79.8	82.4	85.0
1962	85.6	84.8	82.2	82.5	66.9	68.9	74.0	74.9	79.0	78.7	81.7	85.0
1966	83.9	75.9	79.2	69.8	67.9	68.5	72.5	74.6	78.9	79.3	81.1	84.9
1968	73.0	74.0	75.0	68.2	59.3	61.7	71.6	77.2	79.8	79.7	82.6	85.4
1972	81.9	81.7	76.0	74.5	71.2	68.2	73.5	77.8	80.0	79.1	81.6	85.5
1979	82.5	82.0	83.8	72.1	63.8	64.2	68.8	71.5	74.7	79.4	83.0	86.0
Average	**83.2**	**81.5**	**79.1**	**73.8**	**67.2**	**68.2**	**70.7**	**73.2**	**77.0**	**79.0**	**82.1**	**85.**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	78.6	75.8	67.3	65.1	66.9	73.3	69.8	73.2	77.3	78.9	81.4	85.7
1935	90.2	85.6	84.2	73.5	74.7	70.7	64.8	64.9	73.5	77.7	81.6	87.4
1936	86.8	85.0	84.2	72.7	61.0	64.4	68.2	73.1	77.0	79.0	82.5	87.
1937	87.3	85.5	82.6	81.4	68.3	62.7	67.0	72.5	74.5	79.3	83.4	88.
1945	85.0	83.3	80.2	81.5	66.6	66.3	72.6	75.5	76.6	80.0	83.5	87.3
1946	85.4	78.9	62.5	60.6	65.4	69.3	73.6	74.8	77.0	79.3	82.2	86.4
1948	84.8	83.9	83.3	82.3	77.6	76.3	71.4	67.7	72.7	77.3	80.0	82.
1950	86.1	84.9	84.4	77.4	69.3	70.9	71.3	74.0	76.8	78.7	80.4	84.
1959	73.9	75.3	80.0	68.4	60.9	67.9	75.2	78.4	80.2	80.0	82.6	85.0
1962	86.2	85.0	82.3	82.5	66.5	68.7	74.5	75.0	79.1	79.4	81.5	84.9
1966	83.1	73.9	77.2	70.5	68.7	68.3	73.2	74.8	79.0	79.4	81.3	84.
1968	73.1	74.4	75.2	68.1	59.3	61.7	71.6	77.2	79.8	80.0	82.8	85.
1972	79.3	80.4	75.3	76.0	71.8	68.2	74.0	78.0	80.1	79.7	81.1	85.
1979	79.5	80.5	83.3	73.0	64.1	64.3	69.6	72.4	74.7	79.4	83.5	87.2
Average	**82.8**	**80.9**	**78.7**	**73.8**	**67.2**	**68.1**	**71.2**	**73.7**	**77.0**	**79.2**	**82.0**	**85.**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	4.4	2.9	0.2	-0.5	-0.3	0.9	-0.2	-0.8	0.0	0.2	-0.2	0.2
1935	0.0	0.0	0.0	1.1	0.3	0.1	-0.2	0.0	0.0	0.6	0.1	-1.2
1936	-0.9	-0.2	-0.1	0.9	0.3	-0.2	-0.7	-1.0	0.0	1.0	0.5	-0
1937	-1.4	-0.5	0.1	0.2	0.7	0.2	-0.5	-1.5	-0.4	-0.1	0.0	0.
1945	0.0	0.0	1.7	0.5	-0.3	-0.1	-1.0	-1.0	0.0	0.0	-0.2	0.0
1946	-0.1	2.8	1.4	-0.3	-0.1	-0.2	-1.0	-0.3	0.0	0.0	0.2	0.0
1948	-0.5	0.0	0.0	0.0	0.0	0.0	-0.7	-0.5	-0.2	-1.9	0.0	1.
1950	-1.3	-0.5	-0.6	1.9	1.1	0.4	-0.3	-0.4	0.0	-0.4	0.9	0.
1959	0.2	0.0	0.0	-0.1	-0.1	-0.2	-0.1	-0.1	0.0	-0.2	-0.2	0.0
1962	-0.6	-0.2	-0.1	0.0	0.4	0.2	-0.5	-0.1	-0.1	-0.7	0.2	0.1
1966	0.8	2.0	2.0	-0.7	-0.8	0.2	-0.7	-0.2	-0.1	-0.1	-0.2	0.
1968	-0.1	-0.4	-0.2	0.1	0.0	0.0	0.0	0.0	0.0	-0.3	-0.2	0
1972	2.6	1.3	0.7	-1.5	-0.6	0.0	-0.5	-0.2	-0.1	-0.6	0.5	0.1
1979	3.0	1.5	0.5	-0.9	-0.3	-0.1	-0.8	-0.9	0.0	0.0	-0.5	-1.2
Average	**0.4**	**0.6**	**0.4**	**0.0**	**0.0**	**0.1**	**-0.5**	**-0.5**	**-0.1**	**-0.2**	**0.1**	**0**

71 Year Record-Above Normal Years
X2 Position (in Kilometers)
Existing Demand Level

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	82.9	84.1	82.1	79.2	66.6	64.8	67.2	62.0	65.1	74.7	80.9	86.2
1928	84.2	76.3	80.0	72.7	68.7	56.5	63.2	70.1	76.7	77.6	80.6	85.3
1940	85.7	84.7	83.7	74.8	64.7	55.5	55.4	66.9	75.7	78.0	81.4	86.4
1951	83.4	68.0	58.0	56.3	55.6	62.2	69.1	70.4	76.8	77.0	80.2	84.6
1954	81.8	76.4	76.7	69.1	60.6	60.1	60.6	67.2	75.8	76.9	80.0	84.5
1957	78.5	80.6	82.7	79.2	68.0	63.0	68.9	71.3	76.3	76.7	79.2	84.6
1973	83.8	77.7	73.5	60.2	54.2	55.6	65.7	69.6	74.5	77.4	81.0	84.5
1978	90.3	88.1	83.4	64.9	59.1	56.2	59.3	66.5	74.5	77.7	81.9	83.6
1980	86.8	82.8	80.1	59.4	51.3	53.6	65.1	70.6	76.9	78.5	82.2	83.7
Average	**84.2**	**79.9**	**77.8**	**68.4**	**61.0**	**58.6**	**63.8**	**68.3**	**74.7**	**77.2**	**80.8**	**84.8**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	82.9	84.1	80.5	77.1	66.4	65.0	67.9	62.5	64.5	74.4	80.9	85.9
1928	84.8	73.9	78.3	73.3	69.1	56.7	63.5	70.1	76.7	77.5	80.7	85.3
1940	85.7	84.7	83.7	73.6	63.3	54.6	55.3	66.9	75.7	76.8	80.1	85.4
1951	83.4	67.5	57.6	56.6	56.0	62.2	69.9	71.3	77.1	77.3	80.6	84.7
1954	78.1	73.9	79.3	70.3	61.0	60.1	60.9	67.2	75.8	76.8	80.2	84.5
1957	75.1	79.3	82.3	81.1	69.0	63.3	69.0	72.1	76.3	77.0	79.4	84.7
1973	83.9	75.7	71.5	59.7	54.3	55.9	66.5	70.5	74.5	77.7	81.2	84.9
1978	90.3	88.1	83.4	64.9	59.1	56.2	59.3	66.7	74.5	77.7	81.9	83.4
1980	87.2	80.0	76.3	58.4	51.0	53.5	65.4	71.6	77.2	78.6	82.2	83.2
Average	**83.5**	**78.6**	**77.0**	**68.3**	**61.0**	**58.6**	**64.2**	**68.8**	**74.7**	**77.1**	**80.8**	**84.7**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0.0	0.0	1.6	2.1	0.2	-0.2	-0.7	-0.5	0.6	0.3	0.0	0.3
1928	-0.6	2.4	1.7	-0.6	-0.4	-0.2	-0.3	0.0	0.0	0.1	-0.1	0.0
1940	0.0	0.0	0.0	1.2	1.4	0.9	0.1	0.0	0.0	1.2	1.3	1.0
1951	0.0	0.5	0.4	-0.3	-0.4	0.0	-0.8	-0.9	-0.3	-0.3	-0.4	-0.1
1954	3.7	2.5	-2.6	-1.2	-0.4	0.0	-0.3	0.0	0.0	0.1	-0.2	0.0
1957	3.4	1.3	0.4	-1.9	-1.0	-0.3	-0.1	-0.8	0.0	-0.3	-0.2	-0.1
1973	-0.1	2.0	2.0	0.5	-0.1	-0.3	-0.8	-0.9	0.0	-0.3	-0.2	-0.4
1978	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.2
1980	-0.4	2.8	3.8	1.0	0.3	0.1	-0.3	-1.0	-0.3	-0.1	0.0	0.5
Average	**0.7**	**1.3**	**0.8**	**0.1**	**0.0**	**0.0**	**-0.4**	**-0.5**	**0.0**	**0.1**	**0.0**	**0.2**

71 Year Record-Wet Years
X2 Position (in Kilometers)
Existing Demand Level
Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	84.9	80.5	81.1	71.8	56.1	60.0	59.4	65.3	74.8	77.8	81.4	86.2
1938	87.3	75.2	61.5	63.0	51.9	47.2	52.6	55.0	60.6	73.2	79.8	81.4
1941	85.4	84.1	68.5	56.4	51.3	51.1	52.4	58.3	69.5	76.1	80.8	82.7
1942	79.1	74.4	61.6	55.7	49.4	60.8	59.0	61.2	67.6	75.5	80.6	83.1
1943	78.5	73.7	68.3	57.9	56.9	54.3	61.5	68.2	76.1	78.2	81.5	87.2
1952	84.3	82.4	68.1	57.4	54.6	55.5	55.5	55.9	60.9	73.3	79.9	80.2
1953	73.6	74.3	64.6	55.0	62.4	67.7	69.6	68.4	70.6	76.4	80.9	82.6
1956	85.4	84.0	64.1	51.5	51.7	59.1	66.0	62.5	69.2	76.0	80.3	81.7
1958	82.5	81.6	74.8	66.6	52.3	49.5	50.0	57.1	62.3	73.7	80.0	80.9
1963	72.3	78.0	71.7	73.4	61.0	64.4	55.8	62.1	72.9	77.2	80.6	83.2
1965	85.1	83.2	63.9	54.1	61.1	67.8	62.0	66.5	75.5	77.2	80.7	85.6
1967	84.7	83.0	69.9	62.7	58.6	57.6	58.2	59.0	61.1	71.8	79.4	80.1
1969	84.5	83.7	78.5	58.5	50.8	54.9	57.6	56.8	62.7	73.8	80.1	77.9
1970	71.7	72.5	62.2	48.8	50.7	58.5	69.7	75.3	78.4	78.0	81.2	85.5
1971	84.7	77.7	63.0	60.1	64.7	61.1	67.2	65.9	71.4	76.7	80.1	81.8
1974	83.7	65.8	59.0	51.3	57.3	52.4	53.6	63.1	70.6	76.5	80.7	81.0
1975	78.9	76.4	75.2	76.0	62.0	55.5	63.6	63.9	69.3	76.0	80.4	81.5
1982	85.5	72.6	59.0	55.0	52.0	52.5	48.4	55.4	65.7	74.8	80.3	76.3
1983	67.3	61.8	55.0	51.4	45.9	41.6	46.8	50.7	52.8	60.0	71.5	67.7
1984	63.7	56.3	48.8	51.2	56.1	60.1	68.5	73.5	77.5	78.4	81.6	82.6
1986	85.6	84.7	82.1	79.5	54.1	48.4	58.6	69.0	76.4	78.3	81.5	85.6
Average	**80.4**	**76.5**	**66.7**	**59.9**	**55.3**	**56.2**	**58.9**	**62.5**	**68.9**	**75.2**	**80.2**	**81.7**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	85.0	77.8	80.0	71.1	56.1	59.6	59.5	65.8	74.8	77.8	81.4	87.1
1938	87.5	73.2	60.7	64.1	52.3	47.4	52.7	55.1	60.6	73.2	79.8	79.2
1941	86.2	84.0	68.4	56.6	51.4	51.4	52.5	58.4	69.6	76.1	80.8	82.6
1942	76.5	75.3	61.9	55.8	49.5	60.8	59.3	61.6	67.8	75.5	80.6	82.6
1943	75.7	73.0	68.3	57.9	56.9	54.3	61.9	68.2	76.1	78.2	81.5	87.2
1952	84.3	81.4	66.9	56.9	54.9	55.8	55.7	56.0	60.8	73.2	79.9	77.1
1953	73.5	74.7	64.9	55.1	62.4	67.8	70.0	68.9	70.7	76.5	80.9	82.5
1956	85.8	84.1	63.7	51.5	51.9	59.9	66.9	63.1	69.4	76.1	79.8	81.3
1958	79.9	78.5	73.2	67.0	52.5	49.6	50.0	57.4	61.9	73.6	80.0	77.9
1963	71.4	74.6	71.2	76.1	61.7	64.6	55.9	62.6	72.9	77.2	80.7	83.0
1965	86.4	83.0	63.5	53.9	61.7	68.5	62.5	66.6	75.5	77.3	81.2	85.8
1967	85.4	82.7	69.2	62.2	59.0	57.7	58.4	59.2	60.9	71.7	79.4	77.7
1969	84.5	83.4	76.4	57.8	50.9	54.9	57.7	56.8	62.7	73.8	80.1	75.5
1970	71.9	72.5	62.3	48.9	50.7	58.6	69.7	76.2	78.7	78.6	81.6	85.6
1971	84.7	75.8	62.0	60.3	65.1	61.6	67.8	66.4	71.5	76.8	80.2	81.9
1974	83.5	65.1	58.6	51.4	57.4	52.3	53.8	63.7	70.8	76.5	80.9	77.7
1975	75.3	77.1	77.6	76.8	62.1	55.5	64.2	64.5	69.5	76.1	80.2	80.7
1982	85.6	71.7	58.4	55.0	52.4	52.7	48.5	55.4	65.7	74.8	80.3	74.3
1983	67.2	61.8	55.0	51.4	45.9	41.6	46.8	50.7	52.8	60.0	71.5	67.7
1984	63.7	56.3	48.8	51.2	56.1	60.1	69.2	74.5	77.5	78.7	81.7	82.6
1986	85.4	84.2	81.8	77.6	53.4	48.3	59.0	70.2	76.8	78.5	81.6	85.3
Average	**80.0**	**75.7**	**66.3**	**59.9**	**55.4**	**56.3**	**59.1**	**62.9**	**68.9**	**75.2**	**80.2**	**80.7**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	-0.1	2.7	1.1	0.7	0.0	0.4	-0.1	-0.5	0.0	0.0	0.0	-0.9
1938	-0.2	2.0	0.8	-1.1	-0.4	-0.2	-0.1	-0.1	0.0	0.0	0.0	2.2
1941	-0.8	0.1	0.1	-0.2	-0.1	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.1
1942	2.6	-0.9	-0.3	-0.1	-0.1	0.0	-0.3	-0.4	-0.2	0.0	0.0	0.5
1943	2.8	0.7	0.0	0.0	0.0	0.0	-0.4	0.0	0.0	0.0	0.0	0.0
1952	0.0	1.0	1.2	0.5	-0.3	-0.3	-0.2	-0.1	0.1	0.1	0.0	3.1
1953	0.1	-0.4	-0.3	-0.1	0.0	-0.1	-0.4	-0.5	-0.1	-0.1	0.0	0.1
1956	-0.4	-0.1	0.4	0.0	-0.2	-0.8	-0.9	-0.6	-0.2	-0.1	0.5	0.4
1958	2.6	3.1	1.6	-0.4	-0.2	-0.1	0.0	-0.3	0.4	0.1	0.0	3.0
1963	0.9	3.4	0.5	-2.7	-0.7	-0.2	-0.1	-0.5	0.0	0.0	-0.1	0.2
1965	-1.3	0.2	0.4	0.2	-0.6	-0.7	-0.5	-0.1	0.0	-0.1	-0.5	-0.2
1967	-0.7	0.3	0.7	0.5	-0.4	-0.1	-0.2	-0.2	0.2	0.1	0.0	2.4
1969	0.0	0.3	2.1	0.7	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	2.4
1970	-0.2	0.0	-0.1	-0.1	0.0	-0.1	0.0	-0.9	-0.3	-0.6	-0.4	-0.1
1971	0.0	1.9	1.0	-0.2	-0.4	-0.5	-0.6	-0.5	-0.1	-0.1	-0.1	-0.1
1974	0.2	0.7	0.4	-0.1	-0.1	0.1	-0.2	-0.6	-0.2	0.0	-0.2	3.3
1975	3.6	-0.7	-2.4	-0.8	-0.1	0.0	-0.6	-0.6	-0.2	-0.1	0.2	0.8
1982	-0.1	0.9	0.6	0.0	-0.4	-0.2	-0.1	0.0	0.0	0.0	0.0	2.0
1983	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-1.0	0.0	-0.3	-0.1	0.0
1986	0.2	0.5	0.3	1.9	0.7	0.1	-0.4	-1.2	-0.4	-0.2	-0.1	0.3
Average	**0.4**	**0.7**	**0.4**	**-0.1**	**-0.2**	**-0.1**	**-0.3**	**-0.4**	**-0.1**	**-0.1**	**0.0**	**0.9**

71 Year Record-Critical Years
X2 Position (in Kilometers)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	85.9	84.4	81.8	81.9	78.5	77.0	81.0	83.3	85.9	86.6	88.2	89.7
1929	86.2	84.0	82.0	82.8	78.6	77.3	79.3	81.0	80.8	82.3	86.8	89.3
1931	87.8	86.5	83.7	82.7	80.5	80.8	80.0	83.9	86.1	85.9	88.0	89.6
1933	87.5	86.4	86.0	82.3	80.5	79.6	77.4	80.8	81.0	82.5	86.9	89.3
1934	90.1	88.5	83.9	82.0	77.2	75.9	76.2	81.0	81.0	84.8	87.6	89.5
1976	79.6	80.7	80.3	81.3	77.2	77.9	78.9	80.9	81.0	81.4	86.5	89.2
1977	90.1	86.6	83.0	84.9	81.2	80.9	81.0	83.9	86.1	86.9	88.3	89.8
1988	87.4	85.6	82.4	75.5	75.3	78.1	79.4	80.9	81.0	81.8	86.6	89.2
1990	86.7	86.1	83.0	81.3	77.2	79.7	77.5	80.8	80.9	81.1	86.4	89.1
1991	90.1	87.3	84.7	84.4	80.9	72.2	74.2	80.5	80.7	84.0	87.4	89.4
1992	90.2	88.1	86.8	84.9	73.3	73.1	75.1	80.4	81.0	83.6	87.2	89.4
Average	**87.4**	**85.8**	**83.4**	**82.2**	**78.2**	**77.5**	**78.2**	**81.6**	**82.3**	**83.7**	**87.3**	**89.4**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	85.9	84.3	82.0	82.7	78.7	77.1	81.0	83.1	85.9	86.8	88.3	89.7
1929	87.1	84.3	83.3	83.2	78.7	77.4	79.4	81.0	80.8	82.1	86.8	89.2
1931	87.7	86.5	82.7	82.4	80.4	80.8	80.0	83.9	86.1	86.9	88.3	89.8
1933	87.5	86.4	85.7	82.2	80.5	79.5	77.4	80.8	81.0	82.7	86.9	89.3
1934	90.1	88.8	84.0	81.1	77.0	75.8	76.2	81.0	81.0	84.3	87.5	89.5
1976	76.4	76.6	80.6	82.1	77.9	78.1	79.1	81.0	81.0	81.0	86.4	89.1
1977	90.1	86.3	82.5	84.7	81.2	81.0	81.0	84.3	86.2	86.9	88.3	89.8
1988	87.7	85.7	81.7	73.8	74.8	78.1	79.6	81.0	81.0	81.4	86.5	89.2
1990	86.7	86.1	82.5	79.7	76.7	79.6	77.5	81.0	81.0	81.5	86.5	89.2
1991	90.1	88.4	85.0	84.5	80.9	72.2	74.4	80.8	80.8	83.1	87.1	89.3
1992	90.1	88.2	86.9	84.9	72.4	72.8	75.2	80.5	81.0	83.9	87.3	89.4
Average	**87.2**	**85.6**	**83.4**	**81.9**	**78.1**	**77.5**	**78.3**	**81.7**	**82.3**	**83.7**	**87.3**	**89.4**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	0.0	0.1	-0.2	-0.8	-0.2	-0.1	0.0	0.2	0.0	-0.2	-0.1	0.0
1929	-0.9	-0.3	-1.3	-0.4	-0.1	-0.1	-0.1	0.0	0.0	0.2	0.0	0.1
1931	0.1	0.0	1.0	0.3	0.1	0.0	0.0	0.0	0.0	-1.0	-0.3	-0.2
1933	0.0	0.0	0.3	0.1	0.0	0.1	0.0	0.0	0.0	-0.2	0.0	0.0
1934	0.0	-0.3	-0.1	0.9	0.2	0.1	0.0	0.0	0.0	0.5	0.1	0.0
1976	3.2	4.1	-0.3	-0.8	-0.7	-0.2	-0.2	-0.1	0.0	0.4	0.1	0.1
1977	0.0	0.3	0.5	0.2	0.0	-0.1	0.0	-0.4	-0.1	0.0	0.0	0.0
1988	-0.3	-0.1	0.7	1.7	0.5	0.0	-0.2	-0.1	0.0	0.4	0.1	0.0
1990	0.0	0.0	0.5	1.6	0.5	0.1	0.0	-0.2	-0.1	-0.4	-0.1	-0.1
1991	0.0	-1.1	-0.3	-0.1	0.0	0.0	-0.2	-0.3	-0.1	0.9	0.3	0.1
1992	0.1	-0.1	-0.1	0.0	0.9	0.3	-0.1	-0.1	0.0	-0.3	-0.1	0.0
Average	**0.2**	**0.2**	**0.1**	**0.2**	**0.1**	**0.0**	**-0.1**	**-0.1**	**0.0**	**0.0**	**0.0**	**0.0**

71 Year Record-Dry Years
X2 Position (in Kilometers)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	86.9	85.4	83.8	83.0	67.8	71.4	68.9	72.5	77.0	80.5	84.0	86.8
1926	85.9	85.1	83.1	81.7	71.2	74.0	70.3	74.0	79.6	80.7	82.2	84.1
1930	86.7	85.5	82.6	77.5	74.9	70.6	74.2	77.4	80.7	83.4	85.8	88.9
1932	90.2	87.8	81.8	80.5	74.9	75.2	75.3	76.7	76.3	82.0	85.4	88.0
1939	76.0	79.6	81.2	78.4	77.2	77.2	76.6	78.8	81.0	80.8	81.5	84.2
1944	86.0	83.6	81.4	81.4	73.0	72.3	75.4	78.2	78.7	80.5	81.7	86.4
1947	86.7	84.8	82.6	82.0	76.7	73.7	74.8	78.2	81.0	81.1	81.7	85.1
1949	83.4	83.6	81.7	82.9	79.7	66.9	72.2	74.5	78.4	81.5	85.2	86.2
1955	85.6	83.1	76.3	75.8	75.4	78.7	78.1	78.0	79.1	80.5	81.4	85.0
1960	85.8	84.3	82.9	82.8	74.0	73.7	74.7	78.0	80.7	80.4	82.0	83.4
1961	86.0	83.7	81.8	81.9	74.5	73.7	75.4	78.4	81.0	81.2	82.3	87.8
1964	82.4	74.3	79.6	74.6	75.1	78.1	78.9	79.3	80.7	80.7	82.3	83.7
1981	83.8	83.3	82.1	78.0	72.1	68.1	72.4	77.4	80.8	80.6	81.7	83.5
1985	82.2	71.5	69.6	74.8	74.9	75.4	77.1	76.9	80.6	80.3	82.1	82.9
1987	86.5	86.1	82.5	82.0	77.0	71.5	74.2	78.1	81.0	81.0	85.0	87.7
1989	90.1	86.6	85.0	83.6	80.5	70.2	69.6	74.2	79.7	80.9	81.6	85.6
Average	**85.3**	**83.0**	**81.1**	**80.1**	**74.9**	**73.2**	**74.3**	**76.9**	**79.8**	**81.0**	**82.9**	**85.6**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	86.9	85.4	83.8	83.0	67.6	71.3	69.3	73.2	77.0	79.6	84.6	87.2
1926	87.2	85.6	84.4	81.5	70.2	74.0	70.7	74.0	79.6	80.2	81.7	83.8
1930	86.7	85.9	82.8	75.8	74.4	70.4	74.2	77.4	80.7	81.4	85.2	88.7
1932	89.7	87.6	81.1	79.5	74.6	75.0	75.3	76.7	76.3	81.9	85.4	88.0
1939	75.8	77.5	80.7	80.7	77.6	77.3	76.6	78.9	81.0	80.7	81.9	85.6
1944	86.4	83.4	82.4	81.6	72.2	72.0	75.4	78.4	78.7	80.0	82.5	86.9
1947	87.3	85.0	82.4	82.4	76.6	73.7	74.8	78.3	81.0	80.7	82.0	86.3
1949	84.0	83.2	82.8	83.2	79.8	66.3	72.8	74.6	78.4	80.0	84.7	87.0
1955	86.4	83.1	74.7	73.4	74.7	78.7	78.7	78.8	79.1	80.1	81.7	85.3
1960	85.8	84.3	83.3	82.9	73.0	73.3	74.6	78.2	80.8	80.6	81.8	83.8
1961	86.1	83.8	81.8	81.9	73.8	73.5	75.4	78.4	81.0	80.7	82.5	87.9
1964	81.2	72.2	78.9	73.4	74.7	78.1	79.3	79.7	80.8	80.6	81.9	84.7
1981	81.3	82.2	81.8	76.3	71.5	68.4	73.1	77.7	80.8	80.6	81.9	84.7
1985	79.4	69.6	69.0	77.7	76.2	75.9	77.3	76.9	80.6	80.6	81.8	83.8
1987	86.4	85.7	83.2	82.3	77.1	71.5	74.2	78.1	81.0	81.2	85.1	88.7
1989	90.1	86.6	85.0	83.6	80.5	69.3	69.6	74.2	79.7	80.1	81.7	85.6
Average	**85.0**	**82.6**	**81.1**	**80.0**	**74.7**	**73.0**	**74.5**	**77.1**	**79.8**	**80.6**	**82.9**	**86.1**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	0.0	0.0	0.0	0.0	0.2	0.1	-0.4	-0.7	0.0	0.9	-0.6	-0.4
1926	-1.3	-0.5	-1.3	0.2	1.0	0.0	-0.4	0.0	0.0	0.5	0.5	0.3
1930	0.0	-0.4	-0.2	1.7	0.5	0.2	0.0	0.0	0.0	2.0	0.6	0.2
1932	0.5	0.2	0.7	1.0	0.3	0.2	0.0	0.0	0.0	0.1	0.0	0.0
1939	0.2	2.1	0.5	-2.3	-0.4	-0.1	0.0	-0.1	0.0	0.1	-0.4	-1.4
1944	-0.4	0.2	-1.0	-0.2	0.8	0.3	0.0	-0.2	0.0	0.5	-0.8	-0.5
1947	-0.6	-0.2	0.2	-0.4	0.1	0.0	0.0	-0.1	0.0	0.4	-0.3	-1.2
1949	-0.6	0.4	-1.1	-0.3	-0.1	0.6	-0.6	-0.1	0.0	1.5	0.5	-0.8
1955	-0.8	0.0	1.6	2.4	0.7	0.0	-0.6	-0.8	0.0	0.4	-0.3	-0.3
1960	0.0	0.0	-0.4	-0.1	1.0	0.4	0.1	-0.2	-0.1	-0.2	0.2	-0.4
1961	-0.1	-0.1	0.0	0.0	0.7	0.2	0.0	0.0	0.0	0.5	-0.2	-0.1
1964	1.2	2.1	0.7	1.2	0.4	0.0	-0.4	-0.4	-0.1	0.1	0.4	-1.0
1981	2.5	1.1	0.3	1.7	0.6	-0.3	-0.7	-0.3	0.0	0.0	-0.2	-1.2
1985	2.8	1.9	0.6	-2.9	-1.3	-0.5	-0.2	0.0	0.0	-0.3	0.3	-0.9
1987	0.1	0.4	-0.7	-0.3	-0.1	0.0	0.0	0.0	0.0	-0.2	-0.1	-1.0
1989	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.8	-0.1	0.0
Average	**0.2**	**0.4**	**0.0**	**0.1**	**0.3**	**0.1**	**-0.2**	**-0.2**	**0.0**	**0.4**	**0.0**	**-0.5**

71 Year Record-Below Normal Years
X2 Position (in Kilometers)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	84.2	80.5	70.1	66.4	70.2	74.9	69.6	72.4	77.3	79.4	81.8	83.2
1935	90.2	85.4	84.1	74.8	75.1	70.9	64.7	64.9	73.5	78.0	80.7	83.3
1936	85.6	84.6	83.7	73.2	61.6	65.0	67.6	72.1	77.0	78.6	81.1	82.7
1937	85.7	84.5	84.2	81.8	69.1	63.6	66.6	71.5	74.2	78.7	81.0	85.0
1945	85.0	83.1	81.7	82.0	67.7	68.1	71.7	74.5	76.6	79.8	82.9	87.0
1946	85.3	82.5	64.9	61.3	65.4	69.7	72.7	74.5	77.0	80.1	81.9	86.2
1948	84.0	83.7	83.8	82.1	77.5	76.5	71.2	67.8	73.1	77.0	80.0	82.6
1950	86.0	84.8	84.4	79.3	70.4	71.5	70.9	73.9	76.8	79.8	81.0	83.4
1959	77.8	80.3	82.2	69.8	61.5	67.7	75.1	78.3	80.2	79.9	80.4	82.9
1962	87.4	85.3	82.3	82.5	66.9	69.0	72.9	74.5	78.9	79.4	80.2	84.4
1966	84.8	76.2	79.1	71.4	68.6	69.6	72.6	74.6	79.0	79.2	80.3	82.4
1968	77.7	77.0	77.1	69.2	59.8	62.1	71.5	77.2	79.8	79.6	80.5	82.9
1972	83.0	82.3	80.6	80.6	73.1	68.5	73.6	77.9	80.0	79.3	80.5	83.0
1979	83.9	83.0	82.5	75.6	66.7	65.3	68.8	71.6	74.7	77.9	80.0	83.1
Average	**84.3**	**82.4**	**80.1**	**75.0**	**68.1**	**68.7**	**70.7**	**73.3**	**77.0**	**79.1**	**80.9**	**83.7**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	84.1	77.5	69.1	66.5	70.3	74.9	70.1	73.3	77.3	78.8	80.7	83.3
1935	90.2	85.4	84.1	73.7	74.8	70.8	64.9	65.0	73.5	77.6	80.2	85.1
1936	86.2	84.4	83.7	72.3	61.1	65.0	68.2	73.1	77.0	78.7	80.6	83.9
1937	86.1	84.6	84.4	81.7	68.5	62.9	67.0	72.6	74.5	78.0	83.0	88.0
1945	86.1	82.4	79.8	81.4	67.3	67.9	72.4	75.4	76.6	78.7	83.2	87.9
1946	87.4	80.7	63.5	60.9	65.4	69.5	73.6	74.8	77.0	78.7	82.0	87.5
1948	84.8	83.9	83.3	82.3	77.6	76.5	71.6	68.1	73.2	77.4	80.1	81.9
1950	87.2	85.2	84.5	77.2	69.1	71.1	71.3	74.0	76.8	78.6	80.4	83.2
1959	77.2	79.9	82.1	69.9	62.0	67.9	75.2	78.4	80.2	79.8	80.8	83.3
1962	87.4	85.0	82.3	82.5	66.6	68.9	73.6	74.7	79.0	79.4	81.1	85.9
1966	84.9	74.4	76.9	70.7	69.1	69.9	73.4	74.8	79.0	79.4	80.6	84.3
1968	74.7	77.2	79.6	70.7	60.3	62.2	71.6	77.2	79.8	79.6	80.8	83.5
1972	82.8	82.1	77.8	79.6	73.3	68.5	74.0	78.0	80.1	79.7	80.7	83.1
1979	84.3	83.0	83.1	74.5	65.4	65.3	69.5	72.5	74.7	78.0	80.3	86.3
Average	**84.5**	**81.8**	**79.6**	**74.6**	**67.9**	**68.7**	**71.2**	**73.7**	**77.1**	**78.7**	**81.0**	**84.8**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	0.1	3.0	1.0	-0.1	-0.1	0.0	-0.5	-0.9	0.0	0.6	1.1	-0.1
1935	0.0	0.0	0.0	1.1	0.3	0.1	-0.2	-0.1	0.0	0.4	0.5	-1.8
1936	-0.6	0.2	0.0	0.9	0.5	0.0	-0.6	-1.0	0.0	-0.1	0.5	-1.2
1937	-0.4	-0.1	-0.2	0.1	0.6	0.7	-0.4	-1.1	-0.3	0.7	-2.0	-3.0
1945	-1.1	0.7	1.9	0.6	0.4	0.2	-0.7	-0.9	0.0	1.1	-0.3	-0.9
1946	-2.1	1.8	1.4	0.4	0.0	0.2	-0.9	-0.3	0.0	1.4	-0.1	-1.3
1948	-0.8	-0.2	0.5	-0.2	-0.1	0.0	-0.4	-0.3	-0.1	-0.4	-0.1	0.7
1950	-1.2	-0.4	-0.1	2.1	1.3	0.4	-0.4	-0.1	0.0	1.2	0.6	0.2
1959	0.6	0.4	0.1	-0.1	-0.5	-0.2	-0.1	-0.1	0.0	0.1	-0.4	-0.4
1962	0.0	0.3	0.0	0.0	0.3	0.1	-0.7	-0.2	-0.1	0.0	-0.9	-1.5
1966	-0.1	1.8	2.2	0.7	-0.5	-0.3	-0.8	-0.2	0.0	-0.2	-0.3	-1.9
1968	3.0	-0.2	-2.5	-1.5	-0.5	-0.1	-0.1	0.0	0.0	0.0	-0.3	-0.6
1972	0.2	0.2	2.8	1.0	-0.2	0.0	-0.4	-0.1	-0.1	-0.4	-0.2	-0.1
1979	-0.4	0.0	-0.6	1.1	1.3	0.0	-0.7	-0.9	0.0	-0.1	-0.3	-3.2
Average	**-0.2**	**0.5**	**0.5**	**0.4**	**0.2**	**0.1**	**-0.5**	**-0.4**	**0.0**	**0.3**	**-0.2**	**-1.1**

71 Year Record-Above Normal Years
X2 Position (in Kilometers)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	82.9	84.1	81.6	79.0	66.3	65.0	67.1	61.9	65.5	74.8	79.0	84.0
1928	86.1	78.5	80.7	76.1	71.1	57.7	63.4	70.1	76.7	78.5	78.8	84.0
1940	86.2	84.9	83.1	74.0	64.9	55.5	55.4	66.9	75.7	77.3	80.1	82.4
1951	84.3	68.2	57.1	56.0	55.5	62.3	69.1	70.1	76.7	76.8	79.0	81.9
1954	83.1	80.3	81.6	74.0	62.4	60.6	60.7	67.2	75.7	77.3	78.5	82.4
1957	81.0	81.5	83.7	81.8	69.8	63.6	68.8	71.3	76.3	76.6	79.1	81.7
1973	85.0	77.9	74.0	60.8	54.4	55.7	65.7	69.7	74.5	76.5	78.8	83.3
1978	90.3	87.9	83.4	65.4	59.1	57.0	59.5	66.4	74.0	77.6	79.8	84.2
1980	85.9	83.5	80.0	60.8	51.9	53.9	65.0	70.4	76.8	77.5	79.7	85.7
Average	**85.0**	**80.8**	**78.4**	**69.8**	**61.7**	**59.0**	**63.9**	**68.2**	**74.7**	**77.0**	**79.2**	**83.3**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	82.9	84.1	79.3	76.6	66.2	65.3	67.8	62.3	64.5	73.7	80.2	86.1
1928	86.4	76.1	78.6	73.9	70.8	57.7	63.8	70.1	76.7	77.1	79.3	86.8
1940	86.7	85.0	83.2	73.0	64.2	54.9	55.4	66.9	75.7	76.8	79.1	83.7
1951	84.4	68.2	57.5	56.6	55.8	62.5	69.9	70.9	77.0	77.2	79.1	82.4
1954	83.3	77.4	80.6	73.0	62.3	60.9	61.0	67.2	75.8	76.8	78.9	84.8
1957	77.2	80.0	83.2	82.0	69.8	64.0	69.0	72.0	76.3	77.0	78.9	82.3
1973	85.1	76.3	72.1	60.0	54.3	55.7	66.3	70.6	74.5	76.4	79.1	84.7
1978	90.3	87.9	83.4	65.2	59.0	57.0	59.8	67.3	74.3	77.3	81.8	86.0
1980	86.9	82.2	77.2	59.4	51.5	53.9	65.8	71.5	77.2	77.7	79.6	85.4
Average	**84.8**	**79.7**	**77.2**	**68.9**	**61.5**	**59.1**	**64.3**	**68.8**	**74.7**	**76.7**	**79.6**	**84.7**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	0.0	0.0	2.3	2.4	0.1	-0.3	-0.7	-0.4	1.0	1.1	-1.2	-2.1
1928	-0.3	2.4	2.1	2.2	0.3	0.0	-0.4	0.0	0.0	1.4	-0.5	-2.8
1940	-0.5	-0.1	-0.1	1.0	0.7	0.6	0.0	0.0	0.0	0.5	1.0	-1.3
1951	-0.1	0.0	-0.4	-0.6	-0.3	-0.2	-0.8	-0.8	-0.3	-0.4	-0.1	-0.5
1954	-0.2	2.9	1.0	1.0	0.1	-0.3	-0.3	0.0	-0.1	0.5	-0.4	-2.4
1957	3.8	1.5	0.5	-0.2	0.0	-0.4	-0.2	-0.7	0.0	-0.4	0.2	-0.6
1973	-0.1	1.6	1.9	0.8	0.1	0.0	-0.6	-0.9	0.0	0.1	-0.3	-1.4
1978	0.0	0.0	0.0	0.2	0.1	0.0	-0.3	-0.9	-0.3	0.3	-2.0	-1.8
1980	-1.0	1.3	2.8	1.4	0.4	0.0	-0.8	-1.1	-0.4	-0.2	0.1	0.3
Average	**0.2**	**1.1**	**1.1**	**0.9**	**0.2**	**-0.1**	**-0.5**	**-0.5**	**0.0**	**0.3**	**-0.4**	**-1.4**

71 Year Record-Wet Years
X2 Position (in Kilometers)
Future Demand Level
Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	85.5	79.4	80.9	72.8	56.1	59.5	59.0	65.3	74.8	76.6	78.5	83.9
1938	86.5	77.0	63.9	65.9	53.2	47.6	52.8	55.2	61.5	73.5	79.9	82.2
1941	85.6	83.9	69.6	57.1	51.6	51.2	52.4	58.3	69.7	76.1	79.1	83.9
1942	82.9	81.3	65.1	56.9	49.9	61.7	59.0	61.2	67.9	75.6	78.8	84.0
1943	82.8	80.0	72.5	59.5	57.6	54.6	61.4	68.2	76.1	77.5	78.6	83.5
1952	85.5	82.7	68.3	58.0	55.2	55.7	55.5	55.9	62.0	73.6	80.0	81.0
1953	78.0	79.0	66.2	55.7	63.2	68.7	69.4	68.3	70.7	76.3	77.9	81.9
1956	86.3	84.1	64.3	51.6	51.6	59.3	65.8	62.5	69.6	76.0	79.1	82.3
1958	82.1	81.6	75.7	67.3	52.8	49.6	49.8	56.9	63.0	73.9	79.4	81.2
1963	73.4	78.4	72.2	73.4	60.5	63.6	55.4	62.1	72.9	76.1	78.6	82.2
1965	86.0	83.1	64.2	54.1	60.7	68.2	61.9	66.6	75.5	76.9	79.1	83.3
1967	85.6	82.8	70.2	63.7	59.9	57.9	57.9	58.8	61.8	73.6	80.0	81.2
1969	85.3	83.9	78.7	59.1	51.2	55.0	57.7	57.3	64.5	74.4	80.3	79.2
1970	75.7	76.4	63.5	49.3	50.9	58.9	69.7	75.4	78.4	77.5	78.7	82.1
1971	85.5	78.0	63.8	61.5	65.1	61.7	67.2	65.9	71.7	76.0	78.5	81.5
1974	85.1	67.3	59.6	51.6	57.3	52.3	53.5	63.2	70.9	76.2	79.0	81.2
1975	81.9	81.7	78.4	77.1	62.2	55.5	63.5	64.0	69.6	76.1	79.4	81.6
1982	85.7	74.3	60.0	55.6	52.3	52.5	48.4	55.6	66.0	74.9	80.4	76.7
1983	68.9	62.3	55.2	51.5	46.0	41.6	46.8	50.9	53.2	60.9	74.0	69.4
1984	64.7	56.6	49.0	51.4	56.4	60.5	68.4	73.7	77.5	77.1	79.5	82.3
1986	85.8	84.8	82.3	79.5	54.2	48.5	58.8	69.1	76.4	77.5	79.8	85.4
Average	**81.8**	**78.0**	**67.8**	**60.6**	**55.6**	**56.4**	**58.8**	**62.6**	**69.2**	**75.1**	**79.0**	**81.4**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	86.1	77.3	80.2	71.9	56.2	59.5	59.3	65.8	74.8	76.6	78.9	86.1
1938	87.5	74.3	62.5	65.7	53.2	47.6	52.9	55.3	60.9	73.3	79.9	82.0
1941	86.1	84.0	68.8	57.0	51.5	51.4	52.6	58.6	69.7	75.6	80.6	83.6
1942	80.5	77.3	63.5	56.8	49.9	61.6	59.2	61.6	68.1	75.6	80.6	83.7
1943	78.8	75.9	70.3	59.1	57.5	54.6	61.8	68.2	76.1	77.0	79.2	86.3
1952	85.6	82.9	67.7	57.4	55.0	55.8	55.8	56.2	61.2	73.4	79.9	79.8
1953	75.2	77.4	66.2	55.9	63.3	68.7	69.9	68.8	70.9	75.3	78.2	82.1
1956	86.6	84.2	63.9	51.4	51.7	59.3	66.5	63.0	69.7	75.7	79.3	81.8
1958	80.9	79.6	73.5	66.9	52.8	49.6	49.8	57.2	62.0	73.0	79.8	80.0
1963	72.5	75.1	71.3	75.0	60.9	63.7	55.6	62.5	72.9	75.9	78.3	84.0
1965	86.4	83.2	64.0	54.0	61.2	68.5	62.2	66.6	75.5	76.9	78.9	85.8
1967	86.2	83.0	69.4	63.0	59.2	57.7	58.1	59.1	61.1	72.8	79.7	78.8
1969	85.6	83.7	76.5	58.2	51.0	55.0	57.9	57.2	64.2	74.4	80.2	78.5
1970	73.5	74.9	63.5	49.4	51.0	58.9	69.7	76.2	78.7	77.8	79.0	82.9
1971	85.7	76.5	63.0	61.0	65.1	62.0	67.8	66.4	71.8	75.6	78.3	81.5
1974	84.8	66.4	58.9	51.5	57.7	52.4	53.8	63.8	71.1	75.3	79.1	80.4
1975	78.9	78.9	78.2	79.9	62.9	55.7	64.1	64.6	69.8	75.0	80.4	81.2
1982	86.4	73.3	59.1	55.2	52.5	52.7	48.5	55.6	66.0	74.9	80.4	75.0
1983	67.4	62.0	55.4	51.6	46.0	41.6	46.8	50.9	53.2	60.9	72.8	69.2
1984	64.8	56.6	49.0	51.4	56.4	60.5	69.2	74.6	77.5	77.5	79.1	82.2
1986	86.1	84.9	81.4	77.2	53.4	48.2	59.0	70.3	76.8	77.5	79.7	84.9
Average	**81.2**	**76.7**	**67.0**	**60.5**	**55.6**	**56.4**	**59.1**	**63.0**	**69.1**	**74.8**	**79.2**	**81.4**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	-0.6	2.1	0.7	0.9	-0.1	0.0	-0.3	-0.5	0.0	0.0	-0.4	-2.2
1938	-1.0	2.7	1.4	0.2	0.0	0.0	-0.1	-0.1	0.6	0.2	0.0	0.2
1941	-0.5	-0.1	0.8	0.1	0.1	-0.2	-0.2	-0.3	0.0	0.5	-1.5	0.3
1942	2.4	4.0	1.6	0.1	0.0	0.1	-0.2	-0.4	-0.2	0.0	-1.8	0.3
1943	4.0	4.1	2.2	0.4	0.1	0 0	-0.4	0.0	0.0	0.5	-0.6	-2.8
1952	-0.1	-0.2	0.6	0.6	0.2	-0.1	-0.3	-0.3	0.8	0.2	0.1	1.2
1953	2.8	1.6	0.0	-0.2	-0.1	0.0	-0.5	-0.5	-0.2	1.0	-0.3	-0.2
1956	-0.3	-0.1	0.4	0.2	-0.1	0.0	-0.7	-0.5	-0.1	0.3	-0.2	0.5
1958	1.2	2.0	2.2	0.4	0.0	0.0	0.0	-0.3	1.0	0.9	-0.4	1.2
1963	0.9	3.3	0.9	-1.6	-0.4	-0.1	-0.2	-0.4	0.0	0.2	0.3	-1.8
1965	-0.4	-0.1	0.2	0.1	-0.5	-0.3	-0.3	0.0	0.0	0.0	0.2	-2.5
1967	-0.6	-0.2	0.8	0.7	0.7	0.2	-0.2	-0.3	0.7	0.8	0.3	2.4
1969	-0.3	0.2	2.2	0.9	0.2	0.0	-0.2	0.1	0.3	0.0	0.1	0.7
1970	2.2	1.5	0.0	-0.1	-0.1	0.0	0.0	-0.8	-0.3	-0.3	-0.3	-0.8
1971	-0.2	1.5	0.8	0.5	0.0	-0.3	-0.6	-0.5	-0.1	0.4	0.2	0.0
1974	0.3	0.9	0.7	0.1	-0.4	-0.1	-0.3	-0.6	-0.2	0.9	-0.1	0.8
1975	3.0	2.8	0.2	-2.8	-0.7	-0.2	-0.6	-0.6	-0.2	1.1	-1.0	0.4
1982	-0.7	1.0	0.9	0.4	-0.2	-0.2	-0.1	0.0	0.0	0.0	0.0	1.7
1983	1.5	0.3	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.2
198[illegible]	-0.1	0.0	0.0	0.0	0.0	0.0	-0.8	-0.9	0.0	-0.4	0.4	0.1
1986	-0.3	-0.1	0.9	2.3	0.8	0.3	-0.2	-1.2	-0.4	0.0	0.1	0.5
Average	**0.6**	**1.3**	**0.8**	**0.1**	**0.0**	**0.0**	**-0.3**	**-0.4**	**0.1**	**0.3**	**-0.2**	**0.0**

71 Year Record-Critical Years
Sacramento River Flow at Freeport
Existing Demand Level

River Flow (Regulated) (in cubic feet per second)

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	13,034	11,544	16,354	15,805	15,271	15,898	7,464	7,895	10,285	15,008	10,175	7,301
1929	12,129	12,075	14,465	12,551	15,361	14,130	8,787	9,278	14,195	16,843	9,647	7,847
1931	8,158	7,808	10,849	12,873	11,099	10,035	9,829	6,497	10,026	13,602	6,110	6,783
1933	8,446	8,460	9,735	14,414	13,420	11,651	12,100	7,628	14,322	11,240	5,958	7,344
1934	7,430	6,564	13,733	17,189	13,569	17,199	12,810	8,365	13,641	10,551	6,074	6,808
1976	22,319	20,477	15,624	13,398	19,051	15,023	9,471	9,664	14,609	13,411	8,159	7,657
1977	8,124	9,542	14,313	15,968	12,943	10,235	8,476	6,073	7,055	8,793	6,207	6,509
1988	10,732	9,913	15,984	25,075	17,054	12,196	8,790	8,970	14,260	14,904	10,162	7,860
1990	8,651	7,505	14,283	17,202	15,178	11,049	12,250	7,540	14,583	17,226	11,003	7,561
1991	6,480	8,575	11,397	10,631	13,759	28,554	13,744	7,314	12,613	15,716	10,008	8,200
1992	6,670	7,330	11,294	11,479	28,251	19,058	12,590	8,382	14,153	15,822	9,300	7,653
Average	**10,198**	**9,981**	**13,457**	**15,144**	**15,905**	**15,003**	**10,574**	**7,964**	**12,704**	**13,920**	**8,437**	**7,411**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	3,496	2,940	7,066	7,345	4,020	2,992	1,396	1,494	2,183	673	109	1,765
1929	2,874	4,049	6,795	5,461	4,230	3,219	1,528	1,611	2,859	2,068	589	2,226
1931	2,233	3,257	3,100	5,818	3,191	2,135	1,587	1,263	1,271	442	219	1,234
1933	1,761	1,589	2,728	7,151	3,504	4,531	1,339	1,747	2,660	657	303	1,874
1934	1,594	2,152	5,450	7,279	3,119	2,886	1,835	1,501	2,185	544	109	1,711
1976	6,652	6,672	6,325	4,455	4,862	3,437	1,543	1,635	2,232	497	1,175	1,701
1977	2,547	1,397	6,563	6,664	3,464	653	686	1,012	332	2	2	851
1988	1,028	1,596	6,689	7,044	5,627	2,369	1,484	1,557	2,888	1,848	225	1,803
1990	2,510	1,151	3,306	7,026	3,047	2,234	1,815	1,403	1,532	506	415	1,333
1991	1,141	961	1,694	1,882	2,251	6,670	1,895	1,437	1,424	648	183	1,662
1992	1,644	1,221	1,927	3,494	7,506	3,882	1,789	1,506	2,900	1,221	305	2,437
Average	**2,498**	**2,453**	**4,695**	**5,784**	**4,075**	**3,183**	**1,536**	**1,470**	**2,042**	**828**	**330**	**1,691**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	9,538	8,604	9,288	8,460	11,251	12,906	6,068	6,401	8,102	14,335	10,066	5,536
1929	9,255	8,026	7,670	7,090	11,131	10,911	7,259	7,667	11,336	14,775	9,058	5,621
1931	5,925	4,551	7,749	7,055	7,908	7,900	8,242	5,234	8,755	13,160	5,891	5,549
1933	6,685	6,871	7,007	7,263	9,916	7,120	10,761	5,881	11,662	10,583	5,655	5,470
1934	5,836	4,412	8,283	9,910	10,450	14,313	10,975	6,864	11,456	10,007	5,965	5,097
1976	15,667	13,805	9,299	8,943	14,189	11,586	7,928	8,029	12,377	12,914	6,984	5,956
1977	5,577	8,145	7,750	9,304	9,479	9,582	7,790	5,061	6,723	8,791	6,205	5,658
1988	9,704	8,317	9,295	18,031	11,427	9,827	7,306	7,413	11,372	13,056	9,937	6,057
1990	6,141	6,354	10,977	10,176	12,131	8,815	10,435	6,137	13,051	16,720	10,588	6,228
1991	5,339	7,614	9,703	8,749	11,508	21,884	11,849	5,877	11,189	15,068	9,825	6,538
1992	5,026	6,109	9,367	7,985	20,745	15,176	10,801	6,876	11,253	14,601	8,995	5,216
Average	**7,699**	**7,528**	**8,763**	**9,361**	**11,830**	**11,820**	**9,038**	**6,495**	**10,661**	**13,092**	**8,106**	**5,721**

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	273%	293%	131%	115%	280%	431%	435%	428%	371%	2130%	9235%	314%
1929	322%	198%	113%	130%	263%	339%	475%	476%	397%	714%	1538%	253%
1931	265%	140%	250%	121%	248%	370%	519%	414%	689%	2977%	2690%	450%
1933	380%	432%	257%	102%	283%	157%	804%	337%	438%	1611%	1866%	292%
1934	366%	205%	152%	136%	335%	496%	598%	457%	524%	1840%	5472%	298%
1976	236%	207%	147%	201%	292%	337%	514%	491%	555%	2598%	594%	350%
1977	219%	583%	118%	140%	274%	1467%	1136%	500%	2025%	439550%	310250%	665%
1988	944%	521%	139%	256%	203%	415%	492%	476%	394%	706%	4416%	336%
1990	245%	552%	332%	145%	398%	395%	575%	437%	852%	3304%	2551%	467%
1991	468%	792%	573%	465%	511%	328%	625%	409%	786%	2325%	5369%	393%
1992	306%	500%	486%	229%	276%	391%	604%	457%	388%	1196%	2949%	214%
Average	**366%**	**402%**	**245%**	**185%**	**306%**	**466%**	**616%**	**444%**	**674%**	**41723%**	**31539%**	**366%**

71 Year Record-Dry Years
Sacramento River Flow at Freeport
Existing Demand Level

River Flow (Regulated) (in cubic feet per second)

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	12,609	10,500	11,736	10,669	37,294	18,965	22,118	13,005	15,927	20,353	14,918	10,920
1926	14,156	10,267	11,571	16,568	32,899	15,694	17,713	13,350	13,604	21,276	15,073	11,068
1930	12,624	11,264	14,735	21,393	15,973	28,809	12,118	11,202	13,477	16,978	10,558	8,828
1932	9,407	7,776	14,683	16,846	14,335	13,012	11,747	11,328	14,215	11,087	8,758	9,332
1939	24,402	20,324	16,682	15,296	15,632	13,310	11,978	10,027	13,838	20,605	13,862	10,479
1944	13,707	15,117	11,046	14,385	31,404	22,300	9,625	9,147	16,528	19,913	13,703	10,167
1947	14,306	11,344	14,652	15,925	19,295	20,090	12,808	10,099	13,316	23,359	15,554	11,191
1949	16,564	14,586	12,964	11,497	12,822	46,260	12,244	13,695	15,329	16,088	13,370	11,348
1955	13,434	15,962	25,114	19,822	16,734	10,906	8,689	10,562	16,043	23,353	15,557	12,033
1960	13,197	10,674	16,913	13,817	24,717	19,453	13,385	10,347	13,824	24,709	15,945	11,238
1961	13,092	12,409	17,272	11,510	30,677	18,815	12,711	10,484	13,664	24,859	15,610	10,436
1964	18,669	31,820	15,977	24,490	16,253	12,708	8,667	10,250	13,747	23,820	16,704	11,316
1981	16,928	14,220	16,218	25,220	28,023	32,372	13,490	10,010	13,598	20,729	13,863	10,098
1985	17,217	35,366	26,254	14,297	19,640	17,774	9,808	12,891	13,432	23,264	15,592	10,863
1987	10,589	11,202	9,415	13,380	19,140	31,363	12,920	10,874	13,580	21,402	16,957	10,394
1989	6,832	9,883	11,227	12,913	13,894	39,159	22,181	14,044	13,399	23,977	16,993	10,467
Average	14,233	15,170	15,404	16,127	21,796	22,562	13,263	11,332	14,220	20,985	14,564	10,636

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	2,303	2,474	4,493	3,014	7,441	3,973	3,350	2,593	3,271	5,459	3,161	1,625
1926	2,731	2,652	3,325	7,254	7,441	3,137	3,018	2,567	2,766	5,708	3,062	1,579
1930	1,949	2,336	4,874	7,238	3,700	6,929	1,810	1,770	3,702	3,237	2,457	1,726
1932	1,489	1,666	6,974	7,237	3,967	3,095	3,105	1,346	137	138	135	1,423
1939	6,652	6,473	3,473	3,089	3,040	2,697	2,088	1,939	2,813	3,725	2,400	1,242
1944	5,336	6,129	3,646	7,194	8,067	4,791	2,020	1,996	3,322	3,121	2,383	1,423
1947	3,015	4,102	6,836	7,416	6,141	4,109	2,171	1,949	2,717	6,684	3,853	1,668
1949	5,231	3,710	4,356	4,467	3,562	7,066	2,473	2,433	3,106	2,735	2,200	1,867
1955	2,960	6,672	6,993	7,407	5,130	2,262	1,767	1,968	3,279	6,684	6,554	3,485
1960	2,538	2,548	6,893	5,146	7,471	4,052	1,902	1,703	2,818	6,684	6,035	1,915
1961	2,297	4,137	6,876	4,924	7,364	3,650	1,782	1,708	2,783	6,684	5,832	1,962
1964	6,652	6,672	5,836	7,373	2,717	2,537	1,815	1,968	2,813	6,684	5,053	1,812
1981	6,652	6,672	4,906	3,089	3,453	3,513	2,520	1,939	2,775	3,761	2,399	1,356
1985	6,652	6,672	6,159	2,364	4,606	3,704	1,847	2,212	2,744	6,684	4,992	1,851
1987	6,652	4,877	3,726	4,962	5,437	7,019	1,896	1,730	2,768	5,574	2,713	1,384
1989	1,244	2,468	2,577	4,084	2,802	6,930	2,734	2,028	2,751	6,684	5,461	2,905
Average	4,022	4,392	5,121	5,391	5,146	4,342	2,269	1,991	2,785	5,015	3,668	1,826

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	10,306	8,026	7,243	7,655	29,853	14,992	18,768	10,412	12,656	14,894	11,757	9,295
1926	11,425	7,615	8,246	9,314	25,458	12,557	14,695	10,783	10,838	15,568	12,011	9,489
1930	10,675	8,928	9,861	14,155	12,273	21,880	10,308	9,432	9,775	13,741	8,101	7,102
1932	7,918	6,110	7,709	9,609	10,368	9,917	8,642	9,982	14,078	10,929	8,623	7,909
1939	17,750	13,846	13,209	12,207	12,592	10,613	9,890	8,088	11,025	16,880	11,462	9,237
1944	8,371	8,988	7,400	7,191	23,337	17,509	7,605	7,151	13,206	16,792	11,320	8,744
1947	11,291	7,242	7,816	8,509	13,154	15,981	10,637	8,150	10,599	16,675	11,701	9,523
1949	11,333	10,876	8,608	7,030	9,260	39,194	9,771	11,262	12,223	13,353	11,170	9,481
1955	10,474	9,290	18,121	12,415	11,604	8,644	6,922	8,594	12,764	16,669	9,003	8,548
1960	10,659	8,126	10,020	8,671	17,246	15,401	11,483	8,644	11,006	18,025	9,910	9,323
1961	10,795	8,272	10,396	6,586	23,313	15,165	10,929	8,776	10,881	18,175	9,778	8,474
1964	12,017	25,148	10,141	17,117	13,536	10,171	6,852	8,282	10,934	17,136	11,651	9,504
1981	10,276	7,548	11,312	22,131	24,570	28,859	10,970	8,071	10,823	16,968	11,464	8,742
1985	10,565	28,694	20,095	11,933	15,034	14,070	7,961	10,679	10,688	16,580	10,600	9,012
1987	3,937	6,325	5,689	8,418	13,703	24,344	11,024	9,144	10,812	15,828	14,244	9,010
1989	5,588	7,415	8,650	8,829	11,092	32,229	19,447	12,016	10,648	17,293	11,532	7,562
Average	10,211	10,778	10,282	10,736	16,650	18,220	10,994	9,342	11,435	15,969	10,895	8,810

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	448%	324%	161%	254%	401%	377%	560%	402%	387%	273%	372%	572%
1926	418%	287%	248%	128%	342%	400%	487%	420%	392%	273%	392%	601%
1930	548%	382%	202%	196%	332%	316%	570%	533%	264%	424%	330%	411%
1932	532%	367%	111%	133%	261%	320%	278%	742%	10276%	7920%	6387%	556%
1939	267%	214%	380%	395%	414%	394%	474%	417%	392%	453%	478%	744%
1944	157%	147%	203%	100%	289%	365%	376%	358%	398%	538%	475%	614%
1947	374%	177%	114%	115%	214%	389%	490%	418%	390%	249%	304%	571%
1949	217%	293%	198%	157%	260%	555%	395%	463%	394%	488%	508%	508%
1955	354%	139%	259%	168%	226%	382%	392%	437%	389%	249%	137%	245%
1960	420%	319%	145%	168%	231%	380%	604%	508%	391%	270%	164%	487%
1961	470%	200%	151%	134%	317%	415%	613%	514%	391%	272%	168%	432%
1964	181%	377%	174%	232%	498%	401%	378%	421%	389%	256%	231%	525%
1981	154%	113%	231%	716%	712%	821%	435%	416%	390%	451%	478%	645%
1985	159%	430%	326%	505%	326%	380%	431%	483%	390%	248%	212%	487%
1987	59%	130%	153%	170%	252%	347%	581%	529%	391%	284%	525%	651%
1989	449%	300%	336%	216%	396%	465%	711%	593%	387%	259%	211%	260%
Average	325%	262%	212%	237%	342%	419%	486%	478%	1001%	807%	711%	519%

71 Year Record-Below Normal Years
Sacramento River Flow at Freeport — River Flow (Regulated) (in cubic feet per second)
Existing Demand Level
Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	20,401	20,158	32,529	29,936	22,006	11,275	22,537	14,306	15,455	20,331	17,287	10,398
1935	7,012	11,460	11,871	25,114	14,471	22,470	20,470	30,985	16,606	18,886	15,315	10,384
1936	11,928	11,025	11,605	28,507	38,537	33,192	19,175	13,395	15,241	17,632	13,662	10,243
1937	12,379	10,528	14,738	12,954	31,237	37,310	20,992	14,379	19,174	14,529	11,628	8,729
1945	13,904	13,839	16,255	13,074	44,365	26,866	11,823	12,450	17,932	16,394	13,021	9,835
1946	13,112	19,869	58,155	42,827	24,786	20,978	12,043	13,015	17,281	19,468	14,449	10,417
1948	14,291	11,643	12,949	15,811	16,525	14,623	22,773	30,518	20,583	27,148	17,267	12,674
1950	13,952	10,935	12,084	19,534	33,851	21,344	17,676	13,785	17,366	23,452	16,074	11,400
1959	22,814	17,188	12,563	37,039	50,709	20,584	9,678	10,048	14,476	21,433	14,296	11,398
1962	12,478	10,593	16,233	12,125	41,918	24,120	11,120	14,186	14,989	24,941	15,365	11,471
1966	15,504	25,948	15,546	28,754	26,032	26,551	13,059	14,142	14,464	21,235	17,403	11,341
1968	23,545	17,983	16,175	28,229	61,379	34,431	10,986	9,795	14,465	21,025	13,455	11,369
1972	19,169	16,451	22,360	18,238	25,328	32,275	11,257	9,787	14,225	24,047	15,334	10,182
1979	18,296	15,858	10,623	25,053	40,292	30,623	16,639	15,506	19,842	16,714	13,192	11,054
Average	**15,628**	**15,248**	**18,835**	**24,085**	**33,674**	**25,474**	**15,731**	**15,450**	**16,579**	**20,517**	**14,839**	**10,77[illegible]**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	6,652	6,672	7,417	5,303	485	3,048	3,856	3,133	3,270	5,974	3,493	1,791
1935	1,354	3,678	2,681	7,534	3,167	6,056	4,048	4,178	3,620	5,619	3,807	2,043
1936	2,952	2,547	3,247	7,634	8,500	7,254	3,591	3,035	3,245	4,319	3,003	1,908
1937	2,347	2,140	7,052	6,872	8,500	7,592	4,014	3,351	1,443	890	1,882	1,755
1945	2,510	6,672	7,159	7,058	7,942	4,051	2,940	2,528	3,739	2,071	2,348	1,685
1946	4,093	6,672	7,260	7,739	3,230	4,650	2,941	2,681	3,519	5,315	3,244	1,787
1948	3,277	3,655	3,491	6,717	3,223	3,011	3,286	3,854	4,133	6,684	6,554	5,759
1950	2,730	2,820	2,476	7,338	7,441	4,544	2,964	2,699	3,505	6,684	5,495	2,062
1959	6,652	3,709	3,532	3,147	3,657	3,249	1,883	1,965	2,968	3,973	2,521	2,296
1962	1,912	2,808	6,373	3,392	7,934	6,128	2,096	2,461	2,968	6,684	4,246	2,205
1966	6,652	6,672	7,296	7,979	5,805	4,228	2,536	2,433	2,966	5,963	2,990	1,968
1968	4,968	3,372	2,615	2,207	2,759	3,249	2,340	1,937	2,968	3,697	2,434	2,008
1972	6,652	6,672	7,003	5,202	4,542	5,081	2,312	1,967	2,944	6,684	4,989	2,331
1979	6,652	6,672	2,717	6,331	3,589	3,749	3,302	3,256	3,157	993	2,085	2,279
Average	**4,243**	**4,626**	**5,023**	**6,032**	**5,055**	**4,706**	**3,008**	**2,820**	**3,175**	**4,682**	**3,507**	**2,277**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	13,749	13,486	25,112	24,633	21,521	8,227	18,681	11,173	12,185	14,357	13,794	8,607
1935	5,658	7,782	9,190	17,580	11,304	16,414	16,422	26,807	12,986	13,267	11,508	8,341
1936	8,976	8,478	8,358	20,873	30,037	25,938	15,584	10,360	11,996	13,313	10,659	8,335
1937	10,032	8,388	7,686	6,082	22,737	29,718	16,978	11,028	17,731	13,639	9,746	6,974
1945	11,394	7,167	9,096	6,016	36,423	22,815	8,883	9,922	14,193	14,323	10,673	8,150
1946	9,019	13,197	50,895	35,088	21,556	16,328	9,102	10,334	13,762	14,153	11,205	8,630
1948	11,014	7,988	9,458	9,094	13,302	11,612	19,487	26,664	16,450	20,464	10,713	6,915
1950	11,222	8,115	9,608	12,196	26,410	16,800	14,712	11,086	13,861	16,768	10,579	9,338
1959	16,162	13,479	9,031	33,892	47,052	17,335	7,795	8,083	11,508	17,460	11,775	9,100
1962	10,566	7,785	9,860	8,733	33,984	17,992	9,024	11,725	12,021	18,257	11,119	9,266
1966	8,852	19,276	8,250	20,775	20,227	22,323	10,523	11,709	11,498	15,272	14,413	9,373
1968	18,577	14,611	13,560	26,022	58,620	31,182	8,646	7,858	11,497	17,328	11,021	9,361
1972	12,517	9,779	15,357	13,036	20,786	27,194	8,945	7,820	11,281	17,363	10,345	7,851
1979	11,644	9,186	7,906	18,722	36,703	26,874	13,337	12,250	16,685	15,721	11,107	8,775
Average	**11,384**	**10,623**	**13,812**	**18,053**	**28,619**	**20,768**	**12,723**	**12,630**	**13,404**	**15,835**	**11,333**	**8,501**

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	207%	202%	339%	465%	4437%	270%	484%	357%	373%	240%	395%	481%
1935	418%	212%	343%	233%	357%	271%	406%	642%	359%	236%	302%	408%
1936	304%	333%	257%	273%	353%	358%	434%	341%	370%	308%	355%	437%
1937	427%	392%	109%	89%	267%	391%	423%	329%	1229%	1532%	518%	397%
1945	454%	107%	127%	85%	459%	563%	302%	392%	380%	692%	455%	484%
1946	220%	198%	701%	453%	667%	351%	309%	385%	391%	266%	345%	483%
1948	336%	219%	271%	135%	413%	386%	593%	692%	398%	306%	163%	120%
1950	411%	288%	388%	166%	355%	370%	496%	411%	395%	251%	193%	453%
1959	243%	363%	256%	1077%	1287%	534%	414%	411%	388%	439%	467%	398%
1962	553%	277%	155%	257%	428%	294%	431%	476%	405%	273%	262%	420%
1966	133%	289%	113%	260%	348%	528%	415%	481%	388%	256%	482%	476%
1968	374%	433%	519%	1179%	2125%	960%	369%	406%	387%	469%	453%	466%
1972	188%	147%	219%	251%	458%	535%	387%	398%	383%	260%	207%	337%
1979	175%	138%	291%	296%	1023%	717%	404%	376%	529%	1583%	533%	385%
Average	**317%**	**257%**	**292%**	**373%**	**927%**	**466%**	**419%**	**436%**	**455%**	**508%**	**366%**	**410%**

71 Year Record-Above Normal Years
Sacramento River Flow at Freeport
Existing Demand Level

River Flow (Regulated) (in cubic feet per second)

Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	10,067	10,243	15,447	16,764	35,899	29,686	21,029	46,055	33,543	15,067	10,526	9,883
1928	14,868	26,678	15,226	24,291	26,608	88,293	27,042	15,920	15,796	21,583	15,771	11,014
1940	12,600	11,134	12,560	23,855	40,251	59,962	39,755	15,878	15,472	19,278	14,376	10,062
1951	16,299	43,127	59,070	58,194	60,212	29,014	14,312	18,263	15,369	23,921	16,407	11,394
1954	20,539	24,743	16,529	32,135	57,774	47,537	41,007	20,313	15,531	22,837	16,481	11,414
1957	20,947	16,316	11,881	15,674	38,076	42,687	16,352	15,591	16,365	24,277	18,847	10,783
1973	15,641	22,459	27,438	47,796	71,664	45,792	16,912	17,832	18,851	19,710	14,500	11,878
1978	6,628	7,063	15,429	44,847	50,421	49,380	37,669	19,631	14,216	13,312	10,740	13,416
1980	10,599	17,105	19,210	69,302	69,056	35,876	16,642	13,875	12,716	13,509	10,987	13,516
Average	14,243	19,874	21,421	36,984	49,996	47,581	25,636	20,373	17,540	19,277	14,293	11,484

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	2,369	2,652	7,211	7,918	8,500	5,065	4,001	4,377	6,672	311	307	1,847
1928	5,215	6,672	7,103	7,545	4,469	4,228	3,687	2,926	3,161	3,661	2,759	1,652
1940	1,740	2,048	3,160	7,477	7,821	7,254	4,048	3,419	3,164	6,684	4,242	1,981
1951	4,671	6,672	7,592	8,500	6,593	4,363	3,121	3,488	3,154	6,004	3,252	1,945
1954	6,652	6,672	6,424	5,434	3,819	4,349	3,687	3,390	3,132	4,682	3,143	2,053
1957	6,652	6,509	3,506	7,164	6,131	4,375	2,903	2,793	3,381	6,644	3,294	1,893
1973	3,783	6,672	6,990	7,344	8,079	5,734	3,386	3,465	3,907	3,467	2,827	2,662
1978	1,404	1,334	6,584	3,949	1,516	2,846	2,863	2,630	2,017	453	303	3,564
1980	3,460	6,672	7,071	8,500	4,321	3,255	2,887	3,386	1,551	307	703	5,790
Average	3,994	5,100	6,182	7,092	5,694	4,608	3,398	3,319	3,349	3,579	2,314	2,599

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	7,698	7,591	8,236	8,846	27,399	24,621	17,028	41,678	26,871	14,756	10,219	8,036
1928	9,653	20,006	8,123	16,746	22,139	84,065	23,355	12,994	12,635	17,922	13,012	9,362
1940	10,860	9,086	9,400	16,378	32,430	52,708	35,707	12,459	12,308	12,594	10,134	8,081
1951	11,628	36,455	51,478	49,694	53,619	24,651	11,191	14,775	12,215	17,917	13,155	9,449
1954	13,887	18,071	10,105	26,701	53,955	43,188	37,320	16,923	12,399	18,155	13,338	9,361
1957	14,295	9,807	8,375	8,510	31,945	38,312	13,449	12,798	12,984	17,633	15,553	8,890
1973	11,858	15,787	20,448	40,452	63,585	40,058	13,526	14,367	14,944	16,243	11,673	9,216
1978	5,224	5,729	8,845	40,898	48,905	46,534	34,806	17,001	12,199	12,859	10,437	9,852
1980	7,139	10,433	12,139	60,802	64,735	32,621	13,755	10,489	11,165	13,202	10,284	7,726
Average	10,249	14,774	15,239	29,892	44,301	42,973	22,237	17,054	14,191	15,698	11,978	8,886

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	325%	286%	114%	112%	322%	486%	426%	952%	403%	4745%	3329%	435%
1928	185%	300%	114%	222%	495%	1988%	633%	444%	400%	490%	472%	567%
1940	624%	444%	297%	219%	415%	727%	882%	364%	389%	188%	239%	408%
1951	249%	546%	678%	585%	813%	565%	359%	424%	387%	298%	405%	486%
1954	209%	271%	157%	491%	1413%	993%	1012%	499%	396%	388%	424%	456%
1957	215%	151%	239%	119%	521%	876%	463%	458%	384%	265%	472%	470%
1973	313%	237%	293%	551%	787%	699%	399%	415%	382%	469%	413%	346%
1978	372%	429%	134%	1036%	3226%	1635%	1216%	646%	605%	2839%	3445%	276%
1980	206%	156%	172%	715%	1498%	1002%	476%	310%	720%	4300%	1463%	133%
Average	300%	313%	244%	450%	1055%	997%	652%	501%	452%	1554%	1185%	397%

71 Year Record-Wet Years
Sacramento River Flow at Freeport — River Flow (Regulated) (in cubic feet per second)
Existing Demand Level
Fisheries (Run 454)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	13,315	20,705	15,688	31,202	71,081	38,076	45,968	24,267	15,408	16,421	13,750	10,276
1938	10,743	31,008	58,222	30,781	81,652	77,641	46,028	54,986	32,939	13,527	11,241	17,631
1941	12,906	12,105	34,212	72,609	74,485	57,181	42,340	39,466	19,539	13,665	10,954	14,518
1942	22,067	21,101	65,494	63,181	79,077	23,987	44,096	36,372	26,443	14,963	11,006	13,510
1943	21,569	23,556	30,088	57,144	51,816	63,524	27,911	17,172	15,383	17,152	12,853	9,446
1952	13,817	16,448	47,342	66,163	64,256	56,067	57,566	60,752	38,553	17,255	12,128	20,134
1953	23,364	17,513	43,756	64,069	26,157	21,585	18,213	25,631	26,975	17,387	12,977	14,787
1956	12,522	12,461	30,317	77,995	68,684	34,601	18,590	41,361	21,943	17,315	14,543	16,677
1958	19,944	18,745	26,186	36,378	64,536	93,877	52,539	41,227	35,563	15,547	13,305	19,998
1963	29,499	20,913	28,055	15,997	51,913	30,283	68,830	29,281	15,643	18,370	14,560	14,053
1965	12,875	14,466	35,650	79,759	32,996	20,131	45,025	22,313	15,200	21,365	14,263	10,306
1967	13,462	14,431	40,098	36,032	42,955	52,468	38,491	45,174	40,192	15,166	12,454	19,477
1969	14,046	12,391	22,814	74,564	67,092	43,847	43,156	44,408	24,949	12,586	11,400	23,591
1970	21,824	18,757	51,680	91,518	56,216	33,273	11,427	10,289	14,738	21,422	13,922	10,672
1971	13,738	22,518	60,245	47,464	28,666	50,665	19,323	31,190	22,755	18,890	15,493	16,643
1974	15,176	57,452	60,495	78,775	42,015	97,768	36,823	24,438	21,148	16,585	14,053	21,601
1975	22,708	17,805	17,880	16,032	61,624	74,092	21,533	32,214	24,876	18,859	14,333	17,946
1982	12,931	34,206	71,542	53,074	70,537	62,008	78,803	35,744	22,540	15,018	13,803	23,120
1983	29,962	40,150	58,263	57,238	82,606	87,187	64,475	56,196	51,139	23,362	15,542	24,375
1984	27,488	64,594	85,103	45,529	38,969	33,026	14,103	12,536	14,867	19,694	13,267	15,606
1986	12,575	10,776	16,539	18,731	107,734	67,673	19,089	11,015	12,418	15,923	12,607	10,851
Average	**17,930**	**23,910**	**42,841**	**53,059**	**60,241**	**53,284**	**38,778**	**33,144**	**24,439**	**17,165**	**13,260**	**16,439**

Base (Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,457	6,672	6,933	7,117	7,910	4,447	4,048	4,023	2,677	1,049	2,187	1,952
1938	3,108	6,672	7,090	8,123	5,189	3,888	3,312	4,063	5,653	307	305	6,588
1941	2,361	3,766	7,192	8,221	8,500	7,542	3,954	3,736	3,977	307	303	5,038
1942	6,652	6,672	3,458	3,089	3,453	3,376	3,965	4,377	6,658	311	307	6,010
1943	6,652	6,672	4,194	3,228	3,702	3,408	3,946	2,343	2,288	866	1,822	1,458
1952	2,620	6,672	7,043	8,500	8,278	5,306	3,808	4,236	5,248	3,851	955	6,588
1953	5,723	3,618	3,427	2,284	2,745	3,249	2,973	3,745	5,946	311	622	4,285
1956	2,603	3,769	7,040	8,500	8,500	7,254	3,793	4,377	5,406	1,967	3,150	6,588
1958	6,652	6,672	7,111	7,582	4,852	5,512	4,704	4,690	6,165	1,288	2,442	6,588
1963	6,652	6,672	7,005	7,234	2,013	6,281	4,050	4,178	3,536	2,445	2,700	3,861
1965	2,183	6,358	7,047	8,500	7,821	5,380	4,274	4,699	3,167	4,737	3,241	1,995
1967	2,618	6,672	7,265	7,687	7,836	3,205	4,194	4,063	5,653	6,173	1,194	6,588
1969	2,606	4,788	6,988	8,144	8,166	3,103	3,277	3,624	4,996	1,973	382	6,588
1970	6,652	3,618	3,166	3,058	2,745	3,249	3,000	2,353	3,141	2,677	2,307	1,859
1971	2,596	6,672	7,150	7,389	4,742	6,870	3,057	3,851	4,513	3,650	3,264	5,649
1974	6,652	6,672	7,091	7,815	4,093	4,281	4,274	4,458	4,432	2,330	2,181	6,588
1975	6,652	6,672	6,752	3,464	3,941	4,349	4,134	4,377	5,835	1,185	3,057	6,588
1982	1,928	6,672	6,956	7,786	8,500	4,365	4,906	5,713	6,672	3,985	3,390	6,588
1983	6,652	4,029	3,676	2,983	3,020	2,514	3,234	2,207	3,075	3,193	5,445	3,734
1984	2,687	2,361	1,969	1,759	2,499	3,112	3,136	2,552	3,342	1,624	2,117	6,034
1986	2,281	4,427	7,059	7,181	8,500	7,592	6,234	3,597	2,698	860	1,791	3,416
Average	**4,237**	**5,562**	**5,982**	**6,174**	**5,572**	**4,680**	**3,918**	**3,870**	**4,528**	**2,147**	**2,055**	**4,980**

Difference (Run 454 - Run 420)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	10,858	14,033	8,755	24,085	63,171	33,629	41,920	20,244	12,731	15,372	11,563	8,324
1938	7,635	24,336	51,132	22,658	76,463	73,753	42,716	50,923	27,286	13,220	10,936	11,043
1941	10,545	8,339	27,020	64,388	65,985	49,639	38,386	35,730	15,562	13,358	10,651	9,480
1942	15,415	14,429	62,036	60,092	75,624	20,611	40,131	31,995	19,785	14,652	10,699	7,500
1943	14,917	16,884	25,894	53,916	48,114	60,116	23,965	14,829	13,095	16,286	11,031	7,988
1952	11,197	9,776	40,299	57,663	55,978	50,761	53,758	56,516	33,305	13,404	11,173	13,546
1953	17,641	13,895	40,329	61,785	23,412	18,336	15,240	21,886	21,029	17,076	12,355	10,502
1956	9,919	8,692	23,277	69,495	60,184	27,347	14,797	36,984	16,537	15,348	11,393	10,089
1958	13,292	12,073	19,075	28,796	59,684	88,365	47,835	36,537	29,398	14,259	10,863	13,410
1963	22,847	14,241	21,050	8,763	49,900	24,002	64,780	25,103	12,107	15,925	11,860	10,192
1965	10,692	8,108	28,603	71,259	25,175	14,751	40,751	17,614	12,033	16,628	11,022	8,311
1967	10,844	7,759	32,833	28,345	35,119	49,263	34,297	41,111	34,539	8,993	11,260	12,889
1969	11,440	7,603	15,826	66,420	58,926	40,744	39,879	40,784	19,953	10,613	11,018	17,003
1970	15,172	15,139	48,514	88,460	53,471	30,024	8,427	7,936	11,597	18,745	11,615	8,813
1971	11,142	15,846	53,095	40,075	23,924	43,795	16,266	27,339	18,242	15,240	12,229	10,994
1974	8,524	50,780	53,404	70,960	37,922	93,487	32,549	19,980	16,716	14,255	11,872	15,013
1975	16,056	11,133	11,128	12,568	57,683	69,743	17,399	27,837	19,041	17,674	11,276	11,358
1982	11,003	27,534	64,586	45,288	62,037	57,643	73,897	30,031	15,868	11,033	10,413	16,532
1983	23,310	36,121	54,587	54,255	79,586	84,673	61,241	53,989	48,064	20,169	10,097	20,641
1984	24,801	62,233	83,134	43,770	36,470	29,914	10,967	9,984	11,525	18,070	11,150	9,572
1986	10,294	6,349	9,480	11,550	99,234	60,081	12,855	7,418	9,720	15,063	10,816	7,435
Average	**13,693**	**18,348**	**36,860**	**46,885**	**54,670**	**48,604**	**34,860**	**29,275**	**19,911**	**15,018**	**11,204**	**11,459**

71 Year Record-Wet Years
Sacramento River Flow at Freeport River Flow (Regulated) (in cubic feet per second)
Existing Demand Level

Percent Difference [(Run 454 - Run 420)/Run 420]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	442%	210%	126%	338%	799%	756%	1036%	503%	476%	1465%	529%	426%
1938	246%	365%	721%	279%	1474%	1897%	1290%	1253%	483%	4306%	3586%	168%
1941	447%	221%	376%	783%	776%	658%	971%	956%	391%	4351%	3515%	188%
1942	232%	216%	1794%	1945%	2190%	611%	1012%	731%	297%	4711%	3485%	125%
1943	224%	253%	617%	1670%	1300%	1764%	607%	633%	572%	1881%	605%	548%
1952	427%	147%	572%	678%	676%	957%	1412%	1334%	635%	348%	1170%	206%
1953	308%	384%	1177%	2705%	853%	564%	513%	584%	354%	5491%	1986%	245%
1956	381%	231%	331%	818%	708%	377%	390%	845%	306%	780%	362%	153%
1958	200%	181%	268%	380%	1230%	1603%	1017%	779%	477%	1107%	445%	204%
1963	343%	213%	300%	121%	2479%	382%	1600%	601%	342%	651%	439%	264%
1965	490%	128%	406%	838%	322%	274%	953%	375%	380%	351%	340%	417%
1967	414%	116%	452%	369%	448%	1537%	818%	1012%	611%	146%	943%	196%
1969	439%	159%	226%	816%	722%	1313%	1217%	1125%	399%	538%	2884%	258%
1970	228%	418%	1532%	2893%	1948%	924%	281%	337%	369%	700%	503%	474%
1971	429%	238%	743%	542%	505%	637%	532%	710%	404%	418%	375%	195%
1974	128%	761%	753%	908%	927%	2184%	762%	448%	377%	612%	544%	228%
1975	241%	167%	165%	363%	1464%	1604%	421%	636%	326%	1491%	369%	172%
1982	571%	413%	928%	582%	730%	1321%	1506%	526%	238%	277%	307%	251%
1983	350%	897%	1485%	1819%	2635%	3368%	1894%	2446%	1563%	632%	185%	553%
1984	923%	2636%	4222%	2488%	1459%	961%	350%	391%	345%	1113%	527%	159%
1986	451%	143%	134%	161%	1167%	791%	206%	206%	360%	1752%	604%	218%
Average	377%	405%	825%	1024%	1181%	1166%	895%	783%	462%	1577%	1129%	269%

71 Year Record-Critical Years
Sacramento River Flow at Freeport
Future Demand Level

River Flow (Regulated) (in cubic feet per second)

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	9,393	11,719	17,984	15,611	15,862	13,273	7,204	8,154	10,352	12,154	6,817	6,454
1929	9,743	12,413	15,980	12,502	15,591	13,187	8,600	9,310	13,907	16,231	6,957	7,533
1931	8,678	8,058	13,224	12,632	11,198	9,983	9,571	6,527	10,134	12,910	6,422	7,033
1934	7,053	6,930	13,912	15,374	11,978	17,324	12,789	8,408	14,294	12,420	5,680	7,795
1935	6,942	11,660	11,872	24,156	14,489	21,918	19,787	31,050	17,054	20,007	17,621	14,263
1976	21,486	18,358	15,251	13,446	19,262	13,542	9,550	9,691	14,799	18,976	9,282	7,566
1977	8,003	10,170	15,770	8,407	13,336	10,586	8,425	6,155	8,641	9,088	6,157	6,553
1988	7,809	9,925	16,332	25,252	13,580	12,276	8,615	8,495	13,474	17,348	7,774	6,861
1990	9,096	7,346	15,082	17,804	15,015	10,608	12,011	7,570	14,710	20,144	8,148	7,330
1991	6,539	8,811	11,642	11,041	13,854	28,715	13,666	7,714	14,022	13,404	8,733	8,930
1992	6,766	7,296	8,600	11,245	28,984	18,667	12,532	8,517	14,406	14,277	7,174	7,440
Average	**9,228**	**10,244**	**14,150**	**15,225**	**15,741**	**15,462**	**11,159**	**10,145**	**13,254**	**15,178**	**8,251**	**7,978**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	3,452	3,252	7,066	5,328	4,157	2,487	1,380	104	76	152	33	630
1929	2,760	4,390	4,740	5,487	4,286	2,994	1,506	1,606	2,695	1,082	93	1,140
1931	2,169	2,758	6,539	5,905	3,242	2,101	1,568	87	61	62	59	521
1933	1,685	1,538	2,944	6,983	3,235	2,298	2,086	1,732	2,961	3,045	106	779
1934	1,630	2,044	5,942	7,279	2,807	2,854	1,834	1,505	2,546	1,107	111	586
1976	6,652	6,672	5,557	4,479	5,591	3,227	1,549	1,623	2,972	6,684	1,179	1,571
1977	2,426	2,425	6,866	3,345	3,779	795	678	1,022	247	2	2	837
1988	326	1,574	6,930	7,056	1,649	2,367	1,474	1,185	1,163	1,229	85	639
1990	2,687	1,216	5,902	7,042	3,044	2,121	1,795	1,400	1,379	725	236	1,167
1991	1,077	1,133	2,084	2,207	2,588	6,847	1,901	1,438	2,811	2,183	93	1,146
1992	1,682	1,758	2,241	3,670	7,578	4,093	1,790	878	847	619	110	966
Average	**2,413**	**2,615**	**5,165**	**5,344**	**3,814**	**2,926**	**1,596**	**1,144**	**1,614**	**1,535**	**192**	**907**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	5,941	8,467	10,918	10,283	11,705	10,786	5,824	8,050	10,276	12,002	6,784	5,824
1929	6,983	8,023	11,240	7,015	11,305	10,193	7,094	7,704	11,212	15,149	6,864	6,393
1931	6,509	5,300	6,685	6,727	7,956	7,882	8,003	6,440	10,073	12,848	6,363	6,512
1933	5,368	5,392	10,968	8,391	8,743	15,026	10,703	6,676	11,333	9,375	5,574	7,016
1934	5,312	9,616	5,930	16,877	11,682	19,064	17,953	29,545	14,508	18,900	17,510	13,677
1976	14,834	11,686	9,694	8,967	13,671	10,315	8,001	8,068	11,827	12,292	8,103	5,995
1977	5,577	7,745	8,904	5,062	9,557	9,791	7,747	5,133	8,394	9,086	6,155	5,716
1988	7,483	8,351	9,402	18,196	11,931	9,909	7,141	7,310	12,311	16,119	7,689	6,222
1990	6,409	6,130	9,180	10,762	11,971	8,487	10,216	6,170	13,331	19,419	7,912	6,163
1991	5,462	7,678	9,558	8,834	11,266	21,868	11,765	6,276	11,211	11,221	8,640	7,784
1992	5,084	5,538	6,359	7,575	21,406	14,574	10,742	7,639	13,559	13,658	7,064	6,474
Average	**6,815**	**7,630**	**8,985**	**9,881**	**11,927**	**12,536**	**9,563**	**9,001**	**11,640**	**13,643**	**8,060**	**7,071**

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1924	172%	260%	155%	193%	282%	434%	422%	7740%	13521%	7896%	20558%	924%
1929	253%	183%	237%	128%	264%	340%	471%	480%	416%	1400%	7381%	561%
1931	300%	192%	102%	114%	245%	375%	510%	7402%	16513%	20723%	10785%	1250%
1933	319%	351%	373%	120%	270%	654%	513%	385%	383%	308%	5258%	901%
1934	326%	470%	100%	232%	416%	668%	979%	1963%	570%	1707%	15775%	2334%
1976	223%	175%	174%	200%	245%	320%	517%	497%	398%	184%	687%	382%
1977	230%	319%	130%	151%	253%	1232%	1143%	502%	3398%	454300%	307750%	683%
1988	2295%	531%	136%	258%	724%	419%	484%	617%	1059%	1312%	9046%	974%
1990	239%	504%	156%	153%	393%	400%	569%	441%	967%	2678%	3353%	528%
1991	507%	678%	459%	400%	435%	319%	619%	436%	399%	514%	9290%	679%
1992	302%	315%	284%	206%	282%	356%	600%	870%	1601%	2206%	6422%	670%
Average	**470%**	**362%**	**209%**	**196%**	**346%**	**502%**	**621%**	**1939%**	**3566%**	**44839%**	**36028%**	**898%**

71 Year Record-Below Normal Years
Sacramento River Flow at Freeport . River Flow (Regulated) (in cubic feet per second)
Future Demand Level

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	13,640	19,738	29,671	30,033	16,902	13,609	22,893	14,239	15,809	19,339	15,826	15,372
1935	6,942	11,660	11,872	24,156	14,489	21,918	19,787	31,050	17,054	20,007	17,621	14,263
1936	11,328	11,236	12,476	28,879	36,136	31,628	19,550	13,364	15,627	22,308	16,961	16,130
1937	10,545	11,504	11,268	13,100	31,041	36,090	21,217	13,412	20,656	18,900	17,553	11,491
1945	13,429	14,510	16,104	12,951	36,007	22,185	12,738	12,494	18,249	17,922	13,592	10,016
1946	13,027	16,824	51,840	42,327	25,927	19,531	12,021	12,999	17,613	17,333	16,372	10,461
1948	14,697	11,878	11,645	17,974	16,596	14,201	21,002	28,906	20,196	23,490	19,260	15,429
1950	12,320	10,937	11,223	19,222	34,053	20,645	17,772	13,752	17,973	18,084	18,110	14,216
1959	22,175	17,123	12,709	37,852	51,015	21,930	9,493	10,144	14,882	20,938	20,480	14,209
1962	9,493	10,846	16,421	11,926	41,027	23,551	12,267	14,312	15,388	21,399	20,796	11,685
1966	12,795	25,341	15,672	27,368	26,193	23,984	13,282	14,265	14,872	22,176	20,686	16,056
1968	22,925	18,185	16,484	28,798	61,739	34,126	11,124	9,897	14,845	21,490	19,930	14,840
1972	15,608	15,656	19,137	17,673	25,598	32,241	11,401	9,895	14,617	22,894	19,873	14,594
1979	14,651	13,900	14,606	21,343	35,306	29,988	17,322	15,258	20,353	21,995	20,382	14,193
Average	13,827	14,953	17,938	23,829	32,288	24,688	15,848	15,285	17,010	20,591	18,389	13,783

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	6,012	6,672	7,496	8,500	4,172	2,907	3,903	3,098	3,339	6,684	5,692	1,567
1935	1,257	4,016	2,901	7,599	3,176	5,977	4,048	4,150	3,698	6,684	6,554	1,674
1936	3,050	3,139	3,943	7,667	8,500	7,155	3,625	3,004	3,312	6,684	6,554	1,668
1937	2,297	2,693	3,942	7,289	8,500	7,592	4,025	3,295	4,826	6,346	1,853	1,676
1945	2,520	6,672	7,172	6,978	6,497	3,956	3,026	2,502	3,788	3,621	986	1,689
1946	4,360	6,672	7,287	7,739	3,180	4,435	2,946	2,646	3,575	6,684	1,534	1,913
1948	3,474	3,558	3,463	6,774	3,225	2,929	3,222	3,831	4,062	6,684	6,554	4,585
1950	2,642	2,880	2,570	7,397	7,441	4,216	2,976	2,418	3,578	6,684	4,998	1,592
1959	6,652	6,672	4,025	7,691	7,555	3,895	1,871	1,942	3,033	6,684	4,088	2,348
1962	1,815	3,546	6,593	3,376	8,048	5,928	2,474	2,437	3,034	6,684	2,091	2,294
1966	5,644	6,672	7,312	7,990	6,886	4,937	2,555	2,402	3,027	6,684	3,087	1,854
1968	6,652	6,672	7,100	6,588	4,556	4,001	2,345	1,913	3,026	6,684	4,123	1,889
1972	6,652	6,472	7,030	7,374	4,831	4,347	2,132	1,942	3,005	6,684	5,372	2,278
1979	6,652	6,599	4,386	7,853	8,500	6,703	3,371	3,203	4,138	6,684	4,973	2,159
Average	4,263	5,210	5,373	7,201	6,076	4,927	3,037	2,770	3,532	6,441	4,176	2,085

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	7,628	13,066	22,175	21,533	12,730	10,702	18,990	11,141	12,470	12,655	10,134	13,805
1935	5,685	7,644	8,971	16,557	11,313	15,941	15,739	26,900	13,356	13,323	11,067	12,589
1936	8,278	8,097	8,533	21,212	27,636	24,473	15,925	10,360	12,315	15,624	10,407	14,462
1937	8,248	8,811	7,326	5,811	22,541	28,498	17,192	10,117	15,830	12,554	15,700	9,815
1945	10,909	7,838	8,932	5,973	29,510	18,229	9,712	9,992	14,461	14,301	12,606	8,327
1946	8,667	10,152	44,553	34,588	22,747	15,096	9,075	10,353	14,038	10,649	14,838	8,548
1948	11,223	8,320	8,182	11,200	13,371	11,272	17,780	25,075	16,134	16,806	12,706	10,844
1950	9,678	8,057	8,653	11,825	26,612	16,429	14,796	11,334	14,395	11,400	13,112	12,624
1959	15,523	10,451	8,684	30,161	43,460	18,035	7,622	8,202	11,849	14,254	16,392	11,861
1962	7,678	7,300	9,828	8,550	32,979	17,623	9,793	11,875	12,354	14,715	18,705	9,391
1966	7,151	18,669	8,360	19,378	19,307	19,047	10,727	11,863	11,845	15,492	17,599	14,202
1968	16,273	11,513	9,384	22,210	57,183	30,125	8,779	7,984	11,819	14,806	15,807	12,951
1972	8,956	9,184	12,107	10,299	20,767	27,894	9,269	7,953	11,612	16,210	14,501	12,316
1979	7,999	7,301	10,220	13,490	26,806	23,285	13,951	12,055	16,215	15,311	15,409	12,034
Average	9,564	9,743	12,565	16,628	26,212	19,761	12,811	12,515	13,478	14,150	14,213	11,698

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1923	127%	196%	296%	253%	305%	368%	487%	360%	373%	189%	178%	881%
1935	452%	190%	309%	218%	356%	267%	389%	648%	361%	199%	169%	752%
1936	271%	258%	216%	277%	325%	342%	439%	345%	372%	234%	159%	867%
1937	359%	327%	186%	80%	265%	375%	427%	307%	328%	198%	847%	586%
1945	433%	117%	125%	86%	454%	461%	321%	399%	382%	395%	1278%	493%
1946	199%	152%	611%	447%	715%	340%	308%	391%	393%	159%	967%	447%
1948	323%	234%	236%	165%	415%	385%	552%	655%	397%	251%	194%	237%
1950	366%	280%	337%	160%	358%	390%	497%	469%	402%	171%	262%	793%
1959	233%	157%	216%	392%	575%	463%	407%	422%	391%	213%	401%	505%
1962	423%	206%	149%	253%	410%	297%	396%	487%	407%	220%	895%	409%
1966	127%	280%	114%	243%	280%	386%	420%	494%	391%	232%	570%	766%
1968	245%	173%	132%	337%	1255%	753%	374%	417%	391%	222%	383%	686%
1972	135%	142%	172%	140%	430%	642%	435%	410%	386%	243%	270%	541%
1979	120%	111%	233%	172%	315%	347%	414%	376%	392%	229%	310%	557%
Average	272%	202%	238%	230%	461%	415%	419%	441%	383%	225%	492%	609%

71 Year Record-Dry Years
Sacramento River Flow at Freeport
Future Demand Level

River Flow (Regulated) (in cubic feet per second)

Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	11,454	10,357	11,549	10,565	35,848	18,119	22,358	13,040	16,202	17,209	13,065	10,510
1926	12,494	10,214	13,803	15,963	31,440	16,882	18,118	13,819	13,995	18,807	17,496	13,759
1930	11,981	10,216	15,439	21,647	16,101	28,033	12,124	11,287	13,911	13,956	10,653	7,912
1932	7,744	7,756	14,039	15,763	13,177	12,514	11,693	10,558	14,216	11,890	8,853	9,400
1939	23,813	17,738	14,674	13,837	13,130	12,826	11,812	10,086	13,986	20,622	20,085	12,988
1944	10,780	14,103	19,774	14,827	25,799	19,995	10,114	9,294	16,822	18,623	18,640	10,163
1947	11,239	11,451	15,221	16,138	19,301	19,663	12,680	10,144	13,642	19,111	19,351	11,502
1949	15,439	11,774	16,722	11,770	13,321	47,977	12,279	13,744	13,769	15,488	10,604	11,384
1955	10,871	14,517	25,145	19,137	18,090	10,540	9,006	10,685	16,299	19,030	19,496	11,279
1960	10,989	11,940	13,999	12,957	25,262	18,516	13,192	10,395	13,873	22,885	17,832	14,890
1961	9,912	12,724	17,269	11,770	27,628	19,139	12,548	10,425	13,985	18,839	17,920	8,798
1964	17,208	29,338	14,754	23,350	16,453	11,542	8,779	10,374	14,010	20,335	17,386	14,459
1981	15,759	12,956	15,486	20,046	26,240	28,629	13,315	10,099	13,953	21,062	20,089	14,579
1985	16,618	33,250	26,417	13,574	16,434	12,832	9,736	12,979	13,789	22,844	17,517	16,552
1987	10,474	8,993	17,381	16,266	18,316	27,250	13,236	10,872	13,902	19,519	11,448	9,985
1989	6,166	9,636	10,940	13,064	13,748	38,958	22,385	14,022	13,830	18,379	18,975	10,705
Average	12,684	14,185	16,413	15,667	20,643	21,463	13,336	11,364	14,387	18,662	16,213	11,804

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	2,525	2,606	4,971	3,061	7,441	3,844	3,371	2,572	3,340	2,664	870	1,325
1926	2,635	2,642	3,515	7,270	7,441	3,197	3,081	2,276	2,837	6,684	4,829	1,245
1930	1,919	1,248	5,606	7,293	3,607	6,755	1,801	1,771	3,195	4,024	950	1,595
1932	1,438	1,836	7,018	7,264	3,680	3,084	3,060	1,253	130	131	128	1,307
1939	6,652	6,672	7,057	6,764	4,556	2,677	2,078	1,915	2,835	6,684	3,444	658
1944	3,504	5,223	7,032	7,568	8,121	4,330	2,058	1,954	3,377	5,832	951	1,338
1947	2,942	4,395	7,164	6,317	6,284	4,056	2,159	1,924	2,772	6,684	2,084	1,360
1949	3,800	3,987	5,113	4,779	3,645	7,066	2,482	2,405	3,157	2,753	130	1,915
1955	2,854	6,136	7,017	7,456	5,153	2,140	1,796	1,955	3,315	6,684	2,386	1,835
1960	2,416	2,486	3,744	5,796	7,495	3,759	1,887	1,702	2,827	6,684	5,498	1,782
1961	2,187	4,542	6,882	5,176	7,352	3,713	1,787	1,706	2,840	6,309	1,127	2,194
1964	6,652	6,672	5,833	7,395	3,239	2,348	1,802	1,943	2,869	6,684	3,763	1,302
1981	6,652	6,215	7,193	7,697	6,313	4,601	2,412	1,916	2,831	6,684	3,890	1,338
1985	6,652	6,672	7,461	7,120	4,885	2,875	1,919	2,187	2,804	6,684	6,554	1,723
1987	6,292	3,045	6,865	7,255	5,260	6,354	300	1,727	2,013	499	865	1,486
1989	705	2,766	2,909	4,167	2,594	6,916	2,751	2,024	2,823	6,684	5,068	3,001
Average	3,739	4,196	5,961	6,399	5,442	4,232	2,172	1,952	2,748	5,148	2,659	1,588

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	8,929	7,751	6,578	7,504	28,407	14,275	18,987	10,468	12,862	14,545	12,195	9,185
1926	9,859	7,572	10,288	8,693	23,999	13,685	15,037	11,543	11,158	12,123	12,667	12,514
1930	10,062	8,968	9,833	14,354	12,494	21,278	10,323	9,516	10,716	9,932	9,703	6,317
1932	6,306	5,920	7,021	8,499	9,497	9,430	8,633	9,305	14,086	11,759	8,725	8,093
1939	17,161	11,066	7,617	7,073	8,574	10,149	9,734	8,171	11,151	13,938	16,641	12,330
1944	7,276	8,880	12,742	7,259	17,678	15,665	8,056	7,340	13,445	12,791	17,689	8,825
1947	8,297	7,056	8,057	9,821	13,017	15,607	10,521	8,220	10,870	12,427	17,267	10,142
1949	11,639	7,787	11,609	6,991	9,676	40,911	9,797	11,339	10,612	12,735	10,474	9,469
1955	8,017	8,381	18,128	11,681	12,937	8,400	7,210	8,730	12,984	12,346	17,110	9,444
1960	8,573	9,454	10,255	7,161	17,767	14,757	11,305	8,693	11,046	16,201	12,334	13,108
1961	7,725	8,182	10,387	6,594	20,276	15,426	10,761	8,719	11,145	12,530	16,793	6,604
1964	10,556	22,666	8,921	15,955	13,214	9,194	6,977	8,431	11,141	13,651	13,623	13,157
1981	9,107	6,741	8,293	12,349	19,927	24,028	10,903	8,183	11,122	14,378	16,199	13,241
1985	9,966	26,578	18,956	6,454	11,549	9,957	7,817	10,792	10,985	16,160	10,963	14,829
1987	4,182	5,948	10,516	9,011	13,056	20,896	12,936	9,145	11,889	19,020	10,583	8,499
1989	5,461	6,870	8,031	8,897	11,154	32,042	19,634	11,998	11,007	11,695	13,907	7,704
Average	8,945	9,989	10,452	9,269	15,201	17,231	11,164	9,412	11,639	13,514	13,555	10,216

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1925	354%	297%	132%	245%	382%	371%	563%	407%	385%	546%	1402%	693%
1926	374%	287%	293%	120%	323%	428%	488%	507%	393%	181%	262%	1005%
1930	524%	719%	175%	197%	346%	315%	573%	537%	335%	247%	1021%	396%
1932	439%	322%	100%	117%	258%	306%	282%	743%	10835%	8976%	6816%	619%
1939	258%	166%	108%	105%	188%	379%	468%	427%	393%	209%	483%	1874%
1944	208%	170%	181%	96%	218%	362%	391%	376%	398%	219%	1860%	660%
1947	282%	161%	112%	155%	207%	385%	487%	427%	392%	186%	829%	746%
1949	306%	195%	227%	146%	265%	579%	395%	471%	336%	463%	8057%	494%
1955	281%	137%	258%	157%	251%	393%	401%	447%	392%	185%	717%	515%
1960	355%	380%	274%	124%	237%	393%	599%	511%	391%	242%	224%	736%
1961	353%	180%	151%	127%	276%	415%	602%	511%	392%	199%	1490%	301%
1964	159%	340%	153%	216%	408%	392%	387%	434%	388%	204%	362%	1011%
1981	137%	108%	115%	160%	316%	522%	452%	427%	393%	215%	416%	990%
1985	150%	398%	254%	91%	236%	346%	407%	493%	392%	242%	167%	861%
1987	66%	195%	153%	124%	248%	329%	4312%	530%	591%	3812%	1223%	572%
1989	775%	248%	276%	214%	430%	463%	714%	593%	390%	175%	274%	257%
Average	314%	269%	185%	150%	287%	399%	720%	490%	1050%	1019%	1600%	733%

71 Year Record-Above Normal Years
Sacramento River Flow at Freeport **River Flow (Regulated) (in cubic feet per second)**
Future Demand Level

Fisheries **(Run 455)**

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	10,054	10,193	16,242	16,813	35,917	28,853	21,005	46,646	33,391	15,466	16,599	12,000
1928	10,576	23,758	15,535	23,088	24,166	82,937	27,234	16,138	16,116	18,914	21,729	11,927
1940	10,883	11,032	13,795	24,459	37,771	62,717	39,818	15,971	15,907	21,391	16,877	16,014
1951	13,634	43,872	68,521	58,162	60,320	28,035	14,379	19,122	15,733	24,652	20,155	16,608
1954	15,546	21,051	15,041	29,279	58,257	47,976	41,420	20,596	15,897	21,535	21,846	14,357
1957	18,466	16,251	10,607	14,574	38,724	42,980	16,825	15,674	16,715	25,197	19,124	17,204
1973	11,853	22,111	26,394	45,702	70,235	46,117	16,981	17,492	19,231	22,486	20,298	12,789
1978	6,613	7,389	15,068	46,008	50,511	43,248	38,263	19,124	14,132	16,875	17,160	12,150
1980	10,823	14,207	19,087	55,476	69,255	35,241	16,841	14,351	13,111	21,548	18,218	10,222
Average	**12,050**	**18,874**	**22,254**	**34,840**	**49,462**	**46,456**	**25,863**	**20,568**	**17,804**	**20,896**	**19,112**	**13,697**

Base **(Run 411)**

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	2,325	2,746	7,257	7,950	8,500	5,718	4,030	4,336	6,672	6,684	3,291	1,965
1928	3,329	6,672	7,108	7,551	6,163	7,064	3,687	2,904	3,222	6,684	1,511	1,915
1940	1,723	1,980	3,806	7,586	7,821	7,254	4,048	3,393	3,237	6,684	6,554	1,459
1951	4,948	6,672	7,592	8,500	4,161	4,451	3,131	3,531	3,217	6,684	6,343	1,847
1954	6,102	6,672	5,631	7,303	7,441	6,362	3,687	3,364	3,191	6,684	3,099	2,077
1957	6,652	6,370	2,448	5,915	7,725	6,552	2,938	2,774	3,428	6,684	6,554	1,853
1973	3,964	6,672	6,998	7,393	7,446	4,413	3,399	3,402	3,980	6,684	5,181	2,614
1978	1,330	1,614	6,986	6,894	1,517	4,644	4,838	4,532	3,638	5,463	1,739	1,791
1980	3,537	6,672	7,104	8,500	8,500	4,942	3,795	3,387	3,219	6,684	6,346	3,672
Average	**3,768**	**5,119**	**6,103**	**7,510**	**6,586**	**5,711**	**3,728**	**3,514**	**3,756**	**6,548**	**4,513**	**2,133**

Difference **(Run 455 - Run 411)**

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	7,729	7,447	8,985	8,863	27,417	23,135	16,975	42,310	26,719	8,782	13,308	10,035
1928	7,247	17,086	8,427	15,537	18,003	75,873	23,547	13,234	12,894	12,230	20,218	10,012
1940	9,160	9,052	9,989	16,873	29,950	55,463	35,770	12,578	12,670	14,707	10,323	14,555
1951	8,686	37,200	60,929	49,662	56,159	23,584	11,248	15,591	12,516	17,968	13,812	14,761
1954	9,444	14,379	9,410	21,976	50,816	41,614	37,733	17,232	12,706	14,851	18,747	12,280
1957	11,814	9,881	8,159	8,659	30,999	36,428	13,887	12,900	13,287	18,513	12,570	15,351
1973	7,889	15,439	19,396	38,309	62,789	41,704	13,582	14,090	15,251	15,802	15,117	10,175
1978	5,283	5,775	8,082	39,114	48,994	38,604	33,425	14,592	10,494	11,412	15,421	10,359
1980	7,286	7,535	11,983	46,976	60,755	30,299	13,046	10,964	9,892	14,864	11,872	6,550
Average	**8,282**	**13,755**	**16,151**	**27,330**	**42,876**	**40,745**	**22,135**	**17,055**	**14,048**	**14,348**	**14,599**	**11,564**

Percent Difference **[(Run 455 - Run 411)/Run 411]*100**

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1922	332%	271%	124%	111%	323%	405%	421%	976%	400%	131%	404%	511%
1928	218%	256%	119%	206%	292%	1074%	639%	456%	400%	183%	1338%	523%
1940	532%	457%	262%	222%	383%	765%	884%	371%	391%	220%	158%	998%
1951	176%	558%	803%	584%	1350%	530%	359%	442%	389%	269%	218%	799%
1954	155%	216%	167%	301%	683%	654%	1023%	512%	398%	222%	605%	591%
1957	178%	155%	333%	146%	401%	556%	473%	465%	388%	277%	192%	828%
1973	199%	231%	277%	518%	843%	945%	400%	414%	383%	236%	292%	389%
1978	397%	358%	116%	567%	3230%	831%	691%	322%	288%	209%	887%	578%
1980	206%	113%	169%	553%	715%	613%	344%	324%	307%	222%	187%	178%
Average	**266%**	**291%**	**263%**	**357%**	**913%**	**708%**	**581%**	**476%**	**372%**	**219%**	**476%**	**600%**

71 Year Record-Wet Years
Sacramento River Flow at Freeport — River Flow (Regulated) (in cubic feet per second)
Future Demand Level
Fisheries (Run 455)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	11,828	21,736	15,275	29,344	75,964	42,498	46,687	24,042	15,911	22,838	20,675	11,899
1938	10,617	26,385	43,915	27,398	74,922	78,047	46,215	54,521	32,184	13,080	12,629	15,047
1941	9,994	12,908	28,224	68,457	74,431	57,327	42,783	39,478	19,479	17,735	17,419	12,128
1942	16,873	19,888	61,929	63,279	79,293	23,337	45,702	36,400	25,720	18,135	17,727	11,772
1943	17,386	20,012	27,879	57,485	52,014	63,865	28,431	17,109	15,580	21,183	20,688	12,556
1952	10,514	15,582	46,421	60,932	64,346	56,262	57,781	60,487	38,369	16,730	11,783	19,546
1953	22,758	17,765	44,667	64,150	26,175	21,505	19,090	25,555	26,675	20,197	21,579	15,307
1956	11,171	12,786	27,801	75,899	68,961	34,122	19,071	41,245	21,322	19,216	17,296	15,133
1958	18,249	17,916	26,153	36,996	57,518	94,251	53,179	41,041	35,119	14,864	14,383	17,607
1963	25,461	20,380	28,105	16,257	56,570	30,624	69,616	29,066	16,022	22,168	19,245	14,873
1965	9,872	14,744	32,727	79,889	33,068	19,361	46,632	22,132	15,465	22,318	18,454	13,051
1967	10,823	14,791	38,540	31,337	37,887	52,988	39,284	44,691	39,780	14,427	11,959	18,735
1969	11,662	12,403	22,143	66,419	67,344	44,090	43,469	44,031	24,519	12,088	11,812	22,174
1970	21,388	18,837	52,542	91,745	56,396	32,963	11,452	10,371	15,283	23,521	20,829	15,582
1971	10,592	21,886	54,441	44,956	29,050	47,931	19,365	31,147	22,363	21,430	19,678	17,146
1974	12,124	49,663	60,625	78,889	42,177	98,175	37,190	24,029	20,629	19,360	18,000	18,425
1975	18,976	16,429	18,514	16,114	62,308	74,482	21,742	31,759	24,272	19,011	16,643	17,192
1982	11,332	28,832	66,845	53,364	70,735	62,414	79,360	35,456	22,210	14,449	13,512	22,795
1983	29,942	41,158	58,507	57,385	82,786	87,464	65,312	56,056	50,761	22,747	15,156	23,926
1984	27,216	65,736	85,233	45,578	39,113	33,204	14,250	12,211	15,698	24,474	17,820	15,798
1986	9,677	10,583	15,649	18,890	103,561	67,949	19,266	10,936	12,614	21,449	17,207	10,480
Average	**15,641**	**22,877**	**40,768**	**51,655**	**59,744**	**53,469**	**39,327**	**32,941**	**24,285**	**19,115**	**16,881**	**16,246**

Base (Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	2,520	6,672	6,936	7,128	7,970	4,782	4,051	3,972	3,304	6,684	5,366	1,799
1938	3,108	6,672	7,120	8,144	7,005	4,644	4,973	5,766	6,672	3,687	2,225	6,588
1941	2,362	3,738	7,246	8,237	8,500	7,592	5,942	4,575	4,281	6,684	2,710	4,187
1942	6,652	6,672	7,407	8,301	5,406	4,481	4,274	4,336	6,440	6,023	2,223	5,154
1943	6,652	6,672	7,187	7,470	4,358	4,508	4,274	3,806	3,221	6,684	4,870	1,441
1952	2,712	6,650	7,087	8,500	8,272	6,105	4,889	5,343	6,672	4,107	2,225	6,588
1953	6,652	6,672	7,222	7,239	4,556	4,644	3,061	3,713	5,824	6,684	5,938	3,185
1956	2,537	3,931	7,105	8,500	7,235	4,644	3,839	4,336	5,206	6,684	4,739	6,447
1958	6,652	6,672	7,130	7,647	6,364	4,783	5,544	4,575	6,672	5,352	2,225	6,588
1963	6,652	6,672	7,013	6,335	3,642	4,644	4,048	4,150	3,584	6,684	6,554	1,993
1965	2,250	6,045	7,085	8,500	6,108	4,643	4,274	4,494	3,230	6,684	6,082	1,964
1967	2,490	6,586	7,287	7,752	6,696	3,963	5,077	4,575	6,672	6,684	1,154	6,588
1969	2,562	5,133	7,026	8,182	8,500	4,319	4,889	5,522	6,672	2,769	2,225	6,588
1970	6,652	6,672	7,383	6,331	4,556	4,128	3,010	2,317	3,202	6,684	4,448	1,760
1971	2,617	6,672	7,172	7,384	6,359	7,064	3,079	3,827	4,435	6,684	6,403	4,462
1974	5,198	6,672	7,194	8,069	6,308	4,664	4,274	4,264	4,362	6,684	4,404	6,588
1975	6,652	6,672	7,165	6,115	4,515	4,447	4,154	4,336	5,659	6,684	2,427	6,588
1982	2,070	6,672	6,964	7,819	8,301	5,585	5,427	6,189	6,602	4,225	3,315	6,588
1983	6,652	6,672	7,592	4,588	3,584	3,457	4,485	4,237	5,415	5,535	6,554	6,588
1984	4,986	4,174	3,919	3,638	4,382	4,520	3,152	2,494	3,415	6,684	6,554	5,435
1986	2,269	4,286	7,078	7,219	8,500	7,592	6,499	3,589	3,224	6,684	5,613	3,747
Average	**4,328**	**6,061**	**7,015**	**7,290**	**6,339**	**5,010**	**4,439**	**4,306**	**4,989**	**5,965**	**4,203**	**4,808**

Difference (Run 455 - Run 411)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	9,308	15,064	8,339	22,216	67,994	37,716	42,636	20,070	12,607	16,154	15,309	10,100
1938	7,509	19,713	36,795	19,254	67,917	73,403	41,242	48,755	25,512	9,393	10,404	8,459
1941	7,632	9,170	20,978	60,220	65,931	49,735	36,841	34,903	15,198	11,051	14,709	7,941
1942	10,221	13,216	54,522	54,978	73,887	18,856	41,428	32,064	19,280	12,112	15,504	6,618
1943	10,734	13,340	20,692	50,015	47,656	59,357	24,157	13,303	12,359	14,499	15,818	11,115
1952	7,802	8,932	39,334	52,432	56,074	50,157	52,892	55,144	31,697	12,623	9,558	12,958
1953	16,106	11,093	37,445	56,911	21,619	16,861	16,029	21,842	20,851	13,513	15,641	12,122
1956	8,634	8,855	20,696	67,399	61,726	29,478	15,232	36,909	16,116	12,532	12,557	8,686
1958	11,597	11,244	19,023	29,349	49,154	89,468	47,635	36,466	28,447	9,512	12,158	11,019
1963	18,809	13,708	21,092	9,922	52,928	25,980	65,568	24,916	12,438	15,484	12,691	12,880
1965	7,622	8,699	25,642	71,389	26,960	14,718	42,358	17,638	12,235	15,634	12,372	11,087
1967	8,333	8,205	31,253	23,585	31,191	49,025	34,207	40,116	33,108	7,743	10,805	12,147
1969	9,100	7,270	15,117	58,237	58,844	39,771	38,580	38,509	17,847	9,319	9,587	15,586
1970	14,736	12,165	45,159	85,414	51,840	28,835	8,442	8,054	12,081	16,837	16,381	13,822
1971	7,975	15,214	47,269	37,572	22,691	40,867	16,286	27,320	17,928	14,746	13,275	12,684
1974	6,926	42,991	53,431	70,820	35,869	93,511	32,916	19,765	16,267	12,676	13,596	11,837
1975	12,324	9,757	11,349	9,999	57,793	70,035	17,588	27,423	18,613	12,327	14,216	10,604
1982	9,262	22,160	59,881	45,545	62,434	56,829	73,933	29,267	15,608	10,224	10,197	16,207
1983	23,290	34,486	50,915	52,797	79,202	84,007	60,827	51,819	45,346	17,212	8,602	17,338
1984	22,230	61,562	81,314	41,940	34,731	28,684	11,098	9,717	12,283	17,790	11,266	10,363
1986	7,408	6,297	8,571	11,671	95,061	60,357	12,767	7,347	9,390	14,765	11,594	6,733
Average	**11,312**	**16,816**	**33,753**	**44,365**	**53,405**	**48,460**	**34,889**	**28,636**	**19,296**	**13,150**	**12,678**	**11,443**

71 Year Record-Wet Years
Sacramento River Flow at Freeport River Flow (Regulated) (in cubic feet per second)
Future Demand Level

Percent Difference [(Run 455 - Run 411)/Run 411]*100

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1927	369%	226%	120%	312%	853%	789%	1052%	505%	382%	242%	285%	561%
1938	242%	295%	517%	236%	970%	1581%	829%	846%	382%	255%	468%	128%
1941	323%	245%	290%	731%	776%	655%	620%	763%	355%	165%	543%	190%
1942	154%	198%	736%	662%	1367%	421%	969%	739%	299%	201%	697%	128%
1943	161%	200%	288%	670%	1094%	1317%	565%	350%	384%	217%	325%	771%
1952	288%	134%	555%	617%	678%	822%	1082%	1032%	475%	307%	430%	197%
1953	242%	166%	518%	786%	475%	363%	524%	588%	358%	202%	263%	381%
1956	340%	225%	291%	793%	853%	635%	397%	851%	310%	187%	265%	135%
1958	174%	169%	267%	384%	588%	1871%	859%	797%	426%	178%	546%	167%
1963	283%	205%	301%	157%	1453%	559%	1620%	600%	347%	232%	194%	646%
1965	339%	144%	362%	840%	441%	317%	991%	392%	379%	234%	203%	565%
1967	335%	125%	429%	304%	466%	1237%	674%	877%	496%	116%	936%	184%
1969	355%	142%	215%	712%	692%	921%	789%	697%	267%	337%	431%	237%
1970	222%	182%	612%	1349%	1138%	699%	280%	348%	377%	252%	368%	785%
1971	305%	228%	659%	509%	357%	579%	529%	714%	404%	221%	207%	284%
1974	133%	644%	743%	878%	569%	2005%	770%	464%	373%	190%	309%	180%
1975	185%	146%	158%	164%	1280%	1575%	423%	632%	329%	184%	586%	161%
1982	447%	332%	860%	582%	752%	1018%	1362%	473%	236%	242%	308%	246%
1983	350%	517%	671%	1151%	2210%	2430%	1356%	1223%	837%	311%	131%	263%
1984	446%	1475%	2075%	1153%	793%	635%	352%	390%	360%	266%	172%	191%
1986	326%	147%	121%	162%	1118%	795%	196%	205%	291%	221%	207%	180%
Average	287%	293%	514%	626%	901%	1010%	773%	642%	384%	227%	375%	313%

Appendix 4

Regulatory Framework

4.0 Regulatory Framework

Described below are the applicable regulatory and legal requirements that affect ISDP in the following area: (1) water quality; (2) water rights; (3) biological resource protection; (4) waterway modification; and (5) Statewide water project management.

4.1 Water Quality Standards

The regulation of surface and ground water quality in California is governed through a system of laws, including the Porter-Cologne Act of 1969

1 Water Code Section 13000-13361.

and the Federal Clean Water Act of 1972 and their amendments. Under these acts, the State is required to adopt a water quality control policy and waste discharge requirements (WDRs)

2 Equivalent to the National Pollutant Discharge Elimination System (NPDES) permits.

implemented by the State Water Resources Control Board (State Board) and nine Regional Water Quality Control Boards (RWQCBs). The Central Valley RWQCB (CVRWQCB) regulates water quality in the Delta west to Brown Island (see Figure 2-9). The San Francisco RWQCB governs the area east of Brown Island (SFRWQCB 1986).

As part of its water control policy, the State Board has adopted a number of Water Quality Control plans and policies relevant to the proposed project, including The Inland Surface Waters Plan, The Enclosed Bays and Estuaries Plan, and the Delta Plan. These plans include guidelines to set pollutant standards for which the U.S. Environmental Protection Agency (EPA) or the State has developed criteria. The RWQCBs adopt individual water quality control plans (Basin Plans) designating specific beneficial uses

3 Beneficial uses are those uses of the waters than may be protected against water quality degradation. Any use of water which existed in 1975 or later is considered a beneficial use. Economic factors are considered when choosing beneficial uses.

of the waters and establishing water quality objectives

4 Water quality objectives are equivalent to federal water quality criteria. They are defined as "limits or levels of water quality constituents or characteristics" (Water Code Section 13050).

to ensure the protection of the beneficial uses. These objectives can be either narrative or numeric water quality standards derived from EPA criteria

5 Water quality criteria were developed by the EPA to protect approximately 95 percent of the organisms in the aquatic environment based on acute, chronic, and bioaccumulative

testing to species at different trophic levels (EPA, 1986). The criteria were developed from comprehensive species-specific acute, chronic, and bioaccumulation databases. The criteria are used as toxicological estimates for aquatic chemical concentrations that are protective of marine life.

or based on specific receiving water conditions. The standards are enforceable pollutant limits for the bodies of surface or ground waters for which they are established (CVRWQCB 1993).
The specific beneficial uses protected through specific water quality objectives in the Delta are municipal and domestic water supply, agricultural supply, industrial supply (process and service), recreation (water contact and non-contact), freshwater habitat (warm and cold water), fish migration (warm and cold water), fish spawning (warm water fish), wildlife habitat, and navigation. The Basin Plans define surface water quality objectives for several parameters, including suspended material, turbidity, pH, dissolved oxygen, bacteria, temperature, salinity, toxicity, ammonia, and sulfides. Water quality objectives adopted by the RWQCBs to protect the beneficial uses of Delta water are summarized in Table 2-1 and are compared with criteria established by the EPA and with drinking water standards (discussed below).

The specific plans adopted to protect water quality within the Delta are closely tied to water rights issues. Recent State Board decisions on water rights issues and the chronology of regulatory events leading to those decisions are discussed at the end of the following subsection.

4.2 Water Rights

Riparian and Appropriative Rights

California water rights for surface water recognize the doctrines of riparian rights and prior appropriative rights. Under the riparian doctrine, landowners have the right to divert, but not to store, a portion of natural water flowing by their land for reasonable and beneficial uses upon their land within the watershed of the stream. These rights are subject to certain limitations. Generally, all riparian water rights holders must reduce their water use in times of water shortages.

Under the prior appropriation doctrine, water may be diverted, stored, and used regardless whether the land on which it is used is adjacent to a stream or within its watershed, provided that the water is used for reasonable and beneficial uses and is surplus to water from the same stream used by earlier appropriators.

California Constitution

Since 1928, when California amended its Constitution to add what is now Article X, Section 2, the dual system of water rights has been subject to a common standard that a use of water must be "reasonable and beneficial."

6 *"Reasonable and beneficial" remains a concept neither well-defined nor fixed in law. Traditionally, uses considered reasonable and beneficial include: irrigation, domestic, municipal and industrial, stock watering, and hydroelectric power generation. Recently, the definition of beneficial uses has been broadened to include*

recreational use, protection and enhancement of fish and wildlife, and aesthetic enjoyment.

It places a significant limitation on water rights by prohibiting the waste and unreasonable use, unreasonable method of use, or unreasonable method of diversion of water.

Public Trust Doctrine

In the 1980s, the Public Trust Doctrine was used by courts to limit traditional water rights. The Doctrine embodies the principle that certain resources, including water, belong to all and, thus, are held in trust by the State for future generations. In 1983, a landmark California Supreme Court decision

7 *In National Audubon Society v. Superior Court of Alpine County the court held that water right licenses held by the City of Los Angeles to divert water from streams tributary to Mono Lake remain subject to ongoing State supervision under the public trust doctrine.*

held that the public trust doctrine protected not only the traditional uses of water for fishing, navigation, and commerce, but also the changing public needs of ecological preservation, open-space uses, aesthetic values, scientific study, and scenic and wildlife preservation. This decision extended the Public Trust Doctrine's limitations on private rights to appropriative water rights. The Court also ruled that long-standing water rights could be subject to reconsideration and could possibly be curtailed. The Doctrine, however, generally requires the Court and the State Board to perform a balancing test to weigh the potential value to society of a proposed or existing diversion against its impact to trust resources.

Federal Power Act

The Federal Power Act has, at times, conflicted with the administration of State water rights involving hydroelectric projects. The Act creates a federal licensing system administered by the Federal Energy Regulatory Commission (FERC) and requires that a license be obtained for nonfederal hydroelectric projects proposing to use navigable waters of federal lands. While the Act contains a clause which disclaims any intent to affect State water rights law, there have been instances where holders of FERC licenses have claimed preemption from State minimum stream flow requirements and State designation of wild and scenic streams.

8 *Court cases show that the Federal Power Act has preempted state water law, specifically in first Iowa Hydroelectric Cooperative v. Federal Power Commission. In the Federal District Court case of Sayles Hydro Association v. Maughan, the Court held that federal law prevents any state regulation of federally licensed power projects other than determining proprietary water rights. In that case, it was held that the State Board did not have the authority to impose environmental conditions beyond what was required in the FERC license.*

Preemption of State law by terms and conditions in Federal
Power Act licenses is likely to remain a challenge for water management.

Delta Water Use Legislation and Agreements

Other statutes affecting water use in the Delta and its watershed

> 9 *The Burns-Porter Act declares the Delta to be a part of the Sacramento River watershed, so the Delta falls under that basin's area of origin protection.*

include the County of Origin Statutes, the Watershed Protection Statutes, and the Delta Protection Act of 1959.

County of Origin Statutes
During the years when the SWP and CVP were being developed, area of origin legislation was enacted to protect local northern California supplies from being depleted. County of Origin Statutes provide for the reservation of water supplies for counties in which the water originates when, in the judgment of the State Board, an application for the assignment or release from priority of a State water right filing would deprive the county of necessary water for present and future development.

Watershed Protection Statutes
Watershed Protection Statutes are provisions which require that the construction and operation of elements of the CVP and SWP do not preempt the watershed, or area where water originates, or immediately adjacent areas which can be conveniently supplied with water, of the right to use water to reasonably supply the present or future beneficial needs of the watershed area or any of its inhabitants or property owners.

Delta Protection Act of 1959
The Delta Protection Act of 1959 declares that the maintenance of an adequate water supply in the Delta is necessary for the peace, health, safety, and welfare of the people of the State, subject to County of Origin and Watershed Protection laws. The Delta needs protected by this Act include consumptive uses such as agricultural, municipal, industrial, and export to areas of water deficiency, and non-consumptive uses such as recreation.

Water Code Section 1245
In 1984, additional area of origin protections were enacted to prohibit the export of ground water from the Sacramento River and the Delta basins unless export is in compliance with local ground water plans. Water Code Section 1245 also holds municipalities liable for economic damages resulting from their diversion of water from a watershed.

Water Agency Agreements
In addition to the listed regulations, contracts and agreements between DWR and Delta interests provide specific protections. The Delta interests include: the South Delta Water Agency; North Delta Water Agency; Western Delta Municipal Water Users (CCWD, City of Antioch); and Western Delta Industrial Users. Jurisdictions of these agencies are shown in Figure 2-10. Table 2-2 summarizes the agreements between DWR, Reclamation, and these water agencies.

Permits and Licenses

The Water Commission Act, which took effect in 1914 following a referendum, recognized the overriding interest of the people in the waters of the State, but allowed that private rights to use the water may be acquired in the manner provided by law. The Act established a system of State-issued permits and licenses to appropriate water. Amended over the years, it now appears in Division 2 (Section 1000) of the Water Code. These provisions place responsibility for administering appropriative water rights with the State Board (provisions do not apply to pre-1914 appropriative rights). The Act also provides procedures for the adjudication of water rights, including court references to the State Board, and the statutory adjudication of all rights to a stream system.

The State Board is responsible for administering appropriative water rights and has issued permits to DWR for operation of the SWP, to Reclamation for operation of the CVP, and to all other water-rights holders within the Central Valley. In these permits, the State Board reserves jurisdiction to formulate or revise the terms and conditions of vested rights (DWR 1993b).

State Board Decision 1485

In 1978, the State Board adopted Water Right Decision 1485 (D-1485), which set forth a number of conditions for SWP and CVP operations in the Delta,

> 10 *In response to lawsuits filed against the State Board and a court decision (Racanelli Decision), the State Board initiated the Bay/Delta Hearings in 1987 to develop a Delta water quality control plan and to consider public interest issues related to Delta water rights. The State Board adopted the Pollutant Policy Document for the Bay/Delta Estuary and the Water Quality Control Plan for Salinity in 1990 and 1991, respectively.*

including water quality standards, export limitations, and minimum flow rates. This Decision also mandated an extensive monitoring program and required special studies of the Delta and Suisun Marsh areas.

> 11 *In 1979, Reclamation and DWR initiated a cooperative agreement that led to a plan for protection of Suisun Marsh, the construction of a salinity control structure on Montezuma Slough, and the approval of the Suisun Marsh Preservation Agreement between DWR, Reclamation, Suisun Resource Conservation District, and the California Department of Fish and Game (CDFG).*

D-1485 standards require that the SWP and CVP make operational decisions to maintain Delta water quality and to meet Delta fresh water outflow within specified limits (Table 2-3).

Racanelli Decision

Lawsuits by various interests challenged D-1485, and the decision was overturned by the trial court in 1984. In 1986, the Appellate Court in the Racanelli Decision stated that the State Board needed to separate its water quality planning and water rights functions and maintain a "global perspective" in identifying beneficial uses and in allocating responsibility for implementing water quality

objectives. The court recognized the State Board's authority to look to all water rights holders to implement water quality standards and advised the State Board to consider effects of all Delta and upstream water users, as well as those of the SWP and CVP, in setting and implementing water quality standards in the Delta.

Coordinated Operation Agreement
In response to D-1485, DWR and Reclamation signed the Coordinated Operation Agreement in 1986, which specified the respective responsibilities of each project. The agreement sets a formula for sharing the obligation of meeting water quality standards and other in-basin uses. The sharing formula provides for CVP/SWP proportionate splits of 75/25 responsibility for meeting in-basin use from stored water releases and 55/45 for capture and export of excess flow.

Bay/Delta Hearings
The State Board has held a series of Bay-Delta Hearings since 1987 to develop a water quality control plan and consider public interest issues relating to Delta water rights. Several water quality plans and draft water rights plans were released by the State Board in response to the proceedings. In 1992, interim standards were proposed in Water Right Decision 1630. The EPA, however, rejected Decision 1630 and then announced its own proposed standards to replace those proposed by the State Board. A detailed chronology of these events is found in Table 2-3. Prolonged debate over the management of Delta waters resulted in the signing of the Joint Federal and State Delta Agreement between the EPA and the State of California.

Joint Federal and State Delta Agreement

On December 15, 1994, the federal government and the State of California signed a three-year compromise agreement on new protections for the San Francisco Bay and Delta. The agreement forms the basis for the State Board's Draft Water Quality Control Plan for the Bay/Delta which, when adopted in its final form, will replace D-1485. In the Draft Plan the State Board reserved the right to reallocate responsibility for meeting water quality objectives in a water rights proceeding that will be conducted after the final plan is adopted. In that proceeding, the State Board will consider the responsibility of all of the water rights holders who divert water from the watershed of the Bay-Delta Estuary.

The water supply-related objectives of the agreement include Delta outflow, river flows, export limits, Delta Cross Channel operations, and salinity control for protection of beneficial uses. The specific requirements of the Draft Plan are listed in Table 2-4. The water right decision, anticipated for 1998, will allocate responsibility for meeting the objectives among water right holders in the watershed. In addition to implementation measures within the State Board's authority, the Draft Plan also includes recommendations to other agencies.

4.3 Drinking Water Standards

Drinking water standards are established both by State and federal agencies. Public water agencies must meet primary and secondary drinking water standards based on guidelines developed by the EPA and California Department of Health Services (DHS). Federal standards are established pursuant to the Public Health Service Act, as amended by the Safe Drinking Water Act and other federal regulations relating to public water systems. Maximum contaminant levels (MCLs) are

established for microbiological, inorganic chemicals, organic chemicals, and radionuclide contaminants.

The Department of Health Services established primary drinking water standards for dissolved arsenic, cadmium, chromium, lead, and mercury and secondary standards for dissolved copper, iron, manganese, and zinc. Primary drinking water standards are based on National Primary Drinking Water Regulations (40CFR, Part 141) and are the maximum permissible contaminant levels in water to protect human health when the water is used continuously for drinking or cooking. Secondary drinking water standards are based on the Secondary Drinking Water Regulations (40CFR, Part 143) and are the maximum permissible contaminant levels to assure that taste, odor, or appearance of drinking water are not adversely affected. Secondary drinking water standards are not based on human health concerns.

It has been common practice to rely on Primary MCLs as "enforceable standards" for human health. However, MCLs are designed to apply to water within a drinking water distribution system and at the tap. It is not always appropriate to apply Primary MCLs to the protection of the sources of drinking water (ground or surface water resources). For example, some MCLs are based on economic and technological factors rather than human health as determined through one-in-a-million cancer risk estimates. Some groundwater and water quality standards are therefore set at more stringent levels than the MCLs. In the case of metal contaminants, many standards are based on aquatic life criteria which are more restrictive than MCLs.

4.4 Biological Resource Protection

The following subsection summarizes those laws and regulations which affect water project operations and hydrodynamics within the Delta. Most pertinent to Delta hydrodynamics are the recent Biological Opinions of federal resource agencies; agreements between CVP, SWP, and California Department of Fish and Game (CDFG); and the Suisun Marsh Preservation Agreements. Further discussion of general legislation to protect biological resources is found in Chapter 9, Aquatic Biology.

Endangered Species Acts

Endangered Species Act

The federal Endangered Species Act (ESA) is meant to preserve endangered and threatened species by protecting individuals of the species and their habitat through implementing measures to promote their recovery. The ESA sets forth a procedure for listing species as threatened and endangered. Final listing decisions are made by the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS). Once a species is listed, Section 7 of the Act requires that federal agencies in consultation with the USFWS or NMFS ensure that actions do not jeopardize the continued existence of the species. The USFWS or NMFS must then provide an opinion as to whether the federal action would jeopardize the species and must include in the opinion reasonable and prudent alternatives to the action to avoid harm. In addition, State agencies and private parties are subject to ESA through Section 9 prohibitions of the "take" of endangered or threatened species. State agencies and private entities are generally required to obtain a take permit from the USFWS or NMFS under Section 10(a) of the ESA.

California Endangered Species Act (CESA)
This Act is similar to the federal ESA and must be complied with in addition to the federal act. The listing decisions are made by the CDFG, and a similar process of consultation, agency opinion provisions, and alternatives analysis is required for State projects. The CESA directs the CDFG to coordinate with the USFWS and NMFS in consultation so that consistent and compatible opinions or findings are adopted.

In recent years, the regulatory approach to endangered and threatened species has shifted to Natural Community Conservation Planning. Through the adoption of the NCCP Act in 1991, a program is initiated to identify habitat needs of species before they are listed and to develop appropriate voluntary conservation methods compatible with development and growth. This approach is likely to play an increasing role in water development in the future.

California Fish and Game Code

Section 5937 of the Fish and Game Code requires that the owner of any dam allow sufficient water to pass through the dam, at all times, to keep fisheries that are planted or exist below the dam in good condition. In California Trout, Inc. v. the State Water Resources Control Board (1989), the court required the State Board to modify permits and licenses issued to the City of Los Angeles to appropriate water from the streams feeding Mono Lake to ensure sufficient water flow for fisheries. Subsequently, interim flow standards for four streams entering Mono Lake were set.

The Fish and Game Code Sections 1601 and 1603 require that any government agency or private entity altering a river, stream, lake bed, bottom, or channel enter into an agreement with the CDFG. The CDFG may require provisions to protect riparian habitat, fish, and wildlife.

Delta Biological Opinions

Concerns over the protection of fish and wildlife uses within the Delta have led to a series of revisions to water quality and flow standards within the Delta. In D-1485, the State Board intended to set criteria to provide minimum salinity and flow conditions to protect fisheries at levels that would have existed in the absence of State and federal water projects.

> *12 The striped bass index (SBI) was used as a measure of the survival and spawning conditions of this fish. The SBI was correlated with Delta freshwater outflow and Delta diversions to set flow and salinity requirements at critical points in the Delta (EPA, 1994).*

Despite these standards, fisheries have declined within the Delta, resulting in the listing of several species as threatened and endangered. Throughout the chronology of events leading to the federal-State agreement, protection of biological resources has been a key factor. The decisions and plans discussed under water rights also apply to the discussion of fish and wildlife protection. In addition to those decisions, the NMFS and USFWS have issued biological opinions which further constrain operations of the water projects. These opinions present reasonable and prudent alternatives which provide protection for the winter-run chinook salmon (NMFS) and the delta smelt (USFWS). A summary of constraints to SWP operations according to these agencies is found in Table 2-5.

Upstream Flow Requirements

Instream flows for rivers entering the Delta are also regulated by various agencies, such as the CDFG and FERC for hydroelectric power facilities. Agreements between CDFG and DWR set flow requirements for upstream rivers and storage requirements for reservoirs. Studies conducted by resource agencies have led to proposed revisions to these agreements. Flow requirements for the Feather River, American River, and Sacramento River are currently proposed by the CDFG. Ongoing proceedings by FERC may result in requirements for flows in rivers upstream of the Delta. Flow requirements for rivers that are expected to be influenced by the project are listed in Table 2-6.

Fish Protection Agreement

To mitigate fish losses at Delta export facilities, both the SWP and the CVP entered into agreements with the CDFG. The Fish Protection Agreement was signed in December 1986 as a result of negotiations over the addition of four pumps at Banks Pumping Plant. The agreement identifies the steps needed to offset adverse impacts to fish at the plant. It sets up a procedure to calculate direct fishery losses and requires DWR to pay for mitigation projects that would offset the losses. DWR also provided $15 million to initiate a program to increase the probability that results would be quickly demonstrated.

Suisun Marsh Preservation Agreement

Decision 1485 ordered Reclamation and DWR to develop a plan to protect the Suisun Marsh. As a result, the Suisun Marsh Preservation and Restoration Act of 1979 authorized the Secretary of Interior to enter into a Suisun Marsh Cooperative Agreement with the State to protect the marsh and share costs for facilities. The Suisun Marsh Protection Plan was developed by DWR, Reclamation, CDFG, and the Suisun Resources Conservation District in 1980, and initial facilities were completed in 1981.

A Four-Agency Suisun Marsh Preservation Agreement and two auxiliary agreements, a monitoring agreement and mitigation agreement, were signed in March 1987. The four-agency agreement describes proposed facilities to be constructed, a construction schedule, cost-sharing responsibilities, water quality standards, soil salinity, water quality monitoring, and land purchases to mitigate impacts. A key facility of the plan, the salinity control structure on Montezuma Slough, was completed in 1989.

Wild and Natural Area Protection

Federal Wild and Scenic Rivers Act

This Act of 1968 set up a system to preserve the free-flowing condition of rivers which possess remarkable qualities and values. Such rivers are designated as wild and scenic. The Act recognizes the need to complement the national policy of dam and other construction with a policy of conservation. Federal agencies are prohibited from constructing, authorizing, or funding construction of water resources projects that would a have a direct adverse impact on the values of designated rivers or rivers designated for potential addition to the National Wild and Scenic Rivers System.

California Wild and Scenic Rivers Act
This Act was passed by the State legislature in 1972 to preserve extraordinary rivers in the State. It declared that preservation of these rivers' values would be considered the highest and most beneficial uses within the meaning of Article X, Section 2 of the California Constitution. The Act prohibits construction of any dam, reservoir, diversion, or other water impoundment on a designated river, although diversions to supply domestic water may be authorized. The major difference between the federal and State acts is that if a river is designated wild and scenic under the State Act, FERC can still issue a license to build a dam on that river, thus overriding the State system.

Wild Trout Streams
The California Fish and Game Code designates certain sections of streams and rivers as wild trout waters, as a result of the Trout and Steelhead Conservation and Management Planning Act of 1979. According to the Code, "[a]ll necessary actions, consistent with state law, shall be taken to prevent adverse impact by land or water development projects on designated wild trout waters."

4.5 Waterway Modification

Corps of Engineers Regulatory Program

The U.S. Army Cops of Engineers has been involved in regulating certain activities in the nation's water since 1890. Currently, the Corps regulates these activities under two statutory programs, Section 404 of the Clean Water Act and Section 10 of the River and Harbor Act of 1899.

Section 404 of the Clean Water Act requires approval prior to prior discharging dredged or fill material into the waters into he United States. Placement of fill material is typically the addition of clean materials such as dirt, rock, or broken concrete, for the purpose or effect of either replacing an aquatic area with dry land or raising the elevation of an aquatic area. The Corps has interpreted what constitutes a regulated "discharge" broadly to include those actions where total volume of fill is small but where the secondary effects of the activity may result in substantially adverse impacts to the aquatic environment.

Section 404 (b) of the Clean Water Act requires that the Corps issue permits in compliance with guidelines developed by the EPA. These guidelines require that there be a demonstration that no alternative is available to meet the project purpose and need that does not result in a discharge of fill in waters. Once this fist test has been satisfied, the project that is permitted must be the least environmentally damaging practical alternative before the Corps may issue a permit for the proposed activity.

Fish and Wildlife

The Fish and Wildlife Coordination Act requires that any federal agency proposing to control or modify any water body or to issue a permit allowing the control or modification of a body of water must consult with the USFWS and the State Fish and Game officials. This Act requires coordination early in the project planning and environmental review process.

Corps Public Notice 5820A

Current hydraulic conditions in the Delta channels limit monthly maximum SWP exports. The export level is also limited by Corps constraints, set forth in Corps Public Notice 5820A (Amended), issued in October 1981. Daily diversions into Clifton Court Forebay are not to exceed 13,870 acre-feet (three-day average = 13,250 af) unless flow in the San Joaquin River at Vernalis exceeds 1,000 cfs during mid-December to mid-March. During those conditions, DWR may increase diversions by one-third of the San Joaquin River flow. The Corps concluded that such operations would not affect the navigable capacity of the Delta channels.

Flood Protection

The Delta Flood Protection Act of 1988 created the Delta Flood Protection Fund. The Act makes available $6 million annually for local assistance under the Delta Levee Maintenance Subventions Program. An additional $6 million per year is allocated for special flood control projects for eight western Delta islands and the towns of Walnut Grove and Thornton.

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

4.6 Statewide Water Project Management

Regional Water Projects

Numerous statutes authorizing major regional water projects have been passed in California. These include projects such as the Hetch Hetchy Project, the Colorado Aqueduct, the Los Angeles Aqueduct, and the Mokelumne River Aqueduct. In addition, there are 40 different statutes under which local water agencies may be organized and are given the authority to distribute water. There are also a number of special act districts, such as the Metropolitan Water District of Southern California (MWD).

CVP Improvement Act of 1992

This Act, signed in October 1992, makes significant changes to the management of the federal reclamation project and creates a complex set of new programs and requirements applicable to the project. These cover five primary areas: (1) limitations on new and renewed CVP contracts; (2) water conservation and other water management actions; (3) water transfers; (4) fish and wildlife restoration actions; and (5) establishment of an environmental restoration fund. With a few exceptions, new contracts for CVP water are prohibited until several requirements have been met, including completion of a programmatic EIR.

The Act requires that 800,000 acre-feet of project yield be dedicated to fish and wildlife habitat purposes each year. It establishes a goal of doubling the natural production of anadromous fish in

the Central Valley rivers and streams by 2002. Trinity River instream flows and wetland areas in the Sacramento and San Joaquin Valleys are also dedicated to fish and wildlife uses. A number of other physical measures to restore fishery and wildlife habitat are also required. Table 2-7 summarizes requirements of the CVPIA that influence water project operations. The Secretary of Interior is directed to enter into an agreement with the State of California for cost-sharing some of these mandated restoration measures.

The CVPIA also contains provisions intended to increase the use of water transfers by providing that all individuals and districts receiving CVP water may transfer it to any other entity for any project or purpose recognized as a beneficial use under State law.

Water Transfers

Many water managers are seeking water transfers to respond to water supply and allocation problems. Under existing law, holders of pre-1914 appropriative water rights can transfer water without seeking approval of the State Board, provided no other legal user of water is injured. Other holders of appropriative rights must obtain State Board approval. All transfers are subject to CEQA, unless they are for a short term (< 1 year). The State Board has announced that no long-term transfers will be approved until completion of a cumulative environmental impacts analysis is completed. Permits from resource agencies may also be required if a proposed transfer will affect threatened and endangered species.

Riparian water rights are not transferable from place to place, although downstream appropriators may contract with upstream riparian users to leave water in the stream for potential downstream diversion. Under Water Code Section 1707, the State Board can authorize conversion of any existing water right into an "instream appropriation" to benefit fish, wildlife, or other instream beneficial use.

Water obtained pursuant to a water supply contract is also potentially transferable. Although nearly all types of water rights may be transferred, usually only the water is transferred, while the rights remain with the original holder. Drought conditions in the last few years have led to the development of a State Drought Water Bank created by the Governor in 1991. Administered by DWR, the water bank is designed to move water from areas of greatest availability to areas of greatest need. The sources of water included temporary surplus in reservoirs, surface supplies made available by use of groundwater, and surface water made available by fallowing agricultural lands.

Water Use Efficiency

The California Constitution prohibits the waste or unreasonable use of water. Further, Water Code Section 275 directs DWR and the State Board to "take all appropriate proceedings or actions before executive, legislative, or judicial agencies to prevent waste or unreasonable use of water." There are several legislative acts adopted to develop efficient use of water in the State, including the Urban Water Management Planning Act of 1985, Water Conservation in Landscaping Act of 1992, Agricultural Water Management Planning Act, Agricultural Water Suppliers Efficient Management Practices Act of 1990, Water Recycling Act of 1991, and Agricultural Water Conservation and Management Act of 1992. In addition, the California Urban Water Conservation Council is developing Urban Best Management Practices to be included in a Memorandum of Understanding.

Appendix 5

Alternatives Considered
but Eliminated from Detailed Study

5.0 Alternatives Considered but Eliminated from Detailed Study

In addition to the selected alternatives, the preparers of this EIR/EIS considered an extensive list of potential alternatives to the proposed project. More than three dozen potential alternatives were considered but eliminated from detailed study in the EIR/EIS, consistent with the direction contained in the CEQA Guidelines and the NEPA CEQ Regulations, as outlined briefly in the following.

Several potential alternatives were eliminated because they would likely have environmental consequences of greater magnitude than the proposed project. The preparers of the EIR/EIS tried to focus the evaluation upon alternatives that had the potential to be environmentally preferable to the proposed project. Several other potential alternatives were eliminated because they were much larger in scale and/or were oriented toward a longer-term resolution of the Delta water supply issues and concerns. The potential alternatives considered but eliminated from detailed study are as follows:

Peripheral Canal

This water transfer concept, with various modifications, has been studied and presented for public acceptance numerous times in the past 50 years. The State-federal plan as described in the "Report in Response to Senate Concurrent Resolution No. 73", July 1, 1977, and also described in the DEIR for Peripheral Canal, published by DWR in August 1974, was composed of many physical features. These included: 42 miles of unlined channel going from Hood, on the Sacramento River, to Clifton Court Forebay; an intake structure and fish screen at Hood; a pumping plant (21,800 cfs capacity); numerous siphons, bridges and access roads; water release structures located along the length of the canal at major rivers and sloughs; and a connection between Clifton Court Forebay and Tracy Pumping Plant (CVP). This large project would be built in three stages. The "State-only Gravity Canal" was a scaled-down version of the State-federal plan and would only carry enough water to meet SWP exports (5,450 cfs intake capacity at Hood).

Dual transfer system

This plan is comprised of an east Delta conveyance channel, very similar to the Peripheral Canal but only about one third-its size, and continued use of existing Delta channels as conveyance facilities. About 7,500 cfs of the SWP/CVP export water would flow through the new channel. Under the basic alternative, the new channel would operate by gravity and would only have about a 3-foot drop from the intake on the Sacramento River to Clifton Court Forebay. It would have five siphons at the major river crossings and would have several release structures at desired locations. To compliment the basic plan, there are several design options that would boost flow to improve water transfer (pumping plants and Sacramento River control structure), and provide additional protection for Delta fish. Also, there are a number of options to reduce or mitigate damage to fish, such as various fish screen and fish return designs, and hatcheries.

Modified Folsom-South Canal

This alternative plan would control water transfer through existing Delta channels and enlarged channels, install various new features to improve water quality in central and southern Delta, and eliminate reverse flows in the San Joaquin River. The proposed Sacramento River Hood-Clay connection and the Folsom-South Canal would be enlarged to divert 3,800 cfs for release down the Mokelumne, Calaveras, and Stanislaus Rivers. However, the Folsom-South Canal was never completed south of the latitude of Hood. Other features would include channel closures, channel improvements, and a siphon under the San Joaquin River for the Mokelumne River to control water transfer through existing channels. A fish screen at Hood and boat passage facilities at the various channel closures would be needed. The modified Folsom-South Canal alternative is described briefly in the DWR Delta Water Facilities Bulletin 76, July 1978.

Pay for agricultural pump damage in the south Delta

This alternative proposal would essentially be a no-action plan. Damages to pumps caused by low water levels would be compensated by paying for repairs or replacement.

Delta Mendota Canal/Westley Wasteway Plan

This proposed project was one of several alternative water distribution plans that would work in conjunction with the Peripheral Canal. The Peripheral Canal would provide the water for distribution throughout the southern Delta to improve water supply, water quality, and give a net downstream flow in the major channels used by migrating fish. The plan is discussed in DWR "Alternative Report Southeast Delta Water Control Facilities", April 20, 1976 report and November 8, 1977 supplement.

The basic plan consists of a 700 cfs pumping plant in Middle River about three miles above the Peripheral Canal to convey water up-river, levee rework below the pumping plant, a San Joaquin River flow control structure, and some channelization below the end of Westley Wasteway to the San Joaquin River. A small steady flow of water would be pumped out of the Peripheral Canal to flow up the Middle River for distribution in the southeast Delta. This would be supplemented by releases from the Delta-Mendota Canal into San Joaquin River via the Westley Wasteway, which would be in the order of 1,500 cfs.

Reduce San Joaquin River Agricultural Drainage

Current agricultural drainage conditions on the west side of the San Joaquin Valley present three basic problems: (1) salt balance; (2) water balance; and (3) toxic, or potentially toxic, trace elements in subsurface agricultural drainage. In mid-1984, USBR, USF&WS, USGS and DFG formed the San Joaquin Valley Drainage Program (SJVDP) to investigate drainage problems and identify possible solutions. The four goals of the SJVDP are to: (1) minimize potential health risks associated with subsurface agricultural drainage water; (2) protect existing and future reasonable and beneficial uses of surface and ground water from impacts associated with

drainage water; (3) protect, restore, and improve valley fish and wildlife resources; and (4) sustain the productivity of farm land on the west side of the San Joaquin Valley.

In 1987, the SJVDP narrowed its focus on planning alternatives for solving drainage problems to measures that could be taken within the valley itself. In 1989, the SJVDP published a report on preliminary planning alternatives, which would consist of combinations of drainage management strategies falling into seven categories: (1) source control to reduce drainage from individual farms; (2) management of shallow water tables by pumping; (3) treatment of drainage water; (4) reuse of drainage water; (5) disposal of drainage water in the valley; (6) fish and wildlife measures; and (7) institutional changes.

Drainage water reduction and disposal methods include irrigation improvements, reuse of drainage water for propagation of eucalyptus trees and saltbrush, and limited drainage water storage in ground water and disposal in evaporation ponds. The alternative also involves actions to protect public health and to protect and restore fish and wildlife, including provision of fresh water supplies conserved from irrigation improvements for use on existing wetlands and wildlife areas.

DWR is collecting and preparing studies on reuse and disposal of agricultural drainage water in the SWP service area. Analyses emphasize trace elements, such as selenium and arsenic, because of their potential adverse effects on water supplies and the environment.

Chipps Island Barrier

The Chipps Island Barrier site is located in the Sacramento River connecting Chipps Island with Mallard Island. There would also be dikes across Spoonhill Creek. The Sacramento River at the site is about 3,000 feet wide and has a maximum depth of 56 feet below mean sea level. The barrier would include: an embankment, a gated floodway structure, four navigation locks, a salt scavenging system, a fish passage, a removable fuse plug, and other miscellaneous features. Mallard Island would be removed and replaced by the fuse plug. Channel excavation would be required for about two-thirds of the length of the barrier. The floodway structure would consist of 36 gated bays, each bay would be 80 feet wide. The concrete base slab would be 15 feet thick and 90 feet wide with 125-foot piles as the foundation.

Four navigation locks would be constructed parallel to the northern shore between the floodway and Chipps Island. Approach channels would be excavated to a depth of 45 feet and a width of 600 feet. The locks themselves would range from 300 to 800 feet in length and from 45 to 96 feet in width.

Operation of the locks would result in salt water intrusion into the barrier pool. The denser salt water would displace the fresh water at the bottom of the pool, allowing the salt water to be collected in a sump. Removal of the salt water would be accomplished through a salt scavenging system. The salt water could be used in an adjacent fish ladder for fish attraction and acclimation. The fish ladder itself would be concrete and about 670 feet long and 30 feet wide.

To meet national defense requirements, a fuse plug with approach channels would be constructed near the southern shore. The plug would consist of four concrete cellular caissons, three of 100 feet in length and one 75 feet long. Two center caissons would be removable. An approach channel would need to be dredged 200 feet wide with a bottom elevation of 44 feet. This would extend 6,000 feet both upstream and downstream.

The U.S. Public Health Service has recommended that, for any barrier of this type, all municipal and industrial effluent be diverted downstream of the barrier pool. A waste disposal conduit for Chipps Island Barrier would serve nine industrial and two municipal dischargers. Industrial cooling water facilities would also be needed.

Levees in Suisun Bay and in the Delta would require strengthening and raising under the new hydraulic conditions. Also numerous reaches of channels in the Delta would need to be dredged to provide capacity for water transfer and navigation. It is estimated approximately six million cubic yards of material would be dredged.

Dillon Point Barrier

This feature is very similar to Chipps Island Barrier described earlier. It would be located downstream further and would cross Carquinez Strait between Crockett and Benicia. It would have a larger freshwater pool including Suisun Bay and Delta.

Point San Pablo Barrier

This barrier is similar to Chipps Island and Dillon Point Barriers. It would be located across San Pablo Strait separating San Francisco and San Pablo Bays. It would have a very large freshwater pool including San Pablo Bay and Suisun Marsh.

Submerged Sill, Carquinez Strait

Earlier U.S. Corps of Engineers' hydraulic model tests showed that deepening the Baldwin and Stockton Deep Water Ship Channels would cause increased salinity intrusion into the interior Delta for the same level of controlled outflow. Since the State Water Resources Control Board Delta water quality standards would still need to be met, outflow would have to be increased. To mitigate this effect, the Corps proposed a submerged sill in Carquinez Strait to block off the heavier saline water that would otherwise intrude upstream through the deepened channel.

Robert Island Canal Plan

This proposed plan was one of several alternative water distribution plans that would work in conjunction with the Peripheral Canal. The Peripheral Canal would provide the water for distribution throughout the southern Delta to improve water supply, water quality, and give a net downstream flow in the major channels used by migrating fish. The Roberts Island Canal Plan is discussed in DWR "Alternative Report Southeast Delta Water Control Facilities" April 20, 1976 report and November 8, 1977 supplement. The plan would consist of a 2,000 cfs pumping plant in Middle River, an earth-lined canal crossing Roberts Island between Middle River and San Joaquin River capable of carrying 1,100 cfs, and three flow control structures. The flow control structures would be located at the head of Middle River, San Joaquin River below Old River bifurcation, and between the Roberts Island Canal and San Joaquin River. They are needed for proper water distribution and to control flood flows.

The section of Middle River between Roberts Island Canal and Old River would convey the remaining 1,100 cfs for release down Old River. With the large flows in Middle River between the proposed Peripheral Canal crossing and Old River, there would need to be channel dredging and levee rework done.

New Hope Cross Channel (with and without forebay enlargement)

This Delta water transfer proposal actually has two plans, both of which use interior Delta channels for part of the water transfer to the Delta Pumping Plant. New Hope Cross Channel was introduced as another north Delta transfer facility. The canal portion of the New Hope alternative follows the Peripheral Canal alignment. Discussions of the New Hope Cross Channel project can be found in the DWR Delta Water Facilities Bulletin 76, July 1978, and also in a DWR report entitled "Alternatives For Delta Water Transfer", November 1983.

One alternative plan is the New Hope Cross Channel and Enlarged Clifton Court Forebay. The north canal portion is a 12.3-mile reach from Hood to Beaver Slough. Water taken from the Sacramento River at Hood would be discharged into the Mokelumne River, Lost Slough, and enlarged Beaver Slough. The South Fork Mokelumne River would be enlarged, and an 8,000-foot channel constructed across Staten Island to convey water to the North Fork Mokelumne. The Delta Cross Channel would be closed and a boat lock provided for small boats. The initial canal capacity would be 16,500 cfs and would require pumping. About 4,500 cfs would be released into Lost Slough and 1,500 cfs into Mokelumne River. The remaining water would be conveyed on to Beaver Slough and South Fork Mokelumne. A short canal section across Staten Island would transfer 6,500 from the South Fork to the North Fork Mokelumne. Additionally, flood flows from Stone Lake would pass over the canal into Snodgrass Slough through a gated weir. The canal reach between Lost Slough and Mokelumne River would be designed to be overtopped with floodwater. This would require flood gates in the canal at both ends of this reach. Enlarged Clifton Court Forebay would be increased to twice its present capacity. There would be an additional intake on Old River near Indian Slough. New fish screens would be required at the New Hope Channel intake and at both intakes to the forebay, and a more efficient fish collector system installed at the Delta Mendota Intake Channel. The CVP would continue to pump their exports from the Delta.

The other alternative is the New Hope Cross Channel and South Delta Intake Channel. This facility would combine the New Hope Cross Channel (as described) with a South Delta Intake Channel. There would be no enlarged forebay plan. The South Delta channel is a 12-mile canal which would be on the Peripheral Canal alignment between the San Joaquin River and Clifton Court Forebay. Water would be released into Middle River for water quality purpose.

Isleton Cross Channel (with and without forebay enlargement)

Several versions of this alternative have been proposed. This particular plan is the least expensive. A new channel 6,100 feet long, would be constructed between the Sacramento River at Isleton and Georgiana Slough to transfer more water through the central Delta and reduce reverse flow in the western Delta. The channel would be designed to handle a maximum combined tidal and transfer flow of 25,000 cfs, with a net flow of 10,000 cfs. Intake works would include tide control gates and fish screens. Georgiana Slough would be widened between the canal and the South Fork Mokelumne River. Clifton Court Forebay would be enlarged using a portion of Byron Tract, and some South Delta channels would be dredged to increase conveyance capability. This alternative version is described in DWR Bulletin 76, July 1978.

Pumping Water from Clifton Court Forebay to a Portion of SDWA Users

This alternative proposes to pump water out of Clifton Court Forebay to the many SDWA agriculture users on the Delta islands. As a minimum there would need to be a pipeline installed on both sides of Old River from Clifton Court Forebay to Upper Roberts Island. In addition, there would be many distribution service lines throughout the south Delta.

Enlarge Clifton Court Forebay with: Byron Tract; North Victoria; South Victoria; Coney Island; or Union Island.

Several forebay enlargement single component plans are being examined. The purposes of the expansion are to approximately double the forebay area and storage capacity for better pumping flexibility, and to have a larger and more northerly intake location to minimize the impact of gate operation on south Delta water levels and to access better quality water. The hydraulic impacts of an enlarged forebay are based on the intake gate location and surface area of the forebay rather than on the configuration of lands used. Siphons would be used to hydraulically connect the existing forebay to the expanded forebay.

South Delta channel control structures, channel enlargement, and enlarged forebay at: Byron Tract; North Victoria; South Victoria; Coney Island; or Union Island.

Several forebay enlargement plans with flow control structures included are proposed. The purpose of the expansion are to approximately double the forebay area and storage capacity for better pumping flexibility, and to have a larger and more northerly intake location to minimize the impact of gate operation on south Delta water levels and access to better quality water. The

hydraulic impacts of an enlarged forebay are based on the intake gate location and surface area of the forebay rather than on the configuration of lands used. Siphons would be used to hydraulically connect the existing forebay to the expanded forebay.

Up to four channel control structures would be installed in south Delta channels (see Section 2.4, Proposed Action - The Interim South Delta Program, Components 4 and 5), and would include a shift in export pumping times with an increased maximum rate of 10,300 cfs. The pumping rate would be increased during high flow winter months and could take advantage of any available water banking facilities. Exports would be lowered during fish migration periods to reduce impacts to the various species. The larger forebay would give greater pumping flexibility with less impact on local channels because of the increased storage capacity. Greater intake capacity would permit more flexible operation with the tide cycle by diverting during high tide periods, and when combined with the more northerly location, would help improve water levels in the south Delta channels. The flow control structures would improve the low water levels, circulation, and water quality above these sites. A barrier at the head of Old River could be closed during salmon spawning season and during migration of salmon smolt to prevent entrance to Old River.

Mathena Landing Canal

This isolated canal facility would function similar to the Peripheral Canal. It would be constructed in stages. The first stage would be the Mathena Landing Cross Channel, including fish screen and tide gate, Grand Island Channel, and South Stub Canal. As water demands increased and operational experience in managing Delta flows for fish and water quality control gained, the second stage would be built. This would include construction of a connection from the Mokelumne South Fork to the South Stub Canal. Siphons would be constructed under the Mokelumne River, Disappointment Slough, the San Joaquin River, and at Old River at Clifton Court. A pumping plant could be added to meet full transfer potential. Water release and transfer facilities would be needed along the system. Improved fish screens would also be needed at the intake. The capacity of the canal at the headworks would be 23,000 cfs.

West/Central Delta Canal

The West Delta Canal and the Central Delta Canal are two separate projects with different alignments, but would have similar features and costs, and would have similar benefits and impacts. Each would have an 18,000 cfs unlined canal with headworks at Isleton. The alignments traverse through several Delta islands and terminate at Clifton Court Forebay. Physical features include fish screens, siphons, bridges, cross channel closures, and water release structures. Good quality water would be transported to Clifton Court Forebay with certain releases made at key locations along the alignment to provide positive downstream flows in Delta channels.

Montezuma Hills Reservoir and Canal

This alternative would divert water from the Sacramento River by a 15,000 cfs pumping plant into a 350,000 acre-foot reservoir in the Montezuma Hills. The reservoir would be filled to supply projects during periods of diversion curtailment. Water would pass from the reservoir through a tunnel and pipeline across the Sacramento and San Joaquin Rivers to a power plant near Antioch which would utilize excess energy head. From that point, a canal would convey water to Clifton Court Forebay. Also, an alternative could be added to release water to Contra Costa Canal.

Waterway Control Plan

This alternative would use Delta channel structures to hydraulically isolate about one-third of the Delta for conveying project water. Portions of levees upstream of the channel structures would be rehabilitated to handle water levels. Control structures, or pumping plants, would divert Sacramento River water into the Mokelumne River system through the Delta Cross Channel and Georgiana Slough. This diverted water, combined with the Mokelumne River flows, would be siphoned under the San Joaquin River. Middle River and Old Rivers, plus other channels, would be used for conveyance from the siphon to the export pumps. Construction features include: enlarged Delta channels, pumping plant, fish screens, navigation locks, fish passage facilities, control structures, a siphon, channel closures, and levees.

North Stub Canal

This alternative is a full-sized canal, about 23,000 cfs, following the Peripheral Canal alignment from Hood to the San Joaquin River. Water releases would be made into sloughs flowing into the Mokelumne River for water quality purposes. Good quality water would then be transported through Middle and Old Rivers to the export pumps. There would be about 24 miles of canal, a new intake and fish screen, and two siphons constructed.

South Stub Canal

This alternative, like the North Stub Canal, is a segment of the Peripheral Canal. It has the effect of moving the pump intakes in the south Delta northward to the San Joaquin River west of Stockton. The alignment would be from the San Joaquin River to Clifton Court Forebay. The canal plan would be 12 miles long and would carry 18,500 cfs. Water releases would be made into Middle River for water quality purposes. It would eliminate reverse flow in Old and Middle Rivers, and reduce scour and tidal fluctuations in southern Delta.

Mathena Landing Cross Channel and South Stub Canal

Mathena Landing Cross Channel, composed of two short reaches of channel, would be combined with the South Stub Canal alternative to provide for water transfer through the Delta. Features include: a three-mile channel with intake in Steamboat Slough and outlet at the Sacramento River; a four-mile channel with intake at Mathena Landing transporting water to South Fork Mokelumne River; fish screens and tidal gates at the Sacramento River; South Stub Canal, 12 miles long, from San Joaquin River to Clifton Court; southeast Delta water control facilities; and a siphon at Clifton Court.

Appendix 6

Terrestrial Biological Information

6.0 *Terrestrial Biological Information*

Introduction

The following discussion addresses the terrestrial biological resources in the vicinity of the Interim South Delta Program (ISDP) and other elements associated with the State Water Project (SWP), as well as the service area of the SWP. The following includes detailed habitat descriptions, nomenclature of plant and wildlife species mentioned in the text of the EIR/EIS, and information on the special status species associated with the Project.

For the purposes of this section, the affected environment has been divided into three discussions, including Project Area, State Water Project, and Service Areas. The Project Area includes the sites where construction activities are proposed, including the fish barrier site at Old River (near Mossdale), new intake structure at Clifton Court Forebay, dredging area along Old River, two dredge disposal sites on Victoria Island, and three flow barrier sites at Grant Line Canal, Old River (near the DMC), and Middle River. The State Water Project discussion focuses on those areas potentially affected by water level fluctuations, increased water velocities, and changes in salinity. Areas included within the this discussion are the Delta; San Pablo and Suisun bays; several reservoirs within the SWP; and portions of both the Feather and Sacramento rivers. The Service Area discussion includes eighteen counties scattered throughout the State which receive water from the SWP. Methods of obtaining information to describe these resources are described in more detail in the discussion of each Area.

The following documents where used in the preparation of this discussion:

- *Final Wetland Delineation for the Interim South Delta Program Sacramento-San Joaquin Delta, California* (Botanical Research Group August 1994).
- *Draft Sacramento-San Joaquin Delta Master Environmental Assessment* (CDFG/CDWR October 1993).
- *Biological Assessment for South Delta Temporary Barriers Project* (CDWR February 1992).
- *South Delta Water Management Plan Biological Assessment* (ECOS, Inc. October 1987).

- *South Delta Barriers Project: Assessment of Existing Fish, Wildlife and Plant Community Resources and Potential Project Impacts* (CDFG February 1992).
- *South Delta Barriers Project Fishery, Water Quality, and Vegetation Monitoring Report 1993* (CDWR February 1994).
- *Trend Analysis for Existing Biological Condition in the Bay/Delta Estuary* (CDWR February 1994).

6.1 Habitats of the Project Area

Introduction

The following is a discussion of the habitats of the Project Area, including the following sites: fish barrier site at Old River (near Mossdale), redesigned intake structure at Clifton Court Forebay, Old River dredging site, two dredge disposal sites on Victoria Island, a dredged material reuse site on Twitchell Island and flow barrier sites at Grant Line Canal, Old River (near DMC), and Middle River. These habitats are described based on existing documentation of the south Delta and site reconnaissance conducted by ENTRIX terrestrial biologists during the weeks of June 6 and 13, 1994. The Twitchell Island site was investigated on Jane 15, 1996 The purpose of these surveys was to map the habitats at each project site, verify previous studies, and update existing data on biological resources. Surveys were conducted via small boat, by vehicle, and on foot. Infra-red photography and 7.5 minute USGS topographical maps were used in the field for orientation and habitat mapping. Nomenclature of habitats discussed within this section is based on *The Preliminary Descriptions of the Terrestrial Natural Communities of California* (Holland 1986).

Data from the temporary barriers project were utilized to describe the terrestrial resources in the vicinity of the barrier sites. The temporary barriers project was developed as a collaborative effort between the State and Federal agencies to develop information that will lead to a better understanding of the impacts of the barriers, upon such elements as water levels, circulation, water quality, and vegetation. Thus far the program has resulted in three years of data which has been published annually. A thorough analysis of the data set will be conducted at the end of the five year monitoring period.

Habitats occurring at the various Project sites include Coastal and Valley freshwater marsh, riverine, Great Valley willow scrub, Great Valley Cottonwood riparian forest,

cropland, ruderal habitat, Valley wildrye grassland and blackberry thicket. The distribution of these habitats is shown in Figures 10-2 through 10-8. The following discussion includes a detailed description of the onsite habitats, including botanical composition and expected wildlife usage. (Table 10-2 indicates the total habitat acreage at each site).

Coastal and Valley Freshwater Marsh. Freshwater marsh occurs throughout the Delta, typically at the base of levees and on in-channel islands, where tidal influences result in regular inundation. Within the Project Area, freshwater marshes are located in the vicinity of the proposed intake structure, Middle River, and Grant Line barrier sites. Patches of freshwater marsh also occur along the proposed Old River dredge site. In open water ecotones, freshwater marshes intergrade with riverine habitats and in upland ecotones with riparian scrub, riparian forest, and blackberry thicket habitats. The extent of this habitat ranges from small isolated patches to large dense stand, with higher habitat value. This habitat is dominated by tule, with patches of other species such as cattail and common reed. Occasional isolated shrubs occur at scattered locations throughout the marsh habitat including California button-willow, shining willow, and Goodding's black willow. Other species observed in freshwater emergent wetlands include water hyacinth, water primrose, yellow iris, bugleweed, willow dock, water primrose, soft rush, umbrella nut-sedge, willow-herb, and hedge bindweed.

The diverse structure of freshwater wetlands, including open water, cattails, bulrushes, willow thickets and adjacent upland vegetation allows this habitat to support a wide variety of wildlife species (Granholm 1989). Resident waterbirds, migratory waterfowl and shorebirds, upland game birds, passerine birds, and small to medium sized mammals commonly occur within this habitat.

Within the Project Areas, freshwater marshes provide food, refuge, resting areas, and breeding/nesting sites for hundreds of different bird, mammal, reptile, and amphibian species. Wildlife species observed within the project area include several different swallow species (barn, rough-winged, and cliff), green-backed heron, great blue heron, mallard, American coot, northern harrier, red-winged blackbird, song sparrow, marsh wren, muskrat beaver, and western pond turtle.

Riverine. Riverine habitat is the most common open water habitat in the Delta and occurs at all the proposed barrier and dredging sites associated with the project. Riverine

habitat is confined to the natural and manmade channels of the Delta and is generally unvegetated, with infrequent colonies of aquatic plant species, such as water-hyacinth, water-primrose, common waterweed, hornwort, and parrot's feather. Vegetation, when present, is generally restricted to waterways with low water velocities and areas with low levels of disturbance.

This riverine, aquatic habitat is utilized by many species of wading birds, waterfowl, shorebirds, gulls, terns, swifts, and flycatchers. It is also commonly used by the western toad, Pacific treefrog, river otter, muskrat, and beaver (Mayer and Laudenslayer 1988, ABAG 1991). Many of the wildlife species occurring in this type of habitat are closely associated with adjacent marsh or riparian habitats (ABAG 1991).

Great Valley Willow Scrub. Willow scrub commonly occurs throughout the Delta, on levee banks, in-channel islands, and other areas not generally inundated on a regular basis. Within the Project Area, willow scrub occurs at the proposed intake structure, the Old River fish barrier, and the following proposed flow barrier sites: Grant Line, Middle River, and Old River (near DMC). Willow scrub occurs in association with cottonwood riparian forest in upland sites and freshwater marsh at more mesic sites. This habitat is dominated by dense stands of shrubs, such as sandbar willow, shining willow, California button-willow, Himalayan blackberry, white alder, and, occasionally, black willow. Where shrub cover is absent, herbaceous cover is often abundant, and includes the following dominant species: Indian-hemp, yellow iris, centaury, vervain, umbrella nut-grass, creeping bent grass, bugleweed, and hedge-nettle. In disturbed areas, willow scrub intergrades with blackberry habitat.

Willow scrub habitat provides protective cover and nesting habitat for songbird species, such as the song sparrow, black phoebe, California towhee, rufous-sided towhee, and bushtit. Additionally, these habitats provide shelter and forage for wildlife species, including mule deer, Audubon's cottontail, California ground squirrel, western gray squirrel, raccoon, Virginia opossum, striped skunk and coyote; as well as numerous birds, including the northern flicker, scrub jay, American crow, Brewer's blackbird, American robin, yellow-billed magpie, and mourning dove (Mayer and Laudenslayer 1988). Many of the species associated with this riparian scrub utilize the adjacent aquatic habitat for foraging, resting and breeding, including the green-backed heron, western toad and Pacific treefrog. Species such as the ash-throated flycatcher and western wood pewee forage along the riparian edge for terrestrial life stages of aquatic insects (ABAG 1991).

Wildlife species observed within the willow scrub habitat in the Project Area include the ring-necked pheasant, California quail, several species of sparrows (song, Lincoln's, white-crowned, and sage); house finch, scrub jay, brown-headed cowbird, bushtit, black-chinned hummingbird, Brewer's blackbird, red-winged blackbird, green-backed heron, mallard, wood duck, northern harrier, California ground squirrel, black-tailed jackrabbit, muskrat, western pond turtle, and beaver.

Great Valley Cottonwood Riparian Forest. Historically, riparian forest was common throughout the Delta, occurring in association with most waterways, including rivers and sloughs. Currently, riparian habitat occurs at scattered locations throughout the Delta, including one remnant stand of cottonwood riparian forest located near the proposed Grant Line barrier site. At the Grant Line site, a mature stand of Fremont cottonwood forms a nearly contiguous overstory and integrates with freshwater marsh. The understory ranges from dense to open, and is composed of black willow, sandbar willow, and shining willow. Other understory species include Himalayan blackberry, California blackberry, California button-willow, Indian hemp, California rose, coyote brush, and an immature California black walnut. Herbaceous cover is common in areas where shrub cover is sparse or non-existent, and includes Santa Barbara sedge, hoary nettle, creeping wild rye, bracken fern, and hedge-nettle. In disturbed areas, tree canopy includes many non-native species, including Monterey pine, coast redwood, Modesto ash, Canary Island pine, acacia, tree of heaven, alepo pine, and gum tree. Herbaceous cover in disturbed sites includes many non-native species, including Italian thistle, ripgut brome, milk-thistle, periwinkle, and poison-hemlock.

Cottonwood riparian forest also occurs in the vicinity of the Old River fish barrier site on the east bank of the San Joaquin River. At this site, cottonwoods are scattered along the levee bank with an understory of ruderal weeds and scattered shrubs. At the Middle River site, riparian forest occurs on an in-channel island and is dominated by mature black willows with an understory of shrubs, including California button-willow, sandbar willow, shinning willow, and California rose.

Many wildlife species reside in, or utilize riparian forest habitats. These areas provide refuge and shelter, food and water, resting and nesting sites for at least 50 amphibian and reptile species, 147 bird species, and 55 mammal species. The high species diversity is attributed to the complexity of habitat structure created by a multi-layer composition of

trees, shrubs, vines, and both herbaceous and aquatic vegetation (Mayer and Laudenslayer 1988).

Riparian trees, such as cottonwood and valley oak contain broken branches which create nesting cavities for a variety of birds, including the white-breasted nuthatch, plain titmouse, screech owl, violet-green swallow, tree swallow, and downy woodpecker. The yellow warbler, warbling vireo and northern oriole nest and feed high in the canopy. Black-headed grosbeaks occur in the mid-canopy range, while song sparrows, rufous-sided towhees and Swainson's thrush prefer the dense thickets of the understory for nesting and feeding (Small 1974). The leaf litter produced from deciduous trees creates a microhabitat for a number of snails, worms, centipedes, spiders, toads, salamanders, snakes, lizards, and mice, which form an important prey base for a number of birds and mammals. Mule deer, raccoon, skunk and red fox utilize riparian habitats for food and water.

Wildlife species observed within the Project Area include raptors such as the red-tailed hawk, nesting Swainson's hawk, barn owl, and great horned owl; several different woodpeckers (Nuttall's, hairy, and downy); northern oriole, warbler and vireo, rufous-sided towhee, black-headed grosbeak, scrub jay, American crow, and great blue heron.

Cropland. Cropland is the most abundant habitat in the Delta, and occurs at both the proposed dredge disposal sites on Victoria Island and adjacent to many of the proposed structures and dredging sites. Crops planted within the Project Area include wheat, asparagus, sugar beets, safflower, and corn. General cropping practices result in monotypic stands of vegetation for the growing season, and bare ground in the fall and winter. In areas not intensively cultivated, such as fallow fields, roads, ditches, and levee slopes, regular maintenance precludes the establishment of ruderal vegetation, or native communities. At the Victoria Island dredge disposal sites, maintenance activities along ditches and drains preclude the establishment of emergent vegetation or trees typically associated with agricultural habitats.

Numerous wildlife species, especially rodents and birds, occur within cropland habitats, despite regular disturbance. Birds, such as waterfowl, raptors, doves and ring-necked pheasants, often occur in these agricultural habitats. Croplands that are routinely flooded provide freshwater habitat for wetland species, including wading birds, shorebirds, and gulls (Mayer and Laudenslayer 1988).

The grain fields of the Delta provide feeding and roosting sites for wetland-associated birds such as shorebirds, wading birds, gulls, waterfowl and geese, including Aleutian Canada goose. When agricultural wetlands are flooded they attract substantial numbers of migratory shorebirds and waterfowl, such as the greater yellowlegs, long-billed dowitcher, long-billed curlew, western sandpiper, greater white-fronted goose, mallard, and northern pintail.

Wildlife species observed or potentially occurring within the Project Area include raptors, such as the red-tailed hawk, Swainson's hawk, American kestrel, northern harrier, and white-tailed kite; upland game birds such as the mourning dove and ring-necked pheasant; passerines, such as the western meadowlark, house finch, and song sparrow; reptiles, such as the western fence lizard, gopher and garter snakes; and mammals, such as the California ground squirrel, black-tailed jackrabbit, Audubon's cottontail, house mouse, and Virginia opossum.

Ruderal Habitat. Ruderal habitat occurs throughout the south Delta and is common on levee banks in the vicinity of all the proposed flow barrier sites; the fish barrier site at Old River; Twitchell Island dredged material reuse site, and intake structure at Clifton Court Forebay. Ruderal habitat also occurs along the levees of Old River at the dredging site. This habitat includes herbaceous cover with scattered shrubs and riprap. Species composition includes many non-native, weedy species, such as short-podded mustard, milk-thistle, yellow star-thistle, sow's ear thistle, ripgut brome, canary grass, fiddle neck, poison-hemlock, foxtail, nightshade, amaranthus, and common cheeseweed. Scattered trees and shrubs in this area include tree tobacco, Himalayan blackberry, coyote brush, and giant reed.

While ruderal habitats may have lower values to wildlife and support fewer species than habitats such as riparian scrub and forest, they do provide an important source of food and shelter to some species. Larger, less disturbed ruderal areas would be expected to attract similar wildlife species as croplands or riparian scrub, especially if the area is dominated by shrubs and has a large herbaceous component. Degraded or unvegetated areas such as riprap would only attract species tolerating disturbed conditions such as rock dove, house finch, house sparrow, California ground squirrel, house mouse and Norway rat.

Blackberry Thicket. Blackberry thickets are abundant on levee banks throughout the Delta, and occur at the Middle River, Grant Line, and Old River flow barrier sites. These thickets integrade with riparian habitats and are characteristically monotypic stands of Himalayan blackberry with scattered and isolated trees and scrubs including coyote brush, sandbar willow, shining willow, and white alder. Blackberry thickets occur in association with ruderal habitats, however a herbaceous understory is not evident within these thickets.

These dense stands of non-native blackberries provide resting, thermal, and escape cover for local resident wildlife, especially during the winter months when adjacent cropland is fallow. Expected wildlife use in the winter includes the ring-necked pheasant, yellow-rumped warbler, white crowned sparrow, black-tailed jackrabbit, coyote, gopher snake, Norway rat, and Audubon's cottontail. During the spring and summer, blackberry thickets provide nesting sites for such species as red-winged blackbird, Brewer's blackbird, mourning dove, and northern mockingbird. Resident bird species observed at these sites during the site reconnaissance included the California towhee, rufous-sided towhee, California quail, northern mockingbird, red-winged blackbird, Anna's hummingbird, and, in the densest areas, winter wren. Mammal use, detected onsite by tracks, scat or other evidence includes the river otter, raccoon, and Virginia opossum.

Valley Wildrye Grassland. Valley wildrye grassland is dominated by dense, monotypic stands of creeping wildrye and occurs only at the proposed northern intake site. Other species occurring within the habitat include curly dock, stinging nettle, willow herb, mugwort, and bull thistle. Valley wildrye grassland integrates with willow scrub habitat. In some areas, the habitat is disturbed by mowing and road maintenance. Aerial photos and scattered tire ruts indicate that this area has been previously graded, although now revegetated.

Wildlife species observed at this site include the barn swallow, red-winged blackbird, western fence lizard, rufous-sided towhee, black phoebe, and horned lark. Wildlife expected in this habitat include ring-necked pheasant, morning dove, western meadow lark, striped skunk, Virginia opossum, and coyote.

6.2 *Habitats of the State Water Project*

Introduction

The following discussion includes those areas potentially affected by the proposed project including the Delta (with emphasis on the south Delta); San Pablo and Suisun bays; several reservoirs within the SWP; and portions of both the Feather and Sacramento rivers. The classification of habitats within this discussion is based on *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988).

Habitats of the Sacramento-San Joaquin Delta

The Sacramento-San Joaquin River Delta System occurs where these and other rivers meet in the Central Valley and flow westward into Suisun and San Pablo bays and, ultimately, reach the San Francisco Bay. Habitats of the Delta are generally freshwater, integrating with the brackish and saltwater habitats at Suisun Bay to the west. The Delta includes numerous islands, ranging from large to small, separated by rivers, sloughs, and canals. Prior to settlement, this area was a vast mosaic of seasonal and permanent wetlands, with riparian forests occurring in upland areas. The modern Delta is a highly managed system of controlled waterways and productive farmland, with scattered remnants of the original habitats. This discussion of terrestrial biological habitats is based on the *Trend Analysis for Existing Biological Conditions in the Bay/Delta Estuary* (DWR 1994e), limited field reconnaissance conducted by ENTRIX biologists, supplemented with other existing documentation and the experience of ENTRIX terrestrial biologists. The habitats of the Delta include freshwater emergent wetland, riverine, lacustrine, riparian forest, riparian scrub, eucalyptus forest, grassland, ruderal habitat, cropland, and pastureland (DWR 1994e).

Freshwater Emergent Wetland. Freshwater emergent wetlands occur throughout the Delta System, in areas where soils are inundated or saturated for all or most of the growing season, primarily occurring around Delta islands, backwater areas, and in thin bands along the Delta rivers and channels where accumulation of sediments has occurred. Other freshwater emergent wetlands occur on Delta islands in low-lying areas among crop and pasture land. Typical emergent vegetation found in this habitat include tules, cattails, rushes, sedges and grasses.

Freshwater emergent wetlands are extremely productive and important habitat for hundreds of different species of birds, mammals, reptiles, and amphibians. Many species entire life cycles rely on this habitat while migratory species, such as ducks and geese, use these wetlands seasonally.

Riverine. Riverine habitat includes the river channels and sloughs associated with the Sacramento and San Joaquin rivers. These two rivers combine with other smaller rivers, such as the Cosumnes River and Mokelumne River, to create a large network of riverine habitat. Because these rivers merge at a low elevation, they tend to accumulate nutrients which makes the water turbid and the substrate silt laden. Many different habitats occur adjacent to riverine environments, including riparian and freshwater marsh habitats.

Many species rely on riverine habitat and the associated adjacent habitats. Bird species, including herons, shorebirds, and songbirds commonly forage in this habitat. Amphibians, such as newts and frogs, are closely associated with the riverine environment. Also, several mammal species are linked to river habitats, including the river otter, mink, muskrat, and beaver (Mayer and Laudenslayer 1988).

Lacustrine. Lacustrine habitat includes a variety of open water environments, including lakes, reservoirs, and ponds. Lacustrine habitats such as dead end sloughs, forebays, and flooded islands can be found within the Sacramento-San Joaquin Delta. The primary plants associated with lacustrine environments include phytoplankton, floating aquatic, and emergent aquatic species. Riparian forest habitat commonly occurs in association within lacustrine habitats.

Within the Delta, lacustrine habitats provide foraging habitat for a variety of wildlife species. Large lacustrine habitats attract fish-eating birds, such as terns, grebes, cormorants, herons and waterfowl. Lacustrine habitat also provides foraging habitat for many mammal species, including the beaver, river otter, and muskrat.

Riparian Forest. Riparian forest habitats are generally found in association with aquatic environments such as riverine, wetland, and lacustrine habitats, where the ground water table is generally high. The riparian forest habitat is characterized by trees, such as various willows, cottonwood, sycamore, valley oak, and white alder. Typical understory species include wild grape, wild rose, California blackberry, poison-oak, and shrubby willows (Mayer and Laudenslayer 1988). Riparian forest habitat is scattered throughout

the Delta System on islands, along levees, in backwater areas, in sloughs, and in thin bands along river channels.

These areas provide refuge and shelter, food and water, resting and nesting sites for at least 50 amphibian and reptile species, 147 bird species, and 55 mammal species (Mayer and Laudenslayer 1988). Many birds including woodpeckers, owls, and swallows, use cavities in riparian trees as nest sites. Other birds nest among the branches, including warblers, vireos, and grosbeaks. Mammals, such as mule deer and raccoon, utilize riparian corridors for shelter, food, and water.

Riparian Scrub. Riparian scrub habitat is generally found in association with aquatic environments, including riverine, lacustrine, and riparian forest habitats. This habitat includes woody plant species that maintain a shrubby stature, including button-willows, sandbar willows, dogwood, and white alder. In some Delta locations, Himalayan blackberry scrub is common on maintained levees. Generally, many of the wildlife species that use riparian forest habitat also occur in riparian scrub.

Eucalyptus Forest. Eucalyptus habitats range from monotypic stands with little or no understory to scattered trees with a well-developed herbaceous and shrubby understory. When eucalyptus trees are planted in groves or rows, the understory is typically composed of non-native annual grasses. Trees established as small groves in native plant communities contain well-developed understories, including blue elderberry, button-willow, black willow and assorted annuals (Mayer and Laudenslayer 1988). Eucalyptus stands are scattered throughout the Delta complex, occurring mostly near homes and marinas where the trees were most likely planted as wind breaks.

Eucalyptus trees provide perching and nesting sites for many raptor species, such as red-tailed hawk, barn owl, and great-horned owl. Also, eucalyptus stands provide important rookery sites for great egrets and snowy egrets (ABAG 1991).

Grassland. Grassland habitat is typically dominated by non-native annual species of grasses and forbs, including wild oats, soft chess, ripgut brome, wild barley, broadleaf filaree, turkey mullein, California oatgrass and Pacific hairgrass (Mayer and Laudenslayer 1988). Depressions within grassland habitats may collect water during the rainy season, creating seasonal wetland or vernal pool habitat important to many different

organisms. Grasslands occur in many outlying areas surrounding the Delta and on islands within the Delta complex.

Grasslands provide foraging and denning habitat for several mammal species, such as the California ground squirrel, badger, skunk, and coyote. Other common species include the ring-necked pheasant, western meadowlark, red-tailed hawk, western toad, and gopher snake.

Ruderal Habitat. Ruderal habitats are generally composed of non-native plant species adapted to tolerate disturbed conditions. Within the Delta complex, these disturbed conditions are predominant on most of the levees. The constant disturbance of road traffic and levee maintenance create ideal conditions for ruderal plant colonization. The rip-rapped banks of the inner levees are regularly disturbed habitat where pioneering ruderal species exist. Many non-native grasses and forbs occur in this habitat, as well as some native species, such as California poppy, telegraph weed, and coyote brush.

Ruderal areas generally have lower values for wildlife. However, many species utilize this habitat. Many wildlife species found in grassland and cropland habitats also occur in disturbed habitats. Native species which tolerate the conditions of ruderal habitats include the western fence lizard, Brewer's blackbird, lessor goldfinch, and California ground squirrel. This habitat also supports many non-native species of wildlife, including the rock dove, house finch, house sparrow, European starling, ring-necked pheasant, house mouse and Norway rat. Where prey bases are well established and disturbance levels are low, ruderal habitats may be used as foraging habitat for raptor species, including white-tailed kite, American kestrel, northern harrier, and red-tailed hawk.

Cropland. Within the Delta complex, croplands consist of a wide variety of crop types, including sugarbeet, corn, tomatoes, rice, wheat, barley, alfalfa, sunflower, and asparagus. Cropland habitat also includes orchards which occur throughout the Delta, including pears and occasionally walnuts, apples, peaches, apricots and almonds. These crops are highly maintained for weed control with herbicides, consequently plant species diversity is very low.

Croplands are adjacent to nearly every leveed waterway within the Delta system, and may provide important foraging habitat for many species of wildlife that are typically found in adjacent aquatic habitats. The Swainson's hawk and other raptors that nest in riparian

stands along the Delta rivers, commonly forage on adjacent cropland habitat. Grain fields within the Delta provide feeding and resting sites for many species of migratory and resident wildlife, including ducks, geese, wading birds, ring-necked pheasant, and mourning dove. Croplands that are routinely flooded (e.g., for irrigation or weed control) provide freshwater habitat for wetland species, including wading birds, shorebirds, and gulls (Mayer and Laudenslayer 1988). Small mammals, such as voles, gophers, rabbits, rats, and mice, are abundant in cropland habitat. Other larger mammal species also utilize cropland habitat for foraging, including coyote, red fox, mule deer, and raccoon.

Pastureland. Pastureland is perennial habitat maintained for livestock through irrigation and seeding practices. The quality of this non-native habitat varies with the type of livestock, location, and other management practices. Dominant plant species include non-native perennial grasses and legumes, including dallis grass, orchard grass, Bermuda grass, white clover, bird's-foot trefoil, harding grass, and Kentucky fescue.

Although pastureland habitat is non-native, it still provides habitat for wildlife. Mule deer seek these rich foraging areas. Many birds, including ring-necked pheasant, waterfowl, sandhill cranes, and other ground-nesters use pastureland if adequate residual vegetation is present (Mayer and Laudenslayer 1988). During winter migrations, pastureland provides important habitat for waterfowl within the Delta complex.

Habitats of the San Pablo and Suisun Bays

Located to the west of the Delta, the Suisun and San Pablo bays include the Suisun Marsh and support both freshwater and brackish habitats. The extent of these habitats is influenced by freshwater flows from the Delta. This discussion of terrestrial biological habitats is based on the *Trend Analysis for Existing Biological Conditions in the Bay/Delta Estuary* (DWR 1994e), supplemented with other existing documentation and the experience of ENTRIX terrestrial biologists.

Intertidal Mudflats. Intertidal mudflat habitats occupy the general zone between 2.5 feet below mean low water and mean level tide, and are inundated and exposed twice daily during low tides (CDWR 1994). Algae is the predominant vegetation found on these mudflats. Intertidal mudflats occur in both San Pablo and Suisun Bays, and integrade with open water and saline emergent wetland habitats.

When intertidal mudflats are exposed, animals such as arthropods and mollusks present a rich food source for several different species of shorebirds. Common migratory shorebirds include marbled godwits, western sandpipers, and willets. Great blue herons and other wading birds hunt in the shallow water areas adjacent to this habitat. Mammals such as raccoons, Virginia opossum, and foxes forage in intertidal mudflats.

Saline Emergent Wetlands. Saline emergent wetlands include salt and brackish marshes within the Bay estuary system. Vegetation within this habitat includes tules, cattails, pickleweed, and cordgrass. The distribution and occurrence of plant species within saline emergent wetlands varies with fluctuations in salinity and periods of inundation. These fluctuations in salinity and inundation periods are affected by freshwater inflow from the Delta and tidal cycles, respectively.

Within San Pablo and Suisun Bays saline emergent wetlands are used by many species including salt marsh harvest mouse, California clapper rail and California black rail. Several birds, including the black-crowned night heron, great blue heron, snowy egret, great egret, white-tailed kite, marsh wren, northern harrier, and many species of waterfowl occur in saline emergent wetland habitat.

Freshwater Emergent Wetland. Freshwater emergent wetlands occur in San Pablo and Suisun Bays in areas where salinity is low and soils are inundated or saturated for all or most of the growing season. This habitat exists primarily within the freshwater environment of the Sacramento-San Joaquin Delta and at other sources of freshwater, such as along the Napa River. Suisun Bay supports freshwater emergent habitat in diked areas. Other freshwater emergent wetlands occur on Delta islands in low-lying areas among agriculture and pasture land. Typical emergent vegetation occurring in this habitat includes tules, cattails, rushes, sedges, and grasses.

Freshwater emergent wetlands associated with San Pablo and Suisun Bays support many of the same wildlife species associated with the freshwater emergent wetlands of the Delta.

Open Water. Open Water habitat includes the deepwater areas of San Pablo and Suisun Bays. The dominant plant species occupying this habitat are various forms of phytoplankton. Eelgrass is the only dominant rooted aquatic plant in open water habitat, and limited to 22 locations within San Francisco and San Pablo Bays (CDWR 1994).

Open water habitats occur in association with intertidal mudflats and saline emergent wetland.

The open water habitats of San Pablo and Suisun Bays provide foraging opportunities for a variety of bird species. Resident species commonly associated with these areas include the double-crested cormorant, California gull, ring-billed gull and herring gull. During winter, these bays are also used by migrating waterfowl such as canvasback, red head, ring-necked duck, greater scaup, lesser scaup, common goldeneye, and bufflehead.

Estuarine. Estuarine habitats occur where the tidal marine saltwater environment meets freshwater from inland rivers. The mixing of salt and freshwater creates a brackish water environment which is extremely productive and important to many wildlife species. These conditions exist where the Delta River complex meets San Francisco Bay near Antioch, and extend into Suisun and San Pablo Bays. Estuarine habitats are closely related to adjacent intertidal and marshland habitats that estuarine species frequently utilize.

Salt Ponds. Salt ponds were created by diking of saline intertidal marshes throughout the San Francisco Bay Estuary. Large areas of San Pablo Bay have been converted to salt ponds that evaporate salts from sea water. Generally, these areas support little vegetation other than widgeon grass, but green and blue-green algae may be common (ABAG 1991). The quality of salt pond habitat is related to salinity levels, and ponds with low to moderate salinities often have considerable wildlife values (CDWR 1994).

Although salt ponds are non-native habitats, many waterbirds use them for foraging and nesting. Some of the species occurring in this habitat include Caspian terns, American avocets, killdeer, and western snowy plover. During the winter, many species of waterfowl forage and rest on salt ponds, including canvasback, bufflehead, and American widgeon.

Habitats of the Feather and Sacramento Rivers

The following section describes the habitats of the Feather River downstream from Lake Oroville to the Sacramento River, and the Sacramento River from the confluence of the Feather River downstream to the Delta. These rivers carry water from Lake Oroville to

downstream water diversions, including the Banks pumping facilities at Clifton Court Forebay and, as such, are part of the SWP.

Habitats occurring along these water courses are described here based on existing documentation, field experience of ENTRIX staff, and limited field reconnaissance conducted on July 21, 1994 by ENTRIX terrestrial biologists. The purpose of these surveys was to map the habitats at each project site, verify previous studies, and update existing data on biological resources. Habitats occurring along the banks of these waterways include valley-foothill riparian, cropland, and ruderal habitat.

Valley-Foothill Riparian. The banks of the Sacramento and Feather Rivers support various riparian habitats including several phases of riparian habitat: scrub, woodland and forest types. These habitats are in general referred to as valley-foothill riparian. Within woodland and forest habitats, dominant tree species include Fremont cottonwood, California black walnut, valley oak, California sycamore, Oregon ash, and black willow. Woodland habitats generally occur on higher elevation terrace soils, where tree canopies are touching, but do not overlap. Understory within these woodlands is generally variable, with shrub density ranging from low to high. Riparian forest habitats generally occur in association with rivers and river floodplains that support trees with overlapping canopies and dense understories, including species, such as California grape, box elder, sandbar willow, California blackberry, red willow, white alder, and button-willow. Where shrubs are absent, the understory is a lush herbaceous layer, including stinging nettle, barnyard grass, Baltic rush, willow herb, water smartweed, bulgeweed, beggar's ticks, Indian rice cut grass, nut-grass, and rabbit's-foot grass.

These habitats support a variety of wildlife species, including resident bird, reptile, and mammal species, such as the California towhee, Bewick's wren, belted kingfisher, scrub jay, rufous-sided towhee, western fence lizard, Pacific tree frog, striped skunk, raccoon, beaver, and mule deer. Additionally, riparian habitats provide nesting and migrating cover for many migratory songbird species, including blue grosbeak, tree swallow, yellow-rumped warbler, lazuli bunting, western tanager, and northern oriole.

Cropland. Cropland habitat includes orchards, vineyards, and both field and row crops. Orchards and vineyards are more common along the river side of the levees and are generally small to large monotypic stands of trees or vines, including English walnut, prune, peach, pear, kiwi, apple, grape, and almond. Field and row crops are relatively

more common on the landward side of the levee. Crop rotation varies annually in this region and includes alfalfa, wheat, barley, tomatoes, sugar beets, corn, rice, safflower, and irrigated pasture.

Wildlife use of these areas varies throughout the growing season with crop type, level of disturbance, and available cover. Orchard and vineyard typically support resident species, such as scrub jay, northern mockingbird, yellow-billed magpie, American crow, and northern flicker. During the winter, orchard habitats provide foraging habitat and roosting sites for many songbird species, including white-crowned sparrow, dark-eyed junco, golden-crowned sparrow, lessor goldfinch, and yellow-rumped warbler. Species associated with field and row crops include the red-winged blackbird, European starling, western meadowlark, California vole, black-tailed jackrabbit, western harvest mouse, Botta's pocketgopher, raccoon, stripped skunk, and Virginia opossum. Croplands provide foraging habitat for many raptors, including the northern harrier, red-tailed hawk, and white-tailed kite. Fields with ponded or saturated conditions during the winter may support wintering waterfowl and shorebirds such as mallard, northern pintail, greater yellowlegs, long-billed dowitcher, dulin, western sandpiper, and least sandpiper.

Ruderal habitat. Ruderal habitat is common along levee slopes as described in the Delta. Species occurring in ruderal habitats include many non-native species tolerant of regular levee maintenance, including yellow-star thistle, short-podded mustard, soft chess, foxtail, annual ryegrass, wild oat, fennel, bind weed, Russian thistle, lambsquarters, rough cocklebur, and Bermuda grass. Cover and species composition is highly variable depending on soil type, frequency of disturbance, and type of disturbance. Riprap and bare ground are common features within this habitat type.

Wildlife associated with cropland habitat also use ruderal habitats. Depending on disturbance and available plant cover, ruderal habitats may provide important over-wintering habitat for many resident species of wildlife, including the ring-necked pheasant, morning dove, house finch, Brewer's blackbird, California ground squirrel, black-tailed jackrabbit, and California vole.

Habitats of the State Water Project Reservoirs

The following discussion describes the habitats of the primary water storage facilities of the SWP, including Lake Oroville and San Luis Reservoir in northern California; and Pyramid, Perris, Silverwood, and Castaic lakes in southern California.

The northern California reservoirs were surveyed by ENTRIX terrestrial biologists during the week of July 18, 1994. The southern California reservoirs where surveyed by ENTRIX terrestrial biologists during the week of July 5, 1994. These surveys were conducted via boat, vehicle, and on foot to map habitats at the perimeter of the reservoirs and collect data on species occurring within the habitats. The purpose of these surveys was to map the habitats at each project site, verify previous studies, and update existing data on biological resources. The following description is based on the results of those field surveys and augmented with additional information from previous documentation and personal communication with agency specialists.

Mixed Chaparral/Coastal Scrub. Mixed chaparral/coastal scrub habitat occurs on the slopes and shorelines surrounding Perris, Pyramid, Castaic, and Silverwood Lakes. Mixed chaparral consists of a variety of shrubs including chamise, scrub oak, big berry manzanita, mountain mahogany, yucca, and bigpod ceanothus. Blue elderberry occurs infrequently throughout the mixed chaparral habitat. This habitat type is characterized by open to dense shrubland, ranging from 30-100 percent cover and 3-15 feet in height. The height and density of mixed chaparral plant species vary with soil conditions, precipitation, and fire frequency. Within the study area, mixed chaparral integrates with coastal scrub. This mapping includes small to large inclusions of coastal scrub habitat, as well as areas dominated by shrubs from both community types. These patches include stands of purple sage, white sage, rabbit brush, California sage, and California buckwheat. At Pyramid Lake bigcone Douglas-fir and juniper occur on the steep north facing slopes within mixed chaparral habitat. Scattered holly-leaved cherry trees occur along north facing slopes surrounding Castaic Lake. Scattered stands of coast live oak occur in mixed chaparral habitat at several locations surrounding Silverwood, Castaic, and Pyramid Lakes.

At Lake Oroville, mixed chaparral occurs on steep south-facing slopes and includes dense stands of green-leaf manzanita, with other shrubs such as scrub oak, buckbrush, poison-oak, coffeeberry, and California buckeye. Occasional scattered trees within this habitat

type include foothill pine, interior live oak, blue oak, and black oak. Mixed chaparral integrates with mixed oak woodlands.

Many animals utilize these habitats, including mammals, birds, and reptiles. Brush rabbit, black-tailed jackrabbit, and mule deer forage and seek cover within these shrub habitats. Shrub habitats provide foraging and nesting habitat for many bird species including the rufous-sided towhee, California quail, and California thrasher. Raptors, such as the red-tailed hawk, prairie falcon, and Cooper's hawk, hunt above the shrub canopy. Bird species observed at the southern California reservoirs include the scrub jay, common raven, greater roadrunner, Anna's hummingbird, mourning dove, and song sparrow. Reptiles observed in this habitat include the western fence lizard and, at Lake Perris, granite spiny lizard. Other species expected in this habitat include the black bear, bobcat, mountain lion, Merriam's chipmunk, California ground squirrel, western rattlesnake, coast horned lizard, and alligator lizard.

Valley-Foothill Riparian. Riparian habitat generally occurs at the shorelines and in association with tributaries that enter Pyramid, Castaic, Perris, and Silverwood Lakes. The dominant plant species observed in these habitats include sycamore, black willow, Fremont cottonwood, and occasional white alder and Oregon ash. Understory species include sandbar willow, giant reed, California bay, tamarisk, stinging nettle, and mulefat. Species composition varies from one habitat to another, depending on location, disturbance, and substrate. Habitats dominated by sycamores occur in protected canyons where larger tributaries enter the reservoirs, presumably on deeper soils. Habitats dominated by willows and mule fat occur in less protected areas on shorelines and canyons with smaller tributaries. The eastern shoreline of Perris Lake includes an extensive riparian canopy with a well developed understory. A portion of this area is designated as a waterfowl hunting area. At the San Luis Reservoir riparian habitat was limited to scattered patches of mule fat and occasional willows. No riparian habitat was observed at Lake Oroville.

Riparian habitats provide nesting, thermal, foraging, and escape cover for a variety of bird species, including the black phoebe, red-winged blackbird, brewer's blackbird, ash-throated flycatcher, northern rough-winged swallow, scrub jay, black headed grosbeak, California quail, Nuttall's woodpecker, plain titmouse, and California towhee. Mammal species, such as the Merriam's chipmunk, mule deer, coyote, black bear, mountain lion, and raccoon, utilize riparian corridors for shelter, food, and water.

Montane Hardwood-Conifer Forest. Montane hardwood-conifer forest occurs on the south shore of Silverwood Lake on a steep north facing slope. This habitat includes both broadleaf hardwoods and coniferous trees that form a closed forest. Within this habitat, dominant conifers include Douglas-fir, ponderosa pine, and incense-cedar integrating with hardwoods such as canyon live oak and black oak. The understory of montane hardwood-conifer habitat at Silverwood Lake includes coffeeberry, gooseberry, and mugwort.

The conifer forest at Silverwood Lake provides habitat for a wide variety of wildlife species. Bird species occurring within this habitat include the acorn woodpecker, ash-throated flycatcher, scrub jay, and various grosbeaks. The western gray squirrel, mule deer, and raccoon also seek cover and forage in this habitat. Reptiles expected in this habitat include the western rattlesnake, western fence lizard, and California kingsnake.

Oak Woodland. Within the State Water Project facilities, several phases of oak woodland habitat occur at the various reservoir facilities, including blue oak, interior live oak, coast live oak, and mixed oak woodlands. These phases vary in location, structure and species composition. A brief discussion of each of these oak woodland habitats appears below.

Isolated patches of blue oak woodland habitat occur at lower elevations bordering Lake Oroville on south facing slopes. At these sites, composition includes blue oaks ranging from scattered to open, with occasional foothill pine. The understory is dominated by non-native annual grasses, including dog-tail grass, soft chess, ripgut brome, and red brome. Shrub cover is generally sparse, but includes mountain mahogany, buckbrush, and scrub oak.

Scattered blue oak woodlands also occur on the western shore of the San Luis Reservoir, where tree cover is dominated by mature blue oak, but also includes coast live oak, and California buckeye. Within these woodlands shrubs are common and include blue elderberry, poison-oak, California sage, sticky monkey flower, and coyote brush. The herbaceous layer is composed of native and non-native species, including purple needle grass, soft chess, horehound, short-podded mustard, red brome, tocalate , wild oat, naked-stemmed buckwheat, and common fiddleneck.

Isolated patches of coast live oak woodland occur at scattered locations in association with chaparral and coastal scrub habitats. These areas are dominated by coast live oak with understories including California sage, chamise, and California buckwheat.

Interior live oak woodlands occur at Lake Oroville on all aspects at elevations below 1,000 feet, and on south-facing slopes at elevations above 1,000 feet. Below 1,000 foot elevations, interior live oak woodland is the dominate habitat. Interior live oak is the dominant tree species, with occasional blue oak and foothill pine. Canyon live oaks occur in protected areas, including north-facing slopes, canyons, and along drainages. Shrub cover is generally dense and includes scrub oak, green-leaf manzanita, mountain mahogany, buckbrush, and California buckeye. Herbaceous cover is sparse, including annual non-native grasses.

Extensive mixed oak woodlands occur at elevations above 1,000 feet surrounding Lake Oroville. At elevations below 1,000 feet, mixed oak woodlands occur on north and east facing slopes. These dense woodlands are composed of canyon live oak, black oak, and interior live oak. Other trees within the canopy include California bay, madrone, California buckeye, and big-leaf maple. Lower elevation woodlands are generally less dense and include foothill pine and blue oak. At higher elevations ponderosa pine, Douglas fir and incense cedar are common. The understory is characteristically dense, including red bud, green-leaf manzanita, mountain mahogany, deerbrush, sticky monkey flower, and poison oak.

Oak woodlands throughout the State support a diversity of wildlife species. Resident wildlife species expected within these habitats include the acorn woodpecker, northern flicker, wild turkey, plain titmouse, black-tailed jackrabbit, American crow, California quail, Bewick's wren, western fence lizard, coyote, and mule deer. Wildlife observed in the oak woodlands at Lake Oroville include the California ground squirrel, western gray squirrel, scrub jay, acorn woodpecker, and turkey vulture. Wildlife observed at the San Luis Reservoir include the western bluebird, white-breasted nuthatch, American kestrel, coyote, and mule deer. At the southern California reservoir sites, oak woodlands occur in isolated patches at scattered locations, and wildlife use is similar to the surrounding chaparral and coastal scrub habitats.

Annual Grassland. Extensive annual grasslands surround the San Luis Reservoir, integrating with blue oak woodlands on rolling terrain. Annual grasses provide the

dominant cover in this habitat, including wild oat, soft chess, red brome, and rat-tailed fescue. As these sites are not grazed, thatch is generally thick providing high quality cover for rodents and other small grassland species. Remnant stands of native grasses are common throughout the grassland habitat at scattered, undisturbed locations. Native grasses observed include purple needle grass, creeping wild rye, and onion grass. Shrub cover is uncommon within the grassland, however, isolated patches of quail bush, bush lupine, and coyote brush occur at scattered locations, providing perch sites, and both thermal and escape cover for many species of wildlife. Other plant species occurring within this habitat include short-podded mustard, telegraph weed, gum plant, tocalate, Russian thistle, naked stemmed buckwheat, Italian thistle, and narrow-leaved milk weed. Rock outcrops are common throughout the grassland.

Annual grasslands support a diversity of bird species, providing nesting or foraging cover. Bird species observed at the San Luis Reservoir site include the killdeer, loggerhead shrike, white-throated swift, ring-necked pheasant, American crow, rufous-crown sparrow, rock wren, and western meadowlark. Extensive grasslands also provide foraging habitat for many raptor species. The following raptors were observed foraging at the site: red-tailed hawk, American kestrel, Swainson's hawk, white-tailed kite, and northern harrier. Mammal species detected in the field at the reservoir by tracks, scat, or sight included the California vole, black-tailed jackrabbit, California ground squirrel, and coyote. Reptiles observed in the grassland habitat include the western rattlesnake, southern alligator lizard, and western fence lizard.

Developed/Disturbed. Disturbed habitat occurs at the shores of Silverwood, Pyramid, Castaic, and Perris Lakes. This habitat includes recreational, residential, and commercial land uses, such as picnic areas, well-maintained parks, marinas, parking lots, bait and snack shops, sidewalks and trails. Native vegetation within these areas has generally been replaced by non-native trees such as eucalyptus, tamarisk, and exotic pines and junipers.

Developed/disturbed areas are generally poor habitat for wildlife species. Quality of this habitat varies with level of disturbance and the amount of vegetation on the site. Landscaped or park areas provide moderate habitat for species adapted to disturbance such as the rock dove, scrub jay, American crow, common raven, mourning dove, house finch, raccoon, and Virginia opossum. More urbanized habitat, such as parking lots and bait shops, provide very limited habitat value.

Lacustrine. Lacustrine habitat includes the deepwater areas at all reservoir sites. Typically, the dominant plant species occurring in this habitat type are various forms of phytoplankton. Common adjacent habitats include riparian scrub and riparian forest habitats. Where freshwater emergent wetland occurs in association with the lacustrine habitats, these areas have been mapped as riparian. At the reservoir sites, freshwater emergent vegetation was uncommon, due to the continual fluctuations of water levels within the reservoirs. However, some freshwater emergent wetland is present at Elizabeth Canyon at Castaic Lake, where shallow sandy ledges and a high water table support hydrophytic vegetation. Intermittent and perennial tributaries of Pyramid, Castaic, and Silverwood Lakes support small isolated patches of freshwater emergent wetland habitat. Freshwater emergent wetland was not observed at either Lake Oroville or the San Luis Reservoir. When water levels are low, exposed shorelines are a common feature of the reservoirs, and include rocky, sandy or silty substrates. These areas are usually devoid of vegetation, but ruderal species occurs in some areas, including cocklebur, Bermuda grass, tree tobacco, and non-native annual grasses.

Lacustrine areas provide foraging habitat for a variety of bird species. Birds observed foraging in the southern California reservoirs include the belted kingfisher, Caspian tern, ring-billed gull, California gull, Clark's grebe, western grebe, great blue heron, and osprey. Bird species observed foraging over/in lacustrine habitats at Lake Oroville include the barn swallow, western grebe, and great blue heron. Bird species observed at the San Luis Reservoir include the California gull, pied-billed grebe, osprey, common egret, spotted sandpiper and killdeer. Other birds expected in this habitat include double-crested cormorant, bald eagle, white-throated swift, cliff swallow, violet-green swallow, northern rough-winged swallow, and various tern, loon, and waterfowl species. Lacustrine habitat provides foraging and resting habitat for migrating waterfowl such as teal, northern shoveler, pintail and Canada geese.

6.3 Special Status Species of the Project Area and the State Water Project

Introduction

Prior to beginning the EIR/EIS process, DWR and BOR requested information from the resource agencies on special status species which occur within the project area. In

addition, searches of the CNDDB and the CNPS *Electronic Inventory* resulted in several species which are known to occur within the Delta. The following is a discussion of special status species that occur within the Project Area and/or SWP and are not expected to be affected by the construction or operation of ISDP. Species which may be affected by the project are discussed in detail in Section 10 of the EIR/EIS.

The following discussion of special status species is based on extensive literature review, field reconnaissance to identify habitats, the experience of ENTRIX staff, a search of the CNDDB and CNPS *Electronic Inventory*, and consultation with agency specialists. The focus of this discussion is on those species designated as Rare, Threatened, or Endangered by the CDFG and USFWS. Additionally, those species designated Category 1 Candidates for federal listing are analyzed in more detail, than other special status species.

Plants

Antioch Dunes Evening-primrose (*Oenothera deltoides* ssp. *howellii*). The Antioch Dunes evening-primrose occurs on inland stabilized dunes along remnant river bluffs and sand dunes. The distribution of this species includes seven occurrences within the Delta and the San Pablo/Suisun Bay area. Several successful replanting projects have resulted in populations along New York Slough and on Brannan and Browns islands (CNDDB 1994). Because the Antioch dunes evening-primrose occurs in upland areas of the Delta at sites well removed from the Project sites, it is not expected to be affected by the construction or operation of the ISDP.

Contra Costa Goldfields (*Lasthenia conjugens*). This annual species occurs in vernal pools, seasonal wetlands, and mesic grasslands surrounding the Delta and Suisun Marsh. These habitats are not hydrologically connected to the waterways of the Delta, and, therefore, are not expected to be affected by water fluctuations associated with the implementation of the ISDP.

Contra Costa Wallflower (*Erysimum capitatum* ssp. *angustatum*). This perennial herb occurs on stabilized dunes within the San Pablo-Suisun Bay area. This species is only known from the Antioch Dune National Wildlife Refuge, which has been designated as the Critical Habitat pursuant to the federal Endangered Species Act (Skinner and Pavlik 1994a). Contra Costa wallflower occurs in areas well removed from the Project sites that

not subject to tidal influences, and, therefore, is not expected to be affected by the construction and operation of ISDP.

Delta Coyote Thistle (*Eryngium racemosum*). Delta coyote thistle is a perennial herb that occurs on floodplains associated with riparian scrub habitats and clay soils. The distribution of the Delta coyote thistle includes the eastern Delta and along the lower San Joaquin River (MGA 1993b). Historical occurrences from the Delta indicate that this species once occurred within the south Delta, however these occurrences are now extirpated (CNDDB 1994). Extensive surveys of the south Delta did not locate any populations of Delta coyote thistle (MGA 1993a). Therefore, Delta coyote thistle is not expected within the south Delta.

Northern California Black Walnut (*Juglans californica* ssp. *hindsii*). This deciduous tree is common to urban and agricultural areas throughout the Central Valley. Concerns for the protection of the original stands of black walnut in Sacramento, Napa, and Yolo counties led to the listing of this species as a federal candidate (Category 2). One sapling was observed in the riparian forest near the proposed Grant Line barrier (Figure 11-3).

Before European settlement in California, northern California walnut trees occurred on high terraces associated rivers and creeks. With the settlement of California, many of these trees were used for lumber (CNDDB 1994). Additionally, settlers introduced the eastern black walnut and the English walnut to California. Both of these other species form fertile hybrids with the native black walnut. In the following years, the genetic stock of the native walnuts was contaminated with the introduced genes. Stands of genetically clean black walnuts are only known from Mt. Diablo (Contra Costa County) and Capell Creek (Napa County) (Fuller 1978). The black walnuts of the Delta are generally believed to include genetic material from both English and eastern black walnut (Heather Townsen pers. comm.). For these reasons, implementation of the ISDP is not expected to result in significant impacts on populations of northern California black walnuts.

Palmate-bracted Bird's-beak (*Cordylanthus palmatus*). Palmate-bracted bird's-beak occurs in alkaline habitats from Alameda, Yolo, and Colusa counties. Suitable habitats for this species include alkali grassland and iodine bush scrub (CNDDB 1994). Extensive surveys of these habitat types in the Byron Tract area did not located populations of palmate-bracted bird's-beak. Both of these habitats are not associated

with the waterways of the Delta, and, therefore, are not expected to be affected by the implementation of the ISDP.

Soft Bird's-beak (*Cordylanthus mollis* ssp. *mollis*). This annual hemiparasitic herb is known from scattered populations in coastal salt marshes. Populations within the SWP are known form the Benicia State Park, Hastings Slough, Point Pinole, Suisun Marsh (Joyce Island), Suisun Bay (Middle Point), Hill Slough and Grizzly Island (CNDDB 1994). These populations are well removed from the ISDP project sites, and are not expected to be affected by the operation of ISDP.

Suisun Thistle (*Cirsium hydrophilum* var. *hydrophilum*). This perennial herb is known from three populations restricted to Suisun Marsh, where this species occurs in saltmarshes with halophytic vegetation, including saltgrass, pickleweed, and alkali heath. This plant may rely on disturbance for population recruitment (CNDDB 1994). Project operations are not expected to affect these populations.

Invertebrates

Lange's Metalmark Butterfly (*Apodemia mormo langei*). Lange's metalmark butterfly is endemic to the stabilized dunes along the San Joaquin River within the Antioch Dunes area, where it feeds on nectar from several species of wildflowers including its primary host plant wild buckwheat (*Eriogonum nudum* var. *auriculatum*) (CNDDB 1994). Because these populations are well removed from the ISDP project sites and project operations will not affect the habitat for this species, implementation of ISDP is not expected to have an effect on Lange's metalmark butterfly.

San Joaquin Dune Beetle (*Coelus gracilis*). San Joaquin dune beetle occurs in the sandy substrates of the fossil dunes along the western edge of the San Joaquin Valley. The Antioch Dunes is the type locality of this species where it was last observed in 1974. The San Joaquin dune beetle is now considered extirpated at this site due to habitat alteration (CNDDB 1994).

Fairy Shrimp. Three fairy shrimp, conservancy fairy shrimp (*Branchinecta conservatio*), longhorn fairy shrimp (*Branchinecta longiantenna*), and vernal pool fairy shrimp (*Branchinecta lynchi*), occur in swales and seasonal castatic vernal pools, that is, pools that fill and redry one or more times in any given year. The Delta lies within the

documented range of these species and although there is a lack of preferred soil (hardpan or claypan) on the Delta islands, fairy shrimp may occur within the ephemeral vernal swales and pools at the west margin of the Delta. Fairy shrimp have been located in cultivated fields within the region, therefore the possibility does exist for the occurrence of these species in the grasslands and even drainage ditches within the SWP, particularly on Byron Tract (MGA 1993a). These habitats on Byron Tract were surveyed in 1993 and these species of fairy shrimp were not found (Harold Freeman pers. comm.). The ISDP has been redesigned from earlier plans to avoid these habitats.

Vernal Pool Tadpole Shrimp (*Lepidurus packardi*). The vernal pool tadpole shrimp is associated with ephemeral vernal pool habitats in isolated locations in the Sacramento Valley, from the Vina Plains in Butte County south to the Sacramento area and west to Jepson Prairie in Solano County. Although the Delta lies just outside the documented range of this species and no populations are known to occur in the south Delta, its wide tolerance of habitat types and proximity to the ISDP area suggests its occurrence is possible, especially on Byron Tract (MGA 1993a). The seasonal wetland habitats on Byron Tract were surveyed in 1993 and no vernal pool tadpole shrimp were found (Harold Freeman pers. comm.). The ISDP has been redesigned from earlier plans to avoid these habitats.

Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*). The Valley elderberry longhorn beetle (VELB) occurs throughout the Central Valley from Redding to Bakersfield, and is closely associated with elderberry shrubs (*Sambucus* species) that provide habitat for all stages of its life cycle. Both the blue elderberry (*Sambucus mexicana*) and red elderberry (*Sambucus racemosa* var. *microbotrys*) are used by the VELB without distinct preference (MGA 1993a).

Female beetles lay eggs on the exterior of elderberry stems of one inch or more in diameter. Typically the VELB chooses a stem with a diameter of 2 to 8 inches. After emerging from the egg, the VELB larvae enter the stem of a host elderberry. After developing within the stem, the VELB pupates into an adult and emerges, leaving an exit hole. Adults use the elderberry hosts for resting, foraging, and mating (MGA 1993a).

Elderberries commonly occur throughout the south Delta associated with riparian understory and occasionally as isolated shrubs in open areas, such as cropland, grassland,

or ruderal habitats. No elderberries occur at any of the specific project site locations. Therefore, VELBs are not expected to occur within the Project Area.

Amphibians

California Red-legged Frog (*Rana aurora draytonii*). Historically, the California red-legged frog occurred over much of California, including the Coast Ranges, Central Valley, and, possibly, the southern Sierra Nevada. Currently, isolated populations of California red-legged occur at scattered locations within the historical range, limited to the Coast, Transverse, and Peninsular ranges.

California red-legged frog requires dense riparian vegetation of several forms. Emergent herbaceous vegetation such as cattails and bulrushes provide areas of escape and points of attachment for eggs (Stebbins 1985). Woody vegetation, such as willows, provides cover as protection and shade that maintains lower water temperatures. California red-legged frogs are typically not found in areas where these habitat elements are absent (Jennings and Hayes 1992). Seasonal flooding, competition with introduced bullfrogs, and predatory game fish preclude California red-legged frog from the Delta (MGA 1993a). Therefore, California red-legged frogs are not expected in the Delta. Within the SWP Service Area, California red-legged frogs occur in Piru Creek at Pyramid and Castaic Lakes (Cathy Brown pers. comm.). Operations in Piru Creek are not expected to change with the implementation of ISDP. Implementation of the ISDP is not expected to affect California red-legged frogs.

Arroyo Toad (*Bufo micoscaphus*). The arroyo toad is known from five drainages and several small scattered populations occurring along the central and south coast. Populations are known from Santa Barbara, Ventura, Los Angeles, and San Diego Counties. Historically, populations were known from San Luis Obispo County. Individuals have been recently sighted in Orange, Riverside, San Bernardino, and Imperial counties. The arroyo toad is restricted to rivers that have shallow gravelly pools adjacent to sandy terraces, with little or no emergent vegetation. Pools are required for breeding and larval development. Adult toads dig burrows into the sandy terraces. Toads may forage for insects in adjacent riparian habitat (USFWS August 3, 1993).

Within the SWP, the arroyo toad is known to occur within Piru and Castaic Creeks at Pyramid and Castaic Lakes. These populations are confined to the tributaries and are not

expected within Pyramid and Castaic Lakes. The survival of the Piru Creek population is dependent on water releases from Pyramid Lake (Cathy Brown pers. comm.). Water releases from Pyramid Lake are scheduled to mimic natural conditions with peak flows during the winter, coinciding with the rainy season. These water deliveries can be maintained with or without the implementation of ISDP (Jim Mason pers. comm.). Therefore, implementation of the ISDP would have no affect on these populations of arroyo toad.

Tehachapi Slender Salamander (*Batrachoseps stebbinsi*). This species occurs chiefly in moist canyons and ravines in oak or mixed pine-oak woodlands. Populations of Tehachapi slender salamanders are found scattered throughout the Tehachapi Mountains generally at elevations of 2,000-4,600 feet. Although Pyramid and Castaic Lakes are within the documented geographic range of this species, the elevations of these reservoirs 2,578 feet and 1,515 feet, respectively, may be too low. The general absence of suitable habitat also probably excludes this species from these southern California reservoir sites. Therefore, project operations are not expected to affect habitat for this species.

Reptiles

Southern Rubber Boa (*Charina bottae umbratica*). The southern rubber boa occurs in pine forests near streams and meadows from Mount Pinos and the San Bernardino, San Jacinto, Greenhorn, and Tehachapi Mountains (CNDDB 1994). Suitable habitat may be found in the hills in the vicinity of Silverwood Lake, and possibly near Lake Perris. Changes in reservoir operations are not expected to affect stream or meadow habitats which support this species.

Alameda Whipsnake (*Masticophis lateralis euryxanthus*). This species is primarily associated with chaparral habitat, but may also occur in grasslands, open woods, on rocky slopes, and along open streams and arroyos. The geographical range of the Alameda whipsnake is limited to Alameda and Contra Costa counties, and populations are known from the foothills west of the Clifton Court Forebay (CNDDB 1994). The Alameda whipsnake is not expected to occur within the low-lands of the Delta.

Birds

California Brown Pelican (*Pelecanus occidentalis californicus*). The California brown pelican occurs along the California coast and in coastal estuarine habitats. Within California, nesting occurs on the Channel Islands. The brown pelican occurs occasionally on the Salton Sea, however they are not regular visitors to inland waters. Within the SWP, California brown pelicans may forage in San Pablo and Suisun Bays (ABAG 1991). Changes in project operations are not expected to cause substantial changes in these areas, therefore, California brown pelicans are not expected to be affected by implementation of the ISDP.

Aleutian Canada Goose (*Branta canadensis leucopareia*). The Aleutian Canada goose nests on islands of the Alaska Peninsula and Aleutian Archipelago. The Central Valley is the main wintering grounds for this species, where they forage mainly on green shoots and seeds of cultivated grains, wild grasses, forbs, and aquatic plants (Zeiner et al. 1990a). Considering the presence of croplands on Victoria Island and in the vicinity of several of the proposed ISDP sites, Aleutian Canada geese may be found scattered throughout the Project Area during the winter months. Aleutian Canada geese are known to winter in the Delta, on Staten Island (Miriam Green pers. comm.). During winter months, these Canada geese may forage or rest in any cropland habitat throughout the Delta. The wide spread nature of these sightings suggest that suitable foraging and resting habitat is abundant while these birds are migrating through the Delta. Therefore, the implementation of the proposed project is not expected to affect these populations. Flocks of Aleutian Canada geese also winter in the grassland habitats surrounding the San Luis Reservoir (CDFG and CDWR 1989). Operation of ISDP would not affect these populations.

California Condor (*Gymnogys californianus*). The California condor is the largest land bird in North America. California condors were formally widespread in western North America from British Columbia south to Baja California. However, by the early 1980's their range had been reduced to mountain and foothill grasslands and forest habitats from northern Los Angeles County, northward through the Coast Ranges to San Luis Obispo County and northward through the western Sierra Nevada to Tulare County where they foraged on carrion. By the late 1970's, the population plummeted to 25-35 individuals (CDFG 1991).

The decline of this species was so rapid that in 1987 the last remaining 27 birds were trapped for captive breeding. By 1991 the captive population increased to 52. In 1992 two captive-hatched birds were released in the Sespe Condor Sanctuary in Los Angeles County, but due to complications they were returned to captivity. Current reintroduction efforts focus on northern Santa Barbara County where three condors have been released and more releases are planned (Ron Jurek pers. comm.). Pyramid and Castaic Lakes are adjacent to the Sespe Condor Sanctuary. However, since the current population has been removed from the Sanctuary, the presence of this species in the project region is unlikely in the near future.

White-tailed Kite (*Elanus caeruleus*). The white-tailed kite is a resident species commonly inhabiting grasslands and cultivated bottomlands with scattered trees. White-tailed kites require partially open foraging habitat, such as cropland and grassland, and trees for roosting and nesting. This species nests in oak, willow, cottonwood, and sycamore trees (Bent 1937). Cropland adjacent to riparian forests provides abundant feeding areas; therefore, management of this species should include the preservation of woodland trees for successful breeding and resting areas. White-tailed kites are frequently observed foraging over the croplands and grasslands in the south Delta, including the Project Area, at the site of the proposed Old River flow control structure.

White-tailed kites are known to occur throughout California, and were observed at the San Luis Reservoir. Kites are expected to forage and nest at most SWP sites, including the Delta, along the Sacramento and Feather rivers, San Pablo-Suisun Bay area, Suisun Marsh, and at all reservoir sites. While the construction of ISDP may affect raptors (see Section 10.3.4 of the EIR/EIS), the implementation of ISDP is not expected to affect regional populations of white-tailed kites.

Bald Eagle (*Haliaeetus leucocephalus*). The bald eagle is primarily a wintering species throughout California at lakes, reservoirs, rivers, some range lands, and coastal wetlands. The breeding range in California is restricted to the northern one-third of the state in mountainous aquatic habitats; however, in recent years some pairs have nested in southern California. The reasons for historical population declines have been identified as development, agriculture, pesticides and contaminants, timber harvest activities, off-road vehicles and shooting. Through management efforts the breeding population is increasing and the wintering population appears to have stabilized at about 1,000 birds (CDFG 1991).

Bald eagles feed on fish, waterfowl, and carrion. This species could be attracted to any of the reservoir sites as feedings and resting areas during winter. Additionally, Lake Oroville supports a population of nesting bald eagles (Eric See pers. comm.). At the San Luis Reservoir, a small wintering roost occurs south of the reservoir (CDFG and CDWR 1989). These birds are expected to hunt over the reservoir during the winter months. Reservoir operations are not expected to affect these populations of bald eagles.

Golden Eagle (*Aquila chrysaetos*). The golden eagle is a California Fully Protected species occurring throughout the State. Golden eagles are generally a resident species. However, some individuals migrate up-slope to the Sierra Nevada for the nesting season and down-slope to the Central Valley for the winter (Zeiner et al. 1990a). The golden eagle may occur as a winter visitor in the Delta and along the Feather and Sacramento Rivers. While the construction of ISDP may affect raptors (see Section 10.3.4 of the EIR/EIS), the implementation of ISDP is not expected to affect regional populations of golden eagles. At the reservoir sites, golden eagles were not observed, but they may utilize these sites as for foraging during the winter or summer. The changes is operations are not expected to affect regional populations of golden eagles.

American Peregrine Falcon (*Falco peregrinus anatum*). The American peregrine falcon is an opportunistic forager and feeds primarily on a variety of birds, but occasionally takes mammals, insects and fish. The most important habitat requirements for peregrines are the availability of ledges and cliffs for cover, and large, high cliffs above water for nesting (MGA 1993a).

The historic breeding range of peregrines extended from Mexico to Alaska. Presently, the breeding range in California includes the coast, Channel Islands, inland north coastal mountains, and the Cascade, Klamath, and Sierra Nevada ranges (MGA 1993a). Peregrine falcons winter in and migrate through much of California, including the Central Valley (Zeiner et al. 1990). Peregrines occasionally may feed on shorebirds in the Delta during spring and fall migrations (MGA 1993a). American peregrine falcons are expected as an occasional and transient visitors within the SWP (Delta, Feather and Sacramento rivers, and SWP reservoirs). Peregrine falcons may occur more frequently over the San Pablo-Suisun Bay areas, as these areas are within the nesting range of this species (Zeiner et al. 1990a). Peregrines are known to hunt in the area of the San Luis Reservoir (CDFG and CDWR 1989.). Project operations within the SWP are not expected to affect these populations of peregrine falcon.

California Clapper Rail (*Rallus longirostris obsoletus*). The California clapper rail is restricted to tidal salt and brackish marshes, especially those containing abundant invertebrate populations in tidal sloughs (Gill 1979).. Clapper rails forage for estuarine and terrestrial invertebrates primarily in tidal sloughs. The primary nesting habitat occurs in low elevation cordgrass marsh within 10 meters of tidal channels. The upper marsh habitat is also critical for survival, as this area provides cover from predators during high tides (Shellhammer and Harvey 1984). Within the SWP, the highest concentrations of clapper rails occur in west and north San Pablo Bay, especially near the Napa River, and in Suisun Bay (CDFG 1991; 1994). The operation of ISDP is not expected to result in a substantial change to Suisun Marsh habitat, therefore implementation of this program is not expected to affect the California clapper rail.

As with the black rail, the lack of suitable habitat at the southern California reservoir sites most likely excludes clapper rails from the area. Therefore, it is doubtful that this species would occur at any of the southern California reservoir sites.

California Black Rail (*Laterallus jamaicensis coturniculus*). As discussed previously, California black rails occur within the Delta in dense emergent vegetation, where they forage and nest in dense stands of cattails and bulrushes. Nests consist of small sticks built at ground level or elevated slightly in the vegetation. Black rails feed on insects and other small arthropods on the mud surface or vegetation. Black rails also occur in the saltmarsh habitat throughout the San Francisco Bay, including San Pablo Bay, Suisun Bay, and Suisun Marsh (CNDDB 1994). Because the operation of ISDP is not expected to result in substantial changes to marsh habitat throughout the Delta and Suisun Marsh, implementation of ISDP is not expected to affect California black rail populations.

Other populations of black rails are known from San Diego, San Luis Obispo, and Imperial counties. Within the southern California portion of the SWP, very few locations exist with suitable habitat at the southern California reservoir sites. This species is not expected at any of the reservoir sites in the region due to lack of suitable habitat.

Greater Sandhill Crane (*Grus canadensis tabida*). Greater sandhill cranes are known to nest in wet meadow and emergent wetland habitats in Oregon and California. Within California, cranes are known to nest in Lassen, Modoc, Plumas, Shasta, Sierra, and Siskiyou counties. Wintering grounds occur throughout the Central Valley, where greater sandhill cranes congregate with the lesser sandhill cranes in flocks, reaching several

thousand birds. Within the Central Valley, cranes winter in areas with expanses of shallow water for evening roosting in the vicinity of cropland and grassland used for foraging and loafing (CDFG 1991). Within the Delta greater sandhill cranes are known to winter in several locations, and may forage in the cropland habitats at the dredge disposal sites. Greater sandhill cranes are migratory birds that arrive in the Central Valley by late September. The grain fields on the eastern side of the Delta provide critical wintering habitat for this species. The wintering population of greater sandhill cranes in the Central Valley consists of approximately 3,000-3,500 birds. The largest concentrations occur just south of Thornton in San Joaquin County, and in Butte County, near Chico. Substantially smaller populations winter in Stanislaus, Merced, and Tulare counties.

Greater sandhill cranes prefer shallow water habitats for nocturnal roosting. Within the roosting area greater sandhill the cranes prefer areas with low vegetation and they generally avoid trees or tall vegetation. According to Walkinshaw (1973) there are several essential features for successful wintering grounds: (1) there must be large stretches of shallow water where the cranes can roost at night and get drinking water by day; (2) the birds prefer regions adjacent to the night roost area where they can go in the early morning to loaf for 15 to 20 minutes; (3) there must be feeding grounds within 12 to 18 miles of the roosting area; (4) there must be little disturbance in the roosting region; and (5) a temperate climate is preferred. Within the SWP, sandhill cranes are known to winter in the east Delta (MGA 1993a), and in the grassland habitats near the San Luis Reservoir (CDFG and CDWR 1989). Within the Delta, greater sandhill cranes may occur at scattered locations throughout the Delta. Construction of the ISDP facilities is not expected to affect the greater sandhill crane.

Western Snowy Plover (*Charadrius alexandrius nivosus*). This small shorebird is a year-round resident of coastal areas and estuaries that nests on sparsely vegetated, sandy to gravelly beaches, alkali lakes, and salt ponds. Populations located along the coast of California have been designated as Threatened by the USFWS. Populations occurring at inland locations are designated as Candidates for federal listing (Category 2). Within the SWP western snowy plovers nest on the shores of north San Pablo Bay, this population is designated as federally Threatened. Project operations would not affect this population.

California Least Tern (*Sterna antillarum browni*). The California least tern winters in Latin America, returning each spring in April to coastal locations in California to nest in

colonies. Within California, the nesting habitat includes bare or sparsely vegetated substrates near the coast, ranging from the San Francisco Bay to Baja. These terns nest in colonies usually on beaches, coastal wetlands, close to estuaries, bays, or harbors, where fish are abundant (CDFG 1991). Within the SWP, California least terns nest and forage in San Pablo and Suisun Bays, and the Suisun Marsh (ABAG 1991). Project operations would not affect this species.

Western yellow-billed Cuckoo (*Coccyzus americanus occidentalis*). This migratory species winters in South America; migrates through Mexico, El Salvador, and Costa Rica; and nests in riparian habitat throughout the United States west of the Rockies. Locally, the cuckoo generally arrives by late May and departs by late September. Nesting generally begins around mid-June and continues through mid-July, but considerable variation may occur depending upon arrival and food availability. Within California, cuckoos nest as far north as Tehama County. Other nesting locations include Butte County along the Sacramento River; in Sutter and Yuba counties along the Feather River; in Kern County along the Kern River, at scattered locations in the Mojave desert; at the Parado Basin in Riverside and San Bernardino counties, and along the Colorado River (MGA 1993a).

Suitable nesting sites occur within extensive riparian forest with a dense understory of willow, cottonwood, box elder, white alder, nettle, wild grape, and cattail. Proximity to sloughs, lakes, and marshy areas also is important. The nests are generally 5 to 15 feet up and consist of small sticks and twigs (Gaines 1974, 1977, 1978). Laymon (1980) noted that nests are constructed on horizontal branches; however, this type of branch configuration is missing in many riparian associations. Successful nesting in walnut orchards indicates that the horizontal branching requirement can also be met in orchards.

Within the Delta, the occurrence of this species is restricted to areas of suitable riparian forest or orchards. The CNDDB lists one historical sighting of western yellow-billed cuckoos from the Delta and indicates that this population has been extirpated (CNDDB 1994). Due to fragmentation of riparian habitat within the Delta, extensive stands of riparian forest are not available to support nesting western yellow-billed cuckoos.

Because this species migrates through California in the fall and spring, western yellow-billed cuckoos may occur as transient visitor at scattered locations near the southern California reservoir sites. Lake Perris, in particular, has a well-developed willow riparian

forest along portions of the shore that could be utilized by western yellow-billed cuckoo during migration.

Within the SWP, western yellow-billed cuckoos may nest where extensive stands of riparian forest occur along the Sacramento and Feather rivers. The CNDDB reports four sightings of western yellow-billed cuckoos along the Feather River. The operation of ISDP is not expected to cause changes which would affect yellow-billed cuckoos or riparian habitats.

Bank Swallow (*Riparia riparia*). The bank swallow is a migratory species that winters in South America and breeds in much of North America. Although the species has never been very abundant in California, has it nested historically from the upper Sacramento Valley and Coast Ranges to southern California. The largest populations now occur along the Sacramento River between Redding and Colusa (CDFG 1991).

In order to nest, bank swallows require vertical cliffs or banks that contain sandy or loamy layers in which they can dig nesting burrows. Suitable nesting habitat occurs within the Delta, but no bank swallows colonies are known from this area. Locations of suitable habitat include Eucalyptus Island and along the east end of the Grant Line-Fabian Canal. Construction and operation of ISDP is not expected to affect these areas.

Within the SWP, bank swallows are known to occur along the Feather River, where the CNDDB reports 19 locations of bank swallow nesting colonies from mile 2.5 to mile 54 along the river. The operation of ISDP is not expected to affect nesting habitat for these birds.

California Gnatcatcher (*Polioptila californica*). This species occurs in coastal sage scrub habitats at elevations up to 1,000 feet above sea level. Gnatcatchers are known from the south coast region, including Los Angeles, Orange, San Diego, and portions of Ventura, San Bernardino, and Riverside counties. Within the SWP, coastal sage scrub habitat surrounds the southern California reservoirs. However, these sites are above 1,000 feet, and gnatcatchers are not expected in these habitats.

Least Bell's Vireo (*Vireo bellii pusillus*). Least Bell's vireo is a migratory songbird that was once widespread in the Central Valley and at low elevations throughout riverine valleys in California. The least Bell's vireo is a summer resident, breeding in early

succession riparian scrub habitats including willow-cottonwood forests, oak woodlands, shrubby thickets and dry washes (CFDG 1991; USFWS undated). Least Bell's vireos forage for insects in the dense lower strata in riparian habitats, which emphasizes the importance of dense continuous shrubby vegetation from the ground to canopy layer (Franzreb 1989). Noticeable declines of this species were reported in the 1940s when population decreases were documented in parts of southern California, and Sacramento and San Joaquin Valleys (Grinnell and Miller 1944; Goldwasser et al., 1980). Currently, the major remnant populations are located in Monterey, San Benito, Santa Barbara, Riverside, Ventura, and San Diego counties southward into northwestern Baja (CDFG 1991; Franzreb 1989). A small population of least Bell's vireo occurs along the Santa Clara River located approximately 10-20 miles south of Castaic and Pyramid Lakes (RECON 1990). There is a possibility that vireos could occur along streams and shorelines associated with reservoirs with suitable riparian habitat at these reservoir sites. Changes in reservoir operations at Castaic and Pyramid Lakes are not expected to affect Least Bell's vireos or their suitable habitats.

Mammals

Suisun Ornate Shrew (*Sorex ornatus sinuosus*). This endemic species occurs in tidal and brackish marshes along the northern shores of San Pablo and Suisun Bays, extending westward to Sonoma Creek and Napa Creek and eastward to Grizzly Island, including Suisun Marsh, Cordelia Marsh, Sears Pt. Marsh, Southampton Bay, White Slough, South Slough, Dutchman Slough, and Mare Island (CNDDB 1994; Williams 1983, 1986; Rudd 1955). Suisun shrews generally inhabit tidal marshes characterized by California cordgrass, pickleweed, and marsh grindelia; and brackish marshes dominated by California bulrush and common cattail (Williams 1983, 1986; Rudd 1955). The primary habitat structure is dense low-lying vegetation where invertebrates are abundant. This habitat structure, not species composition, is the determining habitat feature for Suisun shrews. Driftwood and other litter above the mean high tide line also play a role in providing essential nesting and foraging habitat.

Uplands contiguous with marshlands are essential high tide refugias. These areas must provide adequate food and cover to sustain shrews during prolonged flooding periods (Rudd 1955). The importance of upland and transitional habitats was demonstrated by Hadaway and Newman (1971) when they found that Suisun shrews were usually trapped at the interface between pickleweed marshes and upland vegetated levees dominated by

grasses. Johnston and Rudd (1957) reported that Suisun shrews are probably similar to salt-marsh wandering shrews in their requirements for marshlands that are not regularly flooded (6 to 8 feet above sea level). The operation of ISDP is not expected to affect known populations of Suisun ornate shrew.

Salt-marsh Wandering Shrew (*Sorex vagrans halicoetes*). Salt-marsh wandering shrew occurs in the middle to upper elevations in tidal salt marshes dominated by pickleweed that are not inundated on a regular basis. The species requires continuous high levels of moisture and cannot live in the highest marsh levels that are too dry. Lower areas that are dominated by cordgrass and inundated daily do not provide suitable habitat. As a result the species is restricted to a narrow portion of the Bay salt marshes, primarily in San Pablo, Suisun, and San Francisco Bays (CDFG 1991). Operation of ISDP is not expected to affect population of salt-marsh wandering shrew.

Riparian Brush Rabbit (*Sylvilagus bachmani riparius*). This species occurs along the banks of the San Joaquin River, associated with the dense riparian thickets of wild rose, willows, and blackberries (Williams 1986). The historic range of the species extended along the San Joaquin and Stanislaus rivers from Stanislaus County to the Delta region. The only presently known population is found on the lower Stanislaus River in Caswell State Park near Manteca. Other small, isolated colonies may reside in suitable riparian habitat between Caswell State Park and the confluence of the San Joaquin and Stanislaus rivers (Williams 1986). The amount of suitable riparian vegetation present within the SWP is limited, and the entire area is more than 20 miles from the only known riparian brush rabbit population. Unless individuals occur within the remaining riparian scrub vegetation along the remote sloughs of the San Joaquin River, the presence of this species within the Delta is very unlikely (MGA 1993a).

Stephen's Kangaroo Rat (*Dipodomys stephensi*). This species inhabits annual grassland with sparse perennial vegetation in the San Jacinto Valley and adjacent areas of western Riverside, southwestern San Bernardino, and northwestern San Diego counties, where it retreats to burrows during the day and feeds at night primarily on seeds. Within the SWP this species occurs from Lake Perris to the eastern side of San Jacinto Valley. The major threat to the Stephen's kangaroo rat is habitat destruction and degradation (CDFG 1991). Changes in reservoir operations are not expected to affect habitat for this species.

Salt-marsh Harvest Mouse (*Reithrodontomys raviventris*). This species is restricted to salt marshes in San Francisco, San Pablo, and Suisun Bays (CNDDB 1994). The preferred habitat of the salt-marsh harvest mouse has a thick continuous cover of vegetation (100 percent) composed of greater than 60 percent pickleweed along with a diverse assemblage of other marsh plant species, including fat hen and alkali heath. Additionally, the habitat value of pickleweed increases with height and density (Harvey and Stanley Associates 1980).

A secondary habitat of upper marsh vegetation is essential during high tides when lower tidal vegetation is inundated. The upper zone peripheral halophytes found in this important area include alkali health, salt grass, jaumea, and California sea lavender. Very high winter tides may force salt-marsh harvest mice into surrounding grasslands. If such upper habitat is not available, mice experience a high causality rate due either to predation or drowning. Operation of ISDP is not expected to affect populations of the salt-marsh harvest mouse.

Ringtail (*Bassariscus astutus*). The ringtail is a resident species of low and middle elevation riparian forest and shrub habitats throughout California, except for the arid portions of the San Joaquin Valley. Ringtails nest in hollow logs, trees, or snags; cavities in talus and rocky outcrops; and occasionally in abandon burrows or woodrat nests. These animals are primarily carnivores, but also eat fruit, nuts, and carrion. This species is nocturnal, foraging on the ground and in trees, usually near water (Ziener et al. 1990b). Within the SWP, ringtails are expected in mature riparian habitats along the Feather and Sacramento rivers, and in the Delta on high terraces safe from flooding. Ringtail are also expected at all reservoir sites. Construction and operation of ISDP is not expected cause significant impacts on local populations of ringtail.

6.4 Biological Resources of the SWP Service Area

Introduction

The following is a description of the terrestrial biological resources of the SWP service area which includes 18 counties in California that receive a portion of their water supply from the SWP. These counties include Alameda, Butte, Imperial, Kings, Kern, Los Angeles, Napa, Orange, Plumas, Riverside, Santa Barbara, San Bernardino, San Diego, Santa Clara, San Luis Obispo, Solano, Stanislaus, and Ventura. These descriptions include general vegetation and wildlife habitats, special status animals, and special status

plants. To facilitate these descriptions the 18 counties have been grouped into seven regional service areas based on the similarity of habitat types and species composition. (Other discussions of the service area describe the these regions based on different geographic arrangements.)

Northern Sacramento Valley Service Area

Vegetation and Wildlife Habitat

Butte and Plumas counties compose the Northern Sacramento Valley Service Area (Figure 6-1). Habitats within this area include foothill woodland, riverine, coniferous and deciduous forests, grasslands, chaparral, seasonal and permanent wetlands, and agricultural lands. Within the Service Area, the foothills, marshlands, and riparian habitats associated with the Feather and Sacramento Rivers are identified as important biological resources. These habitats support 10 listed species of wildlife and five listed plant species. Additional information on these listed species and other special status species is listed in Table 6-1.

Special Status Wildlife

Within this area, suitable nesting habitat for the bald eagle occurs on large lakes, such as Lake Almanor and Lake Oroville. Bald eagles also maintain several winter roost sites within the Service Area. Generally these are in close proximity to winter waterfowl habitat, which provide hunting grounds for the wintering population of bald eagles. During the spring and summer, agricultural portions of this Service Area adjacent to riparian areas provide foraging and nesting habitat for the state-threatened Swainson's hawk. Within the Service Area a small population of greater sandhill cranes nests in Plumas County in wet meadow habitats. During the winter, cranes forage in cropland and grassland areas on the valley floor. Riparian habitat within Butte and Plumas counties provides nesting habitat for both the state-endangered western yellow-billed cuckoo and willow flycatcher and, where these areas support elderberries, the federally threatened valley elderberry longhorn beetle. The banks of the Sacramento and Feather rivers provide nesting habitat for the state-threatened bank swallow. Freshwater emergent wetland on the valley floor provides habitat for the federally threatened giant garter snake. High-elevation portions of Plumes County provide habitat for two state-threatened mammals, the Sierra Nevada red fox and the California wolverine. Additional information regarding these species and other special status wildlife of the Northern Sacramento Valley Service Area is listed in Table 6-1.

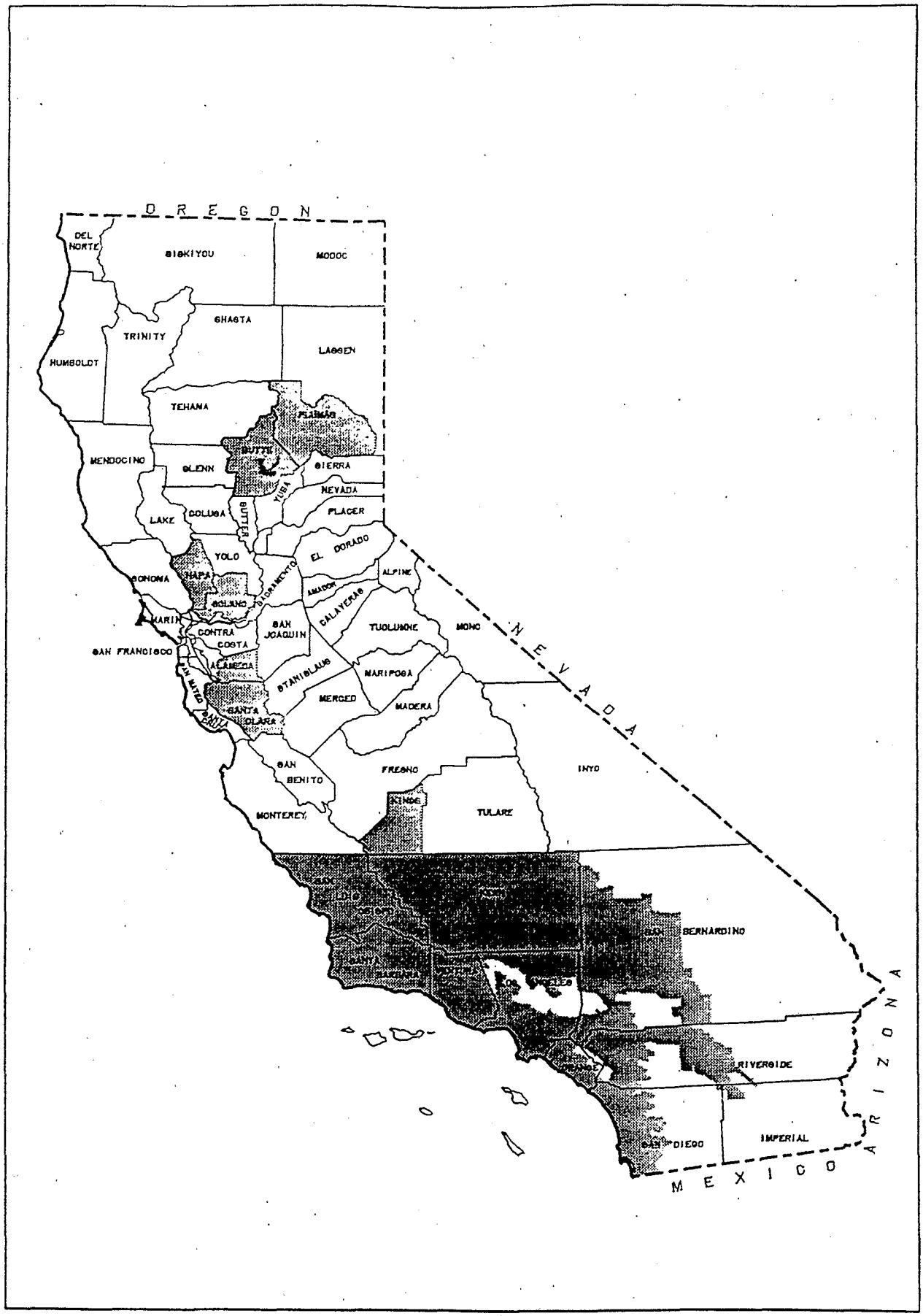


Figure 6-1. State Water Project Service Areas.

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Plants				
San Diego thorn-mint *Acanthomintha ilicifolia*	CE	PE	Chaparral, coastal scrub, valley-foothill grassland; and vernal pool	San Diego County.
Munz's onion *Allium munzii*	CT	PE	On clay soils in chaparral, cismontane woodland, pinyon-juniper woodland, and valley-foothill grassland	Riverside County.
Large flowered fiddleneck *Amsinckia grandiflora*	CE	FE	Cismontane woodland and valley-foothill grassland	Alameda County.
Hearst's manzanita *Arctostaphylos hookeri ssp. hearstiorum*	CE	none	Maritime chaparral, coastal prairie, coastal scrub and valley-foothill grassland	San Luis Obispo County.
Pallid manzanita *Arctostaphylos pallida*	CE	PT	On siliceous shale in broad-leaf upper-montane forest, chaparral, and cismontane woodland	Alameda County.
Marsh sandwort *Arenaria paludicola*	CE	FE	Freshwater marsh and swamp	San Luis Obispo, Los Angeles, and San Bernardino counties.
Clara Hunt's milk-vetch *Astragalus clarianus*	CT	PE	On serpentinite or volcanic clay soils in cismontane woodland, and valley-foothill grassland	Napa and Sonoma counties.
Peirson's milk-vetch *Astragalus magdalenae var. peirsonii*	CE	PE	Desert dunes	Imperial and San Diego counties.
Coastal dunes milk-vetch *Astragalus tener var. titi*	CE	PE	Coast bluff scrub (sandy) and coastal dunes	Los Angeles and San Diego counties.
Encinitas baccharis *Baccharis vanessae*	CE	PE	Maritime chaparral on sandstone substrate	San Diego County.
Nevin's barberry *Berberis nevinii*	CE	PE	Chaparral, cismontane woodland, and coastal scrub, riparian scrub in sandy or gravelly areas.	Los Angeles, Riverside, San Bernardino, and San Diego counties.
Dwarf goldenstar *Bloomeria humilis*	CR	C	Coastal bluff scrub, chaparral, and valley-foothill grassland	San Luis Obispo County.
Thread-leaved brodiaea *Brodiaea filifolia*	CE	PT	On clay soils in coastal scrub, cismontane woodland, valley-foothill grassland, vernal pools	Los Angeles, Orange, Riverside, San Diego, and San Bernardino counties.

C-087706
C—087706

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Dunn's mariposa lily *Calochortus dunnii*	CR	none	On gabbroic or metavolcanic rocky substrates in chaparral or closed-cone forests	San Diego County.
Tiburon Indian paintbrush *Castilleja affinis ssp. neglecta*	CT	PE	Valley-foothill grassland on serpentinite substrate	Napa and Santa Clara counties.
Succulent owl's -clover *Castilleja campestris ssp. succulenta*	CE	PT	Vernal pool	Stanislaus County.
Mt. Gleason Indian paintbrush *Castilleja gleasonii*	CR	none	On granitic substrates in lower coniferous forest	Los Angeles County.
California jewelflower *Caulanthus californicus*	CE	FE	Chenopod scrub, pinyon-juniper woodland, and valley-foothill grassland	Kings, Kern, Santa Barbara, and San Luis Obispo counties.
Hearst's ceanothus *Ceanothus hearstiorum*	CR	none	Maritime chaparral, coastal prairie, and coastal scrub	San Luis Obispo County.
Maritime ceanothus *Ceanothus maritimus*	CR	none	Maritime chaparral and valley-foothill grassland	San Luis Obispo County.
Vail Lake ceanothus *Ceanothus ophilochilus*	CE	PT	On gabbroic or pyroxenite-rich outcrops in chaparral habitat	Riverside County.
Camatta canyon amole *Chlorogalum purpureum var. reductum*	CR	C1	Cismontane woodland on serpentinite substrates	San Luis Obispo County.
Orcutt's spineflower *Chorizanthe orcuttiana*	CE	PE	Maritime chaparral, closed-cone forest, and coastal scrub in sandy openings	San Diego County.
Chorro Creek bog thistle *Cirsium fontinale var. obisponense*	CE	FE	Serpentinite seeps associated with chaparral and cismontane woodland	San Luis Obispo County.
La Grociosa thistle *Cirsium loncholepis*	CT	C	Coastal dunes (mesic), and brackish marsh and swamp	Santa Barbara and San Luis Obispo counties.
Surf thistle *Cirsium rhothophilum*	CT	C	Coastal bluff scrub and coastal dunes	Santa Barbara and San Luis Obispo counties.

C-087707
C-087707

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Presidio clarkia *Clarkia franciscana*	CE	FE	Coastal scrub and valley-foothill grassland on serpentinite substrates	Alameda County.
Pismo clarkia *Claikia speciosa ssp. immaculate*	CR	FE	Chaparral (margins, openings), cismontane woodland, and valley-foothill grassland	San Luis Obispo County.
Salt marsh bird's-beak *Cordylanthus maritimus ssp. maritimus*	CE	FE	Coastal dunes and salt marsh	Los Angeles, Orange, San Barbara , San Diego, Solano, and Ventura counties.
Soft bird's-beak *Cordylanthus mollis ssp. mollis*	CR	PFE	Coastal salt marsh and swamp	Napa and Solano counties.
Palmate-bracted bird's-beak *Cordylanthus palmatus*	CE	FE	Chenopod scrub and alkaline grassland	Alameda County.
Seaside bird's-beak *Cordylanthus rigidus ssp. littoralis*	CE	C	Closed-cone forests, chaparral, cismontane woodland, coastal dunes, coastal scrub on sandy soils	Santa Barbara County.
Cuyamaca Lake larkspur *Delphinium hesperium ssp. cuyamacae*	CR	none	At mesic sites in lower coniferous forest and meadows	Riverside and San Diego counties.
Beach spectaclepod *Dithyrea maritima*	CT	C	Coastal dunes and coastal scrub (sandy)	Los Angeles, San Bernardino, and San Luis Obispo counties.
Slender-horned spineflower *Dodecahema leptocera*	CE	FE	Alluvial fan supporting chaparral and coastal scrub habitats	Los Angeles, Riverside, and San Bernardino counties.
Cuyamaca Lake downingia *Downingia concolor var. brevior*	CE	PE	Meadows (mesic) and vernal pools	San Diego County.
Short-leaved dudleya *Dudleya blochmaniae sap. brevifolia*	CE	PE	Maritime chaparral (openings), and coastal scrub on Torrey sandstone	San Diego County.
Marcescent dudleya *Dudleya cymosa ssp. marcescens*	CR	PT	Chaparral on volcanic substrate	Los Angeles and Ventura counties.
Laguna Beach dudleya *Dudleya stolonifera*	CT	PE	Chaparral, cismontane woodland, coastal scrub, and valley-foothill grassland on rocky substrate	Orange County.

C-087708

C—087708

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Santa Ana River woolly star *Eriastrum densifolium ssp. sanctorum*	CE	FE	Chaparral and coastal scrub occurring on alluvial fans	Orange and San Bernardino counties.
Indian knob mountainbalm *Eriodictyon altissimum*	CE	FE	Maritime chaparral and cismontane woodland	San Luis Obispo County.
Lompoc yerba santa *Eriodictyon capitatum*	CR	C	Closed-cone forests and chaparral in sandy areas	Santa Barbara County.
Conejo buckwheat *Eriogonum crocatum*	CR	none	On conejo volcanic outcrops in chaparral, coastal scrub, and valley-foothill grassland	Ventura County.
Thorne's buckwheat *Eriogonum ericifolium var. thornei*	CE	C	Pinyon-juniper woodland	San Bernardino County.
San Diego button-celery *Eryngium aristulatum var. parishi*	CE	FE	At mesic sites within coastal scrub, valley-foothill grassland, and vernal pool habitats	Riverside and San Diego County.
Delta button-celery *Eryngium racemosum*	CE	none	In vernally mesic riparian scrub habitats with clay substrate	Stanislaus County.
Mexican flannelbush *Fremontodendron mexicanum*	CR	PE	On gabbroic, metavolcanic, or serpentinite substrates in closed-cone forests, chaparral, and cismontane woodlands	Orange (?) and San Diego counties.
Striped adobe-lily *Fritillaria striata*	CT	PT	On adobe soil in cismontane woodland and valley-foothill grassland	Kern County.
Borrego bedstraw *Galium angustifolium ssp. borregoense*	CR	none	Rocky substrates in Sonoran desert scrub	San Diego County.
Algodones Dunes sunflower *Helianthus niveus ssp. tephrodes*	CE	none	Desert dunes	Imperial County.
Red rock tarplant *Hemizonia arida*	CR	none	Mojaven desert scrub on clay soil	Kern County.
Otay tarplant *Hemizonia conjugens*	CE	PE	Coastal scrub and valley-foothill grassland on clay substrates	San Diego County.

C-087709
C-087709

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Gaviota tarplant *Hemizonia increscens ssp. villosa*	CE	C	Coastal bluff scrub, coastal scrub, and valley-foothill grassland	Santa Barbara County.
Santa Susana tarplant *Hemizonia minthornii*	CR	none	Sandstone rock outcrops in chaparral and coastal scrub	Los Angeles and Ventura counties.
Santa Cruz tarplant *Holocarpha macradenia*	CE	C	Coastal prairie and valley-foothill grassland often on clay soil	Alameda County.*
Tahquitz ivesia *Ivesia callida*	CR	none	On granitic substrates in upper-montane conifer forests	Riverside County.
Beach layia *Layia carnosa*	CE	FE	Coastal dunes	Santa Barbara County.*
Mason's lilaeopsis *Lilaeopsis masonii*	CR	none	Brackish or freshwater marshes, swamps, and riparian scrub	Alameda, Napa, and Solano counties.
Butte County meadow foam *Limnanthes floccosa ssp. californica*	CE	FE	Valley-foothill grassland (mesic) and vernal pools	Butte County.
Sebastopol meadow foam *Limnanthes vinculans*	CE	FE	Meadows (mesic) and vernal pools	Napa County.
Parish's meadowfoam *Limnanthes gracilis ssp. parshii*	CE	PT	Vernally mesic meadows and vernal pool	Riverside and San Diego counties.
Sebastopol meadowfoam *Limnanthes vinculans*	CE	FE	Vernal pool and vernally mesic meadows and grassland	Napa (?) County.
Nipomo mesa lupina *Lupinus nipomensis*	CE	C	Coastal dunes	Solano County.
Laguna Mtns. aster *Machaeranthera asteroides var. lagunensis*	CR	none	Lower-montane conifer forest and cismontane woodland	San Diego County.
Willowy monardella *Monardella linoides ssp. viminea*	CE	PE	Closed cone forest, chaparral, riparian forests, riparian scrub and riparian woodland	San Diego County.

C-087710

C-087710

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Few-flowered navarretia *Navarretia leucocephala ssp. pauciflora*	CT	PE	Vernal pools on volcanic ash flow substrate	Napa County.
Twisselmann's nemacladus *Nemacladus twisselmannii*	CR	none	Upper-montane conifer forest on sandy, rocky, or ganintic substrates	Kern County.
Colusa grass *Neostapfia colusana*	CE	PT	Vernal pool	Solano County.
Dehesa nolina *Nolina interrata*	CE	C	Chaparral on gabbroic, metavolcanic, or serpentinite substrates	San Diego County.
Bakersfield cactus *Opuntia basilaris var. treleasei*	CE	FE	Chenoped scrub and valley-foothill grassland in sandy soil	Kern County.
California orcutt grass *Orcuttia californica*	CE	FE	Vernal pool	Los Angeles*, Riverside, San Diego, and Ventura counties.
Hairy orcutt grass *Orcuttia pilosa*	CE	PE	Vernal pool	Butte County.
San Joaquin Valley orcutt grass *Orcuttia inaequalis*	CE	PE	Vernal Pool	Stanislaus County.*
Slender orcutt grass *Orcuttia tenuis*	CE	PT	Vernal pool	Plumas County.
Dudleys lousewort *Pedicularis dudleyi*	CR	none	Maritime chaparral, north-coast conifer forest, and valley-foothill grassland	Solano and Santa Clara counties.
Lyon's pentachaeta *Pentachaeta lyonii*	CE	PE	Chaparral (openings) and valley-foothill grassland	Santa Catalina Island*, Los Angeles and Ventura counties.
Calistoga popcorn-flower *Plagiobothrys strictus*	CT	PE	Alkaline areas near thermal springs associated with broad-leaf upper montane forest, meadows, and valley-foothill grassland	Napa County.
Napa blue grass *Poa napensis*	CE	PE	Alkaline meadows near hot springs	Napa County.

C-087711
C-087711

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
San Diego mesa mint *Pogogyne abramsii*	CE	FE	Vernal pool	San Diego County.
Otay mesa mint *Pogogyne nudiuscula*	CE	FE	Vernal pool	San Diego County.
Hartweg's golden sunburst *Pseudobahia bahifolia*	CE	PE	On clay soil in valley-foothill grassland and cismontane woodland	Stanislaus County.
San Joaquin adobe sunburst *Pseudobahia peirsonii*	CE	PE	On adobe soil in cismontane woodland and valley-foothill grassland	Kern County.
Gambell's watercress *Rorippa gambelli*	CT	FE	Freshwater or brackish marsh and swamp	Los Angeles*, Orange*, San Diego*, and San Luis Obispo counties.
Small-leaved rose *Rosa minutifolia*	CE	none	Chaparral and coastal scrub	San Diego County.
Adobe sanicle *Sanicula maritima*	CR	none	Chaparral, coastal prairie, meadows, valley-foothill grassland on clay and serpentinite substrates	Alameda* and Solano counties.
Rock sanicle *Sanicula saxatilis*	CR	none	Broad-leaved upper-montane forests, chaparral, and valley-foothill grassland on rocky substrates	Contra Costa and Santa Clara counties.
Gander's ragwort *Senecio ganderi*	CR	none	On gabbroic outcrops in chaparral	San Diego and Riverside counties.
Cuesta pass checkerbloom *Sidalcea hickmanii ssp. anomala*	CR	none	Closed-cone forests on serpentinite substrates	San Luis Obispo County.
Parish's checkerbloom *Sidalcea hickmannii ssp. parishii*	CR	C	Chaparral and lower-montane coniferous forest	Santa Barbara and San Bernardino counties.
Bird-foot checkerbloom *Sidalcea pedata*	CE	FE	Meadows (mesic) and pebble plain habitat	San Bernardino County.
Slender-petaled thelypodium *Thelypodium stenopetalum*	CR	FE	Meadows (mesic, alkaline)	San Bernardino County.

C-087712

C—087712

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Santa Ynez false lupine *Thermopsis macrophylla*	CR		In chaparral habitat on sandy granitic substrates	Santa Barbara County.
Greene's tuctoria *Tuctoria greenei*	CR	PE	Vernal pools	Solano and Butte counties.
Crampton's tuctoria *Tuctoria mucronata*	CE	FE	Vernal pools	Butte County.
Crownbeard *Verbesina dissita*	CT	PT	Maritime chaparral Coastal scrub	Orange County.
INVERTEBRATES				
Badwater snail *Assiminea infina*	none	none	Saline springs of Inyo County.	Not expected within the SWP Service Area.
Santa Barbara shelled slug *Binneya notabilis*	none	none	North facing slopes of Santa Barbara Island.	Anacapa and Santa Barbara Islands.
White desertsnail *Eremarionta immaculata*	none	none	Rock slides of the Riverside Mountains.	Riverside County.
Morongo desertsnail *Eremarionta morongoana*	none	none	Under rocks in a gulch on the northside of Morongo Pass.	San Bernardino County.
Kern shoulderband *Helminthoglypta callistoderma*	none	none	Kern River.	Kern County.
Victorville shoulderband *Helminthhoglypta mohaveana*	none	none	Rock outcrops along the Mojave River.	San Bernardino County.
Peninsular Range shoulderband *Helminthoglypta traski coelata*	none	none	Unknown.	Coastal San Diego County.
Morro shoulderband *Helminthoglypta walkeriana*	none	FPE	Coastal strand and coastal sage scrub at Morro Bay.	San Luis Obispo County.
Micrarionta rowelli bakerensis	none	none	Limestone hills and landslides.	San Bernardino County.

C-087713

C—087713

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Mimic tryonia *Tryonia imitator*	none	none	Coastal lagoons and salt marshes.	San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties.
Conservancy fairy shrimp *Branchinecta conservatio*	none	FE	Vernal pools and seasonal wetlands.	Known from Solano, Butte, and Ventura counties.
Longhorn fairy shrimp *Branchinecta longiantenna*	none	FE	Vernal pools and seasonal wetlands.	Known from Alameda and San Luis Obispo counties.
Vernal pool fairy shrimp *Branchinecta lynchi*	none	FT	Vernal pools and seasonal wetlands.	Known from Alameda, Santa Barbara, Riverside, and San Luis Obispo counties.
Riverside fairy shrimp *Streptocephalus woottoni*	none	FE	Vernal pools and seasonal wetlands.	Riverside, Orange, and San Diego counties.
Vernal pool tadpole shrimp *Lepidurus packardi*	none	FE	Vernal pools and seasonal wetlands.	Butte and Solano counties.
California freshwater shrimp *Syncaris pacifica*	SE	FE	Low gradient streams of the north and central coast.	Napa County.
Kelso Jerusalem cricket *Ammopelmatus kelsoensis*	none	none	Dune habitat.	San Bernardino County.
Point Conception Jerusalem cricket *Ammopelmatus muwu*	none	none	Endemic to coastal sand dune habitats at Point Conception.	Santa Barbara County.
Kelso giant sand treader cricket *Macrobaenetes kelsoensis*	none	none	Endemic to the Kelso Dunes, occurring on hard-packed ridges of the Dunes at 2,500 feet elevations.	San Bernardino County.
Santa Monica shieldback katydid *Neduba longipennis*	none	none	Chaparral and canyon stream bottom habitats.	Santa Monica Mountains of Los Angeles County.
Desert monkey grasshopper *Psychomastix deserticola*	none	none	Very arid environments associated with chamise (Adenostoma fasiculuta).	San Bernardino County.
Ciervo aegialian scarab *Aegialia concinna*	none	C	Sandy substrates.	Fresno County, not expected within the SWP Service Area.

C-087714

C-087714

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Oblivious tiger beetle *Cicindela latesignata obliviosa*	none	none	Coastal mudflats.	San Diego County.
Greenest tiger beetle *Cicindela tranquebarica viridissima*	none	C	Damp mud associated with a variety of habitats including open fields, orange groves, riparian and woodland habitats from the Santa Ana River Basin.	Known from Orange, Los Angeles, and San Bernardino counties.
Globose dune beetle *Coelus globosus*	none	none	Fore dunes and sand hummocks along the coast.	San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and Diego counties.
San Joaquin dune beetle *Coelus gracilis*	none	C	Fossil dunes along the western edge of the San Joaquin Valley.	Kings County.
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	none	FT	Elderberry shrubs of the Central Valley.	Napa, Butte, Solano, Kings, and Kern counties.
Delta green ground beetle *Elaphrus viridis*	none	FT	Grasslands with large vernal pools.	Solano County.
Kelso dune glaresis scarab *Glaresis arenata*	none	none	Sand dune habitat.	San Bernardino County.
Curved-foot hygrotus diving beetle *Hygrotus curvipes*	none	none	Various seasonal wetlands with emergent vegetation.	Alameda County.
White sand bear scarab *Lichnanthe albipilosa*	none	none	Coastal sand dunes in association with dune lakes.	Santa Barbara and San Luis Obispo counties.
Hopping's blister beetle *Lytta insperata*	none	none	Foothills of the southern San Joaquin Valley.	Kern and Kings counties.
Mojave Desert blister beetle *Lytta insperata*	none	none	Various habitats of southern California.	Southern California. Known occurrences from San Diego and Ventura counties.
Moestan blister beetle *Lytta moesta*	none	none	Central California known from Stanislaus and Tulare counties.	Potentially occurs in Kings County.
Molestan blister beetle *Lytta molesta*	none	none	Central Valley habitats, including vernal pools.	Known from Kern County.

C-087715

C-087715

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Nelson's milodres weevil *Miloderes nelsoni*	none	none	Sand dunes of Eureka Valley.	Only known from Inyo County. Not expected within the SWP Service Area.
Rude's longhorn beetle *Necydalis rudei*	none	none	Unknown.	Unknown.
Wing-shoulder minute moss beetle *Onychobaris crassalus*	none	none	Aquatic habitats.	Ventura County.
Lange's El Segundo Dune weevil *Onychobaris langei*	none	none	Only known from the El Segundo Dunes.	Los Angeles County.
Dohrn's elegant eucnemid beetle *Paleoxenus dohrni*	none	none	Unknown.	San Bernardino and northern Los Angeles County.
Atascadero June beetle *Polyphylla nubila*	none	none	San dunes in Atascadero and San Luis Obispo.	San Luis Obispo County.
Brown-tassel trigonoscuta weevil *Trignonoscuta brunnotasselata*	none	none	Desert sand dune habitat.	San Bernardino and Imperial counties.
Yorba Linda trigonoscuta weevil *Trigonoscuta yorbalindae*	none	none	Coastal sand dunes.	Orange County.
Dorothy's El Segundo Dune weevil *Rhaphiomidas terminatus abdominalis*	none	none	Coastal sand dunes of Los Angeles County. Endemic to the El Segundo Dunes.	Los Angeles County.
Delhi Sands flower-loving fly *Rhaphiomidas terminatus abdominalis*	none	FE	Delhi Sands. Hostplant is California buckwheat (Eriogonum fasiculatum).	Southwestern San Bernardino and Northwestern Riverside counties.
El Segundo flower-loving fly *Rhaphiomidas terminatus terminatus*	none	C	Southern California coastal dunes and prairies.	Known from Los Angeles County.
Oso Flaco patch butterfly *Chlosyne leanira osoflaco*	none	none	Known only from sand dunes in southern San Luis Obispo County.	San Luis Obispo County.
Andrew's marble butterfly *Euchloe hyantis andrewsi*	none	none	Yellow pine forest near Lake Arrowhead in the San Bernardino Mountains.	San Bernardino County.

C-087716

C-087716

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Henne's eucosman moth *Eucosma hennei*	none	none	Endemic to the El Segundo Dunes. Hostplant is branching phacelia (Phacelia ramosissima).	Los Angeles County.
El Segundo blue *Euphilotes battoides allyni*	none	- /FE	El Segundo Dunes. Hostplant is Dune buckwheat (Eriogonum parvifolium)	Los Angeles County.
Bay checkerspot *Euphydryas editha bayensis*	none	FT	Native grassland on serpentine soil within the San Francisco Bay Area. Hostplants are California plantain (Plantago erecta), owl's-clover (Orthocarpus densiflora), and purple owl's clover (Orthocarpus purpurascens).	Alameda and Santa Clara counties.
Wright's checkerspot *Euphydryas editha quino*	none	C	Annual grasslands with vernal pools. Hostplant is island plantain (Plantago insularis).	Orange, Riverside, and San Diego counties.
Dun skipper *Euphyes vestris harbisoni*	none	none	Riparian woodland and chamise of southern mixed chaparral. Hostplant is San Diego sedge (Carex spissa).	Western San Diego and southern Orange counties.
Kern primrose sphinx moth *Euproserpinus euterpe*	none	FT	Sandy soils of the Walker Basin area. Hostplant is contorted primrose (Camissonia contorta).	Kern County.
Palos Verdes blue *Glaucopsyche lygdamus palosverdesensis*	none	FE	Restricted to the seaward side of the Palos Verdes Hills of Los Angeles County. Hostplant is locoweed (Astragalus trichopodus var. lonchus)	Los Angeles County.
Morro Bay blue *Icaricia icarioides moroensis*	none	none	Coastal dune habitats. Hostplant is dune lupine (Lupinus chamissonis)	San Luis Obispo and Santa Barbara counties.
San Gabriel Mountains elfin *Incisalia mossii ("hikupa")*	none	none	San Gabriel and San Bernardino Mountains. Hostplant is stonecrop (Sedum species).	Los Angeles and San Bernardino counties.
Hermes copper *Lycaena hermes*	none	none	Southern mixed chaparral and coastal scrub, from sea level to 1,250 feet. Hostplant is red berry (Rhamnus crocea).	Western San Diego County.
Saltmarsh skipper *Panoquina errans*	none	none	Salt marshes of southern California. Hostplant is saltgrass (Distichlis spicata).	Known from Los Angeles and San Diego counties. Expected in Orange County.
San Emigdio blue *Plebulina emigdionis*	none	none	Shadscale scrub, near streams or washes.	Lower San Joaquin Valley and Mojave Desert, including Kern, San Bernardino, Riverside, and Los Angeles counties.

C-087717
C-087717

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
San Gabriel Mountains blue *Plejebus saepiolus*	none	none	Wet meadows above 5,000 feet.	Los Angeles and San Bernardino counties.
Mardon skipper *Polites mardon*	none	none	Serpentine grassland of Del Norte County.	Not expected in the SWP Service Area.
Wandering skipper *Pseudocopaeodus eunus eunus*	none	none	Occurs in association with saltgrass (Distichlis spicata) in hot springs and alkali flats.	San Bernardino, Kern, and San Diego counties.
Santa Monica Mountains haristreak *Satyrium auretorun fumosum*	none	none	Oak woodlands of the Santa Monica Mountains. Foodplant is scrub oak (Quercus berberidifolia).	Los Angeles County.
Callippe silverspot *Speyeria callippe callippe*	none	FPE	Coastal scrub of the San Francisco Peninsula. Hostplant is California golden violet (Viola pedunculata).	Not expected within the SWP Service Area.
Tehachapi Mountain silverspot *Speyeria egleis tehachapina*	none	none	Middle and high elevation montane meadows.	Tehachapi Mountains, Kern and Los Angeles counties.
California diplectronan caddisfly *Diplectrona californica*	none		Rapid portions of small cool streams.	Only known from Claremont in Los Angeles County.
AMPHIBIANS				
California tiger salamander *Ambystoma tigrinum californiense*	CSC	C	Vernal pools annual grassland, grassy understory of valley-foothill hardwood habitats, and along stream courses.	Napa, Solano, Alameda, Santa Clara, San Luis Obispo, Santa Barbara, Kings, and Kern counties.
Coast Range newt *Taricha torosa torosa*	CSC	none	Valley-foothill hardwood, valley-foothill hardwood-conifer, coastal scrub, mixed chaparral, annual grassland and mixed conifer types.	San Luis Obispo, Santa Barbara, Los Angeles, San Bernardino, Riverside, Orange, Ventura, and San Diego counties.
Desert slender salamander *Batrachoseps aridus*	SE	FE	Hidden Palm Canyon, barren palm oasis, desert wash and desert scrub.	Riverside County.
Kern Canyon slender salamander *Batrachoseps simatus*	ST	none	Lower Kern River Canyon, elevation of 1,000 feet to 4,000 feet, valley-foothill hardwood, valley-foothill hardwood conifer,	Kern County.

C-087718

C-087718

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Tehachapi slender salamander *Batrachoseps stebbinsi*	ST	none	Elevations of 2,500-5,000 feet, valley-foothill hardwood-conifer and valley-foothill riparian habitats.	Kern, Ventura, and Los Angeles counties.
Yellow-blotched salamander *Ensatina eschscholtzi croceator*	CSC	none	Forests and well shaded canyons, oak woodlands, old chaparral in the Tehachapi Mountains, Mt. Pinos, and vicinity of Fort Tejon.	Kern, Ventura, and Los Angeles counties.
Large-blotched salamander *Ensatina eschscholtzi klauberi*	CSC	none	Conifer and woodland associations.	Riverside and San Diego counties.
Couch's spadefoot toad *Scaphiopus couchii*	CSC	none	Elevations ranging from 500 to 3,000 feet, arid-semi arid habitats, desert washes, desert riparian, palm, oasis, desert succulent-scrub, and desert scrub habitats.	San Bernardino, San Diego, and Riverside counties.
Western spadefoot toad *Scaphiopus hammondii*	CSC	none	Primarily in grassland habitat, occasional valley-foothill hardwood woodlands, some orchard-vineyard habitat. Requires seasonal wetland habitat for breeding.	Napa, Solano, Butte, Alameda, Santa Clara, San Luis Obispo, Kings, Kern, Santa Barbara, Ventura, Los Angeles, San Bernardino, Riverside, and San Diego counties.
Arroyo toad *Bufo microscaphus californicus*	CSC	FE	Semi-arid regions near washes or intermittent streams, valley- foothill and desert riparian, desert wash, etc.	Santa Barbara, Ventura, Los Angeles, Imperial, Orange, San Diego, and San Bernardino counties.
Arizona toad *Bufo microscaphus microscaphus*	none	none	Headwaters of tributaries to the Colorado River.	San Bernardino, Riverside, and Imperial counties.
California red-legged frog *Rana aurora draytonii*	CSC	FT	Quiet pools of stream, marshes, and occasionally ponds, below 4,000 feet, riverine, riparian, heavily vegetated streamside shorelines.	Occurs in all service area counties except Plumas and Imperial.
Foothill yellow-legged frog *Rana boylii*	CSC	none	Elevations ranging from 0-6,000 feet, rocky streams in a variety of habitats, including valley-foothill hardwood, valley-foothill- hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral, and wet -	Napa, Solano, Alameda, Santa Clara, San Luis Obispo, Kings, Santa Barbara, Ventura, Los Angeles, Kern, Butte, and Plumas counties.
Cascade frog *Rana cascadae*	CSC	none	Water and surrounding vegetation in mountain lakes, streams, and ponds in meadows up to timberline. Near Lassen peak at elevations of 3,000-9,000 feet.	Butte and Plumas counties.

C-087719
C-087719

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Mountain yellow-legged frog *Rana muscosa*	CSC	none	Elevations ranging from 4,500-12,000 feet. In the Sierras, this species is associated with streams, lakes, and ponds in montane riparian, lodgepole pine, subalpine conifer, and wet meadows. In southern California, populations are restricted to streams in ponderosa pine, montane hardwood-conifer, and montane riparian habitat types.	Butte, Plumas, Los Angeles, San Bernardino, Riverside and San Diego counties.
Northern leopard frog *Rana pipiens*	CSC	none	Occurs near quiet, permanent and semi-permanent habitats. Also, some irrigated portions in the southern part of the state.	Plumas, Kern, Los Angeles, San Bernardino, and Riverside counties.
Yanapai leopard frog *Rana yavapaiensis*	none	none	Associated with streams, overflow ponds and side channels of major rivers, permanent springs and stock ponds in desert, grassland and oak woodland habitat from sea level to 4, 800 feet.	Imperial and San Bernardino counties.
REPTILES				
Northwestern pond turtle *Clemmys marmorata marmorata*	CSC	none	Associated with permanent or near permanent water in a wide variety of habitat types, including freshwater emergent wetlands, etc..	Kings, Santa Clara, Napa, Solano, Alameda, Butte, and Plumas counties.
Southwestern pond turtle *Clemmys marmorata pallida*	CSC	none	Associated with permanent or near permanent water in a wide variety of habitat types, including freshwater emergent wetlands, etc..	Alameda, Santa Clara, Kings, San Luis Obispo, Kern Santa Barbara, Ventura, Los Angeles, Orange, San Bernardino, Imperial, Riverside, and San Diego counties.
Desert tortoise *Xerobates (=Gopherus) agassizi*	ST	FT,FSS	Most common in desert scrub, desert wash, and Joshua tree habitats, but occurs in almost every desert habitat.	Kern, Los Angeles, San Bernardino, Riverside, Imperial, Kern and San Diego counties.
Barefoot banded gecko *Coleonyx switaki*	ST	none	Deserts, rocky areas at the heads of canyons.	San Diego, Imperial, and Riverside counties.
San Diego banded gecko *Coleonyx variegatus v. abbotti*	none	C2	Coastal and cismontane southern California, uncommon in coastal chaparral, most common on granite or rocky outcrops.	Kern, Ventura, Los Angeles, San Bernardino, Riverside, Orange, and San Diego counties.

C-087720
C-087720

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Blunt-nosed leopard lizard *Gambelia silus*	SE/CFP	FE	Alkali flats, large washes, arroyos, canyons, and low foothills from elevations of 100 to 3,000 feet.	San Luis Obispo, Santa Barbara, Kings, Kern, and Ventura counties.
San Diego horned lizard *Phrynosoma cronatum blainvillei*	CSC	none	Coastal sage scrub, chaparral, arid and semi-arid climate conditions of southwestern California.	San Diego, Ventura, Riverside, Los Angeles, and Orange counties.
California horned lizard *Phrynosoma cronatum frontale*	CSC	none	Valley-foothill hardwood, conifer, riparian habitats, pine-cypress, juniper, annual grass habitats, washes, and floodplains.	Santa Barbara County.
Flat-tailed horned lizard *Phrynosoma mcalli*	CSC	FPT	Creosote bush, desert scrub, wash, succulent shrub, and alkali scrub habitats.	Riverside and San Diego counties.
Chuckwalla *Sauromalus obesus*	none	none	Desert communities, common in creosote communities, restricted to areas with large rocks, boulder piles, or large rock outcrops on slopes, less frequent on flats.	Los Angeles, Kern, San Bernardino, Riverside, and San Diego counties.
Southern sagebrush lizard *Sceloporos graciosus vadenburgianus*	none	none	Montane chaparral, conifer forest, and juniper-pine woodland.	Los Angeles, San Bernardino, Riverside, Imperial, Orange, and San Diego counties.
Coachella Valley fringe-toed lizard *Uma inornata*	SE	FT	Limited to sand dunes in the Coachella Valley, associated with sparse desert scrub, alkali scrub, and desert washes.	Riverside County.
Colorado Desert fringe-toed lizard *Uma notata notata*	CSC	none	Fine loose wind-blown sand dunes, dry lakebeds, sandy beaches of riverbanks, desert washes, and sparse desert scrub.	San Diego County.
Mojave fringe-toed lizard *Uma scoparia*	CSC	none	Fine loose wind-blown deposits in sand dunes, dry lakebeds, riverbanks, desert washes, sparse alkali scrub, and desert shrub habitats.	Los Angeles, San Bernardino, and Riverside counties.
Sandstone night lizard *Xantusia henshawi gracilis*	CSC	none	Arid and semi-arid hills at elevations of 660-4,000 feet, found exclusively in areas of large rocks in a variety of desert scrub, chaparral, and woodland habitats.	Riverside, San Diego, and Imperial counties.
Sierra night lizard *Xantusia vigilis sierrae*	CSC	none	Widely distributed in arid and semiarid deserts, most common in Joshua tree and desert scrub habitats, found in association with yucca, digger pine, chamise, pinyon pine and juniper.	Kern County.

C-087721

C—087721

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Coronado skink *Eumeces skiltonianus interparietalis*	CSC	none	Mixed chaparral, coastal sage scrub, southern willow scrub, and coast live oak.	San Diego County.
Orange-throated whiptail *Cnemidophorus hyperythrus*	CSC	none	Low-elevation coastal scrub, chamise-redshank chaparral, mixed chaparral, and valley-foothill hardwood habitats.	Los Angeles, San Bernardino, Riverside, Orange, and San Diego counties.
Coastal western whiptail *Cnemidophorus tigris multiscutatus*	none	none	Valley-foothill hardwood, valley-foothill hardwood-conifer, valley- foothill riparian, mixed conifer, pine-juniper, chamise-redshank chaparral, mixed chaparral, desert scrub, desert wash, alkali scrub, and annual grassland types.	Ventura, Los Angeles, Orange, and San Diego counties.
Silvery legless lizard *Anniella pulchra pulchra*	CSC	none	Elevations ranging from 0 to 6,000 feet; Common in several habitats but especially in coastal dune, valley-foothill, and chaparral.	Solano, Napa, Santa Clara, Alameda, San Luis Obispo, Santa Barbara, Ventura, and Los Angeles counties.
Black legless lizard *Anniella pulchra nigris*	CSC	none	Chaparral, pine-oak woodland, and riparian habitats.	San Luis Obispo County.
Gila monster *Heloderma suspectum*	CSC	none	Lower slopes of rocky canyons, arroyos, and washes, desert mountains, low abundance in California.	San Bernardino County.
Coastal rosy boa *Lichanura trivirgata rosafusca*	none	none	Chaparral.	Orange, Riverside, and San Diego counties.
Southern rubber boa *Charina bottae umbratica*	ST	C2,FSS	Occurs in moist coniferous and montane hardwood forest habitats, in association with streams and wet meadows.	Riverside, San Bernardino, Los Angeles, Kern, and San Luis Obispo counties.
Baja California rat snake *Bogertiphis rosalie*	CSC	none	Frequents hillslopes and arroyos, especially near springs, seeps, and streams, but also occurs in dry areas.	Imperial County.
San Bernardino ringneck snake *Diadophis punctatus modestus*	none	none	Mixed chaparral, grassland.	San Bernardino, Ventura, and Los Angeles counties.
San Diego ringneck snake *Diadophis punctatus similis*	none	none	Mixed chaparral, grassland.	San Diego County.
San Diego mountain kingsnake *Lampropeltis zonata pulchra*	CSC	none	Restricted to the San Gabriel and San Jacinto Mountains of Southern California, valley-foothill hardwood, coniferous, chaparral, riparian and wet meadows.	Los Angeles, Riverside, San Bernardino, Orange, and San Diego counties.

C-087722

C—087722

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
San Joaquin whipsnake *Masticophis flagellum ruddocki*	CSC	none	Open terrain, most abundant in grassland, desert, scrub, chaparral, and pasture habitats.	Napa, Solano, Alameda Santa Clara, San Luis Obispo, Kings, Kern, and Santa Barbara counties.
Alameda whipsnake *Masticophis lateralis euryxanthus*	ST	FPE	Oak woodlands, chaparral, coastal scrub and annual grassland.	Alameda County.
Coast patch-nosed snake *Salvadora hexalepis virgultea*	CSC	none	Coastal scrub and chaparral.	Kern, San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties.
Giant garter snake *Thamnophis gigas*	ST	FT	Marshes, streams, and sloughs, usually with mud bottoms.	Solano and Butte counties.
Two-striped garter snake *Thamnophis hammondii*	*	none	Found in or near permanent fresh water, often along streams with rocky beds bordered by willows or other streamside growth.	San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, San Diego, San Bernardino, and Riverside counties.
Northern red-diamond rattlesnake *Crotalus ruber ruber*	CSC	none	Chaparral, oak woodland, desert scrub habitats in rocky areas and dense vegetation.	San Diego, San Bernardino, Riverside, and Orange counties.
BIRDS				
Common loon *Gavia immer*	CSC	none	Common in estuarine and subtidal marine habitats along the entire coast of California. Uncommon on large deep lakes in valley, foothills, and mountains.	Occurs in all service areas except Kings and San Bernardino counties.
Clarks grebe *Aechmophorus clarkii*	*	none	Along entire coast in marine subtidal and estuarine waters, large lakes near coast and inland at low elevations.	Occurs in all service areas.
Western grebe *Aechmophorus occidentalis*	*	none	Open water habitats	Occurs throughout the service area.
American white pelican *Pelecanus erythrorhynchos*	CSC	none	Common to abundant on nesting grounds (large freshwater and- saltwater lakes), salt ponds of San Francisco Bay; common at Lake Tahoe and Salton Sea, Colorado River, Morro Bay, San Diego Bay; sporadic elsewhere.	Plumas, Butte, Napa, Solano, Alameda, San Luis Obispo, Kern, Kings, San Bernardino, Riverside, and San Diego counties.

C-087723

C-087723

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
California brown pelican *Pelecanus occidentalis californicus*	SE/CFP	FE	Estuarine, marine, subtidal, and marine pelagic waters along the California Coast. In California, only nests on the Channel Islands.	Coastal areas of Napa, Solano, Alameda, Santa Clara, San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and San Diego counties. The Salton Sea, including Riverside and San Diego counties.
Double-crested cormorant *Phalacrocorax auritis*	CSC	none	Yearlong resident along the entire coast of California and on inland lakes, in fresh, salt, and estuarine waters.	Occurs in all service areas.
Great blue heron *Ardea herodias*	*	none	Fairly common all year throughout California, shallow estuaries, fresh and saline emergent wetlands, riverine and rocky marine shorelines, croplands, pastures, mountains.	Occurs in all service areas.
Great egret *Casmerodius albus*	*	none	Fresh and saline emergent wetlands, along margins of estuaries, lakes, slow-moving streams, mudflats, salt ponds, and irrigated cropland.	Occurs in all service areas except Plumas County.
Reddish egret *Egretta rufescens*	*	none	Coastal lagoons, salt-water marshes, and mud flats.	Orange, San Diego, Riverside, and Imperial counties.
Snowy egret *Egretta thula*	*	none	Shores of coastal estuarine, fresh and saline emergent wetlands, ponds, slow-moving rivers, irrigation ditches, and wet fields.	Occurs in all service areas.
Western least bittern *Ixobrychus exilis hesperis*	CSC	none	Dense emergent wetlands near freshwater.	Butte, Imperial, Los Angeles, Riverside, and San Diego counties.
Black-crowned night heron *Nycticorax nicticorax*	*	none	Lacustrine, large riverine, and fresh and saline emergent habitats; rarely on marine subtidal kelp beds; nests in dense foliaged trees and dense emergent wetlands.	Occurs in all service areas.
Wood stork *Mycteria americana*	CSC	none	Breeds in wooded wetlands. Favor open muddy shallows of lagoons and brackish marshes, or fields undergoing heavy irrigation. Roosts in high perches in trees.	Imperial and San Diego counties.
White-faced ibis *Plegadis chihi*	CSC	none	Freshwater emergent wetlands, shallow lacustrine waters, the muddy ground of wet meadows and irrigated or flooded pastures and crop- lands; nests in dense freshwater emergent wetland.	Butte, Kern, Imperial, Ventura, Los Angeles, Riverside, and San Diego counties.

C-087724

C-087724

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Aleutian Canada goose *Branta canadensis leucopareia*	none	FT	Lacustrine, freshwater emergent wetlands, and moist grasslands, croplands, pastures, and meadows.	Butte, Alameda, Solano, and Santa Clara counties.
Barrow's goldeneye *Bucephala islandica*	CSC	none	Central California Coast, mainly San Francisco Bay and vicinity, estuarine and brackish lacustrine waters; rare and local inland on lacustrine and riverine waters, along Colorado River.	Plumas, Butte, Napa, Solano, Alameda, Santa Clara, San Bernardino, and Riverside counties.
Harlequin duck *Histrionicus histionicus*	CSC	none	Marine waters along rocky coast, previous breeding recordings on large turbulent sierran rivers.	Coastal San Luis Obispo County.
California condor *Gymnogyps californicus*	SE/CFP	FE	Open rangeland, semi-arid rugged mountain ranges surrounding the southern San Joaquin Valley. Roosts on cliffs, large trees, and snags.	Santa Barbara County.
Cooper's hawk *Accipiter cooperi*	CSC	none	Breeding resident through most of the wooded portions of the state, dense stands of live oak, riparian deciduous, or other forests near water used frequently.	Occurs in all service areas.
Northern goshawk *Accipiter gentilis*	CSC	C2,FSS	Prefers middle and higher elevations, and mature dense conifer forests. Casual in foothills during winter, and northern deserts in pinyon-juniper woodland and low elevation riparian habitats.	Butte, Plumas, Kern, Los Angeles, Ventura, Riverside, and San Bernardino counties.
Sharp-shinned hawk *Accipiter striatus*	CSC	none	Breeds in ponderosa pine, black oak, riparian deciduous, mixed conifer, and Jeffrey pine habitats; prefers but not restricted to riparian habitat.	Occurs in all service areas.
Golden eagle *Aquila chrysaetos*	CSC/CFP	none	Typically rolling foothills, mountain areas, sage-juniper flats, and desert.	Occurs in all service areas.
Ferruginous hawk *Buteo regalis*	CSC	C2	Winter visitor to open grasslands, agricultural areas, sagebrush flats, desert scrub, low foothills surrounding valleys, and fringes of pinyon- juniper habitats.	Occurs in all service areas.
Swainson's hawk *Buteo swainsonia*	ST	none	Breeds in stands with few trees in juniper-sage flats, riparian areas, and oak savannah. Forages in adjacent grasslands, suitable grain, alfalfa fields, cropland or livestock pastures.	Plumas, Solano, Kings, Los Angeles, Butte, and San Bernardino counties.

C-087725

C-087725

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Northern harrier *Circus cyaneus*	CSC	none	Occurs from annual grasslands to lodgepole pine and alpine meadows (0-10,000 feet). Frequents meadows, grasslands, open rangelands, desert sinks, fresh and salt water emergent wetlands.	Occurs in all service areas.
Black-shouldered kite *Elanus caeruleus*	CFP *	none	Coastal and valley lowlands, rarely found away from agricultural areas.	Occurs in all service areas except Plumas County.
Bald eagle *Haliaeetus leucocephalus*	SE/CFP	FT	Local winter migrant to various southern California lakes. Most of the breeding population is restricted to more northern counties.	Occurs in all service areas.
Osprey *Pandion haliaetus*	CSC	none	Breeds in northern California, associated strictly with large fish-bearing waters, primarily in ponderosa pine and mixed conifer habitats.	Occurs in all service areas.
Harris' Hawk *Parabuteo unicinctus*	CSC	none	Riparian woodland and adjacent open ground, of river or delta bottomlands.	Imperial, Riverside.
Merlin *Falco columbarius*	CSC	none	Winter visitor to coastlines, open grasslands, savannahs, woodlands, lakes, wetlands, edges, and early successional stages, ranges from annual grasslands to ponderosa pine and montane hardwood- conifer habitats. Rare in Mojave desert and Channel Islands.	Occurs in all service areas.
Prairie falcon *Falco mexicanus*	CSC	none	Distributed from annual grasses to alpine meadows, associated primarily with perennial grasslands, savannahs, rangeland, some agricultural fields, and desert scrub.	Occurs in all service areas.
Arctic peregrine falcon *Falco peregrinus tundrius*	none	none	Nests on rocky cliffs in Artic region. Winters throughout southern north America.	May occur rarely as a winter migrant throughout the service area.
American peregrine falcon *Falco peregrinus anatum*	SE/CFP	FE	Woodland, forest, coastal habitats, riparian areas, coastal and inland wetlands.	Occurs in all service areas.
Sage grouse *Centrocercus urophasianus*	CSC	none	Found primarily in a combination of sagebrush, perennial grassland or wet meadow, and water.	Plumas County.

C-087726

C—087726

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Mt. Pinos Blue grouse *Dendragapus obscurus howardi*	*	none	Open to medium-mature stands of fir, Douglas-fir, and other conifer habitats interspersed with open spaces and available water.	Kern, Los Angeles, and Ventura counties.
Mountain quail *Oreortyx pictus*	none	none	Montane habitats, open brushy stands of conifer and deciduous forest and woodland, chaparral.	Occurs in all service areas except Alameda, Santa Clara, and Kings counties.
Yellow rail *Coturnicops noveboracensis*	CSC	none	Freshwater marshes and marshy meadows for breeding. May also forage in saltwater marshes.	Solano, Napa, Alameda, Santa Clara, San Luis Obispo, Santa Barbara, and Orange counties.
California black rail *Laterallus jamaicensis coturniculus*	ST/CFP	none	Brackish and fresh emergent wetlands in the San Francisco Bay Area, Sacramento-San Joaquin Delta, other scattered locations.	Napa, Solano, Alameda, Santa Clara, San Luis Obispo, Orange, Imperial, San Diego, and Riverside counties.
Light-footed clapper rail *Rallus longirostris levipes*	SE/CFP	FE	Occurs in coastal saline emergent wetland habitats.	Ventura, Orange, Los Angeles, and San Diego counties.
California clapper rail *Rallus longirostris obsoletus*	SE/CFP	FE	Occurs in coastal and brackish wetland habitats.	Alameda, Solano, Napa, San Luis Obispo, and Santa Clara counties.
Yuma clapper rail *Rallus longirostris yumanensis*	ST/CFP	FE	Occurs in freshwater and brackish emergent wetland habitats.	Riverside, Imperial, and San Bernardino counties.
Greater sandhill crane *Grus canadensis tabida*	ST/CFP	none	In and near wet meadows, shallow lacustrine, and fresh emergent wetland habitats, winter habitats include: annual and perennial grasslands, moist croplands with rice or corn stubble, and open emergent wetlands.	Plumas, Butte, San Luis Obispo, Kings, Kern, San Bernardino, Imperial, and Riverside counties.
Western snowy plover *Charadrius alexandrrinus nivosus*	CSC	FT	Nests, feeds, and takes cover on sandy or gravely beaches along the coast, on estuarine salt ponds, alkali lakes, and at the Salton Sea. Coastal populations are federally classified as potentially threatened while inland populations are not listed.	Occurs in all service areas except Plumas and Butte counties.
Mountain plover *Charadrius montanus*	CSC	none	Found on short grasslands and plowed fields, open plains with low, herbaceous or scattered scrub vegetation; also in foothill valleys west San Joaquin Valley, and in Imperial Valley.	Solano, Kings, San Luis Obispo, Santa Barbara, Ventura, Kern, Los Angeles, Riverside, San Diego, and Imperial counties.

C-087727

C-087727

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Long-billed curlew *Numenius americanus*	CSC	none	Upland shortgrass prairies and wet meadows are used for nesting; coastal estuaries, open grasslands, and croplands are used in winter.	Occurs in all service areas.
Black tern *Chlidonias niger*	CSC	none	Uses fresh, emergent wetlands, lakes, ponds, moist grasslands, and agricultural fields. In migration, some take coastal routes and forage offshore.	Plumas, Butte, Solano, Kings, Kern, Riverside, and Imperial counties.
Laughing gull *Larus atricillia*	CSC	none	Prefers warm seas. Forages over water or land, occasionally feeding at garbage dumps. Frequents fields, streams and other habitats near Salton Sea for breeding.	Imperial, Riverside, and San Diego counties.
California gull *Larus californicus*	CSC	none	Nests on islands in alkali or freshwater lakes and salt ponds. Inland, frequents lacustrine, riverine, cropland habitats, landfill dumps, and city lawns. Preferred habitats on coast are sandy beaches, mudflats, rocky intertidal, and pelagic areas of marine and estuarine habitats, as well as emergent wetlands.	Occurs in all service areas.
Black skimmer *Rynchops niger*	CSC	none	Requires shallow, calm water for foraging, and sand bars, beaches, or dikes for roosting and nesting. Also visits coastal estuaries and river mouths of southern California.	Orange, San Diego, Riverside, and Imperial counties.
California least tern *Sterna antillarum browni*	SE/CFP	FE	Breeding colonies located in southern California along marine and estuarine shores, and in San Francisco Bay in abandoned salt ponds and along estuarine shores. After breeding, family groups occur at lacustrine waters near the southern coast.	Alameda, Santa Clara, San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties.
Caspian tern *Sterna caspia*	*	none	For nesting, requires relatively barren, undisturbed islands, levees, or shores, and nearby foraging areas in lakes, estuaries, salt ponds, or emergent wetlands.	Occurs in all service areas except Butte, Kern, Los Angeles, and San Bernardino counties.
Elegant tern *Sterna elegans*	CSC	none	Preferred habitats are inshore coastal waters, bays, estuaries, harbors; rarely occurs far offshore and never inland.	Occurs in all service areas except Plumas, Butte, Kings, Kern, San Bernardino, Riverside, and Imperial counties.

C-087728
C-087728

C-087729

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Forster's tern *Sterna forsteri*	*	none	For nesting, requires low, mostly barren dikes or islands near feeding areas in saltwater bays, lagoons, or freshwater lakes. Abandoned pilings, low boardwalks, or exposed beaches are needed for roosting.	Occurs in all service areas except San Bernardino County.
Gull-billed tern *Sterna nilotica*	CSC	none	Prefers sandy beaches for nesting, and forages over shallow waters, mudflats, grasslands, and croplands near the Salton Sea.	Riverside, San Diego, and Imperial counties.
Rhinoceros auklet *Cerorhinca monocerata*	CSC	none	Prefers undisturbed islands with friable soil for digging burrow, as well as productive, pelagic waters near breeding colony for feeding.	San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties.
Xantus' murrelet *Endomychura hypoleuca scrippsi*	CSC	none	For breeding, requires rocky, undisturbed islands with productive marine waters nearby. Nests on the Channel Islands.	Winters off the Coast of Santa Barbara County.
Common murre *Uria aalge*	*	none	Marine subtidal and pelagic habitats off undisturbed rocky coasts and islands with productive marine habitat nearby.	San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties.
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	SE	none	Inhabits extensive deciduous riparian thickets or forests with dense, low-level or understory foliage, and which abut on slow-moving watercourses, backwaters, or seeps. Nests typically in sites with at least some willow or understory foliage and high humidity.	Butte, Kern, San Bernardino, Riverside, Orange, Imperial, and San Diego counties.
Short-eared owl *Asio flammeus*	CSC	none	Open areas with few trees, such as annual and perennial grasslands, prairies, dunes, meadows, irrigated lands, saline and fresh emergent wetlands. Needs elevated sites for perches, and dense vegetation for roosting and nesting.	Occurs in all service areas.
Long-eared owl *Asio otus*	CSC	none	Frequents dense, riparian and live oak thickets near meadow edges, and nearby woodland and forest habitats. Also found in dense conifer stands at higher elevations.	Occurs in all service areas.

C—087729

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Elf owl *Micrathene whitneyi*	SE	none	Nests in desert riparian habitat with cottonwood, sycamore, willow, or mesquite; absent from desert riparian habitat dominated by saltcedar along the Colorado River. Taller trees with a shrub understory seem to be require.	San Bernardino, Riverside, and Imperial counties.
Burrowing owl *Athene cunicularia*	CSC	none	Open, dry grassland and desert habitats, and in grass, forb, and open shrub stages of pinyon-juniper and ponderosa pine habitats. Uses rodent or other burrow for roosting or nesting cover.	Occurs in all service areas.
Northern spotted owl *Strix occidentalis caurina*	none	FT	Mature conifer forests.	Napa County.
California spotted owl *Strix occidentalis occidentalis*	CSC	none	Resides in dense, old-growth, multi-layered mixed conifer, redwood, and Douglas fir habitats, from sea level up to approximately 7,600 feet. In southern California, nearly always associated with oak and oak- conifer habitats.	Occurs in all service areas except Solano, Alameda, Santa Clara, Kings, and Imperial counties.
Vaux's swift *Chaetura vauxi*	CSC	none	Prefers redwood and Douglas-fir habitats with nest sites in large, hollow trees and snags, especially tall, burned-out stubs. Forages over most terrains and habitats, preferring rivers and lakes.	Plumas, Butte, and Santa Clara counties.
Black swift *Cypseloides niger*	CSC	none	Nests in moist crevice or cave on sea cliffs above the surf, or on cliffs near waterfalls in deep canyons. Forages widely over many habitats; seems to avoid arid regions.	Plumas, Butte, San Luis Obispo, Los Angeles, San Bernardino, and Riverside counties.
Gilded northern flicker *Colaptes auratus chrysoides*	SE	none	Riparian and open forest and shrub habitats with abundant ecotones for feeding, and snags for nest cavities.	San Bernardino, Riverside, and Imperial counties.
Gila woodpecker *Melanerpes uropygialis*	SE	none	Occurs mostly in desert riparian and desert wash habitats, but also found in orchard-vineyard and urban habitats, particularly in shade trees and date palm groves.	San Bernardino, Riverside, and Imperial counties.
Willow flycatcher *Empidonax traillii*	SE	none	Wet meadow and montane riparian habitats from 2,000-8,000 feet. Most often occurs in broad, open river valleys or large mountain meadows with lush growth of shrubby willows.	Plumas, Butte, San Diego, and Kern counties.

C-087730

C-087730

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Southwestern willow flycatcher *Empidonax traillii extimus*	none	FE	Occurs in dense willow and cottonwood riparian habitats.	Los Angeles, Orange, San Bernardino, Riverside, and San Diego counties.
Brown-crested flycatcher *Myiarchus tyrannulus*	CSC	none	Most numerous in riparian groves of cottonwood, mesquite, willow, which afford suitable nest sites, but often forages in adjacent desert scrub or plantings of saltcedar.	San Bernardino, Riverside, and Imperial counties.
Vermillion flycatcher *Pyrocephalus rubinus*	CSC	none	Nesters inhabit cottonwood, willow, mesquite, and other vegetation in desert riparian habitat adjacent to irrigated fields, irrigation ditches, pastures, and other open mesic areas.	Riverside and San Bernardino counties.
California horned lark *Eremophilia alpestris actia*	CSC	none	Grasslands along the coast and deserts near sea level to alpine dwarf- shrub habitat above treeline. Prefers grasslands and other open habitats with low, sparse vegetation.	Occurs in all service areas.
Purple martin *Progne subis*	CSC	none	Old-growth, multi-layered, open forest and woodland with snags in breeding season. Forages over riparian areas. Found in a variety of open habitats in migration.	Occurs in all service areas except Kings, San Bernardino, Ventura, Los Angeles, and Imperial counties.
Bank swallow *Riparia riparia*	ST	none	Requires vertical banks and cliffs with fine-textured or sandy soils near streams, rivers, ponds, lakes, and the ocean for nesting. Feeds primarily over riparian areas during breeding season and over grass- land and cropland during migration.	Plumas, Butte, Santa Barbara, and Butte counties. Historically from Los Angeles, Orange, and San Diego counties.
Eagle Mountain scrub jay *Aphelocoma coerulescens cana*	CSC	none	Pinyon-juniper woodland and sparse scrub. Elevations from 4,000 to 4,800 feet.	Eastern Riverside County.
Bendire's thrasher *Toxostoma bendirei*	CSC	none	Frequents flat desert areas with scattered stands of thorny shrubs and cactus for cover, foraging, and nesting.	San Bernardino and Riverside counties.
Crissal thrasher *Toxostoma crissale*	CSC	none	Occupies dense thickets of shrubs or low trees in desert riparian or desert wash habitats; also occurs in dense sagebrush and other shrubs in washes with juniper and pinyon-juniper habitats, up to 5,900 feet.	San Bernardino, Riverside, Imperial, and San Diego counties.

C-087731
C-087731

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Le Conte's thrasher *Toxostoma lecontei*	CSC	none	Occurs primarily in open desert wash, desert scrub, alkali desert scrub and desert succulent shrub habitats; also occurs in Joshua tree habitat with scattered shrubs.	San Luis Obispo, Kern, Los Angeles, San Bernardino, Riverside, and Imperial counties.
San Diego coastal cactus wren *Canpylorhynchus brunneicapillus sandiegense*	CSC	none	Arid parts of westward draining slopes including thickets, patches, or tracts of larger, branching cacti, stiff-twigged, thorny shrubs, and small trees.	San Diego, Orange, Los Angeles, and Ventura counties.
California gnatcatcher *Polioptila californica*	CSC	FT	Low, dense coastal scrub habitat in arid washes, on mesas, and on slopes of coastal hills. California sagebrush and patches of pricklypear are particularly favored.	San Diego, Riverside, Orange, and Los Angeles counties.
Black-tailed gnatcatcher *Polioptila melanura*	*	none	Nests primarily in wooded desert wash habitat, but also occurs sparingly in desert scrub habitat.	San Diego, Imperial, Riverside, and San Bernardino counties.
Loggerhead shrike *Lanius ludrovicianus*	CSC	none	Open habitats with sparse shrubs and trees, other suitable perches, bare ground, and low sparse herbaceous cover.	Occurs in all service areas.
Arizona Bell's vireo *Vireo bellii arizonae*	SE	none	Inhabits low, dense riparian growth along water or along dry parts of intermittent streams. Typically associated with willow, cottonwood, baccharis, wild blackberry, or mesquite.	Riverside and San Bernardino counties.
Least Bell's vireo *Vireo bellii pusillus*	SE	FE	Willows and other low, dense valley foothill riparian habitat and lower portions of canyons; also desert riparian.	San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties.
Gray vireo *Vireo vicinior*	CSC	none	Arid pinyon-juniper, juniper, and chamise-redshank chaparral habitats from 2,000-6,500 feet.	San Bernardino, Riverside, and San Diego counties.
Tricolored blackbird *Agelaius tricolor*	CSC	none	Breeds near freshwater, preferably in emergent wetland with tall dense cattails or tules, but also in thickets of willow, blackberry, wild rose, tall herbs. Feeds in grassland and cropland habitats.	Occurs in all service areas except Plumas County.
Southern California rufous-crowned sparrow *Aimophila ruficeps canescens*	CSC	none	Occurs on herbage-covered hillsides with scattered shrubs (especially coastal sage) and rock outcrops.	Riverside, San Bernardino, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties.

C-087732

C—087732

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Bell's sage sparrow *Amphispiza belli belli*	CSC	none	Low, fairly dense stands of shrubs in transmontane California occupies sagebrush, alkali desert scrub, and desert scrub. In cismontane California, frequents chaparral dominated by chamise, and coastal scrub dominated by sage.	Occurs in all service areas except Butte County.
Northern cardinal *Cardinalis cardinalis*	CSC	none	Riparian woodland thickets.	Imperial and Los Angeles counties.
Yellow warbler *Dendroica petechia brewsteri*	CSC	none	Breeds in riparian woodlands from coastal and desert lowlands up to 8,000 feet in Sierra Nevada. Also breeds in montane chaparral, open ponderosa pine and mixed conifer habitats with substantial amounts of brush.	Occurs in all service areas.
Saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	CSC	none	Mostly breeds and winters in wet meadow, fresh emergent wetland, and saline emergent wetland.	Napa, Solano, Alameda, and Santa Clara counties.
Yellow-breasted chat *Icteria virens*	CSC	none	Dense, brushy thickets and tangles near water, and thick understory in riparian woodland.	Occurs in all service areas except Kings County.
California gray-headed junco *Junco hyemalis caniceps*	CSC	none	Uses forests, woodlands, edges for breeding; frequents openings edges, stream corridors while foraging; also breeds above timberline near moist, alpine meadows.	Kern, Los Angeles, and San Bernardino counties.
Suisun song sparrow *Melospiza melodia maxillaris*	CSC	none	Habitat fragments of emergent wetlands.	Solano County.
Alameda song sparrow *Melospiza melodia pusillula*	CSC	none	Emergent wetlands of the San Francisco Bay Area.	Napa, Solano, Alameda, and Santa Clara counties.
San Pablo song sparrow *Melospiza melodia samuelis*	CSC	none	Emergent wetlands of the San Francisco Bay Area.	Napa, Solano, Alameda, and Santa Clara counties.
Belding's savannah sparrow *Passerculus sandwichensis beldingi*	SE	none	Frequents pickleweed in a few scattered saline emergent wetlands from Santa Barbara County south.	Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties.
Large-billed savannah sparrow *Passerculus sandwichensis rostratus*	CSC	none	Saline emergent wetlands at Salton Sea and southern coast.	Santa Barbara, Ventura, Los Angeles, Orange, Imperial, Riverside, and San Diego counties.

C-087733
C-087733

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Hepatic tanager *Piranga flava*	CSC	none	Open mountain forests, oaks, pines.	San Bernardino County.
Summer tanager *Piranga rubra*	CSC	none	Frequents cottonwood-willow associations of riparian habitats for breeding, feeding, cover, and other activities.	Kern, Los Angeles, San Bernardino, Riverside, San Diego, and Imperial counties.
Virginia's warbler *Vermivora virginiae*	CSC	none	Breeds in arid, shrubby mixed conifer, pinyon-juniper, montane chaparral, and possibly montane riparian habitats from about 7,000-9,000 feet.	Kern and San Bernardino counties.
MAMMALS				
Alameda Island mole *Scapanus latimanus parvus*	CSC	none	Prefers moist, friable soils. Avoids flooded soils. Occurs only on Alameda Island.	Alameda County.
Buena Vista Lake shrew *Sorax ornatus relictus*	CSC	C	Marshes and sloughs around the perimeter of Buena Vista Lake, (Kern Co.); also may occur in the Tulare Basin and at Kern and Pixley National Wildlife Refuges.	Kern and King counties.
Southern California ornate shrew *Sorax ornatus salicornicus*	CSC	none	Grassland and emergent wetland habitats of southern coastal marshes.	Ventura, Los Angeles, and Orange counties.
Suisun shrew *Sorax ornatus sinuosus*	CSC	C	Dense low-lying cover of salicornia in wetlands of San Pablo and Suisun Bays.	Napa and Solano counties.
Salt-marsh wandering shrew *Sorex vagrans halicoetes*	CSC	C	Low, dense cover of salicornia in salt marshes of San Francisco Bay.	Alameda and Santa Clara counties.
Mexican long-tongued bat *Choeronycteris mexicana*	CSC	none	Forages in desert and montane riparian, desert scrub, desert succulent shrub, and pinyon-juniper habitats.	San Diego County.
California leaf-nosed bat *Macrotus californicus*	CSC	none	Habitats occupied include desert riparian, desert wash, desert scrub, desert succulent shrub, alkali desert scrub, and palm oasis below 2,000 feet.	San Bernardino, Riverside, Imperial, and San Diego counties.
Pallid bat *Antrozous pallidus*	CSC	none	Inhabits grasslands, shrublands, woodlands, and forests from sea level up through mixed conifer forests. Most common in open, dry habitats with rocky areas for roosting.	Occurs in all service areas.

C-087734

C—087734

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Spotted bat *Euderma maculatum*	CSC	none	Habitats range from arid deserts and grasslands through mixed conifer forests up to 10,600 feet. Prefers sites with adequate roosting habitat, such as cliffs. Feeds over water and along marshes.	Ventura, Los Angeles, Orange, San Diego, Kern, Riverside, San Bernardino, and Imperial counties.
Arizona myotis *Myotis lucifugus occultus*	CSC	none	Most common in mid to high elevation forests; fairly common in sagebrush, bitterbrush, alkali desert scrub, wet meadow and montane chaparral. Prefers to feed over water or open habitats.	San Bernardino, Riverside, and Imperial counties.
Cave myotis *Myotis velifer brevis*	CSC	none	Desert scrub, desert succulent scrub, desert wash, and desert riparian habitats in lowlands of Colorado River and adjacent mountain ranges.	San Bernardino, Riverside, and Imperial counties.
Townsend's western big-eared bat *Plecotus townsendii townsendii*	CSC	none	Found in all but alpine and subalpine habitats; most abundant in mesic habitats. Requires caves, mines, tunnels, buildings, or other man-made structures for roosting.	Plumas, Butte, Napa, Solano, Alameda, Santa Clara, and Kings counties.
Pale big-eared bat *Plecotus townsendii pallescens*	CSC	none	Found in all but alpine and subalpine habitats; most abundant in mesic habitats. Requires caves, mines, tunnels, buildings, or other man-made structures for roosting.	Kings, San Luis Obispo, Kern, Santa Barbara, Ventura, Los Angeles, Orange, San Bernardino, Riverside, Imperial, and San Diego counties.
California mastiff bat *Eumops perotis californicus*	CSC	none	Occurs in many open, semi-arid to arid habitats including conifer and deciduous woodlands, coastal scrub, annual and perennial grasslands, palm oases, chaparral, desert scrub, urban.	Occurs in all service areas except Plumas, Butte, Napa, and Solano counties.
Pocketed free-tailed bat *Nyctinomops femorosaccus*	CSC	none	Habitats include pinyon-juniper woodlands, desert scrub, desert succulent shrub, desert riparian, desert wash, alkali desert scrub, Joshua tree woodland, and palm oasis.	Riverside, Imperial, and San Diego counties.
Big free-tailed bat *Nyctinomops macrotis*	CSC	none	Prefers rugged, rocky canyons.	San Diego County.
Snowshoe hare *Lepus americanus*	CSC	none	Montane riparian habitats with thickets of alders and willows, and stands of young conifers interspersed with chaparral.	Plumas and Butte counties.

C-087735

C-087735

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Sierra Nevada snowshoe hare *Lepus americanus tahoensis*	CSC	none	Early stages of conifers and pines and aspen are likely habitats, especially along edges and near meadows.	Plumas County.
San Diego black-tailed jackrabbit *Lepus californicus bennettii*	CSC	none	Intermediate canopy stages of shrub habitats and open shrub/ herbaceous and tree/herbaceous edges provide suitable habitat.	Los Angeles, Orange, and San Diego counties.
White-tailed hare *Lepus townsendii*	CSC	none	Sagebrush, subalpine conifer, juniper, alpine dwarf shrub, and perennial grassland are preferred habitats. Also uses low sagebrush, wet meadow, and early successional stages of various conifer habitats.	Plumas County.
Sierra Nevada mountain beaver *Aplodontia rufa californica*	CSC	none	Montane riparian habitat. Occurs in open and intermediate canopy coverage with a dense understory near water. Deep, friable soils required for burrowing, along with a cool, moist microclimate.	Plumas County.
Point Reyes mountain beaver *Aploduntia rufa phaea*	CSC	none	North facing slopes with dense vegetation at Point Reyes in Marin County.	Not expected within the SWP Service Area. (Distribution limited to Marin County).
San Joaquin antelope squirrel *Ammospermophilus nelsoni*	ST	C	Suitable habitat has widely scattered shrubs, annual forbs and grasses, and is distributed over broken terrain with small gullies and washes.	San Luis Obispo, Santa Barbara, Kings, and Kern counties.
San Bernardino flying squirrel *Glaucomys sabrinus californicus*	none	none	Mature, dense conifer habitats intermixed with various riparian habitats support flying squirrel populations. Large trees and snags required.	San Bernardino, Los Angeles, and Riverside counties.
Mohave ground squirrel *Spermophilus mohavensis*	ST	none	Optimal habitats are open desert scrub, alkali desert scrub, and Joshua tree. also feeds in annual grasslands. Has been found from 1,800-5,000 feet.	Kern, San Bernardino, and Los Angeles counties.
Palm Springs ground squirrel *Spermophilus tereticaudus chlorus*	CSC	none	Prefers open, flat, grassy areas in fine textured, sandy soil in Coachella Valley. A mixture of shrub species is preferred.	Riverside County.
Kingston Mountain chipmunk *Tamius panamintinus acrus*	none	FSS	Resides in pinyon-juniper and juniper habitats, especially in rocky outcrops in these habitats. Ranges from 5,700-9,000 feet.	San Bernardino County.

C-087736

C-087736

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Mount Pinos chipmunk *Tamias speciosus callipeplas*	none	FSS	Occurs in open-canopy forests of mixed conifer, Jeffrey pine, lodgepole, and limber pine, and occasionally in chaparral. Elevational range in southern California is 6,400-10,900 feet.	Kern, Ventura, Los Angeles, San Bernardino, and Riverside counties.
Amargosa pocket gopher *Thomomys bottae amargosae*	none	none	Optimal habitats are perennial meadows, and grass and forb stages of riparian habitats, associated with the Amargosa River Basin.	San Bernardino County.
California pocket mouse *Chaetodipus californicus femoralis*	CSC	none	Occurs in chaparral and grassland, but probably reaches its greatest abundance where these 2 habitats occur in close proximity.	Orange, Riverside, and San Diego counties.
Northwestern San Diego pocket mouse *Chaetodipus fallax fallax*	CSC	none	Coastal scrub, chamise-redshank chaparral, mixed chaparral, sagebrush, desert wash, desert scrub, desert succulent shrub, pinyon-juniper, and annual grassland.	San Diego, Orange, and Riverside counties.
Pallid San Diego pocket mouse *Chaetodipus fallax pallidus*	CSC	none	Coastal scrub, chaparral and annual grassland.	San Diego County.
Berkeley kangaroo rat *Dipodomys heermanni berkeyleyensis*	*	none	Occurs in open spaces in chaparral and blue oak/digger pine woodlands and grassy hills.	Alameda, Santa Clara, Solano, and Napa counties.
Morro Bay kangaroo rat *Dipodomys heermanni morroensis*	SE/CFP	FE	Occurs in coastal scrub habitat at Morro Bay.	San Luis Obispo County.
Giant kangaroo rat *Dipodomys ingens*	SE	FE	Found on fine, sandy loam soils supporting sparse annual grass/forb vegetation, and marginally found in low-density alkali desert scrub.	San Luis Obispo, Kings, Santa Barbara, and Kern counties.
San Bernardino Merriam's kangaroo rat *Dipodomys merriami parvus*	CSC	none	Occurs in desert scrub and alkali desert scrub, sagebrush, Joshua tree, and pinyon-juniper habitats. Prefers sparse to moderate canopy on fine to coarse sands, with or without surface pavement or gravel in the subsoil.	Kern, Los Angeles, San Bernardino, Riverside, San Diego, and Imperial counties.
Short-nosed kangaroo rat *Dipodomys nitratoides brevinasus*	CSC	C	Occurs on flat to hilly terrain in scrubland herbaceous habitats with scattered shrubs.	Kings, Kern, San Luis Obispo, and Santa Barbara counties.

C-087737

C-087737

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Fresno kangaroo rat *Dipodomys nitatoides exilis*	SE	FE	Alkali habitats from 200 to 300 feet elevation.	Kings County.
Tipton kangaroo rat *Dipodomys nitatoides nitratoides*	SE	FE	Occurs in arid grassland and alkali desert scrub habitats.	Kings and Kern counties.
Panamint kangaroo rat *Dipodomys panamintinus panamintinus*	none	FSS	Occurs on sandy-gravely soils, usually with an overstory of big sagebrush, pinyon pine, juniper, or yucca.	Kern, San Bernardino, and Los Angeles counties.
Stephen's kangaroo rat *Dipodomys stephensi*	ST	FE	Occurs primarily in annual and perennial grasslands, but may occur in coastal scrub or sagebrush with sparse canopy cover, or in disturbed areas.	San Bernardino, Riverside, and San Diego counties.
White-eared pocket mouse *Perognathus alticola alticola*	CSC	none	Occurs in ponderosa and Jeffrey pine habitats as well as sagebrush and mixed chaparral habitats from 3,500-5,900 feet.	Kern, Ventura, Los Angeles, and San Bernardino counties.
Tehachapi pocket mouse *Perognathus alticola inexpectatus*	CSC	none	Occurs in arid grassland and scrub habitats.	Kern, Ventura, and Los Angeles counties.
San Joaquin pocket mouse *Perognathus inornatus inornatus*	*	none	Occurs in dry, open grasslands or scrub areas on fine-textured soils between 1,100-2,000 feet in elevation.	San Luis Obispo, Santa Barbara, Napa, Solano, Kings, Kern, and Ventura counties.
Palm Springs pocket mouse *Perognathus longimembris bangsi*	CSC	none	Desert wash and scrub.	Riverside County.
Los Angeles pocket mouse *Perognathus longimembris brevinasus*	CSC	none	Occurs in grassland and coastal sage habitats with sandy soils.	Los Angeles, Orange, San Bernardino, San Diego, and Riverside counties.
Jacumba pocket mouse *Perognathus longimembris internationalis*	CSC	none	Occurs in desert riparian, wash, and scrub habitats.	San Diego County.
Pacific pocket mouse *Perognathus longimembris pacificus*	CSC	FE	Occurs in open areas within sage/scrub habitats with sandy soils.	Los Angeles, Orange, and San Diego counties.

C-087738

C-087738

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Mohave River vole *Microtus californicus mohavensis*	CSC	none	Riparian habitats and irrigated fields along the Mojave River.	San Bernardino County.
Stephen's vole *Microtus californicus stephensi*	CSC	none	Occurs in brackish marshes.	Los Angeles and Orange counties.
San Francisco dusky-footed woodrat *Neotoma fuscipes annectens*	CSC	none	Occurs in chaparral habitats.	Santa Clara and Alameda counties.
Monterey dusky-footed woodrat *Neotoma fuscipes luciana*	CSC	none	Occurs in chaparral and forest habitats with moderate canopy and moderate canopy and moderate to dense understory cover.	San Luis Obispo County.
San Joaquin Valley woodrat *Neotoma fuscipes riparia*	CSC	C	Dense riparian vegetation along the San Joaquin, Stanislaus, and Tuolumne Rivers in San Joaquin and Stanislaus counties.	Not expected within the SWP Service Area.
San Diego desert woodrat *Neotoma lepida intermedia*	CSC	none	Occurs in mixed and chamise-redshank chaparral habitats.	San Luis Obispo, Ventura, Los Angeles, Orange, and San Diego counties.
Southern grasshopper mouse *Onychomys torridus ramona*	CSC	none	Frequents most desert habitats, especially scrub habitats with friable soils for digging.	San Bernardino, Los Angeles, Riverside, and San Diego counties.
Tulare grasshopper mouse *Onychomys torridus tularensis*	CSC	none	Occurs in arid valley and scrub desert habitats.	Kern and San Luis Obispo counties.
Southern marsh harvest mouse *Reithrodontomys megalotis limicola*	CSC	none	Coastal saltmarsh.	Ventura, Los Angeles, Orange, and Santa Barbara counties.
Salt-marsh harvest mouse *Reithrodontomys raviventris*	SE/CFP	FE	Pickleweed saline emergent wetland is preferred, but new grasslands adjacent to pickleweed marsh may also be used.	Napa, Solano, Alameda, and Santa Clara counties.
Colorado River cotton rat *Sigmodon arizonae plenus*	CSC	none	Restricted to moist habitats, such as desert riparian, grassland, cropland, and fresh emergent wetland with trees near the Colorado River.	San Bernardino, Riverside, and Imperial counties.
Yuma cotton rat *Sigmodon hispidus eremicus*	CSC	none	Grasslands, overgrown clearings, and herbaceous borders of fields, and brushy areas are preferred.	Imperial, Riverside, and San Bernardino counties.

C-087739

C-087739

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA (continued)

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Point Reyes jumping mouse *Zapus trinotatus orarius*	CSC	none	Bunch grass marshes of the Point Reyes Peninsula, Marin County.	Not expected within the SWP Service Area. (Distribution limited to Marin County).
San Joaquin kit fox *Vulpes macrotis mutica*	ST	FE	Annual grasslands or grassy open stages of vegetation dominated by scattered shrubs. Some agricultural areas may support these foxes.	Alameda, Santa Clara, San Luis Obispo, Santa Barbara, Kings, and Kern counties.
Sierra Nevada red fox *Vulpes vulpes necator*	ST	FSS	Prefers forests interspersed with meadows or alpine fell-fields. Open areas are used for hunting, forested habitats for cover and reproduction.	Plumas County.
Southern sea otter *Enhydra lutris nereis*	CFP	FT	Nearshore marine environments including canopies of giant kelp and bull kelp to provide important rafting and feeding areas.	San Luis Obispo and Santa Barbara counties.
California wolverine *Gulo gulo luteus*	ST/CFP	none	Mixed conifer, red fir, and lodgepole habitats, and probably use sub-alpine conifer, alpine dwarf shrub, wet meadow, and montane riparian habitats. Occurs in Sierra Nevada from 4,300-10,800 feet.	Plumas and Kern counties.
Ringtail *Basseriscus astutus*	CFP	none	Riparian habitats throughout middle and low elevations.	Occurs throughout the SWP Service Areas.
Humboldt marten *Martes americana humboldtensis*	CSC	none	Optimal habitats are various mixed evergreen forests with more than 40% crown closure, with large trees and snags.	Plumas, Butte, and Kern counties.
Pacific fisher *Martes pennanti pacifica*	CSC	none	Suitable habitat consists of large areas of mature, dense forest stands with snags and greater than 50% canopy closure.	Plumas, Butte, and Kern counties.
American badger *Taxidea taxus*	*	none	Most abundant in drier open stages of most shrub, forest, and herbaceous habitats, with friable soils.	Occurs in all service areas.
Yuma mountain lion *Felis concolor browni*	CSC	none	Require extensive areas of riparian vegetation and brushy stages of various habitats, with interspersions of irregular terrain, rocky outcrops, and tree/brush edges.	San Bernardino, Riverside and Imperial counties.
Guadalupe fur seal *Arctocephalus townsendi*	ST	FT	Inhabits rocky insular shorelines; often found in sheltered crevices and sea caves on outer Channel Islands.	May forage off the coast of San Luis Obispo and Santa Barbara counties.

C-087740

C-087740

Table 6-1 SPECIAL STATUS SPECIES OF THE SWP SERVICE AREA

Name	Status		Habitat	Distribution Within the SWP Service Area
	State	Federal		
Northern (Steller) sea lion *Eumetopias jubatus*	ST	FT	Prefers offshore haul-out and breeding sites with unrestricted access to water, near aquatic food supply in areas of minimal human disturbance.	May forage off the coast of San Luis Obispo and Santa Barbara counties. Small breeding colony located on San Miguel Island.
California bighorn sheep *Ovis canadensis californiana*	ST	none	Historically found along the east side and are east of the Sierra Nevadas in steep open terrain with available water. Winters in sage- brush scrub at lower elevations. Herds known from Inyo, Tulare, Modoc, Fresno, and Mono counties.	Not expected within the SWP Service Area. (Distribution limited to Inyo, Tulare, Modoc, Fresno and Mono counties).
Peninsular bighorn sheep *Ovis canadensis cremnobates*	ST/CFP	FPE	Occurs on open desert slopes.	Riverside, San Diego, and Imperial counties.
Nelson's bighorn sheep *Ovis canadensis nelsoni*	CFP	none	Occurs in rocky, steep environments with available water and herbaceous forage. (Some populations not subject to CFP designation, as described in Section 4902 of the California Fish and Game Code).	San Bernardino, Riverside, Imperial, and Los Angeles counties.

C-087741

C-087741

Special Status Plants

Vernal pool habitat within this area supports several listed species, or species proposed for listing, including Hoover's spurge, Butte County meadowfoam, Greene's tuctoria, slender orcutt grass, and hairy orcutt grass.

North Bay Service Area

Vegetation and Wildlife Habitat

The North Bay Service Area contains Napa and Solano counties (Figure 6-1). A diversity of habitats occur within this Service Area including habitats associated with the Coast Ranges, Bay, Delta, and Central Valley. Some of the habitats such as barren and urban/industrial have relatively low value for wildlife, whereas others such as marshes, and riparian have substantial value for wildlife. Important biological areas within the Service Area include numerous creeks, reservoirs, watersheds, and wildlife refuges and preserves. The diversity of habitats within this Service Area support 16 listed wildlife species and 11 listed plant species. Additional information on these listed species and other special status species is summarized in Table 6-1.

Special Status Wildlife

Within this area, elderberries provide suitable habitat for the valley elderberry longhorn beetle. Orcutt Lake and the surrounding vernal pools at the Jepson Prairie Preserve in Solano County support the only known population of Delta green ground beetles, a federally threatened species. The small coastal streams of Napa County provide habitat for the California freshwater shrimp, a federal and state-endangered species.

A variety of marshland associated with the Bay and Delta within this area supports several listed species, including the salt-marsh harvest mouse, California black rail, California clapper rail, and giant garter snake. The California red-legged frog, a species proposed for federal listing, occurs in permanent and seasonal wetlands, associated with the Coast Ranges.

San Pablo and Suisun bays occur at the southern extreme of the Service Area. Open water and associated shoreline habitats of these areas provide nesting or foraging habitat for populations of the western snowy plover, California least tern, and California brown pelican.

Forested and densely wooded areas of Napa County support populations of the northern spotted owl, a federally threatened species. The federal and state-endangered bald eagle winters at Lake Hennessey in Napa County. Within Solano County, foraging and nesting habitat occurs for the state-threatened Swainson's hawk in cropland and annual grasslands associated with riparian areas or scattered trees.

Special Status Plants

Various vernal pool habitats within this area support several listed plant species, including Sebastopol meadowfoam, Colusa grass, Boggs Lake hedge-hyssop, Crampton's tuctoria, and few-flowered navarretia. Freshwater and brackish marsh and scrub habitats with tidal influences support populations of Mason's lilaeopsis. In the vicinity of Napa and Calistoga, mesic sites near hot springs support the state-endangered Napa blue grass and the state-threatened Calistoga popcorn-flower. Tiburon Indian paintbrush, a state-threatened species that is also proposed for federal listing, occurs at serpentine sites in Napa County. Coastal salt marshes of Napa County support Suisun thistle and soft bird's-beak. Clara hunt's milk-vetch, a state-threatened species, occurs in clay soils within oak woodland and valley grassland habitats, associated with serpentine or volcanic substrates.

South Bay Service Area

Vegetation and Wildlife Habitat

The South Bay Service Area is comprised of Alameda and Santa Clara counties (Figure 6-1). In general, the predominant habitats (and wildlife species) are those associated with San Francisco Bay and adjacent baylands and the immediate inland areas associated with the foothills of the Coast Ranges. Habitats within this Service Area support eleven listed wildlife species and thirteen listed plant species. Other special status species occurring within the South Bay Service Area are summarized in Table 6-1.

Special Status Wildlife

Bay checkerspot butterfly occurs within this Service Area, restricted to native grasslands on outcrops of serpentine soil. Vernal pools within the Service Area provide suitable habitat for the federally-listed longhorn fairy shrimp.

Intermittent and permanent wetlands provide breeding habitat for the California red-legged frog, a species federally listed as threatened. The Alameda whipsnake, a state-threatened species, occurs within foothill habitats of Alameda County.

Marsh habitats within this area support the California black rail and California clapper rail. Barren or sparsely vegetated sites such as beaches or estuary flats provide nesting habitat for the California least tern and western snowy plover. Bank swallow populations are also known from this area at Coyote Hills Regional Park (CNDDB 1996).

Salt marshes throughout the San Francisco Bay support populations of salt-marsh harvest mouse, a federal and state-endangered species. The relatively unpopulated areas within the eastern portion of the South Bay Service Area, including the foothills of the Livermore Valley, support San Joaquin kit fox, a federal and state-listed species. Additional information regarding these listed species and other special status wildlife is listed in Table 6-1.

Special Status Plants

Thirteen listed plant species occur or potentially occur within the South Bay Service Area. Many of these occur in association with specific habitats and/or substrates.

As with the North Bay Service Area, Mason's lilaeopsis occurs within freshwater marsh and riparian scrub habitats of Alameda County within the Delta. Foothill grasslands within the Livermore Valley support the only known populations of the federal and state-endangered large-flowered fiddleneck. The state and federally endangered palmate-bracted bird's beak occurs at Springtown Alkali Sink in Alameda County. The federally endangered robust spineflower occurs in coastal scrub and sand habitats in Santa Clara County.

Various habitats occurring on serpentine substrates support listed species and species proposed for listing, including Santa Clara Valley dudleya, coyote ceanothus, Metcalf canyon jewelflower, Tiburon Indian paintbrush, and Presidio clarkia. Within the South Bay Service Area, Santa Cruz tarplant occurs in clay soils associated with annual grasslands and coastal prairie. Pallid manzanita, a state-endangered species, is limited to siliceous shale slopes and ridge tops in Alameda County. Rock sanicle, a state rare plant, occurs on rock outcrops associated with grassland, chaparral, and broadleaf upland forests.

California seablite, a species proposed for federal listing as endangered, historically occurred in coastal salt marsh habitats throughout the Service Area, and surveys of potential habitat may result in the rediscovery of this species within the area.

San Joaquin Valley Service Area

Vegetation and Wildlife Habitat

Stanislaus, Kings and Kern counties compose the San Joaquin Valley Service Area (Figure 6-1). This service area also includes a small portion of Stanislaus County. A mosaic of riparian forests, coniferous forests, oak woodlands, eucalyptus, wetlands, grasslands, pasture, chaparral, desert, urban, and agricultural areas occur throughout this two-county region. The important biological areas occurring throughout the Service Area include State parks and reserves, national wildlife refuges and forests. These habitats support 17 listed species of wildlife and 11 listed plant species. Additional information on these species and other special status species is included in Table 6-1.

Special Status Wildlife

One federally threatened invertebrate species occurs in this area, the Kern primrose sphinx moth. This species is endemic to the Walker Basin, in the Sierra Nevada of Kern County.

Listed bird species from the San Joaquin Service Area include several species previously mentioned, including the Swainson's hawk, western snowy plover, western yellow-billed cuckoo, and willow flycatcher. The California condor, a federal and state-endangered species, historically occurred throughout the Service Area.

Two state-threatened amphibians occur within the Service Area, including the Kern Canyon slender salamander and the Tehachapi slender salamander. The wet meadows and stream-side habitats associated with the montane habitats of the Tehachapi and Transverse ranges support the state-threatened southern rubber boa. The blunt-nosed leopard lizard occurs in the arid habitats of the Central Valley floor.

Four listed species of rodents occur within the San Joaquin Valley, including the Fresno kangaroo rat, San Joaquin antelope squirrel, Tipton kangaroo rat, and giant kangaroo rat. These species are generally associated with native arid habitats, including valley sink, chenopod scrub, and alkali grassland habitats. These habitats and a variety of others also

support the wide-ranging San Joaquin kit fox, which occurs throughout the Central Valley from Contra Costa County southward through Kern County. Montane portions of this Service Area also support the California wolverine, which occurs in the high-elevations of the Sierra.

Portions of Kern County that extend into the Mojave Desert support populations of desert tortoise and Mohave ground squirrel. These species also occur in the Southern Deserts Service Area.

Special Status Plants

Within the highly variable habitats of the San Joaquin Service Area, eleven listed plant species occur in habitats ranging from Mojave desert scrub to upper montane. Six of these listed plant species occur in the chenopod scrub and valley-foothill grasslands within the San Joaquin Valley, including San Joaquin woollythreads, California jewelflower, Bakersfield cactus, Bakersfield smallscale, Hoover's eriastrum, and Kern mallow. Other listed species occurring within the Service Area include Twisselmann's nemacladus, a State Rare species, occurring on sandy or granitic substrates within the upper-montane conifer forest. Both the San Joaquin adobe sunburst and striped adobe lily occur within the foothill woodlands and grasslands of the western San Joaquin Valley. Mexican flannelbush, a state rare species, is restricted to gabbroic and serpentinite substrates associated with chaparral, cismontane woodland and closed-cone conifer habitats. Red Rock tarplant, a state rare plant, is known from only 15 occurrences in Mojave desert scrub habitat in Red Rock Canyon.

Central Coast Service Area

Vegetation and Wildlife Habitat

The Central Coast Service Area includes San Luis Obispo, Santa Barbara, and Ventura counties (Figure 6-1). Coastal habitats such as marine (aquatic and intertidal), dune, coastal scrub, estuaries and tidal wetlands are present within the western portion of the Service Area. Examples of habitats within the Service Area that occur further inland include cropland, riparian and oak woodland, coniferous forest, freshwater marsh, annual grassland, lacustrine, and riverine. Numerous areas of biological importance occur throughout the Service Area.. The diversity of habitats within this Service Area supports 24 listed wildlife species; six of these species are endemic to the Central Coast Service Area. These habitats also support 37 listed plant species. Other special status plant and

wildlife species that occur within the Central Coast Service Area are summarized in Table 6-1.

Special Status Wildlife

Listed species, endemic to the Central Coast Service Area, include the Morro Bay kangaroo rat and banded dune snail. Both of these species are restricted to the coastal habitats at Morro Bay in San Luis Obispo County. Off shore listed species associated with the Central Coast Service Area include the state-threatened southern sea otter and the federal and state-endangered California brown pelican, which maintains nesting colonies on the Channel Islands (CDFG 1990). After nesting, California brown pelicans disperse to other areas of the Pacific coast line. Also occurring sporadically along the coast, northern sea lions occasionally rest on beaches and rocky shores throughout the Central Coast Service Area (Ziener et al. 1990a). The historical range of the California condor included the foothills and ranges bordering the San Joaquin Valley. After an intensive captive breeding program, a small population of condors has been reintroduced to northern Santa Barbara County (Ron Jurek pers. comm.).

Within the Central Coast Service Area, the Carrizo Plain bordering the San Joaquin Valley includes many of the same habitats and supports many of the same listed species, as previously discussed. These species include the San Joaquin kit fox, blunt-nosed leopard lizard, San Joaquin antelope squirrel, and giant kangaroo rat.

Twelve listed bird species, which also occur in other Service Areas, are also expected to occur within the Central Coast Service Area. Many of the listed species associated with tidal wetlands and coastal habitats of other Service Areas; also occur within the same habitats of the Central Coast Service Area. These species include the western snowy plover, California least tern, light-footed clapper rail, California black rail, and California clapper rail. Also associated with coastal salt marshes, the Belding's savannah sparrow occurs within this Service Area, as well as the salt marshes of the South Coast Service Area. The American peregrine falcon is expected to nest on rock cliffs and forage on marshland and other habitats within the Service Area. Four listed bird species associated with various riparian habitats throughout California also occur or are expected to occur within this area, including the western yellow-billed cuckoo, bank swallow, least Bell's vireo, and willow flycatcher. Within this Service Area, the California gnatcatcher reaches the northern limit of its distribution in southern Ventura County.

Three species associated with wetlands occur within the Central Coast Service Area, including the arroyo southwestern toad, California red-legged frog, and the longhorn fairy shrimp. The arroyo southwestern toad reaches the northern-most limits of its distribution in Santa Barbara County. As with other Service Areas within the Coast Ranges, permanent and temporary wetlands of these ranges support populations of California red-legged frog. Within the Central Coast Service Area, vernal pool habitat supports longhorn fairy shrimp; a federally listed species.

Special Status Plants

The diverse climate, substrates and habitats, within the Central Coast Service Area support 37 listed plant species, many of which are endemic to this area. Additionally, three plant species with historical populations documented within the Service Area, are also expected to occur.

Various habitats occurring on serpentine substrates support rare plants species, including Cuesta Pass checkerbloom, adobe sanicle, Camatta Canyon amole, and Chorro Creek bog thistle. Santa Susana tarplant, a California rare plant, occurs on sandstone outcroppings in the Simi Hills of southern Ventura County. Within the southern portion of the Service Area, limestone outcroppings support Braunton's milk-vetch; a species recently proposed for federal listing as endangered. Also within this area, volcanic substrates support marcescent dudleya, Santa Monica Mountains dudleya, Verity's dudleya, Lyon's pentachaeta, Conejo dudleya, and Conejo buckwheat.

Coastal habitats throughout the Central Coast Service Area include coastal bluff scrub, maritime chaparral, coastal dunes, and salt marsh. These habitats support twelve listed plant species, including Morro manzanita, Hearst's ceanothus, maritime ceanothus, La Graciosa thistle, Dudley's lousewort, surf thistle, salt marsh bird's-beak, seaside bird's-beak, California seablite, beach spectaclepod, Gaviota tarplant, and Nipomo Mesa lupine. Additionally, Hearst's manzanita and dwarf golden star occurs in coastal habitats, however these species are limited to the Arroyo de la Cruz area in San Luis Obispo County.

In the eastern portion of the Service Area that is associated with the San Joaquin Valley, arid habitats, such as chenopod scrub and alkali grassland, support California jewelflower, San Joaquin woollythreads, and Hoover's eriastrum. These species also occur in the San Joaquin Valley Service Area. Vernal pool habitat within the Central

Coast Service Area supports populations of California orcutt grass, a species that also occurs in the South Coast Service Area.

Freshwater and brackish marsh habitats of the Central Coast support Gambell's watercress and marsh sandwort, both federally Endangered species. Chaparral, oak woodland, annual grassland, closed-cone forest, and other upland habitats scattered throughout the Service Area support populations of Santa Ynez false lupine, Parish's checkerbloom, Indian Knob mountainbalm, Lompoc yerba santa, and Pismo clarkia.

Historically, the Central Coast Service Area supported populations of slender-petaled thelypodium, Monterey spineflower, and beach layia. Although suitable habitat remains, known populations of these species have been extirpated from this area. These species are known from other extant occurrences in California and may exist within the Service Area in unsurveyed habitats.

South Coast Service Area

Vegetation and Wildlife Habitat

The South Coast Service Area contains three counties, Los Angeles, Orange, and San Diego (Figure 6-1). While vast portions of this Service Area have been developed, important biological areas occur at scattered locations within the South Coast Service Area. The diverse habitats of the South Coast Service Area support 25 listed wildlife species. These habitats also support 46 listed plant species and provide suitable habitat for four additional species. Other special status animal species expected to occur within the South Coast Service Area are summarized in Table 6-1.

Special Status Wildlife

Three federally endangered invertebrate species occur within the South Coast Service Area. Vernal pools within San Diego County support Riverside fairy shrimp. Within Los Angeles County, the Palos Verdes blue is restricted to the seaward side of the Palos Verdes Hills; and the El Segundo blue butterfly occurs at the El Segundo Dunes.

Within the Service Area one state-threatened reptile occurs on the mainland. The southern rubber boa occurs in the San Bernardino and San Jacinto Mountains in many montane habitats in the vicinity of streams or wet meadows (CNDDB 1996). Within the Service Area, lower elevation streams may support the arroyo southwestern toad.

Thirteen listed bird species are associated with the mainland habitats of the South Coast Service Area. Within the South Coast Service Area, coastal areas with barren to sparsely vegetated flats may support breeding populations of the western snowy plover and California least tern. Within the South Coast Service Area, coastal sage scrub supports many species of sensitive wildlife, including the federally threatened California gnatcatcher. Other listed bird species occurring in riparian habitats within this Service Area include the willow flycatcher and least Bell's vireo. Coastal salt and brackish marshes support populations of light-footed clapper rail, California black rail, and California clapper rail. Where salt marshes include extensive stands of pickleweed, the Belding's savannah sparrow may occur. Within the Service Area, historical reports of bank swallow and western yellow-billed cuckoo indicate that this area once supported populations of these species, however these birds are now reported infrequently. Swainson's hawk occurs infrequently throughout the Service Area, generally as an occasional migrant in spring and fall. California condor historically occurred in this area, however a decline in the population has led to the capture of all wild condors for a captive breeding program (CDFG 1991). Condors have been recently re-introduced to their historical range in northern Santa Barbara County, and are not expected in the South Coast Service Area (Ron Jurek pers. comm.).

The Pacific pocket mouse, a federal endangered species, occurs in coastal plain and scrub habitats within the Service Area, from the Mexican border to El Segundo in the County of Los Angeles.

Where the South Coast Service Area meets the Southern Deserts Service Area, several of the same listed species occur, including the desert tortoise, Mohave ground squirrel, flat-tailed horned lizard, Peninsular big horn sheep, barefoot banded gecko, and Stephen's kangaroo rat.

Special Status Plants

The listed plant species of the South Coast Service Area include 33 extant species occurring in a variety of habitats, including vernal pools, chaparral, coastal scrub, salt marsh, and coastal dunes. Additionally, this Service Area supports 13 species proposed for listing as Endangered or Threatened. Within the Service Area suitable habitat for four listed species occurs in marsh, alluvial fan, and desert dune habitats, although these species are not currently known to occur within the Service Area.

Vernal pools of the South Coast Service Area support several species of listed plants, including San Diego button-celery, California orcutt grass, Cuyamaca Lake downingia, Parish's meadowfoam, San Diego mesa mint, and Otay mesa mint. Other species associated with vernally mesic sites with clay soils, but not necessarily vernal pools, include the Otay tarplant, thread-leaved brodiaea, and San Diego thorn-mint.

Coastal habitats of the South Coast Service Area (coastal salt marsh, coastal bluff scrub, and coastal dunes) support populations of salt-marsh bird's beak, coastal dunes milk-vetch, and beach spectaclepod.

A variety of unique chaparral and coastal scrub habitats occur throughout the Service Area and support State and federally listed species, including Encinitas baccharis, Orcutt's spineflower, slender-horned spineflower, Laguna Beach dudleya, short-leaved dudleya, marcescent dudleya, Lyon's pentachaeta, Nevin's barberry, and crownbeard. Lower montane coniferous forest from this Service Area supports three California rare species, including Mt. Gleason Indian paintbrush, Cuyamaca larkspur, and Laguna Mountains aster.

Four endemic species occur only in the unique habitats of San Diego County. The small-leaved rose is known from one site on the Otay Mesa in southern San Diego County. The Laguna Mountains aster is known from five populations on the Laguna Mountains. The Sonoran desert scrub habitat of Palm Canyon, Hellhollow Canyon, and Pinyon Mountain Valley in eastern San Diego County supports Borrego bedstraw. Willowy monardella occurs at scattered locations in the County in intermittent stream courses associated with a variety of habitats, including chaparral, riparian woodland, and closed-cone conifer forests.

Within the South Coast Service Area seven plant species have been proposed for Endangered status under the federal Endangered Species Act, including the Del Mar manzanita, Braunton's milk-vetch, Encinitas baccharis, Orcutt's spineflower, short-leaved dudleya, and Lyon's pentachaeta, Cuyamaca Lake downingia. Additionally, five species from this Service Area have been proposed for Threatened status. These species include the Del Mar sand aster, marcescent dudleya, Santa Monica Mountains dudleya, crownbeard, and Parish's meadowfoam (Skinner and Pavlik 1994; USFWS August 4, 1994).

Historically the South Coast Service Area supported populations of marsh sandwort, Santa Ana River woolly stars, and Gambell's water cress. Although known populations of these plants have been extirpated from this Service Area, unknown populations may still occur within the Service Area in unsurveyed habitats. All of these species occur elsewhere in California. Although no populations of Peirson's milk-vetch are known from San Diego County, potential habitat (desert dunes) occurs within the eastern desert portions of the county.

Southern Deserts Service Area

Vegetation and Wildlife Habitat

The Southern Desert Service Area includes San Bernardino, Riverside, and Imperial counties. Dominant habitats of the Service Area are those associated with the Sonoran and Mojave deserts, although the western portion of San Bernardino and Riverside counties support vegetation typical of the South Coast Service Area, including coastal scrub and oak woodlands. Twenty-five threatened or endangered wildlife species, or wildlife species proposed for listing occur within this Service Area. The various habitats of the Service Area are expected to support 23 listed species of plants and six species proposed for listing as endangered. Suitable habitat occurs in the county for three other species of listed plants. Additional information on these species and other special status species in the Southern Deserts Service Area is listed in Table 6-1.

Special Status Wildlife

Two federally endangered invertebrate species occur within the Southern Deserts Service Area, including the Riverside fairy shrimp, which occurs in vernal pools and seasonal wetlands; and the Delhi Sands flower-loving fly, which only occurs in the sparsely vegetated sandy habitats of Riverside County.

Three listed amphibians occur within the Southern Deserts Service Area. The State and federally endangered desert slender salamander occurs in the palm oasis, desert wash, barren, and desert scrub habitats of Hidden Palm Canyon in Riverside County. The California red-legged frog occurs in the foothills and on the slopes of the Peninsular and Transverse ranges up to 1,200 meters elevation in permanent and temporary wetland habitats. Additionally, the arroyo southwestern toad occurs in stream habitats at various locations within the Service Area.

Five listed reptile species occur within this Service Area, including the desert tortoise, flat-tailed horned lizard, barefoot banded gecko, Coachella Valley fringe-toed lizard, and southern rubber boa. The desert tortoise occurs throughout the Sonoran and Mojave Deserts. Within the Service Area the flat-tailed horned lizard is restricted to desert washes and desert flats in central Riverside, Imperial, and eastern San Diego counties. The barefoot banded gecko is restricted to the extensive rock out crops from the eastern face of the Peninsular Ranges in Imperial and eastern San Diego counties. Within eastern Riverside County the Coachella Valley fringe-toed lizard occurs only in sand dunes associated with sparse desert scrub, alkali scrub, and desert wash habitats. Where this Service Area includes portions of the San Jacinto and San Bernardino Mountains, the southern rubber boa occurs in montane habitats associated with wet meadows (Zeiner et al. 1988).

The CNDDB lists 12 State and federally listed bird species that occur within the Southern Deserts Service Area. Salt and freshwater marshes including those associated with the Salton Sea support populations of the California black rail and the Yuma clapper rail, a federally endangered and state-threatened species. The California gnatcatcher, occurs in coastal scrub habitats, associated with the western portion of Riverside County. Populations of western yellow-billed cuckoo occur in riparian habitats of the Service Area, including habitats associated with the Colorado River. Riparian habitats also support other riparian associated bird species, including the least Bell's vireo, Gila woodpecker, elf owl, willow flycatcher, and Arizona Bell's vireo. Gilded northern flicker also occurs within this Service Area. Within the Southern Deserts Service Area, Swainson's hawk occurs infrequently, generally as an occasional migrant in spring and fall. Bald eagles winter in both Riverside and San Bernardino counties at Baldwin Lake and Lake Mathews.

Two listed rodent species occur with in the Southern Desert Service Area. The Stephen's kangaroo rat occurs in grasslands and coastal scrub habitats. The distribution of this species includes the San Jacinto Valley of western Riverside County, southwestern San Bernardino County, and the northwestern portion of San Diego County (Zeiner et al. 1990a). Within this Service Area, the Mohave ground Squirrel occurs in open grassland desert scrub, alkali desert scrub, and Joshua tree habitats within the northwestern portions of San Bernardino County.

The peninsular bighorn sheep, a state-threatened species that is also proposed for federal listing as endangered, occurs on open desert slopes below 4,000 feet elevation from San Gorgonio Pass southward into Mexico, including the San Jacinto, Santa Rosa, San Ysidro, Vallecito, Pinyon, Jacumba, and Inkohpah Mountains (CNDDB 1996).

Special Status Plants

Within the Southern Deserts Service Area 23 rare, threatened, or endangered plant species occur in a variety of habitats. Additionally, six species known to occur within the Service Area are proposed for listing as endangered. Because historical populations are known from this area, three additional species possibly occur within the Service Area.

Within the Southern Deserts Service Area, six plant species are proposed for listing as endangered under the federal Endangered Species Act. These species include Coachella Valley milk vetch, Lane Mountains milk-vetch, short-leaved dudleya, Peirson's milk-vetch, triple-ribbed milk-vetch, and Parish's alkali-grass (Skinner and Pavlik 1994; USFWS March 28, 1994). Short-leaved dudleya and Peirson's milk-vetch are also State-listed as endangered.

Five plant species endemic to carbonate deposits of the San Bernardino Mountains were recently listed by the USFWS. Four of these species are federally endangered, including Cushenbury buckwheat, San Bernardino Mountains bladderpod, Cushenbury milk-vetch, and Cushenbury oxytheca. The remaining species, Parish's daisy, is federally threatened. These plants occur in a variety of habitats within the San Bernardino Mountains, including Jeffrey pine-western juniper woodland, pinyon-juniper woodland, pinyon woodland, Joshua tree woodland, blackbrush scrub, and desert wash (USFWS August 24, 1994).

Other endemic plants occur within the boundaries of the Southern Deserts Service Area in a variety of habitats at scattered locations. These species include the Santa Ana River woollystar, Throne's buckwheat, Tahquitz ivesia, Vail Lake ceanothus, and Wiggin's croton. Santa Ana River woollystar at one time occurred in several counties in Southern California, however now only one population is known from alluvial fan scrub habitat along the Santa Ana River in San Bernardino County. The pinyon-juniper woodlands of the New York Mountains in eastern San Bernardino County provide habitat for the only two known populations of Thorne's buckwheat, a state-endangered species. Until 1980, Tahquitz ivesia was thought to be extinct, when two populations were located in the

upper montane coniferous forest of the San Jacinto Wilderness in Riverside County. Vail Lake ceanothus is known from three populations all within the Vail Lake area. One known population of Wiggin's croton, a state rare species, occurs in the desert dune habitat of Imperial County.

Within the counties of the Southern Deserts Service Area thirteen other State or federally listed plant species occur in various habitats. Mesic montane meadows of the Service Area support both the slender-petaled thelypodium and bird's-foot checkerbloom. Alluvial fan habitats of the Service Area support slender-horned spineflower. Lower montane coniferous forest of the Service Area supports Cuyamaca Lake larkspur and Parish's checkerbloom. Vernal pools within the western portion of the Service Area provide habitat for the San Diego button-celery and California orcutt grass. Thread-leaved brodiaea, a California endangered species, occurs in clay soils throughout western Riverside and San Bernardino counties, often in association with vernal pool habitat. Clay soils of the Service Area also support Munz's onion, a state-threatened species. Peirson's milk-vetch and Algodones Dunes sunflower occur in the desert dune habitat of Imperial County. Unlike many of the other listed species of the Service Area, Nevin's barberry is widely distributed and occurs in many habitats, including chaparral, coastal scrub, oak woodland, and riparian scrub. As with the South Coast Service Area, Mexican flannel bush occurs in closed-cone forest, chaparral, and oak woodland habitats in association with gabbroic or serpentinite substrates.

Historically, populations of marsh sandwort, Gambell's water cress, and Mojave tarplant occurred within the Southern Deserts Service Area, however these populations have been extirpated. These plants species are known to occur in other parts of the State. Populations of these plants may occur in unsurveyed areas of suitable habitat.

6.5 *Plant Species Nomenclature*

The following is a list of plant species which corresponds to the common names of plants mentioned in Chapter 10 and the appendices of this report. In general, floral taxonomy used in this report follows the Jepson Manual (Hickman 1993). Floral taxonomy of special status species is based on the California Native Plant Society's *Inventory of Rare and Endangered Vascular Plants of California* (Skinner and Pavlik 1994). Common plant names, were based on many sources, including Hickman (1993), Munz and Keck (1968), Abrams (1923, 1944, and 1951), Abrams and Ferris (1960), and (Skinner and Pavlik 1994).

Common Name	Scientific Name
Acacia	*Acacia* species
Adobe sanicle	*Sanicula maritima*
Adobe sunburst	*Pseudobahia peirsonii*
Alepo pine	*Pinus halepensis*
Algodones Dunes sunflower	*Helianthus niveus* ssp. *tephrodes*
Amaranthus	*Amaranthus* species
Antioch Dunes evening-primrose	*Oenothera deltoides* ssp. *deltoides*
Bakersfield cactus	*Opuntia basilaris* var. *treleasei*
Bakersfield smallscale	*Atriplex tularensis*
Baltic rush	*Juncus balticus*
Barnyard grass	*Echinochloa crus-galli*
Beach layia	*Layia carnosa*
Beach spectaclepod	*Dithyrea maritima*
Begger's ticks	*Bidens frondosa*
Big berry manzanita	*Arctostaphylos glauca*
Big-leaf maple	*Acer macrophyllum*
Bigcone Douglas-fir	*Pseudotsuga macrocarpa*
Bigpod ceanothus	*Ceanothus megacarpa*
Bird-footed checkerbloom	*Sidalcea pedata*
Black oak	*Quercus kelloggii*
Black willow	*Salix gooddingii*
Blackberry	*Rubus* species
Blue elderberry	*Sambucus mexicana*
Blue gum	*Eucalyptus globulus*

Common Name	Scientific Name
Boggs Lake hedge-hyssop	*Gratiola heterosepala*
Box elder	*Acer negundo*
Braunton's milk-vetch	*Astragalus brauntonii*
Bristly sedge	*Carex* species
Brittlescale	*Atriplex depressa*
Broadleaf-filaree	*Erodium botrys*
Buckbrush	*Ceanothus cuneatus*
Bugleweed	*Lycopus americanus*
Bull thistle	*Cirsium vulagre*
Bush lupine	*Lupinus albifrons*
Butte County meadowfoam	*Limnanthes floccosa* ssp. *floccosa*
California buckeye	*Aesculus californica*
California bay	*Umbellularia californica*
California black walnut	*Juglans californica*
California blackberry	*Rubus ursinus*
California buckwheat	*Eriogonum fasciculatum*
California button-willow	*Cephalanthus occidentalis* var. *californicus*
California grape	*Vitus califorica*
California jewelflower	*Caulanthus californicus*
California mugwort	*Artemisia douglasiana*
California oatgrass	*Danthonia californica*
California orcutt grass	*Orcuttia californica*
California poppy	*Eschscholzia californica*
California sage	*Artemisia californica*
California seablite	*Suaeda californica*
Calistoga popcorn-flower	*Plagiobothrys strictus*
Camatta Canyon amole	*Chlorogalum purpureum* var. *reductum*
Canary grass	*Phalaris canariensis*
Canary Island pine	*Pinus canariensis*
Canyon live oak	*Quercus chrysolepis*
Caper fruited tropidocarpum	*Tropidocarpum capparideum*
Carquinez golden bush	*Isocoma arguta*
Cattail	*Typha latifolia*
Centaury	*Centaurium muehlenbergii*
Chamise	*Adenostoma fasciculatum*

Common Name	Scientific Name
Cheese weed	*Malva parviflora*
Chorro Creek bog thistle	*Cirsium fontinale* var. *obispoense*
Clara Hunt's milkvetch	*Astragalus clarianus*
Coachella Valley milkvetch	*Astragalus lentiginosus* var. *coachellae*
Coast live oak	*Quercus agrifolia*
Coast redwood	*Sequoia sempervirens*
Coastal dunes milkvetch	*Astragalus tener* var. *titi*
Cocklebur	*Xanthium strumarium*
Coffeeberry	*Rhamnus californica*
Colusa grass	*Neostapfia colusana*
Common cheeseweed	*Malva parviflora*
Common waterweed	*Elodea* species
Conejo buckwheat	*Eriogonum crocatum*
Conejo dudleya	*Dudleya abramsii* ssp. *parva*
Contra Costa goldfields	*Lasthenia conjugens*
Contra Costa wallflower	*Erysimum capitatum* ssp. *angustatum*
Cordgrass	*Spartina* species
Cottonwood	*Populus* species
Coyote bush	*Baccharis pilularis*
Coyote ceanothus	*Ceanothus ferrisae*
Crampton's tuctoria	*Tuctoria mucronata*
Creeping bent grass	*Agrostis alba*
Creeping wildrye	*Leymus triticoides*
Crownbeard	*Verbesina dissita*
Cuesta Pass checkerbloom	*Sidalcea hickmanii* ssp. *anomala*
Curly dock	*Rumex crispus*
Cushenbury buckwheat	*Eriogonum ovalifolium* var. *vineum*
Cushenbury milkvetch	*Astragalus albens*
Cushenbury oxytheca	*Oxytheca parishii* var. *goodmaniana*
Cuyamaca Lake downingia	*Downingia concolor* var. *brevior*
Cuyamaca Lake larkspur	*Delphinum hesperium* ssp. *cuyamacae*
Cuyamaca larkspur	*Delphinum hesperium* ssp. *cuyamacae*
Deerbrush	*Ceanothus integerrimus*
Del Mar manzanita	*Arctostaphylos glandulosa* ssp. *crassifolia*
Del Mar sand aster	*Corethrogyne filaginifolia* var. *linifolia*

Common Name	Scientific Name
Delta coyote-thistle	*Eryngium racemosum*
Delta mudwort	*Limosella subulata*
Delta tule pea	*Lathyrus jepsonii* var. *jepsonii*
Dog-tail grass	*Cynosurus echinatus*
Dogwood	*Cornus* species
Douglas fir	*Pseudotsuga menziesii*
Dudley's lousewort	*Pedicularis dudleyi*
Dwarf goldenstar	*Bloomeria humilis*
Eel grass	*Zostera marina*
Encinitas baccharis	*Baccharis vanessae*
Ferris's milkvetch	*Astragalus tener* var. *ferrisiae*
Few-flowered navarretia	*Navarretia leucocephola* ssp. *pauciflora*
Fiddleneck	*Amsinckia menziesii* var. *intermedia*
Foothill pine	*Pinus sabiniana*
Four-angled spike rush	*Eleocharis quadrangulata*
Fox sedge	*Carex vulpinoidea*
Foxtail	*Hordeum leporinum*
Fremont cottonwood	*Populus fremontii* ssp. *fremontii*
Gambell's watercress	*Rorippa gambellii*
Gaviota tarplant	*Hemizonia increscens* ssp. *villosa*
Giant reed	*Arundo donax*
Giant reed	*Arundo donax*
Goodding's black willow	*Salix gooddingii*
Green-leaf manzanita	*Arctostaphylos patula*
Greene's tuctoria	*Tuctoria greenei*
Gum plant	*Grindelia camporum*
Gum tree	*Liquidambar styraciflua*
Hairy orcutt grass	*Orcuttia pilosa*
Hearsts' ceanothus	*Ceanothus hea stiorum*
Hearsts' manzanita	*Arctostaphylos hookeri* ssp. *hearstiorum*
Heartleaf saltbush	*Atriplex cordulata*
Hedge bindweed	*Calystegia sepium*
Hedge-nettle	*Stachys* species
Himalayan blackberry	*Rubus discolor*
Hispid bird's-beak	*Cordylanthus mollis* ssp. *hispidus*

Common Name	Scientific Name
Hoary nettle	*Urtica dioica*
Holly-leaved cherry	*Prunus ilicifolia*
Hoover's eriastrum	*Eriastrum hooveri*
Hoover's spurge	*Chamaesyce hooveri*
Horehound	*Marrubium vulgare*
Hornwort	*Ceratophyllum demersum*
Incense cedar	*Calocedrus decurrens*
Indian cut grass	*Leersia oryzoides*
Indian Knob mountainbalm	*Eriodictyon altissimum*
Interior live oak	*Quercus wislizenii*
Italian thistle	*Carduus pycnocephalus*
Jeffrey pine	*Pinus jeffreyi*
Johnson grass	*Sorghum halepense*
Kern mallow	*Eremalche parryi* ssp. *kernensis*
La Graciosa thistle	*Cirsium loncholepis*
Laguna Beach dudleya	*Dudleya stolonifera*
Laguna Mountains aster	*Machaeranthera asteroides* var. *lagunensis*
Lane Mountains milkvetch	*Astragalus jaegerianus*
Large flowered fiddleneck	*Amsinckia grandiflora*
Lompoc yerba santa	*Eriodictyon capitatum*
Lyon's pentachaeta	*Pentachaeta lyonii*
Madrone	*Arbrutus menziesii*
Marcescent dudleya	*Dudleya cymosa* ssp. *marcescens*
Maritime ceanothus	*Ceanothus maritimus*
Marsh pennywort	*Hydrocotyle umbellata*
Marsh sandwort	*Arenaria paludicola*
Mason's lilaeopsis	*Lilaeopsis masonii*
Mediterranean mustard	*Hirschfeldia incana*
Metcalf canyon jewelflower	*Streptanthus albidus* ssp. *albidus*
Mexican flannel bush	*Fremontodendron mexicanum*
Mexican mosquito fern	*Azolla mexicana*
Milk-thistle	*Silybum marianum*
Modesto Ash	*Fraxinus velutina*
Mojave tarplant	*Hemizonia mohavensis*
Monterey pine	*Pinus radiata*

Common Name	Scientific Name
Monterey spineflower	*Chorizanthe pungens* var. *pungens*
Morro manzanita	*Arctostaphylos morrroensis*
Mountain mahogany	*Cercocarpus betuloides*
Mt. Gleason Indian paintbrush	*Castilleja gleasonii*
Mugwort	*Artemisia douglasiana*
Mulefat	*Baccheris viminea*
Munz's onion	*Allium munzii*
Naked-stemmed buckwheat	*Eriogonum nudum*
Napa blue grass	*Poa napensis*
Narrow-leaved milk weed	*Asclepias mexicana*
Nevin's barberry	*Berberis nevinii*
Nightshade	*Solanum* species
Nipomo Mesa lupine	*Lupinus nipomensis*
Nut grass	*Cyperus eragrostis*
Onion grass	*Melica imperfecta*
Orcutt's spineflower	*Chorizanthe orcuttiana*
Oregon ash	*Fraxinus latifolia*
Otay mesa mint	*Pogogyne nudiuscula*
Otay tarplant	*Hemizonia conjugens*
Pacific hairgrass	*Deschampsia cespitosa* ssp. *holciformis*
Pallid manzanita	*Arctostaphylos pallida*
Palmate-bracted bird's-beak	*Cordylanthus palmatus*
Parish's alkali-grass	*Puccinellia parishii*
Parish's checkerbloom	*Sidalcea hickmanii* ssp. *parishii*
Parish's daisy	*Erigeron parishii*
Parish's meadowfoam	*Limnanthes gracilis* ssp. *parishii*
Parrot's feather	*Myriophyllum aquaticum*
Peirson's milkvetch	*Astragalus magdalenae* var. *peirsonii*
Periwinkle	*Vinca major*
Pickleweed	*Salicornia* species
Pismo clarkia	*Clarkia speciosa* ssp. *immaculata*
Poison-hemlock	*Conium maculatum*
Poison-oak	*Toxicodendron diversilobum*
Polygonum species	*Polygonum* species
Ponderosa pine	*Pinus ponderosa*

Common Name	Scientific Name
Presidio clarkia	*Clarkia franciscana*
Purple needle grass	*Nassella pulchra*
Quail bush	*Atriplex lentiformis*
Rabbits's-foot grass	*Polypogon monspeliensis*
Rat-tailed fescue	*Festuca myuros*
Recurved larkspur	*Delphinium recurvatum*
Red brome	*Bromus rubens*
Red Rock tarplant	*Hemizonia arida*
Red willow	*Salix laevigata*
Ripgut brome	*Bromus diandrus*
Robust spineflower	*Chorizanthe robusta*
Rock sanicle	*Sanicula saxatilis*
Rose-mallow	*Hibiscus lasiocarpus*
Russian thistle	*Salsola tragus*
Salt marsh bird's-beak	*Cordylanthus maritimus* ssp. *maritimus*
San Bernardino Mountains bladderpod	*Lesquerella kingii* ssp.*bernardina*
San Clemente Island bedstraw	*Galium catalinense* ssp. *acrispum*
San Clemente Island bird's-foot trefoil	*Lotus argophyllus* var. *adsurgens*
San Clemente Island bushmallow	*Malacothamnus clementinus*
San Clemente Island larkspur	*Delphinium variegatum* ssp. *kinkiense*
San Clemente Island lotus	*Lotus dendroidens* var. *traskiae*
San Clemente Island woodland star	*Lithophragma maximum*
San Clemente Islands Indian paintbrush	*Castilleja grisea*
San Diego button-celery	*Eryngium aristulatum* var. *parishii*
San Diego mesa mint	*Pogogyne abramsii*
San Diego thorn-mint	*Acanthomintha ilicifolia*
San Joaquin woollythreads	*Lembertia congdonii*
Sandbar willow	*Salix sessilifolia*
Sanford's arrowhead	*Sagittaria sanfordii*
Santa Ana River woollystar	*Eriastrum densifolium* ssp. *sanctorum*
Santa Barbara sedge	*Carex barbarae*
Santa Catalina Island mountain-mahogany	*Cercocarpus traskiae*
Santa Clara Valley dudleya	*Dudleya setchellii*
Santa Monica Mountains dudleya	*Dudleya cymosa ovatifolia*
Santa Susana tarplant	*Hemizonia minthornii*

Common Name	Scientific Name
Santa Ynez false lupine	*Thermopsis macrophylla*
Scrub oak	*Quercus berberidifolia*
Seaside bird-beak	*Cordylanthus rigidus* ssp. *littoralis*
Sebastopool meadowfoam	*Limnanthes vinculans*
Sedges	*Carex* species
Shining willow	*Salix lucida*
Short-leaved dudleya	*Dudleya blochmaniae* ssp. *brevifolia*
Short-podded mustard	*Hirschfeldia incana*
Slender orcutt grass	*Orcuttia tenuis*
Slender-horned spineflower	*Dodecahema leptoceras*
Slender-leaved pondweed	*Potamogeton filiformis*
Slender-petaled thelypodium	*Thelypodium stenopetalum*
Slough thistle	*Cirsium crassicaule*
Small-leaved rose	*Rosa minutifolia*
Soft bird's-beak	*Cordylanthus mollis* ssp. *mollis*
Soft chess	*Bromus hordeaceus*
Soft rush	*Juncus effusus*
Sow's ear thistle	*Sonchus arvensis*
Sticky monkey flower	*Mimulus aurantiacus*
Stinging nettle	*Urtica dioica*
Stream dogwood	*Cornus sericea* ssp. *sericea*
Striped adobe lily	*Fritillaria striata*
Suisun Marsh aster	*Aster lentus*
Suisun thistle	*Cirsium hydrophilum* var. *hydrophilum*
Surf thistle	*Cirsium rhothophilum*
Sycamore	*Platanus racemosa*
Tahquitz ivesia	*Ivesia callida*
Tamarisk	*Tamarix* species
Tamarisk	*Tamarix* species
Telegraphweed	*Heterotheca grandiflora*
Thorne's buckwheat	*Eriogonum ericifolium* var. *thornei*
Thread-leaved brodiaea	*Brodiaea filifolia*
Tiburon Indian paintbrush	*Castilleja affinis* ssp. *neglecta*
Tobacco tree	*Nicotiana glauca*
Tocalate	*Centaurea melitensis*

Common Name	Scientific Name
Tree tobacco	*Nicotiana glauca*
Tree-of-heaven	*Ailanthus altissima*
Triple-ribbed milk vetch	*Astragalus tricarinatus*
Tule	*Scirpus* species
Turkey mullien	*Eremocarpus setigerus*
Twisselmann's nemacladus	*Nemacladus twisselmannii*
Umbrella nut-sedge	*Cyperus eragrostis*
Vail Lake ceanothus	*Ceanothus ophiochilus*
Valley oak	*Quercus lobata*
Valley spearscale	*Atriplex joaquiniana*
Verity's dudleya	*Dudleya verityi*
Vervain	*Verbena bonariensis*
Water hyacinth	*Eichhornia crassipes*
Water primrose	*Ludwigia peploides*
Water pygmyweed	*Crassula aquatica*
Water smartweed	*Polygonum amphibium*
White alder	*Alnus rhombifolia*
Wiggin's croton	*Croton wigginsii*
Wild barley	*Hordeum* species
Wild grape	*Vitis californica*
Wild oat	*Avena barbata*
Wild rose	*Rosa californica*
Willow	*Salix* species
Willow dock	*Rumex salicifolius*
Willow-herb	*Epilobium ciliatum*
Willowy monardella	*Monardella linoides* ssp. *viminea*
Wright's trichocoronis	*Trichocoronis wrightii*
Yellow iris	*Iris pseudocarpa*
Yellow-star thistle	*Centaurea solstitialis*
Yucca	*Yucca* species

6.6 *Wildlife Species Nomenclature*

The following list includes both the common and scientific names of the wildlife species mentioned in Chapter 10 and the appendices of this report. In general, the taxonomy follows *A Check-List of the Amphibians, Reptiles, Birds, and Mammals of California* (Laudenslayer et. al., 1991). The taxonomy of special status species is based on the CDFG's *Special Animals List* (CDFG August 1994).

Common Name	Scientific Name
Acorn woodpecker	*Melanerpes formicivorus*
Aleutian Canada goose	*Branta canadensis leucopareia*
Alligator lizard	*Gerrhonotus* species
American avocet	*Recurvirostra americana*
American badger	*Taxidea taxus*
American coot	*Fulica americana*
American crow	*Corvus brachyrhynchos*
American peregrine falcon	*Falco peregrinus anatum*
American kestrel	*Falco sparverius*
American robin	*Turdus migratorius*
American white pelican	*Pelecanus erythrorhynchos*
American widgeon	*Anas americana*
Anna's hummingbird	*Calypte anna*
Arizona Bell's vireo	*Vireo bellii arizonae*
Arroyo southwestern toad	*Bufo microscaphus californicus*
Ash-throated flycatcher	*Myiarchus cinerascens*
Bald eagle	*Haliaeetus leucocephalus*
Bank swallow	*Riparia riparia*
Barefoot banded gecko	*Coleonyx switaki*
Barn owl	*Tyto alba*
Barn swallow	*Hirundo rustica*
Barrow's goldeneye	*Bucephala islandica*
Bay's checkerspot butterfly	*Euphydryas editha bayensis*
Beaver	*Castor canadensis*
Belding's savannah sparrow	*Passerculus sandwichensis beldingi*
Belted kingfisher	*Ceryle alcyon*
Black bear	*Ursus americanus*
Black phoebe	*Sayornis nigricans*

Common Name	Scientific Name
Black-chinned hummingbird	*Archilochus alexandri*
Black-crowned night-heron	*Nycticorax nycticorax*
Black-headed grosbeak	*Pheucticus melanocephalus*
White-tailed kite	*Elanus caeruleus*
Black-tailed hare	*Lepus californicus*
Blunt-nosed leopard lizard	*Gambelia silus*
Bobcat	*Felis rufus*
Brant	*Branta bernicla*
Brewer's blackbird	*Euphagus cyanocephalus*
Brown-headed cowbird	*Molothrus ater*
Brush rabbit	*Sylvilagus bachmani*
Bufflehead	*Bucephala albeola*
Bullfrog	*Rana catesbeiana*
Burrowing owl	*Athene cunicularia*
Bushtit	*Psaltriparus minimus*
California black rail	*Laterallus jamaicensis coturniculus*
California brown pelican	*Pelecanus occidentalis*
California clapper rail	*Rallis longirostris obsoletus*
California condor	*Gymnogyps californianus*
California freshwater shrimp	*Syncaris pacifica*
California gnatcatcher	*Polioptila californica*
California ground squirrel	*Spermophilus beecheyi*
California gull	*Larus californicus*
California horned lark	*Eremophila alpestris*
California kingsnake	*Lampropeltis getulus*
California least tern	*Sterna antillarum browni*
California mastiff bat	*Eumops perotis californicus*
California mountain kingsnake	*Lampropeltis zonata*
California newt	*Taricha torosa*
California quail	*Callipepla californica*
California red-legged frog	*Rana aurora*
California tiger salamander	*Ambystoma tigrinum*
California thrasher	*Toxostoma redivivum*
California towhee	*Pipilo crissalis*
California wolverine	*Gulo gulo*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Caspian tern	*Sterna caspia*

Common Name	Scientific Name
Clark's grebe	*Aechmophorus clarkii*
Cliff swallow	*Hirundo pyrrhonota*
Coast horned lizard	*Phrynosoma coronatum*
Coachella Valley fringe-toed lizard	*Uma inornata*
Coastal western whiptail	*Cnemidophorus tigris*
Common goldeneye	*Bucephala clangula*
Common loon	*Gavia immer*
Common raven	*Corvus corax*
Cooper's hawk	*Accipiter cooperi*
Cottontail	*Sylvilagus* species
Coyote	*Canis latrans*
Delhi sands flower-loving fly	*Rhaphiomidas terminatus abdominalis*
Delta green ground beetle	*Elaphrus viridis*
Desert slender salamander	*Batrachoseps aridus*
Desert tortoise	*Gopherus agassizii*
Double-crested cormorant	*Phalacrocorax auritus*
Downy woodpecker	*Picoides pubescens*
El Segundo blue butterfly	*Euphilotes battoides allyni*
Elf owl	*Micrathene whitneyi*
Ferruginous hawk	*Buteo regalis*
Flat-tailed horned lizard	*Phrynosoma mcallii*
Foothill yellow-legged frog	*Rana boylii*
Fresno kangaroo rat	*Dipodomys nitratoides exilis*
Gadwall	*Anas strepera*
Garter snake	*Thamnophis sirtalis*
Giant garter snake	*Thamnophis couchii gigas*
Giant kangaroo rat	*Dipodomys ingens*
Gila woodpecker	*Melanerpes uropygialis*
Gilded northern flicker	*Colaptes auratus chrysoides*
Golden eagle	*Aquila chrysaetos*
Gopher	*Thomomys* species
Gopher snake	*Pituophis melanoleucus*
Granite spiny lizard	*Sceloporus orcutti*
Great blue heron	*Ardea herodias*
Great egret	*Casmerodius albus*
Great horned owl	*Bubo virginianus*
Greater roadrunner	*Geococcyx californianus*
Greater sandhill crane	*Grus canadensis tabida*

Common Name	Scientific Name
Greater scaup	*Aythya marila*
Greater white-fronted goose	*Anser albifrons*
Greater yellowlegs	*Tringa melanoleuca*
Green-backed heron	*Butorides striatus*
Hairy woodpecker	*Picoides villosus*
Herring gull	*Larus argentatus*
House finch	*Carpodacus mexicanus*
House mouse	*Mus musculus*
House sparrow	*Passer domesticus*
Kern Canyon slender salamander	*Batrachoseps simatus*
Kern primrose sphinx moth	*Euproserpinus euterpe*
Killdeer	*Charadrius vociferus*
Lange's metalmark butterfly	*Apodemia mormo langei*
Largemouth bass	*Micropterus salmoides*
Least bell's vireo	*Vireo bellii pusillus*
Light-footed clapper rail	*Rallus longirostris levipes*
Loggerhead shrike	*Lanius ludovicianus*
Long-billed curlew	*Numenius americanus*
Long-billed dowitcher	*Limnodromus scolopaceus*
Long-eared owl	*Asio otus*
Longhorn fairy shrimp	*Branchinecta longiantenna*
Mallard	*Anas platyrhynchos*
Marbled godwit	*Limosa fedoa*
Marsh wren	*Cistothorus palustris*
Merlin	*Falco columbarius*
Merriam's chipmunk	*Tamias merriami*
Mink	*Mustela vison*
Mohave ground squirrel	*Spermophilus mohavensis*
Mountain lion	*Felis concolor*
Mountain quail	*Oreortyx pictus*
Morro Bay kangaroo rat	*Dipodomys heermanni morroensis*
Mourning dove	*Zenaida macroura*
Mule deer	*Odocoileus hemionus*
Muskrat	*Ondatra zibethicus*
Northern flicker	*Colaptes auratus*
Northern goshawk	*Accipiter gentilis*
Northern harrier	*Circus cyaneus*
Northern mockingbird	*Mimus polyglottos*

Common Name	Scientific Name
Northern oriole	*Icterus galbula*
Northern pintail	*Anas acuta*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Northern sea lions	*Eumetopias jubatus*
Northern shoveler	*Anas clypeata*
Northern spotted owl	*Strix occidentalis caurina*
Norway rat	*Rattus norvegicus*
Nuttall's woodpecker	*Picoides nuttallii*
Osprey	*Pandion haliaetus*
Pacific pocket mouse	*Perognathus longimembris pacificus*
Pacific treefrog	*Hyla regilla*
Pallid bat	*Antrozous pallidus*
Penisular big horn sheep	*Ovis canadensis cremnobates*
Plain titmouse	*Parus inornatus*
Prairie falcon	*Falco mexicanus*
Purple martin	*Progne subis*
Raccoon	*Procyon lotor*
Red fox	*Vulpes vulpes*
Red-shouldered hawk	*Buteo lineatus*
Red-tailed hawk	*Buteo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Redhead	*Aythya americana*
Ring-billed gull	*Larus delawarensis*
Ring-necked duck	*Aythya collaris*
Ring-necked pheasant	*Phasianus colchicus*
Ringtail	*Bassariscus astutus*
River otter	*Lutra canadensis*
Riverside fairy shrimp	*Streptocephalus woottoni*
Rock dove	*Columba livia*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Sacramento Valley tiger beetle	*Cieindela hirticollis abrupta*
Sage sparrow	*Amphispiza belli*
Salt-marsh harvest mouse	*Reithrodontomys raviventris*
Salt-marsh wandering shrew	*Sorex vagans halicoetes*
San Diego banded gecko	*Coleonyx variegatus abbotti*
San Diego horned lizard	*Phrynosoma coronatum blainvillei*
San Joaquin antelope squirrel	*Ammospermophilus nelsoni*
San Joaquin kit fox	*Vulpes macrotis mutica*

Common Name	Scientific Name
San Joaquin pocket mouse	*Perognathus inornatus inornatus*
San Joaquin whipsnake	*Masticophis flagellum ruddocki*
San Pablo song sparrow	*Melospiza melodia samuelis*
Sandhill crane	*Grus canadensis*
Scrub jay	*Aphelocoma coerulescens*
Sharp-shinned hawk	*Accipiter striatus*
Short-eared owl	*Asio flammeus*
Sierra Nevada red fox	*Vulpes vulpes necator*
Snowy egret	*Egretta thula*
Song sparrow	*Melospiza melodia*
Southern rubber boa	*Charina bottae umbratica*
Southern sagebrush lizard	*Sceloporus graciosus*
Southern sea otter	*Enhydra lutris nereis*
Stephen's kangaroo rat	*Dipodomys stephensi*
Striped skunk	*Mephitis mephitis*
Suisun ornate shrew	*Sorex ornatus sinousos*
Suisun song sparrow	*Melospiza melodia maxillaris*
Swainson's hawk	*Buteo swainsoni*
Swainson's thrush	*Catharus ustulatus*
Tipton kangaroo rat	*Dipidomys nitratoides nitratoides*
Tree swallow	*Tachycineta bicolor*
Tricolored blackbird	*Agelaius tricolor*
Two-striped garter snake	*Thamnophis hammondii*
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*
Violet-green swallow	*Tachycineta thalassina*
Virginia opossum	*Didelphis virginiana*
Warbling vireo	*Vireo gilvus*
Western fence lizard	*Sceloporus occidentalis*
Western gray squirrel	*Sciurus griseus*
Western grebe	*Aechmophorus occidentalis*
Western meadowlark	*Sturnella neglecta*
Western pond turtle	*Clemmys marmorata*
Western rattlesnake	*Crotalus viridis*
Western sandpiper	*Calidris mauri*
Western screech owl	*Otus kennicottii*
Western snowy plover	*Charadrius alexandrinus nivosus*
Western spadefoot toad	*Scaphiopus hammondii*
Western toad	*Bufo boreas*

Common Name	Scientific Name
Western wood-pewee	*Contopus sordidulus*
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*
White-breasted nuthatch	*Sitta carolinensis*
White-crowned sparrow	*Zonotrichia leucophrys*
White-faced ibis	*Plegadis chihi*
White-throated swift	*Aeronautes saxatalis*
Willet	*Catoptrophorus semipalmatus*
Willow flycatcher	*Empidonax traillii*
Winter wren	*Troglodytes troglodytes*
Wood duck	*Aix sponsa*
Yellow warbler	*Dendroica petechia*
Yellow-billed cuckoo	*Coccyzus americanus*
Yellow-billed magpie	*Pica nuttalli*
Yellow-breasted chat	*Icteria virens*
Yellow-rumped warbler	*Dendroica coronata*
Yuma clapper rail	*Rallus longirostris yumanensis*

6.7 *Terrestrial Biological Mitigation and Monitoring*

Revegetation of Construction Sites

The following elements shall be included in the revegetation of the construction sites for the intake structure, flow control structures, and fish control structure:

> *The objective of this revegetation program is to restore native vegetation to onsite habitats that have been degraded by construction related activities. Non-native plants such as Himalayan blackberry, giant reed, tamarisk, and non-native grasses would not be planted.*
>
> *Specific goals should include the establishment of riparian scrub, freshwater marsh, and wildrye grassland in comparable acreage as were lost during construction.*
>
> *At the Grant Line and northern intake sites, native riparian scrub vegetation should be replanted, including shining willow, sandbar willow, white alder, California blackberry, and California button-willow.*
>
> *For slope stability and to reduce potential erosion, areas mapped as blackberry thicket within the construction zones at the Grant Line and Old River flow barrier sites will be replanted with a total of native riparian scrub species as listed above.*
>
> *At the northern intake site, Valley wildrye grassland will be recreated by hydroseeding creeping wildrye, stinging nettles, California mugwort, and polygonum. Hydroseeding should take place in the fall, to coincide with the rainy season.*
>
> *At the Grant Line Canal and Middle River sites, freshwater marsh vegetation should be replanted onsite, unless this replanting is determined to be infeasible. In such circumstances, these plantings will occur at an off-site location.*

All plantings should be maintained for a period of five years. This includes weed removal, inspection of the irrigation system, herbivory protection, and other actions necessary to ensure the survival of these plantings. Replanting and monitoring of the riparian and freshwater marsh plantings should be conducted to ensure that these sites achieve 80 percent cover of target species in five years time.

Monitoring reports on the survival of plantings should be submitted on an annual basis to the CDFG, ACOE, and USFWS as specified in the ISDP Mitigation Report.

Monitoring and replanting should continue until the riparian scrub plantings reach 80 percent cover by woody species, the freshwater marsh areas reach 80 percent cover, and Valley wildrye grassland areas reach 90 percent cover.

Freshwater Marsh Habitat

The construction of the northern intake and Grant Line sites would result in the permanent loss of 0.61 acres of freshwater marsh habitat. To compensate for the loss of freshwater marsh habitat, DWR and Reclamation should plant freshwater emergent vegetation at an offsite location according to the following specifications:

The DWR and Reclamation should locate areas of streamside habitat in the Delta where freshwater marsh revegetation could be technically feasible. Ideal sites include areas with minimal wake disturbance, shallow water depths, and slow water velocities. Site selection should avoid areas where dredging and other channel improvements are likely to occur. The DWR and Reclamation should obtain access to these sites through conservation easement or fee title.

Prior to construction, tules and other emergent vegetation will be salvaged from the Grant Line site. Tubers from these plants will be anchored in the shallow water. Non-native plants such as water hyacinth and parrot feather should not be planted.

Planting depth should be determined by observation of conditions at the Grant Line site.

All plantings should be maintained.

Monitoring reports on the survival of plantings should be submitted on an annual basis to the CDFG, ACOE, and USFWS as specified in the ISDP Mitigation Report.

Monitoring and replanting should continue until the freshwater marsh areas reach 80 percent cover.

Riparian Scrub Habitat

The construction of the northern intake structure and the Grant Line barrier would result in the loss of 1.36 acres of riparian scrub habitat. Construction of the Old River site near DMC would result in the loss of 0.61 acres of blackberry scrub. To compensate for the loss of these habitats DWR and Reclamation should create riparian scrub habitat at another location along the waterways of the south Delta. The riparian scrub habitats will be created according the specifications below:

The DWR and Reclamation should locate an area in the Delta where riparian scrub revegetation could be technically feasible. For maximum benefit to the aquatic habitat the plantings should be located on the south side of the waterway. Site selection should avoid areas where dredging and other levee or channel improvements are likely to occur. The DWR and Reclamation should obtain access to the site either through conservation easement or fee title.

Plantings of shining willow, sandbar willow, white alder, stream dogwood, and California button-willow should be installed at appropriate levels along the levee in relation to the water level. Willows and dogwood may be planted from rooted cuttings. Other species should be planted from container stock. All planting material should be genetic stock from the Delta, as these plants are best suited to the region. Herbivory protection should be installed as needed.

All riparian scrub plantings should be maintained for a period of five years, including weed removal, inspection of the irrigation system, herbivory protection, and other actions necessary to ensure the survival of these plantings. Replanting and monitoring of the riparian plantings should be conducted to ensure that these sites achieve 80 percent cover of woody species in five years time.

Monitoring reports on the survival of plantings should be submitted on an annual basis to the CDFG, ACOE, and USFWS. Reports should include the following: a map showing the location of each revegetation site; general description of site conditions; height and cover measurements of riparian scrub plantings; species diversity; and problems onsite with corrective measures needed to ensure success criteria. Onsite problems may include vandalism, irrigation system failure, and herbivory.

Monitoring and replanting should continue until the riparian scrub plantings reach 80 percent cover by woody vegetation.

Valley Wildrye Grassland

The construction of the proposed northern intake structure would result in the loss of 8.86 acres of Valley wildrye grassland. To compensate for this loss, DWR and Reclamation should create Valley wildrye grassland habitat at another location in the Delta. Habitat creation will occur as specified below:

The DWR and Reclamation should locate areas in the south Delta where creation of Valley wildrye grassland habitat could be technically feasible. Ideal sites include areas with little disturbance and prolonged soil moisture into the growing season. Site selection should avoid sites where levee maintenance or other activities may preclude site establishment. The DWR and Reclamation should obtain access to the site either through conservation easement or fee title.

Depending on site conditions, prior to seeding the soil may need to be cultivated to a depth of 3 to 5 inches. The sites should be hydroseeded with a mixture of species observed at the northern intake site, including creeping wildrye, stinging nettles, California mugwort, and polygonum.

Where possible genetic stock from the south Delta should be used, as these plants are best suited to the regional conditions.

All plantings should be maintained for a period of five years, including weed removal and other actions necessary to ensure the survival of these plantings. Reseeding and monitoring of this site should be conducted to ensure that the revegetation effort achieves 80 percent cover by herbaceous species in five years time.

Monitoring reports on the survival of these plantings should be submitted on an annual basis to the CDFG and USFWS. Reports should include the following information: a map showing the location of the revegetation site; a list of species occurring on-site, density of the Valley wildrye grassland, as determined from fixed meter square sampling plots; and problems onsite and corrective measures needed to ensure that the success criteria is met. Onsite problems may include vandalism and herbivory.

Monitoring and replanting should continue until the Valley grassland habitat reaches 80 percent cover by herbaceous species.

Monitoring of Scour

Because of the dynamic nature of the Delta, the precise degree and location of scouring along Old River cannot be accurately predicted. The following program should be implemented by DWR and Reclamation after the dredging of Old River is completed:

The DWR and Reclamation should compare aerial photography taken one year after dredging with photography taken before dredging. Any losses of freshwater marsh vegetation not associated with bank stabilization projects should be compensated for by offsite replanting of freshwater marsh vegetation adjacent to south Delta waterways. Annual monitoring in this fashion should continue for five years or until no loss of vegetation due to scour is detected. Reports noting the progress of this monitoring should be prepared annually and submitted to the ACOE, CDFG and USFWS.

Should this procedure indicate that a project related loss of vegetation has occurred, then revegetation according to the specifications described in previous mitigation measures should occur.

Raptor Nest Avoidance

Should the proposed construction or dredging conflict with nesting raptors, the following measures should be instituted:

Should an active raptor nest occur near construction or dredging areas, activities that may be disruptive to nesting species should be avoided until the biological monitor determines that the young raptors have fledged the nest. Fledglings will leave the nest at various times depending on the species, time of year, and other case specific factors.

Should an active raptor nest occur along a section of the proposed truck route where increased truck traffic may affect nesting birds, the truck route should be altered during the breeding and nesting season to avoid nest disruption. Areas of concern include nests occurring along remote levee roads where regular truck traffic is uncommon, especially unpaved roads in agricultural areas.

Raptor Protection

To avoid raptor electrocutions, prior to construction DWR should incorporate the following design criteria into the final power line configuration:

Where possible single phase poles should be installed with sided-mounted insulators positioned 30 inches below the top of the pole and 24 to 48 inches above the accompanying neutral wire. This configuration is preferable to traditional top-mounted insulators that allow for electrocution of a raptor when the breast of the bird touches the energized phase and the bird's tail touches the ground wire (Olendorff et al. 1981).

Where top-mounted insulators are required, two 4-inch gaps should be placed in the ground wire between the top-mounted phase and the accompanying neutral ground wire. This configuration shall prevent

raptor electrocutions, and allow for lightning to spark over the gaps (Olendorff et al. 1981).

Where crossarms are required, a distance of 60 inches between phases and/or ground neutral wires should be maintained at all locations along the power line. Additionally, perch guards should be placed on the crossarms to prevent perching (Olendorff et al. 1981).

All transformers installed with the power line should include insulation of transformer risers and jumpers to prevent electrocutions of raptors (Olendorff et al. 1981).

Delta Tule Pea

Prior to construction of the Grant Line barrier site, the DWR and Reclamation should relocate the structure to the eastern end of the canal (avoiding operational impacts on Delta Tule Pea) or prepare and implement a plan to establish a new population of Delta tule pea. The program should include the following elements:

Prior to construction, DWR and Reclamation should locate suitable habitat where establishment of Delta tule pea is technical feasible. The size of the site should be adequate to support a population of Delta tule pea the same size as the existing population. The area required for planting is 0.02 acres. Site access should be made through conservation easement or fee title. Site selection criteria should include riparian scrub habitat in areas with little or no disturbance from such activities as recreational boating, channel dredging, and levee maintenance. Site selection should avoid areas where dredging and other channel improvements are likely to occur. Site selection may include areas adjacent to the existing population which are above the project created maximum water elevation.

Delta tule pea is not expected to tolerate transplanting, therefore seeds should be collected prior to construction. The existing plants should not be removed. All seeds collected should be started in containers with soil from the Delta. Plants should be planted at the new site with herbivory protection (tubex tubing).

All plantings should be maintained for a period of five years, including weed removal, replanting, replacement of the herbivory protection, and other actions necessary to ensure the survival of planted Delta tule pea. Should the existing population not survive the increases in water levels, replanting and monitoring of the new plantings should be conducted to ensure this population achieves 80 percent survival over five years time.

Monitoring reports on the survival of existing plants and the new plantings should be submitted on an annual basis to the CDFG and USFWS. Reports should include the following information: a map showing the location of the revegetation site and the existing population; survival of the new and existing plants, and height and cover measurements of Delta tule pea plantings. Seed production of the new plantings should also be evaluated in comparison with a control population to determine whether or not the new population is self-sustaining. Problems onsite and corrective measures needed to ensure success criteria should be included in the annual monitoring report. (Onsite problems may include vandalism, trash dumping, weeds, or herbivory.)

Monitoring and replanting should continue until the plantings reach 80 percent survival over five years.

Mason's Liliaeopsis

For construction related impacts DWR and Reclamation should prepare a plan for the transplanting of the Mason's lilaeopsis. The plan should be based on the *Barker Slough Mason's Lilaeopsis Transplant Study* (ECOS, Inc. 1988 and McCarten 1991). This program has shown that Mason's lilaeopsis can be successfully transplanted. Prior to implementation, the plan will be reviewed and approved by the CDFG. Elements of the plan should include the following:

The goals for the Mason's lilaeopsis mitigation plan should include preservation of existing populations of Mason's lilaeopsis and 80 percent survival of the transplanted populations at the end of the a five-year monitoring period on a cover and population basis (ECOS, Inc. 1988).

Prior to construction, the DWR and Reclamation should locate suitable habitat where transplanting of Mason's lilaeopsis is technically feasible. Site access should be made through conservation easement or fee title. Where State or federally owned lands are available, these sites may also be used. Site selection criteria should include areas with tidal influences, little or no disturbance from such activities as recreational boating, channel dredging, and levee maintenance. Selection should also include occupied habitat where Mason's lilaeopsis is abundant. Site selection should avoid areas where dredging and other channel improvements are likely to occur.

The DWR and Reclamation should provide onsite management and maintenance for five years, including replanting, trash removal, and other measures to ensure that the revegetation goals are met.

Transplanting methods from the Barker Slough Mason's Lilaeopsis Transplant Study (ECOS, Inc. 1988) will be used, as these methods have proven successful in the relocation of Mason's lilaeopsis populations.

The DWR and Reclamation should monitor the transplanted populations for five years following transplanting.

Populations should be measured on a cover basis as described in the Monitoring of Transplanted Mason's Lilaeopsis Populations in Barker Slough (McCarten 1991). Some allowances in the monitoring should be made for site specific conditions and regeneration outside the fixed quadrant monitoring stations.

Monitoring should occur on a quarterly basis for the first year, and on an annual basis in June for the following 4 years. The DWR and Reclamation should submit annual reports to the CDFG and USFWS, including a map showing the location of each transplant site; cover measurements of transplanted populations, and problems onsite and corrective measures needed to ensure that the success criteria are met. (Onsite problems may include vandalism, trash dumping, weeds, or herbivory.)

Rose-Mallow

Extensive surveys located two populations upstream from the Middle River barrier site and one population upstream from the Grant Line site (DWR December 1992). The operation of the barriers at Middle River and Grant Line Canal could inundate rose-mallow populations. Operational impacts at the Middle River location should be mitigated by implementing the reseeding protocol below. Operational impacts on rose-mallow populations at the Grant Line barrier site may be avoided by relocation of the barrier to an eastern location on the canal, that places these plants downstream from the barrier. To mitigate for potential operational impacts on rose-mallow populations at Grant Line Canal, DWR and Reclamation should either implement the following protocol or relocate the structure to the eastern location.

The goal of these efforts is establishment of the same number of plants as currently occurring upstream of the barriers with an 80 percent success rate.

Prior to construction, the DWR and Reclamation should locate suitable habitat where establishment of rose-mallow is technically feasible. Site access should be made through conservation easement or fee title. Where State or federally owned lands are available, these sites may also be used. Site selection criteria should include areas with little or no disturbance from such activities as recreational boating, channel dredging, and levee maintenance. Site selection should avoid areas where dredging and other channel improvements are likely to occur. These plantings may occur with other mitigation related plantings.

All plantings should be maintained for a period of three years, including weed removal and other actions necessary to ensure the survival of rose-mallow. Seeding and monitoring of the plantings should be conducted to ensure that these sites achieve 80 percent survival over three years time.

Monitoring reports on the survival of plantings should be submitted on an annual basis to the CDFG and USFWS. Reports should include the following information: a map showing the location of each site, height and cover measurements of rose-mallow plantings; seed production should also be evaluated; and problems onsite and corrective measures

needed to ensure success criteria. (Onsite problems may include vandalism, trash dumping, weeds, or herbivory).

Monitoring and reseeding should continue until the plantings achieve 80 percent survival over three years.

Swainson's Hawk Nesting

Because of the close proximity of the nest site to the proposed barrier site, the avoidance of construction activities that may disturb nesting Swainson's hawks is unavoidable. The following measures should be implemented by the DWR and Reclamation prior to construction:

In adherence with the guidelines published by the CDFG, the DWR and Reclamation should continue to consult with the CDFG through the CEQA process. During the course of this project, the DWR and Reclamation have included the CDFG in the CEQA process as well as working group meetings. Prior to project construction the DWR and Reclamation should obtain a permit or memorandum of understanding (MOU) from the CDFG, pursuant to Section 2081 of the California Fish and Game Code.

Should construction activities begin before the breeding and nesting season, Swainson's hawks may not use the Grant Line nest site. Construction activities will not begin at this site while the nest is active. Construction will not begin until the biological monitor determines that all young hawks have fledged.

Swainson's Hawk Foraging Habitat

To mitigate for the loss of 5.8 acres of foraging habitat within one mile of a nest tree, the DWR and Reclamation should comply with the CDFG Management Conditions as specified in the *Staff Report regarding Mitigation for Impacts to Swainson's Hawks* (Buteo swainsonii) *in the Central Valley of California.* As per these guidelines, the following are the terms that should be included in the final mitigation agreement:

DWR and Reclamation should provide 5.8 acres of Habitat Management land (at least 10 percent of the HM land requirements should be met by fee title acquisition or a conservation easement allowing for the active

management of the habitat, with the remaining 90 percent of the HM lands protected by a conservation easement [acceptable to the CDFG] on agricultural lands or other suitable habitats that provide foraging habitat for Swainson's hawks); and

DWR and Reclamation should provide for the long term management of the HM lands by funding a management endowment at the rate of $400 per HM land acre.

Giant Garter Snakes

Implementation of the following mitigation measures is expected to reduce impacts to giant garter snakes to a less-than-significant level.

The proposed project may result in the loss of giant garter snakes, a federally threatened species. As such, this project would require compliance with the FESA. Therefore, prior to dredging the DWR and Reclamation must comply with the FESA. Because this project requires federal permits, the DWR and Reclamation must consult with the USFWS pursuant to Section 7 of the FESA. Prior to dredging this permit should be obtained. During the dredging of the project, the DWR, Reclamation, and the contractor should abide by all the provisions of the consultation.

In accordance with guidelines published by the CDFG (CDFG February 1986), the DWR and Reclamation should continue consultation with CDFG staff to verify that the project is in compliance with the CESA. These guidelines indicate that CDFG consultation is included within the CEQA process. Previously, the DWR and Reclamation have solicited comments from the CDFG in the NOP process and included CDFG in working group meetings. Because the project may affect populations of giant garter snakes on Victoria Island, the DWR and Reclamation should obtain a 2081 permit prior to dredging on Old River.

To avoid direct impacts to the giant garter snakes and the loss of giant garter snake habitat, during construction the contractor will avoid placing dredge material in the agricultural drains of Victoria Island.

Appendix 7

Boat Survey Report

BOAT SURVEY REPORT
3/14/96

Purpose of Report

Boat surveys have been conducted over the years because of concerns over the impact of proposed channel flow control structures on recreational boating and emergency-response boating. This report presents the survey data and conclusions drawn.

Background

The Delta is a major recreational area with valuable and unique assets. Recreational development is spread throughout the Delta and can be classified as private (over 20 yacht clubs), commercial (over 100 marinas, with a value of at least $100 million), and public facilities. There are 22 public recreational areas in the Delta, including 5,450 acres of fishing access sites, parks and recreation sites, hunting areas, and boat launch areas. In the south Delta, there are about 20 existing recreational facilities, including several large marinas. The south Delta channels are heavily used for boating, fishing, and other water activities. It is estimated that 25% of the recreation in the Delta occurs in the south Delta area. Any restriction or change in operation of the export facilities may impact the recreation industry of the south Delta.

SDWA Lawsuit

In July 1982, the South Delta Water Agency filed a lawsuit concerning the effects of State Water Project and Central Valley Project operations on the south Delta. The suit sought declaration of rights of the parties, a preliminary injunction, and a permanent injunction requiring that the projects be operated to protect the south Delta. Later, in October 1986, the Department of Water Resources, the United States Bureau of Reclamation and SDWA entered into an agreement on a framework for settling the litigation brought by SDWA. In August 1990, the three agencies signed a letter of language agreement to implement a five year testing period of temporary barriers followed by construction of permanent barriers to prevent litigation.

Temporary Barriers Program

As a result of this agreement, temporary barriers were proposed to be installed on Middle River near Victoria Canal, Old River near the San Joaquin River, Old River near the Delta Mendota Canal intake (Old River near Tracy), and on the west end of Grant Line Canal. The Old River near the San Joaquin River barrier has been installed in the fall of most years since 1968 and more recently for a short time in the spring. The Middle River barrier has been installed since the spring of 1987. The Old River near Tracy barrier was installed beginning in 1991. The Grant Line

Canal barrier is proposed to be installed in the spring of 1996. These barriers are a part of the Temporary Barriers Program and are proposed to be installed annually through 2001. Throughout the testing and evaluation period, water levels and water quality are being monitored in addition to the impacts to fisheries, wildlife, and recreation in the south Delta.

Coordination with Boating Interests

DWR and USBR has coordinated, and will continue to coordinate, all activities with the boating interests groups to determine the best possible solution for the south Delta problems. To minimize inconveniences to boaters, DWR has held public scoping meetings, conducted boat surveys, and included boat portage facilities in the design of the barriers.

In 1990, public hearings concerning issues related to the draft EIR/EIS for the South Delta Water Management Program were held in Sacramento and Tracy. Several boaters and boating groups attended the hearings and expressed concerns with the program. In addition to these hearings, DWR and USBR has met several times with boaters, marina owners, the San Joaquin Sheriff's Department, and boating groups to discuss these issues in more detail. The main concern of these groups is that the barriers would deter boaters from using the south Delta.

Several marinas stated that boating interests would decrease in the areas of the barriers. They feel that the boaters would not utilize the boat portage facilities provided and that they would take their business to other areas. One marina located on the east end of Grant Line Canal is concerned with the Grant Line Canal barrier. Grant Line Canal is a very popular channel for water skiing and they feel the barrier would discourage the boaters. They believe the barrier would isolate them and force them to close their business. Several private clubs believe the barriers would be an inconvenience they do not feel is necessary. Additionally, one island owner is concerned with accessibility of his property by boat.

The San Joaquin County Sheriff's Department, which patrols the Delta with two 21-foot and two 22-foot patrol boats, is concerned that the barriers would slow the emergency response time. Each officer has a large area to patrol and sometimes travels a long distance to respond to an emergency. The Sheriff's Department personnel have priority use of the barriers' boat portage facilities, but any delay to cross the barrier may be critical. Also of concern are the after hours emergencies. The boat portage facilities have been closed after dark and the Sheriff's Department must have a way to cross the barrier when there is an emergency. One possible solution would be to store a boat inside the barrier area to respond to emergency calls within that area. Other alternatives include giving the Sheriff's Department keys to all facilities or to operate the barriers on a 24-hour basis. A feasible solution will have to be coordinated

with the San Joaquin Sheriff's Department.

Boat Portage Facilities

To minimize impacts on boaters, boat portage facilities would be installed at each of the barriers. Any barriers included in the Interim South Delta Management Program would have boat locks, ramps, or jib cranes.

Boat Survey

In an effort to determine the actual boating usage at the locations of the proposed barriers, DWR conducted boat surveys on five different days in each of several years. The days were classified into three categories: typical weekend, typical weekday, and holiday. At each proposed barrier location, the number of boats using the channel were counted from 8:00 a.m. to 6:00 p.m. The proposed barrier locations (and corresponding data tables)are as follows:

- head of Old River near the San Joaquin River (Old River at San Joaquin River and San Joaquin River at Old River)
- Middle River near Victoria Canal (Middle River)
- west end of Grant Line Canal (West Grant Line Canal)
- Old River near the Delta Mendota Canal intake (Old River near Tracy)
- Alternate Grant Line Canal site just east of the Tracy Boulevard bridge (East Grant Line Canal)

Data

Table 1 shows the total number of counted boats at each location for the three different types of days. In order to prevent repetition, a boat was counted once in each direction of travel. If a boat was recognized as being counted previously, it was not counted again. The table also shows the type of boat and type of activity.

At the head of Old River site, the count was broken down to show whether the boats were traveling down Old River or the San Joaquin River.

Figures 1 through 6 compare the boating activity on weekdays, weekends, and holidays for each site; and the type of boats for each site. Figure 7 compares the average level of boating activity at the various sites on weekdays, weekends, and holidays.

Conclusions

As shown in Figures 1 through 6, the majority of the boats

are ski boats. As shown in the same figures and Figure 7, the channels have the greatest usage on the holidays and weekends. As expected, the number of boats decreases on a typical weekday. Generally, on each day, Grant Line Canal and the head of Old River had a large number of boats and Middle River and Old River near Tracy had limited usage. The lower numbers at the latter locations are due to shallow channels upstream of the sites. Also, the west Grant Line location was used more often than the east Grant Line location (data was gathered for one year only at the east site).

Recommendations

Coordination with boating groups, marina owners, and the San Joaquin County Sheriff's Department will continue. As each temporary barrier is constructed, data will continue to be collected to determine the usage and the impacts of the facilities. All the information gathered during the temporary barrier phase will be used to plan safe and efficient permanent structures.

OLD RIVER AT SAN JOAQUIN RIVER

Table 1. Boater Traffic, 1991-1995

1991

BOAT TYPE	Mon, May 27 (holiday)	Wed, June 5	Sat, June 8
Aluminum	0	7	3
Ski Boat	64	6	57
Cruiser	0	0	1
Jet Ski	14	0	2
Other	1	0	1
TOTAL	79	13	64

BOATING ACTIVITY			
Water Ski	14	4	11
Fish	14	0	1
Cruise	34	9	50
Other	12	0	2
TOTAL	74	13	64

Boat Size (ft)
Aluminum 0-14
Ski Boat 15-22
Cruiser 23+

1992

BOAT TYPE	Wed, July 22	Sat, July 25	Wed, Aug 19	Sat, Aug 22	Sat, Sept. 5 (holiday)	Wed, Sept. 16
Aluminum	0	2	0	2	3	1
Ski Boat	5	29	9	56	43	1
Cruiser	0	2	0	3	1	0
Jet Ski	2	1	0	2	9	0
Other	0	1	1	0	2*	1
TOTAL	7	35	10	63	56	3

* Sheriff's Boat

BOATING ACTIVITY						
Water Ski	0	2	3	12	8	0
Fish	0	0	0	1	0	0
Cruise	5	32	7	48	41	1
Other	2	1	0	2	9	2
TOTAL	7	35	10	63	58	3

1993

BOAT TYPE	Wed, June 23	Wed, July 14	Sat, July 17	Wed, Aug 18	Sat, Aug 21	Sat, Sept 5 (holiday)
Aluminum	2	1	0	2	3	3
Ski Boat	10	5	29	4	50	40
Cruiser	0	0	3	1	0	3
Jet Ski	4	6	13	0	10	7
Other	0	0	0	0	2	0
TOTAL	16	12	45	7	65	53

BOATING ACTIVITY						
Water Ski	0	3	10	2	7	9
Fish	0	2	0	0	0	3
Cruise	12	1	22	5	48	34
Other	4	6	13	0	10	7
TOTAL	16	12	45	7	65	53

1995

BOAT TYPE	Wed, July 12	Sat, July 15	Wed, Aug 9	Sat, Aug 12	Sat, Sept 2 (holiday)	Wed, Sept 6
Aluminum	1	0	0	4	0	1
Ski Boat	3	54	18	42	55	7
Cruiser	0	0	0	0	0	0
Jet Ski	0	11	2	24	8	10
Other	0	0	0	0	0	0
TOTAL	4	65	20	70	63	18

BOATING ACTIVITY						
Water Ski	0	18	4	10	11	0
Fish	0	0	0	0	2	0
Cruise	4	36	14	36	51	7
Other	0	11	2	24	0	11
TOTAL	4	65	20	70	64	18

SAN JOAQUIN RIVER AT OLD RIVER

Table 1 (cont'd)

1991

BOAT TYPE	Mon, May 27 (holiday)	Wed, June 5	Sat, June 8
Aluminum	2	6	8
Ski Boat	70	25	162
Cruiser	3	0	0
Jet Ski	7	10	41
Other	2	0	2
TOTAL	84	41	213

BOATING ACTIVITY			
Water Ski	12	13	59
Fish	1	1	3
Cruise	64	17	110
Other	7	10	41
TOTAL	84	41	213

Boat Size (ft)
Aluminum 9-14
Ski Boat 15-22
Cruiser 23+

1992

BOAT TYPE	Wed, July 22	Sat, July 25	Wed, Aug 19	Sat, Aug 22	Sat, Sept. 5 (holiday)	Wed, Sept. 16	Sat, Sept. 19
Aluminum	2	7	0	6	9	3	12
Ski Boat	20	107	49	109	117	13	74
Cruiser	0	6	0	2	5	0	2
Jet Ski	9	22	8	16	32	6	23
Other	2	2	0	2	3	0	0
TOTAL	33	144	57	135	166	22	111

BOATING ACTIVITY							
Water Ski	1	43	24	25	45	9	19
Fish	1	3	0	1	1	1	5
Cruise	21	75	25	93	88	6	63
Other	10	23	8	16	32	6	24
TOTAL	33	144	57	135	166	22	111

1993

BOAT TYPE	Wed, June 23	Wed, July 14	Sat, July 17	Wed, Aug 18	Sat, Aug 21	Sat, Sept 5 (holiday)
Aluminum	2	1	6	4	3	10
Ski Boat	27	11	112	26	126	106
Cruiser	1	0	5	1	3	4
Jet Ski	6	15	38	4	35	28
Other	0	0	1*	0	2	0
TOTAL	36	27	161	35	169	148

* Sheriff's Boat

BOATING ACTIVITY						
Water Ski	7	7	44	9	25	20
Fish	1	0	2	0	1	3
Cruise	22	5	79	22	88	97
Other	6	15	37	4	35	28
TOTAL	36	27	162	35	149	148

1995

BOAT TYPE	Wed, July 12	Sat, July 15	Wed, Aug 9	Sat, Aug 12	Sat, Sept 2 (holiday)	Wed, Sept 6
Aluminum	5	2	2	8	8	1
Ski Boat	13	161	29	72	160	10
Cruiser	0	0	0	0	1	0
Jet Ski	2	41	6	33	26	8
Other	0	0	0	0	0	0
TOTAL	20	204	37	113	195	19

BOATING ACTIVITY						
Water Ski	3	49	5	32	54	1
Fish	1	1	0	0	10	0
Cruise	14	112	23	48	128	9
Other	2	42	9	33	2	9
TOTAL	20	204	37	113	194	19

MIDDLE RIVER

Table 1 (cont'd)

1991

BOAT TYPE	Mon, May 27 (holiday)	Wed, June 5	Sat, June 8
Aluminum	5	0	4
Ski Boat	9	0	7
Cruiser	0	0	0
Jet Ski	0	0	1
Other	0	0	0
TOTAL	14	0	12

BOATING ACTIVITY			
Water Ski	3	0	1
Fish	11	0	5
Cruise	0	0	6
Other	0	0	0
TOTAL	14	0	12

Boat Size (ft)
Aluminum 0-14
Ski Boat 15-22
Cruiser 23+

1992

BOAT TYPE	Wed, July 22	Sat, July 25	Wed, Aug 19	Sat, Sept. 5 (holiday)	Wed, Sept. 16	Sat, Sept. 19
Aluminum	2	1	1	0	2	0
Ski Boat	0	5	2	9	2	5
Cruiser	0	0	0	0	0	0
Jet Ski	2	1	0	0	0	0
Other	0	0	0	0	0	0
TOTAL	4	7	3	9	4	5

BOATING ACTIVITY						
Water Ski	0	0	2	0	0	0
Fish	0	1	1	0	1	1
Cruise	2	5	0	9	3	4
Other	2	1	0	0	0	0
TOTAL	4	7	3	9	4	5

1993

BOAT TYPE	Wed, June 23	Wed, July 14	Sat, July 17	Wed, Aug 18	Sat, Aug 21	Sat, Sept 5 (holiday)
Aluminum	2	2	0	2	3	1
Ski Boat	3	1	5	1	7	13
Cruiser	0	0	0	0	0	0
Jet Ski	0	0	0	0	2	12
Other	0	0	0	0	0	0
TOTAL	5	3	5	3	12	26

BOATING ACTIVITY						
Water Ski	0	0	1	0	0	0
Fish	0	0	4	2	1	4
Cruise	5	3	0	1	9	10
Other	0	0	0	0	2	12
TOTAL	5	3	5	3	12	26

1995

BOAT TYPE	Wed, July 12	Sat, July 15	Wed, Aug 9	Sat, Aug 12	Sat, Sept 2 (holiday)	Wed, Sept 6
Aluminum	2	0	0	2	1	0
Ski Boat	0	15	0	9	6	3
Cruiser	0	0	0	0	0	2
Jet Ski	2	4	0	3	2	0
Other	0	0	0	0	0	0
TOTAL	4	19	0	14	9	5

Temporary Barrier installed on Aug. 9

BOATING ACTIVITY						
Water Ski	0	1	0	1	0	0
Fish	1	6	0	2	1	3
Cruise	1	11	0	8	6	0
Other	2	1	0	3	2	2
TOTAL	4	19	0	14	9	5

WEST GRANT LINE CANAL

Table 1 (cont'd)

1991

BOAT TYPE	Mon, May 27 (holiday)	Wed, June 5	Sat, June 8
Aluminum	35	11	5
Ski Boat	262	37	186
Cruiser	1	0	0
Jet Ski	4	0	21
Other	1	2	1*
TOTAL	303	50	212

* Sheriff's Boat

BOATING ACTIVITY			
Water Ski	31	5	19
Fish	7	6	6
Cruise	262	39	167
Other	4	0	21
TOTAL	304	50	213

Boat Size (ft)
Aluminum 9-14
Ski Boat 16-22
Cruiser 23+

1992

BOAT TYPE	Wed, July 22	Sat, July 25	Wed, Aug 19	Sat, Aug 22	Sat, Sept. 5 (holiday)	Wed, Sept. 16	Sat, Sept. 19
Aluminum	4	11	4	7	5	5	6
Ski Boat	37	241	39	186	177	14	193
Cruiser	5	20	4	8	16	2	0
Jet Ski	1	8	5	8	13	0	12
Other	3	3	0	0	4	0	0
TOTAL	50	283	52	209	215	21	211

BOATING ACTIVITY							
Water Ski	6	90	8	57	56	3	49
Fish	5	5	3	2	1	4	2
Cruise	37	180	36	142	141	13	148
Other	1	8	5	8	17	1	12
TOTAL	49	283	52	209	215	21	211

1993

BOAT TYPE	Wed, June 23	Wed, July 14	Sat, July 17	Wed, Aug 18	Sat, Aug 21	Sat, Sept 5 (holiday)
Aluminum	10	9	26	9	11	6
Ski Boat	36	30	267	38	249	266
Cruiser	2	0	5	0	5	4
Jet Ski	2	0	30	3	10	34
Other	2	1	0	1	3	1
TOTAL	52	40	328	51	278	311

BOATING ACTIVITY						
Water Ski	3	6	79	14	92	54
Fish	3	3	6	4	0	4
Cruise	44	31	213	31	175	219
Other	2	0	30	3	11	34
TOTAL	52	40	328	52	278	311

1995

BOAT TYPE	Wed, July 12	Sat, July 15	Wed, Aug 9	Sat, Aug 12	Sat, Sept 2 (holiday)	Wed, Sept 6
Aluminum	9	3	4	2	5	6
Ski Boat	14	246	24	148	172	18
Cruiser	0	1	0	0	3	2
Jet Ski	2	33	5	18	25	8
Other	0	2	0	2	3	2
TOTAL	25	285	33	170	208	36

BOATING ACTIVITY						
Water Ski	3	86	6	41	46	3
Fish	3	0	0	4	2	0
Cruise	17	158	20	121	160	33
Other	2	41	7	0	0	0
TOTAL	25	285	33	166	208	36

OLD RIVER NEAR TRACY

Table 1 (cont'd)

1991

BOAT TYPE	Mon, May 27 (holiday)	Wed, June 5	Sat, June 8
Aluminum	18	4	7
Ski Boat	43	2	9
Cruiser	1	0	1
Jet Ski	12	0	0
Other	1	0	0
TOTAL	75	6	17

BOATING ACTIVITY			
Water Ski	14	0	4
Fish	14	0	3
Cruise	35	6	10
Other	12	0	0
TOTAL	75	6	17

Boat Size (ft)	
Aluminum	0-14
Ski Boat	15-22
Cruiser	23+

1995

BOAT TYPE	Wed, July 12	Sat, July 15
Aluminum	0	3
Ski Boat	3	19
Cruiser	0	4
Jet Ski	0	12
Other	0	0
TOTAL	3	38

BOATING ACTIVITY		
Water Ski	0	10
Fish	0	2
Cruise	3	12
Other	0	14
TOTAL	3	38

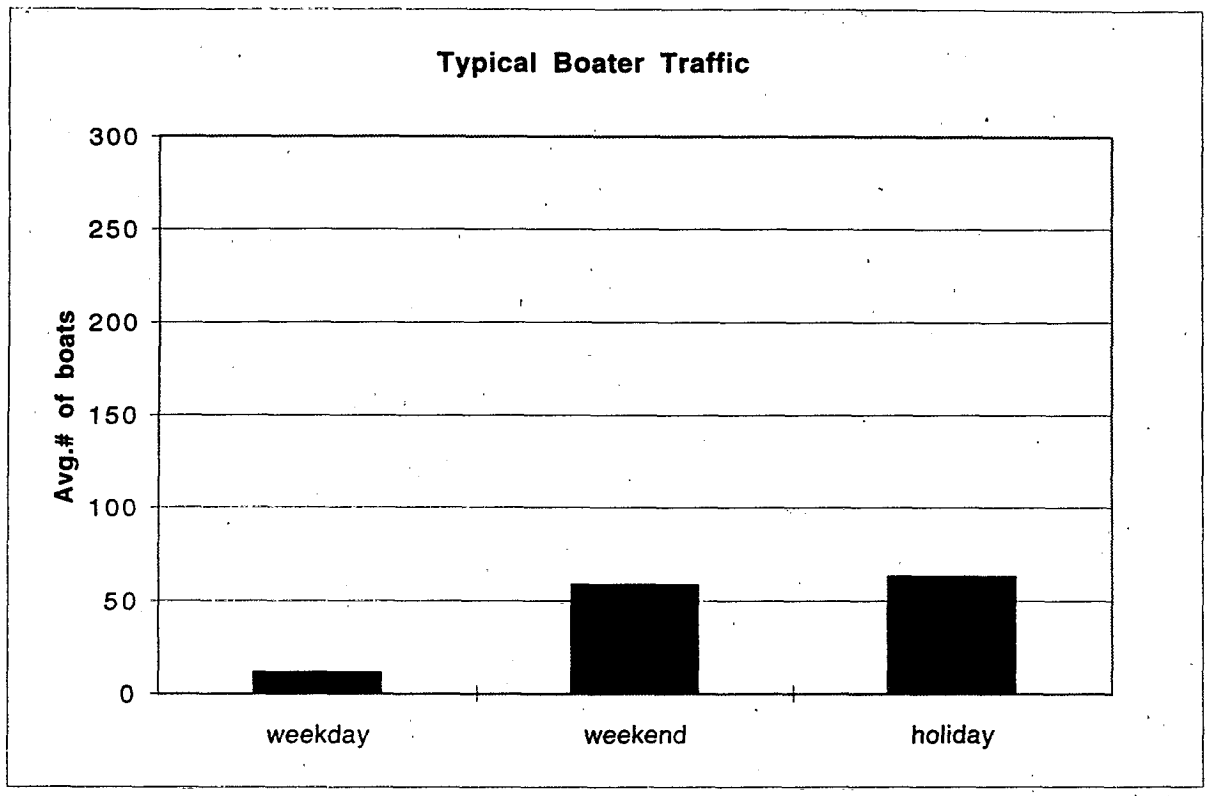
EAST GRANT LINE CANAL

1995

BOAT TYPE	Wed, July 12	Sat, July 15	Wed, Aug 9	Sat, Aug 12	Sat, Sept 2 (holiday)	Wed, Sept 6
Aluminum	1	3	9	5	2	1
Ski Boat	10	98	17	180	77	16
Cruiser	0	0	0	2	0	0
Jet Ski	4	10	12	43	22	9
Other	1	0	0	0	1	2
TOTAL	16	111	38	230	102	28

BOATING ACTIVITY						
Water Ski	3	24	7	77	21	4
Fish	4	0	0	1	0	1
Cruise	5	77	21	109	58	14
Other	4	10	10	43	23	9
TOTAL	16	111	38	230	102	28

Figure 1. Old River @ SJR



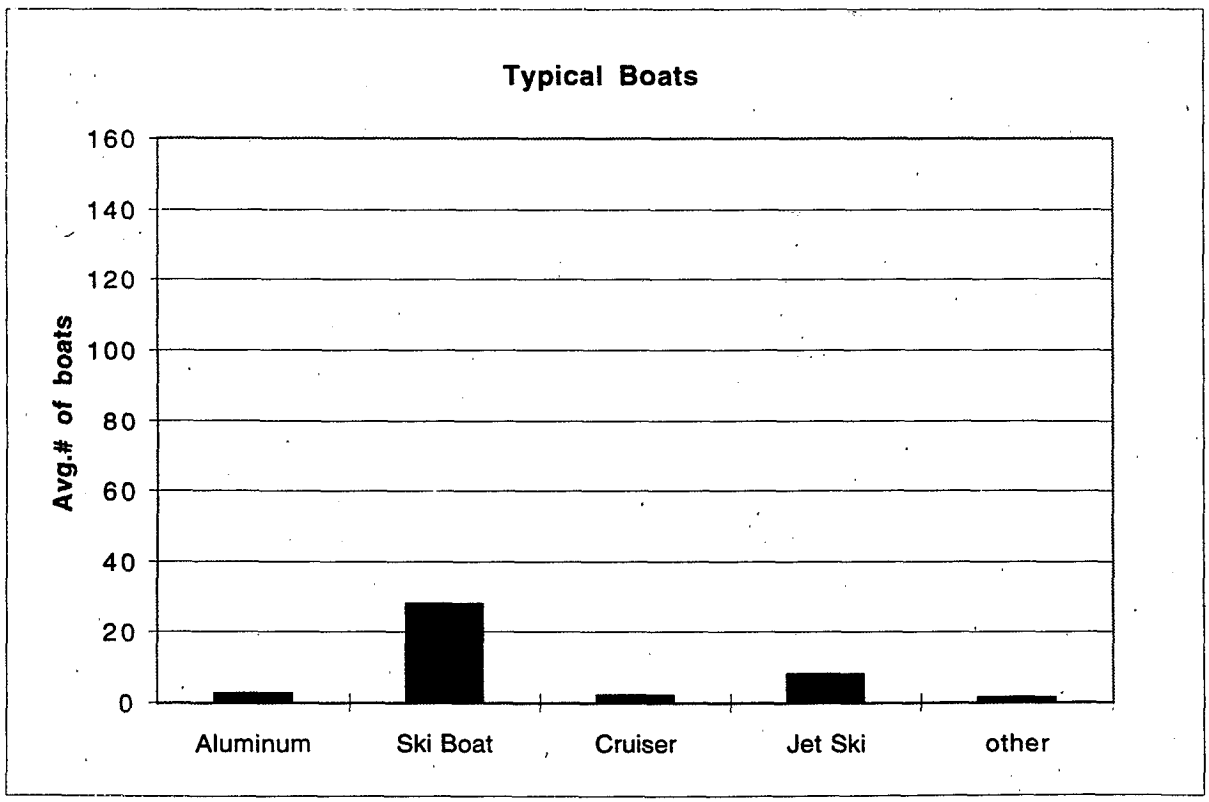
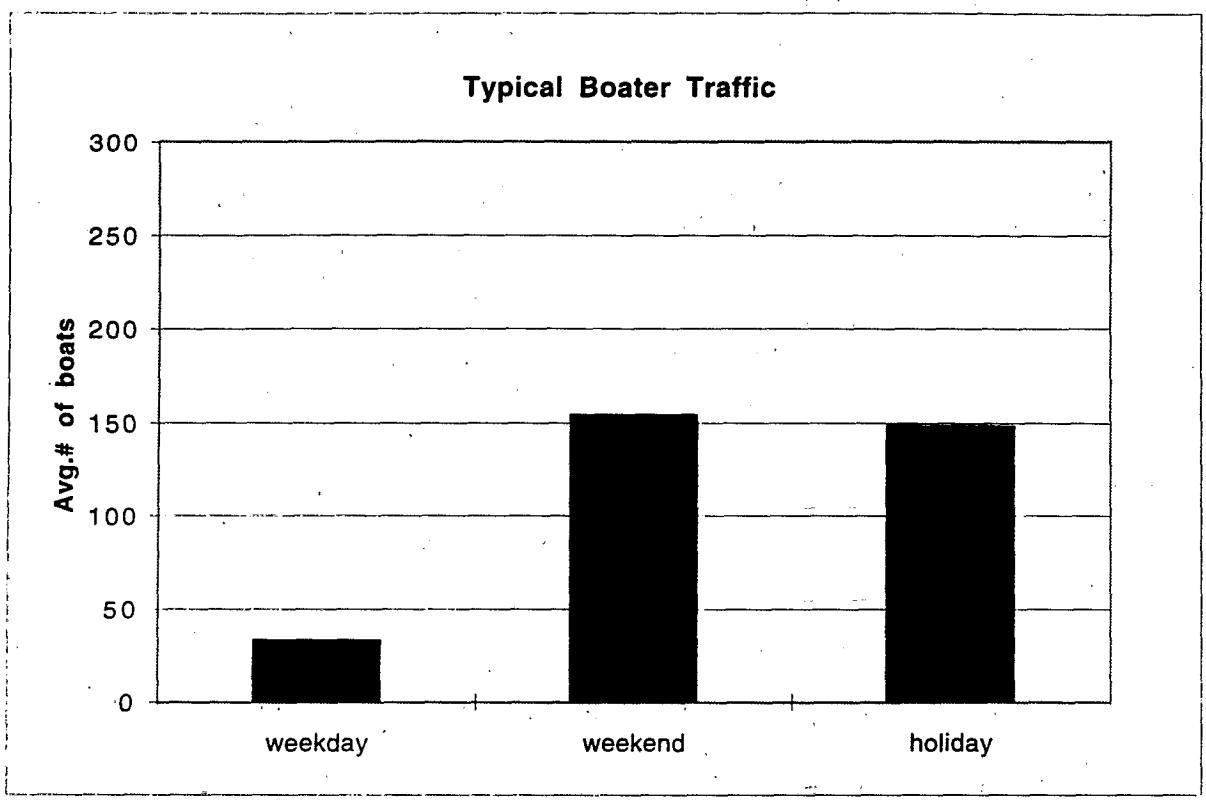


Figure 2. San Joaquin River @ OR



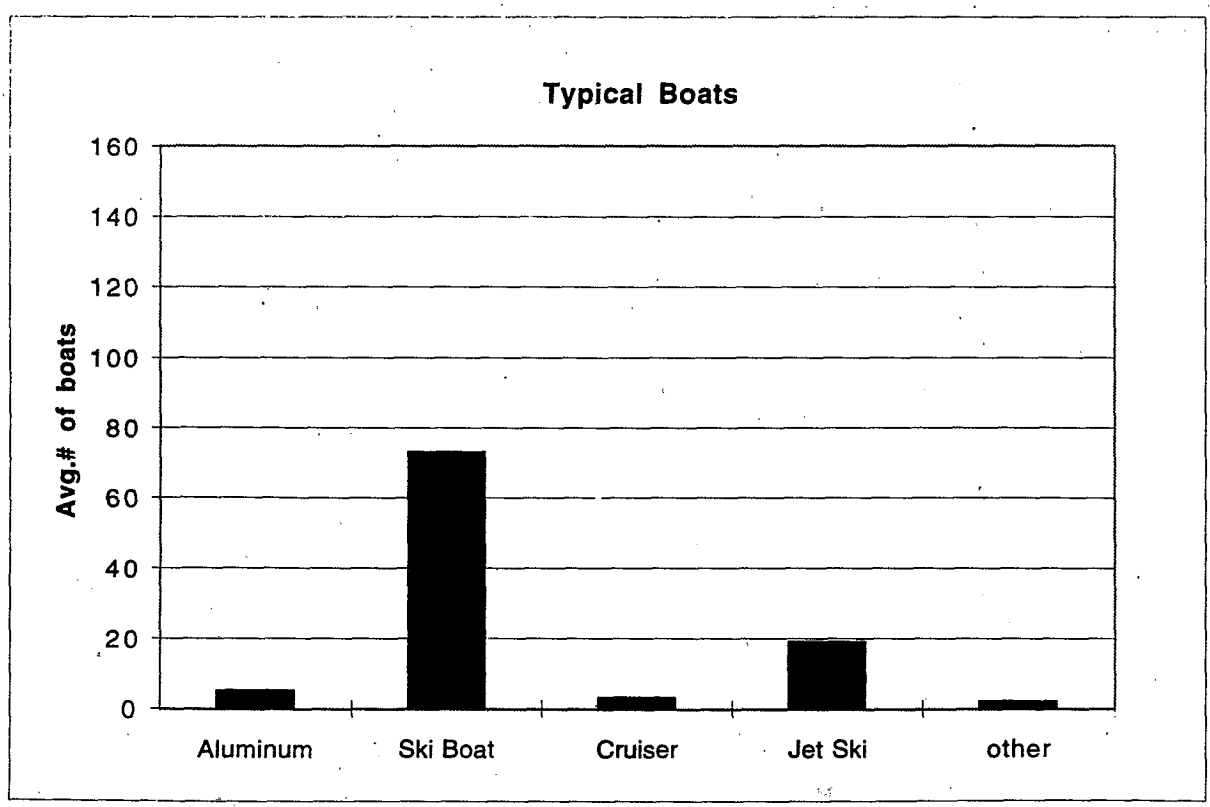
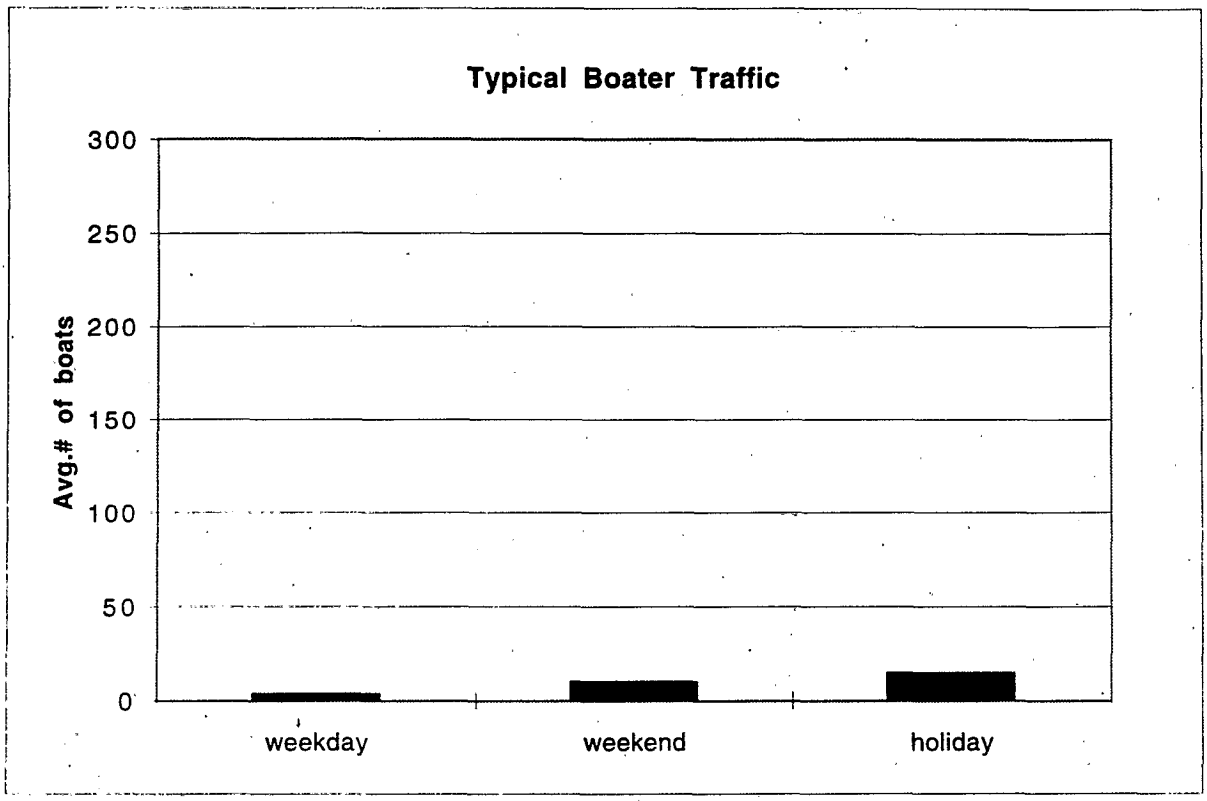


Figure 3. Middle River



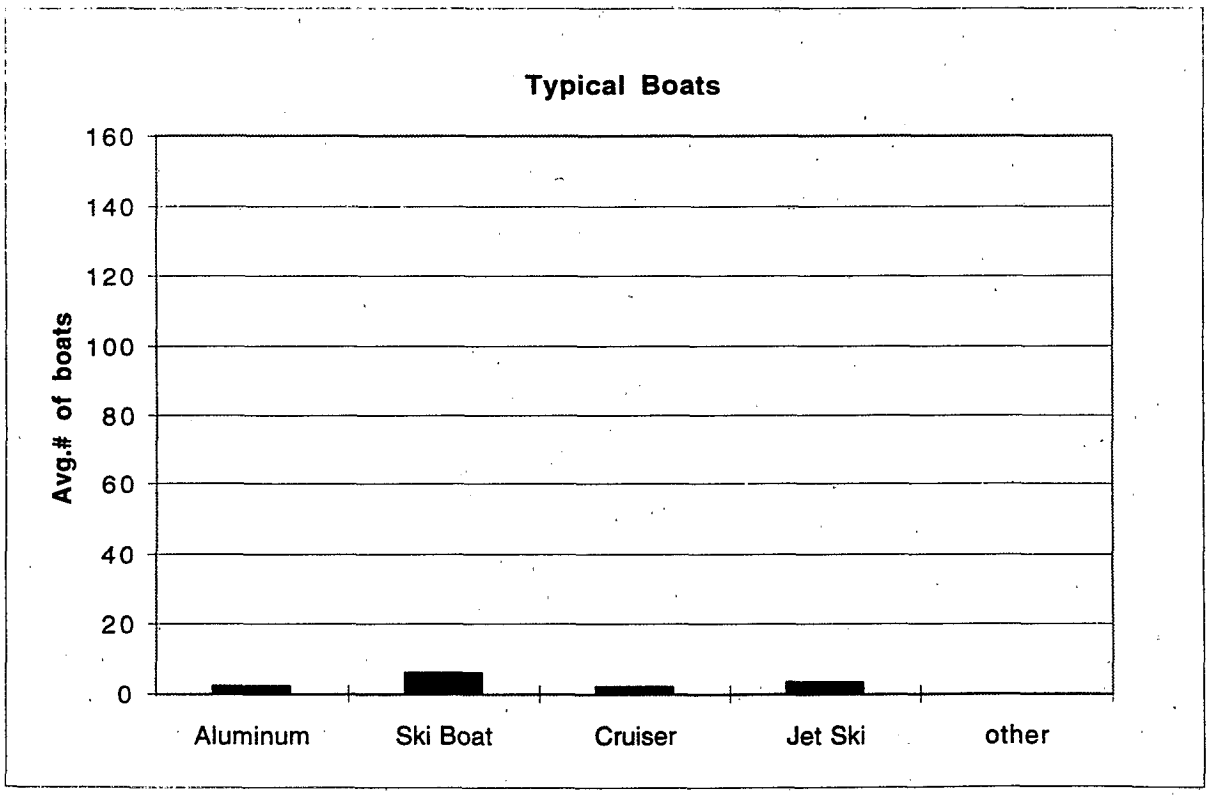
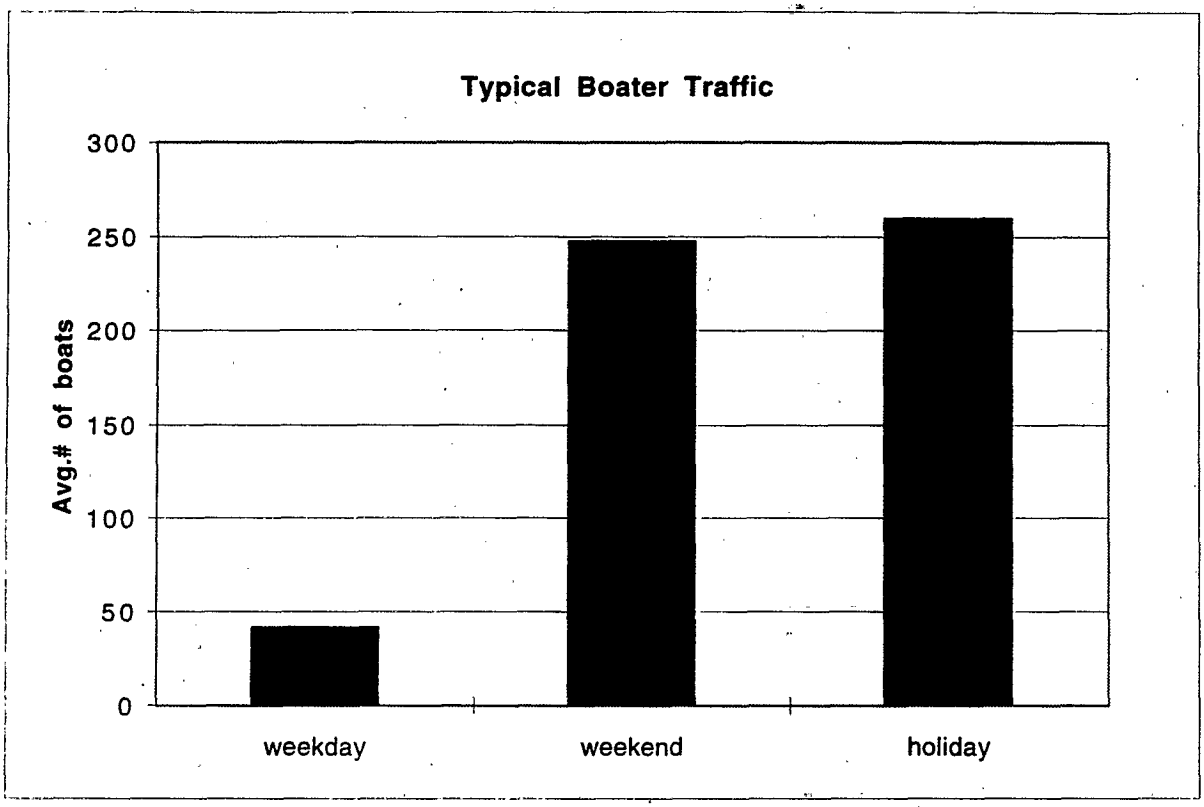


Figure 4. West Grant Line Canal



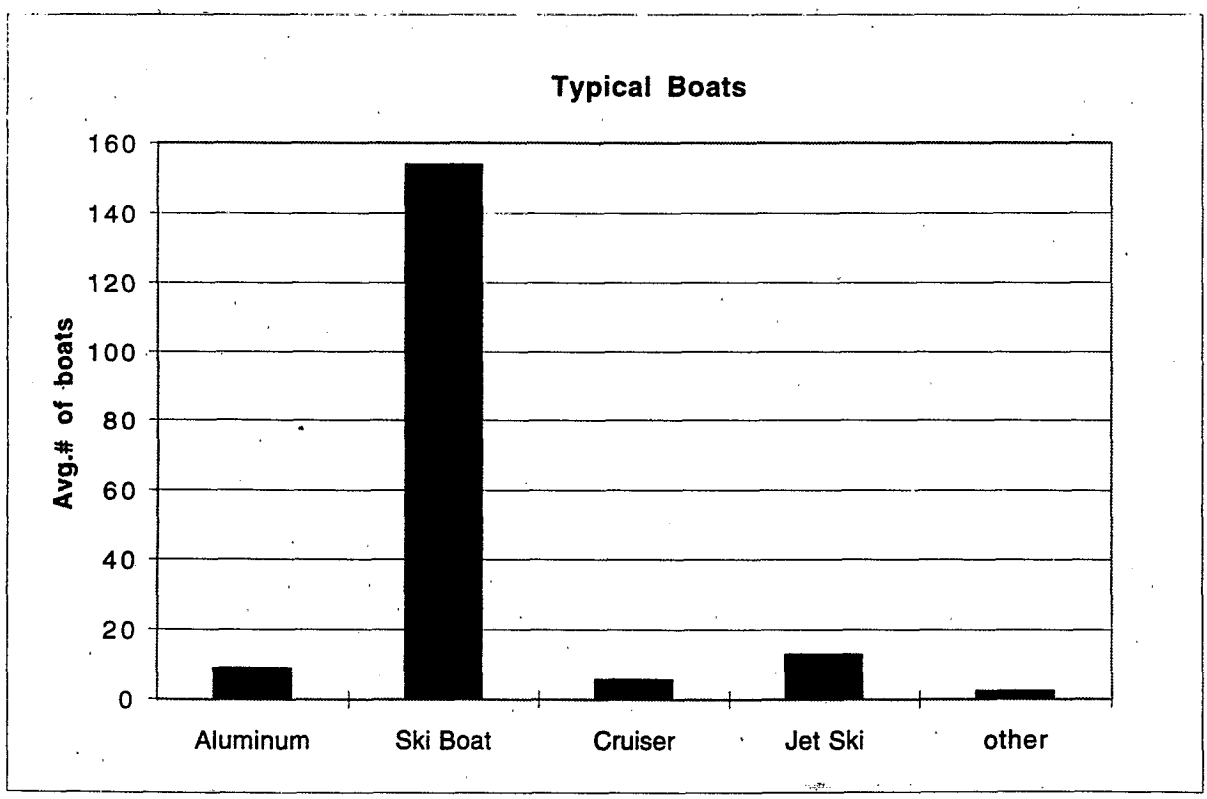
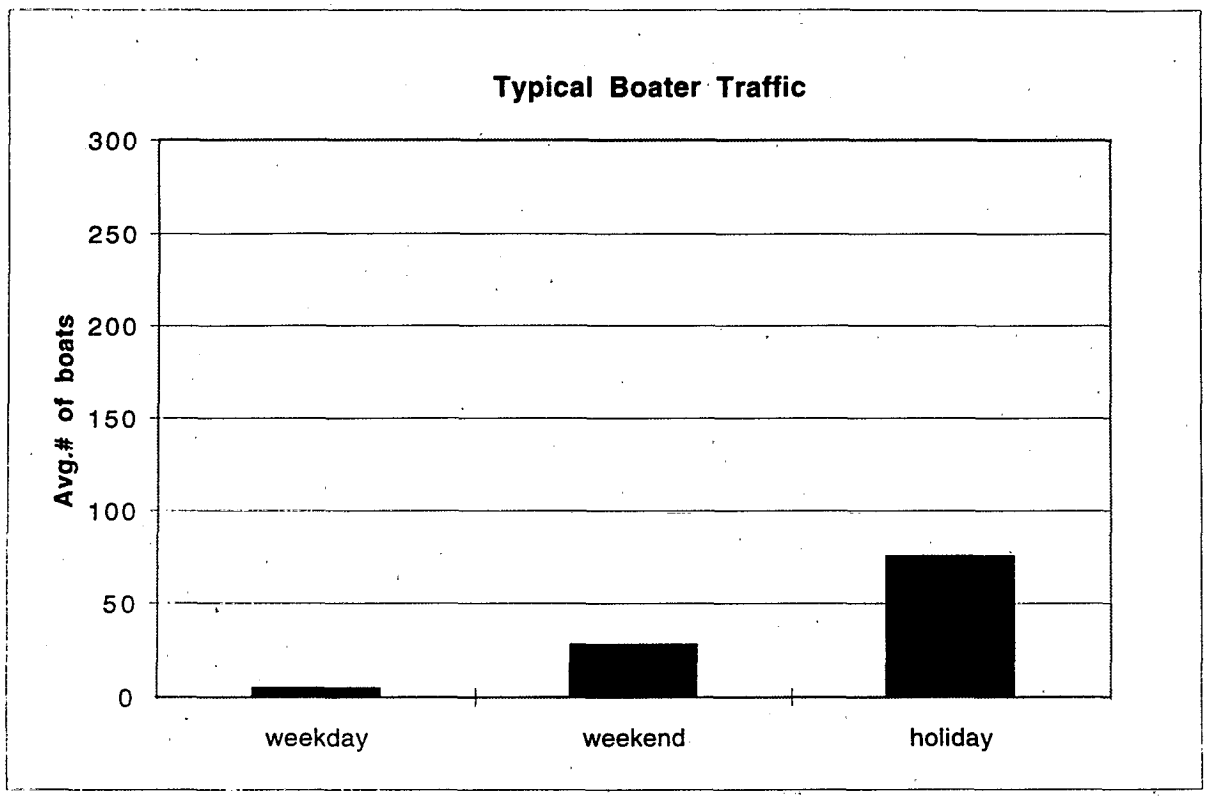


Figure 5. Old River near Tracy



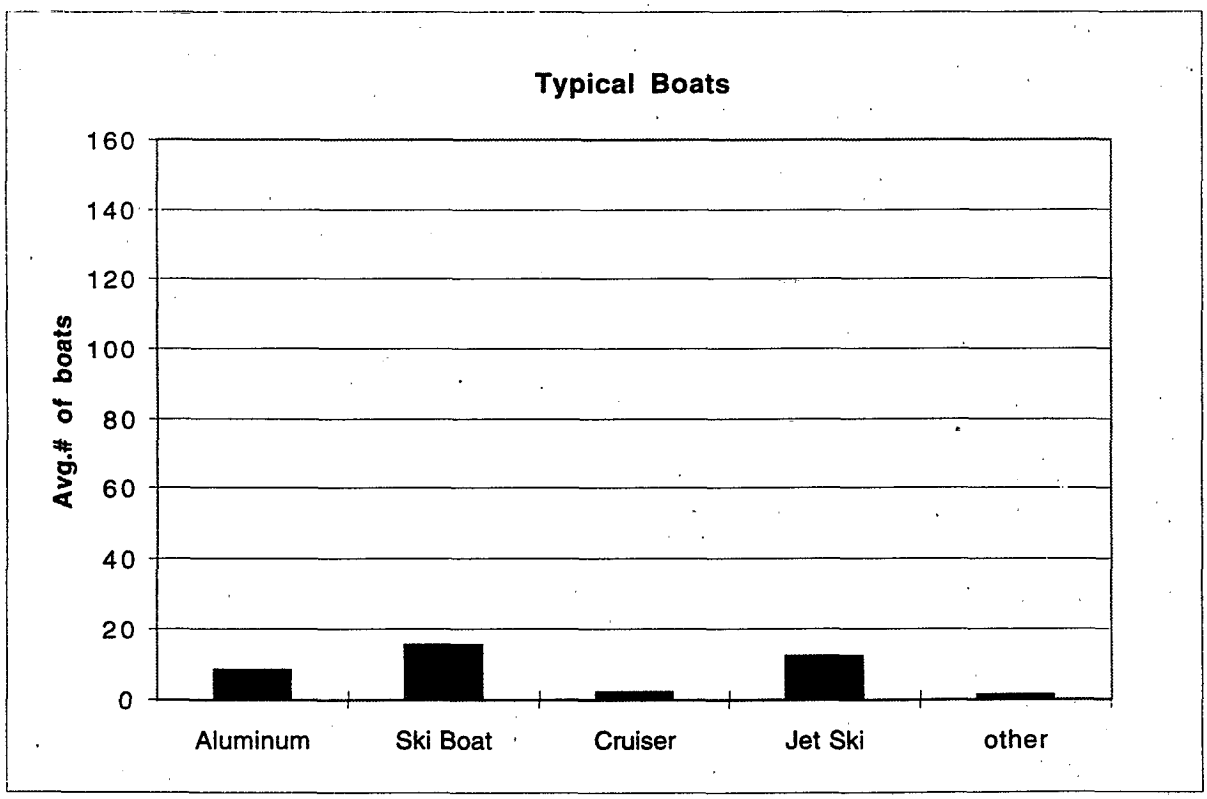
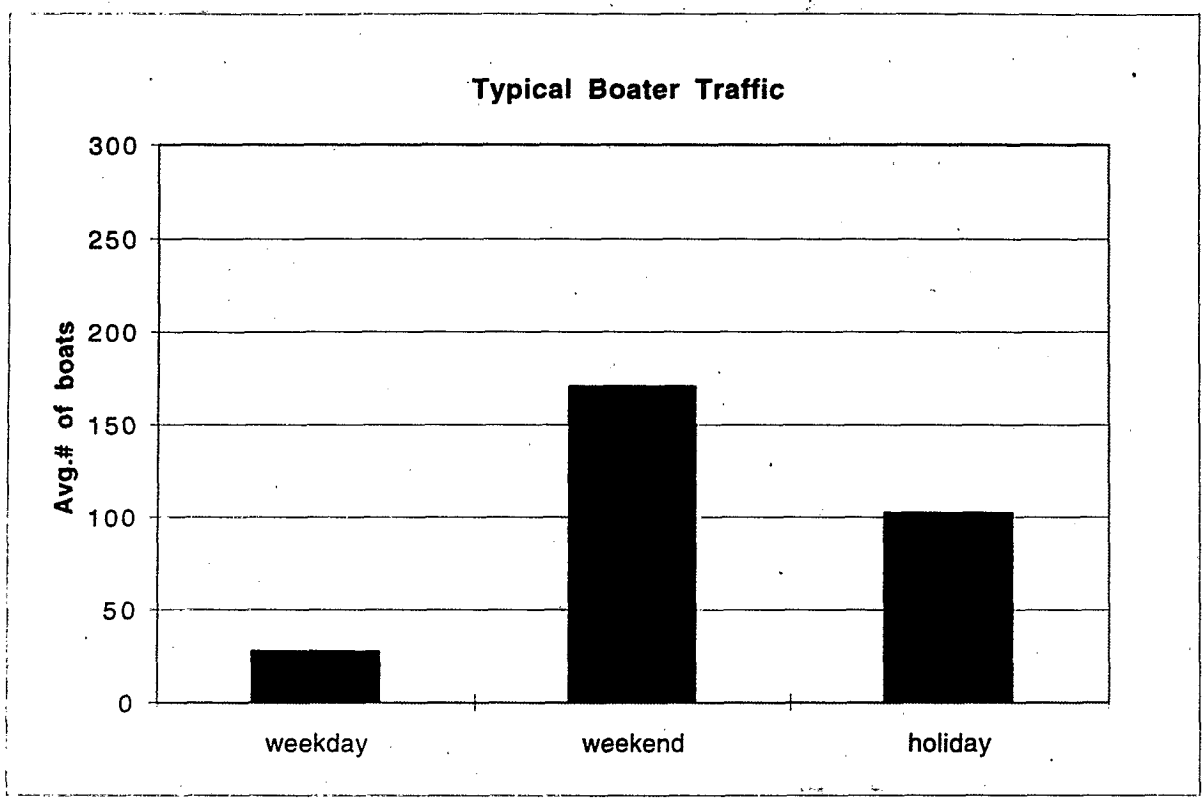


Figure 6. East Grant Line Canal



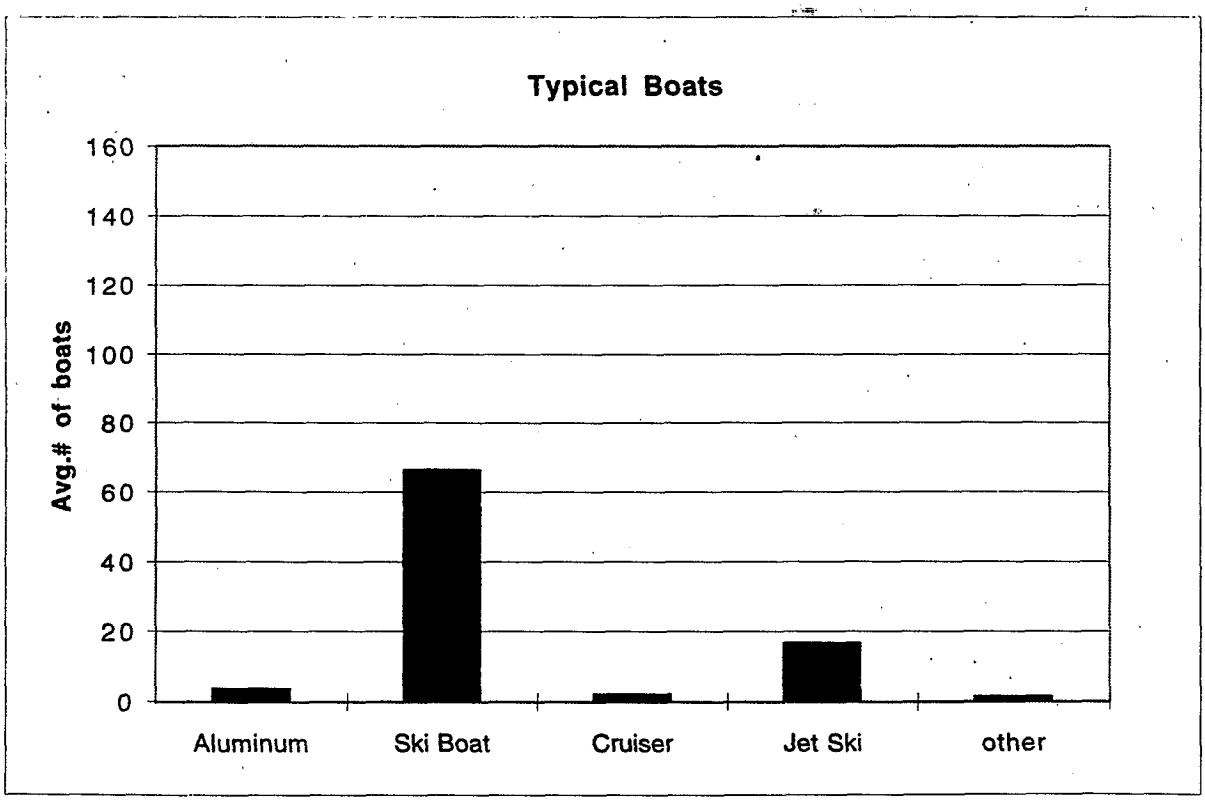
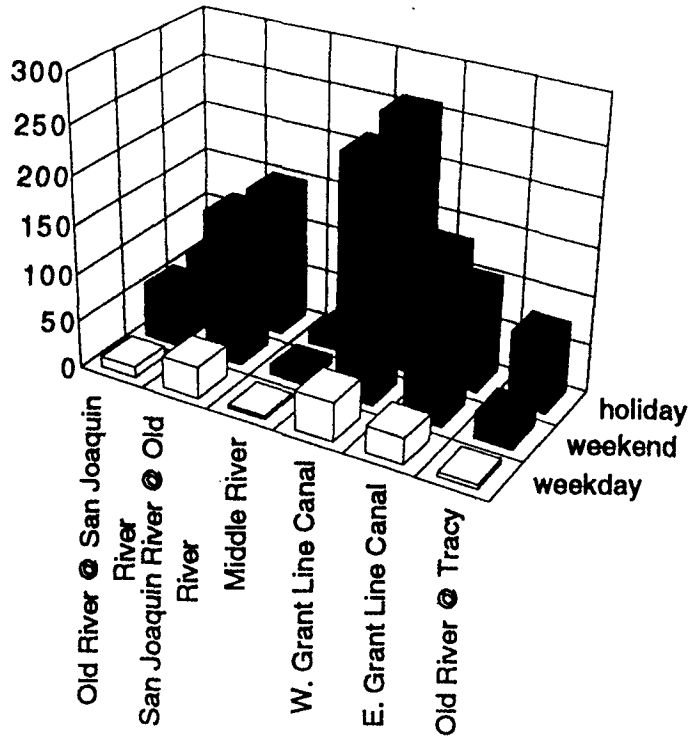


Figure 7. Average Boater Traffic



C-087800

C—087799—001

Appendix 8

Socioeconomic Background Data

8.0 Socioeconomic Background Data

The information in this appendix supports the discussion and conclusions found in Chapter 15 of the EIR/EIS.

8.1 Project Area/Study Area

Project Area. The proposed ISDP facility additions would be located primarily in San Joaquin County, within the Delta Planning Area (San Joaquin County General Plan designated planning area). Clifton Court Forebay and the proposed new intake site are located in the eastern portion of Contra Costa County, along the border of San Joaquin County. The project area is in the rural, unincorporated portions of the two counties where agriculture is the primary activity and only sparse, low-density residential development exists in the immediate vicinity (with the exception of the community of Discovery Bay near Clifton Court Forebay).

Historical Background and Setting of the Project Area

The Delta region with its vast network of navigable waterways has played an important role in the history of California. The diverse backgrounds of settlers to this area, the unique physical setting and the tremendous man-made changes have created a region with a special character and appeal unmatched in other areas of the state. For many decades, it has been a popular recreational and tourist destination.

The first outsiders to the region were Spanish explorers in 1772. They found flooded rivers and large, mosquito-ridden swamps, which were home to a number of Indian settlements. In the 1820s, fur trappers and traders came to the area. They were soon followed by early settlers in the 1840s and fortune seekers in the big boom of the 1849 gold rush. The river ways soon became filled with boats carrying passengers, food and equipment between San Francisco, Stockton and Sacramento. Small communities sprang up along the Delta route, many of which still exist today.

The Delta region began to change dramatically after Congress passed the Swamp and Overflow Act of 1850. This Act allowed individuals to buy up large tracts of marshlands at $1 an acre and reclaim them for agricultural purposes. Over the next few decades, the Delta region was transformed by the continual construction of levees throughout the waterways. The early levees were built by hand by Chinese laborers, who had come to the area after completing work on the transcontinental railroad in 1869. Over the years more and more sophisticated dredging and hauling equipment was developed to build and rebuild the levees ever higher and stronger. By 1930, over 700,000 acres of land had been reclaimed and 55 man-made islands created.

The rich soils allowed agriculture to flourish and a wide variety of crops were grown. The river remained the main transportation route for many years with as many as 200 paddle wheelers crossing the waters over time. The boats stopped at the numerous small landings along the way to pick up agricultural produce, deliver mail and other goods and to carry passengers. The riverboat era began to end by the 1920s, when expansion of the railroads and the introduction of

cars proved too much competition. The last regular riverboat service ceased just before World War II.

Up until the 1950s, the Delta region regularly flooded in the winters, while water flows dwindled dramatically in the summer. The variation in flows was responsible for substantial damage and economic losses over time to the farmers and small communities along the waterways. This situation was substantially altered over the next few decades with the construction of a network of dams, reservoirs and diversions upstream as part of both the federal Central Valley Project and the State Water Project. The area has become safer and more stable, which also has made it more attractive for development.

Throughout the development of the Delta region, immigrants were a major source of labor and helped form the social character of the region. The early Chinese settlers were followed by people of Japanese, Portuguese, Italian, Filipino, and Mexican origin. These diverse populations helped build the towns, run the stores and farm the lands. Today the Delta region remains largely agricultural as well as a popular recreational and sight seeing destination. Boating along the waterways is a major activity with stops at the numerous boat docks and restaurants. The areas has retained much of its rural, rustic character amid growing development pressure from the surrounding metropolitan and suburban areas.

The project area is located in the unincorporated rural portions of the San Joaquin and Contra Costa counties, however, development pressures are not far removed. Nearby cities are expanding rapidly, increasing the demand for water and the use of the rivers and channels for recreational purposes. For example, a large retirement community is now being built in Brentwood, the Discovery Bay development is expanding rapidly, and a developer has proposed a major theme park surrounding the river at the site of the proposed Old River fish control structure.

Study Area

For the purpose of the socieconomic analysis, the larger study area is defined to include all of San Joaquin County and the eastern portions of Alameda and Contra Costa Counties, as identified in the respective General Plans. This includes the major surrounding residential development and economic base relevant to the proposed ISDP.

Generally, the larger study area is a part of California that has been growing rapidly for the past ten years; over the next twenty years, this area is projected to be one of the fastest growing portions of the state. Population growth was initially fostered by the availability of affordable housing, drawing people from the higher cost San Francisco Bay Area and Sacramento regions. Over time, the increase in population and housing development has led to the location of businesses in the study area, creating a growing and diversified economic base. There are still a large number of people who commute to the Bay Area and Sacramento, but this is expected to decrease over time as job opportunities continue to grow in the study area.

Most of the growth in the study area is occurring in the incorporated cities or immediately around the cities (within the cities' spheres of influence). However, the nature of many small rural towns is being transformed as they become larger suburban communities. One of the major

development issues in the study area has been how to adequately manage growth while protecting prime agricultural lands and other natural resources. Growth in portions of the study area is constrained by the availability of water.

The following sections discuss existing and projected population, housing, employment and income in more detail within each of the county areas that comprise the study area.

Population

San Joaquin County

The San Joaquin County General Plan divides the county into eleven planning areas. All of the proposed project additions, except the new intake at Clifton Court Forebay, are located in the southern portion of the Delta Planning Area.

San Joaquin County experienced a slightly higher growth rate than the rest of the state during the 1980-1990 period (3.8 percent in the County versus 2.6 percent average annual growth statewide) and had a population of 480,628 in 1990. Substantial development has occurred in Tracy, Manteca and Stockton as many people in the San Francisco Bay Area have moved to San Joaquin County to find more affordable housing.

Approximately 75 percent of the household population lives in the incorporated cities, and of this number, nearly 60 percent are in Stockton. The unincorporated population is concentrated in the Planning Areas of Stockton, Manteca, Lodi, Tracy and Lockeford. The Delta Planning Area had only 2,883 residents in 1990, making up just 0.6 percent of the County population.

Table 15-1 shows that the County expects to experience a steady increase in population over the next twenty years of 62 percent (or 3.1 percent average annual), which is well above the projected statewide increase of 42.5 percent. This is based on the County's growth policies, the availability of low cost land and the current number of planned residential developments. The General Plan designates that most of this growth will continue to be concentrated in and around the incorporated cities in order to promote higher density development and protect prime agricultural land. The Delta Planning Area is projected to have a small increase in population (1 percent), for a total 3,200 people in the planning area in the year 2010.

Contra Costa County

The Contra Costa County General Plan recognizes three distinct areas for planning purposes: West County, Central County and East County. East County includes two sub-areas, the Pittsburg-Antioch area and "Other East County." Clifton Court Forebay and the proposed new intake are located on the eastern border of the "Other East County" planning sub-area not far from the communities of Byron and Discovery Bay.

East County is the largest land area of the county and has the vast majority of the unincorporated county population. Table 15-1 shows that in 1990, Contra Costa County had a population of 803,732. East County had a population of 165,003 concentrated in the cities of Pittsburg,

Antioch and Brentwood, with smaller populations in the unincorporated communities of Oakley, Bethel Island, Knightsen, Byron, and Discovery Bay.

During the 1980-1990 period, Contra Costa County population grew at an average annual rate of 2.2 percent, which is below the statewide average of 2.6 percent. However, the majority of this growth was concentrated in the Central and East County areas, representing an annual average growth rate of 5.6 percent.

Contra Costa County is expected to have a population of 1,096,300 in 2010, with the East County area growing to approximately 303,900. The population in East County will grow by 84.2 percent during this period, placing pressure on the need for water and many other basic services.

Alameda County
Alameda County has divided the county into two planning areas, West County and East County. East County includes the Livermore-Amador Valleys in which the incorporated cities of Dublin, Pleasanton and Livermore are located. This area is also part of the Tri-Valley region, which also includes the San Ramon Valley in Contra Costa County.

In 1990, Alameda County had a total population of 1,276,702. The East County Planning Area had a population of 135,835, with 96 percent of the people in this area residing in the three incorporated cities. This planning area experienced an average annual growth rate of 3.4 percent during the 1980-1990 period, well above the 2.6 percent rate statewide. Alameda East County has grown rapidly as it offers some of the lowest cost housing in the greater Bay Area region.

The Alameda East County is also expected to experience significant growth over the next twenty years with the population in 2010 forecast to be 240,600 (see Table 15-1). This projected growth in East County represents a 77.1 percent increase in population, for an annual average growth rate of 3.9 percent. The East County Area Plan adopted in May 1994, states that the County strives for compact, managed and balanced growth, in conjunction with the preservation of natural resources.

Housing and Income

San Joaquin County
The housing stock in San Joaquin County grew by one-third in the 1970-1980 period or almost twice as fast as the population growth. This has been credited to pent up demand among existing residents. As a result, during the 1980-1990 period the average annual growth rate slowed to only 1.2 percent despite the 3.8 percent rate for population growth.

In 1990, the county's household population of approximately 465,100 was living in 158,156 dwelling units (there were also over 15,000 people in group quarters). There were a total of 166,274 housing units available resulting in an overall vacancy rate of 4.9 percent. Approximately 70 percent of the housing units are single family dwellings, 8.0 percent are

structures with 2-4 units, 15 percent are apartments with over five units and five percent are mobile homes.

Table 15-2 shows the number of dwelling units and person per household for the county. The City of Stockton accounts for 44 percent of the housing stock in the county, while the Delta Planning Area represents only 0.36 percent. Overall, there are 2.94 persons per household in the county and 2.67 in the Delta Planning Area.

The median rental price in San Joaquin County was $417 per month in 1990 and the median home value was $121,700.

The County projects the housing stock will increase to 276,000 over the twenty years period or approximately 66 percent. This is slightly higher than the 62 percent increase in population during the same period. Given Tracy's location along the Interstate 205 corridor, a substantial demand for housing in the Tracy area is expected due to an overflow of demand from the Tri-Valley area.

Contra Costa County

Residential units in Contra Costa County increased by an average of 2.2 percent per year between 1980 and 1990, with most of this growth occurring in San Ramon Valley and East County. This is reflected by the 4.8 percent annual increase in East County, almost doubling the housing stock during this period.

There were a total of 314,723 housing units in the county in 1990, with 60,212 units in East County. In the East County planning area, approximately 75.6 percent of the residential units were single-family homes, seven percent were condominiums or townhouses, 13 percent were apartment units and 4.4 percent were mobile homes.

In 1990, the average household size in the county was 2.57 and 2.93 in East County. In East County, 68.8 percent of the households owned their home and 31.2 percent were renters. The vacancy rate for rental units in the county was 4 percent, while in the East County planning area the rate was 7.2 percent.

In 1990, the median rent in the Contra Costa East County planning area was $555 per month versus the county average of $625. The median housing value for the East County area was $153,600.

A major portion of the growth in Contra Costa County is expected to occur in the East County area over the next twenty years. The total number of residential units forecast for the county in 2010 is 414,020 units, with 111,680 units expected in the East County. It is anticipated that 12,000 new homes will be built in the Pittsburg-Antioch area and 29,000 new homes in the other areas of East County by 2005. This represents a 37.9 percent increase in housing countywide, but an increase of 83 percent in East County (for an average annual growth rate of 4.1 percent).

Alameda County
Alameda County had a 1990 housing stock of 479,518 units, with 49,961 units in the East County area of which approximately 47,924 units were occupied. This resulted in an overall vacancy rate of 4.1 percent. Household size in the East County was 2.75 persons per household. Approximately 68 percent of the housing units in East County are single family dwellings with 32 percent multi-family units.

In East County, 32 percent of the households are renters with a median rental price of $729 per month in 1990. The median value of homes purchased was $253,500. While these prices are lower than other parts of the Bay Area, they are still not affordable for many of the employees in East County. As a result, many employees commute from San Joaquin County and other lower cost areas.

Alameda East County is expected to see rapid growth and a high demand for housing. Projections for new housing follow the substantial increase in population projected for East County. An additional 47,430 homes are forecast for 2010, representing a 94 percent increase in the number of residential units (in conjunction with a 77.1 percent increase in population). This is a 4.7 percent annual growth rate. Major planning issues involve the trend toward increasing housing costs and the ability to provide enough "affordable" housing to match the income levels of local employees.

Employment

San Joaquin County
Employment in San Joaquin County has been shifting away from agriculture and related jobs in food processing to a more diversified economic base. Recent years have seen employment growth in finance, insurance, and real estate; fabricated metals; electronics; furniture and fixtures; and trucking, warehousing and transportation. However, agriculture and related industries will continue to be a major force in the economy, with the county ranking ninth in the state for the value of agricultural production (1992).

The county has suffered a high unemployment rate for many years, which has been well above the statewide unemployment rate. In January 1995, the county rate was 13.5 percent, compared to 8.7 percent for the state. Wages in San Joaquin County have also been well below the state average.

Table 15-3 shows employment in San Joaquin County by sector for 1989, while table 15-4 shows employment in 1990 by planning areas. There were a total of 178,800 people employed, with the largest number of jobs (32,600) in the services sector. In recent years, a decline in agricultural employment has been largely offset by increases in manufacturing jobs, while the largest job growth has taken place in retail and office employment.

Employment projections for 1997 by sector are also shown in Table 15-3. The service sector is expected to show the greatest increase in jobs, while agriculture and mining decrease substantially. The economy will continue to diversify and the county is expected to attract some large manufacturers given the proximity to the Bay Area, Sacramento and other San Joaquin

Valley markets. Future trends for economic growth affecting employment include: diversification and modernization of the food processing industry; commercial and retail development to serve the growing population and housing developments; regional subcenter for manufacturing and distribution of goods to surrounding metropolitan markets; and Pacific rim trade and foreign investment.

Table 15-4 shows the growth in employment from 1990 to 2010 for San Joaquin County will be 57 percent. The majority of these jobs will be located in Tracy, Manteca, Lathrop and Lockeford.

Contra Costa County

Contra Costa County employment grew 45.4 percent from 1980 to 1990, with the majority of the growth occurring in the San Ramon Valley (as part of the Tri-Valley area) along the I-680 corridor and to a lesser degree in the Pittsburgh-Antioch-Brentwood areas. Large office building complexes supported increases in finance, insurance, real estate, transportation, communications, and utilities employment. There were also big increases in the number of retail and service jobs to support office and housing development. Manufacturing and wholesale trade jobs remained fairly stable with gains in some sectors (petroleum refineries), but losses in others (metal fabrication, high technology "instruments" producers).

Employment in the East County area is concentrated in the Pittsburg-Antioch sub-area, including major petroleum refineries and other manufacturing businesses. In the other areas of East County, employment is limited to commercial/retail jobs (supporting residential communities) and a small amount of agricultural employment.

Over the 1990-2010 period, jobs in East County are projected to increase by 46,050, for a total of 79,860. This is approximately one-third of the new jobs projected for Contra Costa County during this period. This represents an increase of 136 percent, versus a growth rate of 41 percent for the county as a whole. The job growth is expected to be concentrated in services (226 percent), retail (149 percent), and manufacturing/wholesale (81 percent).

Alameda County

Alameda County followed the trend within the Bay Area region of a declining rate of employment growth during the years 1980 to 1990. Where the regional average employment growth rate was 3.8 percent per year from 1960 to 1980, it declined to 1.9 percent over the next ten years. Also, during this period, employment in Alameda County shifted away from the cities along the Bay in West County to the Tri-Valley area in East County. This resulted in an exceedingly high 10.3 percent average annual growth rate for employment in East County during the 1980-1990 decade. This shift reflected a general trend in California of businesses locating away from traditional central urban business centers to decentralized suburban business parks, such as Bishop Ranch and Hacienda Business Park in Alameda's East County.

In 1990, Alameda's East County employed 71,960 people, with most of these jobs located in the three cities and their spheres of influence. Pleasanton had the largest employment (31,110), followed by Livermore (25,230), Dublin (13,000), and the remainder of East County (2,620).

Over the next twenty years, economic growth in the Bay Area region is expected to continue the shift away from jobs in manufacturing to jobs in the service industries. A majority of the economic growth in Alameda County over this period will occur in the East County/Tri-Valley area. As shown in Table 15-4, the number of jobs in East County is expected to grow to 140,310 by the year 2010. This represents a 95 percent increase or a 4.7 percent annual increase in employment, substantially higher than 1.6 percent expected for the Bay Area region. The draw to the East County area is credited to the cost and availability of raw land, the availability of existing leasable building space and the presence of a labor market.

8.2 SWP Service Areas

The SWP provides water to agricultural, industrial and municipal users throughout much of the state. Major water delivery systems, such as the SWP and the Central Valley Project (CVP), have been essential components in California's extensive growth and development. Water transfers from northern California have also fostered agricultural production in the Central Valley and southern California, making the state one of the leading producers in the country.

SWP facilities begin in the upper Feather River basin in Plumas County and continue with the Lake Oroville dam and a series of smaller reservoirs, which lead down the Sacramento River to the Delta area. In the Delta, a number of diversions, reservoirs, canals and pumping plants precede the 444-mile California Aqueduct. This is the largest and longest water conveyance system in the state, extending to Lake Perris south of Riverside in southern California. Throughout the SWP, power plants and power recovery facilities produce electricity for the pumping needs of the system. In addition, many of the reservoirs in the system provide recreational opportunities.

The 29 long-term water supply contractors of the SWP are organized into six service areas: Feather River, North Bay, South Bay, Central Coast, San Joaquin Valley, and Southern California. These areas vary widely in size, location, climate, and population.

The Feather River service area has area-of-origin priorities for SWP supplies and would not be affected by ISDP in terms of water deliveries. The other service areas are described briefly in this section.

Service Area Population, Housing, Employment and Income

This section presents general background on population, employment, housing and income for the SWP service areas based on data for 1990 and 1994, as well as projections for certain years. Because of limitations to available data, the data presented (Tables 15-5 to 15-7) is compiled on a countywide basis, while in actuality some of the service areas include only portions of certain counties. However, countywide data is representative of the general demographic and economic trends for the service areas. Table 15-5 presents countywide population projections for 2010 and 2020 in the service areas. Table 15-8 in contrast presents population data for 1990 and projections for 2020 (not available for 2010) by the specific service area boundaries for the purpose of discussing long term impacts of additional water supplies on the service areas. Thus,

the reader should note there are differences in the population data shown for several service areas in 1990 and 2020 as presented in Tables 15-5 and 15-8 (South Bay, San Joaquin and Southern California).

North Bay Service Area

The North Bay service area includes all of Napa and Solano counties, which are located in the northern portion of the San Francisco Bay Area. SWP contractors are the Napa County Flood Control and Water Conservation District (FC and WCD) and the Solano County Water Agency. Water deliveries go primarily to the cities of Napa and American Canyon in Napa County, and to the cities of Benicia, Fairfield, Suisun, Vacaville, and Vallejo in Solano County.

In July 1994, the estimated population was 119,000 for Napa County and 375,300 for Solano County. Napa County population is projected to grow by 25.4 percent to 139,900 over the twenty year period 1990 to 2010, while Solano County expects a population increase of 61.3 percent with a total of 557,400 residents in 2010 (see Table 15-5).

Most of the growth in Napa County is expected to occur in the incorporated cities, particularly in the City of Napa and the newly incorporated American Canyon (1992). Napa County has experienced relatively moderate population increases in the past due to local government policies to limit growth. Growth has also been concentrated in the existing urban areas to protect prime agricultural lands and other natural resources.

Currently, it is projected that over the 1990-2010 period the number of households in Napa County will increase by 31.7 percent (see Table 15-6). However, projections for continued moderate growth in Napa County could be revised once it is known how much growth will be allowed in American Canyon. The new city is currently in the process of preparing a General Plan. There is a potential that substantial growth may occur in American Canyon and in the Napa Airport Industrial Area (in the unincorporated portion of the County). Napa communities are also expected to receive secondary growth as a spill over from growth in Solano County. Substantial growth in Napa County will place severe stress on major infrastructure and services (including water supply, sewer and roads).

The Napa County economy is increasingly centered around grape-growing, wine-processing and associated tourism (retail trade, hotels, and restaurants). Between 1990 and 1995, the area has experienced a substantial gain in service related jobs, while there were losses in manufacturing and wholesale trade employment. However, in the 1995-2010 period the county is expected to gain over 22,000 jobs, with the highest percentage in services as well as additional manufacturing and wholesale trade jobs. While population is currently projected to increase by only 25.4 percent during the 1990-2010 period, employment is expected to increase 51.8 percent during this same time.

Solano County has experienced significant growth in population and employment in the past due to its location between Sacramento and the San Francisco Bay Area. In the ten year period of 1980 to 1990 alone, the population increased by 45 percent. Substantial growth is expected to continue, well above the statewide average.

The economy of Solano County has grown and diversified in recent years. There is a strong agricultural sector mainly in field crops, fruits and nuts, and livestock. There are also major employers in the manufacturing and wholesale trade sectors. Heavy water-using industries include two meat packing companies and a cannery in Dixon, a refinery in Benicia, a brewery in Fairfield and two food processors in Vacaville. Extensive regional discount shopping centers have been opened in Vacaville. Finally, there are two large military bases in the county, however, the Mare Island Naval Base is scheduled for closure in the next few years.

Economic growth in Solano County is expected in each of the major sectors, with manufacturing and wholesale trade employment projected to almost triple by 2010. Retail trade and service employment will also experience substantial growth of 100 percent and 86 percent respectively. Overall, the county will gain about 75,000 new jobs over the 1990 to 2010 period (see Table 15-7).

This growth is expected to place substantial pressure on the county and cities to plan carefully for new development. Water supply and distribution is a significant constraint in the northern part of the county, which may affect the ability of this growth to be realized.

South Bay Service Area

The South Bay service area includes all of Santa Clara county and the eastern portion of Alameda County. The contractors are the Alameda County Flood Control and Water Conservation District, Zone 7 (serving all of East Alameda County), the Alameda County Water District and the Santa Clara Valley Water District.

In July 1994, Alameda County had an estimated population of 1,352,000 and Santa Clara County had 1,591,900 residents, representing the two most populous counties in the Bay Area region. Alameda's population is expected to increase by 21.7 percent over the 1990 to 2010 period to 1,561,900. Santa Clara's population growth over this period is estimated to be 22.5 percent for a total of 1,839,700 residents. Both of these counties represent large, well-established urban areas that have been growing steadily since 1960.

Since 1980, Alameda County growth has been shifting away from the highly urban West County on the Bay to new suburban development in the East County, including the Livermore-Amador Valley (the cities of Dublin, Pleasanton and Livermore). While the twenty year population growth rate for the county is 21.7 percent, the East County planning area has a projected growth rate of 77.1 percent. This area alone is expected to add about 104,765 new residents and 51,468 housing units.

Over the 1970s and 1980s, Alameda's economy made a transition to a well diversified economic base. In the southern portion of the county, the cities of Fremont, Newark and Union City became a center for high technology industries. In the northern portion of the county, jobs have shifted out of manufacturing to office employment, government centers, transportation and biotechnology. East County has become a center for office employment, communications and high technology industries.

As can be seen in Table 15-7, job growth in Alameda County from 1990 to 1994 has been very small due to the economic recession. The county will suffer from several military base closures in the region, including the Alameda Naval Air Station. However, during the 1995 to 2010 period job growth is expected to recover. The northern portion of the county is expected to continue to lose manufacturing jobs, which will most likely be replaced with service jobs. The southern portion and East County are expected to increase the number of manufacturing and wholesale trade jobs, along with substantial increases in retail employment. The East County is expected to capture 38 percent of the counties overall job growth through 2010.

West County is expected to reach buildout for residential development around 2000, particularly right along the Bay. As a result, most of the new housing and population growth will be in the Central and East County areas. However, there are infrastructure constraints including sewer treatment and outflow capacity and the availability of water. The County is currently studying water storage and other water recovery options as alternatives if future SWP entitlements to Zone 7 can not be met.

Starting in the 1950s and 1960s, Santa Clara County was transformed from a largely rural, agricultural area to a major economic center with a booming suburban housing market. In the 1980s, Santa Clara became the most dynamic economy in the Bay Area, capturing the majority of new jobs in the region, and ranking the county fourth in the State for jobs and population. The county has been one of the nation's major centers for high-technology electronic and computer industries.

From 1990 to early 1994, Santa Clara was hard hit by the economic recession and lost over 80,000 jobs. This type of job loss is unprecedented and represents a major restructuring of the economy. It is expected that beginning in 1995, the county will begin to recover slowly and by 2010 will add 182,000 jobs. However, the electronic and computer industries will not bring in the large job increases as once predicted due to industry restructuring, decentralization and a decline in market share. Cuts in defense spending and cutbacks in transportation equipment manufacturing have had a major effect on employment. It is projected that the county's employment will shift to business, engineering, research and development and professional services jobs. More than half of the new jobs are expected to be in the City of San Jose.

Santa Clara County has always had an imbalance of jobs versus housing, with most home prices being too expensive for the majority of employees to afford. The result has been long commutes from other surrounding counties for most employees and the resulting transportation congestion. The 1990 to 2010 period is expected to see some improvement in this area as new households increase by 21 percent. The county will gain 337,500 persons and 109,420 households, primarily in the City of San Jose. The southern portion of the county around Gilroy and Morgan Hill is a potential high growth area if infrastructure constraints on sewer treatment and outflow capacity can be overcome.

Central Coast Service Area

The Central Coast service area includes all of San Luis Obispo and Santa Barbara counties. The SWP contractors are the San Luis Obispo County Flood Control and Water Conservation District and the Santa Barbara County Flood Control and Water Conservation District. These contractors do not currently receive any of their entitlement water pending completion of the SWP Coastal

Branch, Phase II aqueduct and related delivery systems. The project has been approved and is currently under construction. It is expected to be in operation in the next year or two.

San Luis Obispo and Santa Barbara counties do not import any water from outside the area and currently have severe water shortages. Both counties have been relying on groundwater overdraft for a number of years. San Luis Obispo has a SWP entitlement of 25,000 acre feet per year (AF/YR) and Santa Barbara has 45,486 AF/YR. Once the Phase II aqueduct and the other delivery systems are completed, both counties will be able to receive their water entitlements. However, recent decisions by both counties have changed delivery levels to 41,830 AF/yr and 42,986 AF/yr for San Luis Obispo and Santa Barbara counties, respectively.

San Luis Obispo County had a July 1994 estimated population of 234,500 and Santa Barbara had approximately 394.400 residents. San Luis Obispo's population is projected to increase by 40 percent between 1990 and 2010 to a total of 306,800, while Santa Barbara's population should reach 484,800 in this same period for an increase of 30.6 percent. This is on par with the overall growth rate for the State. In recent years, growth in both counties has been constrained by a number of factors, including the need for additional water supplies.

Table 15-6 shows that households are expected to increase by 44.9 percent from 1990 to 2010 in San Louis Obispo County. Santa Barbara expects a smaller increase of only 21.8 percent over the same period.

The economic base of both these counties includes a strong agricultural sector. Santa Barbara ranked 14th among the counties in the state in 1992, with $455,002,000 in production value, while San Luis Obispo ranked 18th with $276,762,000 in production value. Major crops include broccoli, lettuce, carrots, strawberries and wine grapes, along with cattle grazing and milk production.

Oil production and transportation facilities both on and off-shore are important features of the economy in both counties. In addition, San Luis Obispo has several electric power plants. The largest employment sectors are retail trade, services, and government, making up about 60 percent of employment in both counties. The government sectors include a State University campus in San Luis Obispo and a University of California campus in Santa Barbara. In addition, Santa Barbara has Vandenberg Air Force Base.

Both of these counties have suffered with the recent recession in California. Santa Barbara lost jobs from 1990 through 1993, but has seen an increase in employment in 1994 as seen in Table 15-7. San Luis Obispo had 2,700 less jobs at the start of 1994 then in 1990. Much of the loss of employment is due to cutbacks in federal government spending and resulting losses in the high technology and electronic industries. A drop in retail trade and service jobs has also resulted from reductions in the tourist trade in both counties.

The economy is beginning a slow recovery in California, which will begin to help San Luis Obispo and Santa Barbara. These counties are expected to have substantial increases in retail trade and service employment over the next ten to fifteen years, with modest increases in manufacturing.

San Joaquin Valley Service Area

The San Joaquin Valley service area is located primarily in the southern portion of the valley and consists of all of Kings County and portions of Kern County. Contractors include the County of Kings, Devil's Den Water District, Dudley Ridge Water District, Empire West Side Irrigation District, Kern County Water Agency and Tulare Lake Basin Water Storage District. In addition, the service area includes a small agricultural district (Oak Flat) in Stanislaus County, near the City of Patterson.

The San Joaquin Valley service area is primarily a sparsely populated, arid area characterized by large farms. In July 1994, the population of Kern County was 622,900 with about one-third of the population living in the City of Bakersfield. Kings County had a population of only 115,700, with about 69 percent of the population living in the four incorporated cities (Hanford, Lemoore, Corcoran and Avenal). Both counties are expected to grow rapidly over the 1990 to 2010 period, with Kern's population increasing by 88.8 percent to a total of 1,037,700. Kings County should increase its population by 64.9 percent over the same period, for a total of 168,900 people.

This region is one of the most productive agricultural areas in California. In 1992, Kern County ranked fourth in the State for the value of agricultural production with about $1.5 billion and Kings County ranked eleventh with about $800 million. Production includes a wide variety of orchard, vineyard, truck and field crops.

The economy of Kern County is based primarily on agriculture and the oil industry, with major oil production fields. Over the past ten years, the economy has diversified somewhat with sizable employment in manufacturing, retail trade, services and government.

Kings County is mostly farmland with 88 percent of the acreage in agricultural uses. Other major employers include the Lemoore Naval Air Station, two state prisons, several agricultural processing plants, a hazardous waste treatment and disposal facility, and an automobile tire manufacturer. In addition, there are jobs in retail and services that support the residential population and households.

The economies of both counties are currently quite depressed, with unemployment reaching 14.6 percent in Kern and 14.9 percent in Kings in early 1994 versus a statewide rate of 9.1 percent. Employment has declined since 1990 in both counties, but early 1994 figures show modest increases in the number of jobs.

A large population of migrant workers during the agricultural season places severe demands on services and on temporary, low-income housing markets. Due to the large number of farm workers and general economic conditions in the two counties, the median household incomes are well below that of the State average as shown in Table 15-7.

Future economic growth in Kern County is expected to continue to diversify with strong growth in the retail trade and service sectors, although, agriculture and oil production will remain the largest sectors. Local government policies have been adopted to encourage new residential growth, housing development and economic expansion in existing urban areas to protect prime agricultural lands.

Kings County will remain largely dependent on agricultural production with limited expansion in retail trade and services to support a growing regional population.

Southern California Service Area

The Southern California service area is by far the largest both in land area and population, encompassing almost all of Los Angeles, Orange, Riverside, San Bernardino and San Diego counties, with portions of Kern, Imperial, and Ventura counties. (Note: the data presented in the Tables 5-5 to 5-7 shows Kern County as part of the San Joaquin service area only, since the portion in the Southern California service area is so small). There are twelve SWP contractors in this service area, with the Metropolitan Water District of Southern California (MWD) being the largest (see list of contractors on Table 15-14).

This highly urbanized service area is the major population center of California, with 18,400,100 people in 1994, or over 57 percent of the State's population residing in seven counties, as shown in Table 15-5. Southern California is also the State's leading economic region, despite setbacks in the recent recession.

Population and economic growth in this area over the last fifty years has been dependent on importing water from outside the area. Recent cutbacks in the availability of Colorado River water and water from Mono Lake have changed the water supply picture for the region. MWD is currently proposing a major new water storage dam and is evaluating other water supply and management options.

The population in this area is expected to increase by 37.2 percent over the 1990 to 2010 period, which is slightly below the State average of 41.5 percent. However, this represents half of the total number of new people in the State during this period. Significant growth is expected in the eastern portion of southern California in Riverside, San Bernardino and Imperial counties both in population and in the number of households.

The economy of this region is broadly diversified, with the largest concentration of manufacturing in the State, particularly in the aerospace and high-technology industries. Other major industries include shipping, international trade, oil production and refining, movies and entertainment, fabricated metals, chemical production, food processing and paper production. The region is also a major center for finance, insurance, real estate, and tourism. There have been a number of military bases in the region, but several of these have been closed in recent years, or, are scheduled for closure or cutbacks.

In addition to the economic activities listed above, the region also has substantial agricultural production despite the high level of urbanization. The following list shows the counties in the southern California service area by rank and by value for agricultural production (excluding timber) in 1992:

Riverside	7th	$997,654,000
San Diego	8th	$967,391,000
Imperial	10th	$855,070,000
Ventura	12th	$725,292,000
San Bernardino	14th	$591,901,000
Orange	20th	$251,728,000
Los Angeles	27th	$197,479,000

Source: California Agricultural Commissioners' Reports

The southern California region suffered significantly during the recent economic recession with major cutbacks in federal defense spending and related contracts to the aerospace and electronics industries. Major job losses in most of the economic sectors were experienced in all the counties during 1991 through 1993. The start of 1994 has seen the beginning of a slow recovery with modest job increases throughout the area.

Employment projections show a steady and moderate increase in the number of jobs through 2010, with the strongest sectors being retail trade and services. Manufacturing will not maintain as large a share of the employment market. The fastest rates of employment growth, following that of population growth, will be in the eastern counties of Riverside and San Bernardino.

Service Area Water Supply and Demand

This section examines water supply and demand for the SWP service areas that will be affected by ISDP. Table 15-8 presents population data for 1990 and projections for 2020 (not available for 2010) aggregated by the specific boundaries of the service areas. This population data was used in developing the corresponding water supply and demand numbers shown in Tables 15-9 to 15-14. The water supply and demand numbers were prepared by DWR staff in October 1995 based on data used in the DWR publication, Bulletin 160-93: California Water Plan Update, November 1993. Information in Bulletin 160-93 is aggregated by the ten hydrologic regions in the State, while the information used here is aggregated by the SWP service areas. Table 15-9 presents water supply and demand data for all of the SWP service areas aggregated.

North Bay Service Area

The North Bay service area (all of Napa and Solano counties) is comparatively small, representing only 7 percent of the total net water demand within the overall SWP service area in 1990. The North Bay service area average year water demand of 728 thousand acre feet (taf) per year (63 taf for Napa and 665 taf for Solano) is dominated by the agricultural sector. In 1990 with average year conditions, agricultural demand made up 62 percent of the total demand (Table 15-10). At the same time, urban demand represented 16 percent and environmental

demands (e.g. wetlands restoration, minimum river flows) 21 percent of total demand. By the year 2020, urban uses are expected to increase to 25 percent of total demand with continued population growth. Agricultural use is expected to decline to 56 percent of total demand, while environmental uses remain unchanged.

The North Bay service area presently has adequate water supplies under average conditions and this is expected to be the case in the future. However as shown in Table 15-10, substantial shortages occur under drought conditions. The majority of water supply in 1990 (68 percent) came from local surface water and groundwater pumping. Federal projects supplied 28 percent, while the SWP supplied only 4 percent of the service areas total water. The portion of SWP water supplies is expected to increase to 7 percent by 2020.

South Bay Service Area

The South Bay service area is a highly urban area, as reflected in the water demand figures in Table 15-11. Water demand in 1990 under average conditions was 509 taf, of which 435 taf (85 percent) was urban demand. Agricultural demand was 63 taf, representing only 12 percent of total water demand. It is expected that by 2020 urban demand will increase to 618 taf, while agricultural demand will remain unchanged. However, conservation savings of 81 taf will help reduce the overall demand by this time to 613 taf.

The SWP is a major supplier of water to the South Bay service area, providing approximately 30 percent of the total water supply presently. Future water supplies from the SWP will remain about the same with a small 2 taf reduction by 2020. The service area is expected to increase its groundwater pumping substantially to meet new demands. Currently, the service area has adequate supplies to meet demand under average year conditions, but experiences a 22 percent shortfall with draught conditions. By 2020, there is a small shortfall (4 percent) under average year conditions and a shortage of 36 percent of demand with drought conditions.

Central Coast Service Area.

As seen in Table 15-12, within the Central Coast service area, urban water uses in an average year represented 21 percent of demand in 1990 and agriculture made up 75 percent of demand. By 2020, urban uses increase to 30 percent of water demand and agriculture drops to 69 percent. This reflects the projected 34 percent growth in population in Santa Barbara and San Luis Obispo counties.

Water supplies over the 1990 to 2020 period will change primarily due to the elimination of 176.3 taf of groundwater overdraft (1990). In addition, the service area will begin receiving 52 taf of SWP water deliveries in 1996 or 1997, with completion of the Coastal Branch Phase II aqueduct currently under construction. The service area has long held a contract for SWP entitlements, but there was no physical means of conveying the water from the California aqueduct to the counties. The new coastal aqueduct connection was finally approved in 1993 and is currently under construction. However, the area will still have a 137.7 taf shortage by 2020 representing 29 percent of demand.. Water shortages have been an issue contributing to constrained growth in the two counties for a number of years.

San Joaquin Service Area.

The San Joaquin service area has the second largest demand for water within the SWP service territory, representing 21 percent of the SWP's total demand. At the same time this area has only 2 percent of the population within the SWP service territory. Table 15-13 shows that in 1990 the majority of water in San Joaquin service area was needed for agricultural production (or 92 percent of the demand with an average water year). By 2020, the demand for water in the service is expected to decline slightly, with to the reduction of agricultural land in production. Agricultural water demand is reduced by 7 percent from 1990, due primarily to a lack of water supply. This decline is also due in part to urban development and other environmental uses, as seen in the 2020 water demands that are over twice 1990 levels for both of these uses.

In 1990 with average water conditions, the SWP delivered 1,219.4 taf or about 57 percent of the San Joaquin service area's water supply. SWP deliveries will be reduced to 991.3 taf by 2020, which is the major contributing factor to the expected loss of acreage in agricultural production. The service area has not identified alternative water sources to replace this drop in SWP deliveries. There will be some expansion of ground water pumping in certain areas, but the current groundwater overdraft of 89 taf will be eliminated. Overall, the service area is expected to have an 11 percent shortage in meeting water demand by 2020. Under average year conditions, shortages increase from 6 taf currently to 224.7 taf, while drought year shortages see an increase from 178.7 taf to 401.5 taf (a 19 percent shortfall).

Southern California Service Area

The Southern California service area is a highly urban area with approximately 57 percent of the State's population. Within the service area, urban uses represented 73 percent of the water demand in 1990, while agricultural water demand was just 24 percent of the total. This area represents over half the water demand within the SWP territory. However, because urban water uses statewide are low relative to agricultural uses in the California, total Southern California service area water demand represents only 12.2 percent of the total state-wide water demand.

Projections for the Southern California service area average year water demand in 2020 show urban demand increasing to 95 percent of the total demand in this area as the population grows by about 10.2 million. Agricultural demand is reduced to 9 percent of the total demand as more area is given up to development.

Water supplies in 2020 are expected to increase to 5,240.6 taf from 5,159.7 in 1990, representing 81 taf of additional water. The service area loses 587.3 taf of Colorado River water during this period, while groundwater yield increases 50 taf and SWP supplies increase 761.5 taf. However, demand has increased 1,757.6 taf from 5,162.4 taf to 6,920 taf. As a result water shortages increase from 2.7 taf in 1990 to over 1556.9 taf in 2020. The water shortages are even more severe in 2020 (2,688 taf) under drought year conditions.

References

Abrams, L. 1951. *Illustrated Flora of the Pacific States, Volume III.* Palo Alto: Stanford University Press.

Abrams, L. 1944. *Illustrated Flora of the Pacific States, Volume II.* Palo Alto: Stanford University Press.

Abrams, L. 1923. *Illustrated Flora of the Pacific States, Volume I.* Palo Alto: Stanford University Press.

Abrams, L., and R. S. Ferris. 1960. *Illustrated Flora of the Pacific States, Volume IV.* Palo Alto: Stanford University Press.

Aceituno, M. E., and C. D. Vanicek. 1976. *Life history studies of the Sacramento perch,* Archoplites interruptus *(Girard), in California.* California Department of Fish and Game 62:5-20.

Aceituno, M. E., and C. D. Vanicek. 1976. *Distribution and status of the Sacramento perch,* Archoplites interruptus *(Girard), in California.* California Department of Fish and Game 62:246-254.

Alameda County. February 1993. *Alameda County General Plan: Draft East County Area Plan/Background Reports.*

Alameda County. 1993. *Alameda County General Plan: Environmental Quality and Resources.*

Alameda County Planning Department. 1994a. *East County Area Plan: A Portion of the Alameda County General Plan.* Volume I: Goals, Policies and Programs.

Allen, M. A., and T. J. Hassler. 1986. *Species profile: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) - chinook salmon.* (Biological Report 82[11.49].) U. S. Fish and Wildlife Service. Washington, D. C.

Ambler, J. W., J. E. Cloern, and A. Hutchinson. 1985. "Seasonal cycles of zooplankton form San Francisco Bay." *Hydrobiologia* 129:177-198.

Archeo-Tec. 1990. *Cultural Resources Evaluation of the Proposed Mountain House Planned Community, San Joaquin County, California.* Report prepared for EIP Associates, San Francisco, California. Manuscript report, CCIC-712, Central California Information Center, CSU-Stanislaus.

_____. *Cultural Resources Evaluation of the Proposed Mountain House Planned Community, Alameda and San Joaquin Counties, California.* Report prepared for EIP Associates, San Francisco, California. Manuscript report, CCIC-711, Central California Information Center, CSU-Stanislaus.

Armor, C., and P. L. Herrgesell. 1985. "Distribution and abundance of fishes in the San Francisco Bay estuary between 1980 and 1982." *Hydrobiologia* 129:211-227.

Arthur, J. F. 1975. "Preliminary studies on the entrapment of suspended materials in Suisun Bay, San Francisco Bay-Delta Estuary." *Proceedings of a Workshop on Algal Nutrient Relationships in the San Francisco Bay and Delta*, Ed. R. L. Brown. San Francisco : San Francisco Bay and Estuarine Association. 17-36.

Arthur, J. F. and M. D. Ball. 1978. *Entrapment of Suspended Materials in the San Francisco Bay-Delta Estuary.* Technical Report for U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, California.

Arthur, J. F. and M. D. Ball. 1979. "Factors influencing the entrapment of suspended materials in the San Francisco Bay-Delta Estuary." *San Francisco Bay: The Urbanized Estuary.* Ed. T. J. Conomos. San Francisco: Pacific Division, American Association for the Advancement of Science. 143-174.

Arthur, J. F., and M. D. Ball. 1980. *The Significance of Entrapment Zone Location to the phytoplankton Standing Crop in the San Francisco Bay-Delta Estuary.* Report for the U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, California.

C—087819

C-087820

Association of Bay Area Governments (ABAG). December 1991. *Status and Trends Report on Wetlands and Related Habitats in the San Francisco Estuary.* San Francisco Estuary Project.

Atwater, B. F. 1982. *Geologic Maps of the Sacramento-San Joaquin Delta, California.* Department of the Interior, U.S. Geological Survey.

Atwater, B. F., and D. F. Belknap. 1980. "Tidal-wetland Deposits of the Sacramento-San Joaquin Delta, California." *Quaternary Depositional Environments of the Pacific Coast.* Los Angeles: Pacific Coast Paleogeography Symposium 4.

Auld, A. B., and J. R. Schubel. 1978. *Effects of suspended sediment on fish eggs and larvae: a laboratory assessment.* Estuarine Coastal Marine Science. 6:153-164.

Amorocho, J., T.N. Kadir, J.J. DeVries, and W.J. Hartman. 1983. *Peripheral Canal Intake Studies 3. Suspended Sediment Studies for the Sacramento River Diversion to the Peripheral Canal, Data Preparation and Analysis.* Water Science and Engineering Paper 1075. University of California, Davis.

Baba, B. May 1994. *CEQA-Defined Rare and Endangered Plants Currently Known to Occur Along the Waterways of the Sacramento-San Joaquin Delta.* California Department of Fish and Game.

Bain, R. C. Jr., H. E. Pintler, A. Katko, and R. F. Minnehan. 1968. *San Joaquin Master Drain. Effects on Water Quality of San Francisco Bay and Delta. Appendix Part C. Nutrients and Biological Response.* Report on Central Pacific Basins Project, U.S. Federal Water Pollution Control Administration, Southwest Region, San Francisco, California.

Baker, S. and L. H. Shoup. 1991. *Cultural Resources Investigations of the Proposed Mountain House New Town Project, San Joaquin County, California.* Report prepared by Archaeological/Historical Consultants, Oakland, California, for Baseline Environmental Consulting, Emeryville, California. Manuscript report, CCIC-715, Central California Information Center, CSU-Stanislaus.

Bakus, G. J. 1968. *Sedimentation and benthic invertebrates of Panning Island, Central Pacific.* Marine Geology. 6:45-51.

Ball, D. 1989. *Water Transparency in the Delta and Possible Causes, Initial Working Paper for the Food Chain Committee*. U.S. Bureau of Reclamation. November 17, 1989.

_____. 1987. *Phytoplankton Dynamics and Plankton Chlorophyll Trends in the San Francisco Bay-Delta Estuary.* Exhibit No. 103, California Water Resources Control Board Hearings, U.S. Bureau of Reclamation, Sacramento, California.

_____. 1977. *Phytoplankton Growth and Chlorophyll Levels in the Sacramento-San Joaquin Delta through San Pablo Bay.* Report for U.S. Bureau of Reclamation, Sacramento, California.

_____. 1975. "Chlorophyll levels in the Sacramento-San Joaquin Delta to San Pablo Bay." *Proceedings of a Workshop on Algal Nutrient Relationships in the San Francisco Bay and Delta.* Ed. R. L. Brown. San Francisco: San Francisco Bay and Estuarine Association. 53-102.

Barnard, W. D. 1978. *Prediction and control of dredged material dispersion around dredging and open-water pipeline disposal operations.* U. S. Army Engineer Waterways Experiment Station, Technical Report DS-78-13.

Barnhart, R. B. 1991. Steelhead (*Oncorhynchus mykiss*). Pages 324 to 336 In J. Stolz and J. Schnell, editors. Trout. Stackpole Books, Harrisburg, PA.

Baseline Environmental Consulting. 1994. *Final Environmental Impact Report, Mountain House Master Plan and Specific Plan I.* SCH #90020776.

Baxter, R. 1994a. California Department of Fish and Game, Stockton, CA. Personal communication, January 14 and 19, 1994.

Baxter, R. 1994b. Preliminary results of a summer gill-net survey for Sacramento splittail. Newsletter. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Autumn 1994: 14-15.

Becker, C. D., D. A. Neitzel, and D. H. Fickeisen. 1982. *Effects of dewatering on chinook salmon redds: tolerance of four developmental phases to daily dewaterings.* Transactions of the American Fisheries Society 111: 624-637.

Beer, K. E. 1981. *Embryonic and larval development of* Acipenser transmontanus *Richardson.* M.S. Thesis. University of California, Davis.

Bennett, W. A. 1995. *Potential effects of exotic inland silversides on delta smelt.* Newsletter. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Winter 1995: 4-6.

Bennyhoff, J. A. 1961. *Ethnogeography of the Plains Miwok.* Unpublished dissertation. University of California, Berkeley, Department of Anthropology.

Bent, A. C. 1937. *Life Histories of North American Birds of Prey.* United States National Museum Bulletin 167.

Berg, L. S. 1948. *Freshwater fishes of the USSR and adjacent countries. Akad. Nauk SSSR Zool. Inst.,* Vol. 1, 4th edition. 493 pp. plus appendix (Translation by Israel Prog. for Scientific Translations 1962).

Berg, L., and T. G. Northcote. 1985. "Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment." *Canadian Journal of Fisheries and Aquatic Sciences.* 42:1410-1417.

BioSystems Analysis. 1993. *National Register of Historic Places Determination of Eligibility Report for Prehistoric Sites on Holland Tract, Contra Costa County, California.* Report prepared for Jones & Stokes Associates, Sacramento, California.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 in W. R. Meehan (editor) Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society, Bethesda, MD.

Blaber, S. J. M., and T. G. Blaber. 1980. "Factors affecting the distribution of juvenile estuarine and inshore fish." *Journal of Fish Biology.* 17:143-162.

Bloom, P. H. 1980. *The Status of the Swainson's Hawk in California, 1979.* California Department of Fish and Game, Nongame Wildlife Program Report No. 11-8.0. Sacramento: California Department of Fish and Game.

Bogdanov, A. S., S. I. Doroshev, and A. F. Karpevich. 1967. *Experimental transfer of (Salmo gairdneri) and (Roccus saxatilis) from the USA for acclimatization in bodies of water of the USSR.* Vopr. Ikhtiol. 42: 185-187.

Bolster, B. 1986. *Movement Patterns of Striped Bass* (Morone saxatilis) *in Clifton Court Forebay, Contra Costa County, California.* M.S. Thesis. California State University, Sacramento.

Botanical Research Group. August 1994. *Final Wetland Delineation for the Interim South Delta Program Sacramento-San Joaquin Delta, California.*

Botsford, L. W. and J. Brittnacher. 1994. *A model for projection of striped bass abundance in terms of flows and diversions.* Prepared for the Striped Bass Technical Team for the Central Valley Improvement Act. November 1994.

Botsford, L. W., and D. E. Wickham. 1975. "Correlation of upwelling index and Dungeness crab catch." *Fish. Bull.* 73:901-907.

Botsford, L. W., and D. E. Wickham. 1978. "Behavior of age-specific, density-dependent models and the northern California Dungeness crab (Cancer magister) fishery." *J. Fish. Res. Board Can.* 35:833-843.

Bramlette, A. G., M. Praetzellis, A. Praetzellis, K. M. Dowdall, P. Brunmeier, and D. A. Fredrickson. 1991. *Archaeological Resources Inventory for Los Vaqueros Water Conveyance Alignments, Contra Costa County, California.* Manuscript report, S-13256, Northwest Information Center, Sonoma State University.

Brandes, P. 1994. U.S. Fish and Wildlife Service. Personal communication. October 23, 1995.

Bray. R. N. 1979. *Dredging: A Handbook for Engineers.* London: Edward Arnold Ltd.

Breitburg, D. L. 1988. *Effects of turbidity on prey consumption by striped bass larvae.* Transactions of the American Fisheries Society. 117: 72-77.

Brown, Cathy. 1994. USFWS Biologist, Ventura, Ca. Telephone conversations, October 6 and 13, 1994.

C-087823

C-087824

Brown, R. L., and S. Greene. 1992. *Biological Assessment: Effects of the Central Valley Project and State Water Project Delta Operations on Winter-Run Chinook Salmon.* Dept. of Water Resources. 137pp.

Brown, C. L., G. Young, R. S. Nishioka, and H. A. Bern. 1987. *Preliminary report of the physiological status of striped bass in the Carquinez Strait die-off.* Fisheries Research 6: 5-16.

Brown, R. L. 1982. *Screening agricultural diversions in the Sacramento-San Joaquin Delta.* Department of Water Resources Internal Report.

Bryant, W. A., 1982. *Fault Evaluation Report for the Midland Fault.* California Division of Mines and Geology FER 133.

Burau, J., M. Stacey, and J. Gartner. 1995. *Preliminary Results from the hydrodynamic element of the 1994 Entrapment Zone Study.* Newsletter. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Autumn 1995: 12-17.

Butte County. 1991. *Butte County General Plan.*

California Department of Conservation. 1992. *State of California Farmland Conversion Report 1988-1990.*

_____. 1987. *Minerals for Industry: Southern California, Volume III.* California Department of Conservation, Division of Mines and Geology.

California Department of Finance. 1994. *California Statistical Abstract 1993.*

_____. 1994. *Population Estimates for California Cities and Counties.* Population Research Unit. Report 94-E, May 1994.

_____. 1993. *Population Projections by Race/Ethnicity for California and its Counties 1990-2040.* Population Research Unit. Report 93-P1, April 1993.

C—087824

C-087825

_____. 1992. *California Annual Population and Housing, April 1, 1980 to April 1, 1990. Data for Cities, Counties and the State.* Population Research Unit. Report E-8090CITY, June 1992.

California Department of Fish and Game. 1995. SB 34. Delta levees, master environmental assessment. October 1995.

_____. 1994a. *List of Endangered and Threatened Animals for California.* Sacramento: California Department of Fish and Game, Natural Heritage Division.

_____. November 1994b. *Staff Report Regarding Mitigation for Impacts to Swainson's Hawks* (Buteo swainsoni) *in the Central Valley of California.* Unpublished report.

_____. 1993. Estimation of pre-screen mortality of juvenile chinook salmon at Clifton Court Forebay, State Water Project, Byron, California, December, 1992. Memorandum. February 17, 1993.

_____. 1993a. *Factors Controlling the Abundance of Aquatic Resources in the Sacramento-San Joaquin Estuary.* P. Chadwick, author. 46 pp.

_____. 1993b. *Impact of Water Management on Splittail in the Sacramento-San Joaquin Estuary.* Testimony to the State Water Resources Control Board at the Bay/Delta Hearings. WRINT-DFG-Exhibit 5.

_____. 1993c. *Draft Report on December 1992 Clifton Court Forebay Chinook Predation Loss Experiment.* Patrick Coulston, author. Bay-Delta and Special Water Project Division. 11 pp.

_____. 1992a. Results of Spring, 1992 Clifton Court Forebay and John E. Skinner Fish Facility predator control efforts. Memorandum. August 19, 1992.

_____. 1992b. *Estuary dependent species.* (DFG exhibit No. 6, State Water Resources Control Board 1992 Bay-Delta proceedings, Sacramento, CA.

_____. 1992c. *South Delta Barriers Project: Assessment of Existing Fish, Wildlife and Plant Community Resources and Potential Project Impacts.*

_____. 1992d. *Sturgeon in relation to water development in the Sacramento-San Joaquin Estuary.* Exhibit #28 for the State Water Resources Control Board 1992 Decision on Interim Standards for Water Quality/Water Rights Proceedings on the San Francisco/Sacramento-San Joaquin Delta.

_____. 1992e. *The south Delta barriers project: assessment of existing fish, wildlife and plant community resources and potential project impacts.* California Department of Fish and Game, Bay-Delta and Special Water Projects Division.

_____. 1991. *Annual Report on the Status of California State Listed Threatened and Endangered Animals and Plants.* Sacramento: California Department of Fish and Game.

_____. 1990. *Endangered and Threatened Animals of California.* Sacramento: California Department of Fish and Game.

_____. 1987a. *Requirements of American shad (Alosa sapidissima) in the Sacramento River system.* (DFG Exhibit No. 23, State Water Resources Control Board 1987 water quality/water rights proceeding for the San Francisco Bay/Sacramento-San Joaquin Delta, Sacramento, California.

_____. 1987b. *Delta outflow effects on the abundance and distribution of San Francisco Bay fish and invertebrates, 1980-1985.* (DFG Exhibit No. 60, State Water Resources Control Board 1987 water quality/water rights proceeding for the San Francisco Bay/Sacramento-San Joaquin Delta, Sacramento, CA.

_____. 1987c. *Longterm Trends in Zooplankton Distribution and Abundance in the Sacramento-San Joaquin Estuary.* Exhibit No. 28 to California Water Resources Control Board, 1987 Water Quality/Water Rights Proceeding on the San Francisco Bay/ Sacramento-San Joaquin Delta, Sacramento.

_____. February. 1986. *Guidelines for Consulting with the Department of Fish and Game on Projects Subject to CEQA that May Affect Endangered and Threatened Species.* Prepared by E.W. Cummings and S. J. Nicola. Environmental Services Division Administrative Report 86-1.

_____. 1985a. 1984 Clifton Court Forebay evaluations of predation losses to juvenile chinook salmon and striped bass. Memorandum. May 18, 1985.

_____. 1985b. 1985 Clifton Court Forebay evaluation of predation losses to juvenile chinook salmon. Memorandum. September 20, 1985.

_____. 1981. *The John E. Skinner Fish Protective Facility 1968-1980: A summary of the first thirteen years of operation.* Anadromous Fishes Branch Administrative Report No. 81-6.

California Department of Fish and Game and California Department of Water Resources. October 1993. *Draft Sacramento-San Joaquin Delta Master Environmental Assessment.*

_____. 1989. *Los Banos Grandes Facilities Draft Biological Assessment.*

California Department of Parks and Recreation. 1988. *Lake Oroville State Recreation Area.*

California Department of Water Resources. 1996a. *Interim South Delta Program, Byron Tract-Old River Levee Waterside Stability Analysis.*

_____. 1996b. *Boat Survey Report.* Unpublished report.

_____. 1995a. *Temporary Barriers Project fishery, water quality, and vegetation monitoring.* August 1994. Environmental Services Office, Sacramento, CA.

_____. 1995b. *Information Relative to the Proposed Listing of Sacramento Splittail.* February 21, 1995.

_____. 1995c. *Attachment 1: Comments prepared by DWR in response to the draft delta smelt and splittail Biological Opinion.*

_____. 1994a. *Temporary Barriers Project Fishery, Water Quality, and Vegetation Monitoring, 1993*. Submitted to U.S. Army Corps of Engineers for permit requirements. 169 pp. plus appendices.

_____. 1994b. *Environmental Study for the Interim South Delta Program; Water, Sediment and Soil Quality.*

_____. 1994c. *Results of lower Feather River instream flow study (DRAFT)*. January 26, 1994. Prepared in cooperation with DFG for SWRCB. Sacramento, CA.

_____. 1994d. *Zone of influence*. Division of Planning, Delta Modeling Section. December 6, 1994.

_____. 1994e. *Trends Analysis for Existing Biological Conditions in the Bay/Delta Estuary.*

_____. 1994f. *The California Water Plan Update.* Bulletin 160-93.

_____. 1994g. *Boat Surveys for 1991-1994 (Draft).*

_____. 1994h. *Management of the California State Water Project.* Bulletin 132-92, September 1994.

_____. 1993a. *Comparison Between Transport Modeling Results:* Jones and Stokes Associates, Resource Management Associates, and Department of Water Resources. Unpublished report.

_____. 1993b. *Sacramento-San Joaquin Delta Atlas.*

_____. 1993c. *Program Environmental Impact Report, State Drought Water Bank, Final Environmental Impact Report.*

_____. 1993d. *A Report on Land Use Patterns in the Sacramento-San Joaquin Delta.*

_____. 1993e. *California Water Plan Update, Volume 2.*

C—087828

C-087829

_____. 1993f. *South Delta Water Management Study Social Analysis Appendix,* Final Draft.

_____. 1993g. *Final Environmental Impact Report on the Proposed Additional Pumping Units, Harvey O. Banks Delta Pumping Plant* (SCH #82113008).

_____. 1993h. *Management of the California State Water Project: Appendix E - Water Operations in the Sacramento-San Joaquin Delta.*

_____. 1993i. *California Water Plan Update.* Volume I. Sacramento: California Department of Water Resources.

_____. 1993j. *Compendium of Water Quality Investigations in the Sacramento-San Joaquin Delta.* California Department of Water Resources, Division of Local Assistance.

_____. 1993k. *Document D: Survey and Photometrics, Grant Line Canal.*

_____. 1993l. *Environmental Impact Report for the Interim South Delta Program: Water, Sediment, and Soil Quality Section.* California Department of Water Resources, Division of Local Assistance.

_____. 1993m. *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh.* Fourteenth Annual Progress Report to the State Water Resources Control Board in accordance with Water Right Decision 1485, Order 9. Sacramento: California Department of Water Resources, Division of Planning.

_____. 1993n. *Southern Delta Scour Monitoring 1991 and 1992.* California Department of Water Resources, Central District Memorandum Report.

_____. 1993o. *Water Quality Conditions in the Sacramento-San Joaquin Delta During 1991.* Report to the State Water Resources Control Board in Accordance With Water Right 1485, Order 4(f). California Department of Water Resources, Environmental Services Office.

C-087829

C-087830

_____. 1992a. *Water Quality Conditions in the Sacramento-San Joaquin Delta During 1990.* Report to the State Water Resources Control Board in Accordance with Water Rights Decision 1485, Order 4(f).

_____. 1992b. *South Delta Temporary Barriers Project Monitoring, Evaluation, and Management Program.* California Department of Water Resources, Environmental Services Office.

_____. 1992c. *Management of the California State Water Project.* Bulletin 132-92. December 1992.

_____. 1992d. *Biological Assessment for South Delta Temporary Barriers Project, Appendix G.* Sacramento: California Department of Water Resources, Division of Planning.

_____. 1992e. *Initial Study Proposed Test Program Temporary Barriers Project Reference Material: Appendix H, Draft Biological Assessment-Effects of Central Valley Project and State Water Project Delta Operations on Winter Run Chinook Salmon.* Sacramento: California Department of Water Resources, Division of Planning.

_____. 1992f. *Initial Study Proposed Test Program Temporary Barriers Project Reference Material: Appendix I, Middle River Monitoring Report, 1988.* Sacramento: California Department of Water Resources, Division of Planning.

_____. 1992g. *Initial Study Proposed Test Program Temporary Barriers Project Reference Material: Appendix K, Middle River Monitoring Report, 1990.* Sacramento: California Department of Water Resources, Division of Planning.

_____. 1992h. *Initial Study Proposed Test Program Temporary Barriers Project Reference Material: Appendix L, Middle River Monitoring Report, 1991.* Sacramento: California Department of Water Resources, Division of Planning.

_____. 1992i. *Initial Study Proposed Test Program Temporary Barriers Project Reference Material: Appendix P, Alternative Report on Southeast Delta Water Control Facilities.* Sacramento: California Department of Water Resources, Division of Planning.

_____. 1992j. *Initial Study Proposed Test Program Temporary Barriers Project Reference Material: Appendix Q, Explanation of Tidal Flow Charts*. Sacramento: California Department of Water Resources, Division of Planning.

_____. 1992k. *Initial Study Proposed Test Program Temporary Barriers Project Reference Material: Appendix R, Additional Water Quality Information*. Sacramento: California Department of Water Resources, Division of Planning.

_____. 1991. *Sacramento-San Joaquin Delta Water Quality Surveillance Program - 1989. Volume I - Water Quality.* Monitoring Results Pursuant to Conditions Set Forth in State Water Resources Control Board Water Right Decision 1485. California Department of Water Resources, Division of Local Assistance.

_____. 1990a. *Draft Environmental Impact Report/Environmental Impact Statement, South Delta Water Management Program, Phase I of Water Banking Program, Appendix L, South Delta Recreation Concepts.*

_____. 1990b. *Initial Study and Negative Declaration for Proposed South Delta Water Management Program Land Purchases.*

_____. 1990c. *Project Report of the Interagency Delta Health Aspects Monitoring Program.* Municipal Water Quality Investigations Programs, Summary of Monitoring Results January 1988-December 1989.

_____. 1990d. *Water Quality Conditions in the Sacramento-San Joaquin Delta During 1988.* Report to the State Water Resource Control Board in Accordance with Water Right Decision 1485, Order 4(f). California Department of Water Resources, Division of Local Assistance.

_____. May 1989. *Water Quality Conditions in the Sacramento-San Joaquin Delta During 1987.* Report to the State Water Resources Control Board in Accordance with Water Rights Decision 1485, Order 4(f).

_____. 1988a. *California's State Water Project.*

C-087831

C-087832

_____. 1988b. *South Delta Water Management Program.* California Department of Water Resources, Central District.

_____. 1988c. *West Delta Water Management Program.* California Department of Water Resources, Central District.

_____. 1987. Sacramento-San Joaquin Delta Atlas. August 1987.

_____. 1986. *Final Environmental Impact Report on the Proposed Additional Pumping Units, Harvey O. Banks Delta Pumping Plant* (SCH #82113008).

_____. 1986a. *The Sacramento-San Joaquin Delta Flood Hazard Mitigation Plan.*

_____. 1986b. *Sacramento-San Joaquin Delta Water Quality Surveillance Program, 1978-1986.* Monitoring Results Pursuant to Conditions Set Forth in Delta Water Rights Decision 1485.

_____. 1985. *Sacramento-San Joaquin Delta Water Quality Surveillance Program 1984.* Monitoring Results Pursuant to Conditions Set Forth in Delta Water Rights Decision 1485. August 1985.

_____. 1982. *Delta Levees Investigation.* Bulletin 192-82.

_____. 1980. *Plan of Protection for the Suisun Marsh.*

_____. 1977. *Sediment Study, Alternative Delta Water Facilities, Peripheral Canal Plan.* California Department of Water Resources, Central District.

California Department of Water Resources and U.S. Bureau of Reclamation. 1994. *Biological Assessment. Effects of the Central Valley Project and State Water Project on Delta smelt and Sacramento splittail.* Sacramento, California.

_____. 1993. Mid-Pacific Region. *Effects of the Central Valley Project and State Water Project on Delta Smelt.* Prepared for U.S. Fish and Wildlife Service, Ecological Services, Sacramento, California.

_____. 1990a. *Draft Environmental Impact Report/Environmental Impact Statement, South Delta Water Management Program, Phase I of Water Banking Program.*

_____. 1990b. *Draft Environmental Impact Report/Environmental Impact Statement, South Delta Water Management Program, Phase I of Water Banking Program, Appendix L, South Delta Recreation Concepts..*

California Employment Development Department. 1994. *Monthly Labor Force Data for Counties, April 1994.* California Employment Development Department, Labor Market Information Division.

_____. Published in various years for each region of the State. *Industry Trends and Outlook for Each Region of the State.* California Employment Development Department, Labor Market Information Division.

California Energy Commission. 1994. *Commission Order Adopting Electricity Demand Forecasts.* Docket No. 93 ER-94, March 16, 1994, Appendix A, Table 8.

California Natural Diversity Data Base. 1994. *Data Base Record Search for Information on Threatened, Endangered, Rare, or Otherwise Sensitive Species and Communities in the Vicinity of the Project Area.* Sacramento: California Department of Fish and Game.

California Public Utilities Commission. 1994. *Annual Report 1992-1993.*

California Regional Water Quality Control Board. May 1993. *A Compilation of Water Quality Goals.* Sacramento: California Regional Water Quality Control Board, Central Valley Region.

_____. 1991. Central Valley Region. Water Quality of the Lower San Joaquin River: Lander Avenue to Vernalis. October 1989 to September 1990.

_____. 1986. *Adopting Amendments to the Water Quality Control Plan and Requesting Approval from the State Water Resources Control Board.* Resolution No. 86-14. RWQCB, San Francisco Bay Region.

_____. Order No. 89-120. *Waste Discharge Requirements for Port of Oakland, Reclamation District 2038*. Sacramento: California Regional Water Quality Control Board, Central Valley Region.

California State Association of Counties, 1993. *1991-1992 California County Fact Book.*

California State Lands Commission. 1991. *Delta-Estuary: California's Inland Coast, A Public Trust Report.*

California State Water Resources Control Board. 1995a. *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*. May 1995.

_____. 1995b. *Environmental report. Appendix 1 of Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*. May 1995.

_____. 1993a. *California Enclosed Bays and Estuaries Plan: Water Quality Control Plan for Enclosed Bays and Estuaries of California.* (Report # 93-5WQ).

_____. 1993b. *California Water Plan Update - Volume 2.* (Draft.

_____. 1993c. *Water Rights Decision 1630: San Francisco Bay/Sacramento-San Joaquin Delta Estuary 1992.*

_____. 1993d. *Water Supply Impact Assessment of D-1630.* Draft.

_____. 1983e. *Water Quality Conditions During 1982 in the Sacramento-San Joaquin Delta.* Report to the State Water Resources Control Board in Accordance with Water Rights Decision 1485, Order 4(f).

_____. 1992. *Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse [of Dredged Sediments].* San Francisco Bay Region.

_____. 1992a. *Water Rights Decision 1630: San Francisco Bay/Sacramento-San Joaquin Delta Estuary 1992*. Draft.

_____. 1991a. *California Inland Surface Waters Plan: Water Quality Control Plan for Inland Surface Waters of California.* (Report # 91-12 WQ).

_____. 1991b. *Executive Summary: Water Quality Control Plan for Salinity: San Francisco Bay/Sacramento-San Joaquin Delta Estuary.* (Report # 91-15 WR).

_____. 1991c. *Final Draft: Water Quality Control Plan for Salinity: San Francisco Bay/Sacramento-San Joaquin Delta Estuary.*

_____. 1991d. *Water Quality Control Plan for Salinity: San Francisco Bay/Sacramento-San Joaquin Delta Estuary: Technical Appendix.* (Report # 91-16 WR).

_____. 1991e. *Water Quality Control Plan for Salinity: San Francisco Bay/Sacramento-San Joaquin Delta Estuary.* (Report # 91-15 WR).

_____. 1990. *Pollutant Policy Document: San Francisco Bay/Sacramento-San Joaquin Delta Estuary.* Resolution # 90-67. June 21, 1990.

_____. 1990. *1990 Water Quality Assessment (WQA).* April 1990.

_____. 1987. *California Water: Looking to the Future.* Bulletin 160-87.

_____. 1978. *Water Right Decision 1485. Sacramento-San Joaquin Delta and Suisun Marsh.* August 1978.

California Urban Water Agencies. 1994. *Draft evaluation of factors potentially limiting aquatic species abundance and distribution in the San Francisco Bay/Sacramento-San Joaquin Estuary.* Prepared by R2 Resource Consultants, Inc. for the California Urban Water Agencies.

Cardwell, R. D., C. E. Woelke, M. I. Carr, and E. W. Sanborn. 1976. "Sediment and elutriate toxicity to oyster larvae." *Dredging and its environmental effects.* Eds. P. A. Krenkel, J. Harrison, and J. C. Burdick. Mobile, Alabama.

Carlton, J. T. 1979. "Introduced invertebrates of San Francisco Bay." *San Francisco Bay: The Urbanized Estuary.* Ed. T. J. Conomos. San Francisco: Pacific Division, American Association for the Advancement of Science. 427-444.

Cartier, Robert. 1985. *Cultural Resource Evaluation of an Industrial Site on Kern Street in the City of Stockton, County of San Joaquin.* Prepared by Archeological Resource Management for Lincoln Property Company. Manuscript report, CCIC-726, Central California Information Center, CSU-Stanislaus.

Cashman, J. R. 1993. *Chemical Contaminants in striped bass (Morone saxatilis) from the Sacramento-San Joaquin Delta.* Study for CDFG. December 21, 1993. IGEN Research Institute. Seattle, WA.

Caywood, M. L. 1974. *Contributions to the life history of the splittail Pogonichthys macrolepidotus* (Ayres). M.S. Thesis, California State Univ., Sacramento, CA.

CDFG. See California Department of Fish and Game.

CEC. See California Energy Commission.

Chadwick, H. K. 1972. "Phytoplankton and their environmental requirements." *Ecological Studies of the Sacramento-San Joaquin Estuary.* Ed. J. E. Skinner. Sacramento: California Department of Fish and Game. 20-25.

_____. 1959. *California sturgeon tagging studies.* California Department of Fish and Game 45:297-301.

Chadwick, P. 1993. *Factors Controlling the Abundance of Aquatic Resources in the Sacramento-San Joaquin Estuary.* California Department of Fish and Game.

City of Bakersfield and County of Kern. 1993a. *Metropolitan Bakersfield Habitat Conservation Plan and Final Environmental Impact Report.* Prepared by Metropolitan Bakersfield Habitat Conservation Plan Steering Committee.

_____. 1993b. *Metropolitan Bakersfield Habitat Conservation Plan and Final Environmental Impact Report Appendix D: Response to Comments*. Prepared by Metropolitan Bakersfield Habitat Conservation Plan Steering Committee.

City of Sacramento. 1988. City of Sacramento General Plan.

City of West Sacramento. 1990. *City of West Sacramento General Plan.*

CNDDB. See California Natural Diversity Database.

Cloern, J. E. 1984. "Temporal dynamics and ecological significance of salinity stratification in an estuary (South San Francisco Bay, USA)." *Oceanol. Acta* 7:137-141.

Cloern, J. E., A. E. Alpine, B. E. Cole, R. L. J. Wong, J. F. Arthur, and M. D. Ball. 1983. "River discharged controls phytoplankton dynamics in Northern San Francisco Bay Estuary." *Estuar. Coast. Shelf Sci.* 12:415-429.

Cohen, A. N. 1990. *An Introduction to the Ecology of the San Francisco Estuary*. San Francisco Estuary Project.

Cole, B. E., J. E. Cloern, and A. E. Alpine. 1986. "Biomass and productivity of three phytoplankton size classes in San Francisco Bay." *Estuaries* 9:117-126.

Contra Costa County Community Development Department. 1993. *Contra Costa County General Plan 1990-2005*

_____. 1991. *Contra Costa County General Plan 1990-2005.*

Contra Costa County. 1992. *Draft Environmental Impact Report, Albers General Plan Amendment and Related Actions.* SCH #90030476.

_____. 1991. *Draft Environmental Impact Report, Byron 78 General Plan Amendment and Related Actions.* SCH #90030515.

Contra Costa Water District. March 7, 1994. *Draft Report on Clean Water Quality Standards.* Prepared for the California Urban Water Agencies, Sacramento, California.

Contra Costa Water District and U.S. Department of the Interior, Bureau of Reclamation, Mid-Pacific Region. October 1993. *Stage 2 EIR/EIS for the Los Vaqueros Project, Contra Costa County, California. Final.* Technical assistance provided by Jones and Stokes Associates; Montgomery Watson Associates; Woodward-Clyde Consultants; and Sonoma State University.

Cook, S. F. 1955. *The Aboriginal Population of the San Joaquin Valley, California.* Berkeley: University of California Anthropological Records 16(2):31-80.

Cordone, A. J., and D. W. Kelley. 1961. *The influences of inorganic sediment on the aquatic life of streams.* California Fish and Game. pp. 189-228.

Cosgwell, H. L. 1977. *Water Birds of California.* Berkeley: University of California Press.

Coulston, P. 1993. *Draft Report on December 1992 Clifton Court Forebay Chinook Predation Loss Experiment.* California Department of Fish and Game, Bay-Delta and Special Water Project Division.

County of Los Angeles. 1993. *General Plan Land Use Element.*

Coutant, C. C. 1985. *Striped bass, temperature and dissolved oxygen: a speculative hypothesis for environmental risk.* Transaction of the American Fisheries Society. 114: 31-61.

Crabtree, C. B. 1985. "Allozyme variability in the tidewater goby, *Eucyclogobius newberryi* (Pisces, Gobiidae)." *Isozyme Bull.* 18:70.

Crowl, T. A. 1989. *Effects of crayfish size, orientation, and movement on the reactive distance of largemouth bass foraging in clear and turbid water.* Hydrobiologia. 183: 133-140.

Curtin, Daniel J. 1994. *California Land Use and Planning Law.* Solano Press Books. Point Arena, California.

Cyrus, D. P., and S. J. M. Blaber. 1987. *The influence of turbidity on juvenile marine fishes in estuaries. Part 1. Field studies at Lake St. Lucia on the southeastern coast of Africa.* Journal of Experimental Marine Biology Ecology. 109: 53-70.

CUWA. See California Urban Water Agencies.

Daniels, R. A., and P. B. Moyle. 1983. *Life history of splittail (Cyprinidae: Pogonichthys macrolepidotus) in the Sacramento-San Joaquin estuary.* Fishery Bulletin 84-3: 647-654.

Davis, H. C. 1953. *On food and feeding of larvae of the American oyster.* C. Virginica. Biol. Bull., Woods Hole. 104: 334-350.

DeLorme Mapping Company. 1990. *Southern and Central California Atlas and Gazetteer.* 2nd ed. Freeport, ME.

_____. 1988. *Northern California Atlas and Gazetteer.* 2nd ed. Freeport, ME.

DPR. See California Department of Parks and Recreation.

Dodson, S. I., and D. G. Frey. 1991. "Cladocera and other Brachiopoda." *Ecology and classification of Freshwater invertebrates.* Ed. J. H. Thorp and A. P. Covich. 723-786.

Dryfoos, R. L. 1965. *The life history and ecology of the longfin smelt in Lake Washington.* Doctoral dissertation, University of Washington, Seattle, WA.

DWR. See California Department of Water Resources.

Ebasco Services, Inc. 1988. Recreation Facilities Plan for North and South Delta. March 1988.

ECOS. September 16, 1988. *Experimental Design for a Transplant Study of Mason's Lilaeopsis.* Unpublished report prepared for the US Bureau of Reclamation Mid-Pacific Region and the Department of Water Resources Central District.

Eisenmann, E. 1971. "Range Expansion and Population Increase in North and Middle America of the White-tailed Kite *(Elanus leucurus).*" *American Birds* 25(3):529-536.

Ellis, M. M. 1936. *Erosion silt as a factor in aquatic environments.* Ecology, 17: 29-42.

Elsasser, A. B. 1978. "Development of Regional Prehistoric Cultures." *Handbook of North American Indians, vol. 8, California.* Ed. R. F. Heizer. Washington, D.C.: Smithsonian Institution. 37-57.

Estep, J. E. 1989. *Biology, Movements, and Habitat Relationships of the Swainson's Hawk in the Central Valley of California, 1986-87.* California Department of Fish and Game, Nongame Bird and Mammal Section, Report 53.

Ferrari, F. D., and J. Orsi. 1984. "*Oithona davisae*, new species, and *Limnoithona sinensis* Burckhardt, 1912 (Copepoda: Oithonidae) from the Sacramento-San Joaquin Estuary, California." *J. Crust. Biol.* 4:106-126.

Fisher, F. 1996. California Department of Fish and Game. Personal communication, June 17, 1996.

Flemer, D., W. Dovel, H. Pfitzenmeyer, and D. Ritchie, Jr. 1968. *Biological effects of spoil disposal in Chesapeake Bay.* J. Sanit. Engineer. Div., Proc. of Am. Soc. Civil Engineer.

Foe, C. 1989. *1989 Rice Season Biotoxicity Results.* California Regional Water Quality Control Board, Central Valley Region..

_____. 1990a. Memorandum to W. Wescot and J. A. Bruns on Detection of Pesticides in the San Joaquin Watershed during February, 1990, dated 25 June 1990. Central Valley Regional Water Quality Control Board, Sacramento.

_____. 1990b. Memorandum to W. Wescot and J. A. Burns on Detection of Pesticides in the San Joaquin River on 27 March and 24 April 1990, dated 25 June 1990. Central Valley Regional Water Quality Control Board, Sacramento.

Foe, C. and V. Connor. 1989. Memorandum to J. Bruns and R. Schnagl on 1989 Rice Season Toxicity Monitoring Results, dated 19 October 1989. Central Valley Regional Water Quality Control Board, Sacramento.

Fredrickson, D. 1974. "Cultural Diversity of Early Central California: A View from the North Coast Ranges." *Journal of California Anthropology* 1(1):41-54.

Fry, D. H. 1973. *Anadromous fishes of California.* California Department of Fish and Game.

Gaines, D. 1978. "Cuckoos and Cottonwoods: California's Forgotten Forests." *Audubon Imprint.* Santa Monica Bay Audubon Society. 2:1-5.

_____. 1977. *Current Status and Habitat Requirements of the Yellow-billed Cuckoo in California.* Unpublished report. California Department of Fish and Game, Wildlife Management Branch.

_____. 1974. *Distribution, Density, and Habitat Requirements of the California Yellow-billed Cuckoo in the Sacramento Valley: 1972-73.* California Department of Fish and Game, Wildlife Management, Report W-54-R6.

Ganssle, D. 1966. "Fishes and decapods of San Pablo and Suisun bays." *Ecological Studies of the Sacramento-San Joaquin Estuary, Part I.* Ed. D. W. Kelley. California Department of Fish and Game Bull. No. 133:64-94.

Geologic History in California. 1994. *Historical Perspective and Existing Conditions.*

Gerow, B. A. and R. W. Force. 1968. *An Analysis of the University Village Complex, with a Reappraisal of Central California Archaeology.* Palo Alto: Stanford University Press.

Gilbert, G. K., 1917. *Hydraulic Mining Debris in the Sierra Nevada.* U.S. Geological Survey Professional Paper 105.

Gill, R., Jr. 1972. *South San Francisco Bay Breeding Bird Survey, 1971.* Prepared for the California Department of Fish and Game, Wildlife Management Branch Administrative Report No. 72-6. Wildlife Restoration Project W-54-R.

Goldberg, S. R. 1977. "Seasonal ovarian cycle of the tidewater goby, *Eucyclogobius newberryi,* (Gobiidae)." *Southwest. Nat.* 22:557-559.

Golden, M.L. and P.L. Fielder. June 1991. *Characterization of the Habitat for* Lilaeopsis masonii *(Umbelliferae): A California State-listed Rare Plant Species: Final Report.* Prepared for the California Department of Fish and Game - Endangered Plant Program.

Granholm, S. 1989. *Endangered Habitat: A Report on the Status of Seasonal Wetlands in San Francisco Bay and a Recommended Plan for their Protection.*

Gregory, R. S., and T. G. Northcote. 1993. "Surface, planktonic, and benthic foraging by juvenile chinook salmon *(Oncorhynchus tshawytscha)* in turbid laboratory conditions." *Canadian Journal of Fisheries and Aquatic Sciences*. 50:233-240.

Green, Miriam. 1994/1995. Miriam Green Associates, Sacramento Ca. Telephone conversations and meetings on various dates in 1994 and 1995.

Gregory, R. S., and T. G. Northcote. 1993. *Surface, planktonic, and benthic foraging by juvenile chinook salmon (Oncorhynchus tshawytscha) in turbid laboratory conditions.* Canadian Journal of Fisheries and Aquatic Sciences. 50: 233-240.

Grinnel, J., and A. H. Miller. 1944. *The Distribution of the Birds of California.* Cooper Ornithological Club, Pacific Coast Avifauna No. 27.

Gunther, A. J., J. A. Davis, and D. J. H. Phillips. 1987. *An Assessment of the Loading of Toxic Contaminants to the San Francisco-Bay Delta.* Aquatic Habitat Institute, Richmond, CA. 330 pp.

Hadaway, H. C., and J. R. Newman. 1971. "Differential Responses of Five Species of Salt Marsh Mammals to Inundation." *J. Mamm.* 52:818-820.

Haertel, L., and C. Osterberg. 1967. "Ecology of the zooplankton, benthos and fishes in the Columbia River estuary." *Ecology* 48:459-472.

Hall, F. A. 1980. Evaluation of downstream migrant chinook salmon, *Oncorhynchus tshawytscha*, losses in Clifton Court Forebay, Contra Costa County, California. Administrative Report No. 80-4. March, 1980.

Hallock, R. J., R. A. Iselin. and D. M. Fry, Jr. 1968. *Efficiency tests of the primary louver system, Tracy Fish Screen, 1966-1967.* Calif. Dept. Fish and Game, Marine Res. Branch Admin. Report No. 68-7. 36pp.

Hallock, R. J., R. F. Elwell, and D. H. Fry, Jr. 1970. *Migrations of adult king salmon, Oncorhynchus tshawytscha, in the San Joaquin Delta as demonstrated by the use of sonic tags.* (Fish Bulletin 151.) California Department of Fish and Game, Sacramento, CA.

Hanson. Del's Boat Harbor, personal communication. September 3, 1994.

Hanson Environmental. 1995. *Georgiana Slough acoustical barrier.* Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Winter 1995: 16.

Hart, E. W., 1981. *Fault Evaluation Report for the Greenville Fault.* California Division of Mines and Geology FER 117.

Hart, J. L. 1973. *Pacific Fishes of Canada.* Fisheries Research Board of Canada, Bull. 180.

Harvey, B. C. 1986. *Effects of suction gold dredging on fish and invertebrates in two California streams.* North American Journal of Fisheries Management. 6: 401-409.

Harvey and Stanley Associates, Inc. 1980. *Study of Salt Marsh Harvest Mouse in Suisun Bay, California.* Report prepared for U.S. Department of the Interior, Water and Power Resources Service.

Hassler, T. J. 1988. *Species profiles; life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)- striped bass.* U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.82). U.S. Army Corps of Engineers, TR EL-82-4. 29 pp.

Hatfield, S. E. 1985. "Seasonal and interannual variation in distribution and population abundance of the shrimp *Crangon franciscorum* in San Francisco Bay." *Hydrobiologia* 129:199-210.

Hayes, S. 1995. *Dissolved oxygen conditions in the Stockton Ship Channel.* Newsletter. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Winter 1995: 8-9.

C—087843

C-087844

Heimstra, N. D., D. K. Damkot, and N. G. Benson. 1969. *Some effects of silt turbidity on behavior of juvenile largemouth bass and green sunfish.* Technical Paper 20. Bureau of Sport Fisheries and Wildlife, Washington D.C.

Heizer, R. F. 1949. *The Archaeology of Central California, I: The Early Horizon.* Berkeley: University of California Anthropological Records 12(1):1-84.

Herbich, John B. 1992. *Handbook of Dredging Engineering.* San Francisco: McGraw Hill.

_____. 1975. *Coastal & Deep Ocean Dredging.* Houston, Texas: Gulf.

Herbold, B. 1994. *Habitat requirements of delta smelt.* Newsletter. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Winter 1994: 1-3.

Herbold, B., A. D. Jasby, and P. B. Moyle. 1992. *Status and trends report on aquatic resources in the San Francisco Estuary.* San Francisco Estuary Project. U.S. Environmental Protection Agency.

Herbold, B., and P. B. Moyle. 1989. *The Ecology of the Sacramento-San Joaquin Delta: a Community Profile.* U.S. Fish and Wildlife Service Biol. Rep. No. 85 (7.22). Slidell, Louisiana.

Herrgesell, P. L. 1994. *Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary, 1992 Annual Report.* California Department of Water Resources and Department of Fish and Game.

Herrgesell, P. L. (compiler). 1990. 1989 Annual report. *Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary.* California Dept. Water Resources, Sacramento, CA.

Heubach, W. 1969. "*Neomysis awatschensis* in the Sacramento-San Joaquin Estuary." *Limnol. Oceanogr.* 14:533-546.

Heubach, W., R. J. Toth, and A. M. McCready. 1963. *Food of young-of-the-year striped bass (Roccus saxatilis) in the Sacramento-San Joaquin River system.* Sacramento: California Department of Fish and Game. 49:224-239.

Hickman, J. C. (Ed.). 1994. *The Jepson Manual: Higher Plants of California.* Berkeley and Los Angeles: University of California Press.

Hieb, K and R. Baxter. 1993. Delta outflow/San Francisco Bay. Pages 101-116 in 1991 Annual Report: Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Department of Water Resources, Sacramento, CA.

Holland, R. F. 1986. *Preliminary Descriptions of the Terrestrial Natural Communities of California.* Nongame Heritage Program. Sacramento: California Department of Fish and Game.

Holson, J., S. Lisa, S. Goddard, and J. Bennyhoff. 1993. *National Register of Historic Places Determination of Eligibility Report for Prehistoric Sites on Holland Tract, Contra Costa County, California.* Report prepared by BioSystems Analysis for Jones & Stokes Associates, Sacramento.

Hoover, M. B., H. E. Rensch, and E. G. Rensch. 1948. *Historic Spots in California.* Palo Alto: Stanford University Press.

Hutton, Paul H. and Francis I. Chung. 1994a. *Bromine Distribution Factors in THM Formation.* Journal of Water Resources Planning and Management. 120:1 (pp 1-15). January/February, 1994.

_____. 1994b. *Correlating Trihalomethane Data.* Journal of Engineering. 120:1 (pp 219-241). January/February, 1994.

_____. September/October 1992. "Simulating THM Formation Potential in Sacramento Delta, Part I." *Journal of Water Resources Planning and Management.* 118(5):513-529.

_____. September/October 1992. "Simulating THM Formation Potential in Sacramento Delta. Part II." *Journal of Water Resources Planning and Management.* 118(5):530-542.

HydroQual, Inc. 1984. *Phytoplankton modeling.* Prepared for U.S. Department of Interior and U.S. Bureau of Reclamation, Mahwah, New Jersey.

Interagency Delta Health Aspects Monitoring Program. January 1989. *The Delta as a Source of Drinking Water: Summary of Monitoring Results - 1983 to 1987.*

Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. April 1990. *Evaluation of Selected Biological Factors That May Have Contributed to the Drought and Post-Drought Decline in Chlorophyll a Concentration.* Technical Report #22.

_____September 1992. *An Evaluation of Existing Data in the Entrapment Zone of the San Francisco Bay Estuary.* Technical Report #33.

Irwin J. F and D. L. Soltz. 1984. *The natural history of the tidewater goby,* Eucyclogobius newberryi, *in the San Antonio and Shuman creek system, Santa Barbara County California.* U.S. Fish and Wildlife Service Rpt., Sacramento Endangered Species Off. Contract Order No. 11310-0215-2.

Iwamoto, R. N., E. O. Salo, M. A. Madej, R. L. McComas, and R. L. Rulifson. 1978. *Sediment and water quality: a review of the literature including a suggested approach for water quality criteria with summary of workshop and conclusions and recommendations.* ETA 910/9-78-048.

Jameson, Jr. E. W., and H. J. Peters. 1988. *California Mammals.* Berkeley: University of California Press.

Jassby, A. D. 1992. *Isohaline position as a habitat indicator for estuarine resources: San Francisco Estuary.* Appendix B in Managing freshwater discharge to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: Basis for an estuarine standard. San Francisco Estuary Project, San Francisco, CA.

Jassby, A., W. Kimmerer., S. Monismith., C. Armor., J. Cloern, T. Powell, J. Schubel, and T. Vendlinski. 1994. *Isohaline position as a habitat indicator for estuarine populations. Ecological applications.* In press. 55pp.

Johnson, J. H., and D. S. Dropkin. 1992. "Predation on recently released larval American shad in the Susquehanna River basin." *North American Journal of Fisheries Management.* 12:504-508.

Johnston, R. F., and R. L. Rudd. 1957. "Breeding of the Salt Marsh Shrew." *J. Mamm*, 38:157-163.

Jones & Stokes Associates, Inc. 1995. *Draft Environmental Impact Report and Environmental Impact Statement, Delta Wetlands Project*. Appendices. Prepared for State Water Resources Control Board and U.S. Army Corps of Engineers. September 15, 1995. Sacramento, CA.

_____. 1994. *Central Valley Project Improvement Act Programmatic Environmental Impact Statement, Preliminary Administrative Draft. Recreation, Existing Conditions Technical Appendix.*

_____. 1994a. *Sacramento-San Joaquin Delta Daily Electrical Conductivity and Outflow and Location of Salinity Gradient and Estimated X2 Position for Water Years 1968 to 1992.*

_____. 1993. *Delta smelt: General ecology and effects of Contra Costa Water District diversions.* April 1993. Sacramento, CA.

_____. 1990. *1990 field investigations of Yuba River American shad.* Prepared for Yuba County Water Agency, Marysville, California.

_____. 1989. *Results of Biological Resource Inventories and Habitat Evaluation in the Kellogg Creek Watershed.* Prepared for James M. Montgomery Consulting Engineers.

Jones T., L. Weigel, and D. A. Fredrickson. 1980. *An Archeological Investigation of Selected Areas in the Delta Coves Project, Contra Costa County, California.* Rohnert Park, California: Anthropological Studies Center, Cultural Resources Facility, Sonoma State University Academic Foundation.

Jung, M., J. A. Whipple, and M. Moser. 1984. *Summary report of the Cooperative Striped Bass Study.* Institute for Aquatic Resources, Santa Cruz, CA.

Kano, R. M. 1985. Clifton Court Forebay Evaluation of Predation Losses to Juvenile Chinook Salmon. Office Memorandum: Bay-Delta Project Files. Stockton, California.

Kelley, R., and H. K. Chadwick. 1971. *Some observations on striped bass temperature tolerances.* California Department of Fish and Game, Anadromous Branch Administrative Report No. 71-9.

Kimmerer, W. 1996. Romberg Tiburon Centers, Tiburon, California. Personal communication, February 29, 1996.

_____. 1991. Laboratory tests of predation by the introduced clam *Potamocorbula* on larval stages of the zooplankters Eurytemora affinis and *Pseudodiaptomus* sp. In 1990 Working Papers of the Food Chain Group. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary, Sacramento, CA.

Kimmerer, W. J. 1992. *An Evaluation of Existing Data in the Entrapment Zone of the San Francisco Bay Estuary.* Interagency Program Technical Report 33. Dept. of Water Resources, Sacramento, California.

Kimmerer, William J and James J. Orsi. 1992. *Entrapment Zone Position Affects Abundance of Zooplankton in the San Francisco Bay-Delta Estuary.*

Kings County. 1993. *Biological Resources Survey Resource Conservation Element Update-Kings County General Plan.* Prepared by Hansen's Biological Consulting.

Kjelson, M., P. Brandes, and S. Hovekamp. 1994. *Chinook salmon.* Pages 47-65 in 1992 Annual Report: Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Department of Water Resources, Sacramento, CA.

Kjelson, M. A., S. Green and P. Brandes. 1989. A model for estimating mortality and survival of fall-run chinook salmon smolts in the Sacramento River Delta between Sacramento and Chipps Island. U.S. Fish and Wildlife Service. December 21, 1989.

Kjelson, M., P. F. Raquel, and F. W. Fisher. 1982. Life history of fall run juvenile chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento-San Joaquin Estuary, California. Pages 393-411 in U. S. Kennedy (edition 7, Estuarine Comparisons). Academic Press, New York, NY.

Knudsen, D. L., and D. W. Kohlhorst. 1987. *Striped bass health monitoring 1985 final report.* Prepared for the California Department of Water Resources Control Board under Interagency Agreement 4-090-120-0.

Knutson, A. C., Jr., and J. J. Orsi. 1983. "Factors regulating abundance and distribution of the shrimp *Neomysis mercedis* in the Sacramento-San Joaquin Estuary." *Trans. Am. Fish. Soc.* 112:476-485.

Kohlhorst, D. W. 1992. *Impacts of freshwater outflow and exports on striped bass.* Pages 29-30 in 1992 Annual report: Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. California Department of Water Resources, Sacramento, CA.

_____. 1980. *Recent trends in the white sturgeon population in California Sacramento-San Joaquin Estuary.* California Department of Fish and Game 66(4):210-219.

_____. 1976. *Sturgeon spawning in the Sacramento River in 1973, as determined by distribution of larvae.* Calif. Dept. Fish and Game 62(1): 32-40.

Kohlhorst, D. W., L. W. Botsford, J. S. Brennan, and G. M. Cailliet. 1991. Aspects of the structure and dynamics of an exploited central California population of white sturgeon (*Acipenser transmontanus*). Pages 277-293 in P. Williot (editor), Acipenser: Acts of the First International Sturgeon Symposium. October 3-6, 1989. Cemagref-Dicova, Bordeaux, France.

Kohlhorst, D. W., L. W. Miller, and J. J. Orsi. 1980. *Age and growth of white sturgeon collected in the Sacramento-San Joaquin Estuary, California: 1965-1970 and 1973-1976.* California Department of Fish and Game 66(2):83-95.

Kohlhorst, D. W., D. E. Stevens, and L. W. Miller. 1992. *A model for evaluating the impacts of freshwater outflow and export on striped bass in the Sacramento-San Joaquin Estuary.* Entered by the CDFG for the SWRCB 1992 Water Right Phase of the Bay-Delta Estuary Proceedings. WRINT-DFG-Exhibit 3.

Lasker, R. 1981. The role of a stable ocean in larval fish survival and subsequent recruitment. Pages 79-87 in R. Lasker (editor) Marine fish larvae: morphology, Ecology, and relation to fisheries. University of Washington Press, Seattle, WA.

Laudenslayer, W. F. Jr., W. E. Grenfell, and D. C. Zeiner. 1991. *A Checklist of the Amphibians, Reptiles, Birds, and Mammals of California.* California Fish and Game 77:109-141.

Laymon, S. A. 1980. *Feeding and Nesting Behavior of the Yellow-billed Cuckoo in the Sacramento Valley.* Department of Fish and Game, Wildlife Management Branch Administrative Report 80-2. Sacramento: California Department of Fish and Game.

Leidy, R. A. 1984. "Distribution and ecology of stream fishes in the San Francisco Bay drainage." *Hilgardia* 52:1-175.

Levy, R. 1978. "Eastern Miwok." *Handbook of North American Indians, vol. 8, California*, Ed. R. F. Heizer. Washington, D.C.: Smithsonian Institution. 398-413.

Levy, D. A., and T. G. Northcote. 1982. "Juvenile salmon residency in a marsh area of the Fraser River estuary." *Canadian Journal of Fisheries and Aquatic Sciences.* 39:270-276.

Lillard, J. B., R. F. Heizer, and F. Fenenga. 1939. *An Introduction to the Archaeology of Central California.* Sacramento Junior College, Department of Anthropology, Bulletin 2.

Limerinos, J. T. and Smith, W. 1975. *Evaluation of the Causes of Levee Erosion in the Sacramento-San Joaquin Delta, California.* U.S.G.S. Water Resources Investigations 28-74.

Liston, C., L. Hess, C. Karp, S. Hiebert, G. Mueller, P. Johnson, R. Brockman and J. Kubitschek. 1994. Tracy Fish Collection Facility. Pages 107-111 *In* 1992 Annual report: Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. California Department of Water Resources, Sacramento.

Los Angeles County. 1993. *General Plan Land Use Element.*

Macedo, R. A. 1991. *Creel survey at Clear Lake, California, March-June 1988.* Inland Fisheries Administrative Report No. 91-3.

Mayer, K. E., and W. F. Laudenslayer, Jr. (eds). 1988. *A Guide to Wildlife Habitats of California.* Prepared by the California Department of Forestry in association with the USDA Forest Service, SW Forest and Range Experiment Station; California Department of Fish and Game; Pacific Gas and Electric; and USDA Forest Service Region 5. October.

Maniery, M. L. 1993. *National Register of Historic Places Determination of Eligibility Report, Bacon Island Rural Historic District, San Joaquin County, California.* Prepared by Par & Associates, Sacramento, California, for Jones & Stokes Associates, Sacramento, California. Manuscript report, CCIC-1993, Central California Information Center, CSU-Stanislaus.

Maniery, M. L., and K. A. Syda. 1989. *Cultural Resources Inventory and Evaluation of Delta Wetlands Water Storage Project, Contra Costa and San Joaquin Counties, California.* Prepared by Par & Associates, Sacramento, California, for Jones & Stokes Associates, Sacramento, California. Manuscript report, CCIC-750, Central California Information Center, CSU-Stanislaus.

Mathews, S. B. 1965. "Reproductive behavior of the Sacramento perch." *Copeia* 1965:224-228.

_____. 1962. *The ecology of the Sacramento perch, Archoplites interruptus, from selected areas of California and Nevada.* M.A. Thesis. University of California, Berkeley.

McAllister, R. D., and T. O. Moore, Jr. 1982. *Selected Shellfish Resources of San Francisco Bay: Their Distribution, Abundance, Use, Public Access, and Recommended Management Alternatives.* Report for California Department of Fish & Game and San Francisco Bay Regional Water Quality Control Board, Oakland.

McCarraher, D. B., and R. W. Gregory. 1970. "Adaptability and current status of introductions of Sacramento perch, *Archoplites interruptus*, in North America." *Trans. Am. Fish. Soc.* 99:700-707.

McCarten, N. F. 1993. *Monitoring of Transplanted Mason's Lilaeopsis Populations in Barker Slough 1989-1992.* Sacramento: California Department of Water Resources, Division of Planning.

_____. June 1991. *Monitoring of Transplanted Mason's Lilaeopsis Populations in Barker Slough 1989-1990.* Prepared for Department of Water Resources Central District.

McCauley, J. E., R. A. Parr, and D. R. Hancock. 1977. *Benthic infauna and maintenance dredging: a case study.* Water Research 11: 233-242.

McEwan, D., and T. Jackson. 1994. *Steelhead management plan for California.* California Department of Fish and Game, Inland Fisheries Division, Sacramento, CA.

McKechnie, R. J., and R. B. Fenner. 1971. *Food habits of white sturgeon* Acipenser transmontanus *in San Pablo and Suisun Bays, California.* California Department of Fish and Game 57:209-212.

McKelvey, R., D. Hankin, K. Yanosko, and C. Syngg. 1980. "Stable cycles in multistage recruitment models: an application to the Northern California Dungeness crab (Cancer magister) fishery." *Can. J. Fish. Aq. Sci.* 37:2323-2345.

Meehan, W. R., and T. C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47 to 82 in W. R. Meehan, editor, Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society, Bethesda, MD.

Meinz, M., and W. Heubach. 1978. *Factors affecting sinking rates of striped bass (Morone saxatilis) eggs and larval.* California Department of Fish and Game, Anadromous Fisheries Branch, Administrative Report No. 77-7.

Meng, L., and P. B. Moyle. 1995. *Status of splittail in the Sacramento-San Joaquin Estuary.* Transactions of the American Fisheries Society. 124: 538-549.

Meng, L., and J. J. Orsi. 1991. "Selective predation by larval striped bass on native and introduced copepods." *Trans. Am. Fish. Soc.* 120:187-192.

Metropolitan Water District of Southern California. 1991. *Eastside Reservoir Project, Final Environmental Impact Report.* SCH #89081422.

Metropolitan Water District of Southern California. March 1994. *Potential Refinements & Alternatives to the Environmental Protection Agency's Proposed San Francisco Bay/Delta Water Quality Standards (Draft).* Sacramento: California Urban Water Agencies.

MGA. See Miriam Green Associates.

Miller, D. J., and R. N. Lea. 1972. *Guide to the coastal marine fishes of California.* California Department of Fish and Game Fish Bull. 157.

Miller, L. W. 1972a. *Migrations of sturgeon tagged in the Sacramento-San Joaquin estuary.* California Department of Fish and Game 58(2): 102-106.

_____. 1972b. *White sturgeon population characteristics in the Sacramento-San Joaquin estuary as measured by tagging.* California Department of Fish and Game 58(2): 94-101.

Miller, L. W., and J. Arnold. 1994a. Summer Tow-Net Survey. Page 42 in 1992 Annual Report: Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Department of Water Resources, Sacramento, CA.

_____. 1994b. Midwater Trawl Survey. Page 43 in 1992 Annual Report: Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Department of Water Resources, Sacramento, CA.

Miller, D. J., and R. N. Lea. 1972. *Guide to the coastal marine fishes of California.* California Department of Fish and Game Fish Bulletin. 157: 1-235

Milliken, R. 1994. "Part II, Regional Ethnography." *Native American History of the Los Vaqueros Project Area, Alameda and Contra Costa Counties, California.* Ed. Suzanne B. Stewart. Prepared for Contra Costa Water District. Rohnert Park, California: Anthropological Study Center, Sonoma State University Academic Foundation.

Mills, T. J., and F. Fisher. 1994. *Central Valley anadromous sport fish annual run-size, harvest estimates, and population trends, 1967 through 1991.* Preliminary draft. (Inland Fisheries Technical Report.) California Department of Fish and Game, Sacramento, CA.

Miriam Green Associates. 1994. *Draft Biological Assessment for Threatened, Endangered, and Candidate; Species Interim South Delta Project.* Unpublished report prepared for the California Department of Water Resources.

_____. 1993a. *Phase I Report-Sensitive Species, Interim South Delta Project.* Prepared for U.S. Bureau of Reclamation-Mid Pacific Region, and State of California Department of Water Resources.

_____. 1993b. *Interim South Delta Project Results of 1993 Sensitive Species Field Surveys.* (series of maps) Prepared for U.S. Bureau of Reclamation-Mid Pacific Region, and State of California Department of Water Resources.

Montgomery, R. L. and J. W. Leach. 1984. *Dredging and Dredged Material Disposal.* . New York: American Society of Civil Engineers.

Montoya, B. L. 1987. *Urban Runoff Discharges from Sacramento, California, 1984-1985.* Report #87-1SPSS. Central Valley Regional Water Quality Control Board, Sacramento, CA.

Moran, P. J. 1991. *The effects of dredging on the larval settlement and community development of fouling organisms in Port Kembla Harbor, Australia.* Water Resources. 25: 1151-1155.

Moyle, P. B. 1976. *Inland fishes of California.* University of California Press, Berkeley, CA.

_____. 1976a. *Fishes of California.* Berkeley: University of California Press.

Moyle, P. B., R. A. Daniels, B. Herbold, and D. M. Baltz. 1985. "Patterns in the distribution and abundance of a noncoevolved assemblage of estuarine fishes." *NOAA Fish. Bull.* 84:105-117.

Moyle, P. B., P. J. Foley, and R. M. Yoshiyama. 1992a. *Status of green sturgeon, Acipenser medirostris, in California.* Submitted to National Marine Fisheries Service, Terminal Island, CA.

Moyle, P. B., B. Herbold, D. E. Stevens, and L. W. Miller. 1992b. *Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California.* Transactions of the American Fisheries Society 121: 67-77.

Moyle, P. B., J. E. Williams, and E. D. Wikramanayake. 1989. *Fishes of special concern of California.* Prepared for California Department of Fish and Game, Inland Fisheries Division. Contract No. 7337. Rancho Cordova, CA.

Murphy, G. I. 1948. *A contribution to the life history of the Sacramento perch* (Archoplites interruptus) *in Clear Lake, Lake County, California.* California Department of Fish and Game 34:93-100.

Napton, L. K. 1989. *Cultural Resource Investigation of the Proposed Eighth Street Annexation (95.75 acres), Stockton, San Joaquin County, California.* Manuscript report, CCIC-795, Central California Information Center, CSU-Stanislaus.

_____. 1988. *Cultural Resource Investigation of the Proposed Weston Ranch Levee Improvement Project, San Joaquin County, California.* Report prepared by CSU-Stanislaus, for Valley Planning Consultants, Merced, California. Manuscript report, CCIC-786, Central California Information Center, CSU-Stanislaus.

_____. 1986a. *Cultural Resource Investigation of the Woodward Island Bridge Site, San Joaquin County, California.* Report prepared by California State University, Stanislaus, for George B. Raab, Civil Engineer, Stockton, California. Manuscript report, CCIC-775, Central California Information Center, CSU-Stanislaus.

_____. 1986b. *Cultural Resource Investigations of the Proposed 1300-acre Weston Ranch Residential Development, City of Stockton, San Joaquin County, California.* Prepared by CSU-Stanislaus for Valley Planning Consultants. Manuscript report, CCIC-777, Central California Information Center, CSU-Stanislaus.

_____. 1985. *Cultural Resource Investigation of the Proposed Plantsite for Cogeneration National Corporation, Port of Stockton District Energy Facility, San Joaquin County, California.* Prepared by CSU-Stanislaus for H. W. Campbell & Associates. Manuscript report, CCIC-772, Central California Information Center, CSU-Stanislaus.

_____. 1978. *Archeological Survey of the Proposed Van Buskirk Subdivision, Stockton, San Joaquin County, California.* Prepared by CSU-Stanislaus for R. C. Fuller Associates. Manuscript report, CCIC-757, Central California Information Center, CSU-Stanislaus.

National Audubon Society. 1989. *Endangered Habitat: A Report on the Status of Seasonal Wetlands in San Francisco Bay and a Recommended Plan for their Protection.* National Audubon Society, Marin Audubon Society, Santa Clara Audubon Society, San Francisco Bay Association, Sierra Club Bay Chapter.

Newman, W. A. 1963. "On the introduction of an edible Oriental shrimp (Caridae, Palaemonidae) to San Francisco Bay." *Crust.* 5:119-132.

Nichols, F. H. 1985. "Increased benthic grazing: An alternative explanation for low phytoplankton biomass in Northern San Francisco Bay during the 1976-77 drought." *Estuar. Coast. Shelf Sci.* 21:379-388.

Nichols, F. H., J. E. Cloern, S. N. Luoma, and D. H. Peterson. February 1986. "The Modification of an Estuary." *Science* 231:567-573.

Nichols, F. H., and M. M. Pamatmat. 1988. *The Ecology of the Soft-Bottom Benthos of San Francisco Bay: A Community Profile.* U.S. Fish and Wildlife Service Biol. Rpt. No. 85(7.19). Washington, D.C.: U.S. Fish and Wildlife Service.

Nicol, J. A. C. 1960. *The biology of marine animals.* Interscience, New York.

O'Connor, J. M. 1991. *Evaluation of turbidity and turbidity-related effects on the biota of the San Francisco Bay-Delta Estuary.* Prepared for U.S. Army Engineers, San Francisco, California.

Odum, W. E., and R. F. Wilson. 1962. *Further studies on reaeration and metabolism of Texas bays, 1958-1960.* Pub. Inst. Mar. Sci., University of Texas.

Office of Permit Assistance. 1994. California Permit Handbook.

Olendorff, R.R., A. D. Miller, and R. N. Lehman. 1981 *Suggested Practices for Raptor Protection on Power Lines, The State of the Art in 1981.* A report published by the Raptor Research Foundation.

Orsi, J. J. 1995. *Radical changes in the Estuary's zooplankton caused by introductions from ballast water.* Newsletter. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Summer 1995: 16-17.

_____. 1986. "Interaction between diel vertical migration of a mysidacean shrimp and two-layered estuarine flow." *Hydrobiologia* 137:79-87.

Orsi, J. J., T. E. Bowman, D. C. Marelli, and A. Hutchison. 1983. "Recent introduction of the planktonic calanoid copepod *Sinocalanus doerri* (Centropagidae) from mainland China to the Sacramento-San Joaquin estuary of California." *J. Plank. Res.* 5:357-375.

Orsi, J. J, and A. C. Knutson, Jr. 1979. "The role of mysid shrimp in the Sacramento-San Joaquin Estuary and factors affecting their abundance and distribution." *San Francisco Bay: The Urbanized Estuary.* Ed. T. J. Conomos. Pacific Div., American Association Advancement Science, San Francisco, California. 401-408.

Orsi, J. J., and W. L. Mecum. 1986. "Zooplankton distribution and abundance in the Sacramento-San Joaquin Delta in relation to certain environmental factors." *Estuaries* 9:326-339.

Orsi, J. J., S. Obrebski, and W. Kimmerer. 1991. *Long-term trends in zooplankton distribution and abundance in the Sacramento-San Joaquin Estuary.* Draft Report to Interagency Ecological Study Group.

Owens, K. N. 1991. *Inventory of Historical Resources. Appendix I, in Sacramento-San Joaquin Delta, California, Historical Resources Overview.* Sacramento: Public History Research Institute, California State University.

Page, L. M., and B. M. Burr. 1991. *A Field Guide to Freshwater Fishes*. Houghton Mifflin.

Painter, R. E. 1979. *American shad management plan for the Sacramento River drainage.* Final Report Job No. 5, Anadromous Fish Conservation Act, Project AFS-17. Sacramento: California Department of Fish and Game.

Painter, R. E., L. Wixom, and M. Meinz. 1980. *Management plan for American shad* (Alosa sapidissima) *in central California.* Final Report Job No. 3, Anadromous Fish Conservation Act, Project AFS-17. Sacramento: California Department of Fish and Game.

Painter, R. E., L. H. Wixom, and S. N. Taylor. 1977. *An evaluation of fish populations and fisheries in the Post-Oroville Feather River*. California Department of Fish and Game, Anadromous Fisheries Branch.

Peak, A. S. 1980. *Cultural Resource Assessment of the Proposed Stockton Reuse Project, San Joaquin County, California.* Ann S. Peak & Associates, Manuscript report, CCIC-823, Central California Information Center, CSU-Stanislaus.

Peddicord, R., V. McFarland, D. Belfiori, and T. Byrd. 1975. *Dredge disposal study, San Francisco Bay and estuary. Appendix C. Effects of suspended solids on San Francisco Bay organisms*. U.S. Army Engineers, San Francisco District, San Francisco.

Perkins, E. J. 1974. *The biology of estuaries and coastal waters*. Academic Press, New York.

Peterson, W. T. 1973. "Upwelling indices and annual catches of Dungeness crab (Cancer magister) along the west coast of the United States." *Fish. Bull.* 71:902-910.

Pratt, H.M. 1970. "Breeding Biology of Great Blue Herons and Common Egrets in Central California." *The Condor*, 72:407-416

Pritchard, D. 1967. "What is an Estuary: Physical Viewpoint." *Estuaries.* Ed. G. Lauff. Washington, D.C.: American Association for the Advancement of Science.

R2 Resource Consultants. March 1994. *Review and Evaluation of Foundational Literature and Data Related to the Proposed EPA Salinity Standard.* Prepared for The California Urban Water Agencies.

Radtke, L. D. 1966. *Distribution of smelt, juvenile sturgeon and starry flounder in the Sacramento-San Joaquin Delta with observation on food of sturgeon.* Pages 115-129 in J. L. Turner and D. W. Kelly (eds.), Ecological studies of the Sacramento-San Joaquin Delta. (Fisheries Bulletin 136.) California Department of Fish and Game, Sacramento, CA.

_____. 1966. "Distribution of smelt, juvenile sturgeon and starry flounder in the Sacramento-San Joaquin Delta." *Ecological studies of the Sacramento-San Joaquin estuary, Part 2.* Eds. J. L. Turner and D. W. Kelley. California Department of Fish and Game Fish Bull. No. 136. 115-119.

Ragir, S. 1972. *The Early Horizon in Central California Prehistory.* Berkeley: University of California Archaeological Research Facility Contributions 15.

Raleigh, R. F., W. T. Miller, and P. C. Nelson. 1986. *Habitat suitability index models and instream flow suitability curves: chinook salmon.* (Biological Report 82[10.122].) U. S. Fish and Wildlife Service. Washington, DC.

Regan, D. M., T. L. Wellborn, Jr., and R. G. Bowker. 1968. *Striped bass: development of essential requirements for production.* U.S. Fish and Wildlife Service Bureau of Sport Fisheries and Wildlife, Division of Fish Hatcheries, Atlanta, GA.

Reilly, P. N. 1983. "Dynamics of Dungeness crab, *Cancer magister*, larvae off central and northern California." *Life History, Environment and Mariculture Studies of the Dungeness Crab,* Cancer magister, *with Emphasis on the Central California Fishery Resource.* Eds. P.W. Wild and R.N. Tasto. California Department of Fish and Game Fish Bull. No. 172.

Reiser, D. W., and R. G. White. 1983. *Effects of complete redd dewatering on salmonid egg-hatching success and development of juveniles.* Transactions of the American Fisheries Society 112: 532-540.

Remsen, J. V., Jr. 1978. *Birds of Species of Special Concern in California.* California Department of Fish and Game, Nongame Wildlife Investigation. Wildlife Management Branch Administrative Report 78-1.

Resource Management International, Inc. 1995. *Draft biological assessment for the South Delta Temporary Barriers Project 1996.* Prepared for California Department of Water Resources. September 1995.

Reynolds, F. L., T. Mills, R. Benthin, and A. Low. 1993. *Central Valley anadromous fisheries and associated riparian and wetlands areas protection and restoration action plan (DRAFT).* California Department of Fish and Game, Inland Fisheries Division, Sacramento, CA.

Rogers, B. A., and D. T. Westin. 1978. *A culture methodology for striped bass.* EPA Ecol. Res. Serv. Rep. No. 660/3-78-000.

Romano, Melinda. 1990. *Archaeological Survey and Cultural Resources Inventory, Brentwood Alternative, California, PGT-PG&E Pipeline Expansion Project.* Manuscript report, S-12275, Northwest Information Center, Sonoma State University.

RWQCB. See California Regional Water Quality Control Board.

Rudd, R. L. 1955. *Population Variation and Hybridization in Some California Shrews.* Systematic Zoology. 4:21-34.

S. P. Cramer and Associates. 1994. *The status of steelhead populations in California in regards to the Endangered Species Act.* Special Report, December 1994. Submitted to National Marine Fisheries Service on behalf of Association of California Water Agencies.

San Bernardino County. 1989. *San Bernardino County Biological Resources Background Report.* Prepared by WESTEC Services. San Diego, California.

_____. 1991. *San Bernardino County General Plan.*

San Francisco Estuary Project. 1993. *Managing Freshwater Discharge to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: The Scientific Basis for and Estuarine Standard--Conclusions and Recommendations of Members of the Scientific, Policy, and Management Communities of the Bay/Delta Project.*

_____. 1992. *State of the Estuary. A Report on Conditions and Problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.* San Francisco Estuary Project, Oakland, CA.

_____. 1992a. *How We Use the Estuary's Water.* April 1992.

_____. 1990. *Status and Trends Report on Dredging and Waterway Modification in the San Francisco Estuary.* Prepared under EPA Cooperative Agreement CE.

San Joaquin County. 1994a. *Draft West Lathrop Specific Plan.*

_____. 1994b. *Mountain House New Community, Draft Master Plan.* April, 1994.

_____. 1994c. *Final Environmental Impact Report, Mountain House Master Plan and Specific Plan I.* SCH #90020776. September, 1994.

San Joaquin County. 1992a. *San Joaquin County General Plan 2010: Volume I - Policies/Implementation.*

_____. 1992b. *San Joaquin County General Plan 2010: Volume II - Background Reports.*

_____. 1992c. *San Joaquin County General Plan 2010: Volume III - Technical Appendices.* Adopted July 29, 1992.

San Luis Obispo Area Coordinating Council. 1992. *1992 Regional Profile, County and Cities of San Luis Obispo.*

Santa Barbara County. 1994. *Santa Barbara County Comprehensive Plan: Conservation Element.*

Schaffter, R. G. 1990. *Inland and anadromous sport fish management research; Sacramento-San Joaquin Delta sturgeon population study, spawning habitat preference of sturgeon in California's Sacramento River.* Progress Report. California Department of Fish and Game. Sacramento, California.

_____. 1978. *An evaluation of juvenile king salmon (Oncorhynchus Tshawytscha) loss in Clifton Court Forebay.* Anadromous Fisheries Branch Administrative Report No. 78-21.

Schell, Hal. 1992. *Hal Schell's Delta Map and Guide: The San Joaquin and Sacramento Rivers.* Schell Books, Stockton, California.

Schenck, W. E. 1926. *Historic Aboriginal Groups of the California Delta Region.* Berkeley: University of California Publications in American Archaeology and Ethnology 23(2):123-146.

Schreiber, M. R. 1962. *Observations on the food habits of juvenile white sturgeon.* California Department of Fish and Game 48(1):79-80.

Schubel, J. and J. Wang. 1973. *The effects of suspended sediment on the hatching success of Perca flavescens (yellow perch), Morone americana (white perch), Morone saxatilis (striped bass), and Alosa pseudoharengus (alewife) eggs.* Special Rept. 30. Chesapeake Bay Institute, Johns Hopkins Univ. Baltimore, Md.

Scott, W. B., and E. J. Crossman. 1973. *Freshwater Fishes of Canada.* Fish. Res. Bd. Canada, Bull. 184.

See, Eric. 1994. DWR Biologist at Lake Oroville, Ca. Telephone conversation, July 25, 1994.

SFEP. See San Francisco Estuary Project.

Shellhammer, H. S. and T. E. Harvey. 1984. *Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan.* Portland, Oregon: U.S. Fish and Wildlife Service.

Sherk, J. A., J. M. O'Connor, and D. A. Neumann. 1974. *Effects of suspended and deposited sediments on estuarine environments.* Estuarine Research. pp 541-558.

Shlemon, R. J. 1969. *Geomorphological Investigation of the Lower Mokelumne River Area, California.*

Shlemon, R., and G. Begg. 1975. "Late Quaternary Evolution of the Sacramento-San Joaquin Delta, California." *Quaternary Studies*. Eds. R. P. Suggate and M. M. Cresswell. Wellington: The Royal Society of New Zealand. 259-266.

Siegfried, C. A. 1989. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific southwest) -- Cangonid Shrimp*. U.S. Fish and Wildlife Service Biol. Rep. No. 82 (11.125) U.S. Army Corps of Engineers, TR EL-82-4.

_____. 1982. "Trophic relations of *Crangon franciscorum* and *Palaemon macrodactylus* Rathbun; predation on the opossum shrimp, *Neomysis mercedis* Holmes." *Hydrobiologia* 89:129-139.

Siegfried, C. A., A. W. Knight, and M. E. Kopache. 1978. *Ecological studies on the western Sacramento-San Joaquin Delta during a dry year*. Department of Water Science and Engineering Paper No. 4506. University of California, Davis.

Siegfried, C. A., M. E. Kopache, and A. W. Knight. 1979. "The distribution and abundance of *Neomysis mercidis* in relation to the entrapment zone in the western Sacramento-San Joaquin Delta." *Trans. Am. Fish. Soc.* 108:262-270.

Simenstad, C. A., K. L. Fresh, and E. O. Salo. 1982. "The role of Puget Sound and Washington coastal estuaries in the life history of Pacific Salmon: an unappreciated function." *Estuarine Comparisons*. Ed. V.S. Kennedy. Toronto: Academic Press. 343-364.

Simons, D. B. and Senturk, F. 1977. *Sediment Transport Technology*. Fort Collins, Colorado: Water Resources Publications.

Sitts, R. M. 1978. *Ecological Aspects of the Estuarine Shrimps,* Neomysis mercedis, Crangon franciscorum *and* Palaemon macrodactylus. Ph.D. Dissertation. University of California, Davis.

C-087863

C-087864

Sitts, R. M., and A. W. Knight. 1979. *Plankton Ecology in the Sacramento-San Joaquin Estuary. Department of Land, Air, and Water Resources.* Water Sci. Eng. Pap. No. 45009. University of California, Davis.

Skinner, J. E. 1962. *A historical view of the fish and wildlife resources of the San Francisco Bay area.* California Department of Fish and Game, Water Projects Branch Report.

Skinner, M. W., and B. M. Pavlik. 1994. *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California.* California Native Plant Society. Special Publication, No. 1, 5th ed.

SLC. See California State Lands Commission.

Small, A. 1974. *The Birds of California.* Collier Books. New York.

Smith, S. E., and S. Kato. 1979. "The fisheries of San Francisco Bay: past, present and future." *San Francisco Bay: The Urbanized Estuary.* Ed. T.J. Conomos. Pacific Div., American Association Advancement Science, San Francisco, California. 445-468.

Snider, W. 1995. California Department of Fish and Game, Sacramento, California. Personal communication, November 21, 1995.

Sokal, R. R., and F. J. Rohlf. 1981. *Biometry.* W. H. Freeman and Company. San Francisco, CA.

Solano County. 1980. *Solano County Land Use and Circulation Element, a Part of the Solano County General Plan.* Amended 1991.

Sommer, T. 1995. Department of Water Resources, Sacramento, California. Personal communication, October 16, 1995.

Spaar, S. 1994. *Delta agricultural diversion evaluation, 1992 pilot study.* Interagency Ecological Program for the San Francisco Bay/Delta Estuary. Technical Report 37. May 1994.

Spencer, Lee A. 1989. *Preliminary Paleontological Evaluation of the Sacramento-San Joaquin Delta.* Manuscript report prepared by BioSystems Analysis, Santa Cruz California, for the U.S. Army Corps of Engineers, Sacramento.

Stebbins, R. C. 1985. *A Field Guide to Western Reptiles and Amphibians.* 2nd ed. Boston: Houghton-Mifflin.

Stern, E. M. and Stickle, W. B. 1978. *Effects of Turbidity and Suspended Material in Aquatic Environments, Literature Review.* U.S. Army Engineer Waterways Experiment Station, Dredged Material Research Program. Technical Report D-78-21.

Stevens, D. E. 1979. "Environmental factors affecting striped bass (Morone saxatilis) in the Sacramento-San Joaquin Estuary." *San Francisco Bay: The Urbanized Estuary.* Ed. T.J. Conomos. Pacific Div., American Association Advancement Science, San Francisco, California. 469-478.

_____. 1972. American shad. Pages 52-54 in J. E. Skinner, editors, Ecological Studies of the Sacramento-San Joaquin Estuary, California Department of Fish and Game Delta Fish and Wildlife Protection Study 8.

_____. 1966. Distribution and food habitats of the American shad, *Alosa sapidissima*, in the Sacramento-San Joaquin Estuary. Pages 97-107 in J. L. Turner and D. W. Kelley, editors, Ecological studies of the Sacramento-San Joaquin Estuary, Part II, Fishes of the Delta. California Department of Fish and Game Bulletin 136.

Stevens, D. E. and L. W. Miller. 1983. "Effects of river flow on young chinook salmon, American shad, longfin smelt and delta smelt in the Sacramento-San Joaquin River System." *North American Journal of Fisheries Management* 3:425-437.

_____. 1970. *Distribution of sturgeon larvae in the Sacramento-San Joaquin River system.* California Department of Fish and Game 56(2):80-86.

Stevens, D. E., H. K. Chadwick, and R. E. Painter. 1987. "American shad and striped bass in California's Sacramento-San Joaquin river system." *American Fisheries Society, Symposium* 1:67-78.

Stevens, D. E., D. W. Kohlhorst, L. W. Miller, and D. W. Kelley. 1985. *The decline of striped bass in the Sacramento-San Joaquin Estuary, California.* Transactions of the American Fisheries Society 114: 12-30.

Sullivan, B. K., and D. Hancock. 1977. *Zooplankton and dredging: research perspectives from a critical review.* Water Resources Bulletin. 13: 461-468.

Sutter County. 1983. *General Plan, County of Sutter.*

Sweetnam, D. 1996a. *Delta smelt.* Newsletter. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Winter 1996: 22-26.

_____. 1996b. California Department of Fish and Game, Stockton, CA. Personal communication, May 15, 1996.

_____. 1994. Delta smelt. Pages 67-80 in 1992 Annual report: Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. California Department of Water Resources, Sacramento, CA.

Swift, C.C. 1980. "*Eucyclogobius newberri* (Girard), tidewater goby." *Atlas of North American Fishes*. Eds. D.S. Lee et al. N. Carolina State Mus. Nat. Hist., Raleigh. Page 788.

Swift, C. C., J. L. Nelson, C. Maslow, and T. Stein. 1989. "Biology and distribution of the tidewater goby, *Eucyclogobius newberri* (Pisces: Gobiidae) of California." *Los Angeles Co. Mus. Nat. Hist. Contribs. in Science* 404:1-19.

SWRCB. See California State Water Resources Control Board.

Thomas, V. G. 1985. *Experimentally determined impacts of a small, suction gold dredge on a Montana stream.* North American Journal of Fisheries Management. 5: 480-488.

Thompson, J. 1957. *The Settlement Geography of the Sacramento-San Joaquin Delta, California.* Unpublished dissertation. Stanford University.

Tracor. *Estuarine Modeling: An Assessment. Capabilities and Limitations for Resource Management and Pollution Control.* 1971.

Trimark Communities, San Joaquin County. 1994. *Mountain House New Community, Draft Master Plan.*

True, D. L., Paul Bouey, and Mark Basgall. 1981. *Archaeological Survey of the Proposed San Luis Drain Project: Kesterson Reservoir to the Sacramento-San Joaquin Delta, California.* Prepared for U.S. Bureau of Reclamation. Manuscript report, CCIC-1733, Central California Information Center, CSU-Stanislaus.

Turner, J. 1994. *Trend analysis for existing biological conditions in the Bay/Delta Estuary (DRAFT).* California Department of Water Resources, ISDP Program. February, 1994.

_____. 1976. *Striped bass spawning in the Sacramento and San Joaquin rivers in central California from 1963 to 1972.* California Fish and Game 62: 106-118.

_____. 1966. "Distribution and food habits of centrarchid fishes in the Sacramento-San Joaquin Delta." *Ecological studies of the Sacramento-San Joaquin Estuary.* Eds. J.L. Turner and D.W. Kelley. California Fish and Game Bull. No. 136:144-153.

Turner, J. L., and D. W. Kelley. (Eds.) 1966. *Ecological studies of the Sacramento-San Joaquin Delta, Part 2: Fishes of the Delta.* California Department of Fish and Game, Fish Bull. No. 136.

Turner, J L., and W. Heubach. 1966. "Distribution and concentration of Neomysis awatschensis in the Sacramento-San Joaquin Delta." *Ecological studies of the Sacramento-San Joaquin Delta.* Ed. D.W. Kelley. California Department of Fish and Game, Fish Bull. No.133:105-112.

U.S. Army Corps of Engineers. 1982. *Sacramento-San Joaquin Delta California Documentation Report.*

_____. 1980. *Fourteenmile Slough and Smith Levee Intensive Cultural Resources Survey.* Prepared by Staff Archeologists, Sacramento District, U.S. Army Corps of Engineers. Manuscript report, CCIC-838, Central California Information Center, CSU-Stanislaus.

C—087867

C-087868

U.S. Bureau of Reclamation. 1992. *Biological assessment for U.S. Bureau of Reclamation long-term Central Valley Project operations criteria and plan.* Sacramento, California: U.S. Bureau of Reclamation, Mid-Pacific Region.

U.S. Bureau of Reclamation and California Department of Water Resources. 1986. *Agreement Between the United States of America and the State of California for Coordinated Operation of the Central Valley Project and the State Water Project.*

U.S. Department of Agriculture, Soil Conservation Service. 1992. *Soil Survey of San Joaquin County, California.*

_____. 1980. *Soil Survey of Alameda County, California.*

_____. 1977. *Soil Survey of Contra Costa County, California.*

U.S. Environmental Protection Agency. February 1989. *Guidelines for the Preparation of the 1990 State Water Quality Assessment (305(b) Report).* U.S. Environmental Protection Agency, Office of Water Regulations and Standards.

U. S. Fish and Wildlife Service. 1995. *Working Paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volumes 1-3.* Prepared for the U.S. Fish and Wildlife Services under the direction of the Anadromous Fish Restoration Program Core Group. May 9, 1995. Stockton, CA.

U.S. Fish and Wildlife Service. September 1995. *Standardized Recommendations for the Protection of the San Joaquin Kit Fox.* Unpublished report. 5pp and appendix.

_____. 1994. *Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes (Technical/Agency DRAFT).* Prepared by the Delta Native Fishes Recovery Team. December 8, 1994.

_____. 1994a. "Determination of endangered status for the tidewater goby." *Federal Register.* Vol. 59 No. 24:5494-5499.

_____. August 24, 1994. . "Endangered and Threatened Wildlife and Plants; Five Plants from the San Bernardino Mountains in Southern California Determined to be Threatened or Endangered." *Federal Register* 59FR43652-43664

_____. August 4, 1994. "Endangered and Threatened Wildlife and Plants; Proposed Rule to List Two Plants From Southwestern California as Endangered and Threatened." *Federal Register* 59FR39879-39886.

_____. March 28, 1994. "Endangered and Threatened Wildlife and Plants; Proposed Endangered Status for the Plant Puccinellia Parishii (Parish's Alkali Grass)." *Federal Register* 59FR14378-14382.

_____ 1994. *Technical/Agency Draft Sacramento-San Joaquin Delta Native Fishes Recovery Plan*. Portland, Oregon: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service. October 20, 1993. "Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Giant Garter Snake." *Federal Register* 58FR54053-54064.

_____. 1992. *Abundance and survival of juvenile chinook salmon in the Sacramento-San Joaquin Estuary*. Annual progress report WRINT-USFWS-9. June 26, 1992. Stockton, CA.

_____. 1992a. "Proposed endangered status of the tidewater goby." *Federal Register*. Vol. 57 No. 239:58770-58774.

U.S. Fish and Wildlife Service. Undated. *Least Bell's Vireo Recovery Plan*. Prepared by K.E. Franzreb, U.S. Fish and Wildlife Service, Sacramento, California.

U.S. Fish and Wildlife Service, California Department of Fish and Game, City of Bakersfield, and County of Kern. 1993. *Implementation/Management Agreement.*

U.S. Geological Survey. January 1989. *Programs and Plans: Nomination of San Francisco Bay Estuary as a Surface-Water Contamination Field Site for the Toxic Substances Hydrology Program*. U.S. Department of the Interior, Geological Survey, Water Resources Division.

Unger, P. 1994. *Quantifying salinity habitat of estuarine species*. Newsletter. Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Autumn 1994: 7-10.

University of California, Berkeley, Center for Environmental Design Research. May 1992. *Four Case Studies Evaluating Environmental Decision-Making in the San Francisco Estuary.* San Francisco Estuary Project. Draft.

Upper Sacramento River Fisheries and Riparian Habitat Advisory Council. 1989. *Upper Sacramento River Fisheries and Riparian Habitat Management Plan*. Rpt. Prepared for the Resources Agency, State of California.

USACOE. See U. S. Army Corps of Engineers.

USFWS. See U.S. Fish and Wildlife Service.

Vanicek, C.D. 1980. *Decline of the Lake Greenhaven Sacramento perch population.* California Department of Fish and Game 66:178-183.

Velagic, E. 1995. *Turbidity study: a literature review*. May 1995. Prepared for Delta Planning Branch, California Department of Water Resources by Centers for Water and Wildland Resources, University of California, Davis, CA.

Vogel, D. A., and K. R. Marine. 1991. *U. S. Bureau of Reclamation Central Valley Project guide to Upper Sacramento River chinook salmon life history*. CH2M Hill, Redding, CA.

Vos, D.K. 1984. *Response of Breeding Great Blue Herons to Human Disturbance in Northcentral Colorado.* Masters Thesis. Colorado Division of Wildlife, Wildlife Research Report, January 1984.

Wahle, R. A. 1985. "The feeding ecology of Crangon ftanciscorum and Crangon nigricauda in San Francisco Bay." *California Jour. Crust. Biol.* 5:311-326.

Walkinshaw, L. 1973. *Cranes of the World.* New York: Winchester Press.

C-087870

C-087871

Wallace, W. J. 1978a. "Post-Pleistocene Archeology, 9000 to 2000 B.C." *Handbook of North American Indians, vol. 8, California.* Ed. R.F. Heizer. Washington, D.C.: Smithsonian Institution. 25-36.

_____. 1978b. "Northern Valley Yokuts." *Handbook of North American Indians, vol. 8, California.* Ed. R.F. Heizer. Washington, D.C.: Smithsonian Institution. 462-470.

Wang, J. C. S. 1991. *Early life history of the Delta smelt, Hypomesus transpacificus, in the Sacramento-San Joaquin estuary, with comparison of early life stages of the longfin smelt, Spirinchus thaleichthys.* (FS/BIO-IATR/91-28, Technical Report 28, Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary.) California Department of Water Resources. Sacramento, CA.

_____. 1986. *Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: a guide to the early life stages.* Prepared for the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Technical Rept. 9. Sacramento, CA.

_____. 1986a. *Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: a guide to the early life stages.* Prepared for the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Technical Rept. 9.

_____. 1982. *Early life history and protection of the tidewater goby* Eucyclogobius newberri *(Girard) in the Rodeo Lagoon of the Golden Gate National Recreation Area.* Tech. Rept. No. 7: National Park Service. Contribution No. CPSU/UCD 022/3.

Water Education Foundation. 1994. *Western Water, July/August 1994.*

_____. 1993. *Layperson's Guide to California Water.*

_____. 1993. *Layperson's Guide to San Francisco Bay.*

_____. 1993. *Layperson's Guide to the Delta.*

_____. 1992. *Layperson's Guide to California Rivers and Streams.*

C-087871

C-087872

Weir, W. W. 1950. "Subsidence of Peat Lands of the San Joaquin-Sacramento Delta, California." *Hilgardia* 20:37-56.

Werner, R. H. 1988. *Cultural Resources Investigation, Brookside Community Development Project, Stockton, California.* Manuscript report, CCIC-846, Central California Information Center, CSU-Stanislaus.

_____. 1986. *Cultural Resources Survey Report, Lower San Joaquin River and Tributaries Channel Clearing (1986).* Sacramento: U.S. Army Engineer District. Manuscript report, CCIC-839, Central California Information Center, CSU-Stanislaus.

West G. J. 1994. *A Class III Archeological Survey of the South Delta Water Management Program Area, San Joaquin and Contra Costa Counties, California.* Sacramento: U. S. Bureau of Reclamation. Manuscript report, CCIC-2391, Central California Information Center, CSU-Stanislaus.

_____. 1991. *Archaeological Survey of Temporary Barrier Across Old River, San Joaquin County, California, South Delta Water Management Program.* Sacramento: U. S. Bureau of Reclamation. Manuscript report, CCIC-1730, Central California Information Center, CSU-Stanislaus.

_____. 1977. *Late Holocene Vegetation History of the Sacramento-San Joaquin Delta, California.* Unpublished report prepared by the Department of Parks and Recreation (Cultural Heritage Section) for the Department of Water Resources, Interagency Agreement No. B-50173.

West, G. J., and B. G. Scott. 1990. *A Class II Archeological Survey of the South Delta Water Management Program Area, San Joaquin and Contra Costa Counties, California.* Sacramento: U. S. Bureau of Reclamation. Manuscript report, CCIC-1732, Central California Information Center, CSU-Stanislaus.

Western Area Power Administration. 1992. *California-Oregon Transmission Project Waterfowl Mitigation Plan.* Prepared in cooperation with the Transmission Agency of Northern California.

White, D. R. M. 1995. *Ethnographic Concerns Regarding the Interim South Delta project in Contra Costa and San Joaquin Counties, California.*

Williams, D. F. 1986. *Mammalian Species Concern in California.* California Department of Fish and Game, Wildlife Management Division. Administrative Report 86-1.

_____. 1983. *Populations Survey of the Santa Catalina, San Bernardino and Suisun Shrews.* U.S. Fish and Wildlife Service, Endangered Species Office, Sacramento, California. Contract 11310-0242-2.

Willits, N. H. 1992. *Striped Bass Model.* Appendix C in Kolhorst, D. W., D. E. Stevens, and L. W. Miller. 1992. A model for evaluating the impacts of freshwater outflow and export on striped bass in the Sacramento-San Joaquin Estuary. WRINT-DFG-Exhibit 3. Entered for CDFG for SWRCB Water Rights Phase of the Bay-Delta Estuary Proceedings.

Wixom, L. H. 1981. *Age and spawning history of American shad (Alosa sapidissima) in central California, 1975-1978.* California Department of Fish and Game, Anadromous Fisheries Branch, Administrative Rept. No. 81-3.

Wohlgemuth, E., and C. T. Mears. 1994. *A Cultural Resources Survey of the Stewart Tract and Mossdale Areas of the West Lathrop Specific Plan.* Report prepared by Far Western Anthropological Research Group, Davis California. Manuscript report, Central California Information Center, CSU-Stanislaus.

Wolfenden, J. D. and M. P. Carlin. 1992. *Interim Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse:* Guidance Report prepared for the Regional Water Quality Control Board, San Francisco Bay Region.

Wullschleger, J. 1994. *Estimating winter-run survival with late-fall run fish. Interagency Ecological Program for the Sacramento-San Joaquin Estuary.* Spring 1994: 8-9.

Yolo County. 1983. *Yolo County General Plan.*

Yuba County. 1973. *Yuba County General Plan, Open Space and Conservation Element.*

Yuba County. 1981. *Yuba County General Plan, Land Use Element*. Amended 1988.

Zeiner, D. C., W. F. Laudenslayer Jr., K. E. Mayer, and M. White. 1990. *California's Wildlife, Volume II Birds*. California Statewide Wildlife Habitat Relationships System. Sacramento: California Department of Fish and Game.

_____. 1990a. *California's Wildlife, Volume III Mammals*. California Statewide Wildlife Habitat Relationships System. Sacramento: California Department of Fish and Game.

_____. 1988. *California's Wildlife, Volume I Amphibians and Reptiles*. California Statewide Wildlife Habitat Relationships System. Sacramento: California Department of Fish and Game.

PRINTED BY
DEPARTMENT OF WATER RESOURCES
REPROGRAPHICS

C—087875

C-087876