CHAPTER XIII. ALTERNATIVES FOR IMPLEMENTING THE JOINT POINTS OF DIVERSION

A. PURPOSE

The purpose of this chapter is to disclose and analyze the significant environmental effects of alternatives for implementing the DWR's and the USBR's petition for joint use of SWP and CVP points of diversion (Joint POD) in the Delta. Specifically, the alternatives examine the joint use of the SWP's Harvey O. Banks Pumping Plant and the CVP's Tracy Pumping Plant.

B. BACKGROUND INFORMATION ON JOINT POD

The CVP, operated by the USBR, and the SWP, operated by the DWR, are the largest water development projects in California and supply water to much of the state. They are also the largest water right holders in the state. The main export facilities of the projects are located in the southern Delta, and these facilities pump water south through the Delta-Mendota Canal and the California Aqueduct. This water is then directly used or placed into storage in San Luis Reservoir (see Figure XIII-1). The SWP can also move water farther south to storage facilities in southern California. The primary storage reservoirs of the CVP are Shasta Lake (Sacramento River), Trinity Reservoir (Trinity River), and Folsom Lake (American River), which are located north of the Delta. In times when water is not directly available in the Delta, stored water is released from these reservoirs to meet the CVP demands south of the Delta.

The SWP and the CVP water right permits include instantaneous diversion and rediversion rates (10,350 cfs for the SWP at Banks Pumping Plant and 4,600 cfs at Tracy Pumping Plant) as well as rates of diversion to storage in San Luis Reservoir (10,350 cfs for the SWP and 4,200 cfs for the CVP). The CVP's Tracy Pumping Plant has a capacity of 4,600 cfs. Historically, flexibility in the pumping and transport system allowed maintenance and repair work to be performed without significantly affecting the ability to meet water supply demands. Recently, however, changes in the regulatory environment have eliminated that flexibility. At present, the Tracy Pumping Plant is generally operated either at its full capacity or at the maximum capacity set forth in Biological Opinions established under the Endangered Species Act (ESA) or SWRCB Order WR 98-09.

The SWP's Banks Pumping Plant has capacity to pump up to 10,350 cfs. However, the U.S. Army Corps of Engineers Public Notice 5820-A (PN 5820-A) limits daily diversions into Clifton Court Forebay to 13,870 acre-feet and limits 3-day average diversions to 13,250 AF/day, except in winter when San Joaquin River flow is high. From December 15 to March 15, DWR may divert an additional amount equal to one-third of the total flow at Vernalis when flows at Vernalis exceed 1,000 cfs. The conditions of PN 5820-A effectively limit the operating capacity of Banks Pumping Plant to 6,680 cfs much of the time. At

Figure XIII-1
Location Map for Select Features of the Central Valley Project and the State Water Project

certain times of the year, and under certain operational conditions, the available capacity is not fully utilized by the SWP. At those times, there is excess capacity available at the Banks Pumping Plant that could be used by the CVP.

The actions and events that have increased the need for the USBR to seek assistance from the SWP to wheel[1] CVP water through DWR's Banks Pumping Plant have been progressive. Pumping restrictions for environmental purposes began in 1979 when the SWRCB implemented Water Right Decision 1485 (D-1485). This decision limited pumping at the Tracy Pumping Plant to 3,000 cfs in May and June for the protection of striped bass. The quantity of water that was foregone by this limitation could not always be recaptured solely through the use of the Tracy Pumping Plant because of the timing of demands and the Tracy Pumping Plant's limited pumping capacity. The SWRCB recognized this limitation and authorized CVP use of the Banks Pumping Plant in Condition 3 of D-1485, which states:

> *To the extent that operational constraints on the Central Valley Project to minimize diversion of young striped bass from the Delta during May and June reduce project exports, permittee, the United States Bureau of Reclamation, shall be allowed through coordinated operations to make up such deficiencies during later periods of the year by direct diversion or by re-diversion of releases of stored water through State Water Project facilities.*

After D-1485 was implemented, and with increasing demands on the CVP, the Tracy Pumping Plant's flexibility became limited. Maintenance activities were difficult to perform while meeting full demands and generally were not possible without use of SWP facilities to wheel CVP water. Several temporary actions to allow wheeling for purposes other than those specified in D-1485 were filed with the SWRCB and approved.

The CVP has used the SWP's pumping facility in the Delta to deliver water to four entities (Cross Valley Canal (CVC), Musco Olive, Tracy Golf Course, and the VA Cemetery) for a number of years even though the use of the SWP's pumps for this purpose is not authorized under the current water right permits. While these CVP contractors cannot be served conveniently by using only CVP facilities, the SWP facilities have had available capacity for wheeling CVP water. The CVC contractors, with a total contract allotment of 128,300 acre-feet per year, receive the majority of the water that has been wheeled by the SWP. Average annual deliveries to the CVC for the period 1982-1993 were 75,432 acre-feet.

On December 7, 1981, the USBR filed a petition requesting a permanent change to CVP water rights by the addition of the Banks Pumping Plant as a point of diversion and re-diversion under those rights. This request was repeated in a subsequent petition filed on September 24, 1985, concerning the consolidated place of use. The SWRCB notified the USBR that it would defer action on the USBR's petition and integrate that action into a comprehensive Bay/Delta water rights hearing that would begin in 1987.

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[1] Wheeling involves the pumping and conveyance of CVP-held water through SWP facilities into San Luis Reservoir where it can then be delivered to CVP users.

The SWRCB began the Bay/Delta hearings in 1987. A draft plan issued in November 1988 was withdrawn in January 1989. In May 1991, after additional hearings, the SWRCB adopted the 1991 Bay/Delta Plan, but this water quality control plan did not address the water right issue of combined use of points of diversion. A draft decision, D-1630, was released in December 1992, but was subsequently withdrawn. The series of events that followed the withdrawal of D-1630 included the development of a process that resulted in the 1994 Principles of Agreement and the 1995 Bay/Delta Plan. A summary of this process is provided in Chapter I.

On February 28, 1995, the DWR and the USBR filed a joint petition requesting the SWRCB to amend the water right permits of the SWP and CVP to allow operation to meet the objectives in the 1995 Bay/Delta Plan without violating the terms of D-1485 and to permit combined use of points of diversion. The SWRCB adopted Water Right Order 95-6 (WR 95-6) on June 8, 1995, conditionally approving the petition. WR 95-6 was an interim order that was to expire either (1) upon adoption by the SWRCB of a comprehensive water right decision that allocates final responsibilities for meeting the 1995 Bay/Delta Plan objectives or (2) on December 31, 1998, whichever came first. On December 3, 1998, the effective term of WR 95-6 was extended until December 31, 1999, when the SWRCB adopted Order WR 98-09.

The implementation of the new standards contained in the 1995 Bay/Delta Plan placed additional constraints on the operation of the CVP. WR 95-6 and WR 98-09 also authorized short-term combined use of the points of diversion of the SWP and the CVP subject to the condition that such use must improve fish protection and not result in an increase in average exports above the exports in the absence of the coordinated operations.

The Joint POD alternatives described in the next section are designed to incrementally increase the quantity of CVP water wheeled by the SWP under the joint point concept. Seven alternatives for the use of Joint POD, one alternative representing full implementation of the 1995 Bay/Delta Plan, and the “no project alternative” are summarized in this chapter. Five of the Joint POD alternatives that allow wheeling build upon Joint POD Alternative 2, which represents full implementation of the 1995 Bay/Delta Plan. One Joint POD alternative builds on Flow Alternative 7, the “Letter of Intent” alternative; and, one Joint POD alternative builds on Flow Alternative 8, the San Joaquin River Agreement alternative. (See Chapter II for a description of the Flow Alternatives.

The environmental effects of implementing the Joint POD alternatives are evaluated using a two-step process. River flows, Delta outflow, Delta salinity distribution, and reservoir levels resulting from implementation of the alternatives were modeled using DWRSIM and DWRDSM models (Chapter IV). The modeled hydrology is then compared to the flow and reservoir needs of fish, other aquatic resources, vegetation, and wildlife to determine the key environmental effects of implementing each alternative. Comparisons are made with the base condition to maintain consistency with the analyses presented in previous chapters. Additional comparisons are made, where possible, with Alternative 2, to analyze any incremental effects of other alternatives that allow wheeling.

C. DESCRIPTION OF ALTERNATIVES

A broad range of alternatives is analyzed to encompass all potential impacts. No preferred Joint POD alternative is identified in this final EIR. Any decision of the SWRCB on the Joint POD, whether it reflects one of the alternatives in the EIR, a combination of the EIR's alternatives, or a variant of one of the EIR's alternatives, will fall within the range of alternative actions described and analyzed. The potential impacts of any decision should be adequately identified and analyzed in this report and the decision will not result in addition of significant new information.

The Joint POD alternatives are described below. In general, the Joint POD alternatives build on each other, with subsequent alternatives incorporating features of the previous alternatives, but allowing increasing exports. For purposes of this analysis, all but two of the alternatives assume that the SWP and the CVP are responsible for meeting the objectives in the 1995 Bay/Delta Plan. The flow objectives at Vernalis in Joint POD Alternatives 6 and 9 are different from those specified in the Bay/Delta Plan. In actuality, any of these alternatives could be combined with any of the flow alternatives described in Chapter II. For modeling purposes, Joint POD alternatives 1 through 6 and 9 include the installation and operation of temporary barriers in the south Delta, and Joint POD Alternatives 7 and 8 include the installation and operation of permanent barriers.

1. Joint POD Alternative 1 (No Project)

Under Joint POD Alternative 1 (base case), D-1485 objectives are in effect. The CVP is authorized to use the SWP's point of diversion in the Delta only to make up export deficiencies occurring in May and June caused by export restrictions in D-1485. This alternative is identical to Flow Alternative 1.

2. Joint POD Alternative 2

Under Joint POD Alternative 2, the 1995 Bay/Delta Plan objectives are in effect. Joint use of points of diversion is not authorized. This alternative differs from Flow Alternative 2, which is described in Chapter II and analyzed in Chapter VI, because in this alternative all objectives are met; however, in Flow Alternative 2, salinity objectives at Vernalis are not always met.

3. Joint POD Alternative 3

Under Joint POD Alternative 3, the 1995 Bay/Delta Plan objectives are in effect. The CVP is authorized to use the SWP's point of diversion in the Delta to deliver up to 129 TAF of contract water to the CVC, Musco Olive, Tracy Golf Course, and the Veterans' Administration Cemetery. Combined use of the SWP and the CVP points of diversion in the Delta is limited by the terms and conditions in SWP and CVP water right permits that specify diversion rates of the projects in the Delta. Use of the SWP point of diversion is further limited by USCOE PN 5820-A, as amended.

4. Joint POD Alternative 4

Under Joint POD Alternative 4, the 1995 Bay/Delta Plan objectives are in effect, and the Joint POD is authorized for the uses of water identified in Joint POD Alternative 3. Additionally, the Joint POD is authorized for uses of water to provide a net benefit to fish and wildlife. Any pumping losses incurred by either of the projects as a result of reductions to benefit fish may be made up within twelve months using either or both pumping plants. This alternative is modeled by assuming that exports are reduced during the April 15 through May 15 pulse flow to half the flows at Vernalis and that the reductions are made up through combined use of points of diversion in other months when pumping opportunities occur. Combined use of the SWP and the CVP points of diversion in the Delta is limited by the permitted diversion rates of the projects and by PN 5820-A, as amended.

5. Joint POD Alternative 5

This alternative builds on Joint POD Alternative 3; however, the use of water authorized under the Joint POD is not restricted to deliveries to the entities specified in that alternative. The 1995 Bay/Delta Plan objectives are in effect. Combined use of the SWP and the CVP points of diversion in the Delta is limited only by the permitted diversion rates of the projects in the Delta and by PN 5820-A, as amended.

6. Joint POD Alternative 6

The 1995 Bay/Delta Plan objectives are in effect except that minimum San Joaquin River flows at Vernalis are as specified in the Letter of Intent, as in Flow Alternative 7. Combined use of the SWP and the CVP points of diversion in the Delta is limited by the terms and conditions in SWP and CVP water right permits that specify diversion rates of the projects in the Delta. Use of the SWP point of diversion is further limited by PN 5820-A, as amended.

7. Joint POD Alternative 7

This alternative builds on Joint POD Alternative 5. The 1995 Bay/Delta Plan objectives are in effect. Joint use of the SWP and the CVP points of diversion in the Delta is limited by the permitted diversion rates of the projects in the Delta. The SWP and the CVP permits include instantaneous diversion and rediversion rates as well as rates of diversion to storage in San Luis Reservoir. The restrictions imposed by PN 5820-A are not in effect. For modeling purposes, the ISDP barriers are assumed to be installed and operated.

8. Joint POD Alternative 8

This alternative builds on Joint POD Alternative 7. The 1995 Bay/Delta Plan objectives are in effect. Joint use of the SWP and the CVP points of diversion in the Delta is limited only by the combined physical capacities of the pumping plants and by each project's annual authorized diversion. For modeling purposes, the ISDP barriers are assumed to be installed and operated. This alternative is modeled using the CVP's 2020 level of demand (3.6 MAF) and a method of operation designed to maximize deliveries and the use of Joint POD. This was done to create an alternative where maximum use of the Joint POD is authorized.

9. Joint POD Alternative 9

This alternative is the same as Alternative 5 except that the Vernalis pulse flows and export limits are replaced by the target values in the San Joaquin River Agreement. New Melones Reservoir is operated according to the New Melones Interim Plan of Operation. If water in excess of base flows during the San Joaquin River pulse flow period is needed to meet the Vernalis target flows, the San Joaquin tributaries group provides up to 110 TAF. Combined use of the SWP and the CVP points of diversion in the Delta is limited by the permitted diversion rates of the projects in the Delta. Use of the SWP point of diversion is further limited by the PN 5820-A, as amended.

D. WATER SUPPLY IMPACTS

This section describes the water supply impacts of the Joint POD alternatives. With two exceptions, these alternatives affect only the SWP and the CVP. The exceptions, Alternatives 6 and 9, assume implementation of the Letter of Intent and the San Joaquin River Agreement, respectively. These two alternatives have a water supply impact on some San Joaquin Basin water users. The water supply impact of implementation of these two alternatives is, however, already evaluated in Chapter VI. Consequently, this section and all following sections of this chapter will analyze only the changes to the SWP and the CVP system that result from combined use of points of diversion in the Delta.

The following discussion is divided into four sections: (1) SWP and CVP delivery impacts, (2) SWP wheeling for the CVP, (3) carryover storage in SWP and CVP reservoirs, and (4) transfer capacity.

1. SWP and CVP Delivery Impacts

Water delivery changes to SWP and CVP contractors for the 73-year average and the critical period are summarized in Table XIII-1. As modeled, the SWP receives no benefit for the combined use of points of diversion because the SWP never uses the CVP pumping facilities. In real operation, the SWP may occasionally use the CVP facilities if necessary for fish protection, but such an operation is likely to be rare.

Comparison of the deliveries under Joint POD Alternative 2 to the deliveries under Joint POD Alternatives 3 through 9 shows some effect on the SWP of the combined use of points of diversion, but this is due both to changes in availability of water in the Delta because of altered upstream CVP operations and to variability within the model. Comparison of the corresponding alternatives for the CVP, however, shows a substantial potential water supply benefit over the 73-year modeled hydrology for combined use of points of diversion. Over this period, the average annual water supply increase for the CVP ranges from 45 TAF to 247 TAF. The lower end of the range applies when combined use is limited by the export restrictions in the San Joaquin River Agreement (Alternative 9).

Table XIII-1
Water Delivery Changes (TAF)

73-Year Period Annual Average

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9
SWP Deliveries	2,872	2,763	2,760	2,750	2,750	2,746	2,780	2,775	2,750
compared to Alt 1	--	-109	-112	-122	-122	-126	-92	-97	-122
compared to Alt 2	--	--	-3	-13	-13	-17	17	12	-13
CVP Deliveries	2,770	2,591	2,666	2,683	2,726	2,690	2,744	2,838	2,636
compared to Alt 1	--	-179	-104	-87	-44	-80	-26	68	-134
compared to Alt 2	--	--	75	92	135	99	153	247	45

1928-1934 Critical Period Average

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9
SWP Deliveries	2,520	2,035	2,036	2,043	2,032	2,032	2,065	2,017	2,049
compared to Alt 1	--	-485	-484	-477	-488	-488	-455	-503	-471
compared to Alt 2	--	--	1	8	-3	-3	30	-18	14
CVP Deliveries	2,224	1,987	2,014	2,015	2,040	1,958	2,031	2,014	1,994
compared to Alt 1	--	-237	-210	-209	-184	-266	-193	-210	-230
compared to Alt 2	--	--	27	28	53	-29	44	27	7

When combined use under 1995 Bay/Delta Plan operation is authorized up to the diversion limits set forth in PN 5820-A (Flow Alternative 5), the annual average water supply increase is 135 TAF. When combined use under 1995 Bay/Delta Plan operation is authorized up to the physical export capacity of the projects, the annual average water supply increase is 247 TAF. The ISDP, or some closely related project, is probably necessary before the projects can increase pumping rates above the diversion limits set forth in PN 5820-A.

Table XIII-1 also shows that there is much less potential benefit to the CVP of combined use of points of diversion in the critical period. In dry periods, there is insufficient water available to realize appreciable benefits from combined use of points of diversion.

2. SWP Wheeling for the CVP

Table XIII-2 identifies the annual average quantity of water that is wheeled by the SWP at Banks pumping plant for the CVP under each alternative over the 73-year period and the critical period. A comparison of the alternatives is provided for both the base case and Alternative 2. Table XIII-2 shows that substantial wheeling is presently authorized under Alternative 1, the base case condition. Over the 73-year period, wheeling for Alternatives 3 through 9 ranges from 88 TAF to 347 TAF.

A comparison of Tables XIII-1 and XIII-2 shows that the average annual quantity of water wheeled relative to Alternative 2 is substantially more than the increased average annual CVP water supply relative to Alternative 2. For example, in Alternative 8 the increased annual average water supply deliveries are 247 TAF, but an annual average of 347 TAF is wheeled. The difference between these two quantities is due to altered operation of the CVP, which is able to fill its share of San Luis Reservoir earlier in the year through combined use of points of diversion and reduce pumping later in the season.

Table XIII-3 shows the monthly distribution of wheeled water under the alternatives for the 73-year average and the critical period. Under the base case operation, the water is wheeled in July and August. In Alternatives 3 through 9, the water is wheeled in every month except May, but the quantity of wheeled water is relatively small in March, April and June.

Table XIII-2
SWP Wheeling for CVP at Banks Pumping Plant (TAF)

73-Year Period Annual Average

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9
SWP Wheeling	105	0	88	218	232	228	327	347	202
compared to Alt 1	--	-105	-17	113	127	123	222	242	97
compared to Alt 2	--	--	88	218	232	228	327	347	202

1928-1934 Critical Period Average

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9
SWP Wheeling	44	0	36	47	45	33	64	51	38
compared to Alt 1	--	-44	-8	3	1	-11	20	7	-6
compared to Alt 2	--	--	36	47	45	33	64	51	38

3. Carryover Storage in SWP and CVP Reservoirs

Carryover storage is the amount of water retained in a reservoir at the end of September of each year. Carryover storage helps meet future demand in the event that the next year is dry. The amount of water dedicated to carryover storage is balanced against the amount needed to meet immediate delivery needs, hydropower generation needs, and instream flow requirements of a project, according to operation rules that differ for each reservoir. For the SWP and the CVP reservoirs, the operation rules have been determined through optimization studies. Reservoir operations are modeled in DWRSIM according to these rules.

Reservoirs in this analysis include Shasta, Oroville, Folsom and New Melones.
Tables XIII-4 and XIII-5 show carryover storage volumes in these reservoirs for the 73-year period and the critical period for the alternatives and for the base case. The differences in carryover storage between the alternatives and the base case (Alternative 1) are graphically represented in Figures XIII-2 through XIII-5. The differences in carryover storage between Alternatives 3 through 9 and Alternative 2 are graphically represented in Figures XIII-6 through XIII-9. The tables and figures indicate that carryover storage in the CVP reservoirs in the Sacramento Basin declines slightly for Alternatives 3 through 9 as wheeling quantities increase. This decline is due to the extra water being exported to CVP contractors through combined use of points of diversion. Unlike the Sacramento Basin CVP reservoirs, New Melones Reservoir carryover storage does not change due to combined use because this reservoir is not used to provide water for export. Carryover storage in New Melones

Reservoir is substantially improved for Alternative 6 and to a lesser extent Alternative 9 because reservoir releases for inbasin uses decline under the requirements in the Letter of Intent and the San Joaquin River Agreement, respectively.

Table XIII-3
SWP Wheeling of CVP Water (TAF)

73-Year Period Average Monthly Wheeling

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0	0	0	0	0	0	0	0	0	43	62	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	16	3	10	11	1	13	0	0	0	6	25	3
4	21	10	30	55	17	8	0	0	1	12	43	22
5	24	11	30	60	12	7	0	0	1	16	61	10
6	19	10	26	62	19	6	5	0	1	10	60	9
7	41	27	62	41	10	6	2	0	7	37	86	8
8	26	8	21	111	12	7	2	0	0	42	116	3
9	18	9	32	59	15	4	0	0	1	10	38	16

Critical Period Average Monthly Wheeling

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0	0	0	0	0	0	0	0	0	14	27	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	18	0	0	0	0	0	0	0	0	6	6	3
4	20	0	0	0	0	0	0	0	0	7	1	16
5	22	0	0	0	0	0	0	0	0	8	5	7
6	22	0	0	0	0	0	0	0	3	4	0	2
7	13	0	0	4	10	0	0	0	0	9	27	0
8	16	0	0	0	0	0	0	0	0	6	25	0
9	16	0	0	0	2	0	0	0	0	1	0	17

4. Transfer Capacity

The capacity to use the SWP and the CVP export facilities to transfer water was analyzed using the method described in Chapter V. This method assumes that the July through October period is the most likely period for water transfers to occur and the ability of the projects to accommodate water transfers depends on two factors: (1) unused pumping capacity at Banks and Tracy pumping plants and (2) the requirement that not more than 65 percent of Delta inflow can be exported during this period. The analysis does not consider other possible operational restrictions, such as storage or conveyance capacity south of the Delta. Lastly, the analysis assumes that parties selling water would release from storage, or bypass water, and this water would enter the Delta at the rate at which it was to be transferred.

Table XIII-4

Carryover Storage in Central Valley Reservoirs

73-Year Period Annual Average

(TAF)

Alternativ	Shasta	Oroville	Folsom	New Melones
Alt. 1	2,910	2,310	481	1,543
Alt. 2	2,893	2,195	445	1,286
Alt. 3	2,863	2,182	434	1,291
Alt. 4	2,837	2,160	421	1,287
Alt. 5	2,836	2,188	423	1,292
Alt. 6	2,816	2,171	415	1,608
Alt. 7	2,827	2,182	422	1,292
Alt. 8	2,799	2,186	401	1,292
Alt 9	2,867	2,161	433	1,393

Table XIII-5

Carryover Storage in Central Valley Reservoirs

Critical Period Annual Average

(TAF)

Alternativ	Shasta	Oroville	Folsom	New Melones
Alt. 1	1,944	1,608	261	1,104
Alt. 2	1,893	1,469	182	620
Alt. 3	1,836	1,408	182	624
Alt. 4	1,830	1,427	170	625
Alt. 5	1,848	1,412	186	625
Alt. 6	1,872	1,478	178	1,150
Alt. 7	1,837	1,484	187	625
Alt. 8	1,833	1,487	170	625
Alt 9	1,861	1,439	188	750

The results of the analysis are provided in Figures XIII-10 and XIII-11. The transfer capacity for Alternative 2 increases in comparison to Alternative 1 because the higher flow objectives in Alternative 2 deplete upstream reservoirs which reduces the ability of the projects to release water for export through the Delta in the July through October period. The transfer capacities of Alternatives 3, 4, 5, and 9 decline in comparison to Alternative 2 because the SWP is using some of its excess capacity to export CVP water. The transfer capacities of Alternatives 7 and 8 increase substantially because of the higher maximum SWP export level under these alternatives.

E. ENVIRONMENTAL EFFECTS OF IMPLEMENTING JOINT POD ALTERNATIVES IN THE DELTA

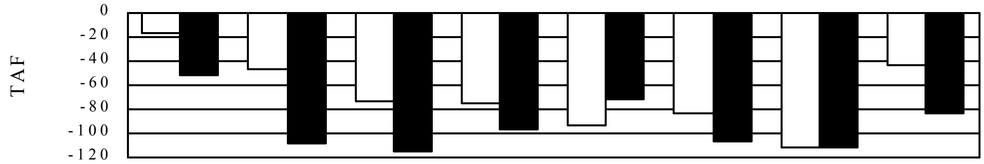
The evaluation of the environmental effects of implementing the Joint POD alternatives in the Delta is divided into the following sections: (1) hydrology, (2) salinity, and (3) fish and aquatic resources.

1. Hydrology

The principal factors affecting Delta hydrology are the tides, river inflow from the Sacramento and San Joaquin river systems, net Delta outflow and total SWP/CVP Delta exports. Tables XIII-6 through XIII-13 list the base case and Alternative 2 monthly flows of the Sacramento River at Freeport, the San Joaquin River at Vernalis, net Delta outflow and Delta export pumping for the 73-year period and the critical period. Below the base case and Alternative 2 flows are the reductions and increases in flows resulting from the Joint POD alternatives. Reductions in flow are expressed as negative values. Tables XIII-14 and XIII-15 list the modeled Export/Inflow ratios for the base cases and the Joint POD alternatives.

Figure XIII-2

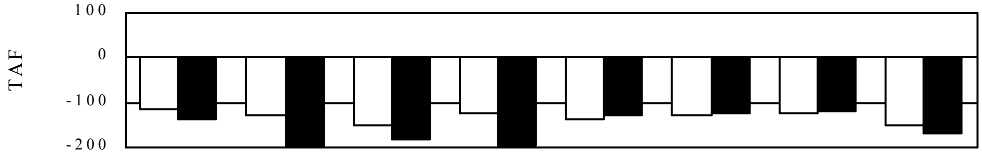
Shasta Lake Carryover Storage Impacts Compared to Alt 1



	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
□ 73-Year Period Avg.	-17	-47	-73	-75	-94	-83	-111	-43
■ Critical Period Avg.	-51	-108	-115	-96	-72	-107	-112	-83

Figure XIII-3

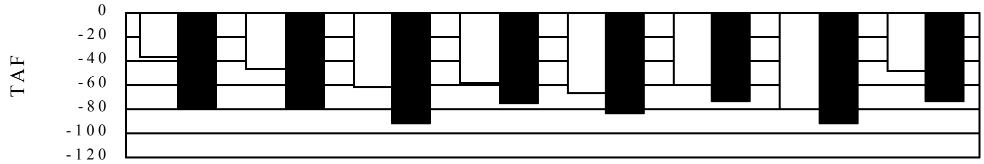
Lake Oroville Carryover Storage Impacts Compared to Alt 1



	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
□ 73-Year Period Avg.	-115	-128	-150	-122	-139	-128	-124	-149
■ Critical Period Avg.	-139	-200	-181	-196	-130	-124	-121	-169

Figure XIII-4

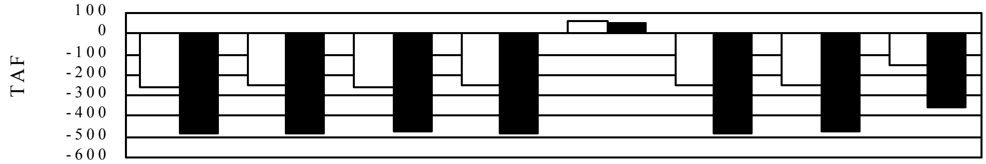
Folsom Lake Carryover Storage Impacts Compared to Alt 1



	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
□ 73-Year Period Avg.	-36	-47	-61	-58	-66	-60	-80	-48
■ Critical Period Avg.	-79	-79	-91	-75	-83	-74	-91	-73

Figure XIII-5

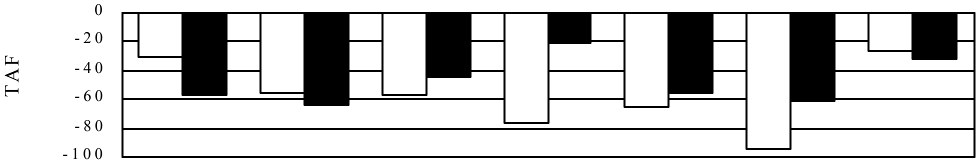
New Melones Res. Carryover Storage Impacts Compared to Alt 1



	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
□ 73-Year Period Avg.	-257	-252	-256	-250	65	-251	-251	-150
■ Critical Period Avg.	-483	-480	-478	-479	47	-479	-478	-354

Figure XIII-6

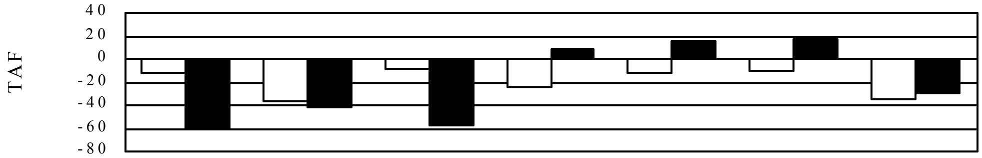
Shasta Lake Carryover Storage Impacts Compared to Alt 2



	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
☐ 73-Year Period Avg.	-30	-56	-57	-77	-65	-94	-26
■ Critical Period Avg.	-57	-64	-45	-21	-56	-61	-32

Figure XIII-7

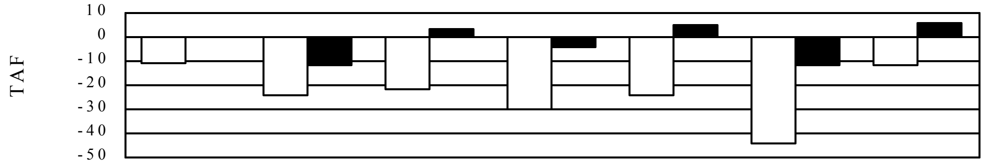
Lake Oroville Carryover Storage Impacts Compared to Alt 2



	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
☐ 73-Year Period Avg.	-13	-36	-8	-25	-13	-10	-34
■ Critical Period Avg.	-61	-42	-57	9	15	18	-30

Figure XIII-8

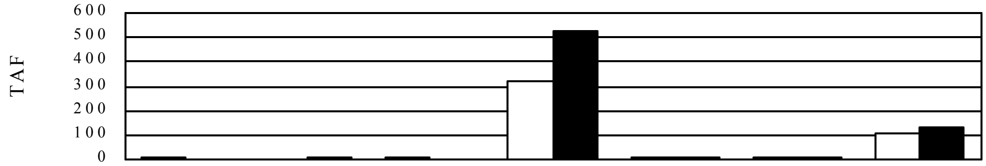
Folsom Lake Carryover Storage Impacts Compared to Alt 2



	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
☐ 73-Year Period Avg.	-11	-24	-22	-30	-24	-44	-12
■ Critical Period Avg.	0	-12	3	-4	5	-12	6

Figure XIII-9

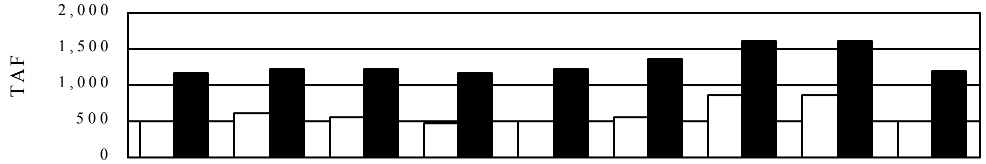
New Melones Res. Carryover Storage Impacts Compared to Alt 2



	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
☐ 73-Year Period Avg.	5	0	6	321	6	6	107
■ Critical Period Avg.	4	5	4	530	5	5	130

Figure XIII-10

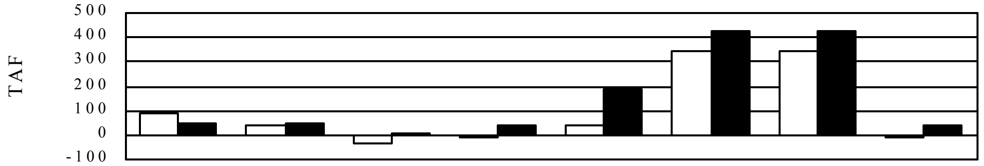
Average Transfer Capacity July through October



	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
□ 72-Year Period Avg.	513	605	553	481	507	554	854	853	501
■ Critical Period Avg.	1,171	1,219	1,220	1,178	1,209	1,361	1,598	1,601	1,207

Figure XIII-11

Transfer Capacity Impacts July through October



	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
□ 72-Year Period Avg.	92	40	-32	-6	41	341	340	-12
■ Critical Period Avg.	48	49	7	38	190	427	430	36

Comparison of the hydrology parameters of Alternatives 3 through 9 to Alternative 2 shows that overall there is not a large change in Delta hydrology due to combined use of points of diversion. The following observations, however, can be drawn from the tables.

1. In comparison to Alternative 2, average monthly exports over the 73-year period (Table XIII-12) under Alternatives 3 through 9 increase from July through January, except in September, due to SWP wheeling of CVP water. Exports then decrease for these alternatives in February and March because the CVP fills its share of San Luis Reservoir early.

2. The net Delta outflow pattern (Table XIII-10) is the opposite of the export pattern. Generally, net Delta outflow under Alternatives 3 through 9 decreases from July through January and increases in February and March, compared to Alternative 2.

3. The combined use of points of diversion does not affect flows at Vernalis. The flow changes at this location (Table XIII-8) are due to changes in the requirements.

Table XIII-6

Sacramento River Flow at Freeport, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
14,211	17,053	24,238	32,539	38,481	35,441	23,335	19,893	16,904	16,385	13,951	11,812

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-693	-28	-662	-691	102	253	262	-252	2862	670	-1644	169
3	-510	-197	-782	-751	-100	123	242	-285	2849	937	-1216	20
4	-736	-420	-843	-924	-264	123	-35	-444	3095	1205	-649	179
5	-619	-299	-892	-790	-212	126	226	-319	2844	1050	-740	-77
6	-785	-591	-1025	-892	-402	74	1145	-901	3408	1032	-522	-190
7	-680	-470	-944	-741	-267	-87	228	-291	2868	2528	-1314	-545
8	-590	-715	-1048	-807	-378	-138	214	-257	2900	2645	-772	-725
9	-701	-361	-813	-770	-185	132	-73	-477	2930	1215	-661	37

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
13,518	17,026	23,576	31,848	38,583	35,694	23,598	19,641	19,766	17,055	12,307	11,982

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	184	-169	-120	-60	-202	-130	-20	-33	-13	267	428	-150
4	-43	-393	-181	-233	-366	-130	-298	-192	234	536	995	10
5	74	-271	-231	-99	-314	-128	-37	-67	-18	380	905	-246
6	-92	-563	-363	-201	-504	-179	882	-649	546	362	1123	-360
7	13	-442	-282	-50	-369	-340	-34	-39	6	1858	330	-715
8	103	-687	-386	-116	-480	-391	-48	-6	39	1975	873	-894
9	-8	-334	-151	-79	-287	-121	-336	-225	68	545	983	-133

Table XIII-7

Sacramento River Flow at Freeport, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10,186	8,893	12,867	16,315	15,126	14,694	10,534	10,121	11,029	14,321	12,063	8,107

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-1213	426	-735	-697	-1123	813	972	1519	3330	-913	-2158	283
3	-920	356	-664	-613	-934	-33	1053	1429	3239	-332	-2005	221
4	-890	317	-773	-781	-1246	-65	546	994	3971	-42	-1875	432
5	-869	303	-705	-697	-1057	-98	1062	1471	3328	-184	-2068	288
6	-806	207	-767	-737	-1183	41	2972	353	3839	-1252	-2391	271
7	-978	328	-718	-653	-973	-22	1053	1468	3558	335	-2679	74
8	-946	353	-670	-651	-1006	-43	992	1457	3659	286	-2623	106
9	-1013	333	-783	-781	-1321	57	387	957	3818	-102	-1982	435

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
8,973	9,319	12,133	15,618	14,003	15,507	11,506	11,640	14,359	13,408	9,904	8,391

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	293	-70	70	84	189	-846	81	-91	-91	581	153	-62
4	323	-109	-38	-84	-123	-878	-426	-525	641	871	283	149
5	344	-123	30	0	66	-911	90	-49	-2	730	91	5
6	407	-218	-33	-41	-60	-773	2000	-1166	509	-339	-232	-12
7	235	-98	16	43	150	-835	81	-51	228	1248	-520	-209
8	267	-73	65	46	117	-857	20	-63	329	1199	-465	-178
9	200	-93	-49	-84	-198	-756	-585	-562	488	811	177	151

Table XIII-8

San Joaquin River Flow at Vernalis, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3,169	2,076	2,927	4,413	6,808	6,177	5,448	4,653	3,722	1,798	1,361	1,874

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-60	-86	-177	-267	-436	-100	350	739	177	226	276	-37
3	-55	-78	-170	-256	-439	-113	351	741	181	230	280	-31
4	-61	-80	-170	-258	-457	-129	370	759	192	231	281	-29
5	-53	-76	-167	-253	-435	-112	351	741	184	233	284	-27
6	382	41	165	155	163	71	-48	260	266	228	-11	-191
7	-55	-77	-166	-248	-420	-112	352	729	184	234	284	-25
8	-51	-74	-163	-247	-422	-123	361	730	179	235	283	-28
9	-57	-104	-67	-105	-306	-6	432	938	195	154	-63	-67

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3,108	1,990	2,750	4,146	6,372	6,077	5,797	5,392	3,900	2,024	1,638	1,837

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	6	8	8	11	-3	-12	1	2	3	4	4	6
4	0	6	8	9	-21	-29	20	20	15	4	5	8
5	8	10	10	14	1	-12	2	2	7	7	7	10
6	442	126	342	422	599	171	-398	-479	88	2	-287	-154
7	5	9	11	19	16	-11	2	-10	7	8	8	12
8	10	12	14	20	13	-23	11	-9	2	9	6	9
9	-75	110	100	7	-94	29	300	328	133	-21	-107	3

Table XIII-9

San Joaquin River Flow at Vernalis, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,870	1,442	1,675	1,778	2,983	2,231	2,409	1,770	1,277	1,099	1,138	1,464

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	60	-129	-149	-141	-297	-30	210	827	281	258	272	-36
3	60	-126	-146	-138	-300	-30	210	827	283	258	274	-31
4	58	-126	-146	-138	-302	-30	210	827	283	258	274	-31
5	60	-126	-146	-138	-300	-30	210	827	283	258	276	-31
6	70	-95	-46	19	71	68	106	346	226	223	-225	-238
7	60	-126	-146	-138	-300	-30	213	827	283	260	274	-31
8	60	-129	-146	-138	-302	-30	210	827	281	249	272	-38
9	-57	-104	-67	-105	-306	-6	432	938	195	154	-63	-67

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,931	1,314	1,526	1,637	2,686	2,201	2,619	2,598	1,558	1,357	1,410	1,428

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	0	3	3	3	-3	0	0	0	2	0	2	5
4	-2	3	3	3	-6	0	0	0	2	0	2	5
5	0	3	3	3	-3	0	0	0	2	0	5	5
6	9	34	103	160	367	98	-104	-481	-55	-35	-497	-202
7	0	3	3	3	-3	0	3	0	2	2	2	5
8	0	0	3	3	-6	0	0	0	0	-9	0	-2
9	-118	24	82	36	-9	24	222	110	-86	-104	-335	-31

Table XIII-10

Delta Outflow, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
8,216	9,974	22,176	38,689	49,942	42,012	24,417	18,415	12,891	6,627	3,870	4,145

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-911	582	-282	-555	944	857	3084	165	376	59	178	527
3	-983	390	-584	-829	817	728	3096	168	380	59	168	432
4	-1191	90	-972	-1564	868	1198	3769	751	505	35	156	332
5	-1177	233	-995	-1471	1206	1174	3092	126	373	35	180	355
6	-830	-11	-910	-1259	1370	1315	1987	795	743	45	147	253
7	-1801	-673	-1742	-686	1779	1132	2887	14	166	-7	149	-105
8	-1534	-717	-1317	-2511	1552	976	2943	15	181	45	194	-107
9	-1315	229	-910	-1402	1091	1371	3981	842	469	33	165	371

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
7,305	10,556	21,893	38,134	50,886	42,869	27,501	18,580	13,267	6,686	4,048	4,672

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	-72	-191	-302	-274	-127	-129	11	3	4	0	-10	-95
4	-279	-491	-689	-1009	-76	341	684	586	129	-25	-22	-195
5	-266	-349	-713	-916	262	317	8	-39	-3	-25	2	-172
6	82	-593	-628	-704	426	458	-1097	630	367	-14	-32	-273
7	-890	-1255	-1460	-131	835	275	-197	-151	-210	-67	-30	-632
8	-623	-1299	-1035	-1956	608	119	-141	-149	-195	-15	15	-634
9	-404	-353	-627	-847	147	514	897	677	93	-26	-13	-156

Table XIII-11

Delta Outflow, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
5,708	3,050	5,998	10,604	8,443	8,118	8,190	4,800	4,228	3,973	4,842	2,650

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-1531	1759	-374	-2163	3148	4632	1101	3566	3229	883	-957	379
3	-1545	1759	-374	-2133	3271	4467	1104	3573	3229	883	-957	384
4	-1545	1759	-388	-2198	2818	4348	1207	3559	3460	883	-971	384
5	-1545	1756	-388	-2168	3079	4372	1109	3576	3229	883	-957	384
6	-1380	1532	-366	-2095	3061	4310	983	3722	3724	883	-911	379
7	-1554	1756	-634	-3234	3118	4567	1109	3580	3308	883	-957	379
8	-1564	1756	-599	-3169	3263	4527	1123	3583	3311	883	-957	379
9	-1779	1754	-363	-2180	2766	4399	1249	3548	3399	883	-830	385

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
4,177	4,809	5,624	8,441	11,591	12,751	9,291	8,366	7,457	4,856	3,885	3,030

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	-14	0	0	30	123	-165	3	7	0	0	0	5
4	-14	0	-14	-35	-330	-285	106	-7	230	0	-14	5
5	-14	-3	-14	-5	-69	-260	8	9	0	0	0	5
6	151	-227	8	68	-87	-323	-118	156	495	0	46	0
7	-23	-3	-260	-1071	-30	-65	8	14	79	0	0	0
8	-33	-3	-225	-1006	115	-106	22	16	82	0	0	0
9	-248	-5	11	-17	-382	-234	148	-18	170	0	127	5

Table XIII-12

Total Delta Exports, 73-Year Period

Alternative 1 Average Monthly Exports (TAF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
534	578	624	611	544	526	527	358	323	526	592	514	6,256

Change in Exports from Alternative 1 (TAF)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2	8	-42	-34	-25	-72	-45	-150	15	152	44	-101	-26	-276
3	24	-40	-23	-11	-76	-46	-152	13	151	61	-74	-29	-202
4	23	-35	-3	23	-89	-75	-207	-32	159	79	-38	-14	-209
5	30	-36	-4	26	-104	-73	-152	13	151	70	-45	-30	-155
6	22	-32	3	32	-90	-75	-60	-101	158	57	-56	-45	-188
7	64	7	39	-19	-138	-83	-140	21	165	163	-79	-31	-30
8	53	-5	6	90	-132	-77	-144	23	166	167	-48	-41	59
9	25	-34	1	23	-104	-84	-205	-25	153	75	-47	-23	-246

Alternative 2 Average Monthly Exports (TAF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
542	536	590	586	472	482	377	373	474	570	491	487	5980

Change in Exports from Alternative 2 (TAF)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
3	16	2	12	14	-4	-1	-2	-2	-1	17	27	-3	74
4	15	6	32	48	-17	-31	-57	-47	7	35	63	13	66
5	21	5	30	51	-32	-28	-3	-2	-1	25	56	-4	120
6	14	9	37	57	-18	-31	90	-116	6	13	45	-19	88
7	56	49	73	6	-67	-38	10	6	13	119	23	-4	245
8	45	37	41	115	-60	-33	6	8	14	123	53	-15	334
9	17	8	35	48	-32	-40	-55	-40	2	31	54	4	31

Table XIII-13

Total Delta Exports, Critical Period

Alternative 1 Average Monthly Exports (TAF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
335	410	573	591	657	573	231	334	295	480	366	326	5171

Change in Exports from Alternative 1 (TAF)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2	22	-87	-32	81	-255	-237	4	-80	15	-102	-64	-11	-747
3	40	-92	-27	85	-252	-279	8	-86	10	-67	-54	-15	-728
4	42	-94	-33	78	-244	-274	-28	-112	40	-49	-45	-3	-720
5	44	-95	-29	82	-248	-277	8	-84	16	-57	-58	-11	-709
6	38	-85	-28	84	-233	-259	124	-191	15	-124	-110	-23	-792
7	38	-93	-14	150	-245	-284	8	-85	24	-26	-96	-23	-646
8	40	-92	-14	146	-256	-284	3	-85	30	-29	-93	-22	-654
9	42	-91	-30	79	-248	-268	-28	-108	32	-55	-79	-2	-757

Alternative 2 Average Monthly Exports (TAF)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
356	323	542	672	402	336	234	254	311	378	302	315	4424

Change in Exports from Alternative 2 (TAF)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
3	19	-5	5	3	4	-42	5	-6	-5	36	10	-4	19
4	21	-7	-1	-3	11	-36	-32	-32	25	54	19	9	28
5	22	-7	3	0	8	-40	5	-4	0	45	6	0	38
6	16	2	4	3	22	-21	121	-110	-1	-21	-47	-12	-45
7	16	-6	17	69	10	-47	5	-4	9	76	-32	-12	102
8	18	-5	18	65	0	-46	0	-5	15	73	-29	-11	94
9	21	-4	1	-2	7	-31	-31	-28	16	47	-15	9	-11

Table XIII-14
Delta Export/Inflow Ratio, 73-Year Period

Base Case Average Monthly E/I Ratio*

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0.48	0.55	0.45	0.33	0.28	0.27	0.36	0.28	0.28	0.43	0.55	0.58

1995 WQCP Monthly E/I Objective

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0.65	0.65	0.65	0.65	0.35**	0.35**	0.35**	0.35**	0.35**	0.65	0.65	0.65

Joint POD Alternatives Average Monthly E/I Ratio

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	0.52	0.50	0.44	0.35	0.21	0.22	0.22	0.24	0.32	0.43	0.48	0.55
3	0.53	0.50	0.45	0.35	0.21	0.22	0.22	0.24	0.32	0.44	0.50	0.55
4	0.53	0.51	0.46	0.37	0.21	0.21	0.19	0.21	0.32	0.45	0.51	0.56
5	0.53	0.51	0.46	0.38	0.20	0.21	0.22	0.24	0.32	0.44	0.51	0.55
6	0.52	0.52	0.46	0.38	0.21	0.21	0.28	0.16	0.32	0.43	0.50	0.54
7	0.56	0.54	0.48	0.36	0.19	0.21	0.23	0.25	0.32	0.47	0.50	0.56
8	0.55	0.53	0.47	0.41	0.19	0.21	0.23	0.25	0.32	0.47	0.51	0.55
9	0.53	0.51	0.46	0.37	0.20	0.20	0.19	0.22	0.32	0.44	0.51	0.55

*There is no E/I objective under D-1485

**Is increased to 0.45 if the Eight River Index for January is less than or equal to 1.0 MAF

Table XIII-15
Delta Export/Inflow Ratio, Critical Period

Base Case Average Monthly E/I Ratio*

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0.41	0.60	0.58	0.49	0.62	0.58	0.27	0.42	0.37	0.47	0.39	0.51

1995 WQCP Monthly E/I Objective

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0.65	0.65	0.65	0.65	0.35**	0.35**	0.35**	0.35**	0.35**	0.65	0.65	0.65

Joint POD Alternatives Average Monthly E/I Ratio

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	0.49	0.46	0.58	0.59	0.39	0.30	0.25	0.26	0.29	0.34	0.33	0.49
3	0.50	0.45	0.58	0.59	0.39	0.27	0.26	0.26	0.28	0.35	0.34	0.48
4	0.50	0.45	0.58	0.59	0.40	0.28	0.22	0.24	0.31	0.37	0.34	0.49
5	0.50	0.45	0.58	0.59	0.39	0.28	0.26	0.26	0.29	0.36	0.33	0.49
6	0.49	0.47	0.58	0.59	0.40	0.29	0.35	0.16	0.27	0.31	0.27	0.48
7	0.50	0.45	0.59	0.64	0.40	0.27	0.26	0.26	0.29	0.37	0.32	0.48
8	0.50	0.45	0.59	0.64	0.39	0.27	0.26	0.26	0.29	0.37	0.32	0.48
9	0.52	0.45	0.58	0.59	0.40	0.28	0.22	0.24	0.30	0.36	0.29	0.49

*There is no E/I objective under D-1485

**Is increased to 0.45 if the Eight River Index for January is less than or equal to 1.0 MAF

2. Salinity

This section analyzes salinity conditions under the eight Joint POD alternatives and the base case. Joint use of points of diversion are not authorized under Alternative 2, however for simplicity it will be referred to as a Joint POD alternative in this section. Two analyses are discussed below to illustrate the alternatives' effects on salinity in the Estuary. In the first analysis, the position of X2, the two parts per thousand (ppt) isohaline position, for each of the Joint POD alternatives is compared with the X2 position of the base case. In the second analysis, the electrical conductivity (EC) of the alternatives at six stations throughout the Delta is compared to that of the base case.

a. X2. X2 is defined as the distance from the Golden Gate bridge in kilometers (km) of the two ppt isohaline at a depth of one meter from the bottom of the channel. The 1995 Bay/Delta Plan provides that the Delta outflow objectives are met from February through June if the location of the X2 isohaline is downstream of specified locations for a certain number of days per month.

DWRSIM was used to determine the location of the X2 isohaline position for each of the eight Joint POD alternatives and the base case. The model predicts the location of X2 as a function of the current and previous months' flows (see section A of Chapter IV). Table XIII-16 shows the monthly average X2 positions for Alternative 1 for the 73-year flow record as predicted by the model. The table also compares the base case monthly average X2 positions to the X2 positions for each of the Joint POD alternatives. The significance of the changes in the X2 position are related to their effects on aquatic resources in the Delta. Positive changes indicate westward movement of the X2 line, which is generally desirable for aquatic species in the Estuary; negative changes indicate a shift toward the Delta.

There are only minor differences in the X2 position among Joint POD Alternatives 2 through 9. This result is expected because monthly average Delta outflow varies little among these alternatives. Compared to the base case, Alternatives 2 through 9 move in the upstream direction in January, October, and December, and move downstream approximately one to three kilometers from February through September. The greatest downstream movement occurs in April and June. Alternative 2 results in the most downstream X2 position of the eight alternatives for six consecutive months (September through February). This movement of the X2 location is due to implementation of the flow alternatives described in Chapter VI, not implementation of the Joint POD alternatives. No significant adverse effects to the environment are expected due to the change in the X2 position.

b. EC Within the Delta. DWRDSM was used to determine the effect of the Joint POD alternatives on EC in the Delta. DWRDSM uses the hydrology generated by DWRSIM studies as input. Thus, modeling assumptions for DWRSIM, discussed in Chapter IV, also apply to this salinity analysis. DWRDSM is not intended to provide absolute predictions of future Delta hydrodynamic and EC conditions; rather, the model is best used as a tool to compare Delta conditions under alternative actions.

Table XIII-16
Modeled Isohaline (X2) Position

73-Year Period Average Monthly X2 Position from the Golden Gate Bridge (km)

Alternative 1

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
83.0	82.4	77.2	70.4	66.4	66.1	70.8	73.3	76.6	80.9	85.7	88.1

Change in X2 Position (km)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2 vs 1	-0.8	1.1	0.2	-0.5	1.1	1.4	3.0	1.9	2.5	1.5	1.0	1.5
3 vs 1	-1.0	0.9	-0.1	-0.7	1.1	1.4	3.0	1.9	2.5	1.5	1.0	1.4
4 vs 1	-1.2	0.6	-0.4	-1.1	0.9	1.4	3.3	2.3	2.7	1.6	1.0	1.2
5 vs 1	-1.2	0.7	-0.4	-1.1	1.0	1.5	3.0	1.9	2.5	1.5	1.0	1.3
6 vs 1	-1.0	0.5	-0.4	-1.0	1.0	1.5	2.6	2.1	2.8	1.6	1.0	1.1
7 vs 1	-1.8	-0.1	-1.0	-1.1	1.1	1.4	3.0	1.8	2.4	1.4	1.0	0.8
8 vs 1	-1.7	0.0	-0.7	-1.6	0.9	1.3	3.0	1.9	2.4	1.4	1.0	0.7
9 vs 1	-1.2	0.8	-0.3	-1.0	1.0	1.5	3.4	2.3	2.6	1.5	1.0	1.3

Alternative 2

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
83.8	81.3	77.0	70.9	65.3	64.7	67.8	71.4	74.1	79.4	84.7	86.6

Change in Exports from Alternative 2 (TAF)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3 vs 2	-0.2	-0.2	-0.3	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
4 vs 2	-0.4	-0.5	-0.6	-0.6	-0.2	0.0	0.3	0.4	0.2	0.1	0.0	-0.3
5 vs 2	-0.4	-0.4	-0.6	-0.6	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.2
6 vs 2	-0.2	-0.6	-0.6	-0.5	-0.1	0.1	-0.4	0.2	0.3	0.1	0.0	-0.4
7 vs 2	-1.0	-1.2	-1.2	-0.6	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.7
8 vs 2	-0.9	-1.1	-0.9	-1.1	-0.2	-0.1	0.0	0.0	-0.1	-0.1	0.0	-0.8
9 vs 2	-0.4	-0.3	-0.5	-0.5	-0.1	0.1	0.4	0.4	0.2	0.0	0.0	-0.2

This analysis examines the results of the simulations at 13 locations in the Delta: three locations in the western Delta (Contra Costa Canal at Pumping Plant #1/Rock Slough, Sacramento River at Emmaton, and San Joaquin River at Jersey Point), three locations in the Central Delta (South Fork Mokelumne River at Terminous, San Joaquin River at San Andreas Landing and San Joaquin River at Prisoners Point) and seven locations in the southern Delta (Contra Costa Los Vaqueros intake, San Joaquin River at Vernalis, San Joaquin River at Tracy Road Bridge, San Joaquin River at Brandt Bridge, Old River at Middle River, Banks Pumping Plant and Tracy Pumping Plant). Figures XIII-12 through XIII-72 show expected EC conditions at these locations, except for Contra Costa Canal Pumping Plant # 1, Contra Costa Los Vaqueros intake, Banks Pumping Plant, and Tracy Pumping Plant where chloride concentrations are reported. The figures compare the eight alternatives and the base case for water years 1976 through 1991.

Where possible, objectives have been noted on the figures. EC objectives for stations in the southern Delta are the same for all year types, while EC objectives at the other stations change based on the year type. One figure is provided for each of the water-year types. The first figure for each station shows the average EC (or chloride concentration) for wet years during the sixteen-year period, the second figure shows the average for above normal years, and so on.

Year types are as defined in the 1995 Bay/Delta Plan. The 40-30-30 Sacramento Basin year type classification system is used for the western and central Delta stations, as well as the Contra Costa/Los Vaqueros intake and Banks and Tracy pumping plants, and the 60-20-20 San Joaquin Basin year type classification is used for the southern Delta stations (San Joaquin River at Vernalis, San Joaquin River at Brandt Bridge, Old River at Tracy Road Bridge, and Old River near Middle River). Since there are no below normal year types occuring during the 1976 - 1991 study period under the 60-20-20 San Joaquin Basin Index convention, below normal year graphs are omitted for the southern Delta stations.

Modeled chloride concentrations at Contra Costa Canal Pumping Plant #1 are shown in Figures XIII-12 through XIII-16. A feature of these plots is that the maximum mean daily chloride objective is exceeded in some periods by all of the alternatives. This result is due to differences between the methods used by DWRSIM and DWRDSM to calculate salinity or chloride concentrations. DWRSIM, the operations model, uses a relationship between outflow and chloride or EC to determine concentrations of these parameters at selected western Delta stations, including the Contra Costa Pumping Plant # 1. DWRSIM makes reservoir releases as necessary to meet objectives at these locations, and DWRSIM output indicates that these objectives are always met. The hydrologic output from DWRSIM is used as input to DWRDSM, which uses a more complicated method for calculating salinity and chloride concentrations. The method used by DWRDSM considers other factors such as exports, barrier operations and tide cycles. Thus, output from DWRDSM may show violations of the chloride objective even when DWRSIM output indicates objectives are met.

In summary, the DWRDSM output indicates a need for carriage water, but the DWRSIM model does not presently include a method for calculating carriage water. Although the DWRDSM output predicts that salinity objectives at certain locations would be violated, in actual operations, the projects would be operated to meet salinity and chloride objectives in the western Delta for all of the alternatives, and violations would not be expected to occur. Because of the conditions described above, salinity information depicted in Figures XIII-12 through XIII-72 is generally discussed relative to base case salinity, rather than to the objectives.

Contra Costa Canal at Pumping Plant No.1. Figure XIII-12 shows that, in wet years, chloride levels under each of the alternatives are well below the 250 mg/l maximum mean daily chloride objective. Alternatives 2 through 9 result in lower chloride levels in June through September, and higher chloride levels relative to the base case in October.

In above normal years, Figure XIII-13 shows that Alternatives 2 through 9 result in higher chloride levels in November and December relative to the base, and lower chloride levels in June, August and September. High chloride levels for Alternatives 7 and 8 are also evident in the fall months because of the higher authorized export rates.

Below normal years show the most dramatic differences between the base case and the alternatives. As shown in Figure XIII-14, average chloride levels in July, August and September for each of the alternatives are approximately 50, 100, and 150 mg/l, respectively, contrasted with the base case which has chloride levels of 227, 364, and 332 mg/l for the same months. Higher chloride levels in the fall months for Alternatives 7 and 8 are also evident.

A similar pattern emerges in dry years (Figure XIII-15), with Alternatives 2 through 9 having lower chloride levels than the base case in June through September. Base case chloride levels are dramatically lower in January. Chloride levels are higher for Alternatives 7 and 8 in July and October than for the other alternatives due to higher exports.

In critical years (Figure XIII-16), the eight alternatives show dramatic improvement over the base case from March through August. In July particularly, chloride levels for Alternatives 2 through 9 are approximately 100 mg/l while base case chloride levels are 330 mg/l. The base case results in lower chloride levels in all other months except November.

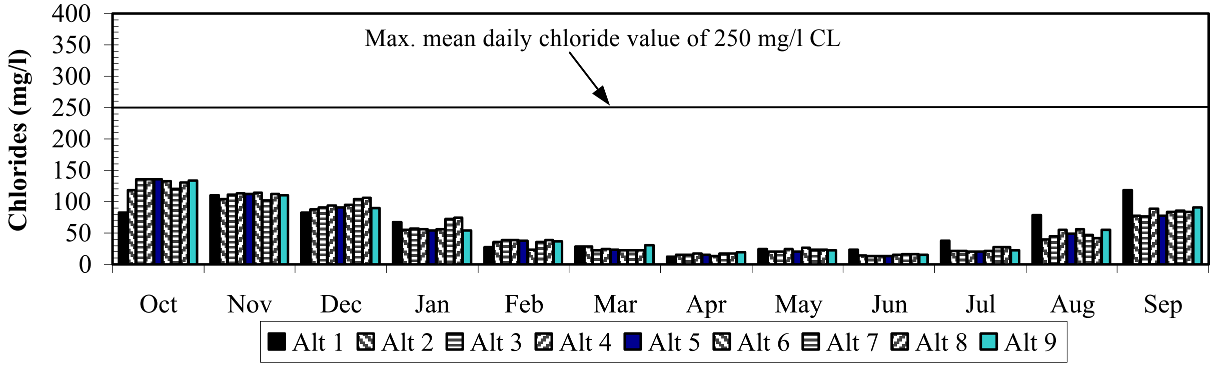
Los Vaqueros Intake on Old River. Figures XIII-17 through XIII-21 show modeled chlorides for Contra Costa Water District's Los Vaqueros Reservoir intake on Old River. In wet years there are no appreciable differences between the base case and the eight Joint POD alternatives. In above normal years, the base case is somewhat higher than the other alternatives in September, but lower in December. In below normal years (Figure XIII-19) chloride levels for the alternatives during July, August, and September are around 50, 75, and 100 mg/l, respectively, while the base case chlorides are 115, 210, and 185 for the same period. Alternatives 7 and 8 are highest during October, November, and December because of higher authorized export rates.

In dry years (Figure XIII-20), the base case salinity is considerably higher from June through September, and considerably lower in December, January and February. In critical years, the base case is higher in June, July and August, and lower in December, January and February.

The 1995 Bay/Delta Plan does not set water quality objectives for the Los Vaqueros intake. However, State Health and Safety regulations and USEPA regulations specify a drinking water standard of 250 mg/l chlorides. The SWRCB may, in a future triennial review of the Basin Plan for the Bay/Delta, set a chloride objective for the Los Vaqueros intake. None of the modeled Joint POD alternatives appear to exceed the chloride standard at this location.

Banks Pumping Plant and Tracy Pumping Plant. Figures XIII-22 through XIII-26 show modeled chlorides for the SWP Banks pumping plant. Figures XIII-27 through XIII-31 show modeled chlorides for the CVP Tracy pumping plant. Because of the close proximity of their respective intakes, the results are similar.

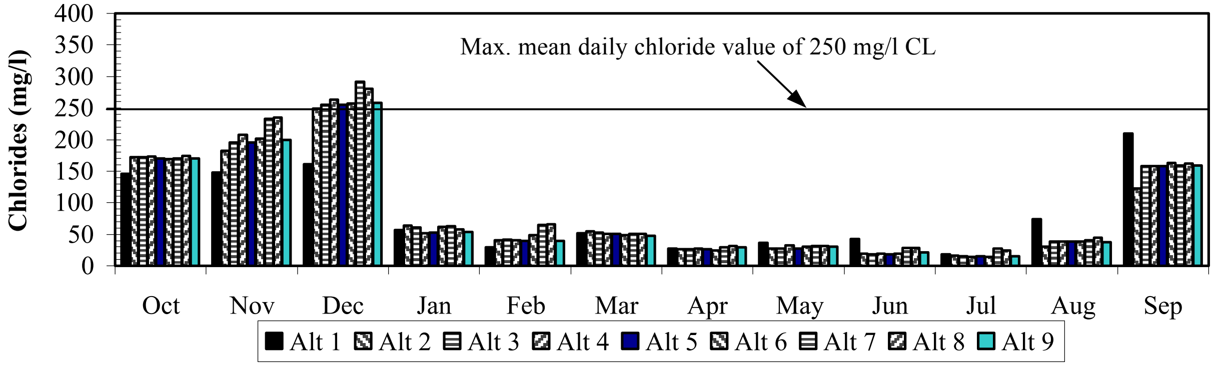
Figure XIII-12
Salinity for Contra Costa Canal at Pumping Plant #1
End-of-Month Simulated Values for Wet Years



For a Wet water year; 240 (66%) days <= 150 mg/l CL
Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

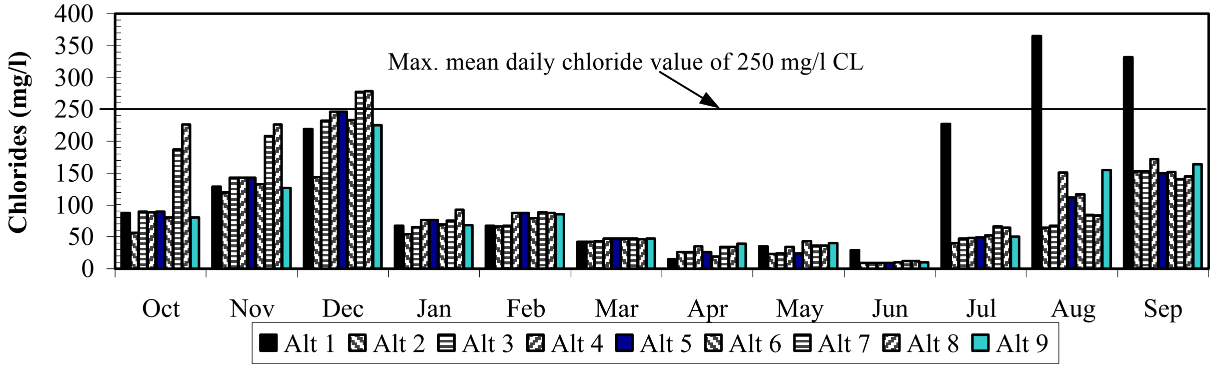
Figure XIII-13
Salinity for Contra Costa Canal at Pumping Plant #1
End-of-Month Simulated Values for Above Normal Years



For a Above Normal water year; 190 (52%) days <= 150 mg/l CL
Salinity objectives are the same for D-1485 & Bay/Delta

Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

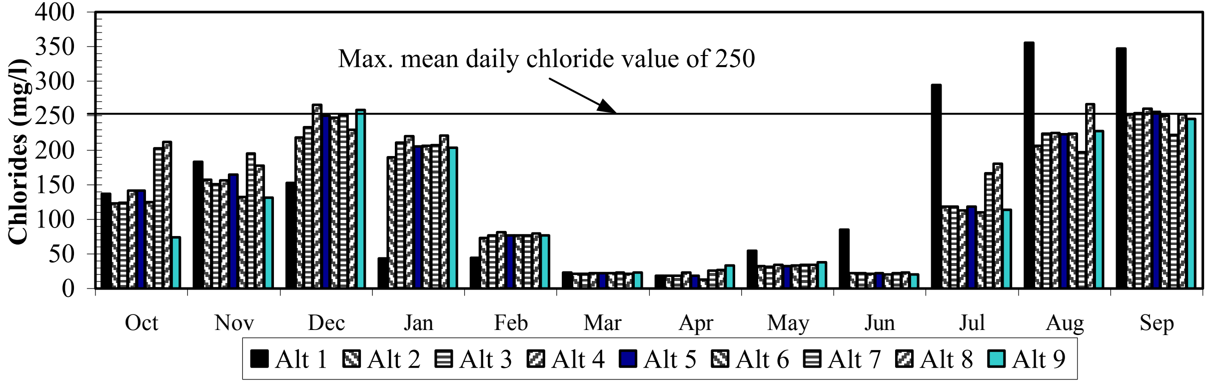
Figure XIII-14
Salinity for Contra Costa Canal at Pumping Plant #1
End-of-Month Simulated Values for Below Normal Years



For a Below Normal water year; 175 (48%) days <= 150 mg/l
Salinity objectives are the same for D-1485 & Bay/Delta

Sacramento "40-30-30" **below normal** year (1979)

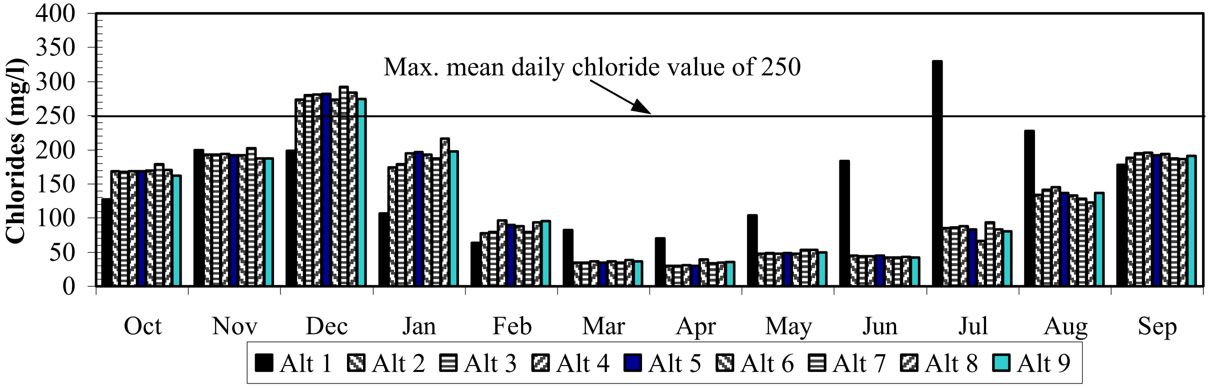
Figure XIII-15
Salinity for Contra Costa Canal at Pumping Plant #1
End-of-Month Simulated Values for Dry Years



For a Dry water year; 165 (45%) days <= 150 mg/l CL
Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **dry** years
averaged (1981, 85, 87 & 89)

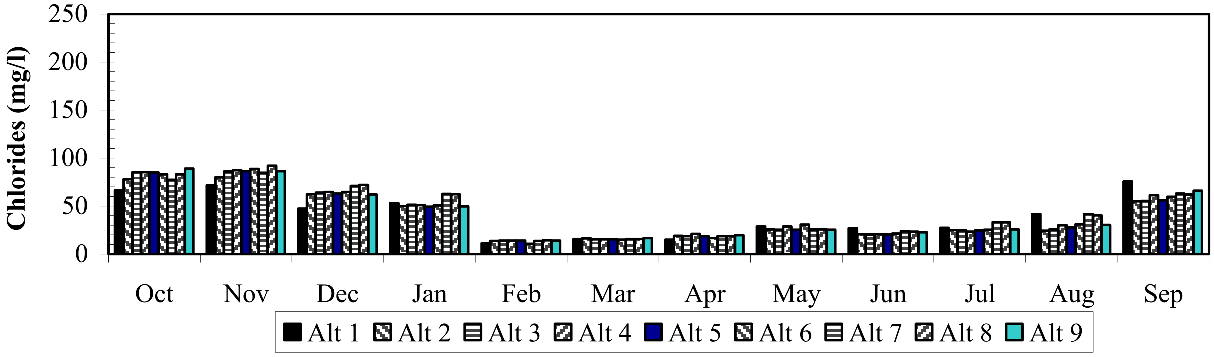
Figure XIII-16
Salinity for Contra Costa Canal at Pumping Plant #1
End-of-Month Simulated Values for Critical Years



For a Critical water year; 155 (42%) days <= 150 mg/l
Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **critical** years
averaged (1976, 77, 88, 90 & 91)

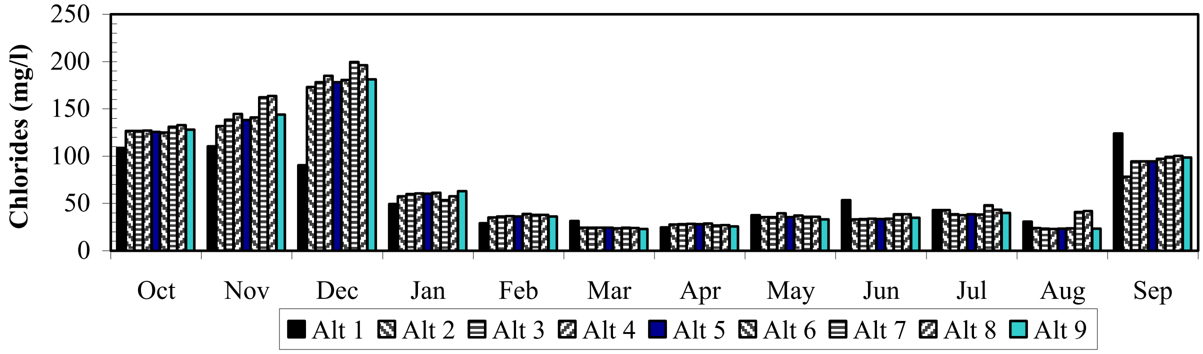
Figure XIII-17
Chloride Levels for Los Vaqueros Intake on Old River
End-of-Month Simulated Values for Wet Years



Water quality objectives have not been established at the location.

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

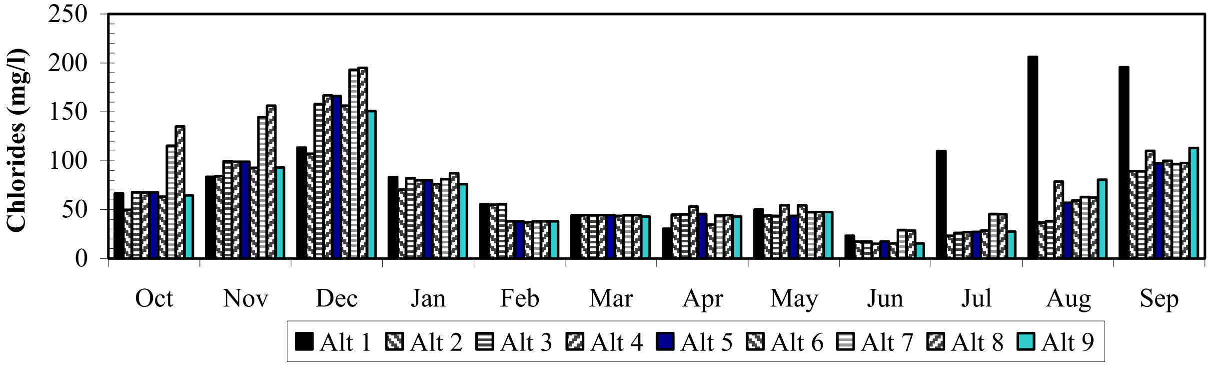
Figure XIII-18
Chloride Levels Los Vaqueros Intake on Old River
End-of-Month Simulated Values for Above Normal Years



Water quality objectives have not been established at the location.

Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

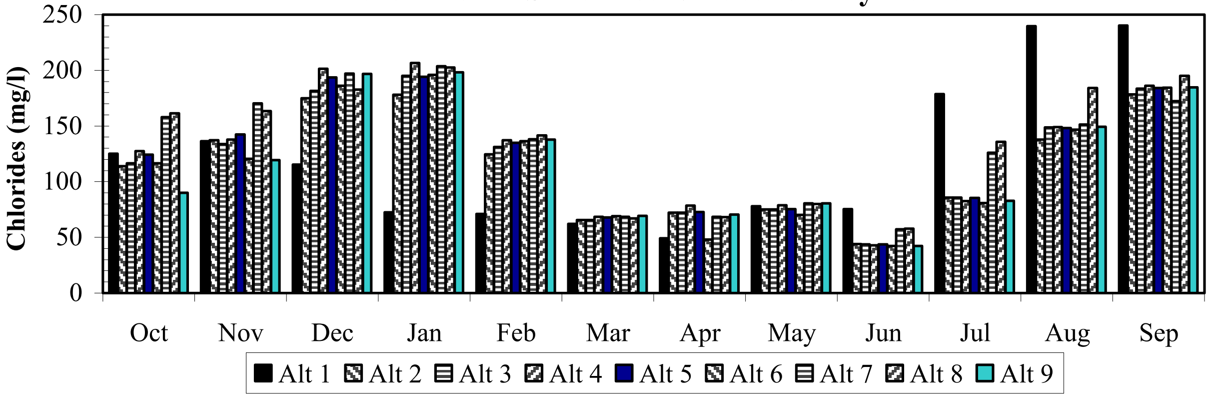
Figure XIII-19
Chloride Levels for Los Vaqueros Intake on Old River
End-of-Month Simulated Values for Below Normal Years



Water quality objectives have not been established at the location.

Sacramento "40-30-30" **below normal** year (1979)

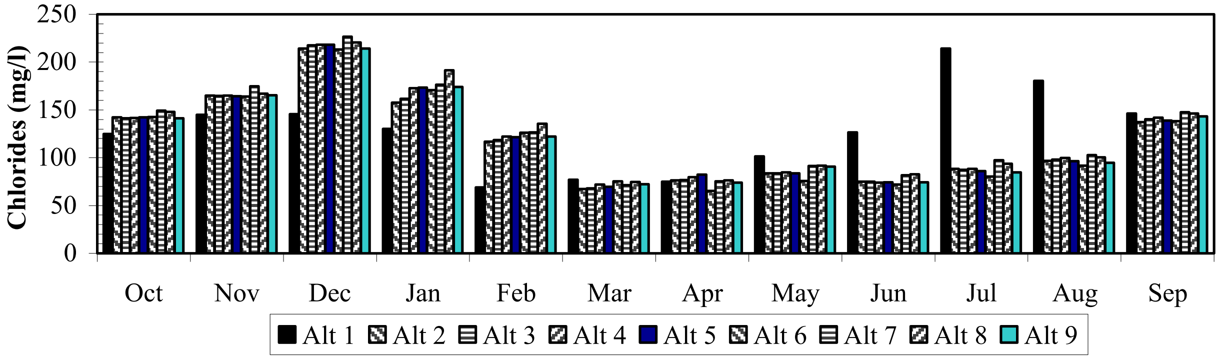
Figure XIII-20
Chloride Levels for Los Vaqueros Intake on Old River
End-of-Month Simulated Values for Dry Years



Water quality objectives have not been established at the location.

Sacramento "40-30-30" **dry** years averaged (1981, 85, 87 & 89)

Figure XIII-21
Chloride Levels for Los Vaqueros Intake on Old River
End-of-Month Simulated Values for Critical Years



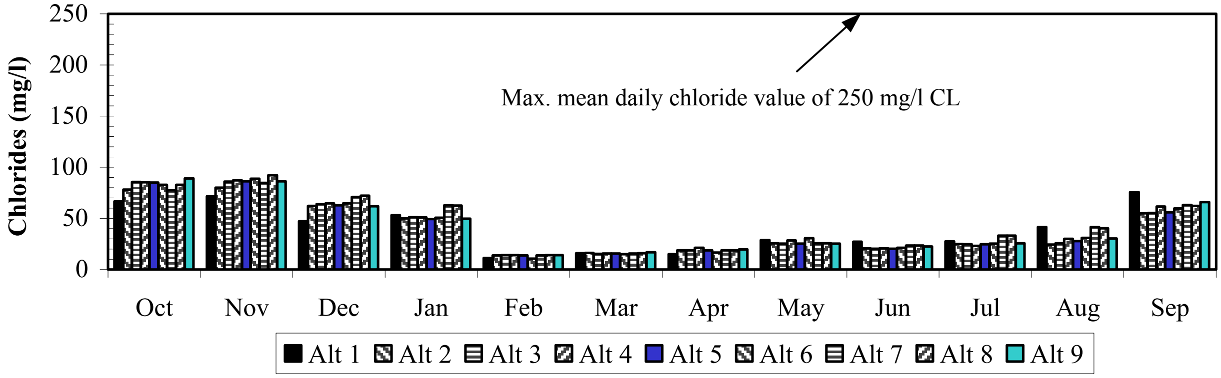
Water quality objectives have not been established at the location.

Sacramento "40-30-30" **critical** years averaged (1976, 77, 88, 90 & 91)

Figure XIII-22

Salinity for Banks Pumping Plant

End-of-Month Simulated Values for Wet Years



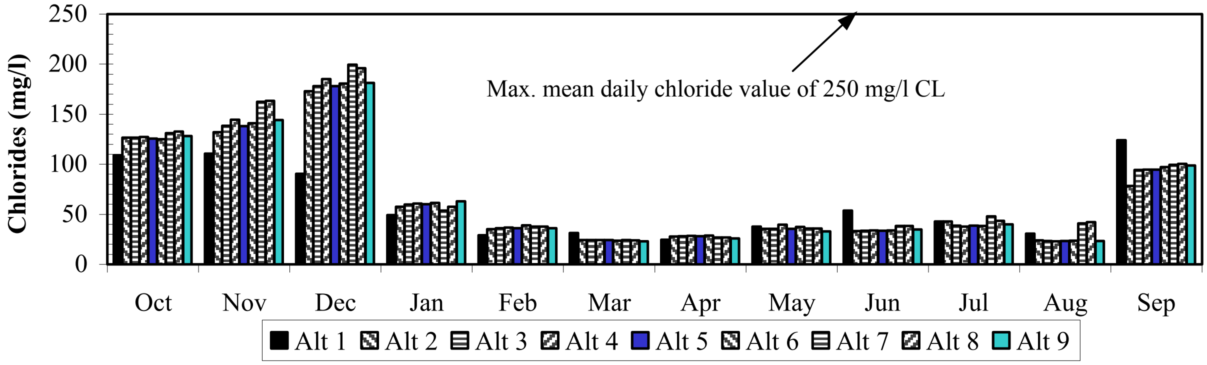
Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

Figure XIII-23

Salinity for Banks Pumping Plant

End-of-Month Simulated Values for Above Normal Years



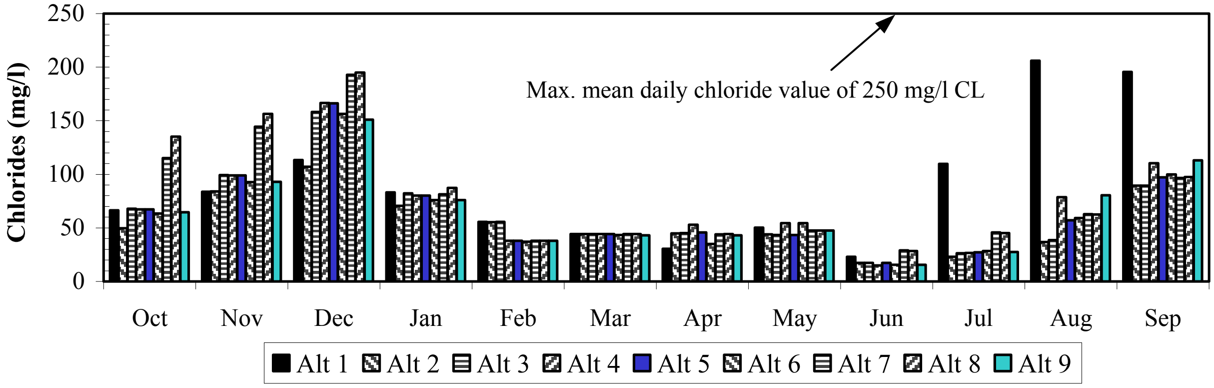
Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

Figure XIII-24

Salinity for Banks Pumping Plant

End-of-Month Simulated Values for Below Normal Years

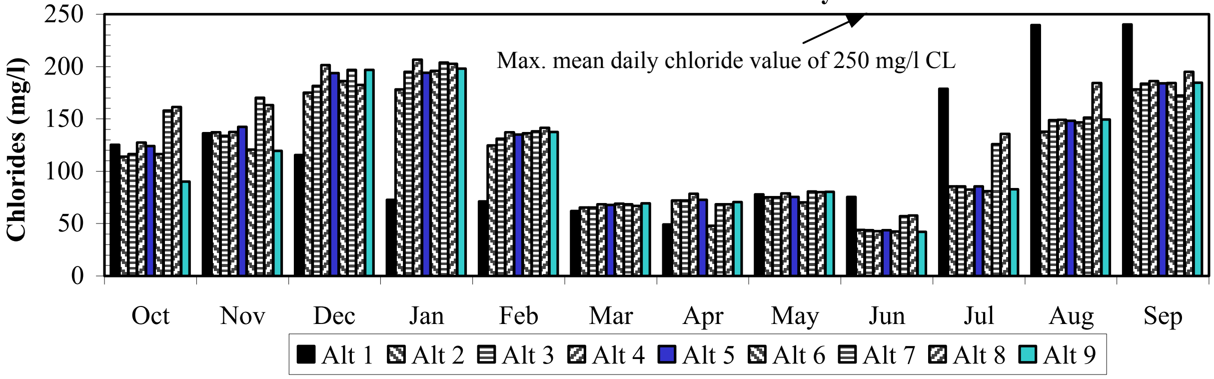


Sacramento "40-30-30" **below normal** year (1979)

Salinity objectives are the same for D-1485 & Bay/Delta Plan

Figure XIII-25

Salinity for Banks Pumping Plant
End-of-Month Simulated Values for Dry Years

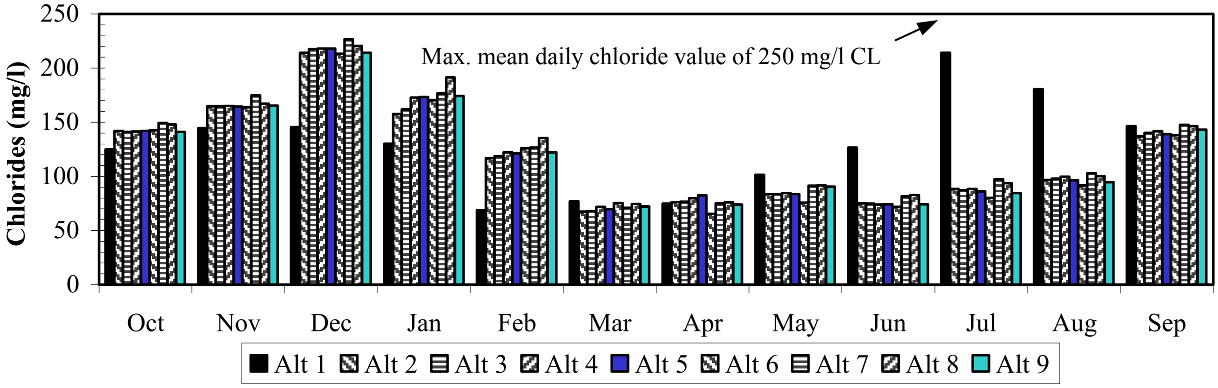


Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **dry** years averaged (1981, 85, 87 & 89)

Figure XIII-26

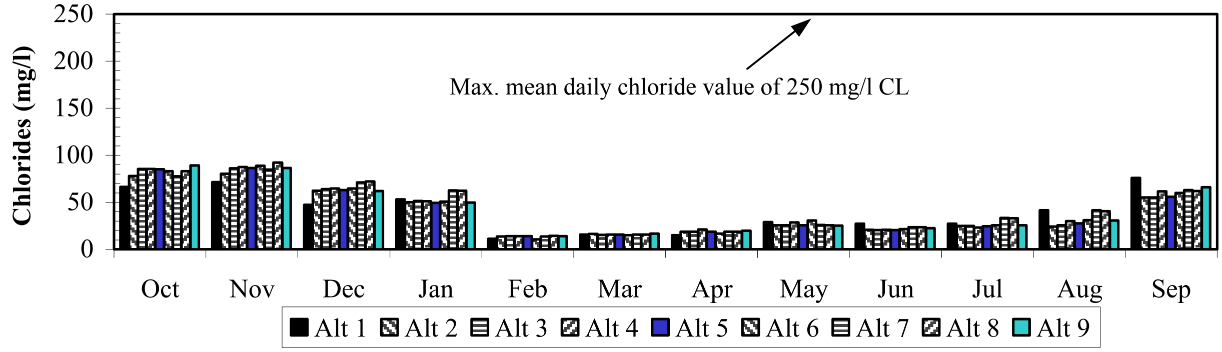
Salinity for Banks Pumping Plant
End-of-Month Simulated Values for Critical Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **critical** years averaged (1976, 77, 88, 90 & 91)

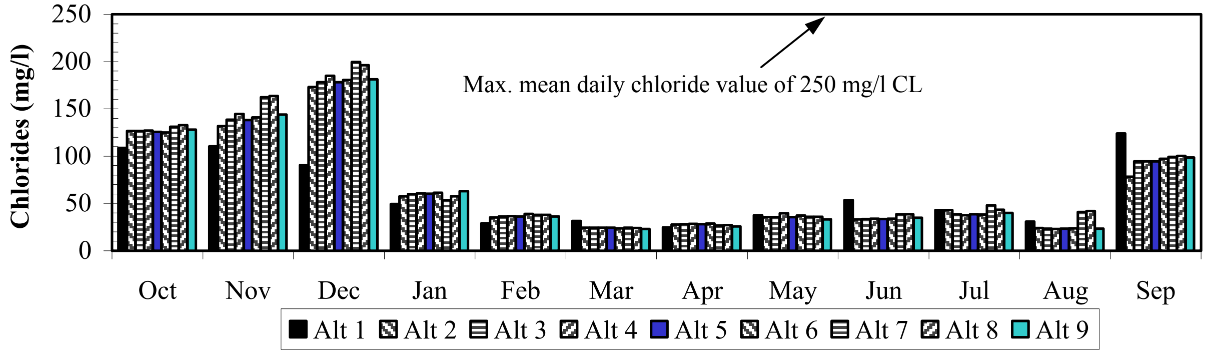
Figure XIII-27
Salinity for Tracy Pumping Plant
End-of-Month Simulated Values for Wet Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

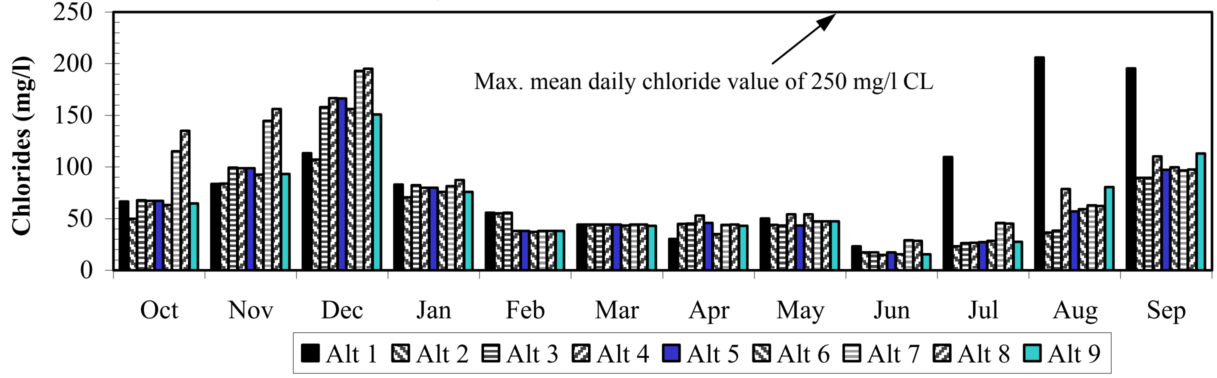
Figure XIII-28
Salinity for Tracy Pumping Plant
End-of-Month Simulated Values for Above Normal Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

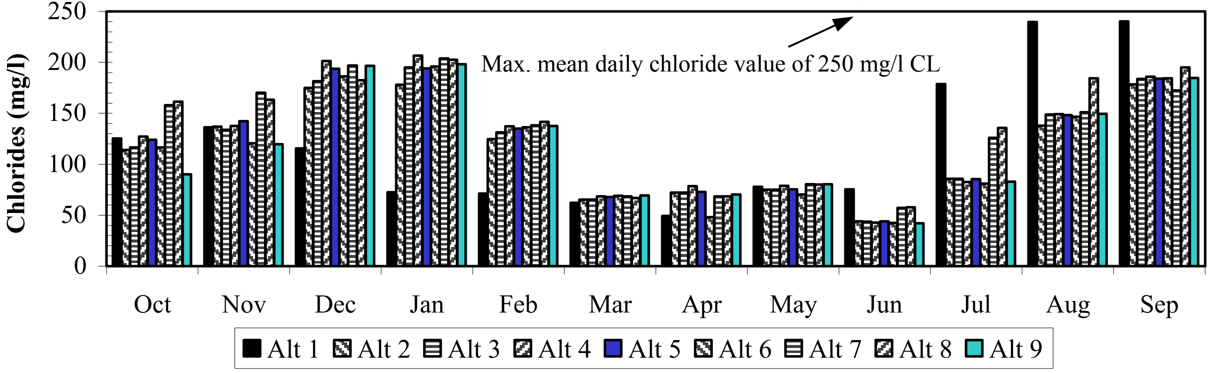
Figure XIII-29
Salinity for Tracy Pumping Plant
End-of-Month Simulated Values for Below Normal Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **below normal** year (1979)

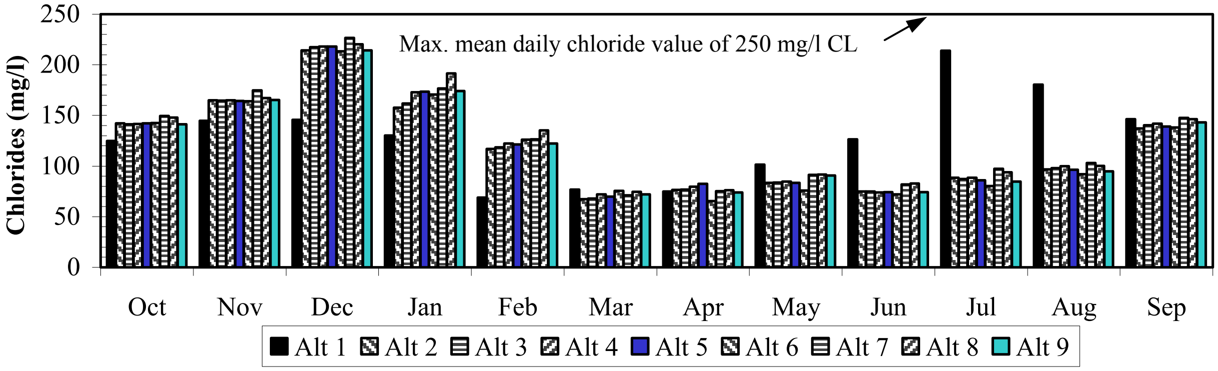
Figure XIII-30
Salinity for Tracy Pumping Plant
End-of-Month Simulated Values for Dry Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **dry** years averaged (1981, 85, 87 & 89)

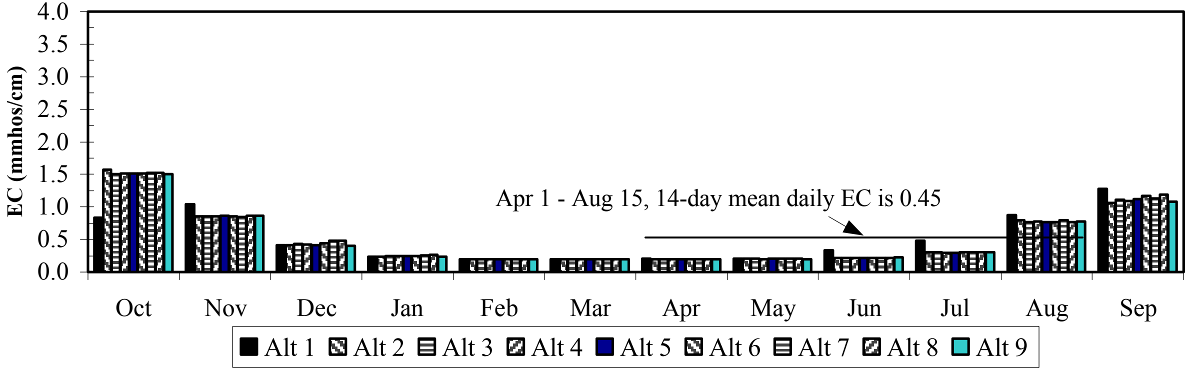
Figure XIII-31
Salinity for Tracy Pumping Plant
End-of-Month Simulated Values for Critical Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **critical** years averaged (1976, 77, 88, 90 & 91)

Figure XIII-32
Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Wet Years

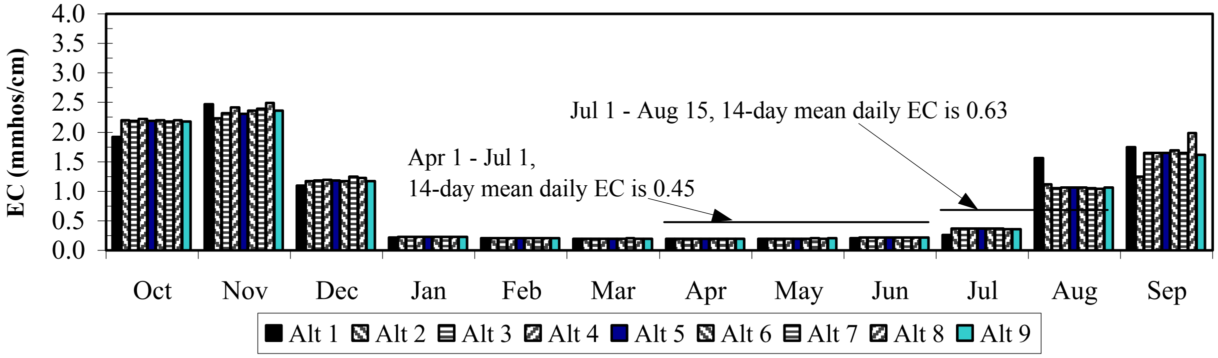


Apr 1 - Aug 15, 14-day mean daily EC is 0.45

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

Salinity objectives are the same for D-1485 & Bay/Delta Plan

Figure XIII-33
Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Above Normal Years



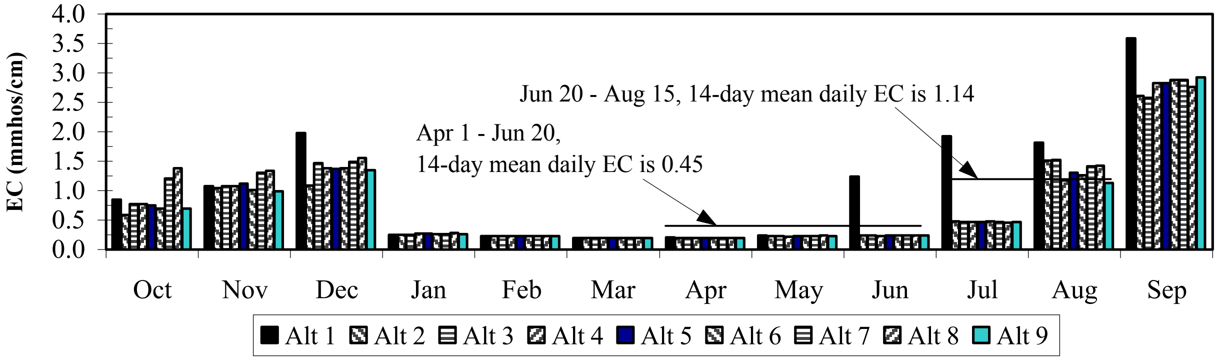
Jul 1 - Aug 15, 14-day mean daily EC is 0.63

Apr 1 - Jul 1,
14-day mean daily EC is 0.45

Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

Figure XIII-34
Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Below Normal Years



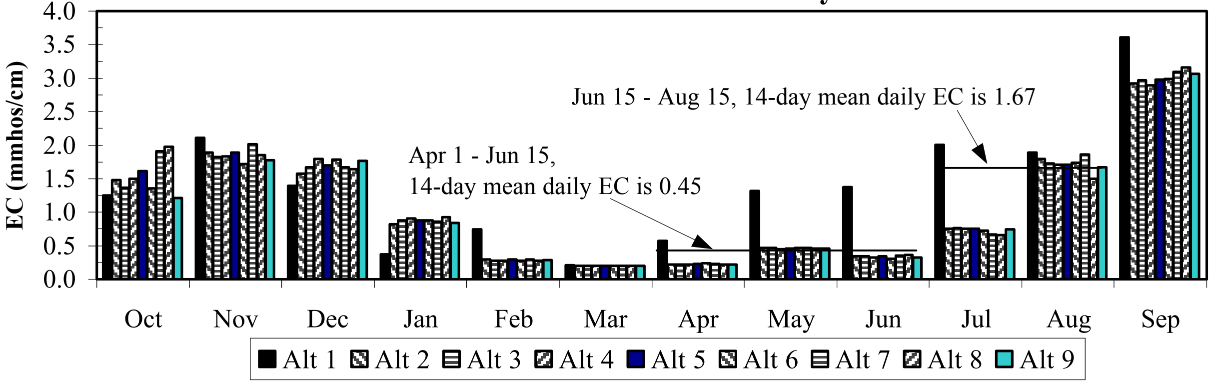
Jun 20 - Aug 15, 14-day mean daily EC is 1.14

Apr 1 - Jun 20,
14-day mean daily EC is 0.45

Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30"
below normal year (1979)

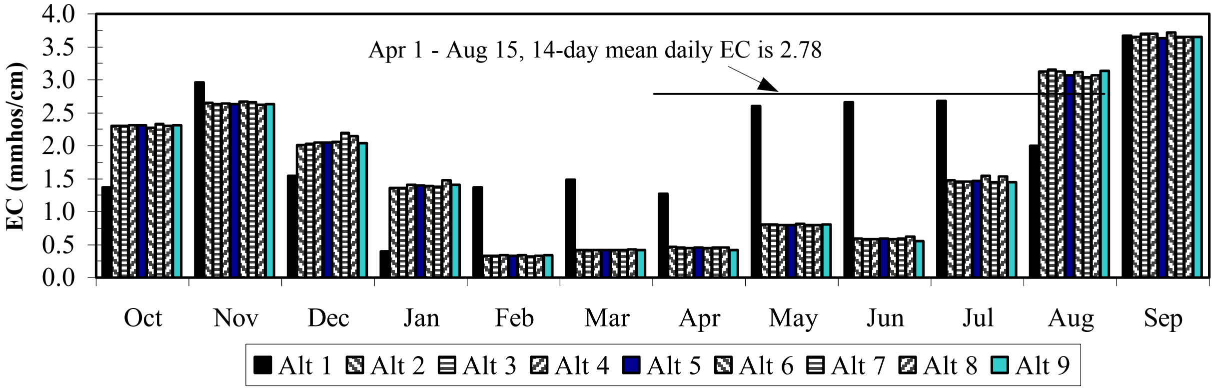
Figure XIII-35
Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Dry Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **dry** years averaged (1981, 85, 87 & 89)

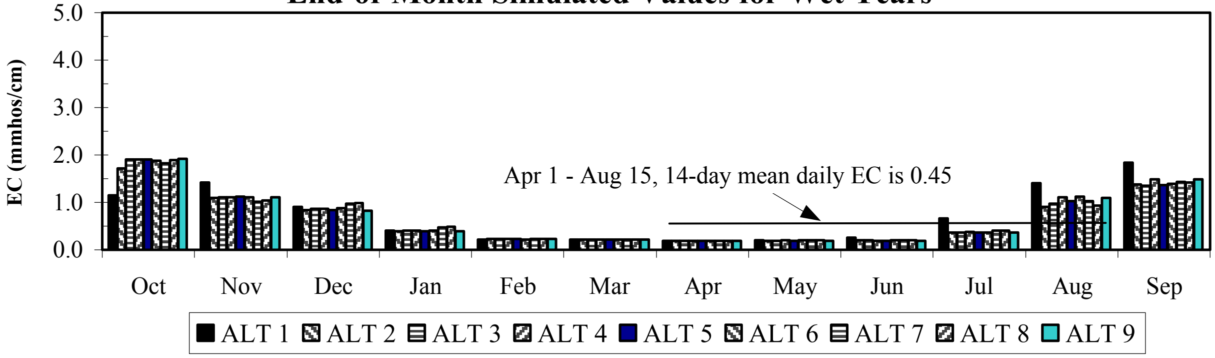
Figure XIII-36
Salinity for Sacramento River at Emmaton
End-of-Month Simulated Values for Critical Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **critical** years averaged (1976, 77, 88, 90 & 91)

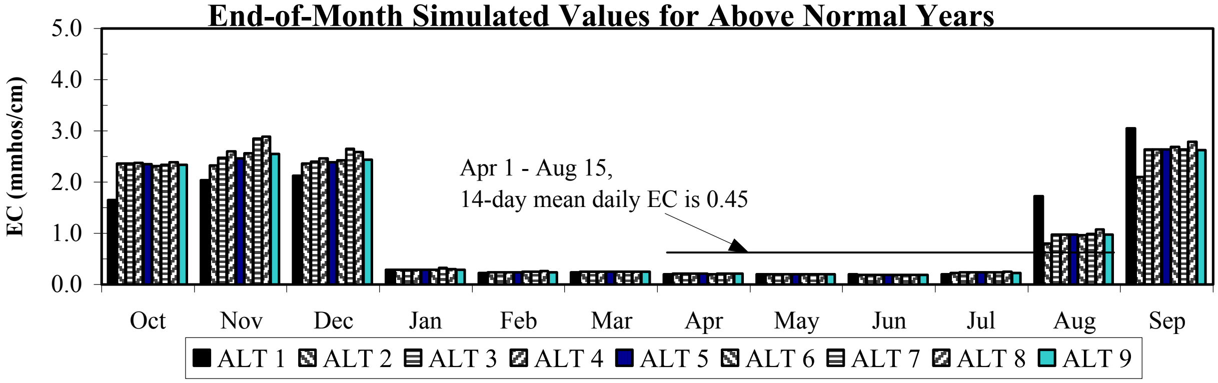
Figure XIII-37
Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Wet Years



The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

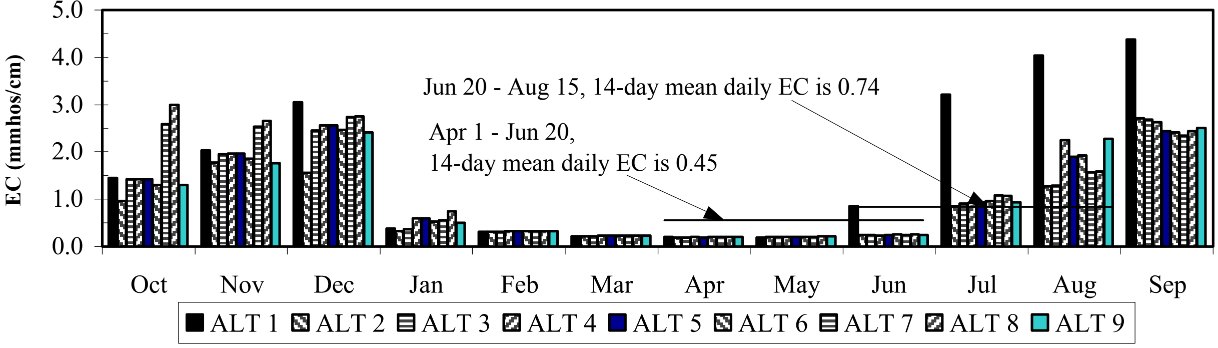
Figure XIII-38
Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Above Normal Years



The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

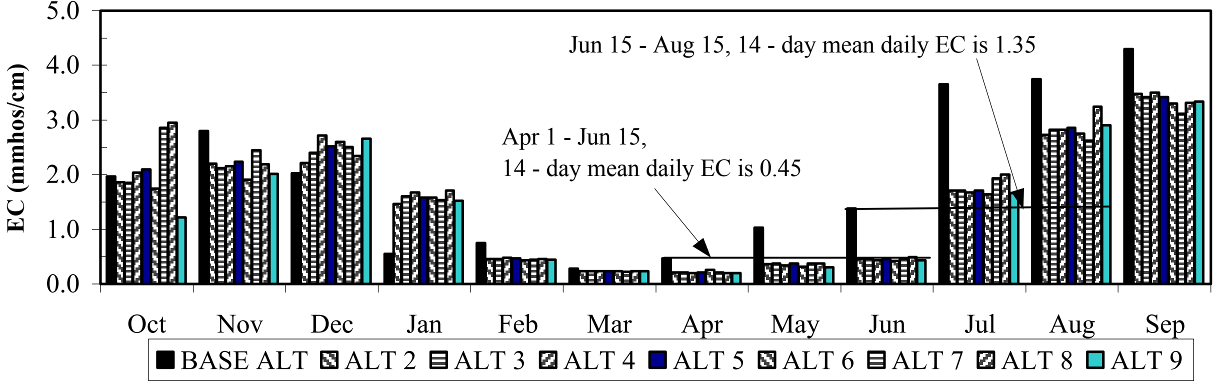
Figure XIII-39
Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Below Normal Years



The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" **below normal** year (1979)

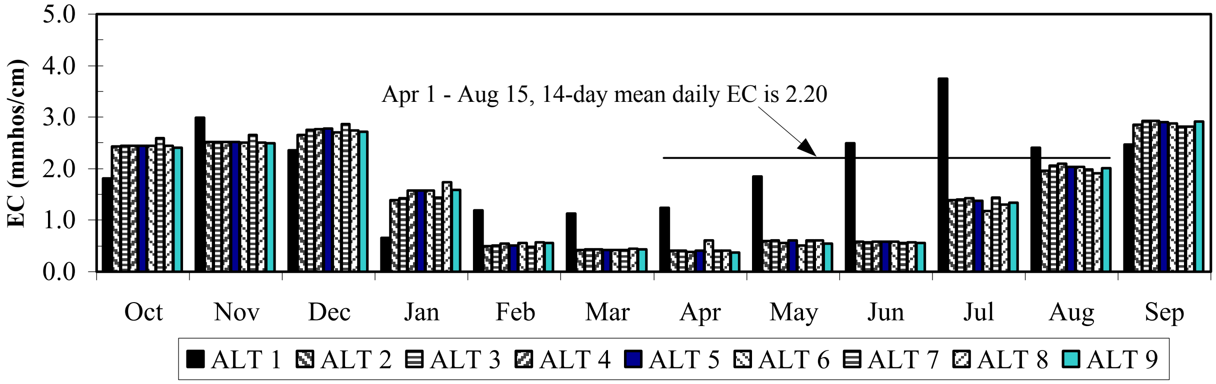
Figure XIII-40
Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Dry Years



The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" **dry** years averaged (1981, 85, 87 & 89)

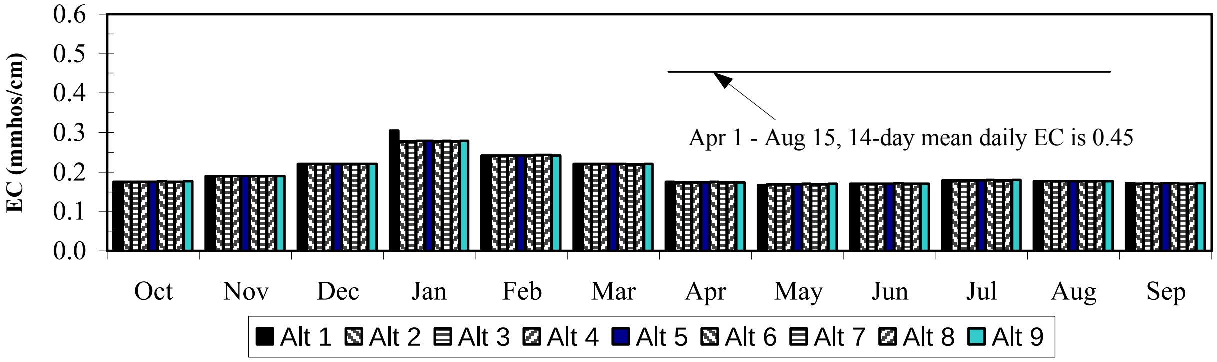
Figure XIII-41
Salinity for San Joaquin River at Jersey Point
End-of-Month Simulated Values for Critical Years



The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" critical years averaged (1976, 77, 88, 90 & 91)

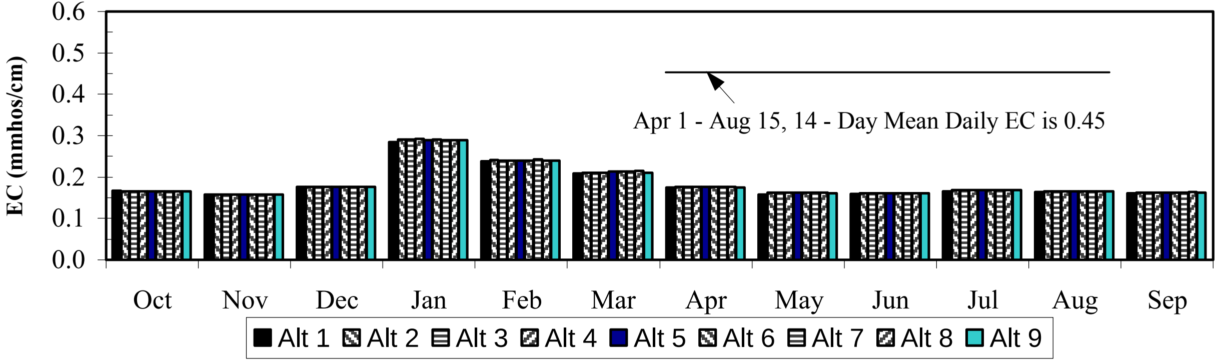
Figure XIII-42
Salinity for South Fork Mokelumne River at Terminous
End-of-Month Simulated Values for Wet Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

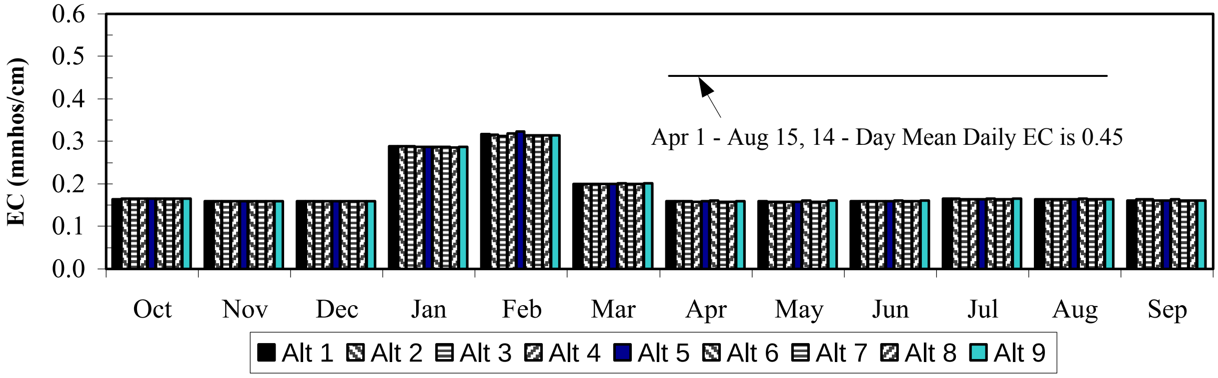
Figure XIII-43
Salinity for South Fork Mokelumne River at Terminous
End-of-Month Simulated Values for Above Normal Years



Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

Salinity objectives are the same for D-1485 & Bay/Delta Plan

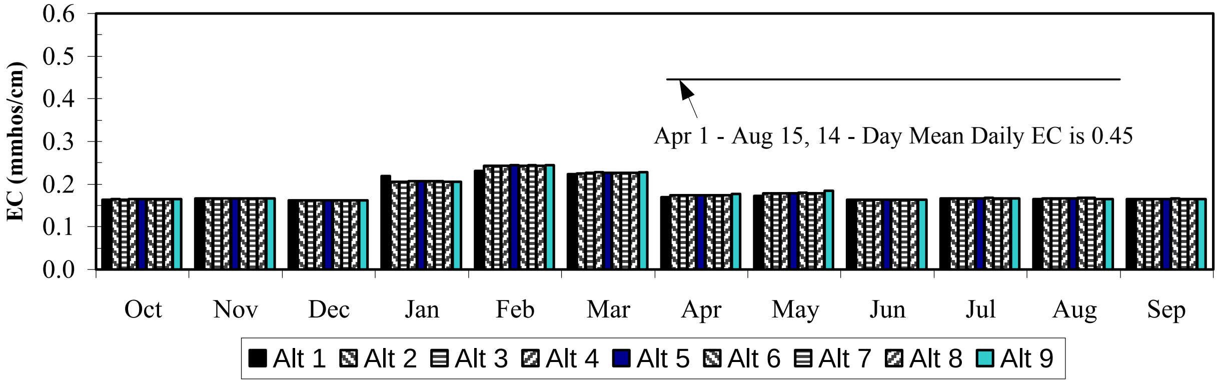
Figure XIII-44
Salinity for South Fork Mokelumne River at Terminous
End-of-Month Simulated Values for Below Normal Years



Sacramento "40-30-30" **below normal** year (1979)

Salinity objectives are the same for D-1485 & Bay/Delta Plan

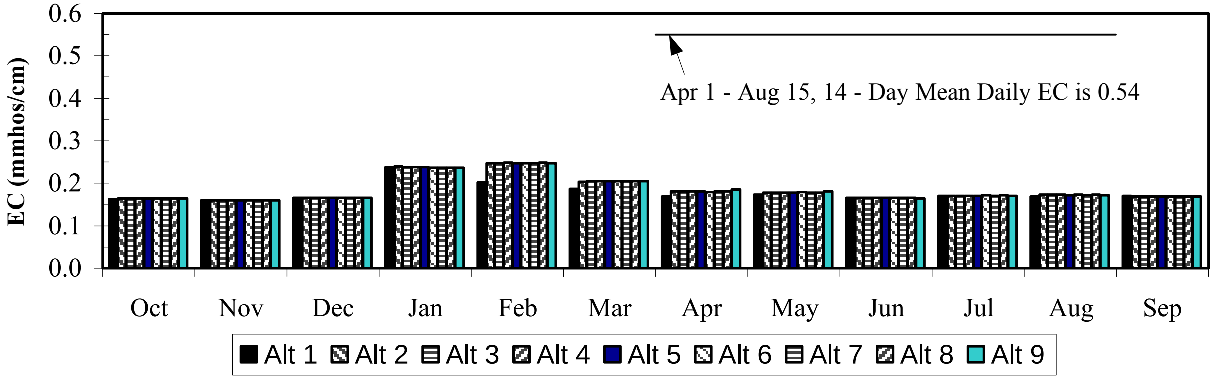
Figure XIII-45
Salinity for South Fork Mokelumne River at Terminous
End-of-Month Simulated Values for Dry Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **dry** years averaged (1981, 85, 87 & 89)

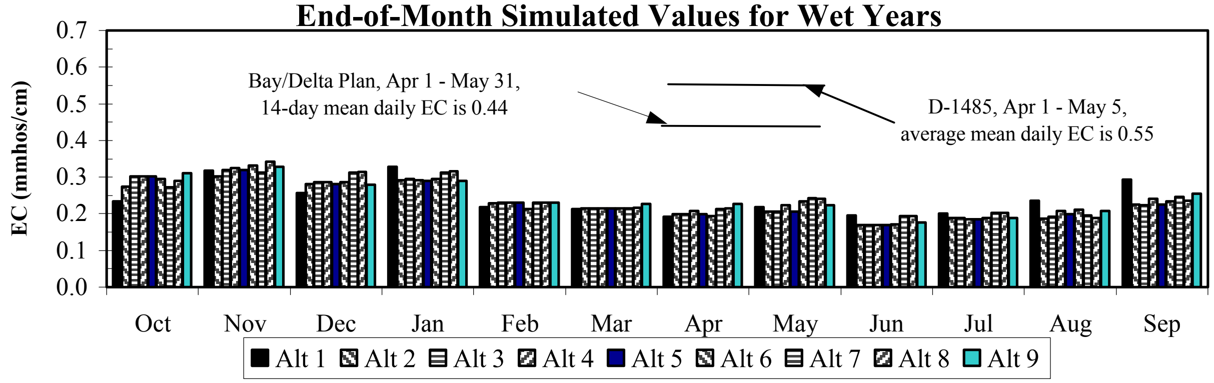
Figure XIII-46
Salinity for South Fork Mokelumne River at Terminous
End-of-Month Simulated Values for Critical Years



Salinity objectives are the same for D-1485 & Bay/Delta Plan

Sacramento "40-30-30" **critical** years averaged (1976, 77, 88, 90 & 91)

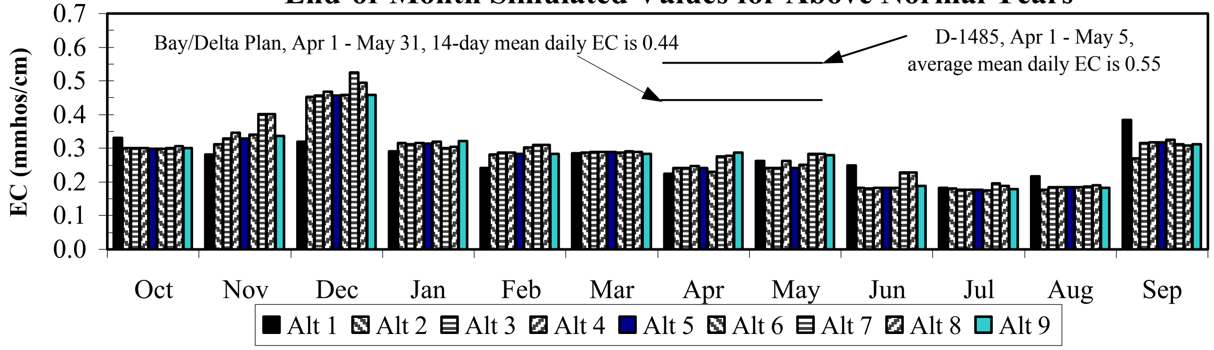
Figure XIII-47
Salinity for San Joaquin River at Prisoners Point
End-of-Month Simulated Values for Wet Years



The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

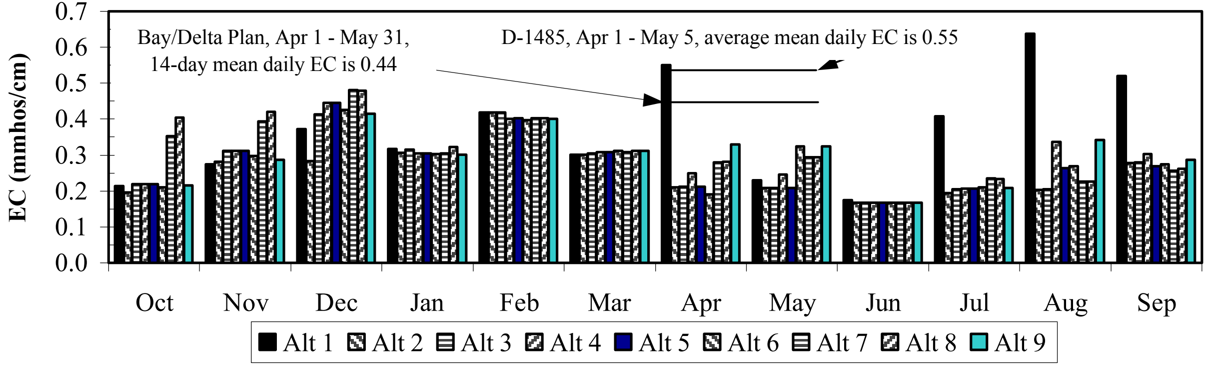
Figure XIII-48
Salinity for San Joaquin River at Prisoners Point
End-of-Month Simulated Values for Above Normal Years



The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

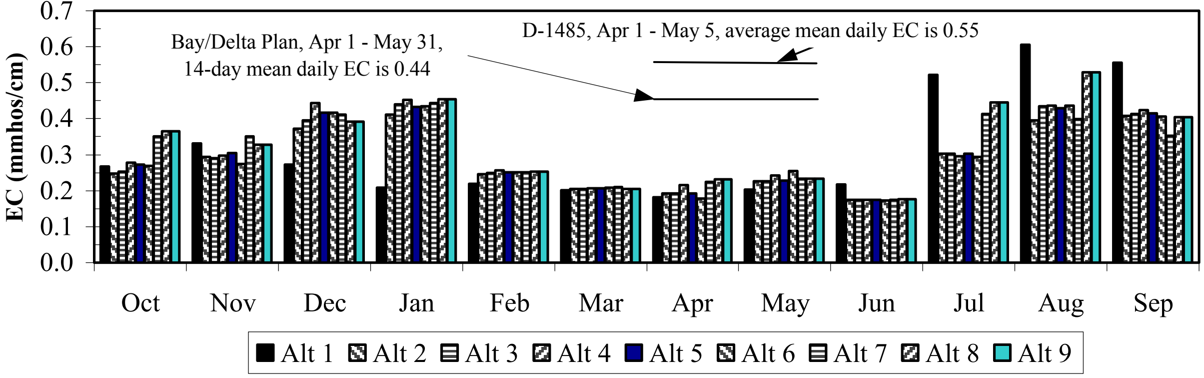
Figure XIII-49
Salinity for San Joaquin River at Prisoners Point
End-of-Month Simulated Values for Below Normal Years



The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" **below normal** year (1979)

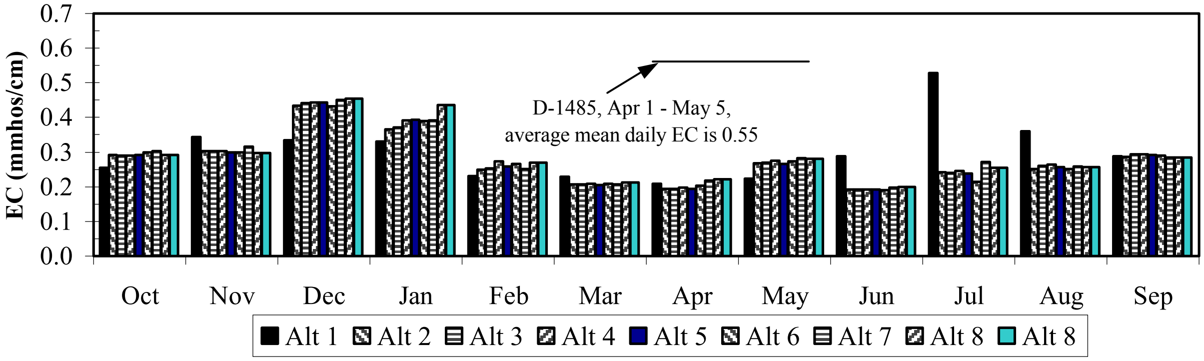
Figure XIII-50
Salinity for San Joaquin River at Prisoners Point
End-of-Month Simulated Values for Dry Years



The 14 - day mean daily salinity objectives for Bay/Delta Plan are 0.44 EC from Apr 1 - May 31, and for D-1485 is 0.55 EC from Apr 1 - May 5

Sacramento "40-30-30" **dry** years averaged (1981, 85, 87 & 89)

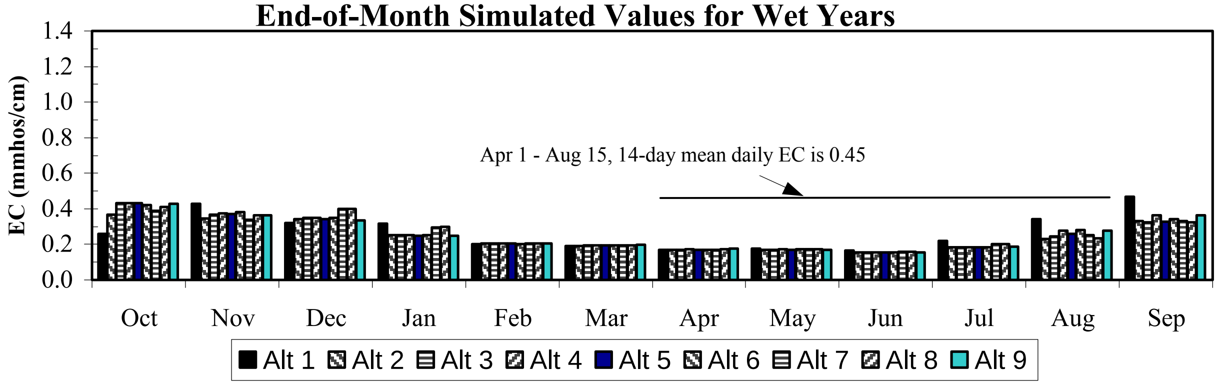
Figure XIII-51
Salinity for San Joaquin River at Prisoners Point
End-of-Month Simulated Values for Critical Years



The Bay/Delta Plan has no salinity objectives for critical years

Sacramento "40-30-30" **critical** years averaged (1976, 77, 88, 90 & 91)

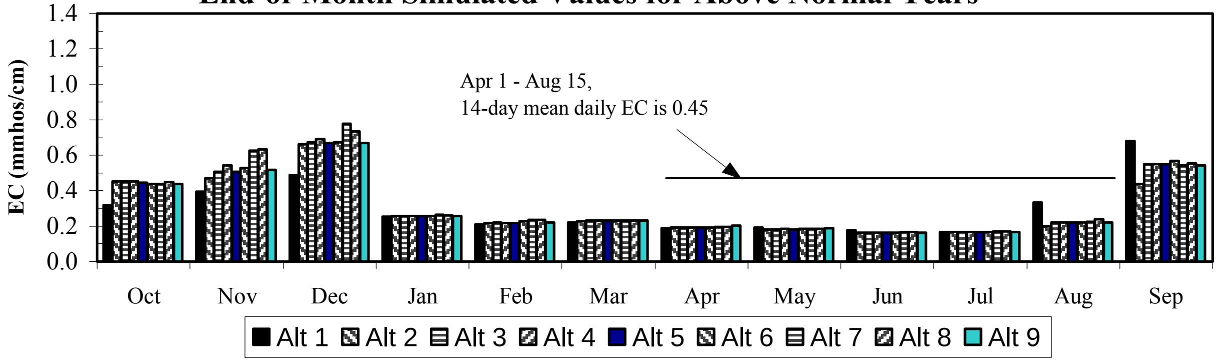
Figure XIII-52
Salinity for San Joaquin River at San Andreas Landing
End-of-Month Simulated Values for Wet Years



The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" **wet** years averaged (1982, 83, 84 & 86)

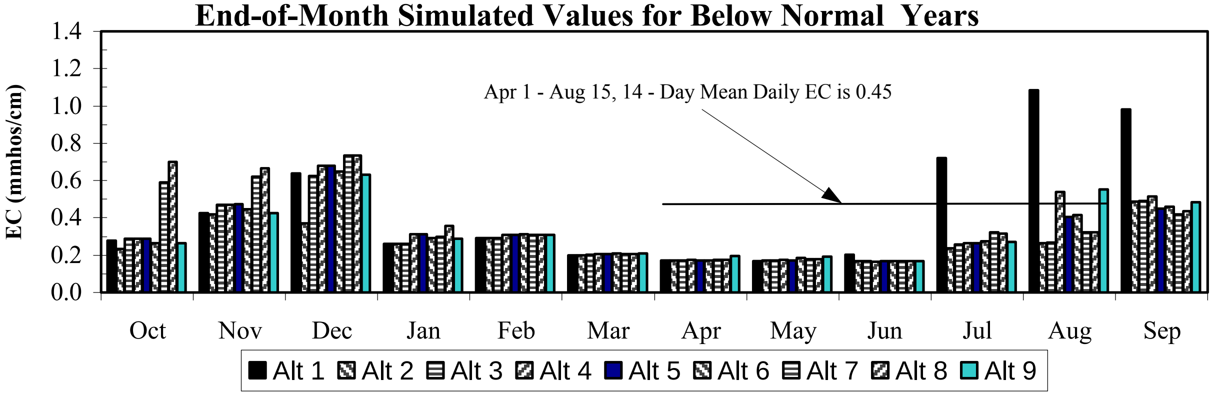
Figure XIII-53
Salinity for San Joaquin River at San Andreas Landing
End-of-Month Simulated Values for Above Normal Years



The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" **above normal** years averaged (1978 & 80)

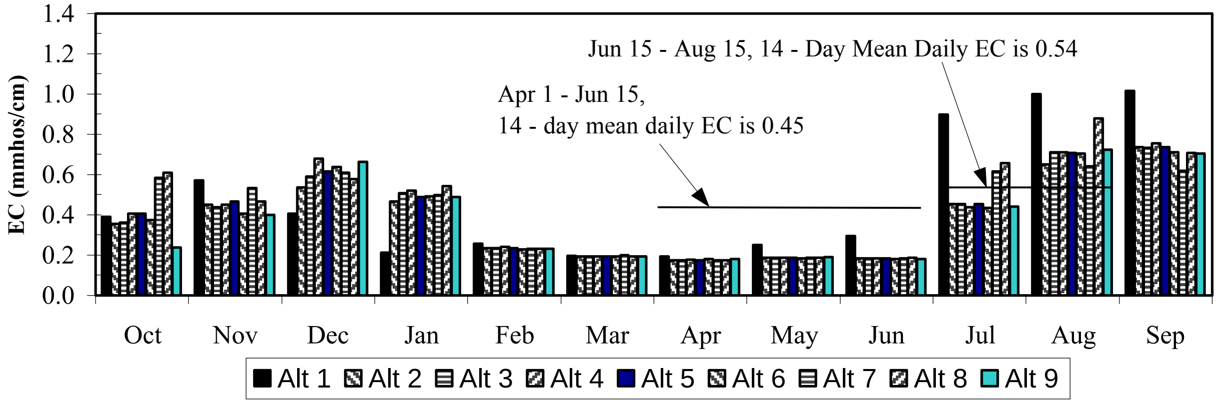
Figure XIII-54
Salinity for San Joaquin River at San Andreas Landing
End-of-Month Simulated Values for Below Normal Years



The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan. The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" **below normal** year (1979)

Figure XIII-55
Salinity for San Joaquin River at San Andreas Landing
End-of-Month Simulated Values for Dry Years



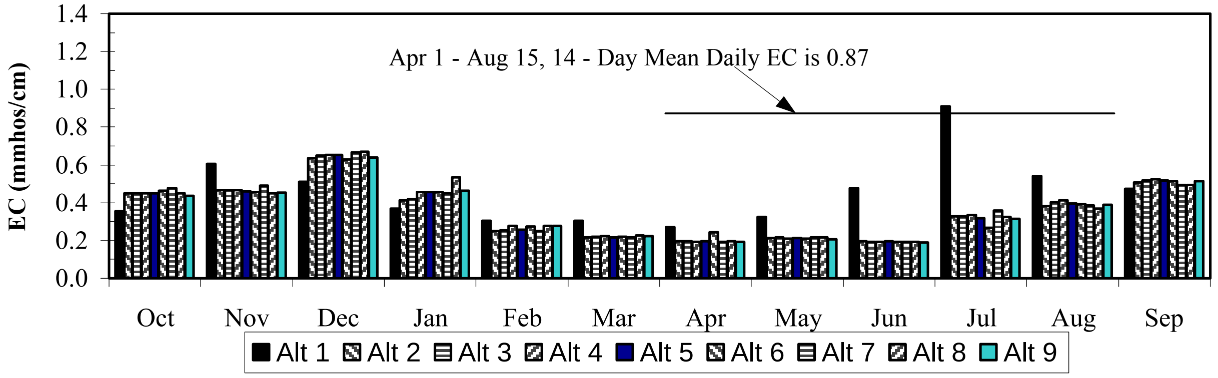
Jun 15 - Aug 15, 14 - Day Mean Daily EC is 0.54

Apr 1 - Jun 15,
14 - day mean daily EC is 0.45

The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan.
The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

Sacramento "40-30-30" **dry** years
averaged (1981, 85, 87 & 89)

Figure XIII-56
Salinity for San Joaquin River at San Andreas Landing
End-of-Month Simulated Values for Critical Years

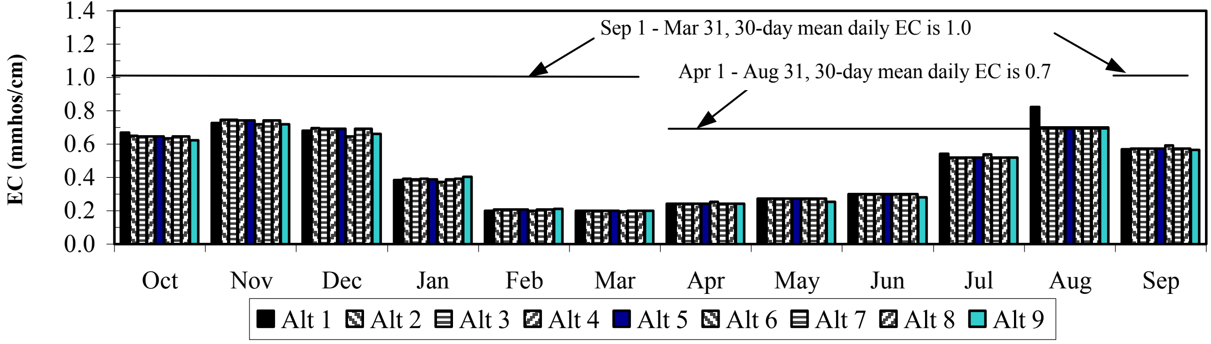


Apr 1 - Aug 15, 14 - Day Mean Daily EC is 0.87

The agricultural salinity objectives are the same for D-1485 & Bay/Delta Plan.
The fish and wildlife Bay/Delta Plan salinity objective for Apr-May is 0.44 mmhos/cm

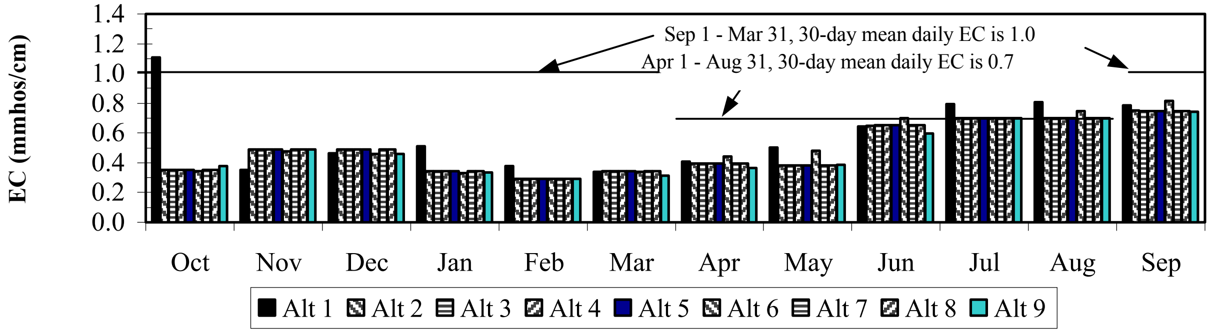
Sacramento "40-30-30" **critical** years
averaged (1976, 77, 88, 90 & 91)

Figure XIII-57
Salinity for San Joaquin River at Airport Bridge (Vernalis) End-of-Month Simulated Values for Wet Years



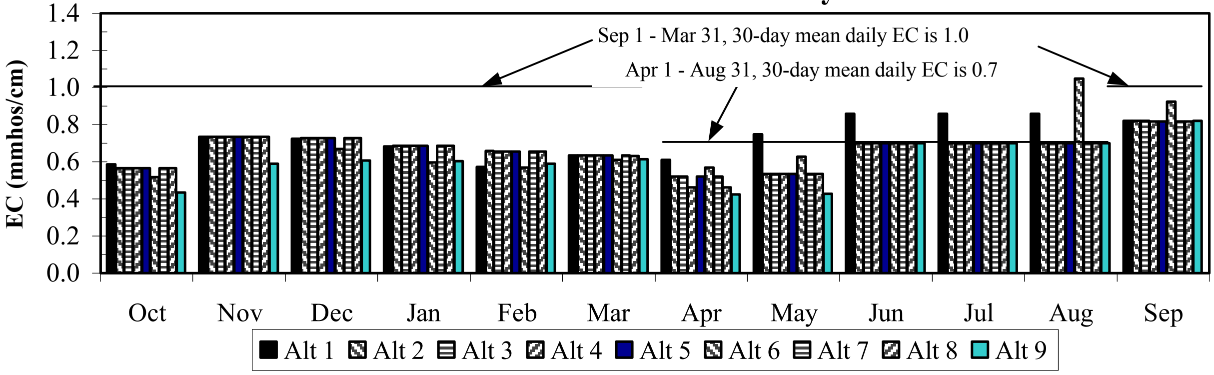
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" wet years averaged (1978, 80, 82, 83 & 86).

Figure XIII-58
Salinity for San Joaquin River at Airport Bridge (Vernalis) End-of-Month Simulated Values for Above Normal Years



Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" wet years averaged (1979 & 84).

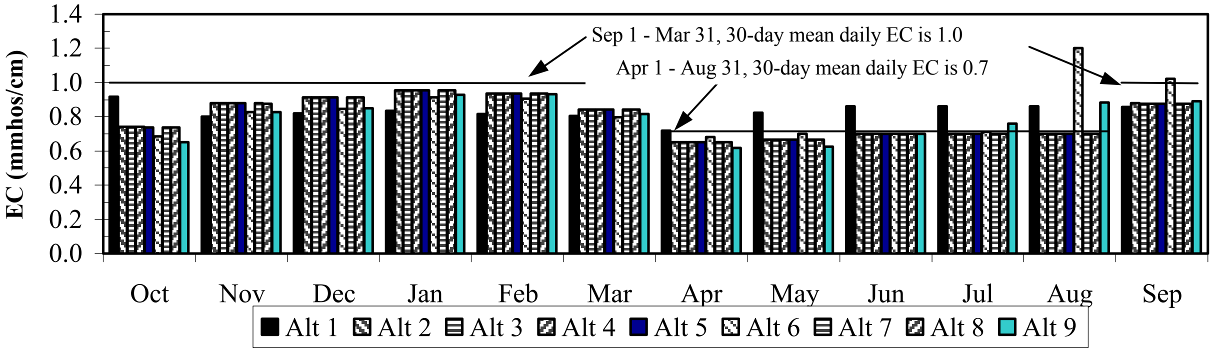
Figure XIII-59
Salinity for San Joaquin River at Airport Bridge (Vernalis)
End-of-Month Simulated Values for Dry Years



Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.

San Joaquin "60-20-20" dry years averaged (1981 & 85).

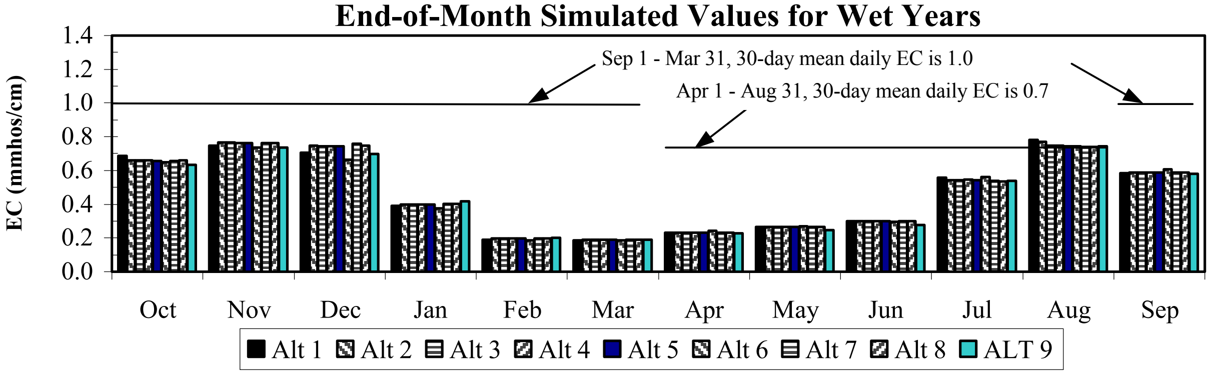
Figure XIII-60
Salinity for San Joaquin River at Airport Bridge (Vernalis)
End-of-Month Simulated Values for Critical Years



Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.

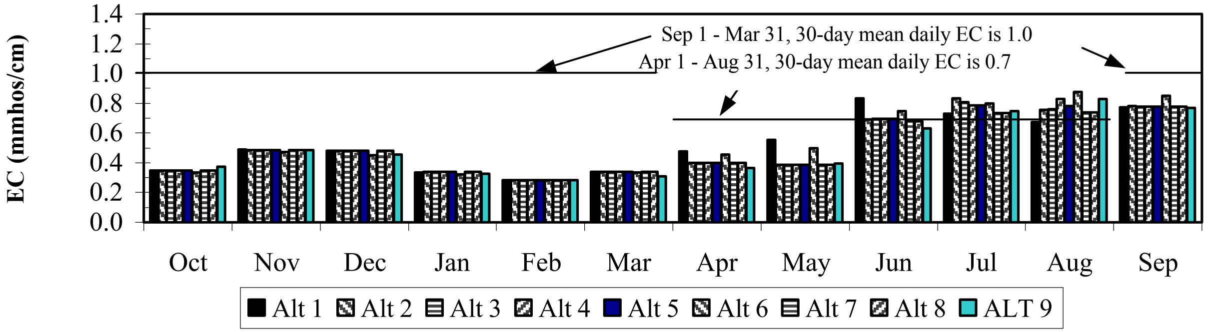
San Joaquin "60-20-20" critical years averaged (1976, 77, 87, 88, 89, 90 & 91).

Figure XIII-61
Salinity for San Joaquin River at Brandt Bridge End-of-Month Simulated Values for Wet Years



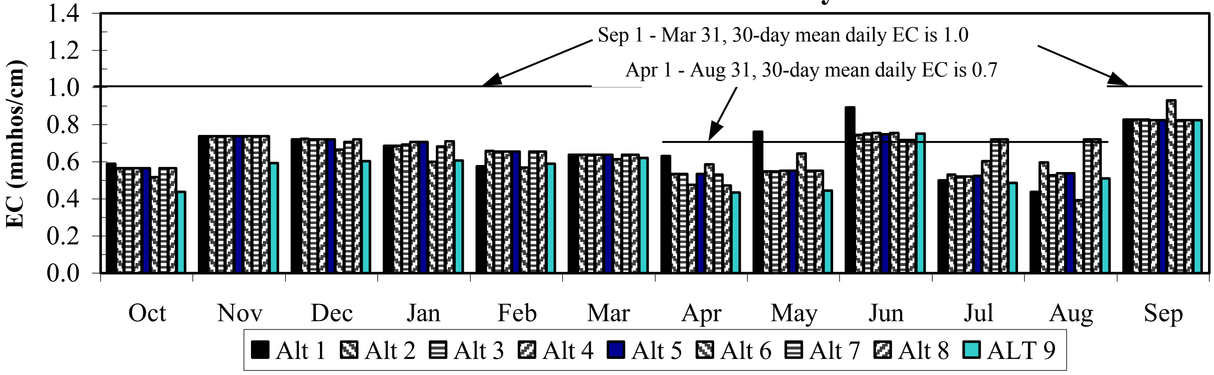
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" wet years averaged (1978, 80, 82, 83 & 86).

Figure XIII-62
Salinity for San Joaquin River at Brandt Bridge End-of-Month Simulated Values for Above Normal Years



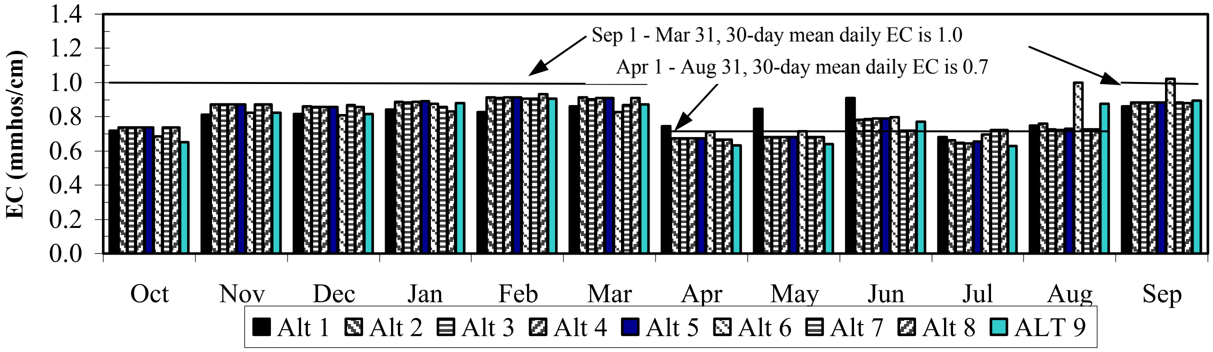
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" wet years averaged (1979 & 84).

Figure XIII-63
Salinity for San Joaquin River at Brandt Bridge
End-of-Month Simulated Values for Dry Years



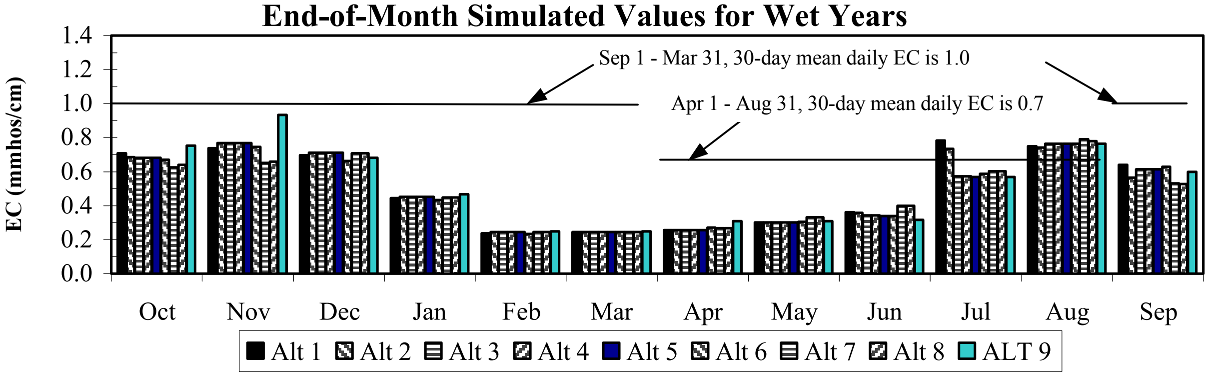
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" dry years averaged (1981 & 85).

Figure XIII-64
Salinity for San Joaquin River at Brandt Bridge
End-of-Month Simulated Values for Critical Years



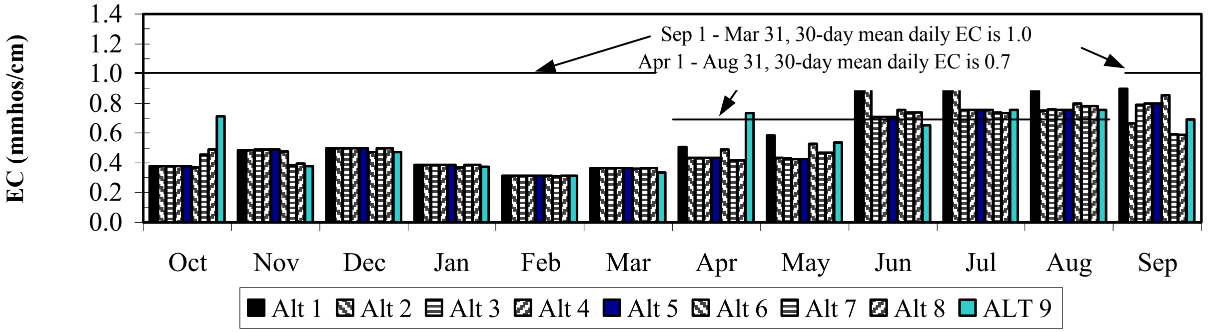
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" critical years averaged (1976, 77, 87, 88, 89, 90 & 91).

Figure XIII-65
Salinity for Old River at Tracy Road Bridge End-of-Month Simulated Values for Wet Years



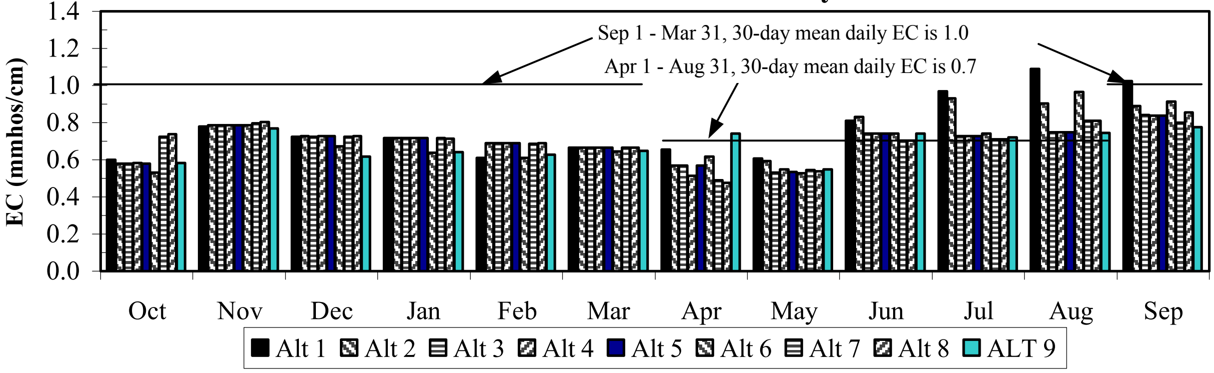
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" wet years averaged (1978, 80, 82, 83 & 86).

Figure XIII-66
Salinity for Old River at Tracy Road Bridge End-of-Month Simulated Values for Above Normal Years



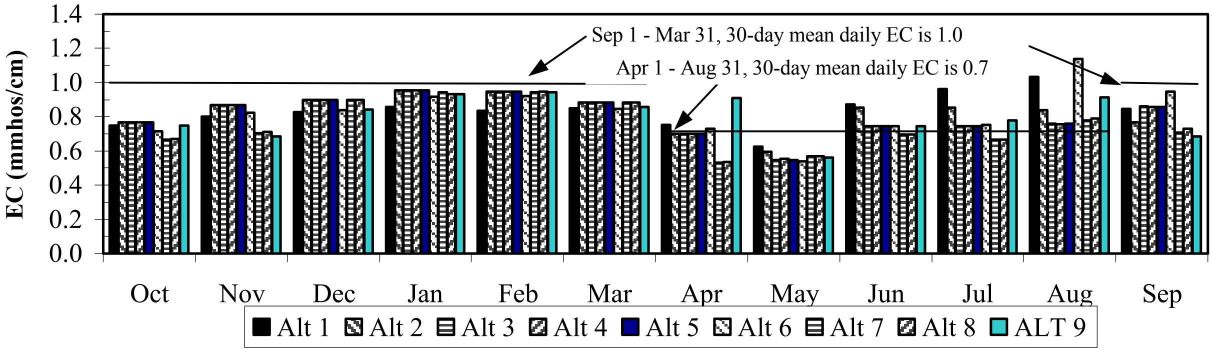
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" wet years averaged (1979 & 84).

Figure XIII-67
Salinity for Old River at Tracy Road Bridge
End-of-Month Simulated Values for Dry Years



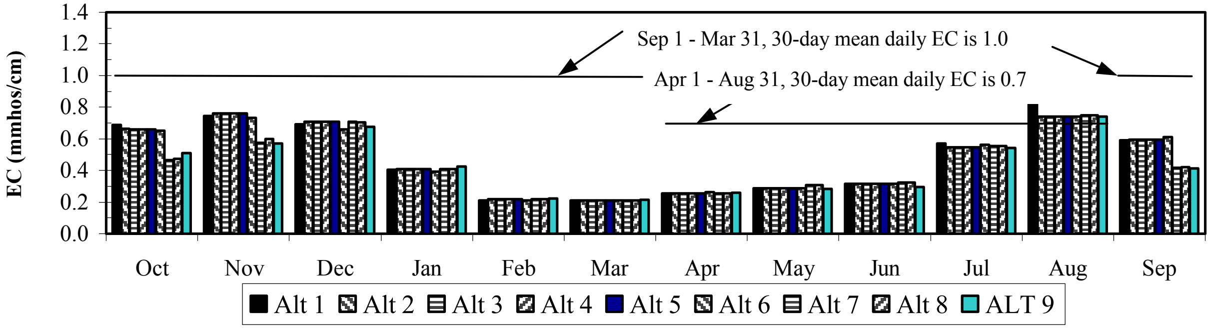
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" dry years averaged (1981 & 85).

Figure XIII-68
Salinity for Old River at Tracy Road Bridge
End-of-Month Simulated Values for Critical Years



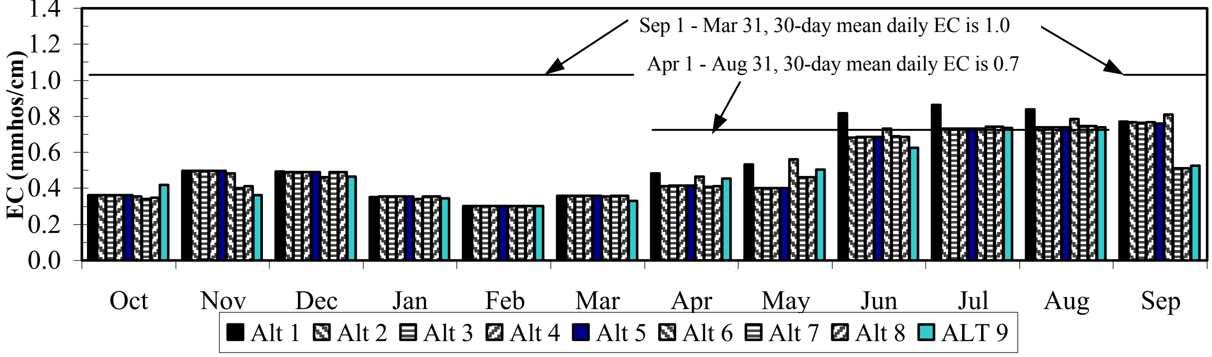
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" critical years averaged (1976, 77, 87, 88, 89, 90 & 91).

Figure XIII-69
Salinity for Old River Near Middle River
End-of-Month Simulated Values for Wet Years



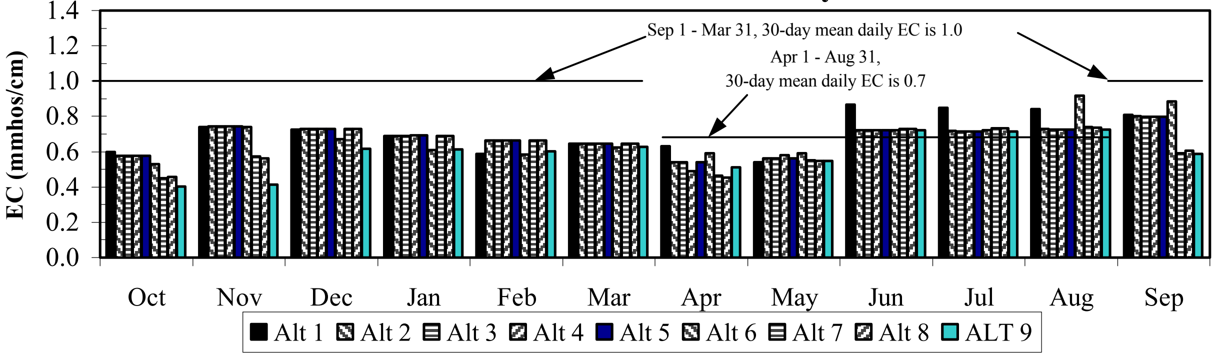
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" wet years averaged (1978, 80, 82, 83 & 86).

Figure XIII-70
Salinity for Old River Near Middle River
End-of-Month Simulated Values for Above Normal Years



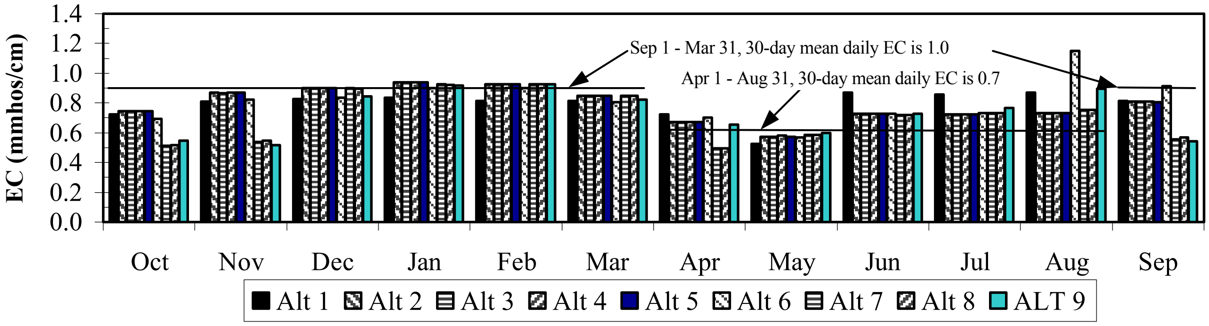
Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" above normal years averaged (1979 & 84)

Figure XIII-71
Salinity for Old River Near Middle River
End-of-Month Simulated Values for Dry Years



Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" dry years averaged (1981 & 85)

Figure XIII-72
Salinity for Old River Near Middle River
End-of-Month Simulated Values for Critical Years



Water quality salinity objectives are for Bay/Delta Plan except Alternative 1. The Vernalis salinity objective for Alternative 1 is 500 ppm TDS (approximately equals 0.86 mmhos/cm) year-round.
San Joaquin "60-20-20" critical years averaged (1976, 77, 87, 88, 89, 90 & 91)

In wet years, there are no appreciable differences among the alternatives with respect to chloride concentrations at the Banks and Tracy pumping plants. In above normal years, chloride levels under the base case are higher in September and lower in December. In below normal years, the base case is considerably higher than the other alternatives in July, August, and September. Alternatives 7 and 8 result in the highest chloride levels in October, November, and December, mostly due to higher exports allowed under these alternatives.

Chlorides come closest to exceeding the maximum chloride limit of 250 mg/l in dry years. This occurs under the base case in July, August, and September for both locations. Alternatives 2 through 8 are not as high as the base case, but are, nevertheless, higher (around 180 mg/l in September) than what is seen in September of other year types. In December and January chloride levels under the alternatives are even higher, in contrast with the base case which stays down between 75 and 110 mg/l.

In dry years (Figures XIII-25 and XIII-30), the base case salinity is higher from June through September and lower in December, January and February.

Sacramento River at Emmaton. Figures XIII-32, XIII-33, and XIII-34 show predicted salinity for Emmaton in the western Delta in wet, above normal, and below normal years. These figures show no appreciable differences among the alternatives from January through May. Alternatives 2 through 9 result in lower salinity in June through September in wet years, in August of above normal years, and June through September and December of below normal years. The base case salinity is lower in October of wet and above normal years.

In dry years (Figure XIII-35), Alternatives 2 through 9 result in lower salinity in February and in April through September, and higher salinity in October, December, and January. In critical years (Figure XIII-36), Alternatives 2 through 9 salinities are lower in February through July and November. Base case salinity is lower in January, August, October, December and January.

The effects of the non-base case alternatives on salinity are practically indistinguishable from each other at this location with the exception of higher salinities for Joint POD Alternatives 7 and 8 in some fall months in below normal and dry year types.

San Joaquin River at Jersey Point. Salinity conditions at Jersey Point are very similar to the conditions at Emmaton. Figures XIII-37, XIII-38, and XIII-39 show virtually no differences among the alternatives from February through June in wet years, from January through July in above normal years, and February through May in below normal years. Alternatives 2 through 9 exhibit lower salinity in June, July, August, and September of wet and below normal years, and August and September of above normal years, with below normal years showing the most dramatic differences in these months.

Figure XIII-40 shows Alternatives 2 through 9 as having lower salinity compared to the base case in April through September of dry years. Figure XIII-41 shows Alternatives 2 through 9 as having lower salinity from February through August and November and somewhat higher salinity in January, September, October, and December of critical years.

South Fork Mokelumne River at Terminous. This station is a Bay/Delta boundary condition in the DWRDSM model and reflects water quality from the DWRSIM model runs used as input. Figures XIII-42 through XIII-46 show that (1) there is relatively high quality water coming down the Mokelumne River in all year types (salinity is a little higher in January and February), (2) all of the alternatives, including the base case, use the same DWRSIM hydrology and water quality parameters for this river system, and (3) closure of the Delta Cross Channel gates in winter months increases salinity.

San Joaquin River at Prisoners Point. Figures XIII-47 through XIII-51 show modeled salinity at this location. The base case alternative has slightly higher salinity in January, August, and September, and slightly lower salinity in October and December of wet years. For above normal years, base case salinity is higher in June, September, and October, and lower in November through February and April. In below normal and dry years, the base case salinity is considerably higher in July, August and September. In critically dry years, the base case salinity is higher in June, July, and August.

Practically no distinction can be made among Alternatives 2 through 9 at this location, with the exception of higher salinities for Alternatives 7 and 8 in some fall months.

San Joaquin River at San Andreas Landing. Salinity conditions at San Andreas Landing are very similar to the conditions on the San Joaquin River at Prisoners Point.

San Joaquin River at Vernalis. Figures XIII-57 through XIII-60 show the EC at this station for four year types. Below normal years under the San Joaquin basin 60-20-20 index convention did not occur during the model study period (1976 - 1991) and therefore the figure for below normal years is omitted for this and the three other southern Delta stations (San Joaquin River at Brandt Bridge, Old River near Middle River and Old River at Tracy Road Bridge). The principal factor controlling the salinity differences between the base case and the alternatives is the different Vernalis objectives that apply. The salinity objectives at Vernalis in the Bay/Delta Plan are 0.7 mmhos/cm from April through August and 1.0 mmhos/cm for September through March. The salinity objective in the base case is 500 ppm (0.86 mmhos/cm) year-round. Because of the difference in objectives, Vernalis salinity is generally lower under the base case in September through March and higher in April through August.

Alternative 6 shows higher salinity than the other alternatives in August and September for dry and critical year types because the Letter of Intent limits releases from New Melones Reservoir for salinity control to 70 TAF. Alternative 9 also limits releases for salinity control, but the limits are based on storage in and expected inflow to New Melones

Reservoir. The effect of these limits can be seen in July and August of critically dry years. No limits on releases of water for salinity control apply to the other alternatives.

San Joaquin River at Brandt Bridge. Figures XIII-61 through XIII-64 show the salinity for the San Joaquin River at Brandt Bridge. The salinities at this location are similar to salinities at Vernalis. Salinity under Alternative 6 is higher in September of dry years and August and September of critical years as dilution water available in New Melones reservoir available for salinity control is depleted.

Old River at Tracy Road Bridge. Figures XIII-65 through XIII-68 show the EC at this station for the four year types. The EC at this location is similar to the EC at Vernalis with two exceptions. First, the EC is usually a little higher because of local agricultural drainage. Second, the EC for Alternatives 7 and 8 are lower in some months than other alternatives because the permanent southern Delta barriers are assumed to be installed. For Alternatives 1 through 6 and 9, the temporary barriers are installed. The temporary barrier at Old River is operated from May through September, while the permanent barrier at Old River is closed from April through October (see Table XIII-15).

Old River near Middle River. Figures XIII-69 through XIII-72 show the EC at this station for the four year types. Salinity at this location is also affected by local agricultural drainage and barrier operation. The effects of limits on the release of water from New Melones under Alternative 6 are evident in August and September of dry and critical years. Alternatives 7, 8 and 9 result in salinities lower than the rest of the alternatives in September and October of wet years, September of above normal years, and September, October and November of dry and critical years.

Summary. The salinity and chloride patterns for Joint POD Alternatives 2 through 9 differ substantially from the base case. In general, Alternatives 2 through 9 exhibit lower salinity in the late spring and summer but higher salinity in the fall and early winter compared to the base case. The principal differences among the alternatives are caused either by differences in the Flow Alternatives, which are already described in Chapter VI, or by implementation of the ISDP. Specifically, within the Joint POD alternatives, salinity differences occur because of implementation of requirements in D-1485 (Joint POD Alternative 1), the Bay/Delta Plan (Joint POD Alternatives 2 through 5, 7, and 8), the Letter of Intent (Joint POD Alternative 6), the San Joaquin River Agreement (Joint POD Alternative 9), and the ISDP (Joint POD Alternatives 7 and 8).

Regardless of the cause of salinity variations among the alternatives, in all of the alternatives, the SWP and the CVP will operate to ensure that the objectives in the western and central Delta are achieved. Therefore, there should be no significant effects associated with implementation of the Joint POD alternatives in comparison to the base case for these areas.

In the southern Delta, the salinity is generally lower than the base case for Alternatives 2-9 during the irrigation season (April through August) because of the more restrictive Vernalis salinity objective in the Bay/Delta Plan for this period. The exception to this observation is Alternative 6 in dry and critical years because salinity control releases under this alternative are limited to 70 TAF. If the SWRCB selects this alternative, the cap on salinity releases may have to be revised to avoid significant impacts.

3. Water Levels

The following section is organized in two parts: (a) impacts to water levels; and (b) mitigation for impacts.

a. <u>Minimum Water Levels</u>. Figures XIII-74 through XIII-85 depict water levels under the nine alternatives at twelve locations shown on Figure XIII-73. Locations were selected upstream and downstream of barrier sites in addition to other sites in the southern Delta and Stockton. Each time period along the x-axis represents a constant condition during which the barrier combination does not change. The heights of the bars show minimum water levels averaged over the 16-year period between 1976 and 1991. When a barrier is installed or removed, the change creates a new condition and a new time period begins. Table XIII-17 shows the schedule of barrier operation under the alternatives.

Table XIII-17
Schedule of Barrier Installation

Time Period	JPOD Alternatives 1-6, 9 South Delta Temporary Barriers [1,3]	JPOD Alternatives 7 and 8 South Delta Permanent Barriers [2,3]
October	Head of Old River	Old River, Middle River, Head of Old River
November	Head of Old River	Head of Old River
December	No Barriers	None Operating
January	No Barriers	None Operating
February	No Barriers	None Operating
March	No Barriers	None Operating
April 1 - 15	No Barriers	Old River, Middle River
April 16 - 30	No Barriers	Old River, Middle River, Head of Old River
May	Old River, Middle River, Head of Old River	Old River, Middle River, Head of Old River
June	Old River, Middle River	Old River, Middle River, Grant Line Canal
July	Old River, Middle River	Old River, Middle River, Grant Line Canal
August	Old River, Middle River	Old River, Middle River, Grant Line Canal
September	Old River, Middle River, Head of Old River	Old River, Middle River, Head of Old River

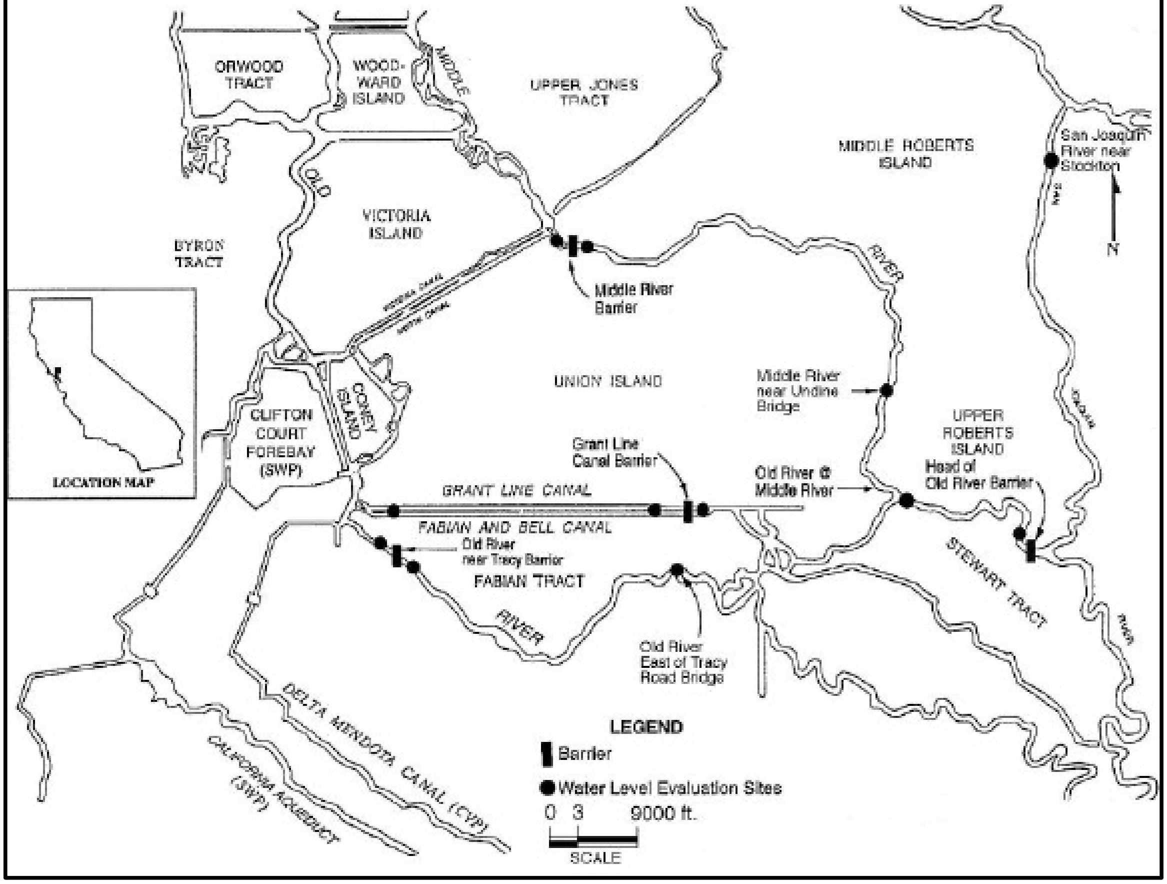
[1] If San Joaquin River flow exceeds 5,000 cfs, the temporary Head of Old River barrier is removed.
[2] If San Joaquin River flow exceeds 8,600 cfs, the permanent Head of Old River barrier is opened.
[3] If San Joaquin River flow exceeds 20,000 cfs, temporary barriers are removed and permanent barriers are opened.

<u>Middle River Barrier Site</u>. Model output shown in Figure XIII-74 shows predicted water levels downstream of the Middle River barrier site. Outputs indicate almost no difference in minimum water levels downstream of the barrier site among alternatives. Upstream of the Middle River barrier site (Figure XIII-75), minimum water levels go up one to two feet when barriers are installed. Under Alternatives 7 and 8, the Middle River permanent barrier closes in April, and minimum water levels rise about two feet under these two alternatives. In May, under Alternatives 1 through 6 and 9, a temporary barrier at Middle River is installed and water levels rise almost as much. Water levels are a little higher with the ISDP permanent barrier closed than they are with the temporary barrier installed because the model assumes water will spill over the temporary barriers during high water level periods, but such spills will not occur with the permanent barriers. In June, the Grant Line Canal permanent barrier closes and water backed up behind the Grant Line barrier also raises minimum water levels behind the Middle River barrier causing water levels under Alternatives 7 and 8 to rise another three feet. In September, the Grant Line barrier is reopened and minimum water levels under Alternatives 7 and 8 drop down to approximately the same level as the other alternatives. From November to March, there are no barriers under any of the alternatives, except for the Head of Old River fish barrier in November, and minimum water level elevations are about the same among alternatives.

Old River Barrier Site. Figure XIII-76 shows water levels downstream of the Old River barrier site. As at the Middle River site, the barrier has very little effect on downstream water levels. Immediately upstream of the Old River barrier site, the Old River permanent barrier installation under Alternatives 7 and 8 in April raises minimum water levels upstream as shown in Figure XIII-77. The Old River temporary barrier under the other alternatives also raises minimum water levels when it gets installed in May. In June, the Grant Line canal permanent barrier, in conjunction with the Old River barrier and Middle River barrier causes a significant increase in minimum water levels under Alternatives 7 and 8, about 3.5 feet. Minimum water levels under Alternatives 7 and 8 return to approximately the same levels as the other alternatives in September when the Grant Line barrier is reopened. In October, minimum water levels under Alternatives 7 and 8 remain about one foot higher than the other alternatives because the Old River permanent barrier is still in while the Old River temporary barrier is removed. From November through March, all barriers are removed, except for the Head of Old River barrier in November, and water levels among the alternatives are about the same.

Grant Line Canal Barrier Site. Figure XIII-78 shows output for a site downstream of the Grant Line Canal barrier site. The DWRDSM model assumptions for Alternatives 7 and 8 places the permanent Grant Line Canal barrier on the east end of Grant Line Canal, near Tracy Road bridge. The other alternatives do not assume any barrier operation on Grant Line Canal. The figures show that Alternatives 7 and 8 result in minimum water level elevations one half foot to one foot lower than the other alternatives in June, July and August when the barrier is closed, and may have an adverse effect on water diversion downstream of the Grant Line barrier. This effect can be eliminated by moving the barrier to the west end of Grant Line Canal. Upstream of the barrier, minimum water levels are about four feet higher in June and July and about three feet higher in August than the other alternatives during the same months (Figure XIII-79).

Figure XIII - 73
Locations Examined for Water Level Changes Under Joint Point Alternatives



Other Locations. Figure XIII-80 shows predicted minimum water levels at a site further downstream of the Grant Line Canal barrier site than Figure XIII-78. The salinities at these locations are very similar except that the drop in minimum water levels associated with closure of the Grant Line Barrier in June, July, and August under Alternatives 7 and 8 is not as pronounced towards the west end of Grant Line Canal.

Figure XIII-81 shows minimum water levels for a location further upstream from the Tracy barrier site. Minimum water levels follow the same pattern as Figure XIII-77 (Old River Upstream of Barrier) except that water levels are about one-half to one foot higher from January to March for all of the alternatives. The Old River permanent barrier, in conjunction with the other permanent ISDP barriers, particularly the Grant Line Canal barrier, results in a dramatic increase in minimum water levels in the summer under Alternatives 7 and 8.

Figure XIII-74
Average Minimum Water Levels by Period at Middle River Downstream of Barrier

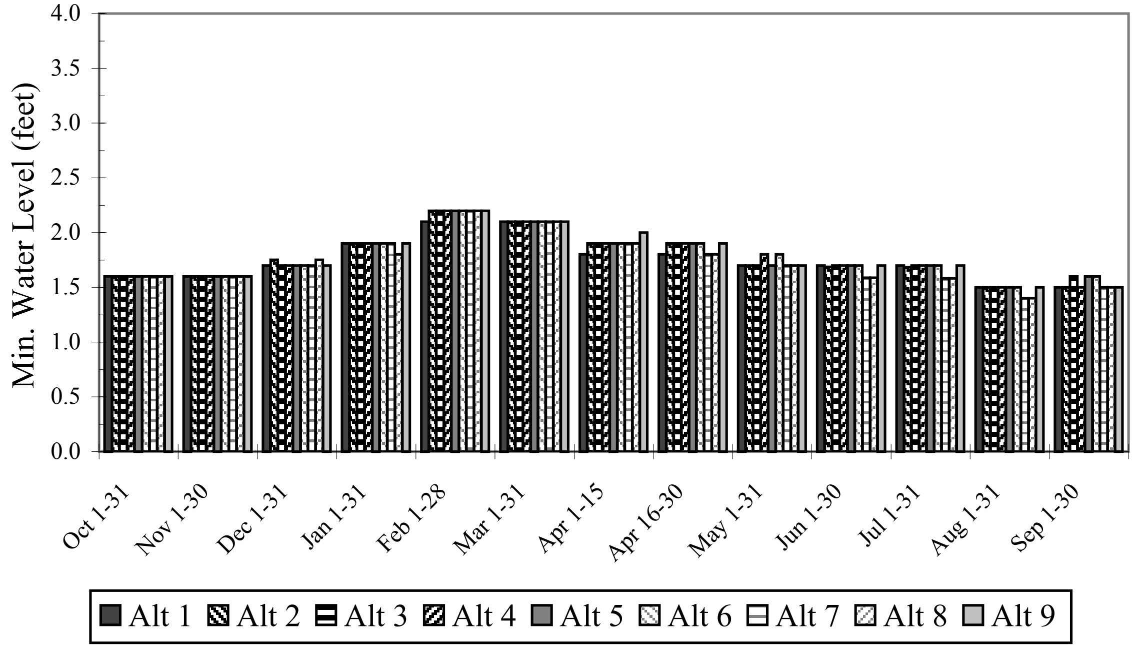


Figure XIII-75
Average Minimum Water Levels by Period at Middle River Upstream of Barrier

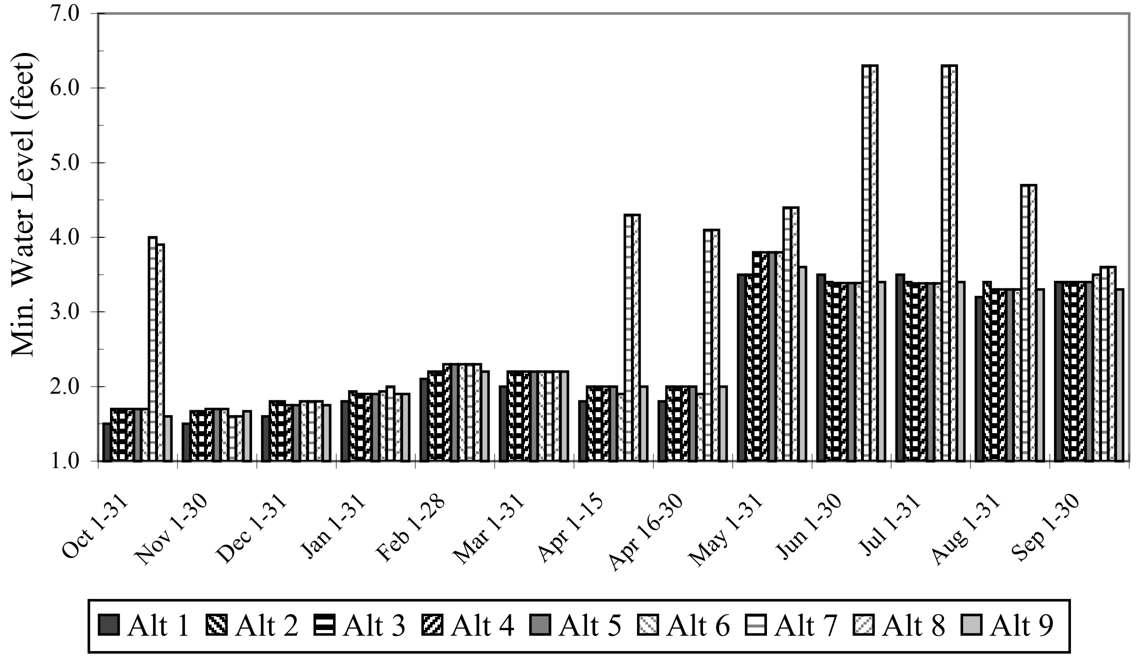


Figure XIII-76

Average Minimum Water Levels by Period at Old River Downstream of Barrier

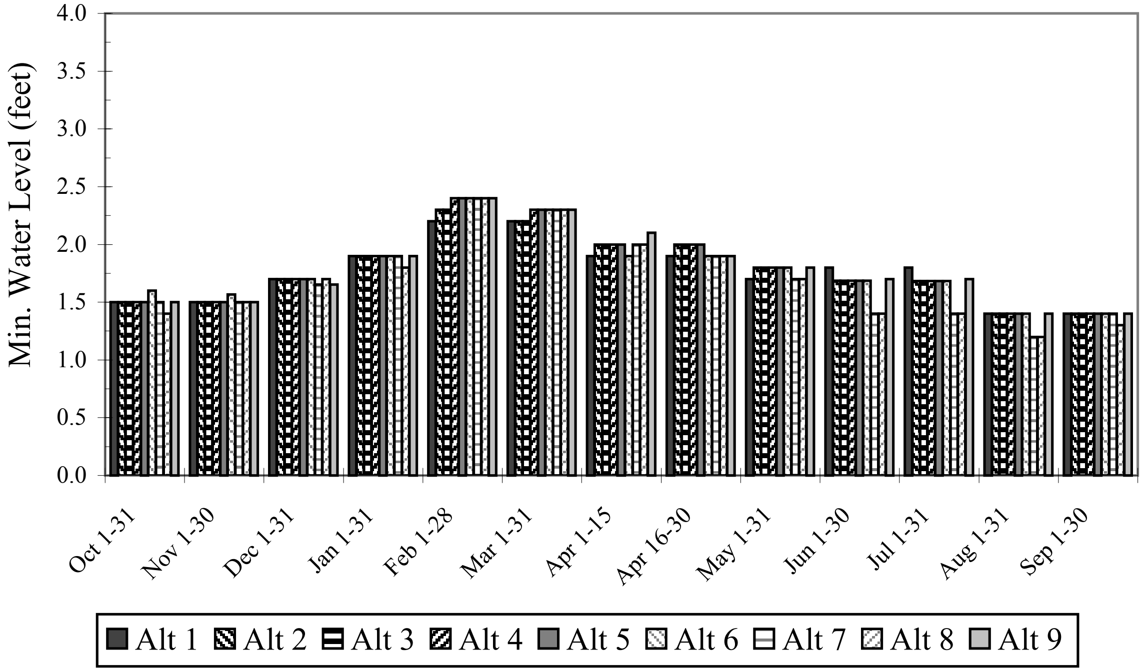


Figure XIII-77

Average Minimum Water Levels by Period at Old River Upstream of Barrier

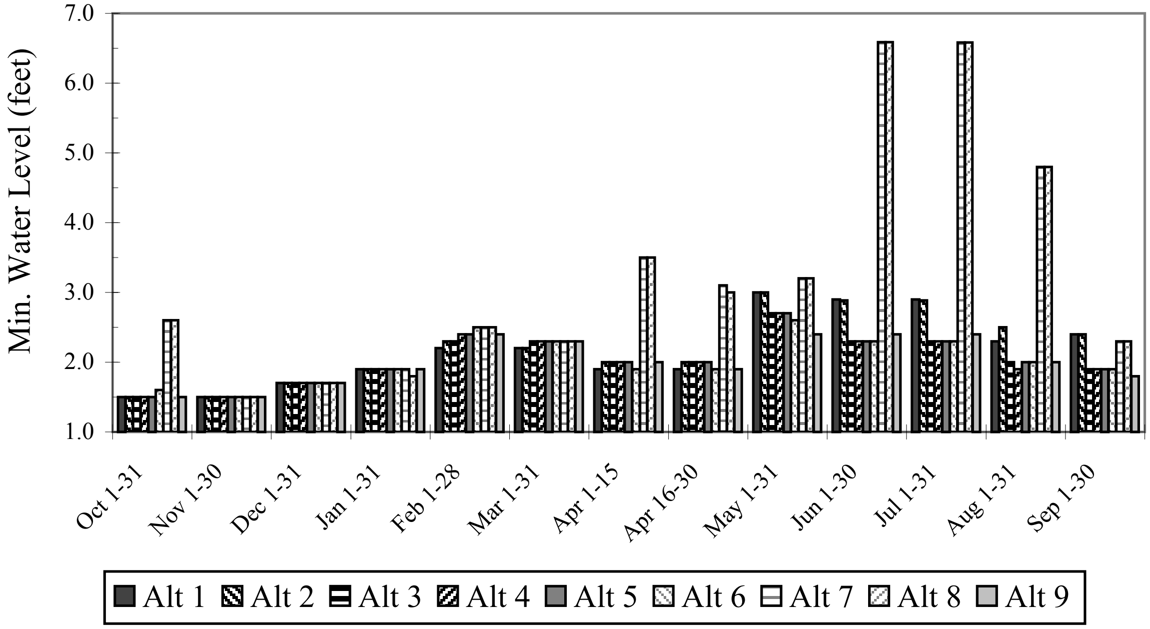


Figure XIII-78
Average Minimum Water Levels by Period at
Grant Line West of Tracy Road Bridge

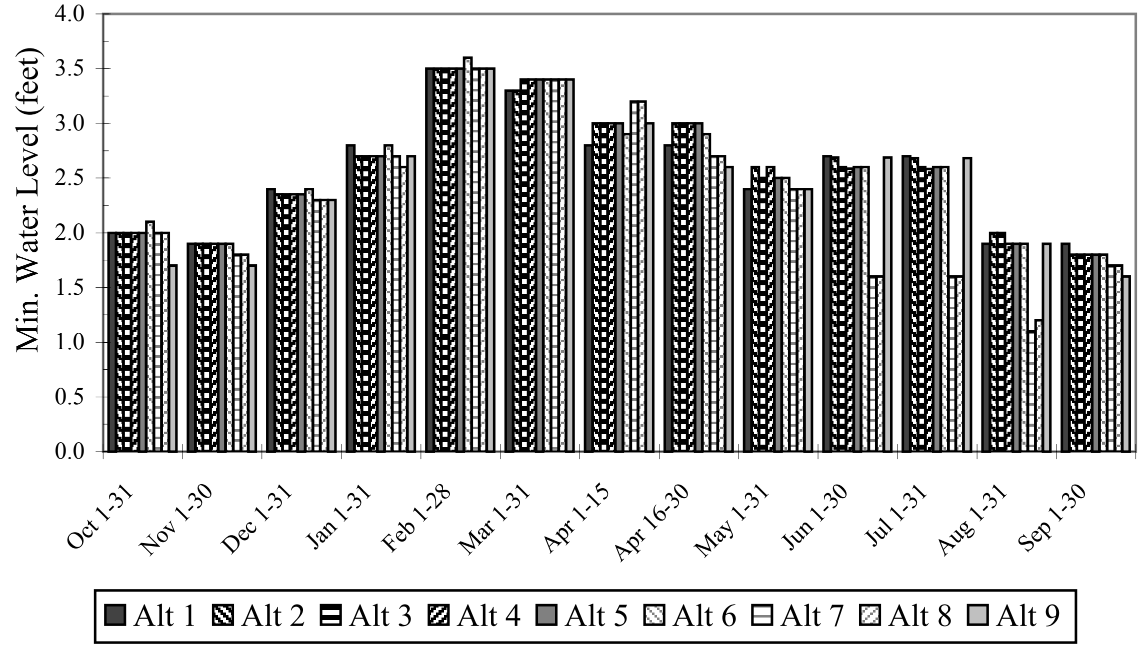


Figure XIII-79
Average Minimum Water Levels by Period at
Grant Line East of Tracy Road Bridge

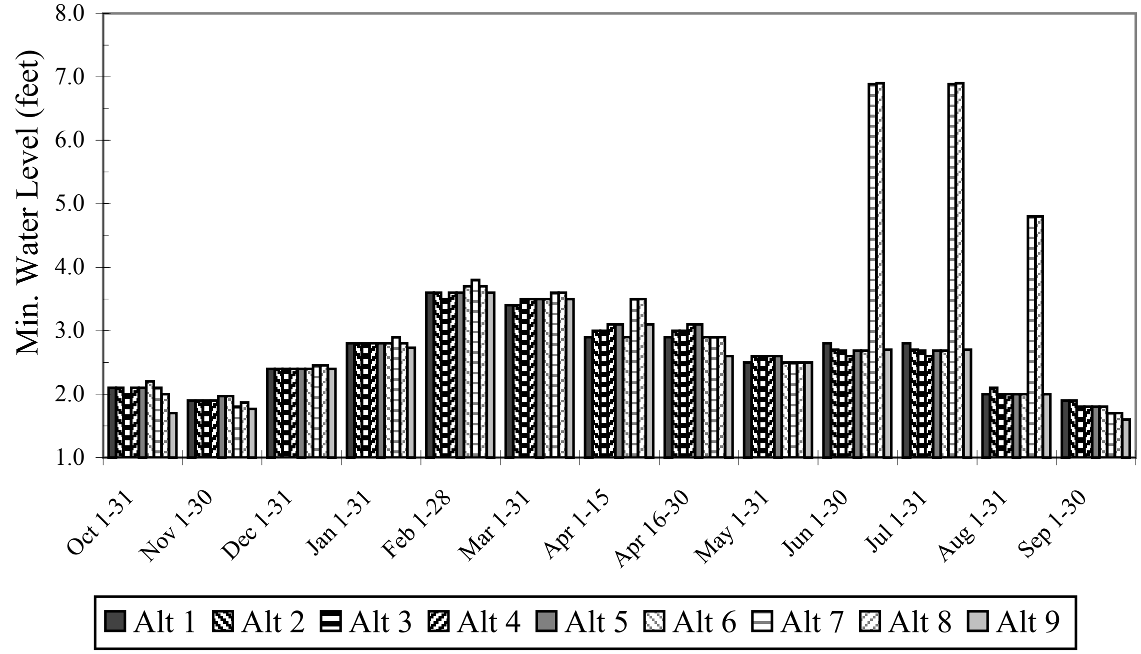


Figure XIII-80
Average Minimum Water Levels by Period at Grant Line Upstream of Grant Line & Old River Confluence

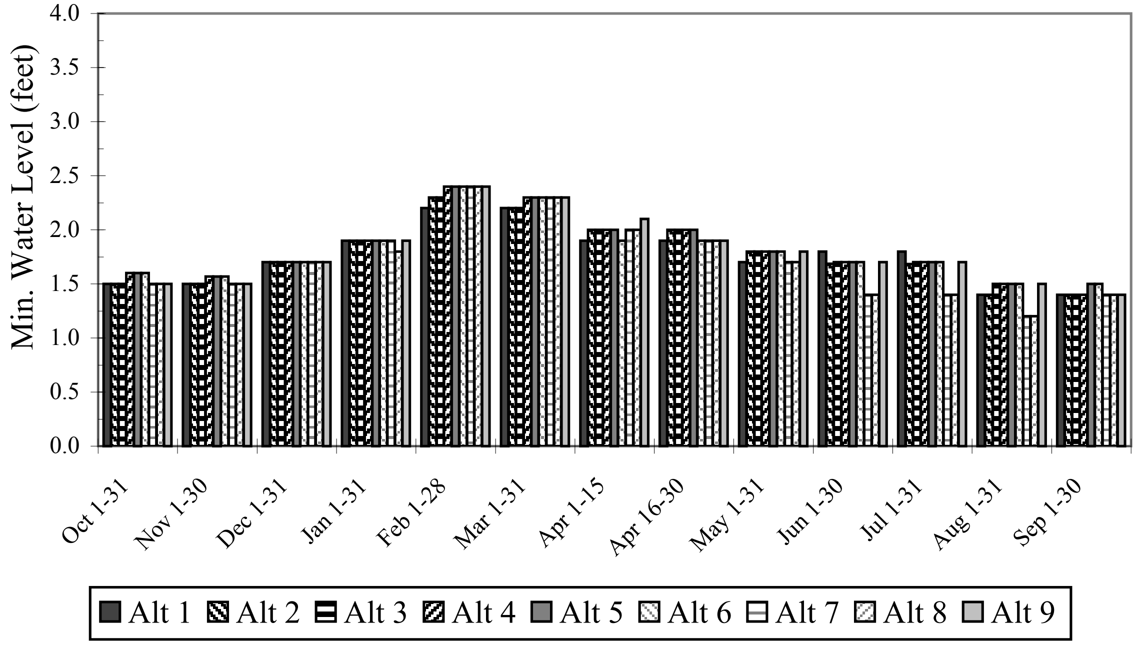


Figure XIII-81
Average Minimum Water Levels by Period at Old River East of Tracy Road Bridge

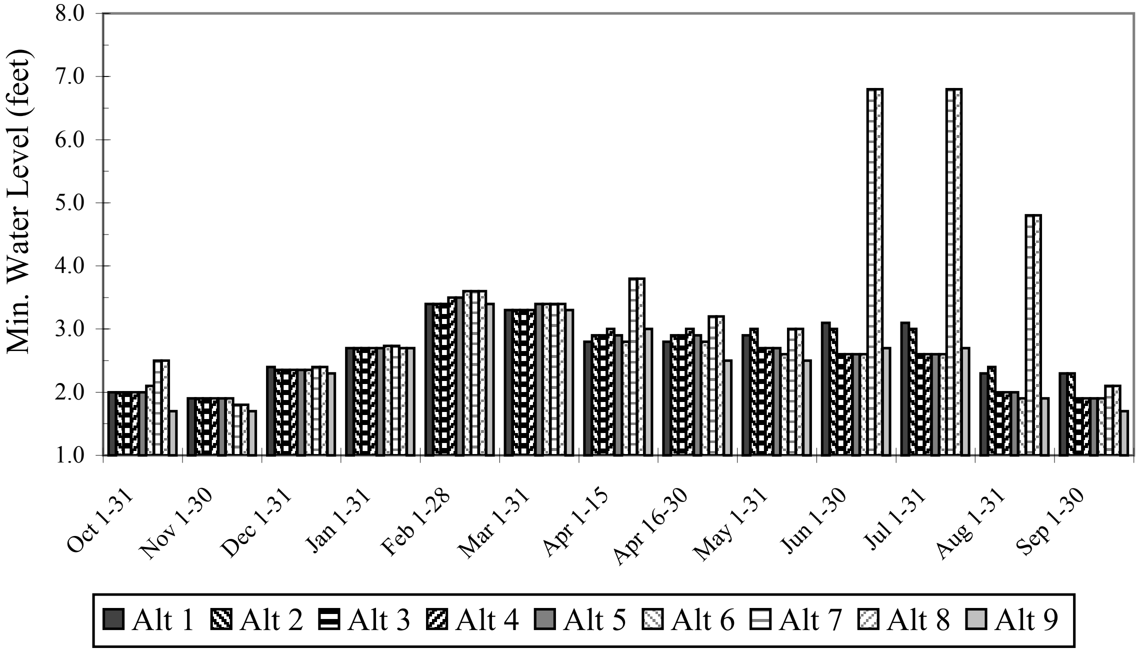


Figure XIII-82

Average Minimum Water Levels by Period at Middle River Near Undine Bridge

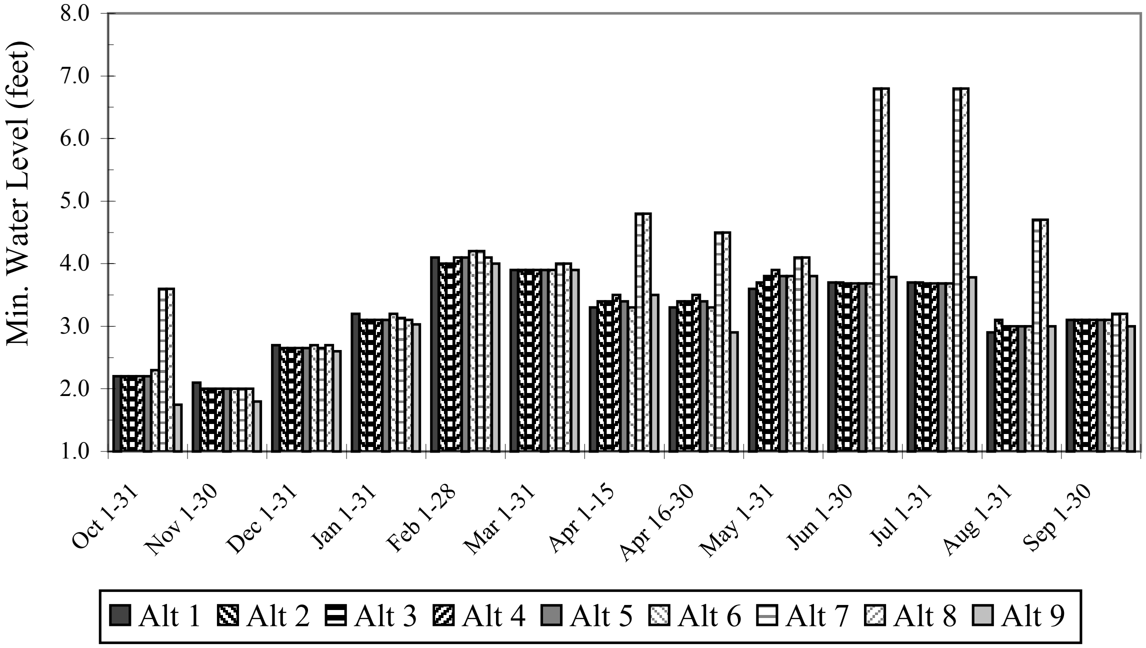


Figure XIII-83

Average Minimum Water Levels by Period at Old River Upstream of Old River & Middle River Confluence

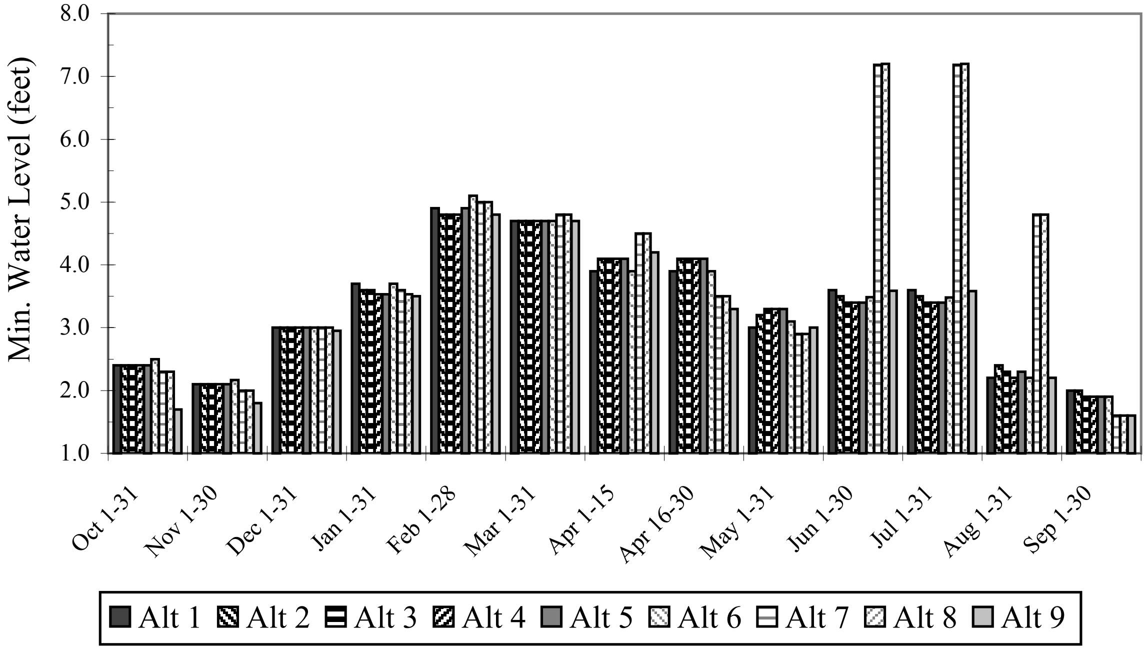


Figure XIII-84

Average Minimum Water Levels by Period at Old River Downstream of Old River Barrier

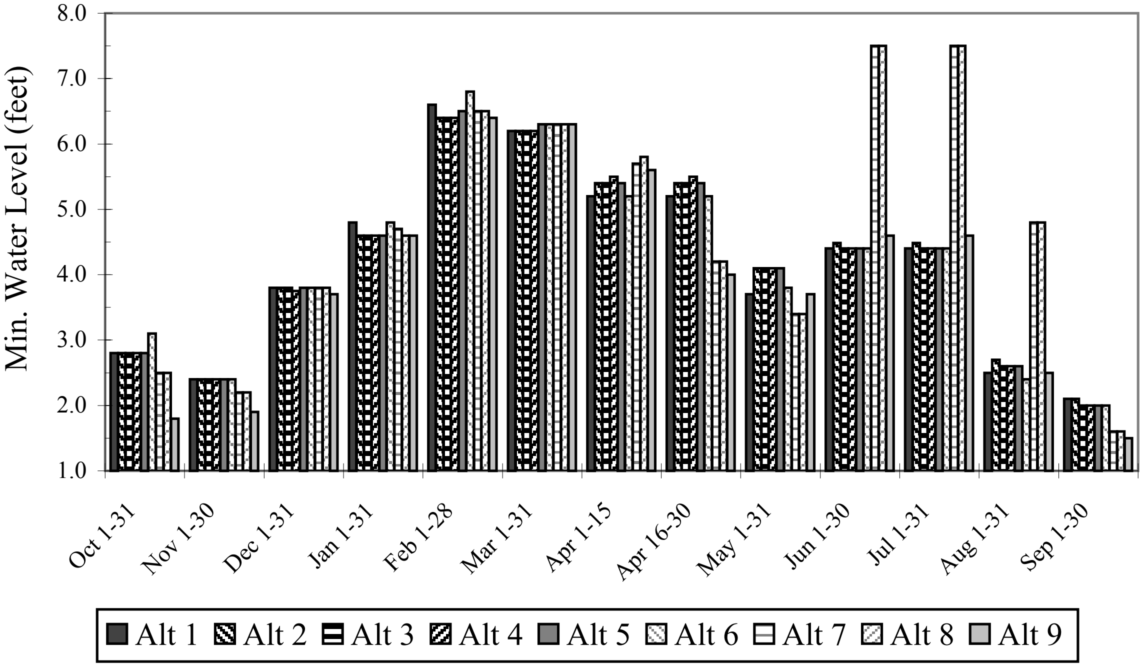
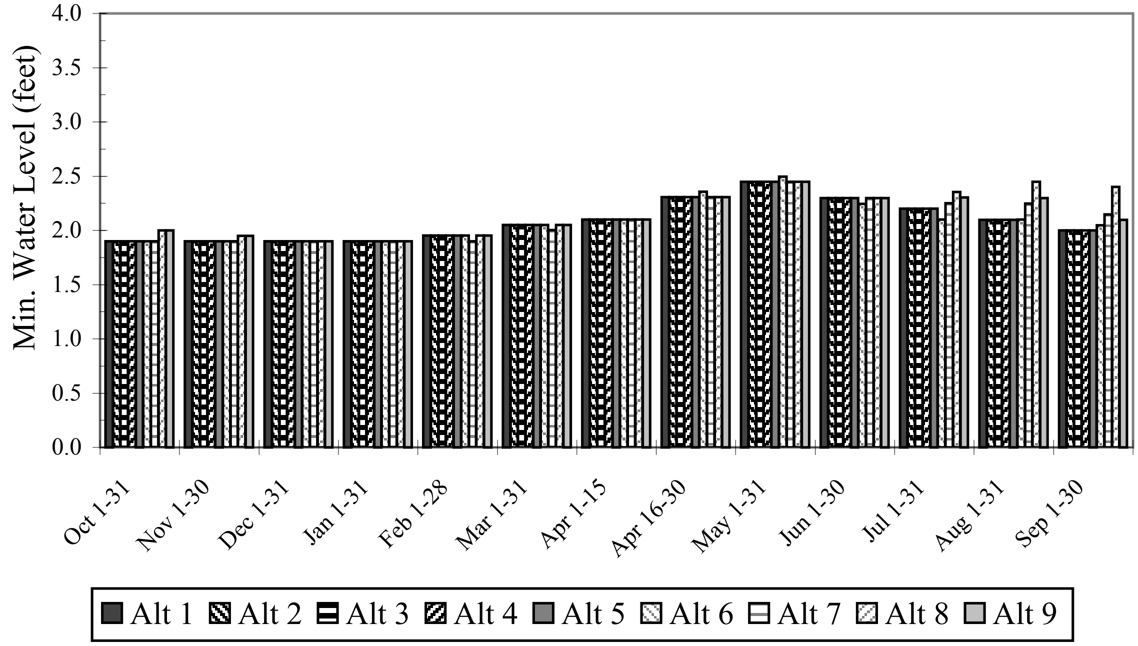


Figure XIII-85

Average Minimum Water Levels by Period at Stockton on the San Joaquin River



Minimum water levels for a location further upstream of the Middle River barrier site are shown in Figure XIII-82. Minimum water levels are similar to those in Figure XIII-75 (Middle River upstream of barrier) except that minimum water levels are about one foot higher from late fall through winter when hydraulics are not being driven by barrier operation. Alternatives 7 and 8 provide the highest minimum water levels from April through October.

Figures XIII-83 and XIII-84 show that minimum water levels at the confluence of Middle River and Old River follow the same pattern as Old River downstream of the Head of Old River Barrier, except that minimum water levels at the upstream location are about 1.5 feet higher overall. Here again, the ISDP barriers, particularly the Grant Line barrier have a big effect in June, July and August on minimum water levels. The Head of Old River Barrier is installed (or closed, in the case of Alternatives 7 and 8) from September to November and then again in May for one month, causing minimum water levels to drop during those months up to a foot or more. Under the DWRDSM assumptions, the temporary Head of Old River Barrier is removed when San Joaquin River flows exceed 5,000 cfs, and the permanent Head of Old River barrier is opened when flows exceed 8,600 cfs. Consequently, there is some variation among alternatives in those months when the Head of Old River Barrier is installed.

Figure XIII-85 shows that barrier construction and operation does not have a significant effect on water levels in the San Joaquin River near Stockton.

In summary, many southern Delta locations show significant improvements in minimum water levels at certain times of the year as a result of barrier and flow operations under Alternatives 7 and 8 compared to the other alternatives and base case. The following locations have monthly minimum water levels of at least two (+2) feet higher under Alternatives 7 and 8 than the other alternatives: Middle River upstream of Barrier in April, June, July, and October; Old River upstream of Barrier in June, July, and August; Grant Line Canal east of Tracy Road Bridge in June, July, and August; Old River east of Tracy Road Bridge in June, July, and August; Middle River near Undine Bridge in June and July; Old River upstream of the Old River and Middle River confluence in June, July, and August; and Old River downstream of the Old River and San Joaquin River confluence in June, July, and August.

In certain months, at certain locations, Alternatives 7 and 8 will cause elevations which are lower than the other alternatives. A monthly minimum water level of negative (-) 0.5 feet or lower (with respect to base case water levels) is considered to have a significant adverse impact and occurs under Alternatives 7 and 8 on Grant Line west of Tracy Road Bridge in June, July, and August.

b. **Mitigation for Impacts to Water Levels**. The installation of the Grant Line Canal barrier would reduce water levels downstream of the barrier creating adverse environmental effects. This effect can be mitigated by moving the Grant Line Barrier as far as feasible to the west on Grant Line Canal.

4. Fish and Aquatic Resources

Effects on aquatic resources resulting from the implementation of the 1995 Bay/Delta Plan are analyzed and disclosed in the ER and this EIR. The purpose of this section is to evaluate the additional effects that implementation of Joint POD alternatives would have on aquatic resources in the Delta.

Modifications to pumping patterns, reservoir releases, and other operations of the water management system resulting from the combined use of points of diversion have the potential to affect aquatic resources system wide. Other impacts from temperature changes, food limitations, habitat losses, introduced species, harvest, and contaminants in the Delta discussed in Chapter VI, are not expected to change significantly for any of the Joint POD alternatives. Alternative 2 represent the effects attributable to implementation of the 1995 Bay/Delta Plan. Alternatives 3 through 9 demonstrate the effects of various levels of wheeling in addition to the effects of implementing the 1995 Bay/Delta Plan.

Of the factors identified above, the Joint POD alternatives are expected to have the most significant potential impacts on entrainment losses and other export-related effects in the Delta. Entrainment in some months is expected to increase due to increased Delta exports. Average exports would increase from July to January, except in September, compared to Alternative 2 (see Table XIII-12). Increased reverse flows associated with the alternatives may shift more organisms toward the central Delta where they would be more vulnerable to entrainment at the export facilities. However, higher exports from the SWP and CVP are considered most harmful during the spring when eggs, larvae, and juveniles of many Bay/Delta species are present. All of the alternatives would reduce exports in February and March compared to Alternative 2 with some reductions in April, May, and June.

Impacts of these export changes would vary by species. Some anadromous species like winter-run chinook salmon may respond positively because the smolt life stage, the most vulnerable to entrainment, would have completed their outmigration by the time exports increase in the summer. However, adverse impacts on winter-run chinook could result from increased exports in the November through January period.

For spring-run chinook salmon, increases in fall and winter pumping may adversely affect yearlings migrating through the Delta and young-of-the-year rearing in the Delta. However, there may be benefits to young-of-the-year spring-run that are rearing and outmigrating through the Delta during the period of reduced export pumping in the late winter and spring. These impacts and benefits may not offset each other. Joint POD-related impacts to spring-run in the fall/winter may primarily affect the Mill and Deer Creek populations, since they tend to emigrate as yearlings. Benefits from reduced spring exports may primarily affect spring-run from other stream populations.

Joint POD Alternative 4 provides greater protection for aquatic resources than Joint POD Alternatives 3 and 5 through 9 because the combined use of points of diversion is used primarily for the benefit of aquatic resources. Based on historical operations, the combined use of points of diversion would probably be used in the fall and winter under this alternative to make up for export restrictions in the spring. Therefore, even this alternative can adversely affect specific aquatic resources if their most critical period in the Delta does not coincide with the window of export reductions.

If operations under Joint POD Alternatives 3 through 9 result in increased entrainment, regulatory constraints could be applied to operations to reduce, offset or avoid impacts. Measures that could be used include switching diversions between SWP and CVP facilities if entrainment is high at one of the facilities, modification of required export/inflow ratios, re-operation of the Delta Cross Channel gates, or reduction or termination of increased exports resulting from joint use of the SWP and CVP points of diversion.

Delta outflow is also expected to change with the implementation of the Joint POD alternatives but the effects are not expected to be as significant as entrainment effects. Delta outflow generally decreases compared to Alternative 2 between July and January and increases during February and March, with increases and decreases in April, May, and June. In general, Alternatives 4 and 9 provide greater increases in outflow in the spring months (March through June) when the abundance of many Delta species shows a significant positive relationship with Delta outflow.

The effects of the Joint POD alternatives on aquatic resources in the Delta are described in this section. The aquatic resource models described in Chapter IV and Chapter VI are used. For purposes of discussion, results are grouped into four categories: (1) special status species; (2) species that characterize potential effects on food webs; (3) abundance/outflow relationships; and (4) net reverse flows. Chinook salmon, steelhead, striped bass, and delta smelt are the special status species considered. Copepods and phytoplankton are evaluated to assess food web effects. Abundance/outflow relationships were evaluated for longfin smelt, Sacramento splittail, starry flounder, and *Crangon franciscorum.*

Chinook Salmon. The USFWS salmon smolt survival model, described in Chapter IV, was used to evaluate the effects of the Joint POD alternatives on survival of chinook salmon smolts outmigrating through the Delta. Survival indices for the following chinook salmon runs/lifestages were modeled:

- Sacramento River fall-run, late fall-run, and winter-run (smolts), and spring-run (young-of-the-year and yearlings)
- San Joaquin River fall-run smolts (with and without the Head of Old River barrier)

Survival indices were predicted over the hydrologic period of record (1922-1992). Model calculations are shown in Volume 2, Appendix 5.

Figures XIII-86 through XIII-92 show the predicted indices for through-Delta migration of each chinook salmon run by Joint POD alternative and water year type. For all runs, predicted survival indices were generally lower in drier water years. Indices predicted for Joint POD Alternatives 2 through 9, in general, were higher than for Alternative 1. For the Sacramento River runs, there were no discernable differences between the Joint POD Alternatives that allow wheeling and Alternative 2 for any of the runs. For these runs, the smolt survival increases under Alternatives 2 through 9 result primarily from the increased closure of the Delta Cross Channel gates. Under Joint POD Alternative 1, the Delta Cross Channel is open more often, potentially diverting juvenile salmon into the central Delta where lower survival is predicted.

For Sacramento River fall-run smolts (Figure XIII-86), survival indices in a wet water year were similar between all of the Joint POD Alternatives. In all other water year types, survival indices for Joint POD Alternatives 2 through 9 were higher than in Alternative 1. The difference between Alternatives 2 through 9 and Alternative 1 increased in drier water years.

For late fall-run, winter-run smolts, and yearling spring-run (Figures XIII-87, 88, and 89), predicted survival indices were higher under Joint POD Alternatives 2 through 9 than in Alternative 1 in all water year types. The difference between Alternatives 2 through 9 and Alternative 1 increased in drier water years.

For young-of-the-year spring-run (Figure XIII-90), survival indices in wet and above normal water years were similar for all of the Joint POD alternatives. In below normal, dry, and critical years, predicted survival indices under Alternatives 2 through 9 were higher than under Alternative 1.

For San Joaquin fall-run (Figures XIII-91 and 92), predicted survival indices were higher with the operation of the Head of Old River barrier than without the barrier, but the relationships between the Joint POD alternatives and the base cases were similar with and without the barrier. In a wet year, predicted indices were similar under Alternatives 1 through 8 and higher under Alternative 9. In all other water year types, predicted survival indices were higher under Joint POD Alternatives 2 through 9 than under Alternative 1. Among Alternatives 2 through 9, indices were generally lower under Alternative 6 and higher under Alternatives 4 and 9 than the other alternatives.

These differences in predicted survival of San Joaquin River fall-run are due to changes in San Joaquin River flow at Vernalis and total Delta exports in April and May. Higher flows and lower exports generally resulted in higher predicted survival indices. In general, flows at Vernalis were increased during this period under Joint POD Alternatives 2 through 5 and 7 through 9 compared to Alternative 1, due to implementation of the Bay-Delta Plan. Spring flows at Vernalis were higher under Alternatives 4 and 9, and lower under Alternative 6, than under Alternative 2. Total Delta exports in April and May were lower under Alternatives 2 through 9 than under Alternative 1. Under Alternatives 4 and 9, total Delta exports were lower than under Alternative 2.

Figure XIII-86

Sacramento River Fall-Run Salmon Smolt Survival Index

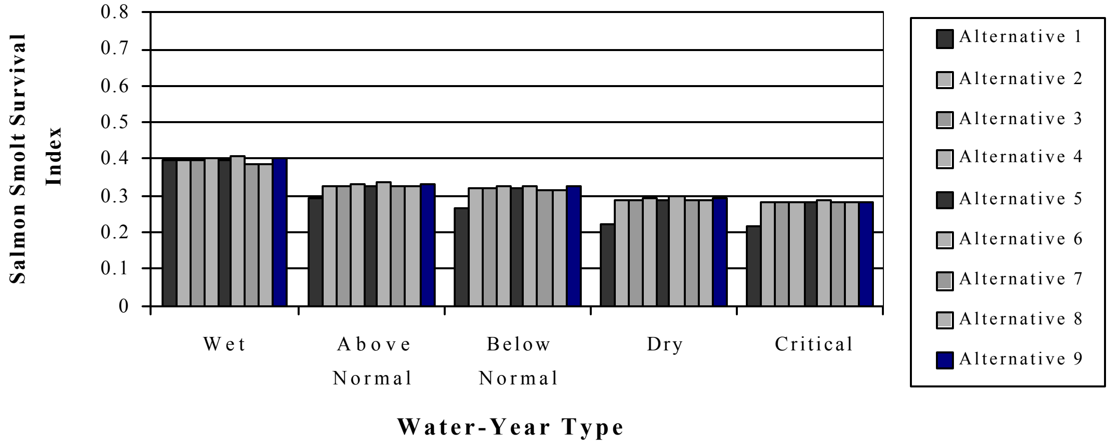


Figure XIII-87

Sacramento River Late Fall-Run Salmon Smolt Survival Index

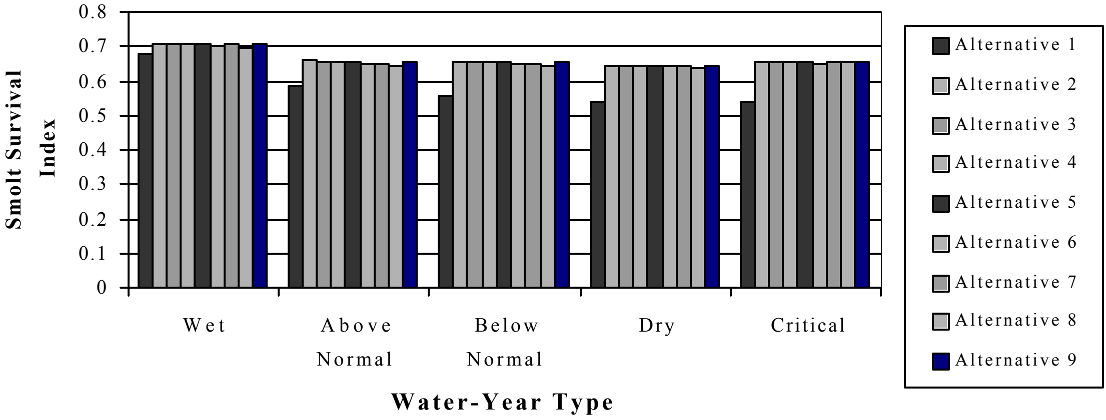


Figure XIII-88

Sacramento River Winter-Run Salmon Smolt Survival Index

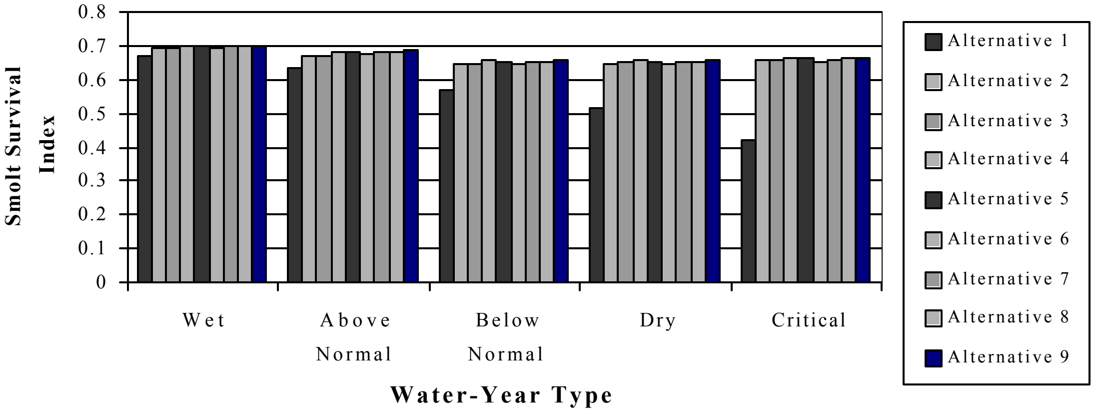


Figure XIII-89

Sacramento River Yearling Spring-Run Salmon Survival Index

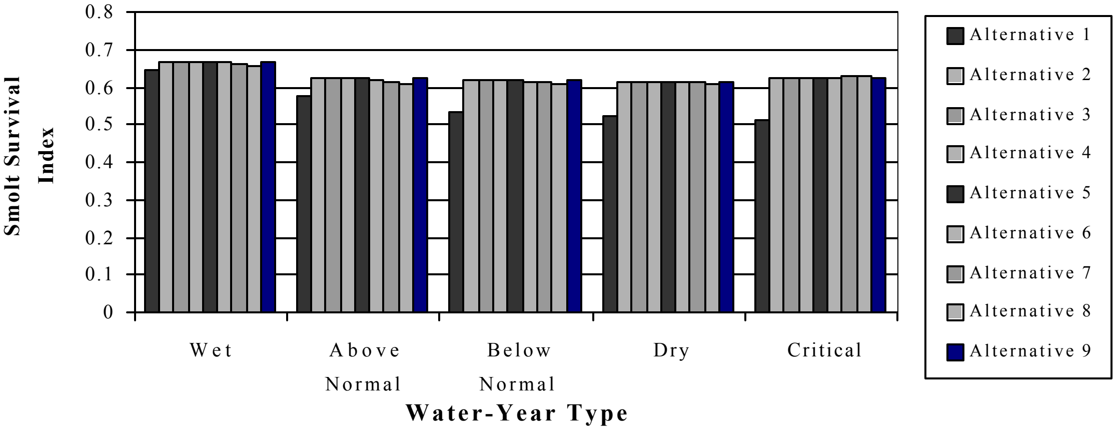


Figure XIII-90

Sacramento River Young-of-the-Year Spring-Run Salmon Smolt Survival Index

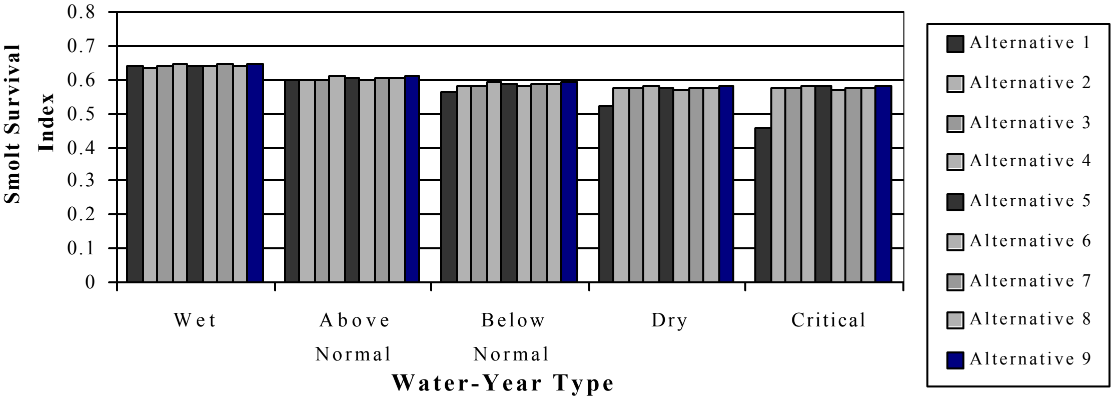


Figure XIII-91

San Joaquin River Fall-Run Salmon Smolt Survival Index with Barrier

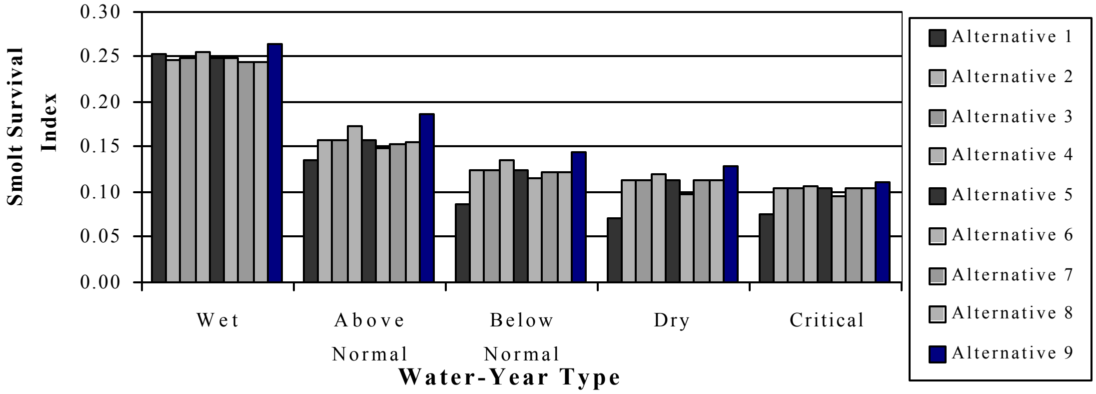
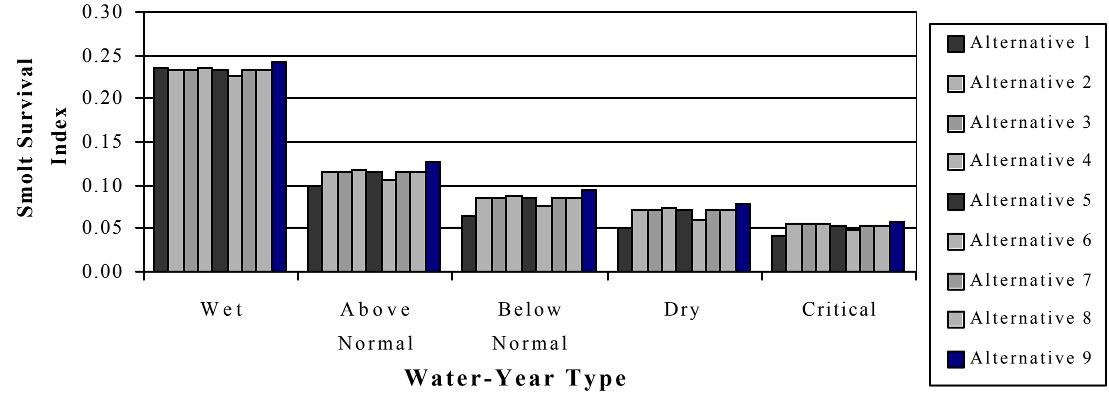


Figure XIII-92

San Joaquin River Fall-Run Salmon Smolt Survival Index without Barrier



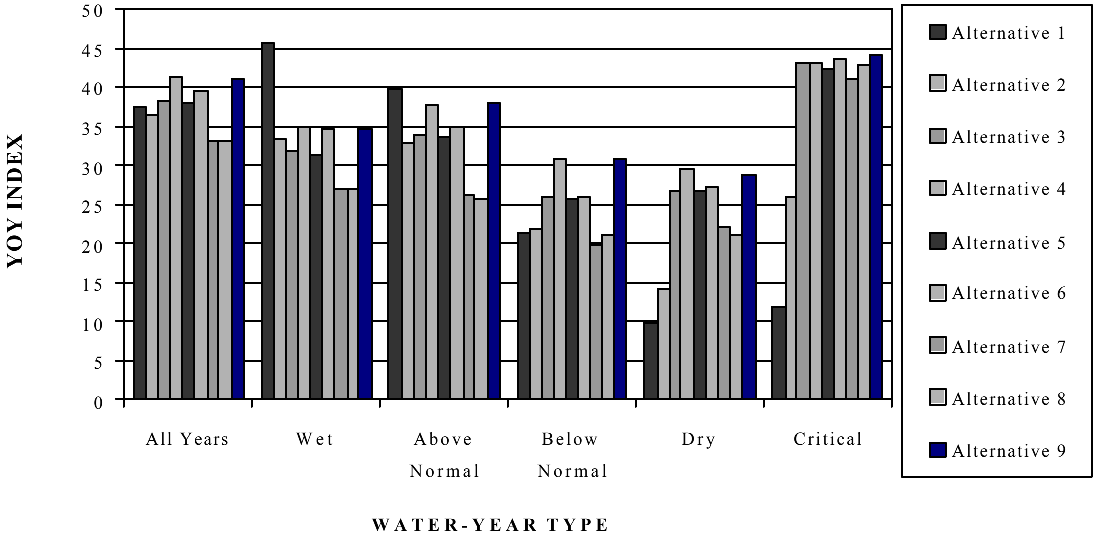
Steelhead. The Joint POD alternatives have the potential to affect juvenile steelhead during the period of emigration through the Delta. Emigration through the Delta occurs from December through May, with peak migration occurring from February through April (DWR and USBR 1999). The primary factors affected by the Joint POD alternatives that may affect survival of juvenile steelhead in the Delta include Delta inflows, exports, and closure of the Delta Cross Channel gates.

In general, survival of juvenile steelhead emigrating through the Delta in the February through April period may improve slightly under Joint POD Alternatives 3 through 9 compared to Alternatives 1 and 2. Delta exports will generally be lower in the February through April period under Joint POD Alternatives 2 through 9 compared to Alternative 1, and under Joint POD Alternatives 3 through 9 compared to Alternative 2. Also, the Delta Cross Channel gates will be closed more often in the February through April period under Joint POD Alternatives 2 through 9 compared to the Alternative 1.

Striped Bass. Changes in flow and Delta exports due to the Joint POD alternatives will primarily affect the young-of-the-year striped bass lifestage. The effects of the Joint POD alternatives on young-of-the-year striped bass abundance were modeled using a multiple regression relating total young-of-the-year striped bass abundance at 38 mm. to the mean April – July San Joaquin River flow past Jersey Point, $\log_{10}$ net Delta outflow, and total Delta exports (including CVP, SWP, Contra Costa Canal, and miscellaneous Delta diversions) (Lee Miller, DFG, personal communication). The regression is described in Chapter IV; regression calculations are shown in Volume 2, Appendix 5.

Figure XIII-93 shows the predicted young-of-the-year index for the Joint POD alternatives, by water year type and all years of record combined. The differences between Joint POD alternatives 1 and 2 show the effects of implementing the Bay-Delta Plan. In wetter water years, predicted abundance indices are higher under Alternative 1 than Alternative 2; in drier years, indices are higher under Alternative 2 than Alternative 1. In wet and above normal water years, predicted indices for Joint POD Alternatives 4, 6, and 9 were slightly higher than Alternative 2; indices for Joint POD Alternatives 7 and 8 were lower than for

FIGURE XIII-93
PREDICTED STRIPED BASS YOY INDEX



Alternative 2. In dry and critical water years, predicted indices for Joint POD Alternatives 3 through 9 were higher than Alternatives 1 and 2.

In all water years combined, predicted indices for Alternatives 3 and 5 were similar to the base cases (Alternatives 1 and 2); indices for Alternatives 4, 6, and 9 were slightly higher, and Alternatives 7 and 8 were lower than the base cases.

The observed differences in the abundance indices are primarily due to changes in total Delta exports. Of the flow/export variables included in the regression, mean April – July total Delta exports had a dominant effect on the predicted abundance indices.

The predicted changes in young-of-the-year abundance under Alternatives 7 and 8 may have a slight adverse impact on recruitment to the adult striped bass population compared to the base cases. Striped bass losses under these alternatives could be mitigated through funding of additional stocking.

Delta Smelt. Implementation of Joint POD Alternatives 2 through 9 may slightly improve conditions for delta smelt compared to the D-1485 base case condition. Implementation of these alternatives would generally reduce Delta exports during the spring when delta smelt are most vulnerable to entrainment. Delta smelt are more abundant when X2 is located in Suisun Bay. The location of X2 in Suisun Bay may allow access to considerably more suitable shallow-water habitats than in the river channels upstream (IEP 1996b). The pattern and magnitude of changes to X2 for Joint POD alternatives can largely be attributed to the implementation of the 1995 Bay/Delta Plan. The mean monthly position of X2 for Joint POD alternatives that allow wheeling is not significantly different from the position predicted for Alternative 2 (Table XIII-16).

Delta Food Webs. Negative correlations have been found between export pumping and phytoplankton community composition and chlorophyll *a* concentrations (Lehman 1992). Jassby and Powell (1994) found that diversion and Delta outflow together account for 86 percent of the variability in chlorophyll *a* concentrations in the entrapment zone. Effects on higher trophic levels are not as obvious. Zooplankton populations, such as rotifers and copepods, may be entrained at rates that can affect local populations, but there is probably no overall population effect because only a small proportion of the total population is entrained (IEP 1996a).

Joint POD alternatives that allow wheeling would generally increase exports and reduce Delta outflow from July through January, which may result in localized impacts on populations of lower trophic organisms compared to Joint POD Alternative 2. However, exports would be reduced and Delta outflow increased in the spring months under Joint POD Alternatives 3 – 9, which may improve conditions for lower trophic level organisms.

Abundance/Outflow Model Results. Results of the abundance/outflow models for Joint POD alternatives are shown in Figures XIII-94 through XIII-97. Predicted abundance indices for Joint POD Alternatives 2 – 9 are similar, and slightly higher than for Alternative 1, for all species considered. There are no significant differences between JPOD alternatives that allow wheeling and Alternative 2.

Net Reverse Flows. Net reverse flows occur when the net flow in Delta channels is toward the Delta rather than downstream towards Suisun Bay. These reverse flows may have adverse effects on aquatic resources in the Delta. Reverse flows may result in increased straying of adult fish. Reverse flows may also entrain eggs, larvae, and juvenile fish into the southern and central Delta where rearing conditions may be less suitable, predation may be higher, and fish may be more vulnerable to entrainment at the export facilities and at local diversions. Table XIII-18 lists QWEST flows from the DWRSIM studies used as a measure of reverse flows in Delta channels. To a certain extent, QWEST can be used as a measure of reverse flow conditions in Delta channels. As QWEST decreases, net reverse flows in some Delta channels will increase. The model output shows that QWEST flows for the Joint POD alternatives are relatively mixed for each alternative in the 73-year annual average with no clear best alternative. QWEST generally increases from the base case for all alternatives in February, March, April, August and September. In May, the QWEST varies. In June, July, and between October and January, QWEST for the alternatives generally decreases from the base case. For the critical period annual averages, QWEST generally increases from the base case for all alternatives in February, March, and June through September. During critical periods, the Joint POD alternatives result in decreased QWEST (increased net reverse flows) from October through January with November being mixed.

Summary of Effects on Fish and Aquatic Resources. For most species, conditions under Joint POD Alternatives 2 through 9 would be beneficial compared to D-1485 conditions (Alternative 1). However, some of the benefits of implementation of the 1995 Bay/Delta Plan may be reduced by the adverse effects of implementing the Joint POD alternatives.

Figure XIII-94

Predicted Abundance Indices for Longfin Smelt

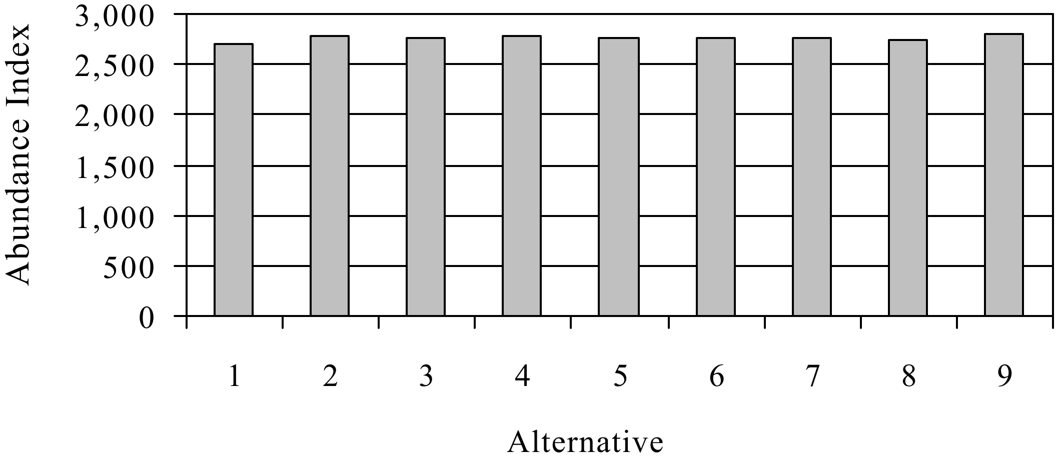


Figure XIII-95

Predicted Abundance Indices for Sacramento Splittail

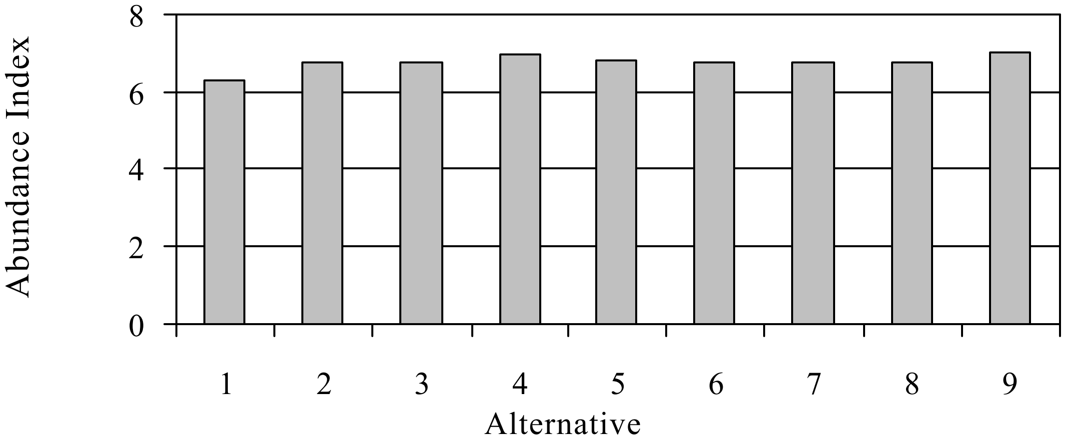


Figure XIII-96
Predicted Abundance Indices for One-Year-Old Starry Flounder

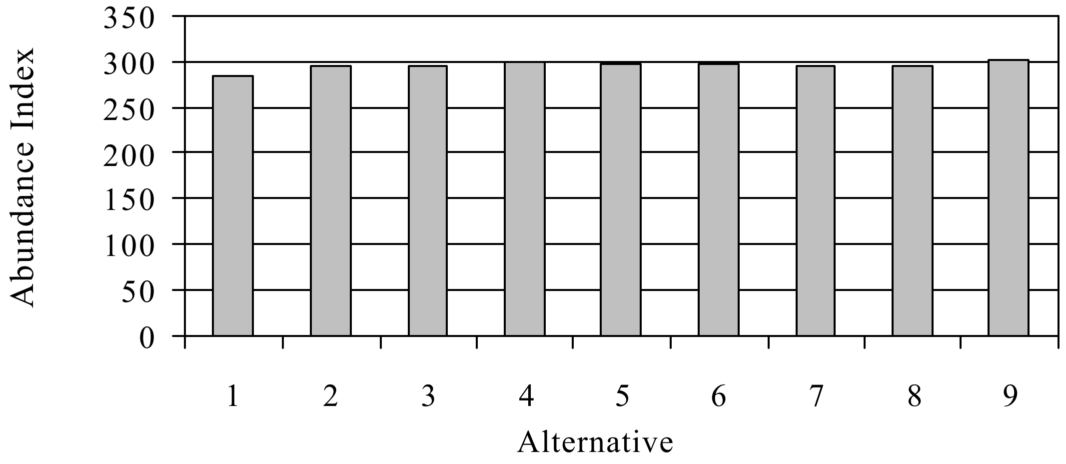


Figure XIII-97
Predicted Abundance Indices for Immature *Crangon franciscorum*

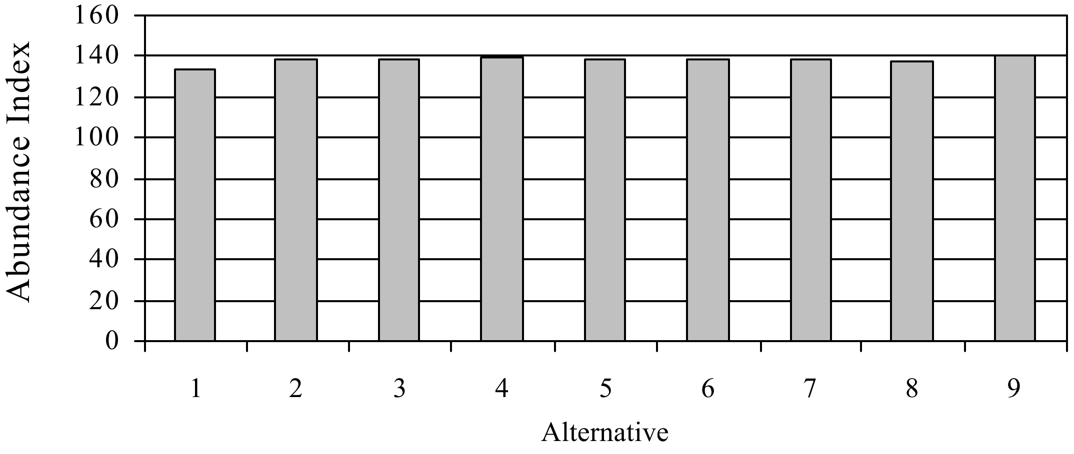


Table XIII-18
QWEST Flows (cfs)

73-Year Annual Average

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	243	-1,133	786	4,357	7,453	6,367	3,335	3,539	3,245	-1,665	-3,111	-1,710
2	-186	-1,481	–153	3,657	7,597	6,319	4,600	2,826	1,119	-2,081	-1,771	-1,313
3	-313	-1,538	-318	3,434	7,646	6,303	4,629	2,856	1,134	-2,270	-2,085	-1,303
4	-362	-1,666	-688	2,923	7,839	6,772	5,543	3,577	1,077	-2,484	-2,497	-1,516
5	-430	-1,623	-632	2,827	8,134	6,745	4,639	2,845	1,130	-2,374	-2,409	-1,313
6	34	-1,634	-433	3,153	8,462	6,931	2,470	4,019	1,088	-2,352	-2,597	-1,336
7	-1,011	-2,339	-1,371	3,570	8,761	6,888	4,434	2,709	905	-3,534	-2,033	-1,444
8	-880	-2,186	-822	1,797	8,629	6,776	4,502	2,682	895	-3,565	-2,373	-1,317
9	-510	-1,572	-650	2,902	7,943	6,937	5,826	3,741	1,163	-2,493	-2,480	-1,379

Critical Period Annual Average

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	720	-884	-1,299	-365	-1,144	717	2,404	424	-339	-2,771	-702	-397
2	-105	-614	-2,625	-3,204	-185	1,724	806	-213	53	-1,254	-140	-255
3	-318	-645	-2,829	-3,249	-221	2,083	747	-130	121	-1,661	-249	-212
4	-340	-658	-2,765	-3,736	-83	2,286	1,368	229	-188	-1,868	-353	-360
5	-355	-647	-2,813	-3,757	-58	2,331	748	-162	56	-1,767	-202	-258
6	-216	-769	-2,736	-3,667	-162	2,359	-1,056	954	178	-1,012	71	-247
7	-300	-1,172	-3,287	-4,076	28	2,438	673	-154	-32	-1,387	230	-109
8	-333	-1,113	-3,012	-4,611	181	2,417	747	-140	-105	-1,344	192	-131
9	-95	-328	-2,616	-3,643	-402	518	1,204	316	-132	-1,824	-139	-363

Joint POD Alternatives 3 through 9 may result in increased entrainment and other export-related effects in the Delta in the July to January period (except September) due to increased Delta exports. Survival of yearling spring-run chinook salmon emigrating through the Delta may be reduced because their emigration period (fall and winter) coincides with the period of increased exports. However, exports would be reduced in the spring months under Joint POD Alternatives 3 through 9 compared to Joint POD Alternatives 1 and 2, potentially reducing entrainment in the critical period for spawning, rearing, and outmigration of many aquatic species in the Delta.

If operations under Joint POD Alternatives 3 through 9 result in increased entrainment, regulatory constraints could be applied to operations on a real-time basis to reduce, offset or avoid impacts. Measures that could be used include switching diversions between SWP and CVP facilities if entrainment is high at one of the facilities, modification of required export/inflow ratios, re-operation of the Delta Cross Channel gates, or reduction or termination of increased exports resulting from joint use of the SWP and CVP points of diversion.

The abundance of many Delta species shows a significant positive relationship with Delta outflow in the spring months. Delta outflow is expected to change with the implementation of the Joint POD alternatives but the effects are not expected to be as significant as entrainment effects. Delta outflow generally decreases compared to the Bay/Delta Plan base case between July and January and increases during February and March, with increases and decreases in April, May, and June.

In general, Joint POD Alternatives 2 through 9 are predicted to have slight beneficial effects on through-Delta survival of juvenile chinook salmon and steelhead, and on abundance of delta smelt, Sacramento splittail, starry flounder, longfin smelt, and *Crangon franciscorum*, compared to the D-1485 base case (Alternative 1). In addition, for most of these species, no significant adverse effects were predicted for the Joint POD alternatives that allow wheeling compared to Alternative 2.

Joint POD Alternative 4 may provide greater protection for aquatic resources than Alternatives 3 and 5 through 9 because the combined use of points of diversion is used primarily for the benefit of aquatic resources.

Joint POD Alternatives 7 and 8 are predicted to have slight adverse impacts on young-of-the-year striped bass abundance compared to the base cases (Alternatives 1 and 2). Potential impacts on striped bass under Joint POD Alternatives 7 and 8 could be mitigated through funding of additional stocking.

F. ENVIRONMENTAL EFFECTS OF IMPLEMENTING JOINT POD ALTERNATIVES IN THE UPSTREAM AREAS

The evaluation of the environmental effects of implementing the Joint POD alternatives in the upstream areas is divided into the following sections: (1) hydrology, (2) water temperature, (3) aquatic habitat, (4) geology, (5) energy, (6) recreation, (7) cultural resources, and (8) economics.

1. Hydrology

This section discusses impacts of the Joint POD alternatives on upstream hydrology. For this analysis, average monthly flows at selected points on Central Valley rivers were compared for each of the Joint POD alternatives. The flows were modeled using DWRSIM, and the analysis focuses on the change in flow on the rivers below the major SWP and CVP reservoirs. The selected points include: the Sacramento River at Red Bluff, Feather River at Gridley, Sacramento River at Verona, American River at Nimbus Dam, and the Stanislaus River at the San Joaquin River.

Tables XIII-19 through XIII-28 illustrate the change in flow among the alternatives at the selected locations. Average monthly flows are compared for the 73-year period and the critical period. Each table presents a comparison of Joint POD Alternatives 2 through 9 to Alternative 1 (base case) and a comparison of Joint POD Alternatives 3 through 9 to Alternative 2. The latter comparison demonstrates the effects of combined use of points of diversion. Most flow changes seen in the comparison to Alternative 1 are the result of the implementation of the Plan's flow objectives. Those impacts are analyzed in Chapter VI.

Tables XIII-19 and XIII-20 show Sacramento River flows at Red Bluff. In comparing Joint POD Alternatives 3 through 9 to Alternative 2, there are no dramatic changes in flows, but overall for the 73-year period, flows are lower for Alternatives 3 through 9 from September through March and in May, and higher in April and June through August. During the critical period, flows are lower for Alternatives 3 through 9 from November through March and in May, and higher in April, June, July and October.

Tables XIII-21 and XIII-22 show Feather River flows at Gridley. Releases from Lake Oroville by the SWP appear to vary considerably under the various Joint POD alternatives, although most of the changes from Alternative 2 are relatively small. However, under Joint POD Alternatives 7 and 8, there is a significant increase in flow in July and a similar decrease in August.

Tables XIII-23 and XIII-24 show Sacramento River flows at Verona. Flows at this point reflect the combined, and sometimes offsetting, effects of changes in releases from Shasta and Oroville. Flows under Joint POD Alternatives 3 through 9 are generally lower than Alternative 2 from November through May and higher from June through August for the 73-year period. For the critical period, flows are lower than Alternative 2 from November through March, and higher than Alternative 2 during June and July.

Tables XIII-25 and XIII-26 show American River flows at Nimbus Dam. Releases from Folsom Lake under Joint POD Alternatives 3 through 9 are generally lower than Alterative 2 in September and from November through May, and higher in July, August and October. During the critical period, flows are considerably lower in March.

Tables XIII-27 and XIII-28 show Stanislaus River flows above the confluence with the San Joaquin River. Only Joint POD Alternatives 6 and 9 show significant changes from Alternative 2. These differences result from changes in the New Melones Reservoir operation with the Letter of Intent (Alternative 6) and the San Joaquin River Agreement (Alternative 9). Under Alternative 6, flows would be lower in comparison to Alternative 2 in April-May and August-September; flows would be higher from October through March and in June. Under Alternative 9, flows are lower in comparison to Alternative 2 in July-August, and in October; flows are higher from November through January, March through June, and in September.

Table XIII-19

Sacramento River Flow at Red Bluff, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	7,227	8,978	12,377	15,272	18,163	15,350	11,477	10,672	10,936	12,776	10,506	6,236

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	72	229	30	-127	220	138	15	-184	1161	-583	-688	38
3	142	79	-37	-158	82	104	33	-220	1186	-439	-451	-15
4	40	-71	-66	-215	49	50	-66	-275	1371	-336	-284	92
5	5	-41	-130	-177	63	-4	42	-242	1193	-280	-120	-19
6	-95	-218	-190	-207	-37	63	433	-497	1590	-438	11	-94
7	-34	-80	-147	-162	17	-84	36	-274	1200	-101	143	-234
8	30	-244	-214	-194	-74	-87	15	-296	1162	-25	547	-296
9	85	-4	-3	-132	92	45	-67	-241	1227	-371	-351	0

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	7,349	9,207	12,407	15,145	18,383	15,488	11,492	10,488	12,097	12,193	9,818	6,274

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	70	-151	-67	-32	-138	-34	19	-36	25	144	238	-53
4	-32	-300	-96	-89	-171	-89	-81	-91	209	246	404	54
5	-67	-270	-161	-50	-157	-143	27	-58	32	303	568	-57
6	-166	-447	-220	-80	-257	-76	418	-313	428	144	699	-132
7	-106	-310	-177	-35	-203	-222	21	-90	39	482	832	-271
8	-42	-473	-244	-67	-294	-225	1	-112	1	558	1235	-334
9	13	-233	-33	-5	-128	-93	-82	-57	66	212	337	-38

Table XIII-20

Sacramento River Flow at Red Bluff, Critical Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	4,793	4,790	6,785	6,904	6,948	6,470	6,907	7,604	8,252	9,739	9,772	5,191

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-190	180	-81	-84	-49	325	51	343	683	811	-1,352	111
3	-35	-40	-81	-84	-39	10	453	290	752	976	-1,420	135
4	-49	34	-123	-125	-90	-36	124	234	1,010	1,124	-1,457	213
5	-56	-85	-123	-125	-81	-38	446	303	840	1,043	-1,400	162
6	-129	-157	-164	-167	-132	-61	730	113	1,318	752	-1,604	131
7	-144	-139	-123	-125	-90	-29	468	282	895	1,069	-1,222	87
8	-35	-69	-123	-125	-46	-18	414	248	934	947	-1,166	67
9	-52	-60	-123	-126	-90	-50	61	266	913	1,063	-1,735	290

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	4,603	4,970	6,704	6,820	6,899	6,795	6,958	7,947	8,935	10,550	8,420	5,302

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	155	-220	0	0	9	-316	402	-54	69	165	-68	24
4	141	-146	-42	-42	-42	-361	73	-109	327	313	-105	102
5	134	-266	-42	-42	-33	-363	395	-40	156	232	-48	50
6	61	-337	-83	-83	-83	-368	679	-230	635	-58	-252	20
7	46	-319	-42	-42	-42	-354	418	-61	211	258	130	-25
8	155	-249	-42	-42	3	-343	363	-95	250	136	186	-44
9	138	-240	-42	-42	-41	-375	10	-77	230	252	-383	179

Table XIII-21

Feather River at Gridley, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,941	2,623	4,525	5,627	6,472	6,280	3,160	3,948	3,351	4,398	3,727	1,818

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-578	-218	-461	-424	79	26	222	-173	867	1601	-576	-189
3	-553	-205	-457	-424	65	-2	181	-187	857	1640	-565	-174
4	-600	-213	-520	-508	23	38	70	-257	775	1761	-277	-131
5	-488	-128	-463	-450	39	99	193	-170	834	1514	-666	-140
6	-561	-249	-539	-476	-39	-6	552	-390	843	1696	-518	-132
7	-520	-236	-464	-412	13	-5	177	-140	864	2725	-1587	-247
8	-514	-232	-460	-408	68	-18	175	-148	880	2675	-1593	-250
9	-662	-273	-568	-481	32	66	30	-306	833	1824	-199	-141

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,363	2,405	4,064	5,203	6,551	6,306	3,383	3,775	4,218	5,999	3,151	1,628

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	25	13	5	0	-14	-27	-41	-14	-10	39	12	15
4	-23	5	-59	-84	-56	13	-152	-83	-92	160	299	58
5	90	90	-2	-26	-40	74	-29	3	-33	-87	-89	49
6	16	-31	-78	-52	-119	-32	330	-216	-24	95	59	57
7	58	-18	-2	13	-66	-30	-45	33	-3	1124	-1010	-57
8	64	-14	2	16	-11	-43	-48	26	13	1073	-1017	-61
9	-84	-55	-107	-57	-47	40	-193	-133	-34	223	377	49

Table XIII-22

Feather River Flow at Gridley, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,841	1,868	2,496	1,185	1,522	1,645	1,661	1,789	3,018	4,382	2,486	1,556

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-1,161	73	-167	-155	-126	220	764	714	633	-445	-48	-374
3	-1,175	78	-172	-155	-105	132	569	706	616	35	21	-496
4	-1,168	84	-169	-155	-126	136	199	419	605	210	248	-496
5	-1,181	70	-173	-155	-105	136	575	707	619	96	-6	-497
6	-1,146	-14	-192	-155	-145	155	1,781	212	418	-620	143	-440
7	-1,151	97	-186	-155	-105	183	621	804	711	646	-986	-444
8	-1,148	104	-185	-155	-103	188	613	778	766	637	-983	-468
9	-1,248	99	-177	-155	-145	170	278	241	670	253	414	-512

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,680	1,941	2,329	1,030	1,396	1,865	2,425	2,503	3,651	3,937	2,438	1,181

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	-14	5	-5	0	21	-87	-195	-8	-17	479	69	-122
4	-7	0	-1	0	0	-84	-364	-295	-28	655	297	-122
5	-19	-3	-5	0	21	-83	-188	-7	-14	540	43	-122
6	16	-87	-25	0	-19	-65	1,017	-502	-215	-175	192	-66
7	10	24	-19	0	21	-37	-143	90	78	1,091	-938	-70
8	13	31	-18	0	24	-32	-151	64	133	1,081	-935	-93
9	-87	26	-10	0	-19	-51	-486	-473	37	698	462	-137

Table XIII-23

Sacramento River at Verona, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
11,776	13,579	19,218	26,962	31,867	30,444	19,148	15,623	12,712	12,853	10,543	9,488

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-509	8	-435	-553	349	165	236	-355	2,030	1,019	-1,264	-152
3	-414	-129	-498	-585	197	104	213	-404	2,044	1,202	-1,015	-190
4	-563	-286	-590	-726	122	89	3	-529	2,147	1,425	-560	-40
5	-487	-172	-598	-630	152	96	234	-409	2,028	1,235	-785	-160
6	-659	-470	-733	-686	-27	58	984	-884	2,434	1,258	-506	-227
7	-557	-319	-614	-576	79	-87	212	-411	2,066	2,624	-1,443	-481
8	-487	-479	-677	-604	43	-103	189	-441	2,044	2,650	-1,046	-547
9	-580	-281	-575	-616	174	113	-39	-545	12,061	1,454	-549	-142

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
11,267	13,587	18,782	26,409	32,216	30,610	19,384	15,268	14,741	13,872	9,279	9,336

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	95	-137	-62	-32	-152	-61	-23	-49	14	183	249	-37
4	-54	-295	-155	-173	-227	-76	-233	-174	118	406	704	112
5	23	-180	-162	-76	-197	-69	-2	-55	-2	216	479	-7
6	-150	-478	-298	-133	-375	-107	748	-529	405	239	758	-75
7	-48	-328	-179	-22	-270	-253	-24	-57	36	1606	-179	-328
8	22	-487	-242	-51	-306	-268	-47	-87	14	1631	218	-395
9	-71	-289	-139	-63	-175	-53	-275	-190	32	435	715	10

Table XIII-24

Sacramento River Flow at Verona, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
8,494	7,232	9,837	13,840	12,231	12,084	8,111	7,686	8,336	10,246	9,066	7,032

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-1,357	253	-250	-240	-153	542	809	1,055	1,319	369	-1,405	-259
3	-1,216	38	-254	-240	-122	139	1,016	993	1,370	1,013	-1,404	-357
4	-1,223	119	-292	-281	-194	98	518	651	1,618	1,337	-1,213	-279
5	-1,242	-16	-296	-281	-164	95	1,015	1,007	1,461	1,142	-1,410	-331
6	-1,280	-171	-358	-323	-255	91	2,505	322	1,738	135	-1,465	-305
7	-1,301	-42	-310	-281	-173	151	1,084	1,084	1,608	1,718	-2,213	-354
8	-1,189	36	-309	-281	-126	167	1,022	1,023	1,702	1,586	-2,154	-396
9	-1,307	39	-302	-281	-213	116	334	503	1,585	1,319	-1,325	-218

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
7,137	7,485	9,587	13,601	12,078	12,626	8,920	8,740	9,654	10,615	7,660	6,773

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	141	-215	-5	0	30	-403	207	-62	52	644	1	-98
4	134	-134	-43	-42	-42	-444	-291	-404	299	968	192	-20
5	115	-269	-47	-42	-11	-447	207	-47	142	773	-5	-72
6	77	-424	-108	-83	-102	-451	1,696	-733	420	-234	-59	-46
7	57	-295	-60	-42	-20	-391	275	29	289	1,349	-807	-95
8	168	-217	-60	-42	27	-375	213	-31	383	1,217	-748	-138
9	50	-214	-52	-42	-60	-426	-476	-551	267	950	81	41

Table XIII-25
American River Flow at Nimbus, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2,159	2,696	3,651	4,374	5,145	4,001	3,695	3,359	3,895	3,513	2,762	1,898

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-189	-37	-227	-140	46	91	29	102	832	-348	-379	319
3	-101	-68	-285	-169	-6	22	31	119	804	-265	-200	206
4	-178	-134	-253	-201	-98	38	-37	84	949	-219	-88	216
5	-138	-127	-295	-163	-73	33	-6	89	816	-185	46	80
6	-131	-122	-292	-209	-89	19	162	-18	975	-225	-15	34
7	-128	-151	-331	-168	-57	4	17	120	803	-96	128	-67
8	-214	-316	-434	-265	-197	-106	-80	44	669	-205	80	-353
9	-126	-82	-261	-155	-69	23	-32	66	868	-238	-111	176

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,970	2,659	3,424	4,234	5,191	4,092	3,724	3,461	4,727	3,165	2,383	2,216

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	88	-31	-58	-28	-52	-69	2	17	-28	83	179	-113
4	12	-97	-25	-60	-144	-53	-66	-17	117	129	292	-102
5	51	-90	-68	-23	-119	-57	-35	-13	-16	163	426	-239
6	58	-85	-65	-69	-135	-71	133	-120	143	123	364	-285
7	61	-114	-104	-28	-103	-86	-11	18	-29	252	508	-386
8	-25	-279	-207	-124	-243	-197	-109	-58	-162	144	460	-672
9	63	-45	-12	-15	-115	-68	-61	-36	36	110	268	-142

Table XIII-26
American River Flow at Nimbus, Critical Period

Alternative 1 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,571	1,314	1,277	1,212	2,039	1,868	2,622	1,791	2,715	4,210	2,412	576

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	143	177	-481	-462	-892	275	162	461	2,009	-1,280	-754	537
3	292	317	-407	-378	-733	-166	38	433	1,867	-1,348	-602	575
4	331	200	-481	-503	-976	-157	27	343	2,354	-1,380	-663	707
5	371	320	-405	-420	-816	-189	46	460	1,866	-1,328	-661	614
6	468	374	-406	-420	-852	-45	463	27	2,100	-1,389	-926	572
7	318	373	-407	-378	-724	-167	-34	383	1,949	-1,386	-470	426
8	152	252	-409	-420	-856	-266	-118	313	1,798	-1,469	-635	357
9	289	295	-480	-504	-1,032	-57	54	449	2,231	-1,424	-659	648

Alternative 2 Average Monthly Flow (cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,713	1,490	796	750	1,147	2,143	2,784	2,252	4,725	2,930	1,658	1,113

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	149	140	74	83	160	-441	-125	-28	-142	-68	152	38
4	189	24	0	-42	-84	-433	-136	-118	344	-100	91	170
5	228	144	76	42	76	-464	-116	-1	-143	-48	93	77
6	326	197	75	42	40	-321	301	-434	90	-108	-172	35
7	175	197	74	83	169	-442	-196	-78	-60	-106	284	-111
8	9	75	72	42	36	-541	-280	-148	-212	-189	119	-180
9	147	119	1	-42	-140	-332	-108	-12	221	-144	95	111

Table XIII-27

Stanislaus River Flow at Mouth, 73-Year Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	853	523	588	739	1,048	736	1,124	789	877	634	601	597

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-106	-63	-135	-203	-329	-70	337	572	178	240	289	-14
3	-103	-58	-134	-197	-334	-80	337	572	178	239	287	-14
4	-105	-59	-135	-198	-352	-92	354	588	177	238	289	-14
5	-103	-58	-134	-196	-333	-80	336	571	176	237	288	-14
6	396	46	164	158	176	75	-132	224	267	235	-6	-183
7	-106	-59	-132	-196	-325	-80	336	570	177	237	284	-14
8	-102	-58	-133	-196	-325	-91	345	571	170	239	285	-14
9	-176	68	2	-176	-330	-5	358	734	381	216	178	-9

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	746	460	452	536	718	666	1,461	1,362	1,055	874	890	583

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	4	5	2	6	-5	-10	0	0	0	-1	-2	0
4	1	4	0	5	-23	-21	18	16	-1	-2	0	0
5	4	5	2	7	-3	-10	-1	-1	-2	-2	-1	0
6	502	108	300	361	506	145	-469	-348	89	-5	-295	-169
7	1	3	3	7	5	-9	-1	-2	-1	-3	-5	0
8	5	5	3	7	4	-20	8	-1	-8	-1	-4	0
9	-69	131	138	27	0	65	21	161	206	-24	-111	5

Table XIII-28

Stanislaus River Flow at Mouth, Critical Period

Alternative 1 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	374	451	407	333	307	344	840	609	653	646	646	588

Change in Flow from Alternative 1 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2	-22	-119	-142	-106	-65	-16	11	276	249	281	293	-14
3	-22	-119	-142	-106	-65	-16	14	274	248	281	293	-14
4	-22	-119	-142	-106	-65	-16	12	274	248	281	293	-14
5	-22	-119	-142	-106	-65	-16	14	276	248	282	293	-14
6	114	-78	-36	26	104	90	49	284	262	254	-203	-210
7	-22	-119	-142	-106	-65	-16	14	276	248	281	293	-14
8	-22	-119	-142	-106	-65	-16	10	279	247	280	293	-14
9	29	-96	-63	-68	-20	7	121	417	294	179	-42	-44

Alternative 2 Average Monthly Flow (cfs)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	352	332	265	227	242	328	852	884	902	927	939	574

Change in Flow from Alternative 2 (cfs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	0	0	0	0	0	0	3	-1	0	0	0	0
4	0	0	0	0	0	0	0	-1	-1	0	0	0
5	0	0	0	0	0	0	3	0	0	0	0	0
6	136	41	106	132	170	106	38	9	14	-27	-496	-196
7	0	0	0	0	0	0	3	0	-1	0	-1	0
8	0	0	0	0	0	0	-1	3	-1	-1	-1	0
9	51	23	80	38	45	23	109	142	45	-102	-335	-30

2. Water Temperature

The effects of implementation of the Joint POD alternatives on water temperature in upstream areas were analyzed to evaluate potential effects on habitat for fish and aquatic resources. The water temperature model developed by the USBR (USBR 1990, 1993, 1997; described in Chapter IV) was used to assess the effects of the Joint POD alternatives on water temperature in four major streams in the Sacramento-San Joaquin River system, the Sacramento, Feather, American, and Stanislaus rivers. Monthly project operations, modeled with DWRSIM, were input to the temperature model for the 72-year hydrologic period of record (1922-93). The model was used to predict mean monthly water temperatures at eight to twelve locations on each stream.

The following sites were selected for detailed analysis of temperature effects (in order from upstream to downstream):

- Sacramento River – Below Keswick Dam, Ball's Ferry, Jelly's Ferry, and Vina
- Feather River – Downstream of the Afterbay, Honcut Creek, and Mouth
- American River – Below Nimbus Dam, Watt Avenue, and Mouth
- Stanislaus River – Below Goodwin Dam, Orange Blossom Bridge, and Mouth

Representative water years were selected for analysis from the period of record for wet, above normal, below normal, dry, and critical water year types. Representative years selected were years closest to the median monthly temperature values for each water year type. For the Sacramento River system, water years 1942, 1928, 1979, 1964, and 1992, respectively, were selected to represent the five water year types. For the Stanislaus River, water years 1980, 1963, 1950, and 1976 were selected to represent wet, above normal, below normal, and critical water year types, respectively. Dry water years were not analyzed for the Stanislaus River because no impacts were identified in other water year types.
Volume 2, Appendix 5 includes predicted mean monthly water temperatures for the above-described stations and water years.

The precision of the model was estimated at approximately ± 1.0° F among the alternatives (J. Rowell, personal communication). In this analysis, water temperatures predicted for Joint POD alternatives 2, 4, 5, 8 and 9 were compared with values predicted for Alternative 1 (base case) for each location and representative water year. Predicted temperature values for Joint POD alternatives within 1.0° F of those predicted for the base case were considered within the error of model predictions.

a. Sacramento River. Water temperatures predicted under the Joint POD alternatives were not different from those predicted for the base cases (Alternatives 1 and 2) at any location in wet or above normal water years. In below normal years, predicted temperatures in September at Ball's Ferry and Vina under Alternatives 5, 8, and 9 were approximately 1.5 °F higher than in Alternatives 1 and 2. In dry years, predicted temperatures in September at Ball's Ferry and Vina under Alternative 2 were approximately 1.5 °F higher than in Alternative 1.

In critical years, predicted temperatures in August at Ball's Ferry, Bend Bridge, and Vina under Alternatives 2, 4, 5, 8 and 9 were approximately 2 – 3 °F higher than in Alternative 1. Also in critical years, temperatures in September at Keswick under Alternatives 4, 5, and 8 were approximately 1.5 – 5 °F higher than in Alternatives 1 and 2; temperatures at Ball's Ferry and Bend Bridge in September of critical years were 1 – 3 °F higher under Alternatives 5 and 8 than in Alternatives 1 and 2.

These modeled temperature differences due to implementation of the Joint POD alternatives are unlikely to result in significant impacts to fishery resources. SWRCB Order WR 90-5 specifies temperature objectives for the mainstem Sacramento River. Temperature criteria also have been established for the protection of winter-run chinook salmon spawning, egg incubation, and rearing in the mainstem Sacramento River in the biological opinion for the operation of the CVP and SWP (NMFS 1993). The Sacramento River Temperature Task Group, consisting of representatives from the SWRCB, USBR, USFWS, WAPA, USCOE and NMFS, meets on a regular basis during the temperature control season (May through October); typical discussions include an assessment of the temperature control operations and forecast of operations for the remainder of the season. Operational adjustments are made on a real-time basis to reduce temperature impacts on winter-run chinook salmon and other species. Operation of the temperature control device at Shasta Dam is increasing the ability to control water temperatures for anadromous fish protection in the mainstem Sacramento River.

b. **Feather River**. In general, water temperature changes predicted by the model were due to implementation of the Water Quality Plan (Alternative 2), but varied little with the addition of joint use of points of diversion in Alternatives 3 through 9.

Water temperatures predicted under the Joint POD alternatives were not different from those predicted for the base cases at any location in wet water years. At all sites, predicted water temperatures in an above normal water year were approximately 1 – 2° F higher in August under Alternative 8 than in the base cases. In a below normal water year, predicted temperatures in August under Alternatives 4, 5, 8 and 9 were approximately 1 – 3° F higher than in Alternative 1, but were similar to Alternative 2.

In a dry water year, predicted temperatures in April under Alternatives 2, 4, 5, 8 and 9 were approximately 2° F higher than in Alternative 1 at the two downstream sites; in May in a dry water year, temperatures under Alternatives 2, 4, 5, 8 and 9 were approximately 2 – 3° F higher than in Alternative 1 at all sites. In a critical water year, temperatures predicted under the Joint POD alternatives were not different from those predicted for the base cases at any location.

These modeled water temperature increases in the lower river are not likely to result in significant impacts to fishery resources compared to the base case condition.

Fall and spring-run chinook salmon and steelhead spawn and rear in the lower Feather River. Fall-run chinook salmon typically emigrate from the lower river from January through March and therefore are not affected by elevated water temperatures. Spring-run chinook salmon spawn in the low flow channel from late August through October; steelhead rear in the low flow channel year-round.

Temperatures in the lower river are controlled through operation of a temperature control device. The DFG/DWR Hatchery Water Supply Temperature Agreement (August 26, 1983) established minimum and maximum criteria for temperatures at the intake to Feather River Hatchery at the Thermalito Diversion Dam. These requirements, in addition to providing suitable rearing temperatures at the hatchery, provide suitable temperature releases for coldwater species in the lower river.

The NMFS is currently completing evaluation of the short-term effects of operation of the CVP and SWP on steelhead trout and spring-run chinook salmon. A biological opinion will be issued in the near future which is likely to include water temperature conditions to protect spring-run chinook salmon spawning and steelhead rearing in the low flow channel of the Feather River.

c. American River. In a wet water year, predicted temperatures at all sites were approximately 2° F higher in July under Alternative 8 than in Alternative 1. In an above normal year, temperatures at all sites were approximately 1 - 3° F higher in September under Alternative 8 than in Alternatives 1 and 2. In a below normal year, temperatures at all sites were approximately 1 – 2° F higher in September under Alternatives 5, 8, and 9 than in the base cases. In a dry water year, temperatures predicted under the alternatives were not different from those predicted for the base cases at any location.

In a critical year, storage at Folsom Reservoir is lower in the summer months under the JPOD alternatives compared to the base cases, resulting in some cases in elevated water temperatures. Predicted temperatures under the Joint POD alternatives differed from the base cases in May, July, and August. Predicted temperatures at the two upstream sites were approximately 1 - 2° F higher in May under Alternative 8 compared to Alternatives 1 and 2. Temperatures in July under Alternatives 4, 5, and 9 ranged approximately 3 – 4° F higher than in Alternative 1 at all sites, but were similar to Alternative 2. Also in July, temperatures under Alternative 8 were approximately 5 °F higher than in Alternatives 2, 4, 5, and 9 at all sites. In August, temperatures under Alternatives 4, 5, 8 and 9 were approximately 2 - 4° F higher than in Alternative 1 at all sites, but were similar to Alternative 2.

These modeled water temperature increases in the lower river are not likely to result in significant impacts to fishery resources compared to the base case condition for the following reasons: 1) even under the base case condition, suitable habitat is not available year-round for all salmonid lifestages, 2) the model did not include real-time operational adjustments that are made to reduce water temperature impacts, 3) the model did not include the planned construction and operation of a multi-level release structure at Folsom Dam, which is expected to allow the release of cooler water in the late summer months.

Under the base case condition, warm summer and fall water temperatures on the lower American River have been identified as a limiting factor to juvenile steelhead rearing in the river (USFWS 1995). Water temperatures in the lower American River from July to October are commonly higher than optimum levels for survival of juvenile steelhead. Steelhead generally do not survive the extended warm waters in many years and move prematurely out of the American River to seek cooler water. High water temperatures have significantly limited natural steelhead production in the lower river (McEwan and Nelson 1991). Elevated temperatures in the late summer are also suspected to delay fall-run chinook spawning in the lower river and may impede reproductive success (USFWS 1995).

The temperature modeling assumed that no operational changes would be made to control temperatures in the lower river. However, the USBR, DFG, USFWS, and NMFS meet routinely to discuss operational changes to benefit fishery resources in the lower American River. Flow and water temperature needs for fisheries are taken into consideration for operations on a real-time basis. A temperature target of 65°F at Watt Avenue is used to protect juvenile steelhead rearing in the lower river. Operational adjustments are often made to reduce impacts on water temperatures in the late summer months of dry and critical water years.

The predicted effects on water temperature in the lower American River in July and August also assume that no new facilities would be constructed. The planned construction and operation of a multi-level release structure at Folsom Dam is expected to permit the release of cooler water in the late summer and fall than was indicated by the model simulations. The NMFS is currently completing evaluation of the short-term effects of operation of the CVP and SWP on steelhead trout. A biological opinion will be issued in the near future which is likely to include conditions to reduce adverse effects of water temperature on steelhead in the lower American River.

d. **Stanislaus River**. In the Stanislaus River, no adverse effects on water temperature were predicted under the Joint POD alternatives in any water year type. In some cases, the Joint POD alternatives are predicted to result in improved temperature conditions in the lower river for coldwater species by lowering water temperatures in the spring months compared to the base case.

3. Aquatic Habitat

River flow and reservoir storage may be directly affected by water operations under the proposed Joint POD alternatives. The frequency, magnitude, and timing of natural flow regimes of rivers tributary to the Delta have been changed significantly by water supply operations. These changes influence aquatic habitat in rivers by changing the streambed and river channel geometry, riparian habitat, substrate composition, and water temperatures. Water supply operations also affect the frequency, duration, magnitude and timing of drawdown in reservoirs. The upstream aquatic habitat impact assessment focuses on the frequency, timing, and magnitude of these changes to instream flows and reservoir surface elevations.

a. **Rivers**. The Range of Variability Approach (RVA) developed by Richter et al (1997) was used to assess the impact of the Joint POD alternatives on aquatic habitat in rivers in the Sacramento-San Joaquin system. This approach, described in Chapter VI, is based on aquatic ecology theory concerning the critical role of hydrologic variability, and associated characteristics of duration and timing, in sustaining aquatic ecosystems.

The RVA method was used to assess the relative effects of the Joint POD alternatives on stream ecosystems below the major SWP and CVP reservoirs at the following locations where estimates of unimpaired flow data were available:

- Sacramento River near Red Bluff
- Feather River near Oroville
- American River at Fair Oaks
- Stanislaus River at Melones Reservoir

Since estimated unimpaired flows were available only on a monthly time step, a subset of the 32 hydrologic parameters recommended in the RVA analysis was calculated for the available period of record (1922 – 1993). Hydrologic parameters used in the analysis are summarized in Table XIII-29, and include the magnitude of monthly flows, the magnitude of annual extreme flow conditions, and the timing of annual extreme flow conditions.

Table XIII-29
Summary of Hydrologic Parameters Used in Assessment of the Impacts of the Joint POD alternatives.

Flow Statistics Group	Regime Characteristics	Hydrologic Parameters
Magnitude of monthly flow conditions	Magnitude	Mean monthly flows
Magnitude of annual extreme flow conditions	Annual Extremes	Mean annual minimum monthly flow Mean annual maximum monthly flow
Timing of annual extreme flow conditions	Timing	Month of annual minimum flow Month of annual maximum flow

From the estimated unimpaired flows, management targets were established for each of the flow parameters (± 1 standard deviation from the mean). For those parameters where a skewed distribution resulted in a standard deviation that exceeded the minimum or maximum value, the actual unimpaired minimum or maximum value was used as the lower or upper target range boundary.

Simulated flows for the period of record (1922 – 1993) for each of the Joint POD alternatives (DWRSIM analysis) were then compared with flow target ranges to evaluate the relative suitability of the alternatives in meeting ecological objectives. For the flow simulations, locations from the DWRSIM analysis were selected that were closest to sites on each river where estimated unimpaired flow data were available. The rate of non-attainment of the flow management targets was calculated for each site and flow parameter.

Table XIII-30 summarizes the RVA for the Stanislaus River at Melones Reservoir. Analyses for all sites are shown in Volume 2, Appendix 5.

Cases where flow parameters showed a greater than 10 percent deviation in the non-attainment rate between the Joint POD alternatives and the base cases (Alternatives 1 and 2) are described below. In some cases, the difference in the rate of non-attainment showed a slight positive effect, moving closer to unimpaired conditions; in other cases, the difference showed a slight adverse effect, moving away from unimpaired conditions.

Sacramento River. No differences in the rate of non-attainment greater than 10 percent were observed between the Joint POD alternatives and the base cases in any of the flow parameters.

Feather River. In October, flows in the Feather River were lower under Alternatives 2 through 9 than under Alternative 1, resulting in lower rates of non-attainment and a shift toward unimpaired conditions. In June, flows were higher under Alternatives 2 through 9 than under Alternative 1, also resulting in lower rates of non-attainment and a shift toward unimpaired conditions. In August, flows were lower under Alternatives 7 and 8 than under Alternatives 1 and 2, also resulting in lower rates of non-attainment and a shift toward unimpaired conditions. However, in January, flows were lower under Alternatives 2 through 9 than under Alternative 1, resulting in slightly higher rates of non-attainment and a shift away from unimpaired conditions.

American River. No differences in the rate of non-attainment greater than 10 percent were observed in monthly flow magnitudes or magnitudes of mean annual extremes among the Joint POD alternatives and between the Joint POD alternatives and the base case. Under Alternatives 2 through 9, the timing of the annual maximum was shifted toward unimpaired conditions compared to Alternative 1.

Stanislaus River. In February, flows were increased under Alternative 6 compared to Alternatives 1 and 2, resulting in a lower rate of non-attainment and a shift toward unimpaired conditions. Under Alternative 9, the lower end of the range of monthly flows simulated for February increased slightly compared to Alternatives 1 and 2, also resulting in a lower rate of non-attainment and a shift toward unimpaired conditions.

In August, flows were increased or slightly decreased under Alternatives 2 through 9 compared to Alternative 1, resulting in higher rates of non-attainment and a shift away from unimpaired conditions. Under Alternative 6, flows are decreased in August compared to Alternative 2, resulting in a lower rate of non-attainment and a shift toward unimpaired conditions.

Table XIII-30. Results of the Range of Variability Analysis Stanislaus River at New Melones Reservoir Joint POD Alternatives

	Unimpaired Conditions (1922 - 93)						Alternative 1					Alternative 2				
			Range limits		RVA Target Range				Range limits					Range limits		
IHA Group 1	Mean	SD	Low	High	Low	High	Mean	SD	Low	High	Rate of Non-Attainment	Mean	SD	Low	High	Rate of Non-Attainment
Monthly Flow Magnitude (cfs)																
October	160	179	0	1,434	0	339	601	1,292	63	5,362	15%	491	1,083	63	5,362	19%
November	475	878	34	6,162	34	1,353	381	466	198	3,360	3%	319	471	198	3,360	3%
December	858	1,309	49	6,712	49	2,166	463	754	130	4,744	4%	325	653	130	4,744	3%
January	1,178	1,354	49	6,240	49	2,533	651	949	130	4,918	7%	446	861	130	4,918	6%
February	1,651	1,507	18	9,596	144	3,158	965	1,204	124	4,986	22%	622	937	124	4,969	28%
March	2,003	1,229	212	6,696	775	3,232	544	988	130	5,292	85%	470	924	130	5,292	92%
April	3,222	1,263	589	7,290	1,958	4,485	750	433	471	1,467	100%	1,093	645	471	3,243	92%
May	4,558	2,247	717	9,694	2,311	6,805	449	328	255	2,067	100%	1,026	615	255	2,707	94%
June	2,914	2,033	185	10,640	881	4,947	585	909	255	4,595	90%	758	659	255	4,595	83%
July	836	807	0	4,659	30	1,643	352	244	265	2,231	1%	591	237	265	2,231	1%
August	200	193	0	1,254	6	393	317	44	283	407	10%	604	73	283	702	99%
September	108	113	0	640	0	221	264	102	249	1,110	100%	253	67	0	758	99%
IHA Group 2																
Mean Annual Extremes (cfs)																
Annual 30-day minimum	69	67	0	488	2	135	115	60	63	289	19%	119	81	0	631	15%
Annual 30-day maximum	4,922	2,280	717	10,640	2,642	7,202	1,547	1,543	471	5,362	78%	1,681	1,232	517	5,362	83%
IHA Group 3																
Timing of Annual Extremes																
Month of annual minimum	9	1	7	2	8	10	11	2	8	3	31%	8	4	1	12	47%
Month of annual maximum	4	1	12	6	3	5	3	2	10	6	44%	5	2	1	10	50%

	Alternative 3					Alternative 4					Alternative 5				
			Range limits					Range limits					Range limits		
IHA Group 1	Mean	SD	Low	High	Rate of Non-Attainment	Mean	SD	Low	High	Rate of Non-Attainment	Mean	SD	Low	High	Rate of Non-Attainment
Monthly Flow Magnitude (cfs)															
October	495	1,082	63	5,362	21%	493	1,083	63	5,362	21%	495	1,082	63	5,362	21%
November	324	472	198	3,360	3%	323	472	198	3,360	3%	324	472	198	3,360	3%
December	327	653	130	4,744	3%	325	653	130	4,744	3%	327	653	130	4,744	3%
January	452	864	130	4,918	6%	451	864	130	4,918	6%	453	865	130	4,918	6%
February	617	940	124	4,969	29%	600	938	124	4,969	31%	619	941	124	4,969	29%
March	460	929	130	5,292	92%	448	884	130	5,292	92%	460	929	130	5,292	92%
April	1,093	644	471	3,243	92%	1,111	642	471	3,243	92%	1,092	643	471	3,243	92%
May	1,026	613	255	2,702	94%	1,043	613	255	2,702	94%	1,025	612	255	2,705	94%
June	758	662	255	4,595	83%	757	645	255	4,595	82%	756	663	255	4,595	83%
July	590	237	265	2,231	1%	590	237	265	2,231	1%	589	237	265	2,231	1%
August	603	72	283	702	99%	605	73	283	703	99%	604	74	283	710	99%
September	253	67	0	758	99%	253	67	0	758	99%	253	67	0	758	99%
IHA Group 2															
Mean Annual Extremes (cfs)															
Annual 30-day minimum	119	81	0	631	15%	118	80	0	631	15%	119	81	0	631	15%
Annual 30-day maximum	1,682	1,234	518	5,362	83%	1,695	1,193	518	5,362	83%	1,682	1,235	518	5,362	83%
IHA Group 3															
Timing of Annual Extremes															
Month of annual minimum	8	4	1	12	47%	8	4	1	12	47%	8	4	1	12	47%
Month of annual maximum	5	2	1	10	50%	5	2	1	10	49%	5	2	1	10	50%

Table XIII-30 continued. Results of the Range of Variability Analysis
Stanislaus River at New Melones Reservoir
Joint POD Alternatives

	Alternative 6					Alternative 7				
			Range limits		Rate of Non-			Range limits		Rate of Non-
IHA Group 1	**Mean**	**SD**	**Low**	**High**	**Attainment**	**Mean**	**SD**	**Low**	**High**	**Attainment**
Monthly Flow Magnitude (cfs)										
October	998	1,607	224	5,866	24%	492	1,083	63	5,362	19%
November	428	472	225	3,363	3%	323	471	198	3,360	3%
December	628	906	224	5,731	4%	328	654	130	4,744	3%
January	811	1,004	224	4,924	8%	453	865	130	4,918	6%
February	1,134	1,280	225	5,973	7%	627	940	124	4,969	28%
March	616	955	224	5,361	83%	460	929	130	5,292	92%
April	619	142	452	1,579	100%	1,092	643	471	3,243	92%
May	673	381	444	3,238	99%	1,024	613	255	2,704	94%
June	849	1,122	200	6,351	90%	756	663	255	4,595	83%
July	586	306	75	2,590	1%	589	237	265	2,231	1%
August	314	213	50	631	44%	600	74	283	703	99%
September	84	144	49	1,230	3%	253	67	0	758	99%
IHA Group 2										
Mean Annual Extremes (cfs)										
Annual 30-day minimum	71	69	49	631	3%	119	81	0	631	15%
Annual 30-day maximum	1,994	1,808	624	6,351	69%	1,682	1,235	518	5,362	83%
IHA Group 3										
Timing of Annual Extremes										
Month of annual minimum	9	1	7	9	8%	8	4	1	12	47%
Month of annual maximum	6	3	1	12	82%	5	2	1	10	50%

	Alternative 8					Alternative 9				
			Range limits		Rate of Non-			Range limits		Rate of Non-
IHA Group 1	**Mean**	**SD**	**Low**	**High**	**Attainment**	**Mean**	**SD**	**Low**	**High**	**Attainment**
Monthly Flow Magnitude (cfs)										
October	496	1,083	63	5,362	21%	418	456	125	1,501	29%
November	324	472	198	3,360	3%	451	416	208	1,501	13%
December	328	654	130	4,744	3%	463	484	208	3,187	1%
January	453	865	130	4,918	6%	473	571	146	3,487	3%
February	627	939	124	4,969	28%	621	724	146	4,825	1%
March	449	882	130	5,292	92%	534	852	146	6,502	85%
April	1,101	648	471	3,241	92%	1,124	396	475	1,591	100%
May	1,026	613	255	2,709	94%	1,196	572	455	3,837	96%
June	750	661	255	4,595	85%	970	1,073	241	8,460	78%
July	591	238	265	2,231	1%	573	271	254	2,545	1%
August	601	75	283	727	99%	504	150	268	685	72%
September	253	67	0	758	99%	270	100	224	1,067	100%
IHA Group 2										
Mean Annual Extremes (cfs)										
Annual 30-day minimum	119	81	0	631	15%	218	83	125	635	82%
Annual 30-day maximum	1,678	1,208	520	5,362	83%	1,368	1,050	584	8,460	94%
IHA Group 3										
Timing of Annual Extremes										
Month of annual minimum	8	4	1	12	47%	9	2	3	10	17%
Month of annual maximum	5	2	1	10	51%	6	2	3	12	43%

Under Alternative 6, the magnitude of the annual 30-day maximum flow was higher compared to Alternatives 1 and 2, resulting in a slightly lower rate of non-attainment and a shift toward unimpaired conditions. Under Alternative 9, the magnitude of the annual 30-day minimum was higher, and the magnitude of the annual 30-day maximum was lower, than under Alternatives 1 and 2, resulting in higher rates of non-attainment and a shift away from unimpaired conditions.

The timing of the annual minimum flow was more variable under Alternatives 2 through 5, 7, and 8 than Alternative 1, resulting in a shift away from unimpaired conditions. Under Alternatives 6 and 9, the timing of the annual minimum flow was closer to unimpaired conditions than under Alternative 1. The timing of the annual maximum flow under Alternative 6 was shifted later in the year and was more variable than under Alternatives 1 and 2, resulting in a shift away from unimpaired conditions.

Summary. Differences in the rate of non-attainment of the target ranges between the Joint POD alternatives and the base cases and among the alternatives are minor. Rates of non-attainment are high in some months for all of the Joint POD alternatives, since the pattern of regulated flow releases in the system differs significantly from the unimpaired condition. However, the pattern of non-attainment of the targets generally is similar among the Joint POD alternatives. No significant impacts on riverine aquatic habitat in upstream areas are therefore expected. No mitigation is required.

b. Reservoirs. Habitat conditions in relation to initial reservoir elevation and fluctuations were analyzed for each of the five major reservoirs in the CVP and SWP project areas. These reservoirs include: Lake Shasta, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Habitat conditions evaluated include the spawning and rearing habitat quality for warmwater fisheries including largemouth bass, smallmouth bass, and spotted bass. A discussion of the assumptions and analytical methods used in the analysis can be found in Chapter VI. The methodology assumes that increases in the quantity and quality of habitat are indicated by increases in the index. Decreases indicate a decrease in habitat value. Modeled reservoir elevations may be expected to have a margin of error of 10 to 20 percent. Therefore, effects of the various alternatives are considered significant only if the differences from the base case are greater than 10 percent.

The results of the analysis of Joint POD Alternatives are shown in Tables XIII-31 and XIII-32 as the 73-Year Average Index and the Critical Period Index. Changes in the 73-year average reservoir index from use of the Joint POD occur primarily at Shasta, Folsom, New Melones, and San Luis Reservoirs which are part of the CVP. Significant decreases are predicted at Folsom Reservoir for Alternative 8 and at New Melones Reservoir for all Joint POD Alternatives except Alternative 6 and Alternative 9. The decreases at New Melones Reservoir are caused by implementation of the 1995 Bay/Delta Plan. Beneficial effects are also predicted at San Luis Reservoir for all alternatives that allow wheeling. Little or no change occurs in the 73-year average reservoir indices at the other reservoirs analyzed.

Significant decreases in the critical period reservoir index are predicted at Folsom Lake under all Joint POD alternatives except Alternative 7 and at New Melones Reservoir for all alternatives except Alternative 6 and Alternative 9. The decreases at Folsom Lake are primarily a cumulative impact of implementing both the 1995 Bay/Delta Plan and the Joint POD. A significant increase in the critical period reservoir index is predicted to occur at San Luis Reservoir for Alternative 6. Minor or no changes are predicted at all other reservoirs for all alternatives.

Table XIII-31

Average Reservoir Habitat Index for 73-Years Under the Joint POD Alternatives

Alternative	73-Year Average Index								
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9
Shasta	459	460	454	448	450	436	448	444	452
Oroville	388	385	383	378	385	377	391	391	377
Folsom	438	426	418	410	412	405	411	393 D	419
New Melones	298	258 D	261 D	259 D	260 D	340 I	259 D	260 D	313
San Luis	265	287	326 I	305 I	331 I	331 I	373 I	342 I	310 I
Totals	1,848	1,794	1,842	1,800	1,838	1,889	1,882	1,830	1,870

I – Increase greater than 10 percent
D - Decrease greater than 10 percent

Table XIII-32
Critical Period Reservoir Habitat Index Under the Joint POD Alternatives

Alternative	Critical Period Index								
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9
Shasta	202	202	201	200	201	203	201	198	200
Oroville	184	191	190	189	191	188	193	189	190
Folsom	250	213 D	222 D	222 D	223 D	214 D	229	219 D	226
New Melones	219	186 D	187 D	186 D	186 D	219	186 D	187 D	201
San Luis	191	187	197	184	192	235 I	199	195	180
Totals	1,046	979	997	981	993	1,059	1,008	988	996

I - Increase greater than 10 percent
D - Decrease greater than 10 percent

Impacts of the Joint POD Alternatives on reservoir habitat conditions are generally temporary and mitigable. If significant effects on reservoir fish populations are observed, mitigation could include additional fish planting, habitat improvement through planting of shoreline vegetation, or addition of habitat structures.

c. Riparian Wetland Habitat. The condition of riparian vegetation and wetland habitat in the riparian zone of major rivers was assessed using simulated river water surface elevation (stage) at 6 locations. Average monthly stage was calculated for the base case and each alternative for average, wet and dry year conditions[1]. Differences among alternatives are expressed as a percent change from the base case. Low summer stages represent drought conditions and high year-round stages indicate inundation mortality. Modeled surface water elevations may be expected to have a margin of error of plus or minus 10 to 20 percent. Differences among alternatives are considered to be significant only if greater than 20 percent. A complete description of the analysis approach and methodology is contained in Chapter VI.

Tables XIII-33 through XIII-38 present the results of this analysis. Values that exceed the 20 percent significance threshold are indicated in bold type and in italics if there is negative impact. River stages increase significantly at Natoma in June of dry years for Alternatives 2, 4, 6 and 9 and in dry Septembers for Alternative 2. On the Sacramento River at Verona, stages are significantly higher under all alternatives in June and for the January to June period under Alternative 2. Significant reductions in river stage occur at Verona during the January to May period of wet years under Alternative 2. On the Feather River, the river stage index for dry years is higher in June for all alternatives; higher in July for Alternatives 7 and 8; higher in April for Alternative 6; lower in May for Alternatives 6 and 9; and lower in August for Alternatives 7 and 8. For wet years, the Feather River stage index is significantly higher in July for Alternatives 4, 6, 7, 8 and 9, and lower in August for Alternatives 7 and 8. In general, the effects of Joint POD alternatives could not be distinguished from the effects resulting from implementation of the 1995 Bay/Delta Plan alone.

In the San Joaquin River basin, impacts to the river stage index at Newman and Vernalis are as described in Chapter VI. The Joint POD alternatives impose no new operating constraints on reservoirs in the basin, hence implementation of any given alternative creates a condition which is indistinguishable from implementation of the 1995 Bay/Delta Plan.

The lower river stages predicted on the Feather River under dry conditions are small enough that riparian wetlands and vegetation would adjust without specific mitigation. Increased stages predicted at various locations in May and June would have a beneficial impact. In general, the effects of the Joint POD alternatives could not be distinguished from the effects resulting from implementation of the 1995 Bay/Delta Plan alone.

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[1] "Wet" years are the average of wet and above normal years as defined in the 1995 Bay/Delta Plan for the Sacramento and San Joaquin river basins. "Dry" years are the average of below normal, dry, and critically dry year types.

Table XIII-33

American River at Natoma Vegetation Impact Analysis

73-Year Average Monthly River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	3.7	3.9	4.4	4.7	5.1	4.7	4.6	4.3	4.8	4.6	4.1	3.3

Percent Change in Average Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-4.3	-1.2	-4.6	-2.9	0.1	1.3	0.4	2.0	11.1	-5.2	-8.3	10.3
Alt 3	-2.2	-2.0	-5.4	-3.2	-0.4	0.3	0.5	2.4	10.7	-4.1	-5.4	8.0
Alt 4	-3.9	-3.1	-5.1	-3.8	-1.8	0.3	-0.8	1.8	12.5	-3.6	-3.9	8.2
Alt 5	-3.1	-3.0	-5.6	-3.0	-1.4	0.2	-0.2	1.9	10.9	-3.1	-1.6	4.4
Alt 6	-3.0	-3.1	-5.8	-3.8	-1.7	0.0	2.9	-0.3	12.8	-3.4	-2.5	2.9
Alt 7	-2.9	-3.4	-6.2	-3.2	-1.2	-0.2	0.1	2.4	10.7	-2.0	0.0	-0.4
Alt 8	-5.3	-6.9	-8.0	-4.9	-3.2	-1.7	-1.2	1.2	9.1	-3.8	-0.8	-8.0
Alt 9	-2.6	-1.9	-4.7	-2.8	-1.3	0.2	-0.7	1.3	11.5	-3.8	-3.9	6.7

Average Monthly Dry Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	3.6	3.6	3.7	3.6	4.0	3.8	3.8	3.5	4.1	4.5	3.9	2.5

Percent Change in Dry Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-2.0	-0.7	-6.6	-5.5	-0.1	2.8	0.0	3.6	**20.4**	-4.5	-15.4	**21.0**
Alt 3	0.7	-0.5	-7.0	-6.2	-1.3	0.5	0.3	4.3	19.6	-3.1	-12.3	17.8
Alt 4	-0.8	-1.4	-6.1	-7.5	-4.3	0.4	-1.8	2.9	**22.8**	-2.6	-10.7	18.9
Alt 5	-0.4	-1.4	-6.4	-5.8	-3.5	0.4	-1.1	3.2	19.9	-1.7	-8.1	12.1
Alt 6	0.5	-0.3	-6.5	-7.2	-4.2	0.0	4.2	-0.8	**22.8**	-2.6	-10.0	11.0
Alt 7	-0.5	-1.9	-7.1	-6.1	-2.9	-0.4	-0.4	4.2	19.4	-0.8	-6.2	4.8
Alt 8	-3.8	-5.5	-8.4	-8.4	-6.3	-3.1	-2.3	3.0	17.2	-3.6	-7.4	-0.3
Alt 9	-0.5	-0.2	-5.7	-5.2	-3.3	0.4	-1.6	1.9	**21.7**	-2.9	-10.1	14.7

Average Monthly Wet Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	3.8	4.3	5.3	6.2	6.7	5.9	5.6	5.4	5.6	4.8	4.4	4.4

Percent Change in Wet Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-7.2	-1.8	-2.7	-0.9	0.3	0.0	0.7	0.6	1.9	-6.0	0.2	2.2
Alt 3	-6.0	-3.6	-3.8	-0.9	0.2	0.1	0.6	0.7	1.9	-5.4	2.9	0.5
Alt 4	-7.8	-4.9	-4.2	-1.0	0.2	0.1	0.2	0.8	2.1	-4.9	4.4	0.2
Alt 5	-6.6	-4.9	-4.9	-0.8	0.3	0.0	0.7	0.6	1.9	-4.9	6.3	-1.4
Alt 6	-7.4	-6.2	-5.2	-1.0	0.3	0.0	1.8	0.1	2.8	-4.6	6.5	-3.3
Alt 7	-5.9	-5.1	-5.4	-0.9	0.3	0.0	0.7	0.7	2.0	-3.6	7.5	-4.5
Alt 8	-7.4	-8.4	-7.5	-2.3	-0.7	-0.4	-0.2	-0.3	0.9	-4.0	7.1	-13.8
Alt 9	-5.4	-3.7	-3.8	-0.9	0.3	0.0	0.2	0.8	1.3	-4.9	3.6	0.7

Table XIII-34
Feather River at Gridley Vegetation Impact Analysis

73-Year Average Monthly River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	2.9	2.6	3.4	3.8	4.1	4.1	2.7	3.1	3.1	3.7	3.2	2.1

Percent Change in Average Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-12.7	-4.2	-7.2	-5.8	1.6	0.7	5.6	-3.3	15.5	17.2	-12.2	-6.7
Alt 3	-12.1	-3.7	-7.0	-5.9	1.6	0.2	4.6	-3.7	15.3	17.7	-12.0	-6.2
Alt 4	-13.1	-4.1	-7.8	-7.0	0.8	0.8	2.2	-4.9	13.9	19.1	-7.5	-4.7
Alt 5	-10.7	-2.4	-7.0	-6.1	1.3	1.6	4.9	-3.2	14.8	16.2	-13.7	-5.0
Alt 6	-12.1	-4.8	-8.1	-6.4	0.2	0.3	13.3	-7.1	15.2	18.1	-11.3	-4.7
Alt 7	-11.6	-4.4	-7.1	-5.8	1.0	-0.1	4.5	-2.7	15.5	**27.8**	***-28.5***	-8.4
Alt 8	-11.3	-4.3	-7.1	-5.8	1.5	-0.2	4.5	-2.8	15.7	**27.2**	***-28.4***	-8.6
Alt 9	-14.5	-5.3	-8.5	-6.6	0.9	1.2	1.3	-5.9	15.0	19.8	-5.7	-5.1

Average Monthly Dry Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	2.8	2.4	2.8	2.6	2.7	2.6	1.9	2.6	2.7	3.8	3.4	2.1

Percent Change in Dry Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-16.1	-3.0	-7.4	-7.4	4.2	1.7	11.5	-16.7	**27.9**	16.3	-8.3	-8.7
Alt 3	-15.2	-2.0	-6.9	-7.4	4.6	0.9	8.8	-17.0	**27.5**	17.1	-8.2	-7.9
Alt 4	-15.8	-2.8	-7.2	-8.5	2.4	2.2	4.2	-18.3	**25.3**	16.5	-5.0	-5.9
Alt 5	-14.0	-1.7	-6.5	-7.1	4.0	4.3	9.7	-16.0	**26.6**	14.5	-11.2	-5.7
Alt 6	-15.6	-3.6	-7.0	-8.5	2.3	2.1	**26.7**	***-21.3***	**25.8**	13.7	-10.0	-5.2
Alt 7	-14.5	-2.5	-7.4	-7.0	4.1	0.7	9.2	-15.1	**27.8**	**30.4**	***-25.9***	-12.6
Alt 8	-13.9	-2.4	-7.5	-6.9	4.7	1.0	9.3	-15.3	**28.2**	**29.5**	***-26.0***	-13.0
Alt 9	-17.1	-4.0	-8.4	-8.2	3.2	2.8	2.4	***-20.3***	**26.7**	17.7	-3.0	-7.0

Average Monthly Wet Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	2.9	2.9	4.3	5.4	6.1	6.1	3.8	3.9	3.5	3.4	3.0	2.2

Percent Change in Wet Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-8.4	-5.6	-7.0	-4.7	0.1	0.0	1.8	8.6	2.3	18.6	-18.3	-4.0
Alt 3	-8.2	-5.6	-7.2	-4.9	-0.2	-0.2	1.8	8.2	2.3	18.7	-18.0	-4.0
Alt 4	-9.5	-5.6	-8.3	-6.0	-0.1	0.0	0.9	6.9	1.8	**22.9**	-11.3	-3.3
Alt 5	-6.4	-3.1	-7.4	-5.4	-0.3	0.0	1.7	8.1	2.3	18.6	-17.6	-4.0
Alt 6	-7.6	-6.2	-9.1	-5.1	-1.0	-0.7	4.4	5.6	4.0	**24.8**	-13.3	-4.1
Alt 7	-7.8	-6.5	-6.8	-5.1	-0.8	-0.6	1.4	8.3	2.4	**23.9**	***-32.5***	-3.0
Alt 8	-8.0	-6.4	-6.7	-5.0	-0.4	-0.8	1.4	8.2	2.4	**23.7**	***-32.2***	-3.0
Alt 9	-11.1	-6.8	-8.7	-5.6	-0.4	0.3	0.5	6.8	2.6	**23.0**	-9.9	-2.8

Table XIII-35
Sacramento River at Red Bluff Vegetation Impact Analysis

73-Year Average Monthly River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	5.3	6.0	7.2	8.1	9.0	8.2	7.0	6.8	7.0	7.7	6.8	4.9

Percent Change in Average Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	0.5	1.8	0.0	-0.6	1.2	0.9	0.1	-1.1	6.5	-2.8	-4.2	0.1
Alt 3	1.2	0.8	-0.3	-0.7	0.7	0.8	0.2	-1.3	6.6	-2.1	-2.8	-0.3
Alt 4	0.4	-0.3	-0.5	-1.0	0.5	0.5	-0.4	-1.6	7.6	-1.6	-1.8	0.8
Alt 5	0.1	-0.1	-0.8	-0.8	0.6	0.2	0.2	-1.4	6.7	-1.3	-0.9	-0.4
Alt 6	-0.8	-1.3	-1.1	-0.9	0.3	0.5	2.6	-3.0	8.8	-2.1	-0.1	-1.1
Alt 7	-0.2	-0.3	-0.8	-0.7	0.4	-0.2	0.2	-1.6	6.7	-0.4	0.6	-2.6
Alt 8	0.3	-1.4	-1.2	-0.9	0.1	-0.3	0.0	-1.8	6.5	-0.1	3.0	-3.0
Alt 9	0.7	0.1	-0.2	-0.6	0.7	0.4	-0.4	-1.5	6.8	-1.8	-2.2	-0.2

Average Monthly Dry Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	5.1	5.4	5.5	5.8	6.6	6.1	5.8	6.1	6.7	7.5	6.7	4.4

Percent Change in Dry Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-0.1	2.7	-0.4	-0.9	2.9	2.4	-0.8	-1.9	9.9	-1.0	-6.6	-1.8
Alt 3	0.4	2.1	-0.5	-1.0	1.9	1.8	-0.3	-2.4	10.1	-0.1	-5.6	-1.6
Alt 4	-0.7	0.9	-0.6	-1.2	1.4	1.1	-1.1	-3.3	11.7	0.6	-4.9	0.4
Alt 5	-1.1	0.9	-0.7	-0.9	1.6	1.1	-0.5	-2.6	10.2	1.1	-4.1	-1.2
Alt 6	-1.6	-0.3	-1.0	-1.0	1.2	1.2	3.1	-4.5	12.8	-0.6	-3.3	-2.3
Alt 7	-1.1	0.7	-0.5	-0.7	1.1	0.0	-0.4	-3.0	10.2	1.8	-2.1	-3.3
Alt 8	-0.7	-0.3	-0.9	-1.0	0.6	-0.3	-0.7	-3.3	10.0	1.7	0.3	-2.2
Alt 9	-0.3	0.7	-0.6	-0.6	1.7	1.1	-1.2	-2.9	11.0	0.2	-5.2	-2.0

Average Monthly Wet Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	5.7	6.8	9.5	11.2	12.3	10.9	8.6	7.8	7.3	8.0	6.9	5.6

Percent Change in Wet Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	1.2	0.9	0.3	-0.4	0.0	-0.1	0.9	-0.2	2.2	-5.1	-1.1	2.1
Alt 3	2.3	-0.7	-0.2	-0.6	-0.2	0.0	0.7	-0.2	2.3	-4.6	0.9	1.0
Alt 4	1.6	-1.6	-0.4	-0.8	-0.1	0.0	0.2	0.1	2.5	-4.3	2.2	1.3
Alt 5	1.6	-1.3	-0.8	-0.7	-0.1	-0.4	0.9	-0.2	2.3	-4.3	3.3	0.5
Alt 6	0.2	-2.4	-1.2	-0.8	-0.4	-0.1	2.2	-1.4	3.7	-4.0	4.1	0.1
Alt 7	0.8	-1.5	-1.1	-0.7	-0.1	-0.3	0.8	-0.1	2.3	-3.3	4.3	-1.8
Alt 8	1.6	-2.6	-1.4	-0.8	-0.2	-0.2	0.7	-0.1	2.1	-2.3	6.5	-4.0
Alt 9	1.9	-0.5	0.1	-0.6	0.0	-0.1	0.3	0.1	1.5	-4.2	1.7	1.8

Table XIII-36
Sacramento River at Verona Vegetation Impact Analysis

73-Year Average Monthly River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	9.1	9.8	12.2	15.5	17.4	16.9	12.2	10.7	9.5	9.7	8.5	7.9

Percent Change in Average Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-3.3	0.4	-1.7	-1.5	1.1	0.6	1.0	-2.1	11.5	5.0	-8.6	-1.2
Alt 3	-2.6	-0.3	-1.9	-1.6	0.8	0.5	1.0	-2.4	11.6	6.0	-7.0	-1.5
Alt 4	-3.5	-1.0	-2.2	-2.0	0.6	0.4	0.1	-3.0	12.2	7.2	-4.0	-0.3
Alt 5	-3.0	-0.6	-2.3	-1.7	0.7	0.5	1.0	-2.4	11.5	6.2	-5.4	-1.2
Alt 6	-4.0	-2.0	-2.8	-1.8	0.2	0.3	4.2	-4.8	13.7	6.1	-3.7	-1.7
Alt 7	-3.5	-1.2	-2.3	-1.5	0.5	-0.1	0.9	-2.4	11.7	12.8	-9.7	-3.6
Alt 8	-3.1	-2.0	-2.6	-1.6	0.4	-0.1	0.8	-2.5	11.6	12.9	-7.2	-4.0
Alt 9	-3.6	-1.0	-2.1	-1.6	0.7	0.5	-0.2	-3.2	11.7	7.3	-3.9	-1.1

Average Monthly Dry Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	8.7	8.6	9.5	11.5	13.2	12.5	8.9	8.0	7.9	9.2	8.5	7.0

Percent Change in Dry Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-2.8	6.0	19.4	**24.6**	**31.7**	**27.3**	**37.8**	**34.3**	**32.1**	10.4	-10.3	4.6
Alt 3	-4.1	1.1	-2.2	-1.8	2.0	1.3	1.2	-8.0	**21.3**	8.8	-8.6	-3.1
Alt 4	-5.0	0.1	-2.3	-2.2	1.4	1.1	-0.2	-9.3	**22.5**	9.4	-6.3	-1.1
Alt 5	-4.8	0.3	-2.2	-1.7	1.7	1.4	1.3	-8.0	**21.1**	9.0	-8.0	-2.2
Alt 6	-5.6	-1.0	-2.5	-2.0	1.2	1.0	7.2	-11.5	**23.9**	6.7	-6.8	-2.9
Alt 7	-4.9	0.0	-2.3	-1.6	1.5	0.3	1.2	-8.1	**21.5**	18.2	-12.4	-5.5
Alt 8	-4.6	-0.8	-2.6	-1.8	1.3	0.2	1.1	-8.4	**21.5**	17.6	-9.9	-4.7
Alt 9	-5.0	-0.4	-2.5	-1.7	1.6	1.2	-0.7	-9.6	**22.1**	9.6	-6.1	-3.0

Average Monthly Wet Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	9.6	11.5	15.9	20.9	23.3	22.7	16.8	14.4	11.6	10.5	8.5	9.0

Percent Change in Wet Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	-3.8	-5.3	-18.8	***-20.9***	***-22.4***	-19.2	***-25.2***	***-29.6***	-7.4	-1.5	-6.3	-7.4
Alt 3	-0.8	-1.7	-1.8	-1.4	-0.2	-0.1	0.8	1.8	2.6	2.6	-4.8	0.2
Alt 4	-1.6	-2.1	-2.1	-1.8	-0.1	-0.1	0.3	1.7	2.7	4.5	-0.9	0.5
Alt 5	-0.8	-1.4	-2.3	-1.6	-0.1	-0.3	0.9	1.8	2.6	2.9	-1.9	-0.2
Alt 6	-2.0	-3.0	-3.0	-1.6	-0.5	-0.2	2.1	0.3	4.3	5.4	0.5	-0.5
Alt 7	-1.7	-2.4	-2.2	-1.5	-0.3	-0.3	0.7	1.9	2.7	6.4	-6.1	-1.7
Alt 8	-1.2	-3.2	-2.5	-1.5	-0.2	-0.3	0.7	1.9	2.6	7.2	-3.4	-3.3
Alt 9	-1.8	-1.7	-1.8	-1.6	-0.1	-0.1	0.2	1.7	2.0	4.6	-1.0	0.9

Table XIII-37

San Joaquin River at Vernalis Vegetation Impact Analysis

73-Year Average Monthly River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	6.9	5.7	6.4	7.7	9.7	9.2	8.9	8.0	6.9	5.2	4.8	5.6

Percent Change in Average Monthly River Stage Compared to the Base Case

Alt 2	0.4	-2.2	-3.2	-3.5	-2.9	-0.4	4.6	11.2	5.6	7.6	9.7	-1.0
Alt 3	0.5	-2.0	-3.1	-3.3	-3.0	-0.6	4.6	11.2	5.7	7.7	9.9	-0.9
Alt 4	0.4	-2.0	-3.1	-3.4	-3.1	-0.7	4.8	11.4	6.0	7.8	9.9	-0.8
Alt 5	0.5	-2.0	-3.0	-3.3	-2.9	-0.6	4.6	11.2	5.7	7.9	10.0	-0.7
Alt 6	5.3	0.9	2.6	1.7	1.8	1.0	0.2	4.2	5.1	7.4	-1.6	-5.7
Alt 7	0.5	-2.0	-3.0	-3.2	-2.7	-0.6	4.6	11.0	5.7	7.9	10.0	-0.7
Alt 8	0.5	-1.9	-2.9	-3.2	-2.8	-0.7	4.7	11.1	5.6	7.9	10.0	-0.7
Alt 9	0.4	1.1	0.0	-2.4	-4.0	-0.2	7.8	14.5	6.2	6.7	5.6	-1.0

Average Monthly Dry Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	6.8	5.4	5.4	5.5	6.4	6.2	6.5	5.5	4.6	4.4	4.5	5.1

Percent Change in Dry Year Monthly River Stage Compared to the Base Case

Alt 2	-2.7	-2.4	0.0	2.4	13.0	10.5	17.0	**28.7**	16.6	13.3	12.9	0.9
Alt 3	-2.6	-2.1	0.1	2.6	12.6	9.9	17.0	**28.7**	16.7	13.5	13.1	1.1
Alt 4	-2.8	-2.1	0.1	2.5	12.2	9.7	17.6	**29.3**	17.6	13.5	13.1	1.2
Alt 5	-2.6	-2.0	0.2	2.6	12.7	9.9	17.0	**28.7**	16.7	13.6	13.2	1.3
Alt 6	2.5	0.5	5.6	7.9	18.0	11.5	12.3	18.8	16.0	13.0	-5.5	-5.5
Alt 7	-2.6	-2.1	0.2	2.6	13.0	9.9	17.0	**28.3**	16.7	13.6	13.2	1.3
Alt 8	-3.2	-2.3	-0.8	1.2	11.0	8.7	15.7	**26.6**	16.3	13.7	12.7	0.7
Alt 9	-1.5	1.8	3.7	3.7	10.8	9.3	**21.0**	**32.4**	15.3	11.2	4.7	-0.1

Average Monthly Wet Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	7.0	6.1	7.7	10.3	13.3	12.6	11.7	10.9	9.5	6.2	5.1	6.1

Percent Change in Wet Year Monthly River Stage Compared to the Base Case

Alt 2	3.9	-2.0	-5.8	-7.0	-11.7	-6.5	-3.3	1.0	-0.5	2.9	6.5	-2.9
Alt 3	3.9	-2.0	-5.6	-6.9	-11.6	-6.5	-3.2	1.1	-0.4	3.0	6.6	-2.7
Alt 4	3.9	-2.0	-5.6	-6.9	-11.6	-6.6	-3.2	1.1	-0.5	3.0	6.7	-2.7
Alt 5	4.0	-1.9	-5.6	-6.8	-11.5	-6.5	-3.2	1.1	-0.4	3.1	6.7	-2.6
Alt 6	8.4	1.2	0.2	-2.1	-7.2	-5.0	-7.4	-4.3	-1.0	2.8	2.4	-5.9
Alt 7	4.0	-1.9	-5.6	-6.8	-11.4	-6.5	-3.2	1.1	-0.4	3.1	6.7	-2.6
Alt 8	5.7	-0.3	-2.1	-1.9	-6.9	-2.0	1.1	5.7	3.9	5.1	8.0	-0.7
Alt 9	3.0	1.4	-0.7	-2.3	-8.8	-1.7	2.7	7.7	5.6	5.2	7.9	-0.4

Table XIII-38

San Joaquin River at Newman Vegetation Impact Analysis

73-Year Average Monthly River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	7.3	5.7	6.2	7.0	8.6	7.6	6.4	7.0	6.4	5.1	4.9	5.8

Percent Change in Average Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	0.6	-0.8	-1.0	-0.6	-1.0	0.1	0.7	4.0	4.0	0.0	-0.6	-0.9
Alt 3	0.6	-0.7	-0.8	-0.6	-1.0	0.1	0.8	4.0	4.0	0.1	-0.4	-0.8
Alt 4	0.5	-0.7	-0.7	-0.6	-1.0	0.1	0.8	4.1	4.1	0.4	-0.4	-0.7
Alt 5	0.7	-0.6	-0.7	-0.6	-0.9	0.1	0.8	4.1	4.1	0.2	-0.3	-0.6
Alt 6	-0.4	-0.3	-0.2	-0.3	-0.1	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5
Alt 7	0.7	-0.6	-0.7	-0.6	-0.8	0.1	0.8	0.8	3.9	0.2	-0.1	-0.6
Alt 8	0.7	-0.5	-0.4	-0.5	-0.9	0.1	0.9	0.9	3.9	0.3	-0.1	-0.6
Alt 9	-3.5	-1.5	-1.6	-1.9	-3.6	-0.7	2.0	2.0	0.9	-1.8	-0.5	-1.0

Average Monthly Dry Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	7.2	5.4	5.0	5.1	6.1	5.8	4.8	4.7	4.6	4.8	4.9	5.5

Percent Change in Dry Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	0.2	0.8	3.8	7.2	13.6	4.8	8.5	18.3	4.1	-1.8	-1.5	-0.7
Alt 3	0.2	0.9	4.0	7.3	13.6	4.6	8.6	18.4	4.3	-1.5	-1.3	-0.5
Alt 4	0.0	0.9	4.0	7.3	13.6	4.7	8.6	18.5	5.0	-1.4	-1.3	-0.4
Alt 5	0.3	0.9	4.1	7.3	13.7	4.7	8.6	18.4	4.5	-1.3	-1.2	-0.4
Alt 6	-0.2	0.9	4.1	7.8	14.7	4.4	6.0	8.5	3.4	-1.6	-1.4	-0.6
Alt 7	0.3	0.9	4.1	7.4	13.7	4.7	8.6	17.8	4.5	-1.3	-1.0	-0.3
Alt 8	-0.1	0.9	3.2	5.9	11.9	4.3	7.8	17.3	4.4	-0.6	-0.9	-0.4
Alt 9	-4.7	0.2	2.5	5.2	9.9	4.2	8.5	11.1	2.1	-0.9	-1.2	-0.7

Average Monthly Wet Year River Stage (ft)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 1	7.3	6.1	7.5	9.3	11.4	9.7	8.2	9.5	8.5	5.4	4.9	6.2

Percent Change in Wet Year Monthly River Stage Compared to the Base Case (percent)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Alt 2	1.1	-2.3	-4.7	-5.6	-10.1	-3.1	-4.6	-4.1	-2.6	0.6	0.5	-1.2
Alt 3	1.1	-2.2	-4.4	-5.5	-10.0	-3.1	-4.6	-4.0	-2.5	0.8	0.7	-1.1
Alt 4	1.1	-2.3	-4.4	-5.5	-10.0	-3.1	-4.5	-4.0	-2.5	0.8	0.6	-1.0
Alt 5	1.1	-2.1	-4.4	-5.5	-10.0	-3.1	-4.5	-4.0	-2.4	1.0	0.8	-1.0
Alt 6	-0.5	-1.5	-3.6	-5.3	-9.3	-3.3	-4.6	-5.2	-2.8	0.9	0.9	-0.3
Alt 7	1.1	-2.1	-4.4	-5.5	-9.8	-3.1	-4.5	-4.0	-2.4	1.0	0.9	-0.9
Alt 8	1.9	-1.0	-0.6	-0.8	-5.8	0.5	-0.8	0.1	1.7	1.5	0.9	0.0
Alt 9	-1.6	-2.3	-2.2	-2.7	-9.3	-0.8	0.7	-1.0	-0.3	1.1	0.5	-0.5

4. Geology

This analysis of geology addresses lands and soils, subsidence, soil quality, agricultural production, and soil erosion.

a. Background and Assumptions. The evaluation of lands and soils is based on water availability to agricultural lands. Urban water users tend to have priority for limited water supplies in dry years. Agricultural users tend to pump more groundwater in areas where it is available at a reasonable cost. Extensive groundwater overdraft has limited water supply in many areas. This analysis assumes the cumulative water supply over the period 1921-1994 is an indicator for agriculture and that relative differences in water supply between alternatives will result in differences in groundwater overdraft potential and agricultural production.

Subsidence has been widespread in the San Joaquin Valley and occurs locally in the Sacramento Valley. Water level declines due to groundwater overdraft have caused the subsidence in most areas. Although much of this damage has already occurred, further damage is possible if overdraft continues to dewater aquifers. This analysis assumes that any alternative that reduces agricultural water supplies will lead to groundwater overdraft and increase subsidence potential. Damage to agriculture from subsidence includes reducing irrigation canal capacity and increasing the need to relevel fields to maintain a uniform gradient.

Soil quality refers to factors such as organic matter content, friability, permeability, and water holding capacity. Soil salinity and sodicity are also important components of soil quality. Irrigation tends to maintain or improve soil quality in irrigated areas; however, soil salinity and sodicity problems can also develop. Any alternative that reduces surface water supply will encourage the use of groundwater for irrigation. In some areas, this will tend to lead to an increase in soil salinity and, in some areas, sodicity because groundwater is nearly always more saline than surface water supplies. The following land types are most affected: westside alluvial fans, basin and basin rim areas, and old eastside terraces. Any alternative that reduces agricultural water supply will lead to increases in groundwater use and will generally increase soil salinity and sodicity and reduce soil quality.

The study area is very dependent on irrigation water for crop production. In years when water is short, these shortages tend to be felt most by agricultural users. In areas where good supplies of groundwater are available, agricultural production is reduced slightly; however, in areas where adequate supplies of groundwater are not available, or are too deep to pump economically, agricultural production is severely reduced. Because of groundwater conditions and priority of service in certain districts, the alluvial fans on the west side of the San Joaquin Valley tend to be affected significantly, and large tracts of idle lands are present during drought years.

Wind erosion potential increases significantly in dry years because more lands are idle and ground cover is sparse because of inadequate water supply. Chronic water shortages could increase water erosion potential if lands are abandoned or if management intensity is reduced. Damages are most likely to occur in steeper areas where orchards have been developed and adequate groundwater is unavailable.

b. Impact Analysis. Based on the delivery reductions shown in Table XIII-1, a qualitative assessment of the impacts of the the Joint POD alternatives to lands compared to Alternative 2 are shown in Table XIII-39. Groundwater overdraft estimates and potential water level declines were calculated for the different alternatives and are shown in Table XIII-40.

Joint POD Alternative 1. Joint POD Alternative 1 reflects D-1485 conditions for 1921-1994. Only Alternative 8 is more beneficial to land and soil resources. California agriculture development has taken place because of water deliveries available under this alternative.

Joint POD Alternative 2. When compared to Alternative 1, Joint POD Alternative 2 results in a reduced water supply for agriculture. The cumulative reduction in water supply amounts to about 21 million acre-feet over the 1921-1994 period. Average annual water supplies for agriculture would be reduced about 6.7 percent. If irrigators decided to pump groundwater to make up the deficit, then groundwater levels may decline on average by 1.2 feet per year.

Table XIII-39 Summary of Impacts of Joint POD Alternatives on Lands (compared to Alternative 2)

Joint POD Alternative	Soil Quality: Soil Salinity and Sodicity	Erosion: Wind and Water	Agricultural Production	Subsidence Potential
1	Slightly beneficial	Slightly beneficial	Slight increase	Slightly beneficial
2	—	—	—	—
3	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial
4	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial
5	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial
6	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial
7	Slightly beneficial	Slightly beneficial	Slight increase	Slightly beneficial
8	Slightly beneficial	Slightly beneficial	Slight increase	Slightly beneficial
9	Very slightly beneficial	Very slightly beneficial	Very slight increase	Very slightly beneficial

In areas where groundwater is available, irrigators would probably pump more groundwater in the short term; however, in the long term, the agricultural production would be reduced as cropping patterns and irrigated acreage come into balance with the reduced water supply. (Refer to the agricultural economics section of this report for further information on agriculture production.)

Compared to Alternative 1, Alternative 2 would tend to decrease soil quality by increasing soil salinity and sodicity because groundwater nearly always contains more salt than surface water.

Table XIII-40 Groundwater Overdraft and Water Level Decline Resulting from Joint POD Alternatives for the 73-Year Period

Alternative	Cumulative Deliveries MAF[1]	Shortage (Overdraft) MAF	Average Annual Overdraft TAF[2]	Percent of Average Ag. Deliveries	Annual Average Groundwater Level Decline[3] (ft)	Agriculture Ranking
1	412	—	—	—	—	—
2	391	21	288	6.7	1.2	8 (worst)
3	396	16	216	5.0	0.92	6
4	397	15	209	4.9	0.86	4
5	400	12	166	3.9	0.78	3
6	397	15	206	4.9	0.86	4
7	403	9	118	2.7	0.52	2
8	410	2	29	0.7	0.11	1 (best)
9	393	19	260	6.1	1.08	7

[1] Million acre-feet.
[2] Thousand acre-feet.
[3] Calculated based on 1.6 million acres agricultural service area and aquifer specific yield of 15 percent. Regional ground water flow systems not considered.

73-year period ground water level decline = (Shortage/1.6)/0.15

Assumptions: All shortages accrue to agriculture.
Average agriculture deliveries - 4.3 million acre-feet.

Soil erosion potential would increase because more land would be idled and thus be susceptible to wind erosion, especially where adequate supplies of groundwater are not available.

Subsidence potential would increase because overdraft under this alternative could dewater some aquifers. Following dewatering, there is a potential for a reduction in pore space due to aquifer consolidation.

Joint POD Alternatives 3, 4, 5, 6, and 9. When compared to Alternative 2, Joint POD Alternatives 3, 4, 5, 6, and 9 would cumulatively increase agricultural water supply in the export areas by 3 million to 9 million acre-feet over the 73-year period. Agricultural production would increase, soil quality would improve, and soil erosion potential would decrease. Subsidence potential would decrease. These alternatives are very slightly beneficial when compared to Alternative 2.

Joint POD Alternatives 7 and 8. Joint POD Alternatives 7 and 8 would result in agricultural water supplies similar to Alternative 1. When compared to Alternative 2, these alternatives would result in improved soil quality, reduced subsidence and erosion potential, and increased agricultural production. Alternative 8 tends to maximize benefits to agriculture, land, and soil resources.

5. Energy

Joint POD alternatives will affect energy production and consumption. This section discusses the impact of implementing the alternatives on: (1) hydroelectric power availability, (2) groundwater pumping, and (3) fossil fuel consumption. Standard outputs of energy generation and consumption from DWR's planning model, DWRSIM, were used to evaluate effects on power availability.

a. Hydroelectric Power Availability. Hydroelectric power is an important component in California's energy budget. Hydroelectric generation plants provide approximately 24 percent of the State's generation capacity. In a typical year, in excess of $1.3 billion of power, as measured by replacement costs, is produced (McCann 1994). Electric utilities seek to maximize the value of their hydroelectric power production. Power produced during peak energy demand periods is more valuable than that produced during lower demand periods. Utilities generally employ hydropower to meet peak loads because it provides a low cost energy source that can be turned on and off quickly. Peak load periods in California typically occur in the summer when electrical demands for groundwater pumping, air conditioning, and industrial needs are the greatest. Changes in the operation of hydropower reservoirs that limit or reduce the availability of water during the peak demand period may result in reductions in hydroelectric plant's ability to meet peak load requirements. This loss of flexibility accelerates the need for additional peaking resources and increases utility costs.

The SWP and the CVP are both producers and consumers of hydroelectric power. Hydroelectric power plants at the reservoirs produce the power and pumping plants at export facilities consume it. The SWP includes 22 dams and reservoirs, eight hydroelectric plants and 17 pumping plants. The CVP includes 19 dams and reservoirs, seven hydroelectric power plants, two pump/generation plants, and 39 pumping plants. The CVP is a net energy producer, having greater production capacity than consumption. The SWP is a net energy consumer, primarily because of the number and size of pumped lifts required along the length of the California Aqueduct. Together, the SWP and CVP produce more energy than is consumed. The Joint POD alternatives permit increased pumping by the SWP, resulting in higher consumption. This higher consumption decreases the availability of energy otherwise produced and utilized outside the SWP and CVP projects. This loss accelerates the need for additional resources and may increase utility costs.

Net SWP, CVP, and combined SWP and CVP energy generation were evaluated. The values reported are a composite index resulting from the complex interaction among the many factors and model assumptions that affect the simulated operations of the SWP and CVP. At any given time it can be difficult to determine the cause of differences among alternatives. The net values reported were calculated by subtracting energy consumption from energy generation for each alternative and then comparing the index to that calculated for Alternative 1. Positive effects on this index generally occur with increases in reservoir releases used for generation or from reductions in pumping and consumption. Negative effects on this index generally occur with decreased reservoir releases and increases in pumping.

Net CVP Hydropower Generation. Table XIII-41 shows the average monthly difference in net CVP energy generation for Joint POD Alternatives 2 through 9 compared to Alternative 1 (base case) for the 73-year period of analysis. This information is graphically represented in Figure XIII-98. The comparison of Alternative 2 with Alternative 1 demonstrates the effect of full implementation of the 1995 Bay/Delta Plan. The increase in the long-term average annual net CVP generation is consistent with similar flow objective alternatives analyzed in Chapter VI, Section 7 and with Beck (1994) who reported that slightly increased amounts of energy are available to the CVP from implementation of the Bay/Delta Plan due to reduced export pumping. Alternatives 3 through 9 show a similar pattern of change in mean monthly net CVP energy generation to that which occurs with implementation of the 1995 Bay/Delta Plan represented by Alternative 2. Increases occur from February through May, when reservoir releases are increased and pumping is curtailed to meet 1995 Bay/Delta Plan objectives. Decreases occur in June and from September through January when the conditions necessary to permit wheeling exist. Of the alternatives that permit joint use of points of diversion, the annual difference over the 73-year period of record shows that net energy generation for Alternatives 3 through 8 would be less than the mean for Alternative 1. Alternative 8, which assumes maximum wheeling, is expected to result in the greatest decrease in net CVP energy generation. Based on a 73-year annual average, Alternative 9 is the only wheeling alternative expected to increase net CVP energy generation. The CVP remains a net energy producer for all alternatives considered.

Net SWP Hydropower Generation. Table XIII-42 shows the average monthly difference in net SWP energy generation for Alternatives 2 through 9 compared to Alternative 1 for the 73-year period analysis. All Joint POD alternatives result in an increase in net SWP energy generation. The greatest increase is predicted to occur with Alternative 2, which represents implementation of the 1995 Bay/Delta Plan. The predicted increases are less for the alternatives that allow wheeling. The smallest net increase is predicted to occur with Alternative 7. This information is graphically represented in Figure XIII-99.

Net Combined SWP and CVP Hydropower Generation. The effects on combined net SWP and CVP energy generation are shown in Table XIII-43 and Figure XIII-100. Alternative 2 shows the greatest increase in net energy generation because of gains in both SWP and CVP net generation with implementation of the 1995 Bay/Delta Plan. The gains predicted for the SWP are greater than the reductions predicted for the CVP, resulting in a net increase in combined generation for Alternatives 3, 4, 5, 6, and 9. Net combined energy generation is predicted to be reduced under Alternatives 7 and 8 which assume combined use would be permitted up to the SWP's maximum pumping capacity of 10,300 cfs.

Impacts on Other Facilities. The analysis of the flow alternatives in Chapter VI indicates that the implementation of the 1995 Bay/Delta Plan will affect hydropower operations other than the SWP and the CVP. However, the implementation of any of the Joint POD alternatives that allow wheeling would affect only the hydropower operations of the SWP and the CVP.

Table XIII-41

Net CVP Energy Generation

Base Case Average Monthly Net Generation (GWHrs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	213.6	186.8	231.4	243.5	271.7	286.1	316.6	489.3	559.7	516.9	361.0	202.4

Change in Net Generation from the Base Case (GWHrs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2	-19.1	3.5	-9.4	-18.2	5.2	12.3	67.6	1.5	-19.9	10.6	19.2	-10.7	42.6
3	-27.4	-4.5	-22.5	-29.2	-1.7	5.2	67.1	2.8	-17.1	9.7	8.9	-15.9	-24.6
4	-31.6	-13.8	-38.4	-57.5	3.3	26.9	93.4	20.7	-15.7	7.1	2.0	-20.4	-24.1
5	-36.1	-14.2	-40.7	-59.8	13.3	26.9	70.1	3.6	-15.4	5.7	-3.4	-20.2	-70.1
6	-18.8	-15.6	-30.2	-49.5	13.3	28.9	20.5	30.1	-9.7	11.1	-3.5	-20.2	-43.5
7	-53.1	-25.2	-65.9	-39.2	29.0	25.7	64.3	1.1	-23.5	-4.7	-16.2	-26.8	-134.7
8	-40.5	-20.6	-40.2	-116.7	20.3	17.7	61.4	0.3	-10.9	-2.5	-25.4	-31.5	-188.5
9	-32.6	-7.8	-33.4	-57.5	13.3	32.9	92.4	20.7	-16.7	5.1	4.0	-19.4	0.9

Note: Negative numbers indicate less energy is produced (net) under the alternatives than the base case.

Figure XIII-98
Net CVP Energy Generation

73-year monthly average compared to Alternative 1 (Base Case)

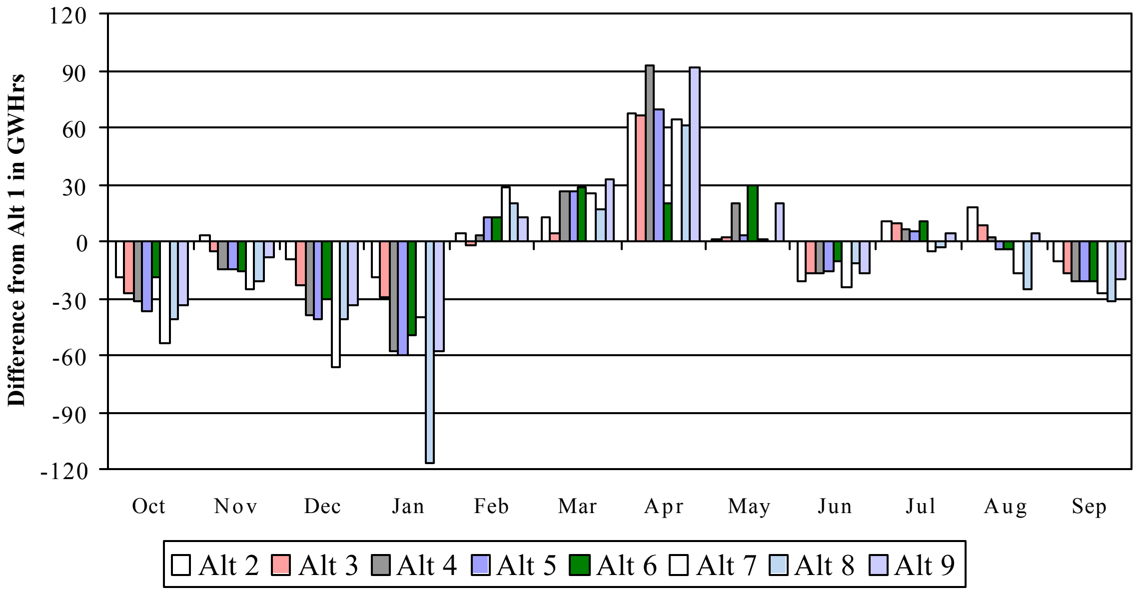


Table XIII-42

Net SWP Energy Generation

Base Case Average Monthly Net Generation (GWHrs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	-366.5	-442.8	-380.6	-280.1	-234.4	-234.3	-282.0	-213.6	-242.6	-269.3	-330.7	-436.1

Change in Net Generation from the Base Case (GWHrs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2	-25.0	-2.7	-1.0	24.3	47.1	25.0	54.5	-8.1	13.9	49.8	7.6	18.6	202.0
3	-25.2	-1.2	-3.8	20.6	47.4	21.2	55.2	-8.3	13.9	49.3	4.4	19.4	193.0
4	-22.5	-0.2	-8.4	12.1	39.4	22.3	64.0	1.6	10.6	52.3	7.7	19.1	198.0
5	-23.3	2.5	-7.5	14.5	42.3	25.6	55.8	-6.3	15.4	48.3	1.0	23.2	191.5
6	-23.2	1.9	-18.0	8.8	43.6	18.2	47.3	8.4	15.9	54.9	7.2	21.8	186.8
7	-56.6	-26.3	-23.9	21.6	54.2	19.9	46.5	-17.6	-0.3	51.9	-27.5	-6.4	35.5
8	-54.4	-20.0	-19.5	9.5	54.2	21.5	46.5	-18.1	0.5	51.0	-31.0	0.4	40.6
9	-27.5	-4.2	-16.4	14.1	40.4	24.3	62.0	-4.4	14.6	54.3	11.7	20.1	189.0

Note: Negative numbers indicate less energy is produced (net) under the alternatives than the base case.

Figure XIII-99

Net SWP Energy Generation

73-year monthly average compared to Alternative 1 (Base Case)

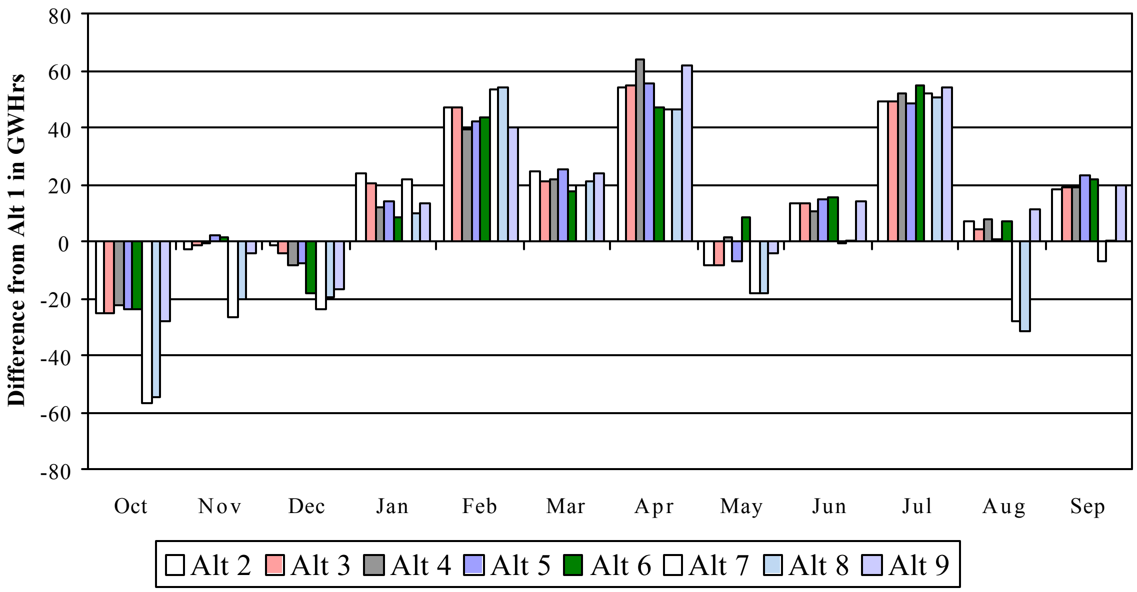


Table XIII-43

Net SWP and CVP Energy Generation

Base Case Average Monthly Net Generation (GWHrs)

Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	-152.9	-256.0	-149.2	-36.6	37.3	51.8	34.6	275.8	317.1	247.5	30.3	-233.7

Change in Net Generation from the Base Case (GWHrs)

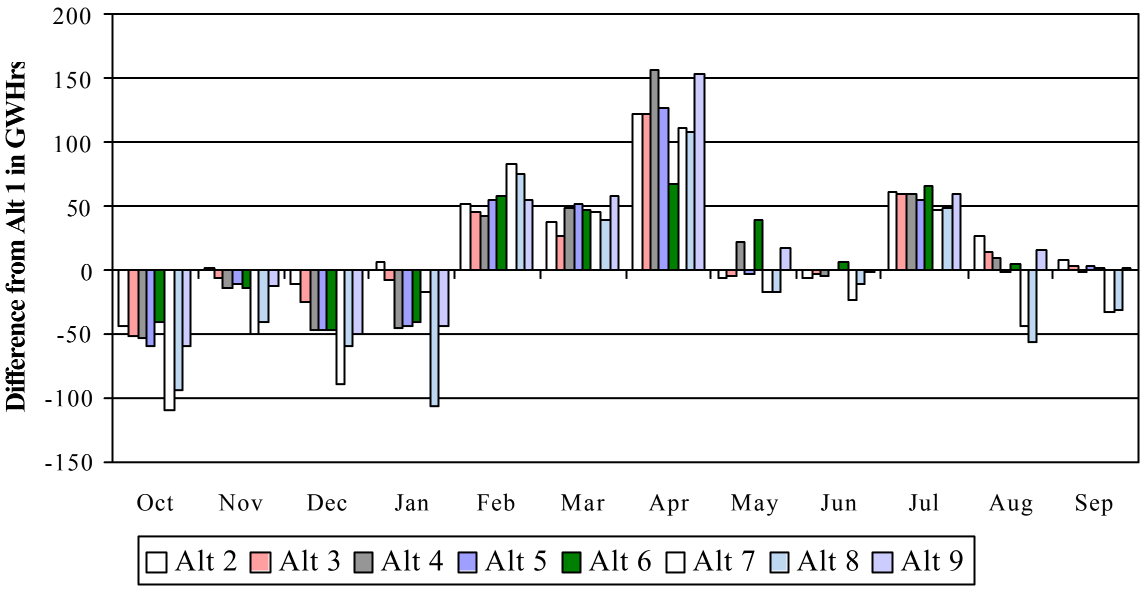
Alt	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2	-44.0	0.8	-10.4	6.1	52.3	37.3	122.1	-6.6	-6.0	60.4	26.7	7.9	246.7
3	-52.6	-5.7	-26.3	-8.6	45.7	26.3	122.3	-5.4	-3.2	59.0	13.4	3.4	168.4
4	-54.1	-14.0	-46.8	-45.4	42.7	49.2	157.4	22.2	-5.1	59.5	9.7	-1.3	173.9
5	-59.5	-11.7	-48.1	-45.3	55.6	52.5	125.9	-2.7	0.0	54.0	-2.4	3.1	121.4
6	-42.0	-13.8	-48.2	-40.7	56.9	47.1	67.9	38.4	6.2	66.0	3.8	1.7	143.3
7	-109.7	-51.5	-89.8	-17.6	83.1	45.6	110.7	-16.5	-23.9	47.2	-43.7	-33.2	-99.2
8	-94.9	-40.6	-59.8	-107.1	74.5	39.2	107.9	-17.7	-10.4	48.5	-56.3	-31.1	-147.9
9	-60.1	-12.0	-49.8	-43.4	53.7	57.2	154.4	16.2	-2.1	59.5	15.7	0.7	189.9

Note: Negative numbers indicate less energy is produced (net) under the alternatives than the base case.

Figure XIII-100

Net SWP and CVP Energy Generation

73-year monthly average compared to Alternative 1 (Base Case)



Mitigation. Reductions in summer hydroelectric power production reduce the amount of energy available for meeting summer-time peak loads. Increasing generation from fossil fuel power plants or from other sources including nuclear, geothermal, biomass, solar thermal, solar photovoltaic and wind generation may make up such reductions. However, non-mitigable impacts would occur with increases in energy generation from fossil fuel sources.

b. Groundwater Pumping. The analysis of alternatives in Chapter VI indicates that the implementation of the 1995 Bay/Delta Plan may cause deficiencies in surface water deliveries. The reductions in surface water supplies have a potential to cause an increase in groundwater pumping. Increased groundwater pumping may lower groundwater levels, resulting in higher pumping lifts and, thus, further increase energy consumption. Implementation of alternatives that include wheeling would reduce the loss of surface water supplies and offset increases in groundwater pumping.

Mitigation. The increase in energy consumption due to groundwater pumping can be partially mitigated through off-peak pumping operations.

c. Fossil Fuels. No attempt was made to estimate the effect of the Joint POD alternatives on fossil fuel consumption. A qualitative assessment of the effects is difficult because decreased hydropower generation will be offset to some extent by decreased groundwater pumping. Overall, it is possible that fossil fuel consumption will increase significantly, but if this occurs, the effect is unmitigable, as described in Chapter VI.

Mitigation. The effect of increasing fossil fuel generation is not entirely mitigable, however other sources of energy generation are available including nuclear, geothermal, biomass, solar thermal, solar photovoltaic and wind generation.

6. Recreation

This section presents the results of the assessment of impacts to recreation that would occur with implementation of the Joint POD. The assessment of recreation impacts analyzes how changes in reservoir storage would affect opportunities for water-related activities at key recreation facilities. Recreation impacts are assessed for the major reservoirs that are operated by the SWP and the CVP. The reservoirs include Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir.

The methodology for this assessment of recreation impacts is the same as described in Chapter VI for analyzing the impacts of implementing the 1995 Bay/Delta Plan. The recreation impact analysis considers the frequency of occurrence with which end-of-month storage (converted to surface elevation) falls below or, in some cases, exceeds the various threshold levels established for each reservoir. Tables XIII-44 through XIII-47 summarize the frequency of occurrence in absolute numbers and as a percentage of the total number of months in the study period.

In general, the end-of-month storage under Joint POD Alternatives 2 through 9 falls below the threshold levels established for each reservoir more often than under Joint POD Alternative 1. However, the differences illustrate the effects of the Bay/Delta Plan over the D-1485 objectives, and not the effects of the Joint POD.

Table XIII-44
Recreation Impact Assessment for Shasta Lake

Main Area
Peak Season (May - Sept.)

		Frequency with which Reservoirs are below Critical Elevation Thresholds					
Period/Alternative	Total Months	844 ft.		947 ft.		987 ft.	
73-YEAR PERIOD	365	total	%	total	%	total	%
Alternative 1 (Base Case)		0	0%	17	5%	64	18%
Alternative 2		0	0%	22	6%	72	20%
Alternative 3		0	0%	25	7%	75	21%
Alternative 4		0	0%	23	6%	76	21%
Alternative 5		0	0%	26	7%	75	21%
Alternative 6		0	0%	22	6%	76	21%
Alternative 7		0	0%	25	7%	76	21%
Alternative 8		0	0%	27	7%	78	21%
Alternative 9		0	0%	21	6%	68	19%
CRITICAL PERIOD	35						
Alternative 1 (Base Case)		0	0%	9	26%	22	63%
Alternative 2		0	0%	8	23%	23	66%
Alternative 3		0	0%	11	31%	24	69%
Alternative 4		0	0%	10	29%	24	69%
Alternative 5		0	0%	10	29%	24	69%
Alternative 6		0	0%	8	23%	24	69%
Alternative 7		0	0%	10	29%	24	69%
Alternative 8		0	0%	10	29%	24	69%
Alternative 9		0	0%	9	26%	21	60%

Main Area
Off-Season (Oct.- April)

		Frequency with which Reservoirs are below Critical Elevation Thresholds			
Period/Alternative	Total Months	844 ft.		947 ft.	
73-YEAR PERIOD	511	total	%	total	%
Alternative 1 (Base Case)		0	0%	26	5%
Alternative 2		0	0%	36	7%
Alternative 3		0	0%	41	8%
Alternative 4		0	0%	41	8%
Alternative 5		0	0%	42	8%
Alternative 6		0	0%	35	7%
Alternative 7		0	0%	39	8%
Alternative 8		0	0%	39	8%
Alternative 9		0	0%	35	7%
CRITICAL PERIOD	43				
Alternative 1 (Base Case)		0	0%	14	33%
Alternative 2		0	0%	15	35%
Alternative 3		0	0%	16	37%
Alternative 4		0	0%	16	37%
Alternative 5		0	0%	16	37%
Alternative 6		0	0%	15	35%
Alternative 7		0	0%	16	37%
Alternative 8		0	0%	16	37%
Alternative 9		0	0%	14	33%

Critical Elevation Thresholds:
<844 ft. msl - last boat ramp out of operation
<947 ft. msl - limited lake surface area (boating constrained)
<987 ft. msl - marina relocated

Table XIII-45
Recreation Impact Assessment for Lake Oroville

Peak Season (April - Sept.)

		Frequency with which Reservoirs are below Critical Elevation Thresholds									
Period/Alternative	Total Months	700 ft.		710 ft.		750 ft.		819 ft.		840 ft.	
73-YEAR PERIOD	438	total	%	total	%	total	%	total	%	total	%
Alternative 1 (Base Case)		13	3%	24	5%	46	11%	133	30%	176	40%
Alternative 2		17	4%	25	6%	64	15%	157	36%	191	44%
Alternative 3		19	4%	29	7%	68	16%	158	36%	196	45%
Alternative 4		20	5%	29	7%	68	16%	160	37%	199	45%
Alternative 5		20	5%	29	7%	65	15%	161	37%	192	44%
Alternative 6		17	4%	27	6%	63	14%	167	38%	198	45%
Alternative 7		18	4%	28	6%	69	16%	169	39%	201	46%
Alternative 8		18	4%	25	6%	68	16%	169	39%	201	46%
Alternative 9		16	4%	28	6%	65	15%	149	34%	182	42%
CRITICAL PERIOD	41										
Alternative 1 (Base Case)		2	5%	4	10%	12	29%	34	83%	36	88%
Alternative 2		1	2%	3	7%	21	51%	36	88%	36	88%
Alternative 3		4	10%	7	17%	24	59%	35	85%	36	88%
Alternative 4		4	10%	6	15%	23	56%	34	83%	36	88%
Alternative 5		4	10%	6	15%	23	56%	35	85%	36	88%
Alternative 6		2	5%	4	10%	19	46%	36	88%	36	88%
Alternative 7		2	5%	3	7%	20	49%	36	88%	36	88%
Alternative 8		2	5%	3	7%	20	49%	36	88%	36	88%
Alternative 9		3	7%	7	17%	22	54%	29	71%	31	76%

Off-Season (Oct.- March)

		Frequency with which Reservoirs are below Critical Elevation Thresholds			
Period/Alternative	Total Months	710 ft.		750 ft.	
73-YEAR PERIOD	438	total	%	total	%
Alternative 1 (Base Case)		39	9%	77	18%
Alternative 2		42	10%	87	20%
Alternative 3		52	12%	89	20%
Alternative 4		53	12%	89	20%
Alternative 5		51	12%	88	20%
Alternative 6		40	9%	88	20%
Alternative 7		52	12%	87	20%
Alternative 8		51	12%	88	20%
Alternative 9		47	11%	85	19%
CRITICAL PERIOD	37				
Alternative 1 (Base Case)		9	24%	18	49%
Alternative 2		8	22%	25	68%
Alternative 3		15	41%	25	68%
Alternative 4		14	38%	25	68%
Alternative 5		15	41%	24	65%
Alternative 6		8	22%	23	62%
Alternative 7		10	27%	22	59%
Alternative 8		10	27%	23	62%
Alternative 9		12	32%	24	65%

Critical Elevation Thresholds:
<700 ft. msl - decline in campground/picnicking use
<710 ft. msl - limited boat ramp availability/marina relocation
<750 ft. msl - limited lake surface area (boating constrained)
<819 ft. msl - beach area closed
<840 ft. msl - decline in beach use

Table XIII-46
Recreation Impact Assessment for Folsom Lake

Peak Season (April - Sept.)

Frequency with which Reservoirs are below Critical Elevation Thresholds (or >450 ft.)

Period/Alternative	Total Months	360 ft.		400 ft.		405 ft.		430 ft.		> 450 ft.	
73-YEAR PERIOD	438	total	%	total	%	total	%	total	%	total	%
Alternative 1 (Base Case)		39	9%	76	17%	85	19%	167	38%	101	23%
Alternative 2		56	13%	106	24%	113	26%	180	41%	99	23%
Alternative 3		61	14%	105	24%	114	26%	189	43%	99	23%
Alternative 4		61	14%	111	25%	122	28%	193	44%	97	22%
Alternative 5		58	13%	110	25%	120	27%	195	45%	98	22%
Alternative 6		61	14%	118	27%	127	29%	202	46%	92	21%
Alternative 7		61	14%	110	25%	124	28%	198	45%	96	22%
Alternative 8		68	16%	118	27%	131	30%	204	47%	88	20%
Alternative 9		55	13%	98	22%	109	25%	172	39%	171	39%
CRITICAL PERIOD	41										
Alternative 1 (Base Case)		13	32%	20	49%	22	54%	30	73%	3	7%
Alternative 2		18	44%	28	68%	28	68%	34	83%	1	2%
Alternative 3		18	44%	27	66%	27	66%	34	83%	2	5%
Alternative 4		18	44%	28	68%	29	71%	34	83%	2	5%
Alternative 5		18	44%	27	66%	28	68%	34	83%	2	5%
Alternative 6		18	44%	30	73%	30	73%	35	85%	1	2%
Alternative 7		18	44%	28	68%	29	71%	34	83%	2	5%
Alternative 8		18	44%	28	68%	30	73%	34	83%	2	5%
Alternative 9		14	34%	24	59%	26	63%	30	73%	8	20%

Off-Season (Oct.- March)

Frequency with which Reservoirs are below Critical Elevation Thresholds

Period/Alternative	Total Months	360 ft.		400 ft.	
73-YEAR PERIOD	438	total	%	total	%
Alternative 1 (Base Case)		29	7%	128	29%
Alternative 2		39	9%	127	29%
Alternative 3		48	11%	139	32%
Alternative 4		46	11%	145	33%
Alternative 5		46	11%	143	33%
Alternative 6		54	12%	152	35%
Alternative 7		46	11%	140	32%
Alternative 8		54	12%	156	36%
Alternative 9		42	10%	141	32%
CRITICAL PERIOD	37				
Alternative 1 (Base Case)		4	11%	26	70%
Alternative 2		12	32%	26	70%
Alternative 3		15	41%	28	76%
Alternative 4		15	41%	28	76%
Alternative 5		15	41%	27	73%
Alternative 6		19	51%	28	76%
Alternative 7		15	41%	27	73%
Alternative 8		16	43%	28	76%
Alternative 9		13	35%	27	73%

Critical Elevation Thresholds:
<360 ft. msl - last boat ramp out of operation
<400 ft. msl - limited lake surface area (boating constrained)
<405 ft. msl - marina closes
<430 ft. msl - decline in campground/picnicking use
>450 ft. msl - beach area inundated

Table XIII-47
Recreation Impact Assessment for New Melones Reservoir

Peak Season (April - Sept.)

Period/Alternative	Total Months	850 ft. total	850 ft. %	860 ft. total	860 ft. %	880 ft. total	880 ft. %	900 ft. total	900 ft. %
73-YEAR PERIOD	438								
Alternative 1 (Base Case)		8	2%	9	2%	11	3%	15	3%
Alternative 2		18	4%	22	5%	34	8%	47	11%
Alternative 3		18	4%	22	5%	34	8%	46	11%
Alternative 4		18	4%	22	5%	34	8%	46	11%
Alternative 5		18	4%	22	5%	34	8%	46	11%
Alternative 6		4	1%	4	1%	10	2%	13	3%
Alternative 7		18	4%	22	5%	34	8%	46	11%
Alternative 8		18	4%	22	5%	34	8%	46	11%
Alternative 9		11	3%	13	3%	20	5%	27	6%
CRITICAL PERIOD	41								
Alternative 1 (Base Case)		0	0%	0	0%	0	0%	1	2%
Alternative 2		8	20%	10	24%	14	34%	20	49%
Alternative 3		8	20%	10	24%	14	34%	20	49%
Alternative 4		8	20%	10	24%	14	34%	20	49%
Alternative 5		8	20%	10	24%	14	34%	20	49%
Alternative 6		0	0%	0	0%	1	2%	3	7%
Alternative 7		8	20%	10	24%	14	34%	20	49%
Alternative 8		8	20%	10	24%	14	34%	20	49%
Alternative 9		3	7%	5	12%	8	20%	12	29%

Frequency with which Reservoirs are below Critical Elevation Thresholds

Off-Season (Oct.- March)

Period/Alternative	Total Months	850 ft. total	850 ft. %	860 ft. total	860 ft. %
73-YEAR PERIOD	438				
Alternative 1 (Base Case)		9	2%	10	2%
Alternative 2		22	5%	26	6%
Alternative 3		22	5%	25	6%
Alternative 4		22	5%	25	6%
Alternative 5		22	5%	25	6%
Alternative 6		4	1%	4	1%
Alternative 7		22	5%	25	6%
Alternative 8		22	5%	25	6%
Alternative 9		15	3%	18	4%
CRITICAL PERIOD	37				
Alternative 1 (Base Case)		0	0%	0	0%
Alternative 2		7	19%	8	22%
Alternative 3		7	19%	8	22%
Alternative 4		7	19%	8	22%
Alternative 5		7	19%	8	22%
Alternative 6		0	0%	0	0%
Alternative 7		7	19%	8	22%
Alternative 8		7	19%	8	22%
Alternative 9		2	5%	3	8%

Frequency with which Reservoirs are below Critical Elevation Thresholds

Critical Elevation Thresholds:
<850 ft. msl - last boat ramp out of operation
<860 ft. msl - limited lake surface area and decline in campground/picnicking use
<880 ft. msl - marina closes
<900 ft. msl - decline in beach use

There is little difference in recreation impacts between Joint POD Alternative 2 and Joint POD Alternatives 3 through 9. Joint POD Alternatives 3 through 9 generally have a slightly higher frequency of occurrence with which end-of-month storage falls below the various thresholds than Joint POD Alternative 2. An exception to this is seen at New Melones Reservoir under Joint POD Alternatives 6 and 9. Here, the frequency of occurrence with which end-of-month storage falls below the various thresholds is similar to Alternative 1 and lower than the other alternatives, particularly in the critical period. However, this is a result of implementing the New Melones operation associated with the Letter of Intent and San Joaquin River Agreement for Alternatives 6 and 9, respectively, and not the result of the Joint POD.

Potential impacts to recreation on the rivers below the major reservoirs as a result of implementing the 1995 Bay/Delta Plan were assessed in Chapter VI. In general, increased flows would result in beneficial impacts to recreation. River flows are not expected to change dramatically as a result of the Joint POD alternatives and would be within the normal range experienced on those rivers. The principal effect of the Joint POD alternatives on river flows is to shift the timing of releases somewhat, and these changes will not result in significant impacts to recreation. Based on the analysis of impacts to water levels, the Joint POD alternatives will not result in significant impacts to recreation in the Delta.

7. Cultural Resources

This section presents the results of the assessment of impacts to cultural resources that would occur with implementation of the Joint POD alternatives.

Federal law requires federal agencies to consider the effect of their undertakings on cultural resources. The National Historic Preservation Act of 1966, as amended (NHPA), is the basic federal law governing preservation of cultural resources of national, regional, state and local significance. Specifically, section 106 of the NHPA requires each federal agency to consider the effect of its actions on "any district, site, building, structure or object that is included in or eligible for inclusion in the National Register." Eligible cultural resources may also include traditional cultural properties, which are generally defined as specific locations that are significant due to their association with cultural practices or beliefs of a living community that are (1) rooted in the community's history and (2) are important in maintaining the continuing cultural identity of the community" (National Park Service, Bulletin 38). Procedures for meeting section 106 requirements are defined in federal regulations, at 36 CFR section 800, et seq. Other federal legislation further promotes and requires the protection of historic and archaeological resources by the federal government. Among these laws are the Archaeological Resources Protection Act and the Native American Graves Protection and Repatriation Act for federal lands.

a. Impacts. All the proposed alternatives deal with changing project operations to affect varying degrees of use of the joint points of diversion. The reservoirs to be affected include Lake Shasta, Lake Oroville, Folsom Lake, New Melones Reservoir, and San Luis Reservoir. Rivers include the Sacramento, Feather, American, and Stanislaus. No construction or ground-disturbing activities are involved. The maximum water surface elevation at the subject reservoirs under all alternatives is at 100-percent capacity and will not exceed that which has occurred under historic operations (i.e., flood operations that completely fill the reservoir or operations in wet years in which the reservoirs fill in the spring snowmelt). It should be noted that New Melones Reservoir has never filled completely (i.e., the emergency overflow spillway has never been used), but as a practical matter can be considered to have filled completely with its maximum elevation being only 4 feet from the elevation of the emergency spillway. No new lands will be inundated around the reservoirs.

River flows will also not exceed high-level flows experienced under the range of normal associated reservoir operations. Inundation of cultural resources adjacent to rivers is, therefore, not expected. Implementing the alternatives would not result in changes to reservoir operations related to flood control. Flood flows in the tributaries downstream from the reservoirs are a function of hydrology and not reservoir operation.

Cropping patterns are expected to remain the same and no new lands will be brought into production as a result of the Joint POD alternatives. Therefore, there will be no impacts from changes in agricultural practices due to the alternatives. Any deficiencies in surface water deliveries are expected to be made up to some degree by groundwater pumping. In reality, the joint points of diversion project will allow for lower deficiencies than would otherwise be imposed on CVP users.

Changes will occur in the minimum pool elevations at all of the reservoirs between Alternative 1 (base case) and Alternatives 2 through 9. Therefore, the assessment of new impacts to cultural resources at the subject reservoirs is limited to comparing the minimum reservoir pool elevations of Alternative 1 to the minimum reservoir pool elevations of the other alternatives (the Area of Potential Effects). The differences between Alternative 1 and the other eight alternatives in minimum pool elevations for the affected reservoirs vary significantly (see Table XIII-48). These differences range from a minimum pool lowered by 53 feet at Folsom Lake under Alternative 8 to a minimum pool raised by 46 feet at New Melones Reservoir under Alternative 6. The reason for the unique, significant upward increase at New Melones Reservoir is described in Section C (description of alternatives) of this chapter.

An analysis of the minimum and maximum pool elevations for San Luis Reservoir is not included because under normal operating procedures, water elevations currently fluctuate about 250 feet a year. The range of fluctuations under the alternatives is expected to be similar to normal fluctuations. Therefore, no new impacts are anticipated at San Luis Reservoir. Furthermore, extensive mitigation was conducted at the site of San Luis Reservoir during construction of San Luis Dam. Surveys and a great deal of excavation were completed in the 1960s. Additional surveys have been conducted since then, including one in the early 1980s when the reservoir was drawn down to conduct repairs. A National Register district at San Luis Reservoir includes about eight sites, several of which are within the fluctuating reservoir pool.

Table XIII-48

73-Year Minimum Annual Reservoir Elevation (ft)

Alternative	Shasta	Oroville	Folsom	New Melones
Historic	839	647	352	721
Alt 1	879	589	286	759
Differences Between Minimum Annual Reservoir Elevation and Base Case (ft)				
Alt 2	-13	-2	0	-41
Alt 3	-12	-13	0	-41
Alt 4	-5	-12	1	-41
Alt 5	-7	-5	1	-41
Alt 6	4	-28	-18	46
Alt 7	-4	-45	1	-41
Alt 8	-3	-47	-53	-41
Alt 9	2	6	1	13

73 Year Maximum Annual Reservoir Elevation (ft)

Alternative	Shasta	Oroville	Folsom	New Melones
Historic	1067	899	469	1084
Alt 1	1067	900	466	1088
Difference Between Minimum Annual Reservoir Elevation and Base Case (ft)				
Alt 2	0	0	0	0
Alt 3	0	0	0	0
Alt 4	0	0	0	0
Alt 5	0	0	0	0
Alt 6	0	0	0	0
Alt 7	0	0	0	0
Alt 8	0	0	0	0
Alt 9	0	0	0	0

For the purpose of this analysis, minimum simulated reservoir pool elevations for Alternative 1 are used as an impact threshold instead of historic reservoir elevations. The analysis uses simulated reservoir elevation from DWRSIM model output for the 73-year hydrology. It should be noted that short-term flood events are not captured in the monthly operation studies. It also must be noted for all of the alternatives, minimum pool elevations occur under very adverse hydrologic conditions, such as occurred during 1976-1977 or 1990-1991. Actual operations in the future under such adverse conditions may be different from those elevations depicted because operating decisions at the time may prevent such low drawdowns.

In addition to the data developed for the various alternatives, Table XIII-48 also includes the historic minimum and maximum pool elevations at the four reservoirs. At Lake Shasta, the historic minimum pool elevation is below the modeled minimum pool elevation for all alternatives. Thus, no lands in the reservoir basin will be exposed that have not already been exposed under historic operating conditions. At Lake Oroville, Folsom Lake, and New Melones Reservoir, the opposite condition exists; the historic minimum pool elevations are higher than the simulated minimum pool elevations under most alternatives. This indicates that the drawdowns would expose lands normally inundated within the reservoir basin.

Table XIII-49 shows the minimum and maximum annual river stages along the American, Feather, and Sacramento rivers. As can be seen from the table, there is little variation in both minimum and maximum river stages. Therefore, no new impacts to cultural resources are expected to occur.

The impact mechanisms related to reservoir operations that could potentially affect different types of cultural resources under the Joint POD alternatives are described in Chapter VI (impact mechanisms). These mechanisms include changes in reservoir pool elevations and changes in recreation, including unauthorized activities (i.e., intentional vandalism and amateur collecting). Studies on the effects of reservoir inundation on archaeological sites have concluded that the nature and extent of the effects depend on several factors, most notably the location of a cultural property within the reservoir basin. Sites within the zone of seasonal drawdown suffer the greatest impacts, primarily in the form of erosion/scouring, deflation, hydrologic sorting, and artifact displacement caused by waves and currents. Sites located lower in the reservoir, within the deep pool, were more likely to be covered with silt, which sometimes formed a protective cap. Sites at or near the high water line and sites during drawdown suffered both erosion and vandalism (Waechter et al 1994).

Due to incomplete cultural resource inventories of all reservoirs, the actual effects of water fluctuations to sites are unknown but could possibly be adverse to any cultural resources present. Of all the reservoirs, New Melones has been the most comprehensively surveyed. A number of surveys have been completed there, beginning with the Smithsonian River Basin Survey in 1949. To date, more than 627 historic and prehistoric sites have been identified within the New Melones Recreation Area. These sites range from ancient hunting camps to 19th century gold mining boom towns, together representing approximately 10,000 years of human activity. More than 106,000 pre-historic and historic artifacts, records, photographs, and other data have been recovered from more than 42 sites as part of cultural resource mitigation programs. In the permanent pool zone below 808 feet amsl, which would include the area of potential effect, 122 sites have been identified. The greatest number of documented sites (232) occur in the fluctuating pool zone between 808 and 1088 feet amsl (USBR, 1996).

Table XIII-49

73-Year Minimum Annual River Stage (ft)

Alternative	American River at Natoma	Feather River	Sacramento River	
			at Red Bluff	at Verona
Alt 1	1.5	1.3	3.5	4.9
Differences Between Minimum Annual River Stage and Base Case (ft)				
Alt 2	-0.1	0.0	0.0	0.3
Alt 3	-0.1	0.0	0.0	0.3
Alt 4	-0.1	0.0	0.0	0.3
Alt 5	-0.1	0.0	0.0	0.3
Alt 6	0.0	0.0	0.0	0.2
Alt 7	-0.1	0.0	0.0	0.3
Alt 8	-0.1	0.0	0.0	0.3
Alt 9	0.0	0.0	0.0	0.3

73-Year Maximum Annual River Stage (ft)

Alternative	American River at Natoma	Feather River	Sacramento River	
			at Red Bluff	at Verona
Alt 1	13.2	12.7	24.2	36.6
Difference Between Minimum Annual River Stage and Base Case (ft)				
Alt 2	0.0	0.0	0.0	0.1
Alt 3	0.0	0.0	0.0	0.1
Alt 4	0.0	0.0	0.0	0.1
Alt 5	0.0	0.0	0.0	0.1
Alt 6	0.0	0.0	0.0	0.1
Alt 7	0.0	0.0	0.0	0.1
Alt 8	0.0	0.0	0.0	0.1
Alt 9	0.0	0.0	0.0	0.1

As of 1994, there were 123 known prehistoric sites within the Folsom Reservoir basin (Waechter et al 1994). No additional surveys have taken place since then. The recorded sites occur between elevations 330 feet and 466 feet amsl, well above the minimum pool elevation of any of the alternatives. Of the recorded sites within the reservoir basin, only two had been excavated and documented. Undoubtedly, other sites exist that have not been recorded especially within the area of potential effect.

Lake Shasta, although never comprehensively surveyed, has had several individual surveys beginning in 1941-1942 during the dam construction period. The most extensive survey was conducted by the U.S. Forest Service between 1976-1978 when the reservoir reached its historic low of 839 feet amsl during a drought, which resulted in the exposure of more than three-fourths of the total pool area. As of 1986, there were a total of 115 recorded sites within the Shasta Lake pool area. These sites are located between elevation 700 feet and 1080 feet amsl (above high-water level). Only two of the sites are located within the area of potential effect (Henn and Sundahl 1986).

Considerable cultural resource surveys have also been conducted at Oroville Reservoir. An intensive archaeological program was carried out for the DWR at the Oroville Reservoir area in conjunction with construction of the reservoir. Between 1960 and 1967 when the reservoir was filled, 225 sites were recorded in the project area. At least 145 of these sites were inundated. While much information was obtained, the entire project area was not surveyed. In particular, no survey work was done at the recreation areas. Since then, some additional cultural resources survey work has been undertaken. In the early 1990s, a whole series of sites were resurveyed during low water levels. These included sites along the reservoir periphery as well as some in the basin.

b. Continuing Effects. Under any of the alternatives, sites within the reservoir pools will be subject to the same impacts as they have been historically. These impacts would include inundation and exposure during drawdowns with the resulting effects to cultural resources.

c. Impact Analysis. Overall, based on a comparison of the predicted minimum pool elevations under all alternatives against the historic ones, it appears that the greatest new impacts to cultural resources are likely to occur at Oroville, Folsom, and New Melones reservoirs. As stated above, this is because the predicted minimum pools at these three reservoirs would be below the historic minimums during the worst case scenarios. Significant new impacts at Lake Shasta are less likely because the minimum pool elevations under all alternatives are higher than the historic minimums, and the fluctuation in simulated minimum pool elevations is not that great.

Alternative 1. Alternative 1 is the base case against which Joint POD Alternatives 2 through 9 are compared. Alternative 1 would occur in the absence of a water right decision. The 1978 Bay/Delta Plan objectives are in effect and are implemented through D-1485.

Alternative 2. Alternative 2 represents the conditions that would exist when the 1995 Bay/Delta Plan flow objectives are fully implemented. Minimum pool elevations would be lower at Lake Shasta, Lake Oroville, and New Melones Reservoir; there would be no change at Folsom Lake. At Lake Oroville, the drop in pool minimum elevation would be only 2 feet; at Lake Shasta, the drop would be 13 feet; and at New Melones Reservoir, the drop would be 41 feet. These minimum pool elevations would occur between September and November. Visitation drops off significantly after Labor Day. The potential for hydrological and recreational impacts, including unauthorized activities, would likely be greatest at the latter two reservoirs.

Alternative 3. Under Alternative 3, minimum pool elevations would be lower at Lake Shasta, Lake Oroville, and New Melones Reservoir; there would be a slight increase at Folsom Lake. At Lake Shasta and Lake Oroville, the change would be 12 and 13 feet, respectively, while at New Melones Reservoir, the minimum pool elevation would drop 41 feet. These minimum pool elevations would occur between September and November. Hydrological and recreational impacts, including unauthorized activities, could occur at these three reservoirs, with the greatest impacts likely occurring at New Melones Reservoir.

Alternative 4. Under Alternative 4, minimum pool elevations would be lower at Lake Shasta, Lake Oroville, and New Melones Reservoir; at Folsom Lake, the minimum pool elevation would increase by only 1 foot. The greatest change in minimum pool elevation would occur at New Melones Reservoir, where it would drop 41 feet. At Lake Shasta, the minimum pool elevation would drop 5 feet; at Lake Oroville, it would drop 12 feet. These minimum pool elevations would occur between September and November. Hydrological and recreational impacts, including unauthorized activities, could occur at Lake Shasta, Lake Oroville, and New Melones Reservoir, with the greatest effects likely occurring at New Melones Reservoir.

Alternative 5. Under Alternative 5, minimum pool elevations would be lower at Lake Shasta, Lake Oroville and New Melones Reservoir; at Folsom Lake, the minimum pool elevation would increase by only 1 foot. The greatest change in minimum pool elevation would occur at New Melones Reservoir, where it would drop 41 feet. At Lake Shasta, the minimum pool elevation would drop 7 feet; at Lake Oroville, it would drop 5 feet. These minimum pool elevations would occur between September and November. Hydrological and recreational impacts, including unauthorized activities, could occur at Lake Shasta, Lake Oroville, and New Melones Reservoir, with the greatest effects likely occurring at New Melones Reservoir.

Alternative 6. Under Alternative 6, minimum pool elevations would drop at Lake Oroville and Folsom Lake and increase at Lake Shasta and New Melones Reservoir. The greatest changes would occur at Folsom Lake, where the minimum pool elevation would drop by 18 feet, at Lake Oroville, where the minimum pool elevation would drop by 28 feet, and at New Melones Reservoir, where it would increase by 46 feet. This minimum pool elevation is significantly different than that for the other alternatives and is a result of the reservoir operations assumed for the Stanislaus River under the Letter of Intent (see Flow Alternative 7, Chapter II) which is different than all the other alternatives. At Lake Shasta, the minimum pool elevation would increase by only 4 feet. These changes would occur between September and November, with the exception of Folsom Lake, where the minimum pool elevation would be reached in August. Hydrological and recreational impacts, including unauthorized activities, could occur at all four reservoirs, with the greatest effects likely at Lake Oroville, Folsom Lake, and New Melones Reservoir.

Alternative 7. Under Alternative 7, minimum pool elevations would drop at Lake Shasta, Lake Oroville, and New Melones Reservoir; the minimum pool elevation would increase by only 1 foot at Folsom Lake. The greatest differences would occur at Lake Oroville and New Melones Reservoir, where minimum pool elevations would drop by 45 and 41 feet, respectively. At Lake Shasta, the minimum pool elevation would drop by only 4 feet. All of these minimum pool elevations would occur between September and November. Hydrological and recreational impacts, including unauthorized activities, could occur at Lake Shasta, Lake Oroville, and New Melones Reservoir, with the greatest effects likely at Lake Oroville and New Melones Reservoir.

Alternative 8. Under Alternative 8, minimum pool elevations would drop at all four reservoirs, with the greatest decreases occurring at Lake Oroville (47 feet), Folsom Lake (53 feet), and New Melones Reservoir (41 feet). At Lake Shasta, the decrease would be only 3 feet. All of these minimum pool elevations would occur between September and November, with the exception of Folsom Lake, where the minimum pool elevation would be reached in August. Hydrological and recreational impacts, including unauthorized activities, could occur at all four reservoirs, with the greatest effects likely at Lake Oroville, Folsom Lake, and New Melones Reservoir.

Alternative 9. Under Alternative 9, minimum reservoir levels at lakes Shasta, Oroville, Folsom and New Melones are slightly higher than the base case. Therefore there is no impact at these reservoirs. Additional water is supplied under this alternative by the San Joaquin River Tributary Authority agencies to help meet the Vernalis flow objective. New Don Pedro Reservoir and Lake McClure are operated at lower levels than under the other Joint Point alternatives. For an analysis of impacts to these reservoirs, see Chapter 6.

In summary, all alternatives, with the exception of Alternative 9, have the potential to impact cultural resources at one or more reservoirs. These impacts are based on the worst case scenario (i.e., drought conditions) and would occur infrequently. Average conditions at the reservoirs would not create these new impacts.

d. Consultation with the California State Historic Preservation Officer. Under any alternative involving a federal undertaking, USBR will consult with the California State Historic Preservation Officer (SHPO) about meeting the requirements of 36 CFR 800. At present, it is not known which federal, state, and local agencies will be responsible for the different undertakings required to implement each of the proposed Joint POD alternatives. Consultation by USBR with the California SHPO will address cultural resources identification, evaluation, effects, and possible mitigation needs.

8. Economic Analysis

a. Introduction. This section summarizes the economic impacts of the Joint POD alternatives. The analysis consists of the estimation of economic impacts to agriculture, municipal and industrial (M&I) water, and recreation under the various Joint POD alternatives. The analysis was limited by the following assumptions:

- Water shortages are assumed to accrue only to agriculture south of the Delta. It is assumed that shortages of M&I water would be addressed by water transfers from irrigated lands.

- Economic losses are based on average water losses over the historic timeframe, rather than on a range of losses reflecting high, medium, and low water deliveries.

- No distinction is made between the economic value or productivity of various irrigated agricultural lands in the CVP. Rather, an average value based on marginal net revenue is applied to all irrigation water.

- No attempt was made to quantify impacts of water shortages on regional economies. Regional impacts due to reduced agricultural water deliveries are briefly addressed in narrative. No attempt was made to estimate impacts of costs of water transfers to urban users.

- Impacts on agricultural land use are briefly addressed in narrative.

- No attempt was made to quantify recreation impacts. Rather, recreation impacts at major reservoirs are briefly addressed in narrative. It was assumed that end-of-year reservoir water levels are reflective of water levels throughout the year.

b. Irrigation and M&I Water Impacts. According to delivery estimates from the DWRSIM modeling studies, water shortages resulting from the implementation of the 1995 Bay/Delta Plan would primarily occur in areas south of the Delta. For the most part, CVP delivery reductions would be to the contractors in the San Luis and Delta Mendota Water Authority service area, as they comprise the largest group of contractors south of the Delta. Water delivery impacts are shown in Table XIII-50. Average annual diversion under Alternative 1 is 5.4 MAF. Six of the alternatives (Alternatives 2 through 6, and 9) result in annual water reductions of less than 6 percent compared to Alternative 1, and two of the alternatives (Alternatives 7 and 8) result in comparatively no water reductions.

There are a number of potential reactions to water shortages. For example, irrigators could fallow acreage, change crops, pump additional groundwater, or use water transferred from other areas. The initial response of irrigators would probably be to pump additional groundwater. Eventually, this response would result in falling water tables, increased pumping costs, increased water quality problems, and land subsidence.

Urban water utilities could address shortages through transfers of water, increased use of recycled water, reduced water use through mandatory conservation programs, or imposition of rationing. Although conservation programs could address some potential losses, the most likely responses to the majority of the losses would be those of arranging transfers or rationing. However, as stated in Chapter XI of this EIR, the costs of water losses (rationing) in an M&I capacity are estimated to range from $1,400 to $2,000 per acre-foot. By contrast, the marginal net revenue attributable to an additional acre-foot of irrigation water in the CVP is estimated to vary from about $50 to $275, depending on the area and on the amount by

Table XIII-50

Estimate of Economic Impacts of Irrigation Water Losses under Joint POD Alternatives

Alternative	Average Annual Shortage (TAF)	Average Annual Shortage (%)	Economic Value of Water per Acre-foot ($)[1]	Annual Economic Losses ($million)[2]
1				
2	288	5.3	70	20.2
3	216	4.0	70	15.1
4	209	3.9	70	14.6
5	166	3.1	70	11.6
6	206	3.8	70	14.4
7	118	2.2	70	8.3
8	29	0.5	70	2.0
9	256	4.7	70	17.9

[1] When water supplies are 5-10 percent below normal.

[2] Average annual shortage (x) economic value of water per acre-foot.

which water supplies are below the amount normally available (see Chapter XI, section A.2). Also, according to the EIR, the cost to urban districts of water transfers from agriculture vary from about $200 to $350 per acre-foot, or an average of about $275. Utility managers will have strong incentives to transfer water from agricultural users rather than ration water. Similarly, irrigators would presumably part with water that provides levels of marginal net revenue below the price municipalities would pay. Thus, the simplifying assumption was made that water shortages will ultimately accrue only to agriculture. The average economic costs of water shortages resulting under each alternative were estimated by multiplying the shortages by the marginal value of irrigation water on lands south of the Delta. That value averages about $70 per acre-foot, on a weighted average delivery basis, when water supplies are 5-10 percent below normal. While this simplified approach provides only a very rough approximation of costs, it should at least provide a consistent comparison of relative costs among alternatives. The estimated annual losses for each alternative, which range from $2.0 to $20.2 million, are shown in Table XIII-50.

c. Impacts on Regional Economies. Reductions in water deliveries to agriculture have the potential, at least in the short run, to affect all sectors of the economy. Reduced farm production will generally result in the hiring of fewer workers. Unless or until those workers find new employment, consumer spending will fall, affecting retailers and other businesses.

In addition, growers will reduce purchases of equipment and materials from suppliers, resulting in reduced income and jobs.

Alternatives 3 through 9 would result in reduced shortages in comparison to Alternative 2; however, none of the shortages under Alternatives 2 through 6 would exceed 6 percent of total deliveries under Alternative 1. Alternatives 7 and 8 essentially result in little or no shortages in comparison to Alternative 1. Potential marginal net revenue losses per acre-foot of water are relatively small at such low levels of water loss. Additionally, these impacts would take place in a dynamic and mobile economy with a capacity for rapid adjustment to economic changes. Therefore, it reasonably can be assumed that impacts to regional economies under any of the alternatives would be minimal, and all alternatives would result in reduced losses as compared to Alternative 1. However, those alternatives that result in higher shortages would have a greater regional impact than the two alternatives that result in little or no loss.

No attempt was made to address the impact on urban water users of the costs of water transferred from agricultural users. However, there presumably would be some increases of costs to users.

d. Impacts on Land Use. The relatively small average water shortages under Alternatives 2 through 6, and 9 could potentially result in some adjustments in land use. These adjustments could take the form of small adjustments in cropping patterns or possibly some fallowing of lands. However, average water losses of around 5 to 6 percent should require minimal adjustment, and that adjustment would most likely involve, as necessary, small changes in cropping patterns.

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Volume 2 of this Final EIR contains the five technical appendices described below. This document is available on the internet at http://www.waterrights.ca.gov/baydelta/ and on compact disc. Parties on the Bay/Delta Hearing Service List are entitled to one free printed copy. Other parties wishing a printed copy of the document should send a written request and $20.00, payable to the SWRCB. Send requests to:

Nick Wilcox
State Water Resources Control Board
Division of Water Rights
P.O. Box 2000
Sacramento, CA 95812-2000

Appendix 1. Persons Contacted and Water Right Hearing Service List

Appendix 1 contains the list of parties contacted throughout the proceeding. The SWRCB maintains three separate Bay/Delta mailing lists. In this appendix, the shorter active party list and the longer interested party list are combined. The water right hearing service list is also included. In addition to parties identified in this appendix, a postcard mailing was sent to all appropriative water right holders in the Central Valley advising that a Notice of Preparation had been prepared and was available upon request. Persons expressing interest as a result of this mailing were added to the Bay/Delta mailing list.

Appendix 2. Modeling Assumptions

Appendix 2 contains the assumptions used to model the Flow Alternatives, the Joint Point of Diversion Alternatives, and the Cumulative Impacts analysis. The descriptions of the modeling assumptions were drawn from the DWRSIM web site maintained by the Department of Water Resources. The web site containing the assumptions and all modeling output can be found at http://wwwhydro.water.ca.gov/swrcb.html.

Appendix 3. Water Right Calculations for Flow Alternatives 3 and 4

Appendix 3 contains the information used in the water right calculations for Flow Alternatives 3 and 4. The general methodology for the calculations is described in Chapter IV, section G of the final EIR.

Appendix 4. Watershed Flow Obligation Calculations for Flow Alternative 5

Appendix 4 contains data used in the calculation of watershed flow obligations under Flow Alternative 5. The general methodology for the calculation is described in Chapter II, section E.1.e.

Appendix 5. Aquatic Resources Analysis Modeling Data

Appendix 5 contains DWRSIM model output and spreadsheet calculations for: (1) the Sacramento River fall-run, late fall-run, winter-run, yearling spring-run, and young-of-the-year spring-run salmon smolt survival model, (2) the San Joaquin river fall-run salmon smolt survival model, (3) the striped bass model, (4) the water temperature analysis (5) the range of variability analysis (RVA), and (6) reservoir habitat index calculations. The salmon and striped bass models are described in Chapter IV, section F of the final EIR. The water temperature model is described in Chapter IV, section E. The RVA is described in Chapter VI, section C.3.a. The reservoir index methodology is described in Chapter VI, section C.3.b.